



# CitiMeasure Behaviour & Policy guidelines

Publication Year: 2022



*This project has received funding from the European Union's Technical Support Instrument (TSI) programme under grant agreement 101046124.*

# 1 Contents

1. Executive summary .....	5
2. Introduction .....	5
2.1 Purpose of the document .....	5
2.2 Who are these guidelines for? .....	5
2.3 What can you expect to find in this guideline? .....	5
2.4 What this guideline is not? .....	6
2.5 Who to contact for questions or feedback? .....	6
2.6 List of contributors.....	6
3. Background .....	7
3.1 About CitiMeasure .....	7
3.2 About the CitiMeasure Behaviour and Policy working group.....	7
3.3 Development of the guidelines.....	10
4. Triggering behaviour change using citizen science.....	12
4.1 Challenges of changing actors' behaviour .....	12
4.2 Applications and expected impacts of citizen science for behaviour change .....	13
4.3 Conceptualising behaviour change .....	13
4.4 Recommendations for triggering behaviour change using citizen science .....	15
4.4.1 Recommendations for cities .....	15
4.4.2 Recommendations for citizen science initiatives.....	15
5. Fostering policy impact of citizen science.....	19
5.1 Challenges encountered in influencing policy .....	22
5.2 Applications and expected impacts of citizen science for policy change .....	23
5.3 Conceptualising policy change.....	23
5.4 recommendations for enhancing policy uptake of citizen science.....	25
5.4.1 Recommendations for cities .....	25
5.4.2 Recommendations for citizen science initiatives.....	25
6. Concluding remarks and next steps.....	29
7. References .....	32

# 2 Table of figures

Figure 1: Cities and (non-)governmental organizations that are member of the CitiMeasure Behaviour and Policy working group.....	8
Figure 2: Key outputs of all the CitiMeasure co-creation sessions.....	10

Figure 3 Theories of Planned Behaviour and Reasoned Action ..... 14  
Figure 4: cyclic value chain of Citizen Science for policy ..... 23

### 3 Table of Tables

Table 1 Contributors to the guidelines by providing resources, and/or critically reviewing those resource ..... 7

## Acronyms

<b>EC</b>	European Commission
<b>DG</b>	Directorate General
<b>DOI</b>	Digital Object Identifier System
<b>EU</b>	European Union
<b>JRC</b>	Joint Research Centre
<b>NGO</b>	Non-Governmental Organization
<b>NILU</b>	Norwegian Institute for Air Research
<b>PGRA</b>	Flood Risk Management Plan
<b>PM</b>	Particulate Matter
<b>R&amp;I</b>	Research and Innovation
<b>RIVM</b>	Dutch National Institute for Public Health and the Environment
<b>Scivil</b>	Citizen Science Vlaanderen
<b>SDGs</b>	Sustainable Development Goals
<b>SDI</b>	Spatial Data infrastructure
<b>TPB</b>	Theories of Planned Behaviour
<b>TRA</b>	Theories of Reasoned Action
<b>UWE</b>	University of Western England
<b>WG</b>	Working Group

# 1. Executive summary

The CitiMeasure Behaviour and Policy guidelines aim to advance the understanding of policy and behavioural change aspects of citizen science. This includes challenges and applications of citizen science for changing policies and actors' behaviour, conceptualising policy and behavioural change, and recommendations for cities and citizen science initiatives on how to foster policy and behaviour change using citizen science.

These guidelines are the result of a co-creation process led by Eurocities in close collaboration with the CitiMeasure Behaviour and Policy working group members. The co-creation process included a joint effort for identifying and sharing relevant resources and experiences, as well as joint analysis and sense making of the identified resources. As such, these guidelines reflect the collective understanding and experiences of 35 CitiMeasure working group members that represent 19 European cities and 7 organizations with interest and expertise in the topic.

## 2. Introduction

### 2.1 PURPOSE OF THE DOCUMENT

Changes in actors' behaviour (at both individual and societal levels) and change in policy processes are among the most desired outcomes of citizen science initiatives. However, such changes are complex to understand, achieve and measure. The CitiMeasure Behaviour & Policy guidelines aim to advance the understanding of the changes in behaviour of different stakeholder groups, as well as decision and policy making processes. This includes changes in trust, participation behaviour, new culture of collaboration, sharing responsibilities, as well as established decision and policy making processes. The current guidelines help unpack the applications of citizen science for policy and behaviour change, understand challenges that citizen science projects face for fostering such changes, and provide practical recommendations on how to tackle such challenges.

### 2.2 WHO ARE THESE GUIDELINES FOR?

The CitiMeasure Behaviour & Policy guidelines are primarily developed to guide those who are interested in identifying, understanding, and enhancing policy and behavioural changes resulting from citizen science initiatives. This includes cities, organizations, researchers, and practitioners who are involved in initiating citizen science projects, or those who aim to study or improve current practices in existing citizen science initiatives.

We also hope that these guidelines are informative for those who are interested in the broader topics of policy change and behaviour change in participatory governance processes.

### 2.3 WHAT CAN YOU EXPECT TO FIND IN THIS GUIDELINE?

Section 3 of the guidelines provides background information about the CitiMeasure project and these guidelines. This includes a description of the project and the CitiMeasure Behaviour & Policy working group, as well as a description of the methodology followed for developing the guidelines.

The main content of the guidelines is summarized in Sections 3.3 and 3.4. These sections start with challenges and needs related to policy and behaviour change. We then explore purpose and applications of citizen science. The main contribution of the guidelines is a set of recommendations on how to systematically think about and enhance policy and behaviour change outcomes of citizen science initiatives.

## 2.4 WHAT THIS GUIDELINE IS NOT?

There are many things that these guidelines are not, but we would like to emphasize a few:

- These are not step-by-step guidelines to identify and improve policy and behaviour-related impacts of citizen science initiatives.
- The recommendations presented in the current guidelines are built on a wealth of theoretical and empirical insights from several resources and expertise of 35 individual members of the CitiMeasure Behaviour & Policy working group. Nevertheless, this shouldn't be considered as a comprehensive source of recommendations for behaviour and policy change in citizen science. There are certainly more experiences, recommendations and best practices related to behaviour and policy change in citizen science that we couldn't capture and include in these guidelines simply because they were not known to the working group members, and due to the fact that we didn't have the time and resources to conduct a systematic and holistic literature review on the topic.

Lastly, replication is always context-specific, so although many solutions presented in the guidelines may be replicable, we believe applying these solutions should be considered on a case-by-case basis, linked to the aims of the actors or initiatives, and with the local context in mind.

## 2.5 WHO TO CONTACT FOR QUESTIONS OR FEEDBACK?

For questions, comments, or feedbacks about these guidelines, please contact the CitiMeasure Project Coordinator Mohammad Gharesifard at [Mohammad.gharesifard@eurocities.eu](mailto:Mohammad.gharesifard@eurocities.eu).

## 2.6 LIST OF CONTRIBUTORS

These guidelines are the result of an iterative co-creation process with inputs from members of the CitiMeasure Behaviour & Policy Working group. The members of this working group are affiliated to 19 European cities and 7 (non-)governmental and research organizations (see Figure 1). In particular, 19 out of the 35 individual working group members have contributed to these guidelines by providing resources, and/or critically reviewing those resources. The detailed list of contributors and their affiliations are provided in Table 1. In addition to contributors from the working group, Table 1 also includes the name and affiliations of two Eurocities team members who have been involved in developing the guidelines, as well as one external expert (Margaret Gold) who contributed to the development of these guidelines by reviewing 10 resources.

WG member	Affiliation
Anna Berti Suman	European Commission Joint Research Centre (JRC)
Anna Georgieva	Sofia
Annelies Duerinckx	Scivil
Christina Paci	Milan
Diana Escobar	Barcelona
Emily Daemen	The Green Land
Irene Vivas Lalinde*	Eurocities
Joanna Heyda	Warsaw
Jussi Kulonpalo	Helsinki
Koen Broumels	Sittard-Geleen
Metodiyka Tarlyovska	Sofia
Margaret Gold**	Leiden University
Michael Lažan	Sensor. Community Prague
Mohammad Gharesifard*	Eurocities

WG member	Affiliation
Natalie Riedel	University of Munster
Sara Spaargaren	The Green Land
Slaveya Georgieva	Sofia
Sophie Laggan	University of Western England (UWE)
Stella Psarropoulou	Thessaloniki
Valerie De Prycker	Ghent
Velko Velkov	Sofia
Youetta de Jager	ICTU Foundation

*\*Eurocities team members*

*\*\*External Expert*

*Table 1 Contributors to the guidelines by providing resources, and/or critically reviewing those resource*

## 3. Background

### 3.1 ABOUT CITIMEASURE

Citizen measurement (or citizen science) initiatives contribute to a sustainable transition in European cities. By using an array of tools and instruments, citizens can play a role in the measurement and monitoring indicators on air quality, temperature, soil moisture, biodiversity, or risk management, among other environmental areas. Citizen measurement initiatives also can foster communications and interactions among stakeholders and contribute to the democratisation of science and policy. The CitiMeasure project (2021-2023) aims to bring together the experiences and expertise of European cities, organisations and networks in implementing citizen science initiatives (in the form of guidelines, toolbox, web-platform, Apps, etc.). The project builds upon the lessons learned from the Dutch City Deal Working Groups, a network of stakeholders working on the broader area of smart cities, including citizen measurement initiatives. The City Deal partners have been working closely with the Dutch Ministry of Interior and Kingdom Relations for over a year.

CitiMeasure builds upon these experiences and will use those to develop and pilot three ‘instruments’, namely:

1. An instrument that allows the outputs of different city measurement initiatives to be compared.
2. An instrument that safeguards the digital inclusivity of city measurement initiatives (maximising the opportunities for participation of interested individuals and communities).
3. An instrument that connects information to behaviour and policy change.

A 4th (Strategy and Oversight) working group focuses on providing strategic direction and ensuring cohesion of activities across the three Instrument Sub-Groups and the project in general. CitiMeasure will also raise awareness of the importance of citizen measurement initiatives and capitalise on the results and tools of similar citizen science projects by creating an online European Knowledge Centre with a repository of good practices.

### 3.2 ABOUT THE CITIMEASURE BEHAVIOUR AND POLICY WORKING GROUP

The Behaviour & Policy working group is one of the three CitiMeasure working groups developing instruments to create sustainable, inclusive, and smart cities. The group was initially formed through a call for expressions of interest that was shared through the Eurocities and City Deal networks, as well as personal networks of the CitiMeasure team. In September 2021, following an inception meeting, the group started to co-design a shared vision and a number of objectives that helped

advance the understanding of behaviour and policy change resulting from citizen science. Since September 2021, and following a co-creation approach, Eurocities has supported the development of the current set of guidelines related to behaviour and policy change outcomes of citizen science. This was done by organizing and facilitating monthly online meetings, as well as communications with the working group members to share knowledge, experience, and resources for creating those guidelines. Currently, the working group has 35 members from cities, governmental, research and other organisations.

Cities	(Non-) governmental and research organizations
<ul style="list-style-type: none"> <li>• Apeldoorn</li> <li>• Barcelona</li> <li>• Capelle aan den IJssel</li> <li>• Dublin</li> <li>• Ghent</li> <li>• Helsinki</li> <li>• Maribor</li> <li>• Milan</li> <li>• Piastow</li> <li>• Porto</li> <li>• Prague</li> <li>• Roeseleare</li> <li>• Rumia</li> <li>• Sittard – Geleen</li> <li>• Sofia</li> <li>• Thessaloniki</li> <li>• Torino</li> <li>• Warsaw</li> <li>• Zwolle</li> </ul>	<ul style="list-style-type: none"> <li>• ICTU</li> <li>• Joint Research Centre (JRC)</li> <li>• Norwegian Institute for Air Research (NILU)</li> <li>• Citizen Science Vlaanderen (Scivil)</li> <li>• The Green Land</li> <li>• University of Munster</li> <li>• University of Western England (UWE)</li> </ul>

*Figure 1: Cities and (non-)governmental organizations that are member of the CitiMeasure Behaviour and Policy working group*



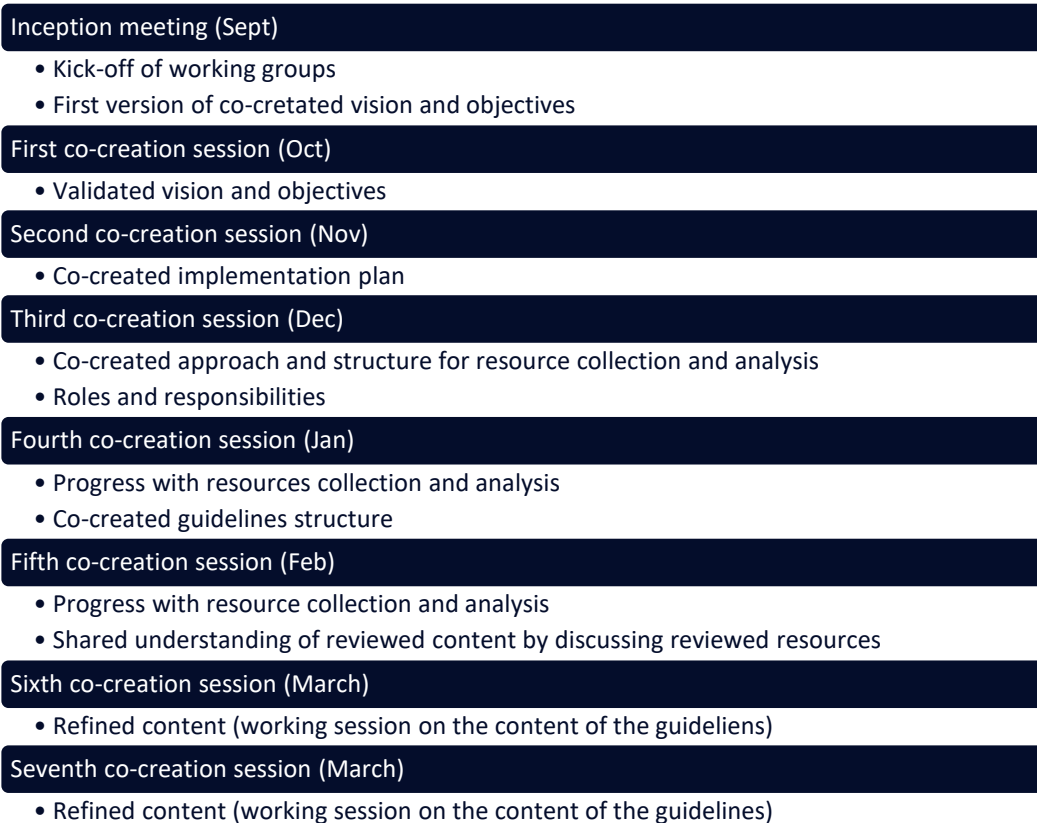
Here are the co-designed vision and objectives of the working group:

**Vision:** “The CitiMeasure Behaviour & Policy WG works towards increased understanding of the changes in behaviour of different stakeholder groups, as well as decision and policy making processes. This includes changes in trust, participation behaviour, new culture of collaboration, sharing responsibilities, as well as established decision and policy making processes.”

### **Objectives:**

1. Share ideas, case studies, best practices related to behaviour and policy change in citizen science initiatives. These best practices are documented with a close attention to their context (e.g., geographic, cultural, legal, and social context).
2. Jointly analyse and document the lessons learned from (un-)successful initiatives in terms of catalysing changes in behaviour of different stakeholders (e.g., trust, participation behaviour, new culture of collaboration, sharing responsibilities), as well as established decision and policy making processes.
3. By April 2022, develop guidelines and principles on behaviour and policy change that help cities and citizen science initiatives foster such changes.
4. Pilot the developed best practice in at least one real life example of citizen science initiatives between May and December 2022.
5. Consolidate the guideline/principles with lessons learned from the pilot phase and further analysis by March 2023.

Besides the Inception Meeting, seven co-creation sessions were organized to work towards development of the prototype guidelines. Throughout the co-creation sessions, the working group developed different elements paving the way to create these guidelines. Development of the shared vision and objectives as described above framed the scope of the work. In November 2021, the working group adopted an implementation plan for the different actions needed to produce their desired outputs. From December 2021 until February 2022, the working group members collected and shared resources such as academic articles, project reports and deliverables, policy documents, and other useful sources of information, such as toolboxes and webinars. The resource collection was conducted in parallel with the resources analysis by members and Eurocities staff. Figure 2 describes the key outputs of all the CitiMeasure co-creation sessions. Further elaboration on the co-creation process of the guidelines is presented in Section 3.3.



*Figure 2: Key outputs of all the CitiMeasure co-creation sessions*

### 3.3 DEVELOPMENT OF THE GUIDELINES

The CitiMeasure Behaviour & Policy guidelines were developed using the following methodological steps and approach:

#### **Definition of the scope**

With the support of the Eurocities team, the working group members defined a shared vision and five objectives (see Section 3.2.1). Objective 3 specifies that the members found ‘guidelines’ as the most appropriate format for the outputs of this working group.

#### **Resource collection and initial scanning**

Based on the vision, the working group members and the Eurocities team collected and shared resources on behaviour changes, changes in decision and policymaking processes, trust, participation behaviour, a new culture of collaboration, and sharing responsibilities in the context of cities and citizen science initiatives. A shared online workspace (SharePoint) was created so that working group members could easily access and share resources. The working group members and the Eurocities team volunteered to perform an initial scan of the resources and made a suggestion for their inclusion or exclusion for an in-depth review. To standardize the resource collection/suggestion process, the following structure of information (in form of a table) was proposed by Eurocities and validated with the working group members during the third co-creation session.

- Name of the file
- Year of the publication
- Language
- Title of the resource
- Type of resource
- Keywords
- Link
- The person who suggested the resource
- Relevance for the instrument
- Name of the reviewer
- Progress review
- Starting date and review deadline
- Notes
- Should everybody review this resource?
- Is this a difficult resource to review?
- Include or discard?

### **Analysis of individual resources**

The working group members and the Eurocities team volunteered to analyse the collected resources. Similarly, a structure was designed by the CitiMeasure team (in form of a table) and validated by the working group members. This structure included the following information and allowed for a uniform analysis of the shared resources:

- Name of the file
- Type of the resource – Paper, report, audio, deliverable, website, report, etc.
- Name of the reviewer
- Main focus – Policy change, behavioural change or both
- Best practices, approaches and recommendations (policy change, behaviour change and context).
  - Which best practices are identified in relation to policy change?
  - Which best practices are identified in relation to behavioural change?
  - Add the geographic, cultural, legal, and social context.
- Viewpoint (if possible) – Indicate if the resource approaches the topic from a specific viewpoint, perspective, or with certain assumptions or methods.
- Main research question and findings
- Relevance for the instrument
- Limitations
- Notes

Due to the large number of resources and time limit, an external expert was hired to review 10 resources using the same structure.

### **Peer review and quality control**

The Eurocities team checked the individual reviews in terms of completeness and quality, and when necessary either completed the analysis table with missing information from the resource or re-opened the resource for review by the members or the external expert.

## **Synthesis of the reviews**

Synthesizing the insights from individual reviews, was done by adopting an inductive analysis approach. Without prior conceptions in mind, the assessment of individual reviews was done by coding the content and allowing for categories of insights to emerge from the reviews. Coded insights from one resource were checked and compared against coded insights from other resources to create categories of information. The main categories of coded content included applications, expected impacts, challenges, and needs of citizen science initiatives, conceptual elements of behaviour and policy change, and recommendations related to triggering behaviour change and increasing policy uptake of citizen science for cities and citizen science initiatives. Constant comparison of the labelled content resulted in shaping the content that are summarized in Sections 3.3 and 3.4 of these guidelines.

## **Drafting the guidelines:**

The Eurocities team drafted an initial version of the guidelines and organized two working sessions with the working group members to work towards developing the first draft of the guidelines. The two working group sessions took place in March 2022. In the first session, participants were divided into two groups, one working on the Behaviour change, and the other group on Policy change. Participants reviewed the content in terms of structure, formulations, and categories of findings. In the second session, all the participants reviewed together the formulation of the recommendations. Working versions of the guidelines were shared with working group members between March and April 2022 to provide room for reflection outside of the working sessions, and to allow members who could not attend the working sessions to provide their contributions. A section of the content of the guidelines was also presented during the Eurocities Environment Forum 2022 in Grenoble and feedback from that session also contributed to improving the guidelines.

# 4. Triggering behaviour change using citizen science

These guidelines aim to advance the understanding of behavioural change aspects of citizen science. The following sub-sections focus on describing challenges and applications of citizen science for changing actors' behaviour, conceptualising behavioural change, and recommendations for cities and citizen science initiatives on how to foster behaviour change using citizen science.

## **4.1 CHALLENGES OF CHANGING ACTORS' BEHAVIOUR**

Change in actors' behaviour such as behaviour towards environment, creating new culture of collaboration and sharing responsibilities are among the aims of many citizen science initiatives. Nevertheless, there are several factors that may hinder such changes. Communities are heterogeneous and each person has certain perceptions, priorities and needs that drive their behaviour. In addition, challenges that citizen science projects address are often complex and existing formal processes and informal norms pretty much define actors' behaviour towards those challenges.

Although several citizen science initiatives aim to, or claim to have, changed actor behaviour, measuring such changes is not easy. Quite often, a baseline situation of actors' behaviour before involvement in a citizen science initiative is missing. Moreover, a significant proportion of citizen science projects' impacts, including changes in actors' behaviour, happens after the lifetime of the projects and their funding period, it is therefore highly difficult to measure such changes (3).

## 4.2 APPLICATIONS AND EXPECTED IMPACTS OF CITIZEN SCIENCE FOR BEHAVIOUR CHANGE

Behaviour change resulting from citizen science interventions can occur at every level from the individual to societal, to the institutional. Applications and expected impacts of citizen science for behaviour change include:

- **Changes in** ecological *perceptions*, sense of place, connections between science, place, ecosystem, and impacts of one's actions on the environment (3, 41, 22).
- **Increase knowledge and raise awareness:** participants acquire new knowledge and may be sensitized towards new issues and social challenges, and to act as a bridge to research and knowledge (32, 53).
- **Shift of attitude** towards more environmentally sustainable resource management, science, local conservation action, activism, and nature in general (1, 3, 39, 41, 52, 59).
- **Diffusion of** participants' acquired *skills and knowledge* to peers through social networks (3, 21, 22).
- **Increased confidence** to express ideas to natural resource managers and figures of authority, assert their authority e.g., as knowledge brokers, enhance political participation and activism, and foster people's agency for climate action (3, 19, 22, 32, 52, 59)
- **Changes in relationships and partnerships** among societal actors, community dynamics (including capacity, wellbeing, and livelihoods) (41, 22).
- **Triggering (social) innovation**, enhance learning at individual and societal levels and contribute to behaviour change of all actors (3, 22)
- Foster **social capital**, new forms of participation, mobilisation of people, and community building (15, 37, 39, 41)

Citizen science can serve as a rhetorical resource to **create new narratives** around environmental issues (37).

## 4.3 CONCEPTUALISING BEHAVIOUR CHANGE

Behaviour change is understood as altering current habits or ways of performing certain tasks. Social psychology theories have long established a link between change in behaviour and change in attitude, intention, and knowledge. For example, the Theories of Reasoned Action (TRA) and Planned Behaviour (TPB) that helps understand actions thought about and 'planned for' suggests that attitudes and behavioural intentions are drivers of behaviour (36). Other scholars have also suggested that knowledge and attitudes are linked (14). An increase in knowledge, however, does not necessarily lead to changes in behaviour. It is thus essential that these changes in behaviour remain even after the intervention or initiative is over (43).

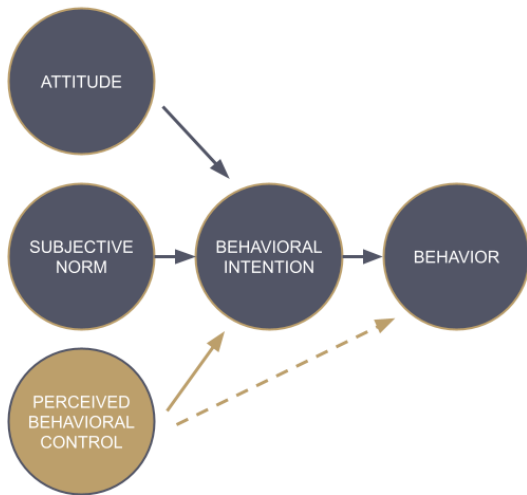


Figure 3 Theories of Planned Behaviour and Reasoned Action<sup>1</sup>

There are several reasons for participation of volunteers in citizen science. E.g., participation may be self-initiated as driven by an environmental concern, as well as scientific curiosity and a sense of fulfilment for being part of finding answers (32)

Citizen science can lead to changes in the participants' behaviour and other stakeholders, i.e., decision makers directly or indirectly involved in an initiative (15, 22). Projects such as iSCAPE, HOPE, CAPTOR, WeSenselt, Ground Truth 2.0, CitiesHealth, CurieuzenNeuzen and WeCount have attempted to better understand and measure behaviour changes. There are other approaches to behaviour in the context of citizen science. The work of Berti Suman (27), for instance, focuses on understanding the social uptake of citizen science and frames behavioural adaptations as one of its potential consequences.

In the context of these guidelines, behaviour change is defined as *a measurable change in action resulting from engagement in citizen science, that lasts beyond the citizen science project itself*. It can range from a one-off direct action (e.g., installing a low-cost sensor) to incremental changes in attitude and long-term behaviour change (e.g., no longer driving your car within the city) (3, 32).

<sup>1</sup> Source of image: <https://positivepsychology.com/behavior-change/>

## 4.4 RECOMMENDATIONS FOR TRIGGERING BEHAVIOUR CHANGE USING CITIZEN SCIENCE

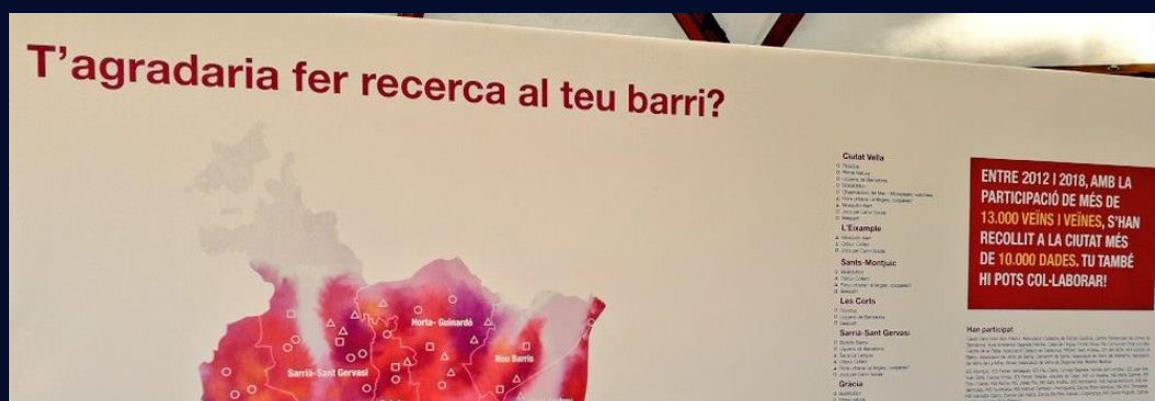
This section summarizes the recommendations on how to trigger behaviour changes using citizen science. The recommendations are organized in two main sections, based on whether they are more relevant for cities or citizen science initiatives. Relevant recommendations are clustered under common themes, and where possible accompanied by empirical insights or examples from existing initiatives.

### 4.4.1 RECOMMENDATIONS FOR CITIES

- **Institutionalise citizen science at the city level:**
  - Institutionalise citizen science at the local level, e.g., by adding it as an approach in strategic documents and policies (32), or by setting up a citizen science office at the municipality, which works with communities, universities, and projects for co-creating local initiatives, and providing spaces for stakeholder interactions (9).

#### BOX 1: The Barcelona citizen science office

Established in 2012, the Barcelona Office of Citizen Science's mission is to support citizen science in the city of Barcelona (Spain). Since its creation, the office has advised, accompanied, and promoted citizen science projects active in the city and its Metropolitan Area resulting in the involvement of around 13,000 residents and schoolchildren, who have collected more than 10,000 valuable data for scientific research.



This is one of the few examples of citizen science structures at local level in Europe. The office plays a key role in connecting the public administration and local initiatives, along with researchers, and new civic and cultural agents, while providing services such as dissemination of activities and promotion of spaces for mutual learning.

<https://www.barcelona.cat/barcelonaciencia/en/citizen-science>

- **Facilitate and promote capacity building and knowledge sharing:**
  - Provide training for city administration staff who are not familiar with the role of behaviour-related aspects of citizen science initiatives (3). Example training may include reaching diverse audiences, public engagement, evaluation, and impact assessment, etc.
  - Set up citizen science working groups to develop a network of cities and organisations that facilitate cross-learning (9).

#### BOX 2: The Dutch City Deal

The Dutch City Deal “A smart city, that’s how you do it” is an initiative launched by the Dutch Ministry of Interior and Kingdom Relations and the G40 network in 2020. It represents 58 stakeholders working on the broader area of smart cities in the Netherlands, which includes the topic of citizen measurement initiatives. Twelve working groups of the Dutch City Deal are collaborating to co-design optimal future-proof solutions by using digitization and technology. These include the working group “Lokaal meten: betrekken en activeren burgers” which focuses on engagement aspects of citizen science initiatives and “Lokaal meten: Vergelijken van uitkomsten tussen” which focuses on comparability of data produced by citizen science initiatives. The Future City Foundation has been coordinating the efforts towards developing different outputs as well as cross-learning opportunities in online and offline meetings.



<https://agendastad.nl/citydeal/een-slimme-stad-zo-doe-je-dat/>



- Keep an up-to-date repository of citizen science projects that can be used as a showcase of the activities of each city in this area. This can be a part of a national repository and needs to showcase scientific, educational, social, cultural, economic, political relevance of the initiatives The EU-Citizen.Science platform is a good place to start building this repository (17).

### BOX 3: Bürger schaffen Wissen platform

The Bürger schaffen Wissen (citizens create knowledge, in English) is the central national online platform for citizen science in Germany. It was created in November 2013 as a repository of citizen science projects. Its main goal is to present, connect and support these types of projects while further increasing the visibility of the approach within the German public and discourse. Since 2020, it has also been working on the development of quality criteria and the impact of citizen science. The repository includes a search tool based on the project's theme and the region where the project is being implemented. It also includes information about the social, scientific, or cultural impact of the different initiatives.

<p>Find out what the color of water says about climate change by using the EyeOnWater app.</p>  <p><b>EyeOnWater</b> mit App</p> <p>Sagt die Farbe von Wasser etwas über den Klimawandel aus? Finde es heraus, indem du mit der EyeOnWater-App ein Foto von der Wasseroberfläche machst und die Wasserfarbe auswertest.</p> <p><i>Gewässer, Klima</i></p> <p>mehr →</p>	<p>Help to research the distribution of mosquito species.</p>  <p><b>Mückenatlas</b></p> <p>Mücken fangen, einfrieren, abschicken – mit jeder eingeschickten Mücke wird der Mückenatlas größer! Hilf dabei die Verbreitung der Mückenarten zu erforschen.</p> <p><i>Klima, Tiere</i></p> <p>mehr →</p>	<p>Support the creation of a "DNA Barcode Library of Life" for plants and animals.</p>  <p>Wir suchen deutschlandweit nach ehrenamtlichen Helfern mit sehr guter Artenkenntnis, die durch ihre Sammelaktivität gezielt zur Bioinventur beitragen wollen!</p> <p><b>GBOL - German Barcode of Life</b></p> <p>Inventur der Biologie! Bei GBOL unterstützt du durch das Bestimmen von Pflanzen- und Tiermaterial den Aufbau einer „DNA Barcode Bibliothek des Lebens“.</p> <p><i>Pflanzen, Tiere</i></p> <p>mehr →</p>
--	---	---

<https://www.buergerschaffenwissen.de/en>

- **Strengthen communication efforts:**

- Citizen science projects can be a good source of information for tailored communications for specific groups, aiming to connect with a group's lived experiences and day-to-day behaviours. This approach helps raise awareness about actions that 'people like me' take to address an issue in their living environment. (20, 22)
- Public environmental communication can be an effective tool to motivate sustainable behaviour, provided that attention is paid to the role of cognitive biases, emotions (e.g., fear and hope), and expectations about the motivations of the communication source and other people's (environmental) behaviours (18).

#### BOX 4: Changing behaviour through air quality initiatives in the city of Ghent

The city of Ghent (Belgium) has started several local air quality monitoring initiatives to involve citizens and raise awareness. In 2016, 348 Ghent residents and 50 locations were selected to display NO<sub>2</sub> passive samplers. In 2018, the city participated in the regional project Curieuze Neuzen. From 2022, Ghent is planning to use participative monitoring to see changes in circulation of traffic in Ghent's districts. This work will include behavioural research to investigate the effect on awareness of air quality, perception, motivation, thresholds, triggers and expectations, modal shifts, and support base for school streets. The city is also using communication and positive storytelling approaches in their strategy for raising awareness and behaviour change.



<https://stad.gent/nl/mobiliteit-openbare-werken/plannen-en-realisaties-mobiliteit/wijkmobiliteitsplan>

#### 4.4.2 RECOMMENDATIONS FOR CITIZEN SCIENCE INITIATIVES

- **Pay attention to the context:**
  - Conduct studies at the early stages of the project to understand the social, institutional, political, cultural context in which you are going to operate (24).
- **Strengthen engagement efforts:**
  - Involve citizens, policy/decision makers and other actors from the very beginning in story finding. This will help with identifying problems for different audiences/target groups, co-create hypotheses, design the research process adapted to those problems, and collect data that contributes to raising awareness and behavioural changes (3, 6, 22, 23, 24, 32, 47, 54).
  - Plan for involving citizens of a wide range of ages is important to achieve a change in behaviour that is effective for awareness-raising from the grassroots of society and for its influence on the family (23, 24).
  - Use co-creation tools and techniques to promote and strengthen shared ownership of the process and its outcomes, and increase trust (24, 38)

##### **BOX 5:** The ‘Botellon no me deja dormir’ project

The ‘Botellon no me deja dormir’ project is a collaborative initiative co-created by the community of neighbours in Plaça del Sol (Barcelona) and it was one of the pilots of the project Making Sense EU. It builds upon the lessons learnt from previous projects such as Sound Map. Co-design was as the core of the process of installation, sensing and raising awareness about the issue of noise pollution in this area of the city. A series of tools for co-creation and engagement i.e., co-creation assemblies were included in a toolkit available on their website.



<http://making-sense.eu/>

- Citizens are more likely to engage in initiatives aiming at policy and behavioural change if issues are framed around their values and focus on more local and tangible concerns, and if individuals believe their actions make a difference (3, 6, 22, 38, 57, 59).
- Community building efforts better take place after the scoping stage, but before the start of detailed planning of the initiative (24).
- **Realise stakeholders' needs and work towards fulfilling those:**
  - **To maximise impact, project designers need to understand who their potential participants are, what motivates them, what barriers to participation they face, how these barriers can be overcome, and how their motivations align with the intended project impact (3, 24, 47).**
  - To drive change, make sure that data, motivations, and collaboration opportunities target all involved stakeholder, including e.g., citizens, researchers, government agencies, NGOs, and industry (3, 24).

#### **BOX 6: The STEP CHANGE project**

The H2020 project STEP CHANGE, launched in March 2021, is implementing citizen science initiatives, working with energy communities in Germany. The project brings novelty in citizen science research while contributing to broader science aspects. The overall objective is to formulate recommendations and instruments for better mainstream citizen science within research and innovation (R&I) institutions as well as changing researchers' mindsets on its value. In this specific initiative, households will receive a monthly report about their consumptions as well as have real-time access to their energy consumption data which might affect their energy lifestyle.

- Criteria for citizen science projects that aim to result in successful environmental activism must be 'credible enough' to engage policymakers, must be appealing and inspiring to a wide audience to mobilise action, must be personally relevant to participants, mechanisms must be in place for advocates to be heard by the actors who can action change (3, 59).
- **Enhance communication efforts:**
  - **Invest in developing a good communication and dissemination strategy (3, 6, 24).**
  - **Have dedicated people, ideally community champions (stewards) as the main contact point with the target audiences (24, 38).**
  - Use storytelling as an approach to reach out to a wide range of audiences. In order to achieve the full potential with stories, move away from 'issue-based' towards 'action-based' narratives. Action based stories clarify opportunities for community members to engage in concrete actions and help address specific local challenges (19, 54).
  - Utilise technology to access a broad audience quickly and efficiently (16).
  - Use traditional advertising techniques to reach out to less tech-savvy parts of the population, or those with limited access to technology (16).

### **BOX 7: Curieuzeneuzen and Curieuzen Air – innovative ways to communicate and reach out to marginalized communities**

The Curieuzeneuzen project used in its recruitment process both traditional media, including TV, radio, printed media, billboards, as well as online media such as websites, and social media. In addition, citizens were involved in innovative ways, including colourful V-boards as points of recognition of participants; postcards; ads at the Ringland Rock Festival (June 2016); a booth at a science innovation festival (September 2018); video clips with well-known artists as ambassadors; and a large knowledge event with 900 citizen researchers in Antwerp in 2016 (4).

On the other hand, the CurieuzenAir project (involving this time the city of Brussels) also collaborated with local newspapers, used social media, and launched a website in three main languages (French, Dutch and English). To reach more vulnerable communities, they followed an innovative approach by collaborating with a local NGO that engaged the community through air quality city walks, individual calls, and dissemination activities in public places such as medical homes and key stores in the neighbourhood (25).

- Include tailored communications for specific groups, aiming to connect with a group's lived experiences and day-to-day behaviours. This approach helps raise awareness about actions that 'people like me' take to address an issue. (20)
- Policies that promote positive environmental behaviour work best, if promotion of 'good behaviour' is combined with measures for discouraging 'bad behaviour' (46). Citizen science projects that try to influence such policies should consider providing examples and recommendations for both encouraging good behaviour and discouraging bad behaviour.
- Providing 'average user' data may discourage behaviour change. This is especially the case for those who are already performing better than average as they may see no reason to change (50).
- **Develop a robust monitoring and evaluation plan:**
  - Invest in developing a good project monitoring and evaluation plan based on project evaluation principles and best practices (3). Evaluation of citizen science impact (e.g., on behaviour or policy) can be done in collaboration with citizens and by involving them in co-creation of evaluation KPIs and impact assessment instruments. This requires researchers to relinquish control over such processes and increasingly adopt co-evaluation principles such as participant ownership, openness, and reflexivity, [participant] transformation, flexibility, documentation and transparency, time [slow research] (10).
- **Value transparency accountability and responsiveness**
  - Project leaders should operate ethically and not (inadvertently) mislead participants to endorse a specific agenda. To avoid such situations, projects need to operate transparently, uphold high data, and project design standards, and ensure that the issue or solution they advocate for is evidence based (3).

## 5. Fostering policy impact of citizen science

This section of the guidelines aims to advance the understanding of policy change aspects of citizen science. The following sub-sections focus on describing challenges and applications of citizen science for changing policies, conceptualizations of policy change, and recommendations for cities and citizen science initiatives on how to foster policy impact of citizen science.

### 5.1 CHALLENGES ENCOUNTERED IN INFLUENCING POLICY

The science-policy interface is complex, and many factors contribute to whether findings of a citizen science initiative are adopted by policy stakeholders, and lead to policy change (7). Some of these challenges are listed below:

- There is a lack of alignment between research, community, and policymakers (3, 20). This translates into a mismatch between citizen science data and policy questions, goals and actions on the ground, scientific and political processes in timing and aptness of data to a specific policy process, i.e. public consultation, time cycles, and data infrastructures. Citizen science projects are often short-lived or cease to exist if they don't achieve their desired outcomes; and data can sit on a website and reside there silently without being used by the public or government (23, 30, 53, 55).
- There is a power imbalance so there is need to share power, fear of political biases. Most policy making is still top-down and evidence-based often exclude citizen science (2, 32).
- There are conflicting interests or goals of policymakers, citizen scientists and researchers from citizen science projects (30).
- There is divergent legislation and cultures across science and governance levels that hamper the spread of knowledge and uptake of citizen science (30).
- A common challenge for civil servants who would like to have citizens engaged in data collection practices is that they do not trust the data they collect (15).
- It is difficult to connect citizen science with collaborative policymaking processes such as public consultations and citizen-initiated policy proposals.
- The lack of resources such as funding, time and expertise hinders policy impact.
- There is a high level of distrust and lack of mutual understanding between scientists, politicians, and citizens scientists. Civil servants and public officials who would like to have citizens engaged in data collection practices or citizen science often do not trust the quality (robustness, reliability, safety, and representativeness) of the collected data nor the approach itself as they fear political biases (15, 22, 30, 33, 55).
- There is a lack of awareness about the benefits of citizen science, or even about the breadth and diversity citizen science has to offer (30)
- **A significant proportion of citizen science projects' impacts, including policy change impacts, happens after the lifetime of the projects and their funding period, it is therefore highly difficult to measure such changes (3, 53, 56).**
- Funding streams are a key consideration for the success of any project. Some projects are in a "proof-of-concept" phase and therefore depend on external funding to sustain their operations before they are able to generate sufficient income, while other projects face the risk of stopping if the external funding from donors and development agencies runs out. Projects are thus exploring different revenue strategies and diversifying their income streams (23, 53).

## 5.2 APPLICATIONS AND EXPECTED IMPACTS OF CITIZEN SCIENCE FOR POLICY CHANGE

Citizen science initiatives can contribute to problem and policy formulation, policy implementation, policy monitoring, policy evaluation, compliance assurance, awareness rising, anticipation and early warning (3, 37, 41, 52). Citizen science can support knowledge creation, education and communication and climate action at both individual (agency) and decision maker level using evidence collected through citizen science (22, 55). Examples of such contributions include providing complementary evidence for environment policies, helping to monitor and achieve SDGs, and contributing to geospatial intelligence (1, 36, 53). Citizen science initiatives also facilitate multi-level actor interactions and communications, as well as help with balancing power-relationships, and building trust among stakeholders (41).

## 5.3 CONCEPTUALISING POLICY CHANGE

Change in policy and governance processes can be interpreted in a variety of ways and can have multiple meanings including changes in institutions, (in)formal procedures, interests, alliances, and ideas. Citizen science can contribute to changes in governance processes in various ways. This includes informing certain steps of the Policy Cycle that include problem definition, policy formation, policy adoption, policy implementation, and policy evaluation. Figure 4 provides an interpretation of the value of citizen science in different steps of the policy cycle (59). Next to actual change in existing policy documents and procedures, policy change can also be interpreted as change in governance processes, such as multi-level actors' interactions and relationships. Specific indicators for such changes include "contributions to management plans and policy", "stakeholder interactions in decision-making processes (e.g., data provision, expressing preferences, deliberation, and negotiation, etc.)" and "change in the level of authority and power of each stakeholder" (35, 37, 41).

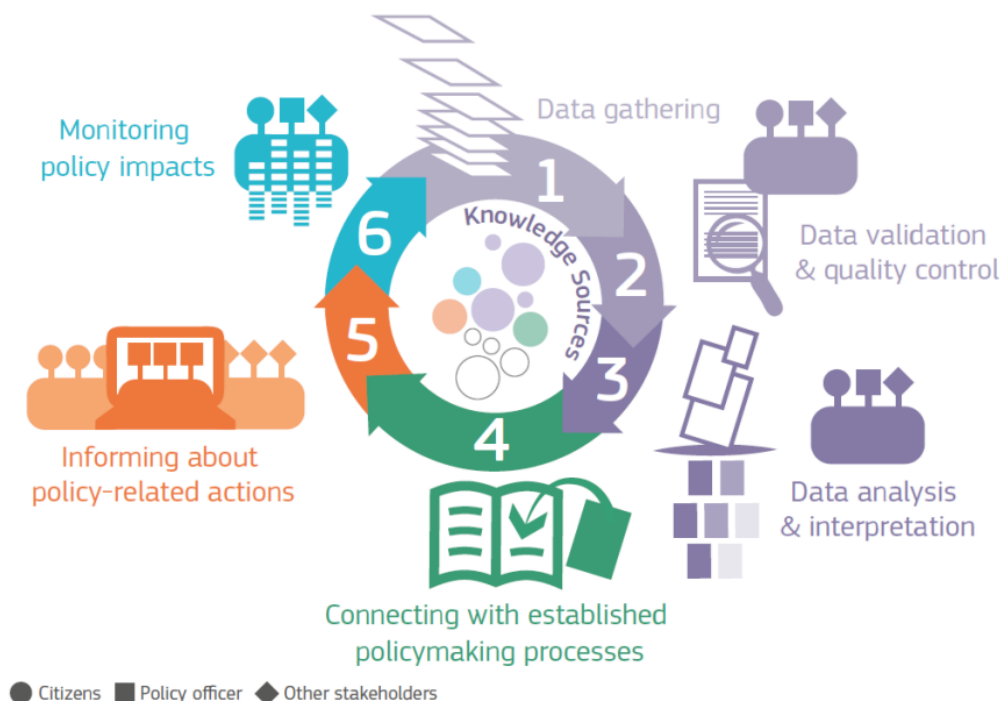


Figure 4: cyclic value chain of Citizen Science for policy

Citizen science initiatives can be influential at any stage of the policy process. A recent report by the European Commission Joint Research Centre (JRC) that included an inventory of 503 citizen science initiatives, and an in-depth analysis of 45 projects, considers policy impact as one of the main outcomes.

If policies fail, a judicial uptake might be necessary. For instance, on 10 October 2018, in a decision of the Court of First Instance of Brussels in *Greenpeace v Flemish Region*, the Court found that supplementary information based on data collected via a citizen science project reporting on air quality must be taken seriously and passed on to the European Commission (33). In another example, the project "SensJus" deploys research on the potential of environmental citizen science as a source of evidence for judicial litigation and as a tool to foster mediation<sup>2</sup>.

While citizen science's impacts on society, governance and environment belong to different impact domains (41), they are interlinked. For example, Ceccaroni et al. (2021) links policy impacts of citizen science projects with actual environmental impacts (3). Policy change must be meaningful, which means handling, mitigating, or removing a specific (environmental) risk and therefore resulting in a (positive) environmental change (24, 27, 28). The social uptake can facilitate or hinder the policy uptake, even to the point the latter is no longer needed if the environmental risk is eliminated or mitigated. On the contrary, the social and policy uptake can also be in tension. Citizen science initiatives must thus find the right balance between engaging institutions and maintaining social support (27).

In her research, Anna Berti Suman defines **policy uptake of citizen science** as 'the adoption by institutional actors of (some component of) the initiative and/or the performing of policy/regulatory/factual interventions expressly demanded by the initiative or, in any event, stimulated by the initiative'. (27)

These interlinkages acknowledge the existence of power dynamics within a citizen science initiative and outside it, i.e., political context. It also explains why demand-driven initiatives might be more successful than supply-driven (or top-down) ones (35). Top-down, or supply-driven initiatives refer to projects that are initiated by actors with higher influence on policy or decision making, or by scientists, as opposed to bottom-up or demand-driven projects that are initiated by actors such as community groups, individuals, or volunteers (35).

### **New approaches to citizen science: Environmental justice and the ClairCity project**

The term environmental justice acknowledges the unequal effects of environmental policies, the power imbalances within the policymaking process and the lack of representation in environment-related data. While environmental justice is a widely researched topic in the field of social sciences, it is not the higher purpose of many participatory approaches to science. This is changing with projects such as ClairCity, an EU-funded project which aimed to put people at the heart of air pollution management. The project assessed to what extent citizens suffering the worst impacts of air pollution are themselves responsible for the greatest emissions. It also explored the feasibility of performing studies on environmental justice at the city scale and provide six recommendations for other cities when undertaking similar studies (27, 41)

<sup>2</sup> <https://sensingforjustice.webnode.it/>



## 5.4 RECOMMENDATIONS FOR ENHANCING POLICY UPTAKE OF CITIZEN SCIENCE

This section summarizes the recommendations on how to enhance policy uptake of citizen science initiatives. Similar to section 3.3.4, the recommendations are organized in two main sections, based on whether they are more relevant for cities or citizen science initiatives. Relevant recommendations are clustered under common themes, and where possible accompanied by empirical insights or examples from existing initiatives.

### 5.4.1 RECOMMENDATIONS FOR CITIES

- **Facilitate knowledge exchange about and across citizen science initiatives:**
  - Promote best practices for the use of citizen science data and information (1, 30, 53).

#### **BOX 8: Knowledge exchange between governmental organisations and citizen science initiatives – Sensor.Community and RIVM**

Sensor.Community is a bottom-up initiative of citizens who seek to contribute to the creation of open environmental data. The community facilitates the access and use of low-cost sensors, and the visualisation of the collected data. The main focus of the initiatives is on air quality (PM 2.5 and PM10) and noise monitoring. So far, its interactive map displays more than 17 billion data points from 14.000 sensors worldwide.

The Dutch National Institute for Public Health and the Environment (RIVM) is a reference in Europe regarding data comparability, and it integrates citizens' science data into its databases. They have developed a data infrastructure in collaboration with other initiatives such as Sensor.Community that has been later used in other projects, i.e., Sniffer bike (or Snuffelfiets in Dutch), or Dutch Skies (Hollandse Luchten in English) (25).

- Raise awareness of public institutions regarding citizen science (1).
- Provide training for staff not familiar with policy impacts of citizen science (3, 28).
- Improve coordination among citizen science initiatives at different governance and thematic levels (1).
- As much as possible, follow open data principles and establish open data platforms (30, 53).
- Create networks or communities of practice on different aspects of citizen science initiatives with an urban focus, share their knowledge and experience, and support pilots and practical experimentations (2, 30, 51).
- Consider developing a central interactive platform or portal where citizen science initiatives can publicise their data and communities interact with the initiatives. The platform should enable exchange between and across initiatives and can also operate as a screening system for purpose-specific search for projects in line with quality standards (28, 31, 51, 53).
- Develop and maintain an updated repository of citizen science projects that can be used as a showcase of the activities of the city in this area. This can be a part of a national or pan-European repository and needs to showcase scientific, educational, social, cultural, economic, political relevance of the initiatives. The EU-Citizen.Science platform is a good place to start building this repository (17).
- Use co-creation in citizen science as a mediation tool. Co-created citizen science initiatives have the potential to act as a mediation channel for bridging polarised views

about certain policies. They enable new narratives to be explored as different viewpoints are represented and considered within a co-creation setting (35, 57).

- Consider combining citizen science and Urban Living Labs to achieve better policy impact. Such an approach can enable knowledge sharing and exchange between public and private sector actors, create a better picture of problems (e.g., based on citizen-generated data) and solutions, and save resources for cities (58).
- **Pay attention to allocation of roles and responsibilities:**
  - City administrations that proceed in adopting citizen science projects should refrain from (giving the impression that they are) appropriating and controlling the initiative, paying attention to a fair allocation of roles and responsibilities in the process (28).

## 5.4.2 RECOMMENDATIONS FOR CITIZEN SCIENCE INITIATIVES

- **Pay attention to the context:**
  - Citizen science projects are most likely to feed into management plans if they are place based and firmly rooted in the local context, carried out over multiple years, deliberately designed for management purposes with scientifically robust protocols, co-created with stakeholders and citizens to identify their needs and decision-making timelines (3).
  - Consider contextual factors (e.g., social, economic, cultural settings, and power dynamics) and the specific political landscape in which the initiative is inserted (27, 42).
  - Recognise and pay attention to diverse interests in data and its application by different actors (47)
- **Realise stakeholders' needs and work towards fulfilling those:**
  - **To maximise impact, project designers need to understand who their potential participants are, what motivates them, what barriers to participation they face, how these barriers can be overcome, and how their motivations align with the intended project impact (3).**
  - **To drive change, make sure that data, motivation, and collaboration opportunities target all involved, including e.g., citizens, researchers, government agencies, NGOs, and industry (3).**
- **Link to policy and decision-making processes:**
  - Identify current policy aims, objectives and concerns, and align projects with ongoing or future policy agendas, processes, debates, and standards (2, 16, 22, 30, 34, 42, 54, 55).
  - Constantly identify evolving policy linkages of the citizen initiative e.g., with bulletins directed to competent authorities and adapting to changing contexts (and scales) (28, 54).
  - When possible, actively seek government support as it favours policy uptake (1). This is also recommended for citizen science initiatives that are established to contrast certain government policies, as they may be able to find allies in the local government level, e.g., the city councils (28).

- Influence policy processes by linking citizen science and the collected data (empirical evidence) to existing policy agendas, datasets, strategies, and processes, with the aim of complementing existing inputs, processes and outputs (32, 42, 47, 54).
- **Think of ways to improve engagement, acceptability, and credibility:**
  - Engage, and collaborate with, a wide range of actors as this increases policy relevance and adoption (1, 5).
  - Take time to co-create and codesign approaches with strategic partners and networks (1, 24, 30).
  - Invest time and resources on scientific rigour, involvement of NGOs, developing sustainable business models as these encourages policy use (1).

#### **BOX 9: Developing business models in the Ground Truth 2.0 project**

The Ground Truth 2.0 project followed a non-profit business model approach to the viability and sustainability of the project's services. It identified their value proposition through a business model canvas and analysed the market characteristics in the different project pilots. More information can be found in the Deliverable D3.2 Updated report on market analysis and market uptake.

<https://gt20.eu/wp-content/uploads/2019/10/Deliverable-D3.2-Updated-report-on-market-analysis-and-market-uptake.pdf>

- **Collaboration, and including policymakers, communities and other actors from the outset and aligning to their needs increases the chance of policy uptake (3, 21, 55).**
- Projects are most likely to influence policy if they received government support, not only in the form of funding, but also through active participation in the design and implementation of the project, and have a straightforward engagement process for participants, requiring limited effort and a priori scientific skills (3).
- **Citizens are more likely to engage in initiatives aiming at policy and behavioural change if issues are framed around their values and focus on more local and tangible concerns, and if individuals believe their actions make a difference (57).**
- Data quality is a critical issue in policy context. Citizen science projects that aim for policy uptake need to ensure alignment with monitoring requirements and regulatory standards. In other words, they need to follow a fit for purpose (or fit for use) approach where key aspects like data quality, scale, cost, interoperability, and data format are taken into account. (15, 55)
- In order to increase trust in citizen science data, it is recommended that where possible, initiatives describe their "data stories"<sup>3</sup> together with representation of official data. (15)
- Citizen science projects can best engage citizens in science and policy if their activities are playful, simple, visible, personal, and practical (51, 22).
- It is recommended that citizen science projects create a dedicated work package that focuses on policy implementation, including both the citizen and the cities voice (21).

<sup>3</sup> Data stories here refer to narratives that are supported by and/or build around collected data and information in a citizen science initiative.

- It is important to design engagement activities which appeal to a wide variety of audiences to ensure that a broad cross-section of society can participate in engagement with policymaking (21).
  - Identify and engage governmental 'champions' who are willing to encourage their colleagues and managers to integrate citizen science data in the work inside governmental organisations (22, 24).
  - Have dedicated 'community engagement and outreach' officials with the task of spotting citizen initiatives and leveraging for its adoption (28).
  - Foster dialogue through e.g., environmental mediators showing that citizen sensing can be a tool to calm discussions and reward cases of successful adoption with funding (but adopting appropriate safeguards to avoid prevailing of financial interests) (28).
  - Clearly define roles and responsibilities in collaborations between policy makers and actors involved in citizen science initiatives at the early stages of the initiative establishment process (30)
  - Understand different types of biases and errors issues to enable specialists and decision makers to take into account these potentially misleading factors (54)
  - Use metadata to contextualize data and reduce the chance of misinterpretation or misuse of data (54).
  - Use established spatial data infrastructure (SDI), standardized approaches and terminology to increase accessibility, acceptability and openness of the results and increase the uptake of data for multiple purposes and end-users (54).
  - Provide guidance on how to contribute to data collection, monitoring, analysis and reporting e.g., to responsible authorities (53).
- **Enhance communication efforts:**
    - **Invest in developing a good communication and dissemination strategy (3).**
    - **Utilise technology to access a broad audience quickly and efficiently (16, 24).**
    - **Use traditional advertising techniques to reach out to the less tech-savvy part of the population, or those with limited access to technology (16, 24).**
    - Effective communication about policy and policy change is best done using simple messages that provide action perspective (18).
    - Publish about citizen science initiatives' activities and results in written press and media as it will help change political opinion about the initiatives and their results (5).
    - Storytelling is a recommended approach for capturing and communicating policy impacts of citizen science. (8)
    - Data and stories should thus be used in tandem to affect evidence-based political activism, because data alone may be too abstract, and pictures and stories often elicit a much stronger public response than data alone (3).
    - Local dissemination activities, such as meetings with local decision-makers, newspaper and television reports, and a public exhibition, contributes to wider awareness-raising, and can help increase political pressure towards policy change (6).
    - Provide opportunities for citizens to present their evidence to policy makers (spaces for encounter and mediation) and actively seek out existing opportunities and needs such as desired changes and required resources. Examples for such settings include e.g., citizen assemblies and participatory budgeting (21, 28, 31).

### **BOX 10: Public advocacy and lobbying in the D-NOSES project**

D-NOSES advocated introduction of odour pollution into policy agendas at local, national, and international level. The project managed to provide input for several regulatory processes in Chile, Portugal, and Uganda. In addition, the D-NOSES project attracted the attention of the European Parliament and organized an event with the title “Revisiting Odour Pollution in Europe” hosted by the European Parliament Intergroup on ‘Climate Change, Biodiversity and Sustainable Development’. The meeting was planned in October 2021 and aimed at bringing together policy makers, representatives from industries, communities, and scientists to share their perspectives on the issue, discuss the main challenges of regulating odours, and share recommendations for an improved odour management policy framework, based on the lessons learned by D-NOSES (13).

- Actively try to link to 'trigger events', e.g. emergencies, disasters, or outbreaks such as COVID-19. This will open up both the need and the willingness to utilise alternative sources of data (22).
- **Develop a robust monitoring and evaluation plan:**
  - **Invest in developing a good project monitoring and evaluation plan based on project evaluation principles and best practices (3).**
  - **Evaluation of citizen science impact (e.g., on behaviour or policy) can be done in collaboration with citizens and by involving them in co-creation of evaluation KPIs and impact assessment instruments. This requires researchers to relinquish control over such processes and increasingly adopt co-evaluation principles such as participant ownership, openness and reflexivity, [participant] transformation, flexibility, documentation and transparency, time [slow research] (10).**
  - Demonstrate the added value of citizen science for specific environmental issues (e.g., through a mechanism tracking successes; cost-benefit analysis, open discussions on failures; reward mechanisms such as prizes) to involved policy-makers (28).

### **BOX 11: Measuring success in Brenta-Bacchiglione Citizens Observatory**

“Before the pilot case of Brenta-Bacchiglione Citizens Observatory in WeSenseIt, flood risk management practices in the catchment were predominantly structural measures. However, during the WeSenseIt pilot, the value of the initiative for improving early warning systems, models and on-the-ground flood risk management practices was proven. This triggered a change in the official Flood Risk Management Plan (PGR) of the Brenta-Bacchiglione catchment, which was the inclusion of citizen science initiatives as an official prevention measure to reduce the flood risk in the Brenta-Bacchiglione catchment. A cost-benefit analysis and risk assessments by AAWA showed the substantial monetary benefit from running the Brenta-Bacchiglione Citizens Observatory for flood risk management in the catchment. This is approximately €137 million of damage avoided per year, which equals avoided damage of 45 % as compared to a ‘business as usual’ scenario. Both monetary and social benefits of this initiative convinced the Ministry of the Environment to fund the development of a scaled-up citizen science initiative at the district level. The case of Brenta-Bacchiglione Citizens Observatory is among the few cases that has a tangible, and already materialised, policy impact. This case has been identified by the European Commission as a ‘good practice’ for the implementation of the Floods Directive (2007/60/EC) and specific local measures as a part of the PGR (13)’.

- Monitor meaningful policy or governance through internal tracking mechanisms and with direct monitoring by the parties involved, including political decision-makers and citizen scientists as they are often the best judges of what counts as meaningful change (42).
- Do not over-standardise impact monitoring and evaluation approaches but keep processes flexible and adapt evaluation strategies to projects based on their unique characteristics (56).
- **Consider post-project needs and actions:**
  - Take time to reflect on how the process went, the ways in which the citizens’ efforts can be used post-project and support them to apply for funding or connect them to relevant organisations or follow-on projects (21, 47).
  - Ensure that mid/long-term maintenance for a project can be provided by the organisation in charge of the project (28).
  - Funding shouldn’t only be considered for establishing a new citizen science initiative, but also, for supporting the integration of results into established policy processes and for long-term support of initiative infrastructures e.g., website, data platform, and Apps (47, 56).

## 6. Concluding remarks and next steps

CitiMeasure provided a unique opportunity for representatives of European cities, academia, and (non-)governmental organizations to come together, discuss and identify the ways by which citizen science initiatives can change actors' behaviour and enhance their policy impact. The result is this prototype of a co-created set of guidelines for cities and citizen science initiatives that includes 25 unique recommendations on how to trigger behaviour change and 57 recommendations on how to enhance policy impacts of citizen science. The recommendations provided in the CitiMeasure Behaviour and Policy guidelines build on a wealth of resources and experiences of cities and citizen science projects. Nevertheless, they are not meant to be used as a step-by-step guideline, nor a prescription on how to achieve such desired changes. Rather, they are meant to be taken as a source of inspiration and best practices. Adopting each recommendation should be considered in relation with the context in which a citizen science project will operate, and closely linked to its aims.

This is the first version (prototype) of the CitiMeasure guidelines on Behaviour and Policy. Between May and December 2022, these prototype guidelines will be tested in a number of real-life cases of citizen science initiatives. Each case will have a unique pilot plan and based on its context and needs will choose to focus on certain recommendations of the guidelines. The results from the pilot phase will feed into an updated version of the guidelines that is planned to be published in April 2023.

## 7. References

1. European Commission (2020). Staff Working Document “Best practices in citizen science for environmental monitoring.” Retrieved from: [https://ec.europa.eu/environment/legal/reporting/pdf/best\\_practices\\_citizen\\_science\\_environmental\\_monitoring.pdf](https://ec.europa.eu/environment/legal/reporting/pdf/best_practices_citizen_science_environmental_monitoring.pdf)
2. Hecker, S., In Haklay, M., In Bowser, A., In Makuch, Z., In Vogel, J., & In Bonn, A. (2018). Citizen science: Innovation in open science, society and policy. <https://doi.org/10.14324/111.9781787352339>
3. Vohland, K., Land, A., Ceccaroni, L., Lemmens, R., Perelló, J., Ponti, M., Samson, R., Wagenknecht, K. (Eds.) (2021) The Science of Citizen Science. Springer, <https://www.springer.com/de/book/9783030582777>
4. Huyse, H.; Bachus, K.; Merlevede, T.; Delanoeije, J.; Heidi Knipprath, H. (2019). Societal Impact of the Citizen Science Project “CurieuzeNeuzen Vlaanderen”: Final report. 2019. Publisher: HIVA-KU Leuven
5. Van Brussel, S., & Huyse, H. (2019). Citizen science on speed? Realising the triple objective of scientific rigour, policy influence and deep citizen engagement in a large-scale citizen science project on ambient air quality in Antwerp. *Journal of Environmental Planning and Management*, 62(3), 534-551. <https://doi.org/10.1080/09640568.2018.1428183>
6. Schaefer, T., Kieslinger, B., & Fabian, C. M. (2020). Citizen-Based Air Quality Monitoring: The Impact on Individual Citizen Scientists and How to Leverage the Benefits to Affect Whole Regions. *Citizen Science: Theory and Practice*, 5(1), 6. DOI: <http://doi.org/10.5334/cstp.245>
7. Rose, D. (2014). Five ways to enhance the impact of climate science. *Nature Climate Change*, 4 522-524. <https://doi.org/10.1038/nclimate2270>
8. WeObserve Impact Community of Practice. (2021). CSISTA Impact Inquiry Instrument. Zenodo. <https://doi.org/10.5281/zenodo.4543603>
9. Psaltoglou, A., et al., (2021) D1.3 Requirements and motivations of quadruple helix stakeholders for active engagement in the Citizen Science. Retrieved from: <https://incentive-project.eu/wp-content/uploads/2021/07/INCENTIVE-D1.3.pdf>
10. Mayer, K., Kieslinger, B., Schäfer, T & Schürz, S., (2021). Participatory evaluation in citizen science. Citizen Science Association Conference 2021 (CitSciVirtual 2021). Zenodo. <https://doi.org/10.5281/zenodo.4820791>.
11. Maccani G., Goossensen M., Righi V., Creus J. and Balestrini M., Scaling up Citizen Science - What are the factors associated with increased reach and how to lever them to achieve impact, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-25157-6, doi:10.2760/00926, JRC122219 .
12. European Commission, Directorate-General for Environment, (2018). Citizen science for environmental policy: development of an EU-wide inventory and analysis of selected practices, Publications Office. <https://data.europa.eu/doi/10.2779/961304>
13. Gharesifard, M., Flanagan, B. (2021). D1.2: 4 case studies on good practice. Deliverable report of the CitiMeasure project (grant agreement No 101046124), Brussels, Belgium.
14. Zwickle, A., & Jones, K. (2018). Sustainability Knowledge and Attitudes—Assessing Latent Constructs. In (pp. 435-451). [https://doi.org/10.1007/978-3-319-67122-2\\_25](https://doi.org/10.1007/978-3-319-67122-2_25)
15. Ponti M. & Craglia M. (2020) Citizen-generated data for public policy, European Commission, Ispra, JRC120231.
16. Latham, M., and Ceccaroni, L. (2021). D4.5: Report on policymaker engagement and awareness-raising activities. EU-Citizen.Science.



17. Camacho, P. and García, F. S. (2021). D4.4: Report on the outcomes of the case study for the implementation of policy recommendations for citizen science. Deliverable report of project H2020 EU-Citizen.Science (grant agreement No 824580).
18. de Vries, G. (2020), Public Communication as a Tool to Implement Environmental Policies. *Social Issues and Policy Review*, 14: 244-272. <https://doi.org/10.1111/sipr.12061>
19. De Meyer, K., Coren, E., McCaffrey, M., & Slean, C. (2020). Transforming the stories we tell about climate change: from 'issue' to 'action'. *Environmental Research Letters*.
20. Fogg-Rogers, L., Hayes, E., Vanherle, K., Pápics, P. I., Chatterton, T., Barnes, J., Slingerland, S., et al. (2021). Applying Social Learning to Climate Communications—Visualising 'People Like Me' in Air Pollution and Climate Change Data. *Sustainability*, 13(6), 3406. MDPI AG. Retrieved from <http://dx.doi.org/10.3390/su13063406>
21. Laggan, S., Sardo, M., Franchois, E., Bracke, A., & Maccanni, G. (2021) Citizen science on urban mobility - A practitioner's guide to evaluation, engagement and policy change. Zenodo. <https://doi.org/10.5281/zenodo.5742726>
22. Cohen, K., In Doubleday, R., & Centre for Science and Policy. (2021). Future directions for citizen science and public policy.
23. Kocman, D., et al., (2019). Deliverable 2.1: Compilation of good practices in governance models, in research protocols, in boom-up impact assessment, and in informing policy making and local governments. CitiS-Health project
24. Woods, M., Balestrini, M., Bejtullahu, S., Bocconi, S., Boerwinkel, G., Boonstra, M., Boschman, D-S., Camprodon, G., Coulson, S., Diez, T., Fazey, I., Hemment, D., van den Horn, C., Ilazi, T., Jansen-Dings, I., Kresin, F., McQuillan, D., Nascimento, S., Pareschi, E., ... Seiz, G. (2018). Citizen Sensing: A Toolkit. Making Sense. <https://doi.org/10.20933/100001112>
25. Vivas Lalinde, Gharesifard, M., Flanagan, B. (2021). D1.1: Report of landscape review. Deliverable report of the CitiMeasure project (grant agreement No 101046124), Brussels, Belgium.
26. Rebeiro-Hargrave, A., Fung, P. L., Varjonen, S., Huertas Suarez, A. F., Sillanpää, S., Luoma, K., Hussein, T., Petäjä, T., Timonen, H., Limo, J., Nousiainen, V., & Tarkoma, S. (2021). City Wide Participatory Sensing of Air Quality. *Frontiers in Environmental Science*. <https://doi.org/10.3389/fenvs.2021.773778>
27. Berti Suman, A. (2021). *The Policy Uptake of Citizen Sensing*. Edward Elgar.
28. Berti Suman A. (2020) "Sensing the risk. A case for integrating citizen sensing into risk governance". Open Press TiU. ISBN: 978-94-6240-631-5.
29. Leeuwen, van, J. P. J., Rijken, D., Bloothoofd, I. I., & Cobussen, E. E. (March 31, 2020). Finding New Perspectives through Theme Investigation. *The Design Journal. an International Journal for All Aspects of Design*, 23, 3, 441-461. DOI: 10.1080/14606925.2020.1744258
30. Thuermer, G., (2022). Participatory science toolkit against pollution
31. Notermans, V.I., Montanari, M. C., Janssen, A., Hölscher, K., Wittmayer, J.M., & Passani, A. (2022). Recommendations to mainstream citizen science in policy. ACTION project. DOI: 10.5281/zenodo.5772236
32. Phillips, T, et al. 2018. A Framework for Articulating and Measuring Individual Learning Outcomes from Participation in Citizen Science. *Citizen Science: Theory and Practice*, 3(2): 3, pp. 1–19, DOI: <https://doi.org/10.5334/cstp.126>
33. Misonne, Delphine. (2020). The emergence of a right to clean air: Transforming European Union law through litigation and citizen science. *Review of European, Comparative & International Environmental Law*. 10.1111/reel.12336. <https://doi.org/10.1111/reel.12336>

34. Mollie Latham, & Luigi Ceccaroni. (2020). Deliverable 4.1: Guidelines and Recommendations Based on a Range of Best Practices for Achieving Societal and Policy-Maker Engagement. Zenodo. <https://doi.org/10.5281/zenodo.3690772>
35. Gharesifard, M. (2020). Community-based monitoring initiatives of water and environment Evaluation of establishment dynamics and results. <https://doi.org/10.1201/9781003131243>
36. Ajzen, I. (2005). *Attitudes, personality, and behavior*: McGraw-Hill International.
37. Berti Suman, A., Schade, S., & Abe, Y. (2020). Exploring legitimization strategies for contested uses of citizen-generated data for policy. In B. J. Richardson (Ed.), *From student strikes to the extinction rebellion: New protest movements shaping our future* (Special issue ed., Vol. 11, pp. 74–102). Edward Elgar Publishing Ltd. <https://doi.org/10.4337/9781800881099.00008>
38. Cologna, V., & Siegrist, M. (2020). The role of trust for climate change mitigation and adaptation behaviour: A meta-analysis. *Journal of Environmental Psychology*, 69, 101428. <https://doi.org/https://doi.org/10.1016/j.jenvp.2020.101428>
39. Kieslinger, B., Schaefer, T., Heigl, F., Dörler, D., Richter, A., & Bonn, A. (2017). The Challenge of Evaluation: An Open Framework for Evaluating Citizen Science Activities. <https://doi.org/10.17605/OSF.IO/ENZC9>
40. Weyhenmeyer, G. A., Mackay, M., Stockwell, J. D., Thiery, W., Grossart, H. P., Augusto-Silva, P. B., Baulch, H. M., de Eyto, E., Hejzlar, J., Kangur, K., Kirillin, G., Pierson, D. C., Rusak, J. A., Sadro, S., & Woolway, R. I. (2017). Citizen science shows systematic changes in the temperature difference between air and inland waters with global warming. *Scientific reports*, 7, 43890. <https://doi.org/10.1038/srep43890>
41. Wehn, U., Gharesifard, M., Ceccaroni, L., Joyce, H., Ajates, R., Woods, S., Bilbao, A., Parkinson, S., Gold, M., & Wheatland, J. (2021). Impact Assessment of Citizen Science: State of the Art and Guiding Principles for a Consolidated Approach. *Environmental Impact Assessment Review*, 16, 1683-1699. <https://doi.org/10.1007/s11625-021-00959-2>
42. Passani, A., Janssen, A.L., Hoelscher, K. (2020), Impact assessment methodological framework v.1. <https://doi.org/10.5281/zenodo.4432132>
43. Abrahamse, W., & Matthies, E. (2012). Informational strategies to promote proenvironmental behaviours: Changing knowledge, awareness, and attitudes. *Environmental psychology: An introduction*, 223-232.
44. Enda Hayes, & Jo Barnes. (2020). D3.6 Environmental justice report. Zenodo. <https://doi.org/10.5281/zenodo.3972936>
45. Emily Prestwood, Laura Devito, Enda Hayes, & Jim Longhurst. (2017). D6.3 Evaluation of approaches cities take to emission footprints and city carbon initiatives. Zenodo. <https://doi.org/10.5281/zenodo.3972677>
46. Stephan Slingerland, & Irati Artola. (2020). D7.6 Final Cross–City Policy Analysis Report. Zenodo. <https://doi.org/10.5281/zenodo.3972951>
47. Lämmerhirt, Danny & Jameson, Shazade & Prasetyo, Eko. (2016). Making citizen generated data work: Towards a framework strengthening collaborations between citizens, civil society organisations, and others. CIVICUS. <http://dx.doi.org/10.2139/ssrn.3320485>
48. Sarigiannis (2020) D8.11 Report on recommendation for policy makers
49. ICARUS (2018) Integrated Climate forcing and Air pollution Reduction in Urban Systems
50. Vaittinen, I., et al (2019). D7.11 Living Labs for Air quality knowledge and policy package
51. Vaittinen, I., et al (2019). D7.11 Living Labs for Air quality knowledge and policy package (Policy Brief No 2. The Citizen Engagement in Science and Policy Manifesto)
52. Vaittinen, I., et al (2019). D7.11 Living Labs for Air quality knowledge and policy package (Policy brief No.9. Citizen science: A collaborative approach to air pollution control)

- Moczek, N., Voigt-Heucke, S. L., Mortega, K. G., Fabó Cartas, C., & Knobloch, J. (2021). A Self-Assessment of European Citizen Science Projects on Their Contribution to the UN Sustainable Development Goals (SDGs). *Sustainability*, 13(4), 1774. MDPI AG. Retrieved from <http://dx.doi.org/10.3390/su13041774>
53. Chapman, C., & Hodges, C. (2017). Can Citizen Science Seriously Contribute to Policy Development?: A Decision Maker's View.
  54. Honkoop, J. (2020) SCIENTIA POTENTIA EST? A diverse case analysis of the process through which citizen science coalitions attempt to change Dutch air quality policy and the way it is made. Erasmus School of Social and Behavioural Sciences, Erasmus University Rotterdam, The Netherlands.
  55. Schäfer, T., & Kieslinger, B. (2016). Supporting emerging forms of citizen science: a plea for diversity, creativity, and social innovation.
  56. Kythreotis, A. P., Mantyka-Pringle, C., Mercer, T. G., Whitmarsh, L. E., Corner, A., Paavola, J., Chambers, C., Miller, B. A. & Castree, N. (2019). Citizen Social Science for More Integrative and Effective Climate Action: A Science-Policy Perspective. *Frontiers in Environmental Science*, 7 (10), 1-10. <http://dx.doi.org/10.3389/fenvs.2019.00010>
  57. Veeckman, C., & Temmerman, L. (2021). Urban Living Labs and Citizen Science: From Innovation and Science towards Policy Impacts. *Sustainability*, 13(2), 1-15. [526]. <https://doi.org/10.3390/su13020526>
  58. Williams, C. R., Burnell, S. M., Rogers, M., Flies, E. J., & Baldock, K. L. (2021). Nature-Based Citizen Science as a Mechanism to Improve Human Health in Urban Areas. *International journal of environmental research and public health*, 19(1), 68. <https://doi.org/10.3390/ijerph19010068>
  59. Schade, S., Manzoni-Brusati, M., Tsinaraki, C., Kotsev, A., Fullerton, K., Sgnaolin, R., ... & Mitton, I. (2017). Using new data sources for policymaking. Luxembourg: Publications Office of the European Union. DOI: <https://doi.org/10.2760/739266>