This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement n° 101037648 – SOCIO-BEE

SOCIO-BEE
Community for Change

Grant Agreement No: 101037648
[H2020-LC-GD-2020-3]

Wearables and droneS fOr CIty Socio-Environmental Observations and Behavioral ChangE

Deliverable

D7.1. Case study analysis assessing impact of citizen science

Workpackage No.	**WP7**	Workpackage Title	**Socio economic sustainability of SOCIO-BEE**
Task No.	**T7.1**	Task(s) Title(s)	**Systematization and Identification of SOCIO-BEE contribution to decision making and policy translation**
Lead beneficiary		**UNIPD**	
Dissemination level		***PU***	
Nature of Deliverable		***R***	
Delivery date		**31 July 2023**	
Status		**F: final**	
File Name:		**[SocioBee] D7.1 – CaseStudyAnalysis_version1.3.docx**	
Project start date, duration		**01 October 2021, 36 Months**	

Authors List

Leading Author (Editor)				
Surname		*Initials*	*Beneficiary Name*	*Contact email*
Sarcina		AS	UNIPD	andrea.sarcina@unipd.it
Co-authors (in alphabetic order)				
#	*Surname*	*Initials*	*Beneficiary Name*	*Contact email*
1	Amadei	CA	UNIPD	claudia.amadei@unipd.it
2	Greco	LG	UNIPD	luciano.greco@unipd.it
3				
4				
5				

Contributors (in alphabetic order)				
#	*Surname*	*Initials*	*Beneficiary Name*	*Contact email*
1	Dosi	CD	UNIPD	cesare.dosi@unipd.it
2	D'Alpaos	CDA	UNIPD	chiara.dalpaos@unipd.it
3				
4				
5				

Reviewers List

List of Reviewers (in alphabetic order)				
#	*Surname*	*Initials*	*Beneficiary Name*	*Contact email*
1	Grigoriadis	DG	HYP	d.grigoriadis@hypertech.gr
2	Illueca Fernández	EIF	HOPU	eduardo.illuec@libelium.com

Document History			
Date	*Version*	*Author*	*Description*

List of definitions & abbreviations

Abbreviation	Description
CBA	Cost-Benefit Analysis
CS	Citizen Science
KPI	Key Performance Indicators
SDG	Sustainable Development Goal
UN	United Nations

Executive Summary

This document presents the state of the art of citizen science (CS) projects and their implementation both in the literature and in practice. The scope is to provide the reader with a description of what are the possible outcomes of these projects and how they may be evaluated to assess the degree of success of the endeavour. The outcomes, the evaluation, and the subsequent translation of the results into longer-term effects may be linked either to direct project effects or policy translation of the results.

The initial literature review provides a brief description of what is understood to be the economic impact assessment and its application in the context of CS projects. The review highlights how the economic assessment of such projects often aims to capture a series of intangible effects, such as, for example: the increase in participation, the increased environmental sensibility, or the strengthening of community bonds. At the same time, despite providing some techniques for the quantification of such dimensions, there is a generalised lack of techniques suited for the translation of collected data into monetary measures of costs and benefits.

The following sections, focusing on the analysis of case studies and highlighting the heterogeneity of the recorded projects, detected a generalised lack of *ex-ante* and *ex-post* assessments. Even when an impact analysis could be found, the projects selected to be as comparable as possible to SOCIO-BEE showed a constant lack of standardisation. As the case study section clarifies, the solutions that are chosen to face typical challenges posed by the CS projects are often tailor-made and hard to replicate outside the specific situation they were developed for.

Another constant both in the literature and in the analysis of case studies is that the economic impact analysis is often limited to the cost-effectiveness analysis. This is possibly due to the ready availability of data on costs. In the same vein, the few examples of cost-benefit analyses (CBAs) often quantify their benefits in saved costs (e.g., Ferri et al. [1]), instead of carrying out a systematic quantification and monetization of the effects that are usually associated with this kind of project.

The lack of information about projects beyond the deadline of the granting period implies two additional problems. First, it is difficult to estimate the survival rate of the projects or projects' effects after the granting period. Second, it is also difficult to assess the impact and influence of such projects on policies.

Table of Contents

List of Figures

List of Tables

1 Introduction

1.1 Purpose of the document

One of the prerequisites for a successful CS project is to provide evidence of its impact. While a clear-cut definition of impact assessment in the domain of CS is still missing, there has been some progress in the literature and in the practical implementation one can draw from Gertler et al. [2]. Indeed, the systematization of the impact assessment literature's state of the art is the starting point to build upon in the steps towards the definition of an integrated methodology for the impact assessment of CS initiatives.

This work aims to provide an overview of the status quo in the socio-economic evaluation of CS Projects, both through a theoretical review of the existing methodologies proposed in the literature and through a case study analysis of the practical implementation in the context of previous CS initiatives. Both the theoretical perspective and the case study analysis aim to inquire whether there is consensus within the community of experts (i.e., academics and practitioners) on methodologies and approaches, in addition to highlighting areas for intervention and testing of proposed methodologies. The literature is expected to have a more generalist take on evaluation methodologies, proposing solutions that can be applied to a variety of different projects, and its integration with case studies proves useful in testing whether those proposed solutions can be successfully applied in a real-world scenario.

This work will lead to the identification of the best practices currently in use, as well as to the description of the main challenges encountered in the implementation of socio-economic impact evaluation in the context of CS. Indeed, most benefits are often expected to be non-pecuniary in nature and, hence, more difficult to quantify. Moreover, it is of the foremost importance to clearly define, since the beginning of the project, the objectives and the scope of the action, and thus identify the impacts to be deepened throughout the evaluation. The absence of this crucial first step hinders the proper implementation of impact evaluation and may also generate confusion among project partners on the main goals of the evaluation. The achievement of this first step will guide the impact assessment process both through the clarification of the objectives to reach, and the choice of the fitter methodologies to the purpose.

1.2 Relationship with other deliverables

The current work lays the foundation for deliverables 7.3 and 7.4 “Cost-benefit analysis guidelines” (first and second releases), as well as for D7.5 “Guidelines on possible financing strategies for citizen science platform”. Following, this deliverable will be updated by the end of the project in D 7.2 (see Table 1)

Table 1 - Deliverables summary table

Deliverable	Title	Due time	Month – Year
D7.2	Report on requirements for data-driven decision making	M35	August 2024

D 7.3	Cost-Benefit analysis guideline (1st issue)	M25	October 2023
D 7.4	Cost-Benefit analysis guideline (2nd issue)	M36	September 2024
D 7.5	Guidelines on possible financing strategies for citizen science platform	M36	September 2024

The work inquiries about the currently applied methodologies in the CS domain, with particular attention on the gaps to be filled, for example: the expected outcomes, their quantification, and possibly their monetisation. The study will expand on the existence of widespread methodologies or their potential applicability to the SOCIO-BEE case.

The development of a new methodology will fine-tune with the specific case of SOCIO-BEE to pursue flexibility and replicability of the action. Both characteristics will enable the methodology to be adapted to the different needs of future initiatives and will provide a level playing field for CS evaluation.

The insights on the policy role of past CS initiatives will also prove useful for the downstream development of deliverable D7.2 “Report on requirements for data-driven decision making”, aiming to assess the results of CS projects and their translation into policies.

2 Literature Review: Economic Impact on Citizen Science

This paragraph introduces the academic take on the concept of CS, what it is considered to be, what are the most common outcomes of CS projects, how to quantify them, and possibly how to monetise them. A unique definition of CS is yet to be found in the literature. In fact, it is possible to find different variations of the same [3]. Nonetheless, those definitions share the underlying idea of involving non-professional scientists in a project, who contribute to the activities of professional scientists. To give a few examples:

> *"The scientific activities in which non-professional scientists volunteer to participate in data collection, analysis, and dissemination of a scientific project."*
>
> *[4]*
>
> *"Any activity that involves the public in the scientific research and thus has the potential to bring together science, policymakers, and society […] in an impactful way. […] all people can participate in many stages of the scientific process."*
>
> *(EU-Citizen.Science)*
>
> *"Citizen science is the involvement of the public in scientific research, whether community-driven research or global investigations."*
>
> *(Citizen Science Association (US))*

In this sense, Haklay et al. identify over thirty definitions of the same concept, highlighting how, both in the academic and the political debate, the question of what exactly is a CS project remains to be settled [3]. As already argued, some common ground characterizes all existing definitions. For example, it is clear the involvement of the so-called "public" or "general public" in the project (32% of the cases). Even if not specified, in the context of most of the definitions, it is possible to assume that the public does not comprise professionally trained researchers. However, – and quite relevant to the purpose of this document – not all definitions agree on the *voluntary nature* of citizens' efforts in such projects. Unsurprisingly, the lack of any form of monetary compensation impacts the economic feasibility of the assessment of any CS project.

Additionally, the various definitions often refer to a generic scientific activity, without specifying how this should be intended and how it should be operated. A few definitions of CS also include the need for data collection activities and possibly subsequent analysis and interpretation. However, according to the bulk of definitions of CS, the following features characterize CS projects:

1) A scientific activity, meaning any research applying the scientific method,
2) The participation of trained researchers,
3) The support of a non-defined amount of non-trained researchers in the aforementioned activity.

2.1 The impacts and their economic evaluation

Having clarified the concept of CS, let us now focus on the kind of impacts of CS projects and, subsequently, on their *economic evaluation.* The former can be defined as the outcomes of a project and its effects on a set of variables of interest both directly quantifiable (e.g., air quality, income) and not (e.g., environmental sensitivity, public perception of the topic, quality of life). The economic evaluation, on the other hand, can be defined as *"the comparative analysis of alternative courses of action in terms of both their costs and their consequences"* [6]. However, we should point out how this definition does not provide any clarification about the concept of consequences, the timing of the evaluation and the methodologies to be applied.

Quite trivially, it is possible to imagine an economic assessment of any kind to be concerned with monetary values. On the one hand, this fact possibly clarifies the scope of any of these inquiries but, on the other, it may provide a false sense of understanding. Quantifying and comparing costs and benefits to obtain the net value generated by a project may leave anyone wondering why such an endeavour should be deemed necessary for projects with little to no prospects of generating a positive balance between benefits and costs.

Additionally, the concept of consequence implies a causal link between at least two events, leaving to the analysis the burden of identifying (i.e., demonstrating and quantifying) the relationship.

Finally, when to perform the analysis is to be decided. The decision on whether any effort should be spent before or after the beginning of the studied event depends on the case and on the needs of those both requiring and performing the analysis. The definition seems to favour the *ex-post* analysis since the consequences of any human activity are visible only after the event, but there is scope also for *ex-ante* analysis, which is valuable during the planning and decision-making phase.

In this sense, the impact (i.e., effect or consequence) evaluation is a particular type of evaluation aiming to answer the question: what is the causal effect of a program on an outcome of interest? This means that the scope of the analysis is to evaluate only the changes directly attributable either to a project, its modality or design innovation [2]. The economic dimension of such analysis is obtained through the study of economic activities as variables of interest, such as [7]:

1) Business output,
2) Value added,
3) Wealth (and property values),
4) Personal income,
5) Jobs.

An important question is whether the economic analysis should focus only on (market) economic indicators. In general, the answer is negative. Non-market economic values are very important to understand and measure the functioning of economies or, more in line with the scope of this document, to the impacts of projects and policies. As an example, few of the most common benefits linked to CS

projects is the collection of vast amounts of data, knowledge and skills gains (i.e., increase in human capital), local action, and policy influence. How those gains will distribute among the communities at large is a matter of representativity and, hence, diversity among participants. An inquiry on the topic pointed out how males are more likely to participate in such projects than women, and members of the white ethnic group are more likely than minorities members. As consequence, minority women participation is particularly low [8]. How to quantify the impacts of such inequality and how to evaluate them it is an issue that the literature still must face.

As Economics is mostly concerned with economic values, usually expressed in monetary terms, the scope of the analysis may be simply to prove the mere existence of an economic profit, but it might also be to investigate the cost-effectiveness of the endeavour, to demonstrate the opportunity of starting a project, or to show that the allocated resources were not wasted. Depending on the aim of the inquiry, the methods vary accordingly.

The monetary values used in the analysis might be the market prices when the inputs or the outputs of the project are "market goods" (i.e., exchanged in existing markets). This is possible as long as the market is "perfect". In this case, the prices provide a reliable measure of welfare through which quantifying the social opportunity cost of the used resources. Since perfect markets are often distorted (e.g., due to supply restrictions, fiscal policies, monopolies) the alternative is to estimate the "shadow prices", meaning the prices that would otherwise emerge in an ideal "perfect" market.

Another kind of monetisation problem often arises regarding the project's outputs. Those may be "non-market goods" (e.g., externalities) and the monetary value must be assigned via estimation techniques (e.g., State-preference surveys, Revealed-preference methods, Value transfer). The choice of the most appropriate methodology closely relates to the costs involved in the evaluation process, namely one should prefer those methodologies that reduce the efforts involved in the evaluation.

In the following subsection, a list of possible methodologies will be presented, with the specification of the declared aims, advantages, and drawbacks.

2.2 Methodologies

Following Rudmik & Drummond it is possible to provide a list of possible alternatives for the economic evaluation [9].

Cost minimisation: it is the simplest form of analysis. It compares the costs of at least two alternatives, and it prefers the cheapest one. The implicit assumption of this kind of analysis is that all outcomes (which do not correspond to costs) are invariant across alternatives. This kind of analysis is quite simplistic and, particularly in the case of environmental projects, can rarely be applied without incurring considerable errors.

Cost-effectiveness analysis (CEA): by fixing a set of key performance indicators (KPIs), this type of analysis aims to evaluate how much it costs to achieve a quantifiable (but non-monetary) objective. An example may be the cost-per-data collected.

The intrinsic advantage of this kind of analysis is the use of KPIs that, once reached, already demonstrate the effectiveness of the project. Additionally, the ratio between costs and the selected indicator of interest provides a handy tool for subsequent comparison among similar studies.

At the same time, it is difficult to compare the cost-effectiveness of projects that differ in the type of KPIs. Additionally, this kind of assessment simply considers the cost-per-unit of pursuing an already defined course of action, without allowing to estimate the opportunity cost of pursuing an alternative. In turn, CEA cannot provide any *ex-ante* indication on the best allocation of resources (unless the research relies on experience from similar projects, though with the intrinsic consequences in terms of "external validity" of past assessments).

Cost-utility analysis: this type of analysis can be considered as a special case of CEA, and it is usually applied in health economics. In this case, instead of computing the ratio of costs per data, the analysis' result is usually summarised by the ratio between the costs and a numerical indicator of the stakeholders' preferences. In health economics applications this preference is assumed to be "being in perfect health" and it is represented by the QALY (Quality-Adjusted Life Years).

The QALY is a numerical indicator ranging from 0 (dead) to 1 (perfect health) representing the disease burden of an additional year of life, usually following a medical intervention. Then, the obtained numerical value can be equal to or less than the number of added years (e.g., if an intervention is estimated to add a total of three additional years, then QALY may take values between 3 and 0, depending on the estimated quality of life).

The analysis outcome might then be summarised by the ratio between the costs and the computed QALY value, and eventually compared with similar interventions.

Cost-benefit analysis: this is considered the most comprehensive economic assessment method and finds its theoretical background in the welfare economics theory.

In this type of analysis, all the studied variables are expressed in monetary terms, and when it is done correctly this method is the most suited to inform allocation decisions. Thanks to its structure, it is possible to compare different alternatives and projects, allowing decision-makers to assess the (social) return-on-investment even among projects that differ in the type of outcomes.

A major issue with this kind of analysis is the heavy data requirement for its conduct, and even when those requirements are met, there are still methodological issues regarding the monetisation of the data. Many outcomes may be intangible or hardly mediated by the markets, hence having no price attached. How to convert quantitative data into monetary values is an endeavour that usually requires an *ad-hoc* methodology, then adding to the degree of complexity of the analysis.

Following Philippe et al. it is possible to add two additional methodologies to the ones enumerated so far [10].

1) **Return on Investment (ROI):** this cannot be considered an analysis type by itself, but for simple projects, this indicator may provide useful indications of the financial feasibility. The ROI is an economic indicator structured as a ratio between the net income and the initial investment of a project and focuses only on the financial dimension of the project (i.e., income vs investment),

and should be considered more as an efficiency metric useful for comparison rather than a fully-fledged analysis. Often it should be used together with other indicators, but ROI can provide a useful initial evaluation of the financial performance of the project. This method has its limitation in its simplicity and in the need for the project to have a financial return, which is not always the case, then making even this simple evaluation impossible.

2) **Multicriteria Analysis (MCA):** This analysis is a middle ground between the two extremes of leaving full freedom to the decision maker and letting her choose any alternative without a clear rationale, or introducing a more or less restrictive hypothesis to allow the allocation problem to be solved through the classical tools of mathematical optimisation analysis [11]. In this sense, the multicriteria method combines the mathematical modelling (and its necessary restrictive assumptions) with the information and needs of the decision maker, allowing the decision maker to construct the solution, instead of providing her one. The MCA has the advantage of providing the tools to assess the qualitative, alongside the quantitative dimension, of impact.

The ROI is used as a tool to compare different investment alternatives within a portfolio. Usually, the alternative with the highest ROI values is the one prioritised. What must be taken into account, is the lack of time-adjustment of the metric, hence not considering any discounting factor in the computation. Additionally, the ROI accrues both long-term and short-term investments, and it does not provide any useful indication of how to distinguish the two categories, making it impossible to determine either the relevance or riskiness of the investments.

As for ROI, the MCA is not directly concerned with the passing of time, but instead of focusing on the financial dimensions of the project, it focuses on associating a “weight” to each of the policymakers’ alternatives. These alternatives are different dimensions or variables to be considered by the decisionmakers and, since these variables (criteria) may be conflicting, the “weights” should guide the decisions.

Still, the MCA cannot be reduced to mere problem-solving. Solving a multicriteria decision problem is similar to a compromise, dependent on declared preferences, preference structures, and preference aggregation structures. The aim is to guide the decisionmakers in coping with the complex data involved in their problem and helping them to advance towards a solution [12]. Finally, the multicriteria problems are ill-defined mathematical problems, hence with no objective solution. As a consequence, there is no “optimal” solution.

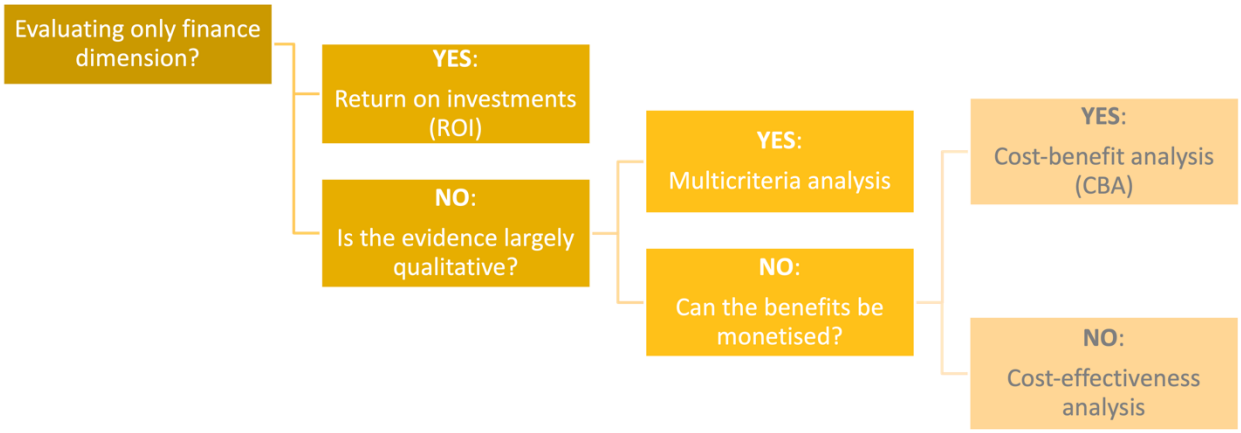


Figure 1: Evaluation model choice map (Authors elaboration on Philippe et al., 2016).

As a final step, the problem of choosing the right method to apply for the project assessment should be addressed. Aside from the intrinsic strength and weaknesses of each one of the methods shown so far, the decision tree in Figure 1 provides a preliminary guide on what to apply and when[1].

In conclusion, the definition of impact as the consequence of an action may be interpreted differently. The analyst should have clear in mind what an impact is in the context while considering what data are available and what she aims to highlight with the analysis, alternatively: financial soundness, decision guidance, cost optimisation, external effects, and choose accordingly.

[1] It must be kept in mind that the tree does not provide a ranking among the methods according to the appropriateness or difficulty of the analysis. Rather, it focuses more on the data requirements and the scope of the analyses. As an example, the MCA is not a simpler version of the CBA, but the former does not require the data to be translated in monetary terms (data requirements), even if both provide guidance to decisionmakers (scope).

2.3 CBA impact analysis in the European guidelines and the literature

The European Union (EU) has established guidelines for conducting a CBA to ensure that projects funded by EU programs align with the principles of economic efficiency, effectiveness, and sustainability. These guidelines are particularly relevant for the 2014-2020 programming period and apply to various EU funding programs, including the European Structural and Investment Funds (ESIF), Horizon 2020, and Horizon Europe (see Regulation (EU) 2021/1060 [13]).

The primary document outlining the European guidelines for CBA is the "Guide to Cost-Benefit Analysis of Investment Projects" (CBA Guide). This guide provides a comprehensive framework and methodological principles for conducting CBAs of projects seeking EU funding. The CBA Guide serves as a reference for project promoters, evaluators, and stakeholders involved in the project appraisal process.

The CBA Guide covers essential aspects of conducting a CBA, ensuring a consistent and standardized approach across different projects. Some key components of the guidelines include:

1. Scope and Boundaries: The guidelines emphasize the definition of the project's scope and its boundaries to ensure that all relevant costs and benefits are considered. This includes identifying the project's objectives, alternatives, and the timeframe for analysis.

2. Cost Identification: The guidelines guide the identification and the quantification of the costs associated with the project. This includes both initial investment costs as well as recurring costs over the project's lifecycle. The guidelines also stress the importance of considering opportunity costs and the appropriate treatment of inflation.

3. Benefit Identification: The guidelines outline the process of identifying and quantifying the benefits generated by the project. These benefits can be economic, social, or environmental in nature. The guidelines encourage a comprehensive assessment of both market and non-market benefits, taking into account factors such as job creation, improved public health, reduced congestion, and environmental sustainability.

4. Discounting and Time Horizon: The guidelines guide the discounting of future costs and benefits to present value. They specify the discount rate to be used for EU projects and highlight the importance of considering the appropriate time horizon for the analysis.

5. Sensitivity Analysis: The guidelines recommend conducting a sensitivity analysis to assess the robustness of the CBA results. This involves testing the impacts of different assumptions and variables to evaluate the sensitivity of the project's outcomes to changes in these factors.

6. Reporting and Documentation: The guidelines stress the importance of clear and transparent reporting of the CBA methodology, assumptions, and results. This includes providing a detailed description of the project, the analysis process, and the CBA findings. The documentation should be easily understandable and accessible to stakeholders and decision-makers.

It is essential to note that while the European guidelines for CBA provide a general framework, specific requirements may vary depending on the EU funding program or the country where the project is being implemented. Therefore, project promoters should also refer to the specific guidelines and regulations

provided by the relevant funding program or national authorities to ensure compliance with the applicable requirements.

The official website of the European Commission provides the most up-to-date tools and information for those wishing to follow the outlined methodology [14].

As seen before, the CBA analysis is a demanding endeavour in terms of data requirements. Since setting up a CS data-collection project is a costly undertaking, with the cost ranging from a minimum of 37 € per observation to a maximum of 300 € per observation [15], it is paramount to understand whether the effort is worth the cost.

Additionally, since the impact evaluation assesses the changes that can be attributed to a particular intervention, such as a project, program or policy, both intended ones, as well as ideally the unintended ones [2], it poses the question of what are the changes that should be considered and how they should be quantified.

The problem is particularly relevant in the case of a CBA since, as the analytical tool often used for the assessment of public interventions, with a particular focus on public welfare effects rather than the investors' profits, it prerequires the possibility of translating each measured impact into monetary values [16].

This issue becomes particularly relevant in conjunction with the so-called externalities, which are defined as "*the indirect effects of consumption or production activity effects on agents other than the originator of such activity which does not work through the price system*" [17]. Since the externalities stem their effect on the economy without the need for market intermediation, their existence puts into question any analysis conducted through market prices, since prices may then be imperfect information carriers. The monetisation process is still always possible, even if it becomes increasingly difficult as the evaluation object strays away from market intermediation. For example, pollution and, more in general, environmental variables, are rarely priced by markets, hence requiring specific methodologies for their pricing, which leave room for discussion on the best approach to follow.

Given the difficulty in identifying the outcomes of CS projects, and once done in quantifying and evaluating them, the literature shows a general lack of benefit evaluation techniques. In the literature, there are examples of assessments focusing more on cost evaluation techniques rather than benefit qualification and quantification. Just to give a few examples:

- Benefits evaluated in terms of time invested in engagement and training activities versus the sampling and measurement of saved time [18]: they highlight how the collaboration with non-professionals, even considering the time and costs involved in their training, can be worth the effort. Nevertheless, the risk of biases in data sampling location and frequency should be accounted for.
- Evaluation in terms of cost-per-observation [19]: in this case, the authors compare the cost of the data-collection activity between the case of a CS project using only volunteers and a project using paid collaborators (still, not professional researchers).

Philippe et al. enumerates various possible benefits connected with CS projects, subdividing them according to the most affected stakeholder category. However, while they provide suggestions on benefit quantification techniques, they usually do not suggest monetisation methodologies for each of those benefits [10].

In general, the literature proposes several possible quantification techniques of benefits of CS projects, such as:

- Tulloch et al. focus on the project influence in the scientific literature. In the paper, the authors use the ROI technique to provide a benefit quantification. They compare the benefit, estimated either in the number of publications or the citation number linked to the CS projects under study, to the investment cost, usually quantified with the average annual cost for volunteers and coordinators [20].
- Chao et al. focus on identifying the qualitative variables influencing both environmental attitude and environmental behaviour. The former refers to the intention to solve or, at least, make a contribution to solving an environmental issue. Instead, the latter refers to the extent to which an individual is willing to take action to protect the environment. Despite the study being aimed at testing a decision-making model, the article provides a series of qualitative variables and methods to quantify them [21].
- Conrad & Daoust highlight how the communities want to be involved and understand the need to participate in any project, by providing a framework to assess the progress of any community-based monitoring action. The progress can be assessed by defining a series of performance indicators (i.e., KPIs), also of qualitative nature, and by quantifying them through observation and survey [22].
- Milfont & Duckitt assess the environmental attitudes. Those are constructs used by environmental psychologists to measure the degree of favour or disfavour towards the natural environment of the studied subjects. Since, in the literature, scholars tend to create new metrics for each study, instead of relying on and organising those already existing, the paper provides the theoretical background for the creation of a sound environmental attitude inventory. The inventory measures twelve different dimensions composing the environmental attitude (e.g., enjoyment of nature, environmental activism, population growth, and conservation policies) [23].
- Another possible CS outcome is the project contribution in complementing a database. Alfonso et al. estimate the CS benefit in terms of data complementarity, which is the ability of the CS project to fill the gaps in already collected data. The authors differentiate between “spatial” and “time” complementarity. The spatial complementarity is linked to the total amount of collectable data (space) and its covered ratio. In this case, the CS added value is equal to the added portion of coved space (additional data). Similarly, time complementarity is linked to the multitemporal data collection and the CS initiative’s ability to provide the needed coverage over time[2]. Note that some of the data collected by CS participants may overlap with the already existing data, hence the contribution might be less than the total amount of collected data [15].

[2] One example is the continuous observation of some natural phenomenon. Researchers may not have the manpower to observe the phenomenon all day for prolonged periods of time. This may become possible with the aid of citizen scientists, making up the CS contribution.

- The General Ecological Behavior Scale is another method to measure individual environmental attitudes used in behavioural studies. It is composed of fifty questions divided into six different subscales: (i) energy savings, (ii) mobility, (iii) waste avoidance, (iv) consumption, (v) recycling, and (iv) social commitment [24].
- The Sustainability Assessment Scale divides the concept of sustainability into three dimensions: Ecological, Social, and Economic. This particular scale has not been extensively used and tested, and it is aimed to evaluate students' attitudes in particular [25].

In choosing the method to apply, the researchers should consider several factors. For once, the geographical dispersion of the participants drives the choice between surveys and face-to-face evaluation methods. Another factor to consider is the age of participants. For example, a survey may not be suited for both working-age and schooling-age participants. At the same time, given the resource limitation of CS projects, the assessment methods should not be resource intensive, while being usable by non-experts and easy to implement [26].

In conclusion, the topic of CS projects' benefits identification and quantification seems to be still a subject open for discussion among academics and professionals. For CS projects being a relatively new approach to research endeavours, the lack of consensus on how to tackle each of the several issues arising from the practice of such projects should not come as a surprise.

As it will be shown in the following sections through the exposition of selected case studies, the general approach is usually tailor-made to each of the projects in an attempt of answering the numerous assessment problems gradually arising during the inquiry. Despite the methods often proving themselves to be internally consistent, they lack external validity, namely the feature of being replicable outside the applied study. The lack of standardised evaluation methods does not only hinder any attempt at comparing the efficacy, if not the efficiency, of the projects, but in doing so it may frustrate any attempt at translating the projects' outcomes into policies.

3 A Case Study Analysis: Methodology and Selection Criteria

3.1 Data framework

Even though evidence on the effective relevance and uptake in policymaking is still lacking, environmental CS initiatives have been increasing in number in the last few years. To provide a common ground for the analysis of the relevance of CS projects in the domain of environmental policymaking, the European Commission entrusted the development of a "Study on an inventory of citizen science activities for environmental policies" to Bio Innovation Service (FR), in collaboration with Fundacion Ibercivis (ES) and The Natural History Museum (UK). The Inventory was meant to shed light on the relevance of Citizen Science projects in environmental policy and in the contribution to the United Nations (UN) Sustainable Development Goals (SDGs) and reports on 503 citizen science projects of relevance to environmental policy [27].

To the best of our knowledge, the inventory is one of the most comprehensive collections of past experiences in the domain of CS. Furthermore, given its focus on CS initiatives having environmental issues at the heart of its mission, the inventory presents projects with a good degree of comparability with SOCIO-BEE. Indeed, some of the reported projects include the collection of environmental data as a fundamental part of their activity, often through the development and implementation of novel technologies.

The inventory contains mainly descriptive information on the project's topics, start and end dates (when known), geographical extent, country (countries) of implementation and links to projects' websites. Moreover, some information is provided on policy aims, and the contribution to each of the seventeen SDGs.

For these reasons, the inventory was the base for the selection of appropriate and comparable case studies. The aim is to complement the descriptive information available through the inventory with a thorough review of projects' documentation that offers insights on the assessment of the potential impacts (socio-economic and environmental) and the relevance in policy-making and public decision-making cycles of citizen science initiatives. Indeed, the experience can provide useful insight into any best (and worst) practices, other than contributing to the identification of gaps and of any issues that need to be addressed to promote the public uptake of these initiatives in the future.

3.2 Case Studies' Selection Process

The case studies selection process was directed to the definition of a sample of past CS initiatives that can be considered comparable, in terms of size and scale, to the SOCIO-BEE project. For this reason, a first screening of the 503 projects was carried out by limiting the "Geographical extent" to a size that is at least "Macro-regional".[3] Secondly, a screening based on the start year of the initiative was also considered, choosing 2007[4] as the baseline year, assuming greater comparability of the technological solutions

[3] In the Inventory, the "Geographical extent" can be: Neighbourhood; City; Sub-national; National; Regional; Macro-regional; Global.

[4] 2007 has been chosen as it was the year of release of the first iPhone, given that many environmental initiatives rely on personal smartphone devices of the citizens.

developed within the initiatives. The screening of the total 503 projects in the Inventory by these two criteria of selection limited the sample size to 126 projects.

The aim of the case study analysis was that of assessing the CS projects' outcomes translation into policy implications, with the strong limitation of using publicly available documents and information. Provided such eligibility requirements, the additional sample restriction of "availability of relevant information" was added.

Indeed, all the projects whose websites were no longer active, or for which relevant documentation to assess impact and policy translation was either unavailable or unavailable in English were excluded. This led to a significant reduction of the sample size, which has been reduced to 54 projects (for the full list of the selected projects, please refer to Appendix I*).* The fact that more than half of the initially selected projects have been excluded based on these relevance criteria may be a signal of poor survival rates of the projects or the lower attention given to official documentation presenting impact assessment and public relevance of the projects.[5]

For the selected initiatives, a thorough analysis of public deliverables, scientific articles, and documents[6] was directed to the identification of the following variables of interest in the assessment of the impact of the initiatives:

- Project objectives;
- Types of stakeholders involved;
- Survival after the first financing period;
- Involvement of public actors and policy uptake;
- Economic impact evaluation methodologies (when applicable).

These variables encompass several aspects of the impact of CS projects. The objective defines the scope of the action and the aspects that are most relevant in the implementation of economic impact assessments. The involvement of public actors and the policy uptake indicate the political impact, and whether the initiatives hold public interest characteristics and, as such, could complement, or substitute for other traditional alternatives. The survival after the initial financing period indicates the success of the initiative in identifying business models apt to the continuation of the project activities. Lastly, economic impact refers to all the potential domains of impact on a broader scale, including the environmental and social dimensions.

3.3 Characterization of the Selected Projects

The fifty-four selected projects display a degree of heterogeneity across several variables of interest, allowing us to make some remarks regarding the characteristics more frequently observed across projects (Figure 2).

[5] The selection of projects with available information may have led to a selection of the "best-in-class" experiences, thereby, at least in part, biasing upwards our results. Even if we are aware of this possible limitation, it was necessary to gain an informed understanding of the economic impact in Citizen Science projects.

[6] The main sources of information have been official project websites, web searches and the EC's CORDIS.

While a third of the initiatives reported not have a policy aim, all projects recorded a different kind of policy relevance. More specifically, almost half of the projects (43 per cent) held policy relevance in the field of policy monitoring or implementation, while a third focused on problem definition (33 per cent). The other domains of policy relevance which have been recorded, even if with a lower frequency, are early warning (15 per cent) and policy evaluation (9 per cent). This seems to ascribe to CS projects a role limited to the inputs provision to already existing or emerging policies, rather than that of a formulation contribution of new ones.

Regarding the start year, while the database takes into consideration projects that started between 2007 and 2018, the years 2016 and 2017 have experienced the greatest number of emerging initiatives, with 20 and 9 projects, respectively, out of the 54 total. The year 2016 displays a spike, interrupting an otherwise increasing trend of initiatives, and suggesting greater attention to Citizen Science initiatives. The surge in initiatives may relate to the *Horizon 2020 programme* implementation, which dedicated specific lines of action to societal challenges in the achievement of green development objectives and to the integration of citizens in science and innovation issues, policies and activities. In 2016, the *Green Paper Citizen Science Strategy 2020 for Germany* has been published, enlightening the potential of this new branch of scientific research, and prompting a national strategy for engaging citizens in science.

Finally, the most common type of CS projects initiator is organizations in academia, which represent just above the majority of the leading organizations for the projects under exam (52 per cent), followed by consortia of organizations (22 per cent), while governmental (13 per cent), non-governmental (7 per cent) and private organizations (6 per cent) less frequently take a leading role.

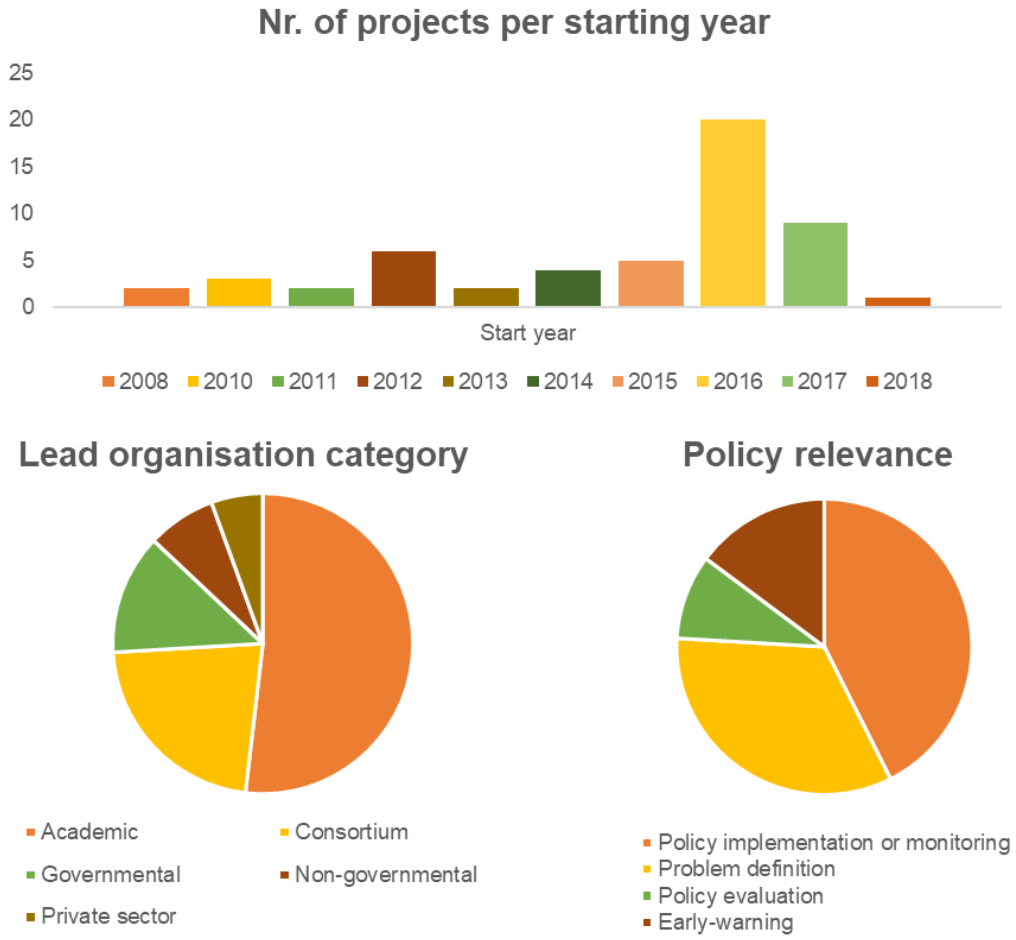


Figure 2 - Characterization of the selected projects (Authors' elaboration based on JRC data, 2018).

3.4 Impact Evaluation in the Selected Case Studies

The analysis of the official project documentation for the selected case studies enabled the identification of the key domains where the impact of these initiatives has been recorded. Even if these domains are intertwined, it is still worth trying to individually define each of those impact categories.

Firstly, given the fact that the inventory is mainly centred on initiatives that have environmental issues at the heart of their missions, the ***environmental*** impact, intended as the (positive or negative) effects on the natural environment at large, is a natural consequence of project implementation. In this regard, past initiatives have recorded, for example, impact in terms of an increased participants' sensitivity towards pollution topics, or in terms of improved capability to contribute to a pro-environmental change in user behaviour.

The multi-faceted nature of citizen science initiatives is reflected also by the importance of ***social*** impacts, defined as impacts which can be recorded both in society and at the individual level, but also on collective values and relationships [28]. Some examples of social impacts are: (i) a greater sense of responsibility on

the side of the society at large towards pollution topics, (ii) community building, (iii) a sense of belonging to people that share a common goal, which can also be achieved through the implementation of technological tools which enable communication between participants.

Another crucial aspect of the implementation of CS initiatives is the ***scientific*** impact. Indeed, CS is meant to foster a proactive role of the general population in some of the phases of the scientific process, and in the interpretation of the results. This can be recorded in terms of increased citizens' knowledge of, for example, pollution topics, or of the availability of open-source research and data.

The ***economic*** impact of these initiatives has mainly been ascribed to the financial dimension, namely the uptake of crowd-funding initiatives, the impact on access to finance and entrepreneurship, or the return on investments. However, economic impacts have a much greater reach, as they encompass all aspects that can be characterized as costs and benefits throughout the project implementation. This requires a careful and comprehensive quantification of all items that do not have an attached financial value (e.g., health improvements from better quality of the air, reduced risk of damage).

Finally, the ***political*** (or *governance*, see Wehn et al. [28])impact is another dimension that has been at the heart of CS initiatives. In this context, the analysed case studies displayed the capacity to increase citizen participation in civic society, as well as the capability to influence public decision- and policy-making processes and institutions.

The different areas of impact that have been recorded by previous initiatives call for the application of different methodologies to embrace their diversity and multi-dimensionality. This same diversity may have been an obstacle to the full appreciation of impacts in the field of CS.

Indeed, from the current analysis, it emerged that half of the projects analysed did not perform any impact assessment or, if they did, they did not do so by publicly sharing their results and insights. Among the remaining initiatives, the methodologies for impact assessment that have been deployed have been grouped by similarity into three main categories (Figure 3). 19 per cent of the sampled initiatives have relied on survey-based evaluations, with survey forms being submitted to end-users, project partners, or, in exceptional cases, external experts. Another 19 per cent of the projects have relied on impact indicators, used to assess both quantitative and qualitative aspects of the project's impact, as it will be shown in greater detail in Section 3.5. Finally, only 6 out of the 54 selected cases, have developed a CBA drawing from the fundamentals of economic *ex-ante* evaluations. [7] Lastly, one of the initiatives has developed an *ad-hoc* methodology, which could not be ascribed to any of the previous categories as it deployed several approaches to appreciate the different dimensions of the impact that characterised the project.

[7] While several projects have relied on a mixed methodology based on more than one of the those listed in the main three categories, these projects have been attributed to a single category on the basis of the methodology that has allowed to draw the final conclusions on impact. While some discretion has played a role in this characterization, it should be noted that cross-fertilization occurs in the use of impact assessment methodologies.

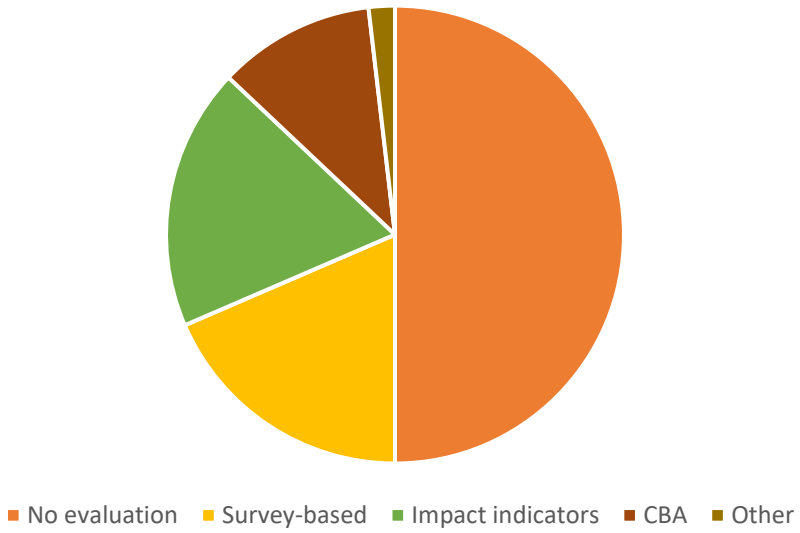


Figure 3 - Methodologies for impact evaluation in the selected case studies (Authors' elaboration, 2023).

3.5 Selected Case Studies for Impact Evaluation

To provide an overview of the practical implementation of the methodologies for impact evaluation of citizen science initiatives, this Section will offer a general commentary based on the case study analysis that has been developed and go through a few anonymised examples.

3.5.1 Survey-based evaluation

The heading of survey-based evaluation groups together initiatives that relied on the collection of information from end users, project partners or external experts through questionnaires. These evaluation forms are handed out to the above-mentioned groups of interest on several occasions, which include the organisation of thematic events or workshops.

While surveys can represent a source of information for some qualitative indicators, a stand-alone category of impact assessment has been defined for the case where surveys were the main end of the impact evaluation process.

The case studies implementing a survey-based evaluation of the project's achievements are characterized by the common feature of administering information from evaluation reports and forms dispensed to interested stakeholders. Often, the information collected from questionnaires is complemented by structured and semi-structured interviews.

On the one hand, evaluation forms are found to be handed out to project partners, advisory board members, or external experts. The main aim of this kind of evaluation is to assess the progress towards projects' objectives, which can also be carried out at different stages of the implementation. On occasion, this process has allowed me to obtain insights also in terms of recommendations and good practices.

On the other hand, evaluation forms could also be directed to the end users targeted by the project. In this case, the main aim is to assess the strengths and weaknesses of the solutions developed throughout

the course of the projects and, more specifically, during the pilots' implementation. Ultimately, the surveys to end users represent an opportunity to collect overall feedback and recommendations concerning the acceptance of solutions from those they have been designed for.

Survey-based evaluation: Anonymized case study #1

The main aim of the selected case study was to combine CS, collaborative learning, and environmental grassroots activism to leverage existing networks of local communities and allow them to gain an understanding of air pollution topics, to address authorities with valuable and robust data from citizens' monitoring stations, and to transform the debate into solutions.

The impact assessment of the project's pilots has been developed through a questionnaire developed by partners. The evaluation tool was designed to be generic and possibly adjusted to the specific needs of each pilot. The questionnaire answers allowed us to obtain information on the acceptance of the solutions developed by the target users, as well as to collect recommendations for future improvements. The surveys provided some insights into the perception of the general audience regarding the environmental (e.g., CO_2 reduction), social (e.g., greater awareness of traditional and novel methodologies for cultivation) and economic impacts (e.g., increased agricultural income, creation of new jobs) of the demonstrators.

3.5.2 Impact indicators evaluation

The multi-dimensional nature of the impact of CS initiatives calls for the use of qualitative and quantitative indicators. The literature on the assessment of participative science processes has proposed a wide array of indicators enabling the appreciation of the diversity of impacts stemming from CS initiatives.

While quantitative indicators indicate figures of the extent to which the desired performance has been reached, qualitative indicators offer descriptive evidence on the extent of non-quantifiable dimensions of impact, that are predominant in the domain of CS.

The qualitative nature of this last type of indicator hinders the attribution of an objective measure. This may imply that they are of little use to governmental entities who need to choose how to allocate public funding to competing initiatives based on comparable variables.

The analysed case studies have deployed impact indicators either defined *ad hoc* to assess the project's performance concerning the initial objectives (i.e., Key Performance Indicators), or fine-tuned starting from those that had already been developed by pre-existing methodologies.

Projects that choose impact indicators fitting with their overall objectives can be found in the former category. In this case, the methodology follows a tailor-made approach, which is highly specific to the project's activities, and may be lacking in terms of comparability with other actions, as well as in terms of future replicability. Some fit-for-purpose indices in this category include, for example, the availability of projects' deliverables and other outputs, the number of meetings and conferences organised, the increased capability of citizens to influence policies and to share knowledge on project-specific topics, as well as the definition of indicators that capture impacts related to specific projects' activities.

On the other hand, projects may choose to rely on commonly defined methodologies, which provide a more general framework, that can be adapted to the specificities of the action. One notable example in this realm is the methodology of Impact Assessment for Social Innovation (IA4SI) [29], developed by the

self-titled project in the field of Collective Awareness Platform for Sustainability (CAPS). Three of the ten case studies under this category have drawn from the IA4SI methodology, which provides a list of vertical indices that measure the impacts in the social, economic, environmental and political areas. The approach, in this case, has been to select from the indicators proposed by the IA4SI those that more closely aligned with project objectives and was to be found in the foreseen areas of impact.

Some examples of indicators proposed by the IA4SI methodology include:

- Social impact:
  - Community building and empowerment – measured by:
    - Comparison of the number of users of the solutions at the beginning VS at the end of the project;
    - Time spent by users on the platform at the beginning VS at the end of the project;
    - Degree of communication on the platform;
- Environmental impact:
  - Greenhouse gas emissions – measured by, e.g.:
    - Number of compensation activities performed by users since engagement with the project;
    - Capacity to increase users' sensitivity towards the issue of air pollution;
- Economic impact:
  - Impact on user's economic empowerment – measured by:
    - Impact on entrepreneurship and access to finance;
  - Economic value generation by the project – measured by:
    - Cost-benefit and return on investments;
- Political impact:
  - Impact on civic and political participation - measured by:
    - Increase in the number of grassroots organisations;
    - Participation of citizens in (signature) campaigns and boycotts.

These indices can be measured in a variety of ways, ranging from questionnaires and interviews to internal statistics and project documentation.

Within this framework, the International Association for Impact Assessment has proposed an impact assessment that runs in phases. First, it is a fundamental prerequisite to well define the perimeter of action, by fully understanding the proposed project, as well as the social area of influence. Only after this preliminary step, one can proceed with the actual prediction and analysis of the key impact pathways, by putting a particular emphasis also on social and indirect impacts. Afterwards, the final two phases focus on the planning and implementation of strategies and monitoring programmes, that allow to address negative impacts and follow up on the project's actions, respectively.

Impact indicators evaluation: Anonymized case study #2

The chosen anonymized case study had the aim of raising collective awareness about the daily conditions of air quality and thermal comfort, and to provide information about the forest fires probability in Europe.

In this context, the impact assessment development has been two-fold.

Firstly, the project aimed to assess the social and environmental impact on the involved communities from the use of the developed solution. As the main impacts had been ascribed to the social and environmental

areas of impact, the project partners entrusted with the evaluation task chose among the vertical indices provided by the IA4SI methodology those that more closely fit with the foreseen domains of the impact of the project. The list thus defined has then been complemented by some more indices developed by internal partners and specific to the purpose of the project.

The second part of the evaluation concerned the assessment of behavioural change induced by the project's actions. To assess the effectiveness of the behavioural change interventions, especially in terms of the adoption of more pro-environmental behaviour, different kinds of experiments have been carried out, before and after the participation in workshops, and during the use of the specific features of the platform developed by the project.

The most prominent impacts on behaviour have been recorded in terms of voice, namely greater empowerment of citizens in the process for the definition of policies at the local levels, in terms of perceived and actual knowledge on the topic of air pollution, and of soft mobility behaviour.

Below, we propose a table with the indicators that have been selected by the case study in its impact assessment.

Table 2 - Indicators selected for project evaluation of case study #2 (Authors' elaboration based on project documentation, 2023).

Social impact	Impact on community building and Empowerment	Online community building (e.g., number of users of the platform at the beginning and the end of the project, amount of time spent by users at the beginning and end of the project, degree of communication on the platform)
		Local community building (e.g., the capacity to enlarge the local community)
		Impact on social innovation CAPS community (e.g., number of collaborations with other projects within the domain, and outside the domain)
	Impact on information	Access to and sharing of information (amount of available information – on AQ, perceived improvement of access of info for users, capability to influence information asymmetries – between aware and non-aware citizens on AQ)
	Impact on ways of thinking/opinions and changes in behaviour for individual and collective behaviour and lifestyles	Changes in ways of thinking (number of people participating – in engagement activities, increased level of awareness, change in opinion about air quality (AQ))
	Impact on Education and human capital	Training provided by the project (number of different topics covered by training activities, tools for education developed by the project – about AQ, number of workshops provided)

	Impact on Science and academia	Knowledge sharing (use of open access, sharing through social media, dissemination through project website, sharing through events)
		Citizen Science (proportion of open science contributions, number of local measurement initiatives developed, consortium attitudes towards citizen science, number of activities for citizens to contribute to data, number of activities where citizens can analyse and interpret data)
Environmental impact	The impact on user's environmental behaviour	Number of compensation activities performed by users since their engagement with the project
		Project's capability to contribute to the change in users' participation in environment-related actions
		Project's capacity to increase users' sensitivity towards the issue of air pollution

3.5.3 Cost-Benefit Analysis

A CBA framework has the advantage to monetise incremental costs and benefits with respect to some other alternative or the status quo. Nevertheless, only a few initiatives in the sample have adopted this sound methodology in their evaluation process.

While there should be no particular issue in the assessment of costs (both one-off and running), the main causes behind the poor uptake of CBA are to be found in the nature of the benefits that arise from the implementation of social innovation and CS initiatives. The use of CBA also requires a clear definition of the end goal of the initiative, so as to appropriately set the baseline concerning which costs and benefits are to be estimated.

The six case studies which have chosen to employ a CBA in their evaluation processes had a clear-cut definition of the expected areas of impact, and of the possible benefits that could be obtained from the project's actions.

The project implementation costs can be obtained from the project's accounting, as well as from internal investigations with partners. The assessment of investment costs is based on the actual costs incurred for the project's implementation and the development of the project's solutions while running costs (e.g., maintenance) need to be estimated starting from the expectations of project partners.

A greater effort is required in the estimation of projects' benefits. Based on the previous experiences that have been analysed, these can be found as benefits (e.g., health improvements from better environmental conditions), or as avoided costs (e.g., reduced life risks for individuals and averted damage for infrastructures).

Cost-Benefit Analysis: Anonymized case study #3

The principal aim of case study #3 was to integrate existing services into a platform supporting the emergency management cycle, supplementing already available information with real-time citizen reporting and integrating it in nowcast and forecast models.

The evaluation of the project's activity aimed to provide an indication of the value added offered by the project's solutions concerning the already available technologies. To achieve this, project partners first defined a case for the CBA, by choosing the flood risk protection at the national level of one of the pilot countries. Information has then been collected from the selected users and the interested stakeholders, through interviews, working sessions and conference calls. This information has then been funnelled into the definition of the main costs and benefits (Figure 4). The formers were made up of investment costs (CapEx), running costs (OpEx) related to system adoption, as well as the main costs from the disaster considered (e.g., death toll, affected people, economic damages). The latter was made of mainly social benefits, as well as estimations of avoided costs from the system adoption.

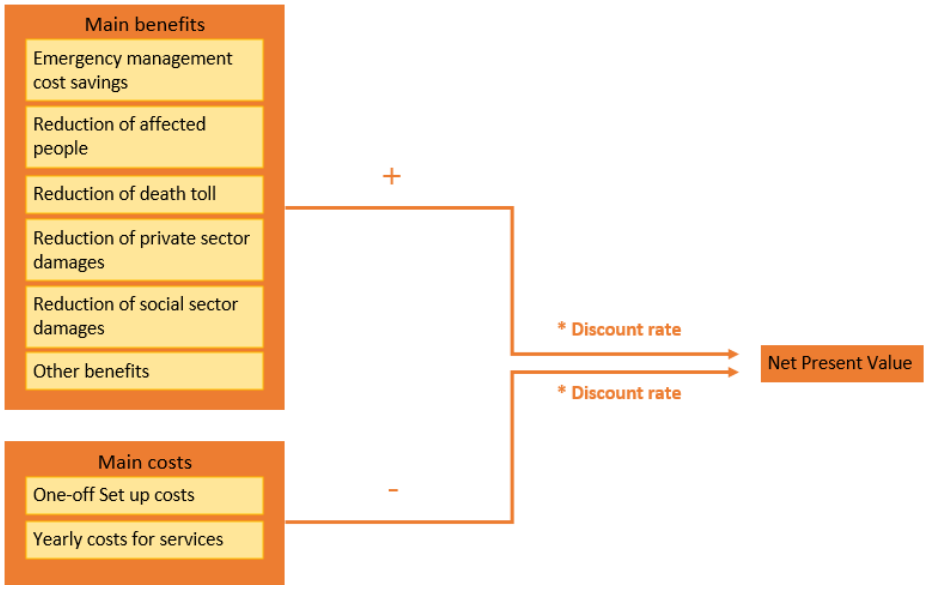


Figure 4 - Summary of the CBA of case study #3. Source: authors' elaboration on project documentation (2023).

3.5.4 Mixed Methodology: Anonymized case study #4

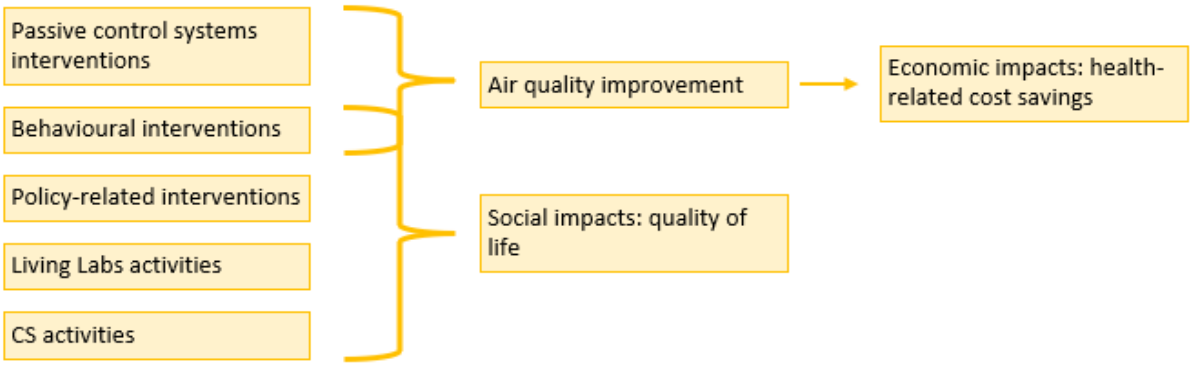
The one project that has adopted a mixed methodology has drawn from two main strands of literature in the outline of the impact assessment.

The main aim of the project was to reduce urban air pollution and the negative impacts of climate change by leveraging sustainable passive control systems, behavioural change initiatives and Living Labs.

To assess the socio-economic impact of projects' activities, a modular approach has been developed, to adapt to the range of solutions that have been proposed (Figure 5). In the case of passive control systems and behavioural change interventions, the main impacts have been recognized as environmental, as they directly related to air quality improvements. To appreciate the extent of the mainly health-related benefits stemming from these impacts, a wide range of methodologies from economic literature have

been deployed (e.g., hedonic pricing method and meta-analysis), and selected to conform to the specificity of the solution proposed and of the local context of implementation.

Policy-related interventions, living labs and CS activities at large have been recognized as interventions with mostly social impact, especially in terms of quality of life. In this regard, drawing from Multi-Criteria Analysis, different indicators have been chosen to describe different areas of impact.



City	Intervention	Economic impacts	Methodology
City 2a	Green roofs	[1] Uptake of pollutants [2] Reduced energy use for heating and cooling [3] Aesthetic benefits [4] Storm-water management benefits [5] Heat Island effect (reduction of) [6] Noise insulation benefits [7] Membrane longevity	City-level meteorological models combined with avoided-cost techniques Hedonic pricing (change in thermal comfort index) Earlier estimates of green roofs benefits (Nurmi et al., 2016) Unit cost modelling (meta-analysis)
City 2b	Behavioural change – warning systems	[1] Reduced exposure to air pollutants and resulting health benefits	Reduced form analysis with sensitivity analysis of changes in the exposed population Information uptake models (WSCA modified)

Area of impact	Indicators	Variables
Material and living conditions	Income	Change in income for commercial activities in the area of pilot action Change in household tenure (cost saving) Change in income for companies or other organizations exploiting the project's technical outputs (green services providers)
Behaviours	Impacts on green behaviours Impact on other behaviours	To be developed on case-by-case (e.g., mobility-related behaviour, electricity consumption, green consumption) Impact on Perceived citizens' effectiveness

Figure 5 - Summary of the evaluation in the anonymised case study #4. Source: authors' elaboration on project's documentation (2023).

3.6 The Policy Role of the Selected Initiatives

The other focus of the case study analysis has been on the policy relevance and uptake of the results of past initiatives, as well as on the involvement of public authorities in the project's activities. While the influence on public policies and decision-making processes is the declared rationale for many initiatives in the environmental domain, the actual uptake in the selected case studies does not appear to be the general rule, with only a few notable exceptions.

35 out of the total 54 projects either mention policy aims or the relevance of their results in official documentation, issue recommendations or policy briefs or involve public authorities in the project's activities. However, it is difficult to assess the actual uptake by local authorities of interest.

While collaboration with public authorities is beneficial, as it shapes the project's activities accordingly to public needs, this does not automatically imply a policy translation of the results. Indeed, on occasion, the resistance of the public authorities has been recorded, either because of little trust in citizen-provided data, or because of a general reticence to leave traditional paradigms of data collection in favour of systems that are perceived as less mature and "experimental". The duration of the projects may also not allow for documentation on the actual use of the project's activities in public decision-making processes, as has been reported by a couple of the case studies in the official documentation.

As a result, the documented policy uptake of the results of the analysed case studies has been limited. The most notable case study in this regard has been successfully reported to have influenced new legislation and licensing activities, as well as to highlight the importance of public participation and citizen observations in monitoring policymakers. This may have been a direct consequence of the involvement of local authorities in all phases of each of the demonstrators.

3.7 The Survival After Initial Funding

A further variable of interest in the case study analysis has been the continuation of project activities after the end of the first financing period. Although data on the actual continuation is not readily available, some inferences can be made starting from the last updates of project websites and social media, as well as from the official project documentation.

Out of the fifty-four projects analysed, 30 per cent (16 projects) reported some form of continuation of their activities even after the end of the first financing period. Examples of forms of continuation include the creation of a foundation to carry on with the activities, the livelihood of communities generated throughout the course of the project, or the continuation through the generation of a new project.

Nevertheless, nearly half of the projects (24) either do not have an active website/social media or have an active website/social media but are not updated, possibly signalling a poor continuation of project actions.

The remainder of the experiences either developed specific consideration on the continuity of the action through the ideation of a business plan or the drafting of possible commercialization activities, but do not report any evidence on the actual continuation (12 projects), or are still ongoing and no inferences can be made on continuation (2 projects).

It is interesting to note that more than half (9) of the projects that reported some degree of continuation of their activities had also carried out an impact assessment, strengthening the case for the relevance of socio-economic impacts in the decision to support project actions.

3.8 Discussion on case studies analysis

The review of the practical implementation of impact assessment through a case studies analysis of past environmental CS initiatives complements the conclusions drawn in the first part of the present work.

Previous initiatives seem to have struggled with the application of impact assessment, as evidenced by half of the selected initiatives that did not report on their impact.

Nevertheless, even among those initiatives that did carry out an impact assessment, little consensus has been reached regarding the use of a common framework for the assessment. Indeed, while some methodologies have found application across different initiatives, there is a wide range of methodologies in place, with clear consequences in terms of comparability.

While this issue comes as a direct consequence of the nature of CS initiatives, where the social dimension is predominant, the use of a common evaluation framework could bring several benefits also for public decision-makers who need to make an informed opinion on the valued added provided by these experiences concerning other alternatives.

Lastly, another notable feature of the impact assessment implemented by the different initiatives is the limited exploitation of the main economic methodologies typically used for project impact evaluation, such as CBA and multi-criteria analysis. A possible rationale for this phenomenon is to be found in the difficulty in the quantification of non-monetary benefits, which represents one of the main obstacles for CS practitioners.

The policy role, despite being one of the main aims of CS initiatives, does not appear to have reached the general rule status, but some encouraging interactions between policymakers and CS practitioners have been observed in past experiences.

Finally, a gap to be filled in the future is the poor survival rate of the initiatives after the end of the first programming period. It is of the foremost importance to address this issue, through appropriate formulation of continuation options and impact estimates to build awareness on the socio-economic value creation that can be brought about by CS concerning traditional alternatives.

4 Conclusions

Past literature has referred to the several barriers to impact assessment in the CS domain [28]. The first main issue is related to the mismatch in the timing of the funded project activities concerning the longer-term nature of impacts' materialization. Moreover, the collection of impact-relevant data is not straightforward and may, as a consequence, lead to limited observation of projects' results. The issue is compounded by the difficulties in quantifying the variables deemed of interest in CS project studies. The reliance on surveys cannot be an answer to the problem, given the costs implied in the management of a large and comprehensive survey campaign.

Generally, the literature highlights the assessment problems lined with difficulties in quantification techniques and the eventual monetisation of the data. While the literature provides some insights on the quantification techniques, the puzzle of how to transform quantitative data into monetary values remains an *ad-hoc* endeavour.

Despite all the problems connected with the assessment of CS projects, the CBA remains the preferable method to both evaluate the projects and, at the same time, highlight the projects' outcomes, with the opportunity of them affecting policy implementation.

Another obstacle reported in the literature is related to the project priorities diverting the attention from impact assessment, or to the absence of skills among the consortia or of resources to appropriately deliver the assessment.

The work carried out has allowed to shed light on some open questions that remain to be addressed in future work, which will open up the path for deliverables 7.3 and 7.4 on the guidelines for cost-benefit evaluation:

- What is the **timing** of the assessment?
  This can be either *ex-ante*, as in the case of a CBA, or *ex-post*, as in the case of impact evaluation at large. The different timing brings differences both in terms of the variables which can be assessed and in terms of the aim of the assessment: in the former case, it represents a tool for public entities who wish to carry out financing decisions based on comparable metrics, in the latter case, it represents a tool to assess the achievement of project's objectives, as well as the obtained results.
- Do **citizens** have a role in the evaluation process?
  Previous literature did not focus much on the implications of the involvement of citizens in the assessment process, but a clear trade-off should be carefully considered ahead of any decision. Indeed, while citizens, being the main target of social innovation projects at large can provide useful insights on the development of projects' solutions, they may also be tempted to misreport their opinions, in a way that favours their interests.
- **What** should a citizen science initiative be assessed **against**? Does it represent an alternative way (e.g., to command-and-control measures) to formulate policies in the environmental domain? Or is it an alternative approach to collecting data and information?
  To be able to answer these questions, project initiators should set their objectives clearly and objectively. The definition of the main alternatives should be a direct consequence of this crucial first step. The so called 0 alternative (i.e., the baseline) to the CS approach should be identified on a case-by-case basis, and the identification of the alternative provides a benchmark to compare the CS project outcome. The lack of understanding of what options could be adopted instead of

the CS approach prevents the analysis from clearly identifying the incremental effect of one method compared to the other.

- Who should be the **recipients** of the assessment? Is it directed to local authorities (e.g., Municipalities) or the initiators of future initiatives?
  The different kinds of recipients will give more weight to different aspects of the assessment. While the former may be more interested in the economic dimension, the latter may be more likely to focus on social and environmental dimensions.

In conclusion, the project evaluation is an information intensive process, dependant on several variables. Still, a general agreement on the data requirements is lacking in both the practice and the literature. The lack of agreement and common practices, by hindering the evaluation processes, translates in difficult comparisons among project outcomes and their eventual policy implementation. The CBA may prove a useful framework in boosting comparability, but it may be burdened by the issue of clearly identifying all the involved stakeholders and towards whom the benefits go. In this sense, the complexity of the CBA is its main weakness and strength at once. What is needed to strengthen the approach is a sound and replicable framework, underlining the methodology thoroughness.

In the same vein, CS data standards are often fragmented, and need to be integrated with traditional data sources already in use. The following deliverable (D7.2) will focus on the role of data in guiding typical decision-making processes by local authorities at different levels. In this regard, D7.2 will draw data requirements so as to ease and guide the decision process while also providing an overview on their use in monitoring system integration and in performance contract schemes.

Finally, the deliverables following D7.2 will integrate the insights found in practice and literature into CBA guidelines aimed at clarifying the best approaches to develop the CS project assessment and to obtain standardised and comparable results. This is expected to favour the methodology adoption and ease decisionmakers in choosing the fittest alternative.

References

[1] M. Ferri, U. Wehn, L. See, M. Monego, and S. Fritz, 'The value of citizen science for flood risk reduction: Cost-benefit analysis of a citizen observatory in the Brenta-Bacchiglione catchment', *Hydrol. Earth Syst. Sci.*, vol. 24, no. 12, pp. 5781–5798, 2020, doi: 10.5194/hess-24-5781-2020.

[2] P. J. Gertler, S. Martinez, P. Premand, L. B. Rawlings, and C. M. J. Vermeersch, *Impact Evaluation in Practice, Second Edition*. Washington, DC: Inter-American Development Bank and World Bank, 2016. doi: 10.1596/978-1-4648-0779-4.

[3] M. Haklay, D. Dörler, F. Heigl, M. Manzoni, S. Hecker, and K. Vohland, 'What Is Citizen Science? The Challenges of Definition', in *The Science of Citizen Science*, K. Vohland, A. Land-Zandstra, L. Ceccaroni, R. Lemmens, J. Perelló, M. Ponti, R. Samson, and K. Wagenknecht, Eds., Cham: Springer International Publishing, 2021, pp. 13–33. doi: 10.1007/978-3-030-58278-4_2.

[4] M. Haklay, 'Citizen Science and Volunteered Geographic Information: Overview and Typology of Participation', in *Crowdsourcing Geographic Knowledge: Volunteered Geographic Information (VGI) in Theory and Practice*, D. Sui, S. Elwood, and M. Goodchild, Eds., Dordrecht: Springer Netherlands, 2013, pp. 105–122. doi: 10.1007/978-94-007-4587-2_7.

[5] 'EU-Citizen.Science', 2023. https://eu-citizen.science/ (accessed Jul. 04, 2023).

[6] K. Blumenschein and M. Johannesson, 'Economic Evaluation in Healthcare', *PharmacoEconomics*, vol. 10, no. 2, pp. 114–122, Aug. 1996, doi: 10.2165/00019053-199610020-00003.

[7] G. Weisbrod and B. Weisbrod, 'Measuring economic impacts of projects and programs', *Econ. Dev. Res. Group*, vol. 10, pp. 1–11, Apr. 1997.

[8] R. M. Pateman, A. Dyke, and S. E. West, 'The Diversity of Participants in Environmental Citizen Science', *Citiz. Sci. Theory Pract.*, Mar. 2021, Accessed: Jul. 25, 2023. [Online]. Available: https://doi.org/10.5334/cstp.369

[9] L. Rudmik and M. Drummond, 'Health economic evaluation: Important principles and methodology', *The Laryngoscope*, vol. 123, no. 6, pp. 1341–1347, 2013, doi: 10.1002/lary.23943.

[10] A. Philippe, R. Blaney, M. Pocock, and G. Jones, 'Citizen Science and Environmental Monitoring-Final Report', UKEOF, UK, P11591, May 2016. [Online]. Available: https://www.ukeof.org.uk/resources/citizen-science-resources/Costbenefitcitizenscience.pdf

[11] B. Roy and P. Vincke, 'Multicriteria analysis: survey and new directions', *Eur. J. Oper. Res.*, vol. 8, no. 3, pp. 207–218, Nov. 1981, doi: 10.1016/0377-2217(81)90168-5.

[12] B. Roy, 'Decision-aid and decision-making', *Eur. J. Oper. Res.*, vol. 45, no. 2, pp. 324–331, Apr. 1990, doi: 10.1016/0377-2217(90)90196-I.

[13] *Regulation (EU) 2021/1060*, vol. 231. 2021. Accessed: Jul. 12, 2023. [Online]. Available: http://data.europa.eu/eli/reg/2021/1060/oj/eng

[14] European Community, Ed., *Guide to cost-benefit analysis of investment projects: economic appraisal tool for cohesion policy 2014-2020*. Luxembourg: European Union, 2015.

[15] L. Alfonso, M. Gharesifard, and U. Wehn, 'Analysing the value of environmental citizen-generated data: Complementarity and cost per observation', *J. Environ. Manage.*, vol. 303, 2022, doi: 10.1016/j.jenvman.2021.114157.

[16] K. Turečková and J. Nevima, 'The Cost Benefit Analysis for the Concept of a Smart City: How to Measure the Efficiency of Smart Solutions?', *Sustainability*, vol. 12, no. 7, Art. no. 7, Jan. 2020, doi: 10.3390/su12072663.

[17] J. J. Laffont, 'Externalities', in *The New Palgrave Dictionary of Economics*, London: Palgrave Macmillan UK, 2017, pp. 1–4. doi: 10.1057/978-1-349-95121-5_126-2.

[18] I. Thornhill, S. Loiselle, K. Lind, and D. Ophof, 'The Citizen Science Opportunity for Researchers and Agencies', *BioScience*, vol. 66, no. 9, pp. 720–721, Sep. 2016, doi: 10.1093/biosci/biw089.
[19] J. C. Davids *et al.*, 'Soda bottle science—citizen science monsoon precipitation monitoring in Nepal', *Front. Earth Sci.*, vol. 7, 2019, doi: 10.3389/feart.2019.00046.
[20] A. I. T. Tulloch, H. P. Possingham, L. N. Joseph, J. Szabo, and T. G. Martin, 'Realising the full potential of citizen science monitoring programs', *Biol. Conserv.*, vol. 165, pp. 128–138, 2013, doi: 10.1016/j.biocon.2013.05.025.
[21] S.-H. Chao *et al.*, 'Understanding pro-environmental behavior of citizen science: an exploratory study of the bird survey in taoyuan's farm ponds project', *Sustain. Switz.*, vol. 13, no. 9, 2021, doi: 10.3390/su13095126.
[22] C. T. Conrad and T. Daoust, 'Community-based monitoring frameworks: increasing the effectiveness of environmental stewardship', *Environ. Manage.*, vol. 41, no. 3, pp. 358–366, Mar. 2008, doi: 10.1007/s00267-007-9042-x.
[23] T. L. Milfont and J. Duckitt, 'The environmental attitudes inventory: A valid and reliable measure to assess the structure of environmental attitudes', *J. Environ. Psychol.*, vol. 30, no. 1, pp. 80–94, Mar. 2010, doi: 10.1016/j.jenvp.2009.09.001.
[24] S. Kaiser, M. Oliveira, C. Vassillo, G. Orlandini, and A. Zucaro, 'Social and Environmental Assessment of a Solidarity Oriented Energy Community: A Case-Study in San Giovanni a Teduccio, Napoli (IT)', *ENERGIES*, vol. 15, no. 4, Feb. 2022, doi: 10.3390/en15041557.
[25] Á. Zsóka, Z. M. Szerényi, A. Széchy, and T. Kocsis, 'Greening due to environmental education? Environmental knowledge, attitudes, consumer behavior and everyday pro-environmental activities of Hungarian high school and university students', *J. Clean. Prod.*, vol. 48, pp. 126–138, Jun. 2013, doi: 10.1016/j.jclepro.2012.11.030.
[26] L. Somerwill and U. Wehn, 'How to measure the impact of citizen science on environmental attitudes, behaviour and knowledge? A review of state-of-the-art approaches', *Environ. Sci. Eur.*, vol. 34, no. 1, p. 18, Feb. 2022, doi: 10.1186/s12302-022-00596-1.
[27] European Commission and Joint Research Centre (JRC), 'An inventory of citizen science activities for environmental policies'. European Commission, Joint Research Centre (JRC), Oct. 01, 2018. Accessed: Jul. 05, 2023. [Online]. Available: http://data.europa.eu/89h/jrc-citsci-10004
[28] U. Wehn *et al.*, 'Impact assessment of citizen science: state of the art and guiding principles for a consolidated approach', *Sustain. Sci.*, vol. 16, no. 5, pp. 1683–1699, Sep. 2021, doi: 10.1007/s11625-021-00959-2.
[29] F. Bellini *et al.*, *Exploring Impacts of Collective Awareness Platforms for Sustainability and Social Innovation*. 2016.

Annex I

Table 3 - List of selected case studies. Source: EC JRC Inventory of citizen science activities for environmental policies (2018).

Name	Website	Brief description	Duration	Delivery of an Impact Assessment	Continuation of project activities
BEWATER	http://www.bewaterproject.eu	Delivery of recommendations to strengthen policy and institutional frameworks in tackling global change impacts within water management and adaptation planning	2014 - 2017	Y	Y
BigPicnic	https://www.bgci.org/our-work/projects-and-case-studies/bigpicnic/	Engagement of the public with Responsible Research and Innovation on Food Security	2017 - unknown	Y	Active but not updated or not an active website/social media
Bioenergy Villages (BioVill)	https://cordis.europa.eu/project/id/691661	Transfer and adaptation of experiences gained in countries where bioenergy villages already exist to countries with fewer examples in this sector	2016 - unknown	Y	Business considerations but no evidence of the continuation
BlueSCities	https://cordis.europa.eu/project/id/642354/it	Development of the methodology for a coordinated approach to the integration of the water and waste sectors within the EIP Smart Cities and Communities	2017 - unknown	N	Active but not updated or not an active website/social media
CAPSELLA	http://www.capsella.eu	Development of innovative ICT solutions tailored to the needs of all food, field and seed-related actors engaging in agrobiodiversity	2016 - unknown	Y	Business considerations but no evidence of the continuation
CAPTOR	https://www.captor-project.eu/	Close collaboration between citizens and scientists to monitor and address ozone pollution in Europe, the establishment of low-cost sensor networks maintained by citizens to measure ozone pollution in dispersed areas, stimulation of collaborative solution finding	2016 - unknown	Y	Business considerations but no evidence of the continuation

CASI	https://cordis.europa.eu/project/id/612113	EU-wide cross-sectoral partnership on innovation-related challenges, that looks into the impacts of social and technological innovation, the types of actors involved, and their inherent interests	2014 - 2017	Y (not public)	Active but not updated or not an active website/social media
CITCLOPS	http://www.citclops.eu	Citizens' Observatory for the coast and ocean optical monitoring	2014 - unknown	Y	Active but not updated or not an active website/social media
CITI-SENSE	https://co.citi-sense.eu/default.aspx	Citizens' access to real-time environmental information provided by sensors and sensor platforms, and provision of a forum for discussion, debate and sharing of personal observations	2012 - unknown	Y	Active but not updated or not an active website/social media
Cities at Night	http://citiesatnight.org	Creation of a map using the night photographs that astronauts make on board the International Space Station (ISS)	2014 - unknown	N	Y
COBWEB	https://cordis.europa.eu/project/id/308513	Development of a generic crowdsourcing infrastructure platform and toolkit that could be used in multiple scenarios generating data of a sufficient quality to be used by policymakers	2012 - unknown	Y	Y
COST Action Citizen Sensor	http://www.citizensensor-cost.eu	Exploration of issues linked to topics ranging from citizen motivation, data acquisition, data quality and the use of citizen-derived data in the production of maps that rival, and sometimes surpass, maps arising from authoritative agencies	2012 - unknown	N	Active but not updated or not an active website/social media
Crowd4Roads	http://www.c4rs.eu	CROWD sensing and ride-sharing FOR ROAD Sustainability	2016 - unknown	Y	Y
Decarbonet	https://www.decarbonet.eu	Investigation of the potential of social platforms in mitigating climate change	2013 - 2016	Y	Active but not updated or not an active website/social media
ENABLE.EU	http://www.enable-eu.com	Enabling the Energy Union by understanding the drivers of	2016 - unknown	Y	Active but not updated or not an active

		individual and collective energy choices in Europe			website/social media
EU BON	http://www.eubon.eu	European Biodiversity Observation Network	2012 - unknown	N	Business considerations but no evidence of the continuation
FoodSmartphone	http://www.foodsmartphone.eu	Smartphone analysers for on-site testing of food quality and safety	2017 - unknown	N	Active but not updated or not an active website/social media
GAP2	http://gap2.eu	Demonstration of the role and value of stakeholder-driven science within the context of fisheries' governance	2011 - 2015	Y	Active but not updated or not an active website/social media
Greenmapper	http://www.greenmapper.org/	Mapping and connection to local, regional, national and worldwide natural places	2016 - unknown	N	Business considerations but no evidence of the continuation
Ground Truth 2.0	www.gt20.eu	Citizen observatories in four European and two African pilots, demonstrate that they are technologically feasible, can be implemented sustainably and that they have many societal and economic benefits	2016 - unknown	Y	Active but not updated or not an active website/social media
GROW	https://growobservatory.org	Sustainable citizen platform and community to generate, share and utilise information on land, soil and water resource at a resolution hitherto not previously considered, focusing on saving soils and adapting to climate change	2016 - unknown	N	Y
hackAIR	http://hackair.eu/	Open technology platform to access, collect and improve air quality information in Europe	2015 - unknown	Y	Y
Hercules Landscapes	www.hercules-landscapes.eu	Increased understanding of drivers, patterns, and values of European cultural landscapes and use of this knowledge to develop, test, and demonstrate strategies for their protection, management, and planning	2013 - unknown	N	Active but not updated or not an active website/social media
Humanitarian	https://www.hotosm.org	Open source and open data sharing for humanitarian	2010 - unknown	N	Y

OpenStreetMap		response and economic development			
I-REACT	http://www.i-react.eu	First European-wide platform integrating emergency management data from multiple sources, including that provided by citizens through social media and crowdsourcing	2016 - unknown	Y	Business considerations but no evidence of the continuation
ICARUS	http://icarus2020.eu	Integrated Climate Forcing and Air Pollution Reduction in Urban Systems	2016 - unknown	N	Business considerations but no evidence of the continuation
InSPIRES	http://inspiresproject.com	Ingenious Science shops to promote Participatory Innovation, Research and Equity in Science	2017 - unknown	Y	Business considerations but no evidence of the continuation
INTAROS	http://www.intaros.eu	Integrated Arctic observation system	2017 - unknown	N	Business considerations but no evidence of the continuation
INTERACT	https://eu-interact.org	International Network for Terrestrial Research and Monitoring in the Arctic, including community-based monitoring citizen science	2010 - 2016	N	Y
ISABEL	https://isabel-project.eu	Triggering Sustainable Biogas Energy Communities through Social Innovation	2015 - unknown	N	Business considerations but no evidence of the continuation
iSCAPE	https://www.iscapeproject.eu	Improving smart control of air pollution in Europe	2016 - unknown	Y	Business considerations but no evidence of the continuation
iSpot - COS4CLOUD	www.ispotnature.org	Biodiversity observation recording platform that leverages community-based verification of observations programs	2008 - unknown	N	Y
Landsense	https://landsense.eu	Aggregation of innovative technologies, mobile devices, community-based environmental monitoring, data collection, interpretation and information delivery systems to empower communities to monitor and report on their environment	2016 - unknown	N	Active but not updated or not an active website/social media

LIFE AskREACH LIFE16 GIE/DE/000738	http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=6325	Provision of incentives for manufacturers, importers and downstream users of chemicals to replace substances of very high concern (SVHC) with suitable alternatives	2017 - unknown	N	n.a.
EuroBirdPortal	http://life.eurobirdportal.org/overview	Development of the EuroBird web portal displaying detailed and up-to-date European-wide spatiotemporal patterns of bird distribution in near-real-time and a reliable manner	2016 - unknown	Y	Business considerations but no evidence of the continuation
LIFE EUROLARGECARNIVORES LIFE16 GIE/DE/000661	http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=6326&docType=pdf	Improvement of transboundary cooperation and population management of large carnivores in Europe	2017 - unknown	Y	n.a.
NETLAKE	http://www.netlake.org/	Establishment of a network of scientists, technologists, managers and stakeholders focused on the development and application of cutting-edge sensor technology for the protection of European lakes and reservoirs	2012 - 2016	N	Active but not updated or not an active website/social media
Noise Tube	http://www.noisetube.net/index.html#&panel1-1	Use of mobile phones as environmental sensors to monitor noise pollution	2008 - unknown	Y	Y
Omniscientis	http://www.omniscientis.eu	Odour Monitoring and Information System based on Citizen and Technology Innovative Sensors	2012 - 2014	N	Active but not updated or not an active website/social media

PERARES	https://cordis.europa.eu/project/id/244264/it	Strengthening of public engagement in research by involving researchers and Civil Society Organisations in the formulation of research agendas and the research process	2010 - 2014	Y	Active but not updated or not an active website/social media
PERSEUS	http://www.perseus-net.eu/site/content.php	Policy-oriented Marine Environmental Research in the Southern EUropean Seas	2011 - unknown	Y (but not public)	Active but not updated or not an active website/social media
POWER	https://www.power-h2020.eu	Political and social awareness of water environmental challenges	2015 - unknown	Y	Y
PROS	http://www.proso-project.eu	Promoting Societal Engagement in Research and Innovation, through the provision of guidance on how to encourage engagement of citizens and third-sector organizations, like NGOs and civil society organizations, in Europe's research and innovation processes	2016 - 2018	N	Active but not updated or not an active website/social media
SAF21	https://www.saf21.eu	Development of effective fisheries management strategies, and understanding of how to manage socio-ecological complex systems better	2015 - unknown	N	Active but not updated or not an active website/social media
Scent	https://scent-project.eu/	Enhanced provision of flood hazard maps and spatiotemporal flooding patterns which are affecting the application of the Flood Directive	2016 - unknown	N	Active but not updated or not an active website/social media
SeaChange	http://www.seachangeproject.eu	Change in the way European citizens view their relationship with the sea, by empowering them to take direct and sustainable action towards healthy seas and oceans, healthy communities and ultimately a healthy planet	2015 - unknown	Y	Active but not updated or not an active website/social media
STARS4ALL	http://www.stars4all.eu	Care and preservation of the darkness of European skies	2016 - unknown	N	Y

Vespa velutina	https://www.vespavelutina.eu/en-us/the-project/The-project	Citizen science tools for the detection and control of the Asian wasp (Vespa velutina), management of traceability in Modern Apiculture (i.e., managing beekeeping operations and creating Geolocalised Alerts as citizen science tools for the detection and control of invasive species: Asian Vespa, Aethina Tumida, etc.)	2016 - unknown	Y	Y
Waste4Think	http://waste4think.eu/es/	Moving towards Life Cycle Thinking by integrating Advanced Waste Management Systems	2016 - unknown	Y	Active but not updated or not an active website/social media
Water shrew survey	http://jncc.defra.gov.uk/page-3742	Role in mammal conservation in the UK, within Europe and beyond	2017 - unknown	N	Y
WeObserve	http://www.iiasa.ac.at/web/home/research/researchPrograms/EcosystemsServicesandManagement/WeObserve.html	CSA to mainstream CS into environmental policymaking	2017 - unknown	Y	Y
Women for Water Partnership	https://www.womenforwater.org/	Improved profile of women in the water and development sector, both in their professional capacity and as a major group in society	2016 - unknown	Y	Y
D-NOSES	http://mappingforchange.org.uk/projects/d-noses/	Use of OdourCollect, creation of the International Odour Observatory, promotion of engagement at national, local and international levels, work with 10 international local communities for citizen science interventions, move towards the introduction of odour pollution in the policy agendas, definition of a multi-level governance model and writing	2018 - unknown	N	Active but not updated or not an active website/social media

		of the Green Book in odour pollution and a medium-term roadmap			
AirSensEUR	https://airsenseur.org/	An open-source hardware/software/data platform for observation of air quality and radiation	2016 - 2019	N	Active but not updated or not an active website/social media