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D6.4 Impact Assessment Report V2

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Abstract	This document reports the results of the impact assessment of the ACTION project considering the entire duration of the project. Following the ACTION impact assessment methodology (D6.1) the main areas of impact considered are: scientific, social, economic, political and environmental. The transformative potential of the pilots is also considered together with their potential contribution to UN Sustainable Development Goals (SDGs). The areas of impact that score highest are the scientific and the social ones and promising results are observable also in terms of political impact.
Keywords	Impact assessment, impact of CS projects, social impact, economic impact, scientific impact, environmental impact, policy impact, transformative potential of CS projects

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EXECUTIVE SUMMARY

This report describes the scientific, social, economic, political and environmental impacts of ACTION and of its 16 pilots.

Overall, the mapped impacts are aligned with the expectations: many projects have a strong scientific and/or social impact, a high transformative potential, and promising political impacts. Environmental and economic impact emerged as more difficult to measure in a relatively short time frame as the one considered.

Altogether, the pilots reached more than **89.000 persons** through events and dissemination activities and engaged more than **1200 persons** in citizen science (CS) activities. 14 pilots engaged citizens in data collection, 6 of them (also) in data analysis and interpretation, five also in the development of data gathering tools, in data curation and in the communication of the pilots' results.

The UN Sustainable Development Goals (SDGs) more relevant for ACTION pilots are: 3 – Good health and wellbeing, 11 - Sustainable cities and communities, 12 - Responsible production and consumption but overall 10 of the 17 UN SDGs are touched by the ACTION pilots.

ACTION achieved a very positive **scientific impact**. In total, pilots gathered more than **108.000 data points**. Furthermore, ACTION pilots produced **15 scientific articles**, and 64 non-scientific publications to which we must add **24 scientific outputs** produced by the ACTION consortium. For almost all the project data quality is very high and most pilots are following Open Science and Open data principles.

Considering **social impacts**, it is possible to say that almost all the pilots report a positive social impact in terms of knowledge, skills and competencies acquired by engaged citizens. Some of the pilots report positive results in changing participants' opinions and way of thinking, especially on the specific topic covered by the pilots. Changes in opinions on more general aspects such as environmental sustainability or trust in science didn't emerge so well, because, in many cases participants showed a pro-environmental and pro-science value orientation already at the beginning of the pilots. Nevertheless, the pilots engaging students or people from more diversified communities show a positive impact on this aspect by increasing participants' interest for science and for nature and for the specific topic addressed by the pilot such as air, soil, water, and light pollution.

The situation for *behavioural change* is similar, but it is positive to see that some pilots can report behavioural changes already during the lifetime of the pilots since usually this kind of impact takes longer to become visible. With reference to the *social inclusion* dimension, it is fair to say that the covid-19 situation had a negative impact on the capability of pilots to engage citizens belonging to categories at risk of social exclusion. Indeed, the need to avoid face to face activi-

ties and the intensification of online activities made their engagement more difficult. Nevertheless, some projects, especially those that could count on a pre-existing community before joining the ACTION acceleration, show positive impact in terms of community empowerment by supporting the creation of new groups or by enlarging the existing ones. In addition, 11 pilots show a positive impact on the perception of citizens to be able to make a difference and become more active (self-perceived efficacy).

Economic impact was not an expected impact by most of the ACTION pilots: more should be done to support CS project managers in also considering this aspect of their work. However, there are promising achievements. Indeed, at least three projects saw or are expecting an increase in revenues by participating in ACTION, two got a positive impact in terms of employment and at least 4 are in a good position for having positive economic impacts on their local communities. In addition, we calculated the economic value of the research activities generated by volunteers in 7 of the ACTION pilots which is equal to approximately 29.000 euros overall. Considering now the economic impact of ACTION overall, the success of the project is testified by the fact that some of its partners were able to attract additional funds thanks to the collaboration and the experience of the project and at least three new projects have been awarded.

Political impact is a long-term impact that is generally achieved toward the end of the projects or, more often, after. Some of the ACTION pilots saw this area of impact as relevant from the planning phases and it is important to say that some of them already succeeded in engaging decision makers, in providing them with the results of their pilots and in opening an informed dialogue between citizens and local administration on pollution-related topics. It is reasonable to say that effective political impacts will emerge in the upcoming months and years as a long-term impact of ACTION. Beside the work of the pilot, the ACTION consortium generated and will generate additional political impact thanks to the work done through the policy masterclasses and the related recommendations and more local/national level actions that are supporting the emergence of national association of CS in countries where they were not possible and to a better interstation of CS in decision making mechanisms.

Finally, considering **environmental impact**, it appears to be mainly an indirect impact for most of the pilots and it can be achieved through policy impact or by succeeding in spreading more sustainable behaviours among a relatively high number of citizens. Indeed, CS can be one of the contributing factors for environmental impact, by collecting the necessary knowledge leading to individual, policy and social changes.

This report is, at the same time, a research output and an informative report interesting for both internal as well as external to the ACTION consortium readers. From a research perspective this report represents the application of the ACTION impact assessment methodology presented in Passani, Jenssen and Hölscher, K. (2020). In this sense, it can be useful to CS projects and social science researchers dealing with CS impact assessment and interesting in better understanding what kind of information can be gathered with the ACTION methodology and how to analyse them. From the impact assessment results presented here, as well as the feedback received from the projects during the assessment, it is possible to say that the methodology responds to the needs of citizen science pilots and supports the analysis project as well at aggregated level. Indeed, the modular and flexible structure makes sure that a diverse range of projects can show their impact, while allowing for some comparisons across projects.

1. INTRODUCTION

There are different ways to recognize and evaluate CS projects outcomes but collecting evidence to assess CS projects' impacts in a systematic way (considering several dimensions at the same time) is still a challenge. This is mainly due to the diversity of CS activities, ways of engaging citizens and fields of action. Beside this, there is often a lack of competences, time and/or resources of CS teams to carry out impact assessment activities.

Some attempts have been made to create guidelines for supporting CS projects' managers such as the Citizen Science White Paper (Socientize, 2014) and the Green Paper on the Citizen Science Strategy 2020 for Germany (Hecker et al., 2016). A process-based approach, linking evaluation and impact has been developed by Kieslinger, et al. (2017) and there is also a project dedicated to developing a online self-assessment tool for CS (MICS[1]), but the research in the field is still ongoing.

Indeed, even in recent meetings and conferences within the Citizen Science community (SWAFS programme project networking event, held in the January 2020; First Global Interdisciplinary Conference, held in September 2021 and final conference of ACTION and EU.citizen-science projects in November 2021), impact assessment emerged as one of the areas in which more research and training to CS managers is needed. There are several tools dedicated to one or more specific impacts of CS (impact on learning, for example) but, as stated by Shirk et al. (2012), "dealing with the Citizen Science project impact assessment implies the necessity to adopt a more holistic approach" (Haywood B. K.. Besley J. C., 2014).

The ACTION impact assessment framework (Passani, Janssen and Hoelscher, 2020) aimed to fill this gap and offers a standardised, yet flexible, impact assessment framework - including relative indicators and operational tools.

By applying the above-mentioned methodology (summarised in section 2), this document describes the main achievements of the ACTION project as a whole and of its 16 pilots in terms of scientific, social, economic, political, and environmental impacts. It also considers the transformative potential of ACTION pilots and their contribution to the Sustainable Development Goal. Finally, it also considers the impact of ACTION on the organisations engaged in the project.

This document is the fourth deliverable of WP 6 - Enhancing reflexivity, impact assessment and policy road mapping. More specifically, it is the second deliverable of Task 6.3 - Social, economic, policy and environmental impact assessment and analyses the data gathered as part of Task 6.2 - Data gathering.

The analysis included here is related to the entire duration of the project activities and represents an update of the previous deliverable 6.3 Impact assessment report v1.

This document is organised as follows: section one summarises the ACTION impact assessment methodology and describes the data gathering activities performed so far. Section two reports the aggregated data analysis of the impact of all pilots. Section three considers the overall impacts of ACTION as a project. Section four closes the document by reporting the main lesson learned from a methodological and data gathering point of view and drafts recommendations on how to maximise

[1] https://mics.tools/about-mics

citizen science projects' impacts. Annex B reports the impacts achieved by each of the ACTION pilots through a dedicated impact assessment report.

2. IMPACT ASSESSMENT METHODOLOGY, DATA GATHERING AND ANALYSIS

The following analysis of the pilots' impact is based on the ACTION impact assessment methodology described in D6.1 (Passani, Janssen and Hoelscher, 2020[2]). It has been developed and further refined following a co-design approach, engaging the ACTION consortium partners and the other citizen science pilots participating in the ACTION accelerator.

The ACTION impact assessment framework considers five areas of impact: scientific, social, economic, political and environmental, which are articulated in several dimensions each, with a total of 24 dimensions. These include, but are not limited to, impact on scientific knowledge, community empowerment, inclusiveness, impact on learning, behavioural change, impact on policy process, job creation and economic empowerment of local communities (Fig. 1).

*Fig. 1: **ACTION impact assessment areas and dimensions***

Besides these five areas of impact, the methodology also considers the transformative potential of the CS pilots, i.e., the degree to which a pilot can help to change, alter, or replace current systems, the business-as-usual in one or more fields such as science production or environmental protection.

The methodology is quali-quantitative and is designed to be modular and flexible in order to be adaptable to the specific characteristics of each CS pilot but, at the same time, assuring a cross-pilot and cumulative analysis. Indeed, not all the dimensions are (equally) relevant for all CS pilots, depending on their nature, their specific focus and the level of citizen engagement.

[2]The updates of the methodology will be available on Zenodo

The specific needs of each pilot in terms of impact assessment and the relevance of the various dimensions were collected and presented with help of the ACTION impact assessment canvas. The ACTION impact assessment canvas (Passani, Janssen and Hoelscher, 2022[3]), is a four-pages graphic form that supports CS pilots in mapping their stakeholders, their main outputs and the relevance of the impact dimensions (see Annex A)[4].

Then, for each pilot, an ad hoc impact assessment process has been defined, accompanied by the development of the necessary data gathering instruments (paper-based questionnaires, online surveys, focus group guidelines, etc.).

2.1 Data gathering process

For all the pilots, the first step of the data gathering process was to fill in the ACTION impact assessment canvas. Through the canvas each project was requested to identify the main project input, activities, outputs, outcomes, and impact, to analyse the stakeholders that could be impacted by their project and rate the relevance of the ACTION areas of impact and dimensions considered.

The ACTION impact assessment canvas proved to be a useful and effective tool and positive feedback from the pilots has been collected. Indeed, the canvas helped the impact assessment team in providing a focused impact assessment analysis and supported the CS managers in thinking in a more structured way about their impacts and, in some cases, also in adjusting the planning of their activities in order to cover desired impacts mentioned in the canvas but not considered before.

Then, moving from the information gathered through the impact assessment canvas, one to one online meetings were organised with all the pilots described in this report in order to co-design the data gathering process and related instruments. Information to be gathered was related to the areas of impact and dimensions emerging as more relevant for each pilot as per the impact assessment canvas, but for all pilots information on the number and profile of the citizens scientists engaged, scientific and technological outputs and dissemination activities were gathered too.

For the pilots engaged through the ACTION first open call, data were gathered mostly by interviewing the pilot coordinators. Online interviews lasted one hour and a half approximately and were recorded. For the pilots engaged through the second open call data were gathered via semi-structured questionnaires to pilots coordinators and online surveys to the citizens participating to the pilots. For the pilots that are ACTION partners since the beginning of the project, data were gathered in two rounds (around month 16/17 and in month 34/35) mainly through semi-structured questionnaires anticipated and followed by email exchange and ad hoc online meetings for clarifying specific topics.

For some pilots it was not possible to gather information directly from the citizen scientists/volunteers. In some cases, the reasons were related to opportunity (asking information directly from them would have required too much effort for them or would have undermined the engagement process) while in others were time-related.

[3]It is also available for download in Zenodo: https://www.zenodo.org/record/5930525#.YhNzed_SIXo

[4]The ACTION impact canvas design is inspired by different business and impact canvas and adapted to the specificity of CS projects (Phillips et al, 2017; Ratto-Nielsen, 2017). Other source of inspiration have been: https://www.artsculture-finance.org/wp-content/uploads/2018/09/Impact-Management-Canvas.pdf and https://www.threebility.com/sustainability-impact-canvas

Besides questionnaires and interviews, data were gathered by publicly available online resources and by considering the reports developed by the pilots as part of their work with the ACTION accelerator. The table below summarises the data gathering channels used for each pilot.

Pilots	**Impact assessment canvas**	**Online interview with project manager**	**Self-administered questionnaire to project manager**	**Survey to volunteers (i.e., citizens scientists, students, teachers)**	**Analysis of available documents (internal-to-ACTION reports, blog posts, pilot websites, etc.)**
Students, air pollution and DIY sensing	*		*	*	
Citizen scientists, dragonflies and pesticides	*		*		
Tatort street light	*	*			*
Loss of the night	*	*			*
Street spectra	*		*	*	
Azotea	*		*		
Sonic Kayak	*	*			*
Noise maps	*	*			*
CitiComPlastic	*	*			*
In my backyard	*	*			*
WOW nature	*		*	*	*
Walk Up Aniene	*		*	*	
Mapping mobility	*		*		
Open Soil Atlas	*		*	*	
Restart	*		*	*	
Water Sentinels	*		*	*	

Tab. 1 ***Data gathering channels used***

For the analysis of project impact on ACTION partners, beside the one engaged in pilot, a dedicated questionnaire was developed.

2.2 Data analysis

Data were analysed both at aggregated level (see section 3) and at project-by-project level (see Annex B).

For the aggregated analysis quantitative data such as the number of citizens engaged, reached via dissemination activities and number of outputs, were collected and summed up on a regular basis through the project. Analysis related to the impacts were analysed first considering the dimensions and then at the level of areas of impact. We considered a project to have a positive impact on a specific dimension if positive results were recorded on the majority of the variables considered. The same logic was applied when considering the impact on a specific area.

For the analysis at single project level, collected information was considered in a more qualitative way, following an interpretative approach for the interviews/questionnaires' results and by triangulating the data coming from other sources for validating the results of the interviews/questionnaires and enriching them.

Data related to the impacts on project partners, besides the ones engaged in pilots, have been also gathered via an online questionnaire and the results were analysed at aggregated level following a qualitative and interpretative/narrative approach.

3 Aggregated analysis

This section reports the aggregated analysis of all ACTION pilots. In reading the following analysis it is important to remember that the ACTION impact assessment methodology was applied in a modular way to the project pilots so that not all the areas of impact and related dimensions have been investigated for all the projects. Moreover, given the diversity among pilots and also the different level of data available among them, we only report those dimensions and information for which data aggregation is more meaningful/doable.

3.1 Overview

Out of the 16 ACTION pilots, 4 dealt with light pollution, 6 with soil pollution, 3 with water pollution, one with noise pollution and one with air pollution.

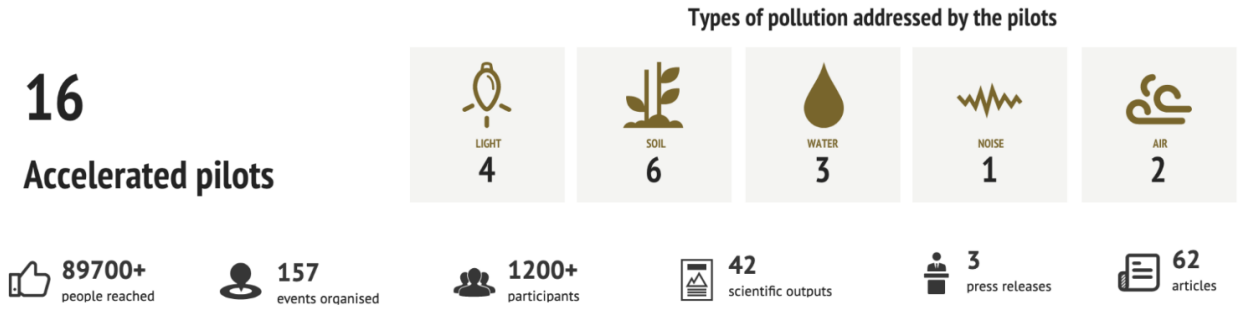

Fig. 2 Overview of the ACTION pilots in terms of reach and topic covered as illustrated by the ACTION dashboard (Scandolari, et al., 2022)

Considered altogether, the pilots reached more than 89.000 persons through events (157 events were organised) and other dissemination activities. It is important to notice that due to the Covid-19 situation, online dissemination and engagement has been crucial for all of them. 42 scientific outputs such as articles and posters have been published as well as 62 articles on non-scientific publication and 3 press releases. More than 12.000 citizens have been engaged as citizen scientists in project activities.

Looking at citizen engagement in CS activities (see figure 3), most of the pilots (14 out of 16) engaged citizens in data collection, which is confirmed to be the most common activity among CS projects. However, 6 projects engaged citizens in data analysis and interpretation (or *also* in data analysis and interpretation) and 5 in data gathering tools' development, in data curation and in results' communication. All the phases of a participatory research process were covered by at least 2 projects.

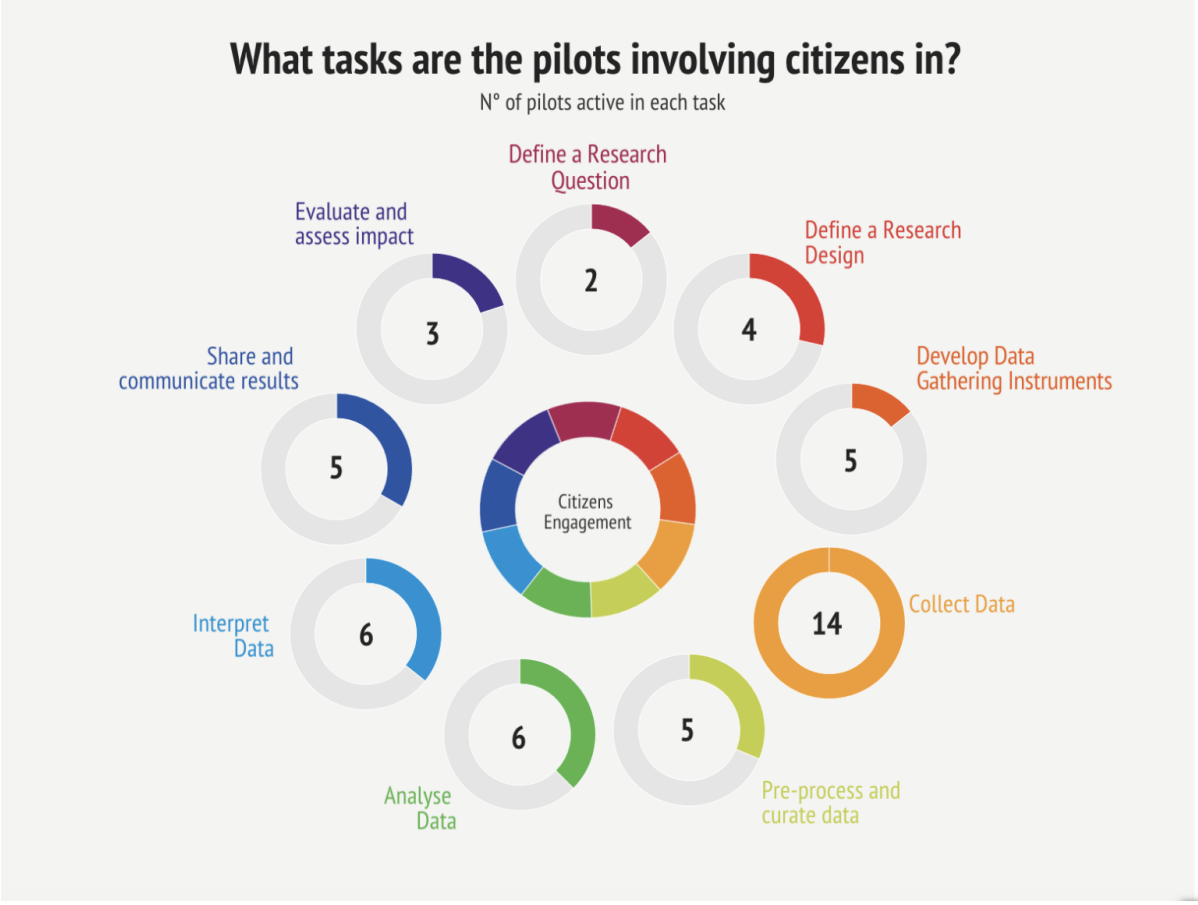

Fig. 3 Overview of the ACTION pilots' citizen engagement as illustrated by the ACTION dashboard

Social, scientific and environmental impacts are the ones considered as most relevant by the majority of the pilots, for some political impacts are relevant too, while for the vast majority economic impact is considered as not relevant (see figure 4). As we will see in the following subsections the perceived relevance of an area of impact is not always aligned with the actual achieved impact.

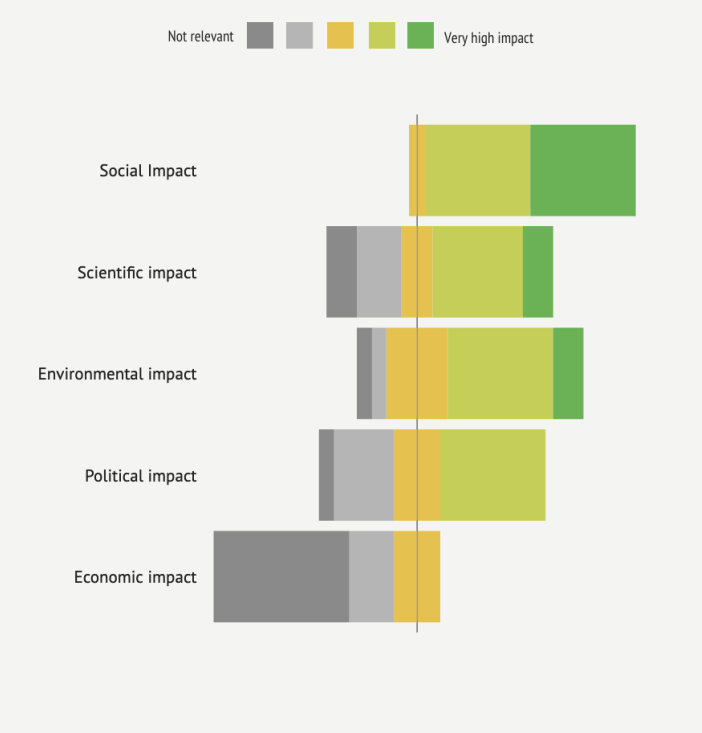

Fig. 4 Relevance of the areas of impact as illustrated by the ACTION dashboard

Considering the contribution of the ACTION pilots to UN sustainable Development Goals (SDGs), the figure below visualises the goals on which a positive impact is observed or should be expected in the medium to long period.

Fig. 5 ACTION pilots and SDGs as illustrated by the ACTION dashboard

Going more into details, the table below shows the targets that are more relevant for the ACTION pilots and how pilots contribute or are expected to contribute to their improvement/achievement. The levels to which they might contribute are the following:

- The target is addressed by providing useful data
- The target is addressed with dedicated actions at local level
- The target is addressed by providing innovation capable to provide an impact at regional/national or international level.

SDG goals/targets	***Data provision***	***Local level***	***National/international level***
Goal 2. Target 2.4		*	
Goal 3. Target:3.6 and 3.9		*	
Goal 4. Target: 4.7		*	
Goal 6. Targets: 6.1, 6.3 and 6.6	* (for 6.3)	*	
Goal 10. Target: 10.2		*	
Goal 11. Target: 11.2, 11.3, 11.4, 11.6 and 11.7	* (for 11.6)	*	
Goal 12. Target: 12. 5, 12.6 and 12.8		*	*
Goal 13. Target: 13.3		*	
Goal 15. Target 15.3 and 15.5	* (for 15.5)	*	

Tab. 2 Pilots' impact on SDGs

3.2 Scientific impact

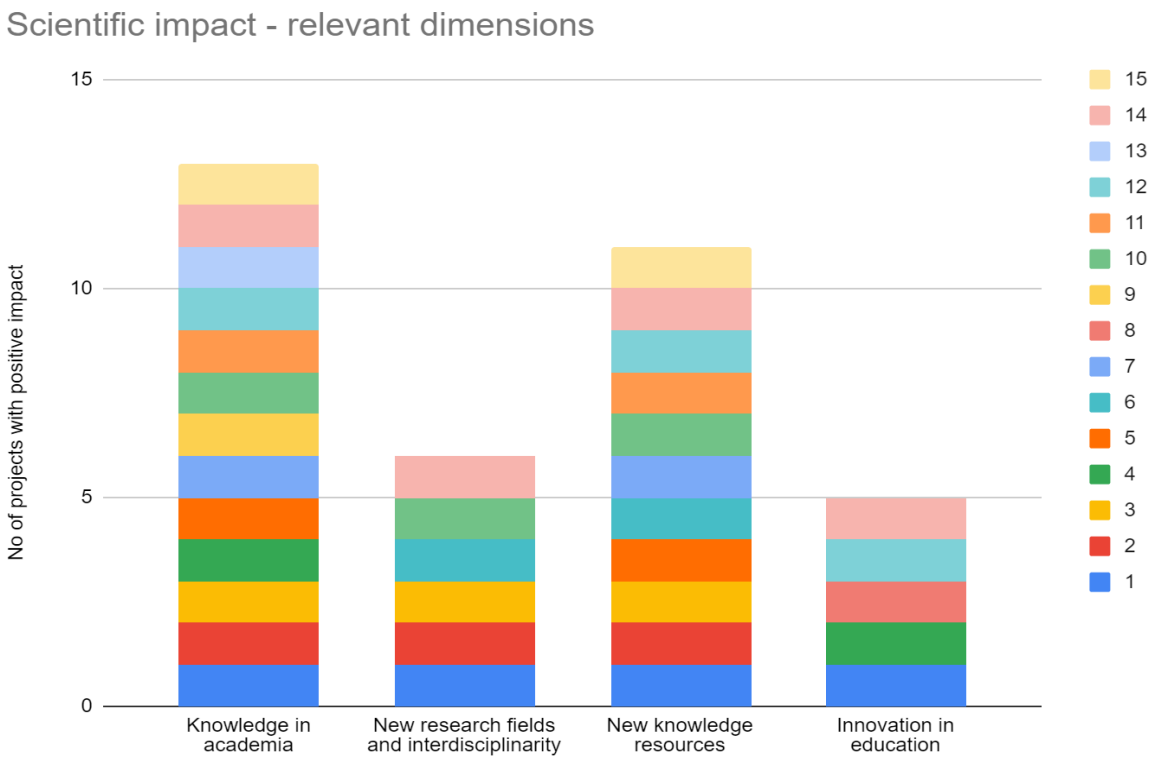

Figure 6. Aggregate scientific impact per sub dimension

All ACTION projects have had a positive scientific impact, many of which had a high scientific impact. All subdimensions are represented in the pilots (see figure 6) for an overview. We can see that most projects (13) have a positive impact on **knowledge in academia,** and that **new knowledge resources** are made by most of the projects (11). A substantial amount of projects have created **new research fields** and/or are highly **interdisciplinary** (6), and/or have contributed to innovation in education (5).

Below we go into more detail about the Knowledge in Academia sub dimension, because there are several variables that determine this impact.

Knowledge in Academia

In total, projects gathered more than 108.000 data points. Furthermore, ACTION produced 15 scientific articles, and 62 non-scientific publications.

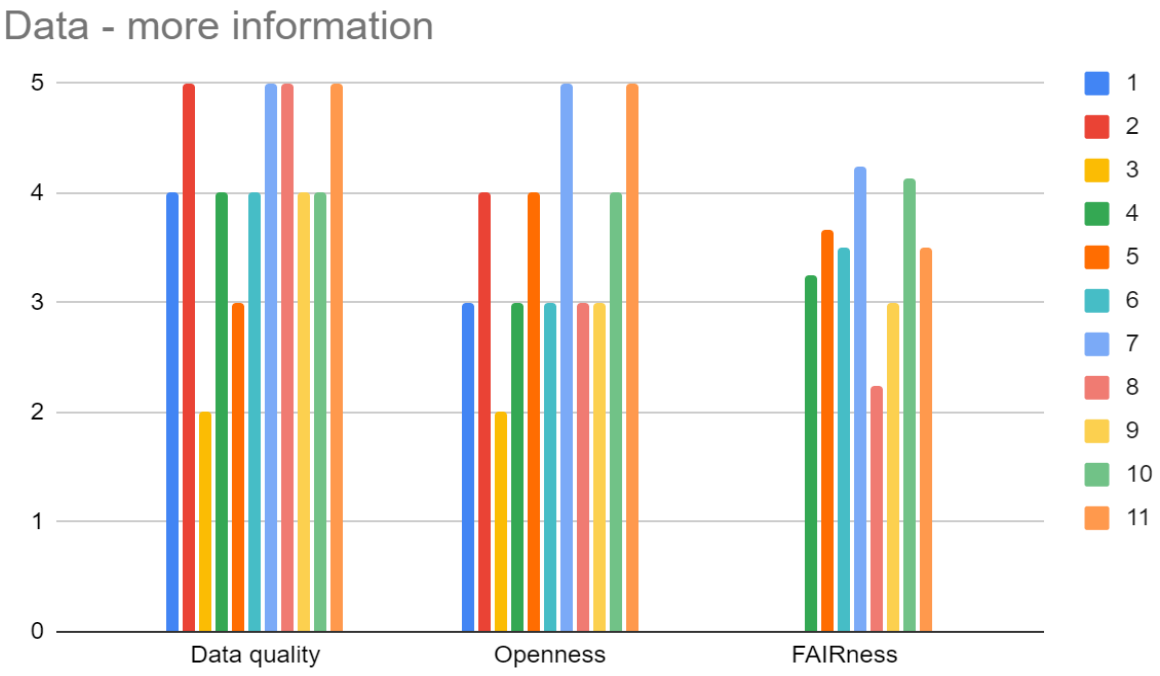

Figure 7. Scores (out of 5) on data quality, openness, and FAIRness

Data quality

For almost all projects for whom data collection was important, data quality is very high, scoring 4 or 5 out of 5 (see figure 7). One project scored 3, which still implies good data quality. One project scored 2. This score can partly be explained by the adaptations made to the project due to the pandemic, and partly because there was a shift of focus. Figure 8 shows which indicators were positive and for how many of those projects. This shows us that the projects scored very well on most indicators, but that we should focus more on implementing a procedure for adapting the process of data collection based on feedback, before data collection is fully rolled out.

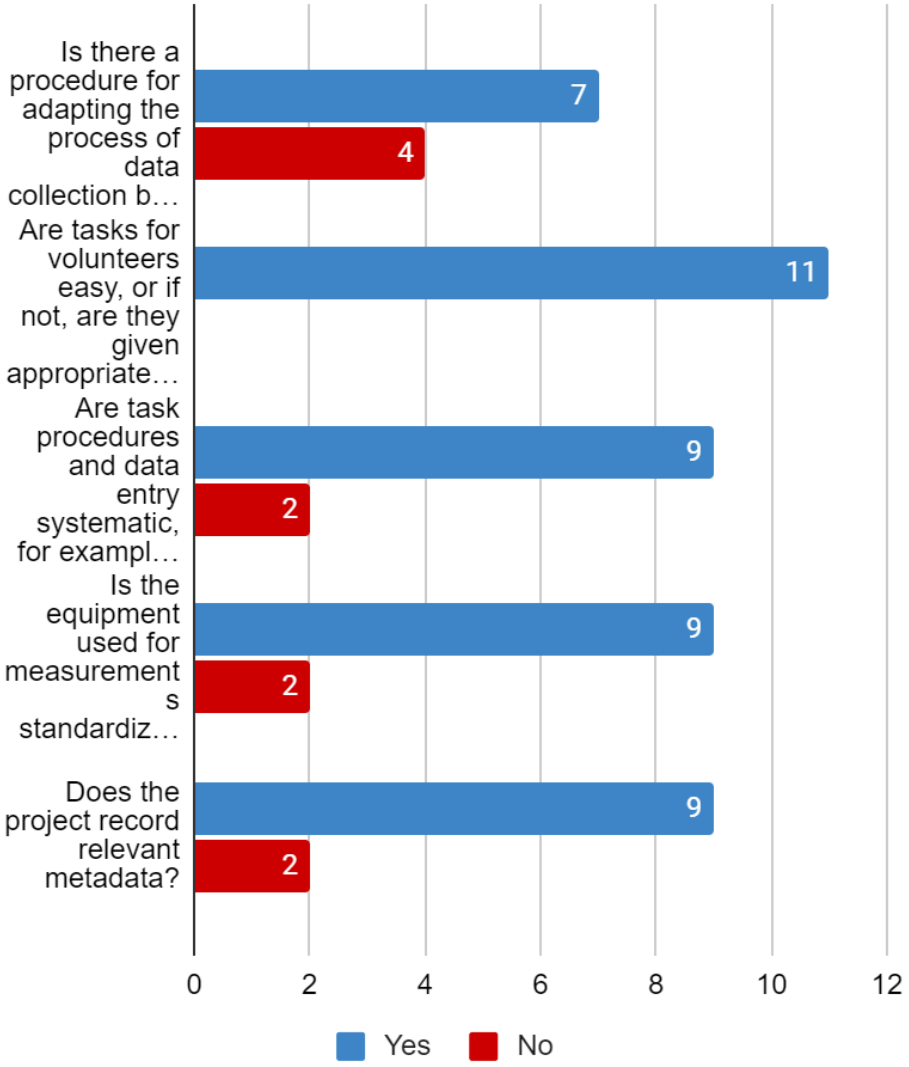

Figure 8. Aggregated data quality score (out of 5) per indicator

Openness

Most projects for whom data collection was a priority score well on the openness of their data, see figure 9.

In figure 9, indeed, we can see that many indicators for the openness of data are positive, but that the projects could improve by following standards from for example W3C and by linking to other datasets for context.

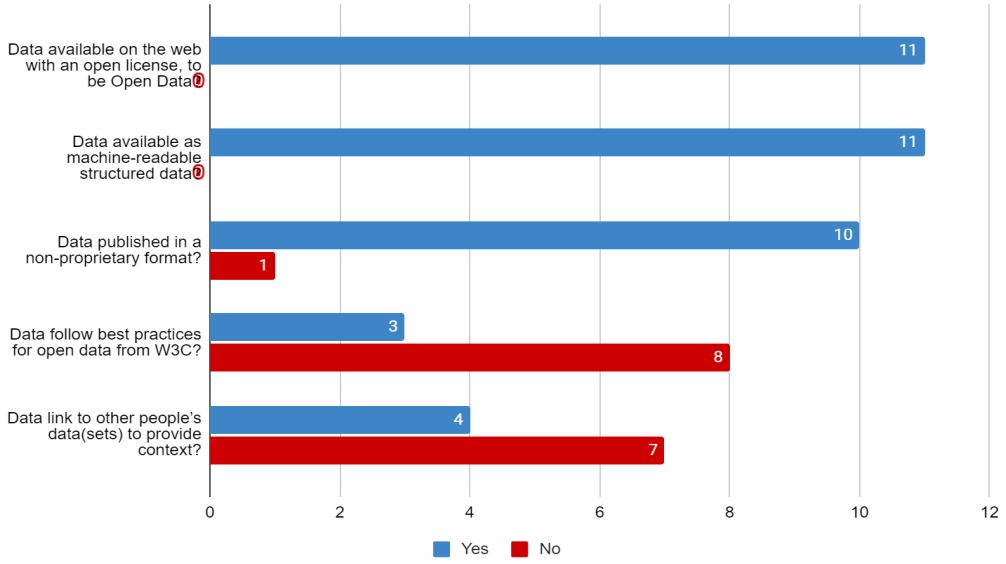

Figure 9. Aggregated openness of data score (out of 5) per indicator

3.3 Social impact

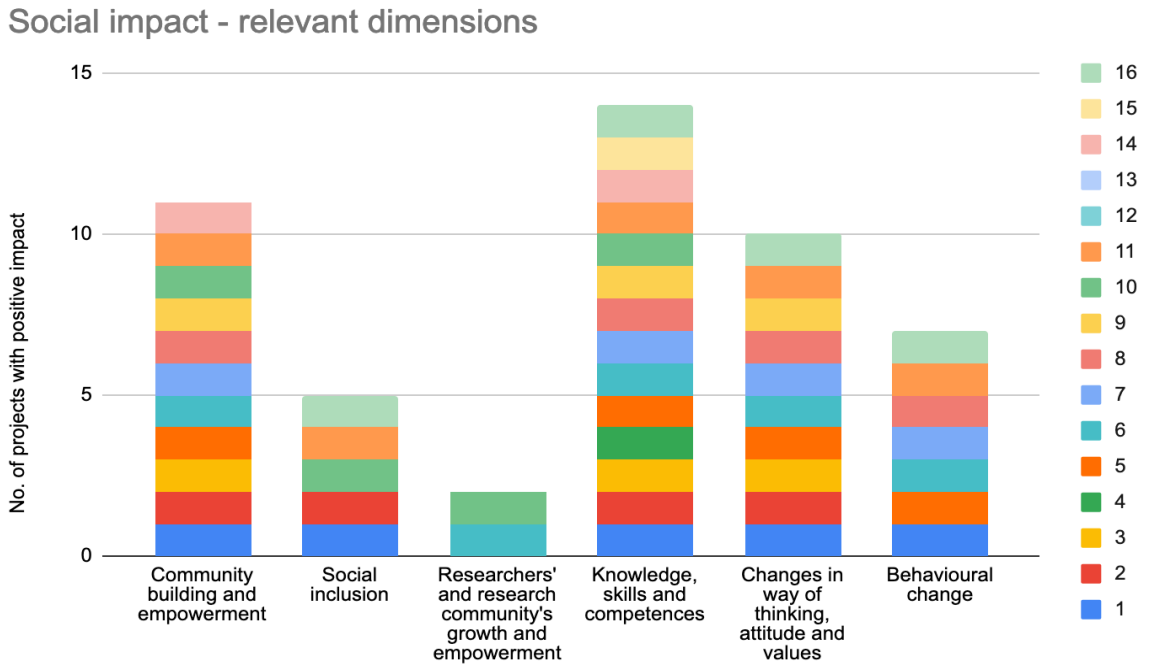

Fig. 6 Aggregate social impact per sub dimension

From the analysis that we carried out, it is possible to say that social impact is the dimension in which impacts are more visible, together with the scientific one. Indeed, almost all the projects have a positive impact on **knowledge, skills and competencies**. In all the cases this is true with reference to the topic directly tackled by the pilots, while for others the engaged volunteers also improved their

understanding of scientific processes, broader environmental issues, understanding of technology and specific data gathering and analysis processes.

Change in **way of thinking** happened for some projects, again more with reference to the specific topic covered by the pilot than on other more general aspects such as environmental sustainability or trust in science. In many cases this is due to the fact that participants were already interested in environmental issues, and showed a pro-environmental and pro-science value orientation before starting the CS project. Indeed, in those projects in which participants were less close to the "ethos" of the project, positive impact on way of thinning on these more general terms is observed.

The situation for **behavioural change** is similar, but it is positive to see that many projects are able to report behavioural changes already during the lifetime of the pilots since usually this kind of impact takes longer to become visible. Behavioural changes are reported especially by pilots that engage citizens in activities and topics directly linked with their personal behaviours such as purchasing choices or gardening practices.

With reference to the **social inclusion** dimension, it is fair to say that the covid-19 situation had a negative impact on the capability of pilots to engage citizens belonging to categories at risk of social exclusion such as migrants, persons with disabilities and low income families and persons. Indeed, the need to avoid face to face activities and the moving of the engagement in the "online sphere" made their engagement more difficult. This is for various reasons, among which is the fact that digital divide and lack of digital skills goes, sometimes, hands in hands with other risk factors. Another reason is linked to the need to invest more time and develop collaboration with other associations for engaging these communities and gaining their trust, activities that were planned in at least three pilots and that could not happen or happened in a more limited way during the covid-19 period. Indeed, some of the pilots, particularly the ones with a pre-existing communities before the starting of the ACTION acceleration period such as Water Sentinels and ReStart, succeed in reaching people belonging to groups at risk of social exclusion, thanks to the pre-existing links and the long term trust relationship available.

In some cases the pandemic situation also reduced the impact on **community building and empowerment**, for example by reducing the number of volunteers engaged, and the possibility to support participants in enlarging and strengthening their social links. Higher impacts on social capital, for example, would have been probably reported if the activities would have been carried out in a face-to-face way. Indeed, in the pilots that were able to do so (at least for a brief period or partially), we reported improvement in the social relationships among participants and the creation of new social links. Nevertheless, the pilots did important work in spreading their work to a large audience and supporting awareness raising at local level and beyond. In addition, three pilots supported the creation of new communities and /or social groups, four supported the enlargement of pre-existing communities and social groups and eleven pilots declared to have increased participants' self-perceived efficacy. This is of particular interest as self-perceived efficacy is the capability of a person to feel him/herself as capable to make a difference in a given situation and is positive linked with the behavioural change, self-organisation and active engagement in positive action towards a given objective such as, for example, increase air quality, reduce soil pollution etc.

3.4 Economic impact

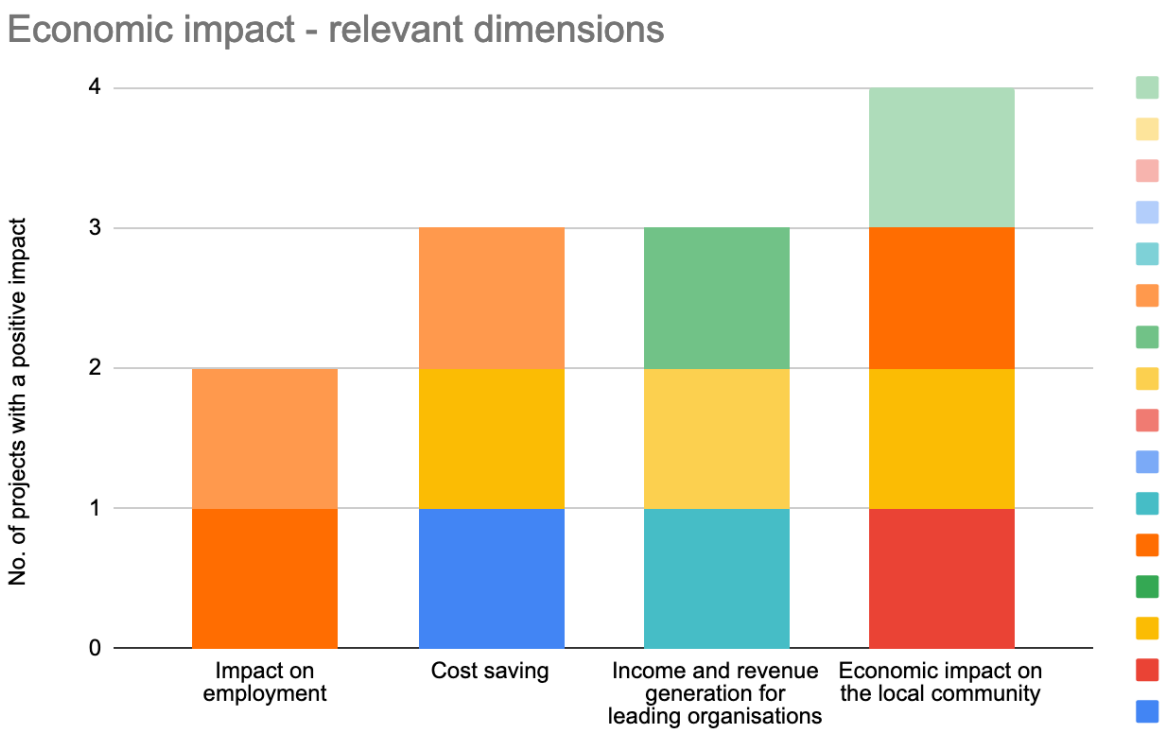

Fig. 7 Aggregate economic impact per sub dimension

Economic impact was not seen as an expected impact by the majority of the ACTION projects. Indeed, economic impacts are often underestimated when analysing citizen science. The final impact assessment report investigated deeper one of the main economic impacts of CS which is linked with the capacity of CS projects to gather data that is otherwise impossible to gather.

Indeed, the time invested by citizens in gathering data and, sometimes, in curating and analysing them has a clear economic value. Paying professional researchers for doing so would be unsustainable from an economic point of view for many research organisations, if not all so that CS can learn to save costs for those organisations and society overall. Also from a management point, in pilots like Loss of the Night and Street spectra, there is the need to gather data for a decade or longer: an effort difficult to achieve with the current instability of work position in the research organisations and the fast pace of research funding and targets' changes.

The analysis of CS cost saving, addresses the question: "to what extent does the project produce cost or time saving for local stakeholders, for example the Municipality or the research community, by carrying out activities that would be otherwise more expensive or impossible to perform?". For doing this, we moved from the work by Blaney et al. (2016), and simplified it in order to reduce the amount of information to be provided by CS project teams. We applied the following formula:

(number of volunteer x average number of hours dedicated to project activities) x average hourly wage of a post-Doc student[5]

The choice to use the salary of post-doc students in this analysis is based on the consideration that in most cases this type of research figure is the one that carries out research work. This formula provides the *economic value generated by volunteers*.

In order to assess if this constitutes an actual cost saving it needs to be compared with the hours dedicated to engaging, training and support citizen scientists that, for simplicity, we have evaluated with the same salatìry cost of the post-doc students even if this constitutes a simplification considering that the actual job position working with CS volunteers can vary considerably.

Considering all the ACTION pilots that provided the needed information for this analysis (which are 7 out of 16) we can say that 1551 hours of volunteer effort have been dedicated to data generation and analysis and that the overall economic generated value is approximately equal to 29.000 Euros.

On average, each of the considered ACTION pilots generates a bit more than 4000 Euros of value in terms of data gathering and analysis. If we use this mean value for scaling the potential impact of all ACTION pilots, the potential economic value generated would be 64.000 Euros.

Considering the cost saving, only three projects show a clear cost saving and those are ReStart, Street Spectra and WoW Nature. What the first two have in common is a strong emphasis on online engagement of volunteers and an efficient use of online tools for data gathering and analysis. Another characteristic that all three share is that they didn't start with ACTION, indeed all of them could count on a well-experienced team and this, at least partially, explains the higher capability of training and supporting volunteers in an efficient way. For the other, the cost of supporting citizens in their work of data generation and analysis is higher than its economic value and the same if true for ACTION overall: indeed for each Euros spent in doing CS, the consortium invested three Euros in providing support. Higher efficiency will be achievable in the future, now that many resources and learning tools have been developed (i.e. the ACTION toolkit) and to the use of additional online tools.

Beside this, three projects such as Tatort Street Light are expected to have a positive economic impact on the local community by safeguarding the target territories and promoting them for their reservation characteristics. Indeed, this pilot is expecting to support the local community in attracting visitors willing to take advantage of dark skies and to support, in this way, a twist towards sustainable tourism.

CitiComPlastic represented a good example of how a CS project can link with social entrepreneurship and support job creation. Due to the covid situation this link didn't roll out as planned but still the work done constitutes a preliminary proof of concept on how composting of new materials could

[5]Based on Ribeiro et al 2019, the average hourly wage of a post-Doc student in the EU is equal to 18,8 Euros. More precisely, ACTION being a project mainly devoted to exploring environmental issues, we used the median annual gross salary calculated in the previously mentioned study for a postdoc in environmental sciences (Env&Geo), that is equal to 31,200 EUR. Then, to calculate the approximate working hours of a postdoc in one year, we calculated roughly the number of working days in a solar year. A solar year has 365 days, with 104 weekend days (52 Saturdays and 52 Sundays). We considered public holidays too, for which it is difficult to have an average estimation as this largely varies across countries. However, given the experience of the authors of this report and of the other project participants, we can approximate public holidays in 10 days. We also consider an annual average of 30 annual leave days for holidays and health. We therefore have a total of 144 days in which a postdoc, officially, does not work in a solar year. This means there are 221 effective working days during a solar year for a postdoc. We consider that the average working hours in each day are 7.5. This means that the effective working hours of a postdoc in 221 days are 1,657. Based on this estimation, we can say that 31,200 EUR are spread over 1,657 working hours, therefore each working hour is paid 18,8 EUR. This value is being used to estimate the economic impacts of each pilot and then aggregated to reach the figures in this sub-paragraph.

be translated into job and opportunities, especially for the marginalised youth of the Osla area originally targeted by the pilot.

In addition, three pilots showed economic impact in terms of revenue generation for the leading organisation. In most of the cases this happens through public funds, by attracting additional funds for related and spin-off projects but in some other cases, like Sonic Kayak, this happens also through the offering of consultancy services and training on the project results and technological outputs (like, for example, sensors, or the related software).

Another interesting economic impact is impact on employment: only two pilots had a positive impact on this dimension, generating two new working positions thanks to ACTION funds.

Finally, sustainability is a relevant topic for all the pilots and training on this topic was offered by ACTION. From the interviews with pilot managers it emerged that, when planning a project, thinking about long term sustainability is crucial, especially when Apps are involved. In some cases, indeed, the team could be able to support follow-up research activities or engagement activities on a voluntary basis or with a low budget, but costs for App updates and adaptations can be high so that they should be considered upfront in order to avoid risks of project interruption and community disintegration.

3.5 Political impact

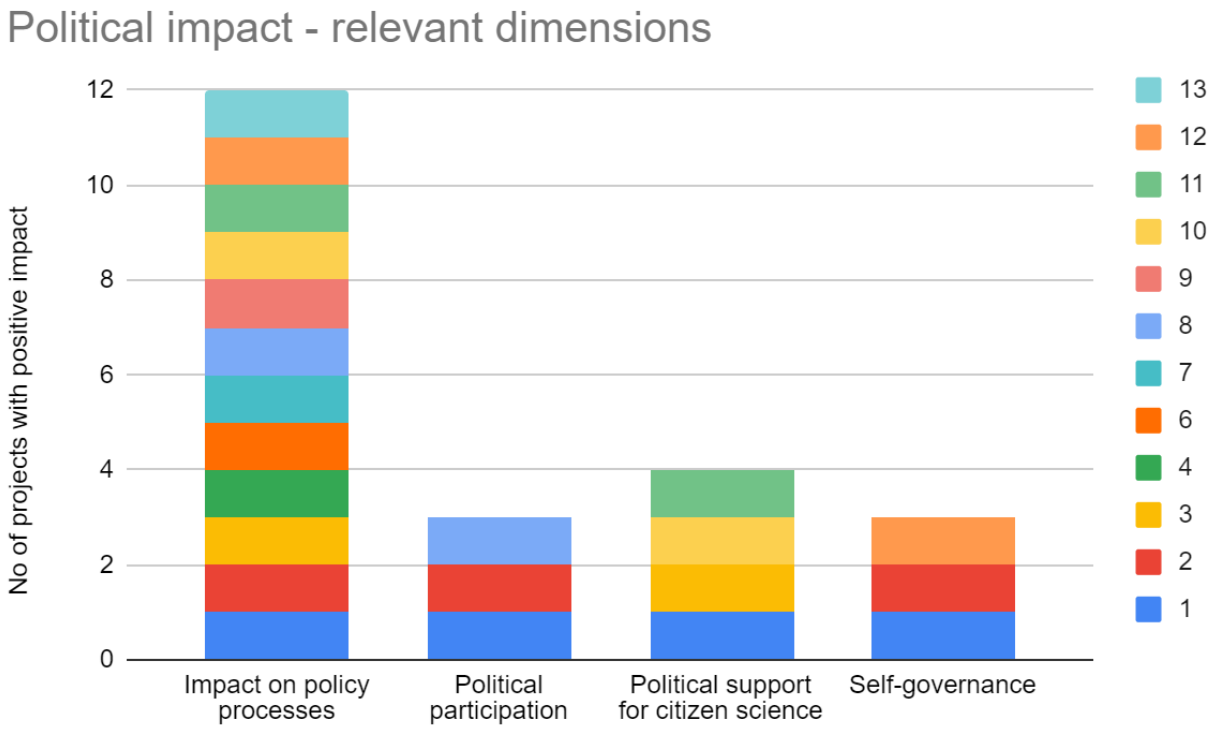

Fig. 8 Aggregate political impact per sub dimension

Fourteen projects have already had a positive political impact (see Fig. 8). All sub dimensions are represented in two or more projects, with **impact on policy processes** being the most important sub dimension (relevant for twelve projects). For this sub dimension, as well as self-governance, impact is in line with the expected political impact. For the other two sub dimensions - citizen empowerment and political support for citizen science - impact is somewhat lower than expected. The (proposed) reason for this is that we believe that political impact is often a longer-term impact. For example, an increase in political support for citizen science might only happen some time after the project has ended, when policy makers hear of the project's successes. All in all, we believe that the results of the pilots in terms of political impact are promising and show us that citizen science can have a political impact.

3.6 Environmental impact

While for many projects, environmental impact seemed important and obtained high scores in the impact assessment canvas, we were unable to measure actual environmental impact. We believe this is due to the fact that environmental impact usually only becomes apparent after a long time, such as long-term behavioural change of a group of citizens, or after a big-scale intervention, such as closing down a polluting factory. Both the scale and the duration of citizen science projects does not lend itself to environmental impact that is measurable.

This does not mean that the citizen science projects did not impact the environment positively. Citizen science can be one of the contributing factors for environmental impact, by collecting the necessary knowledge or support for changing policy or behaviour. For example, the analysis of the correlation between dragonfly presence and pesticides in DBC's project has an environmental impact in the sense that knowing about the threats for biodiversity will help reduce those threats. This means that the project does cover a vital step in achieving environmental impact but does not generate a direct impact on the environment. Another example comes from the StreetSpectra project and Tatort: while these projects have not decreased light pollution directly, they increase light pollution awareness, which is expected to have an impact in the long-term.

3.7 Transformative impact

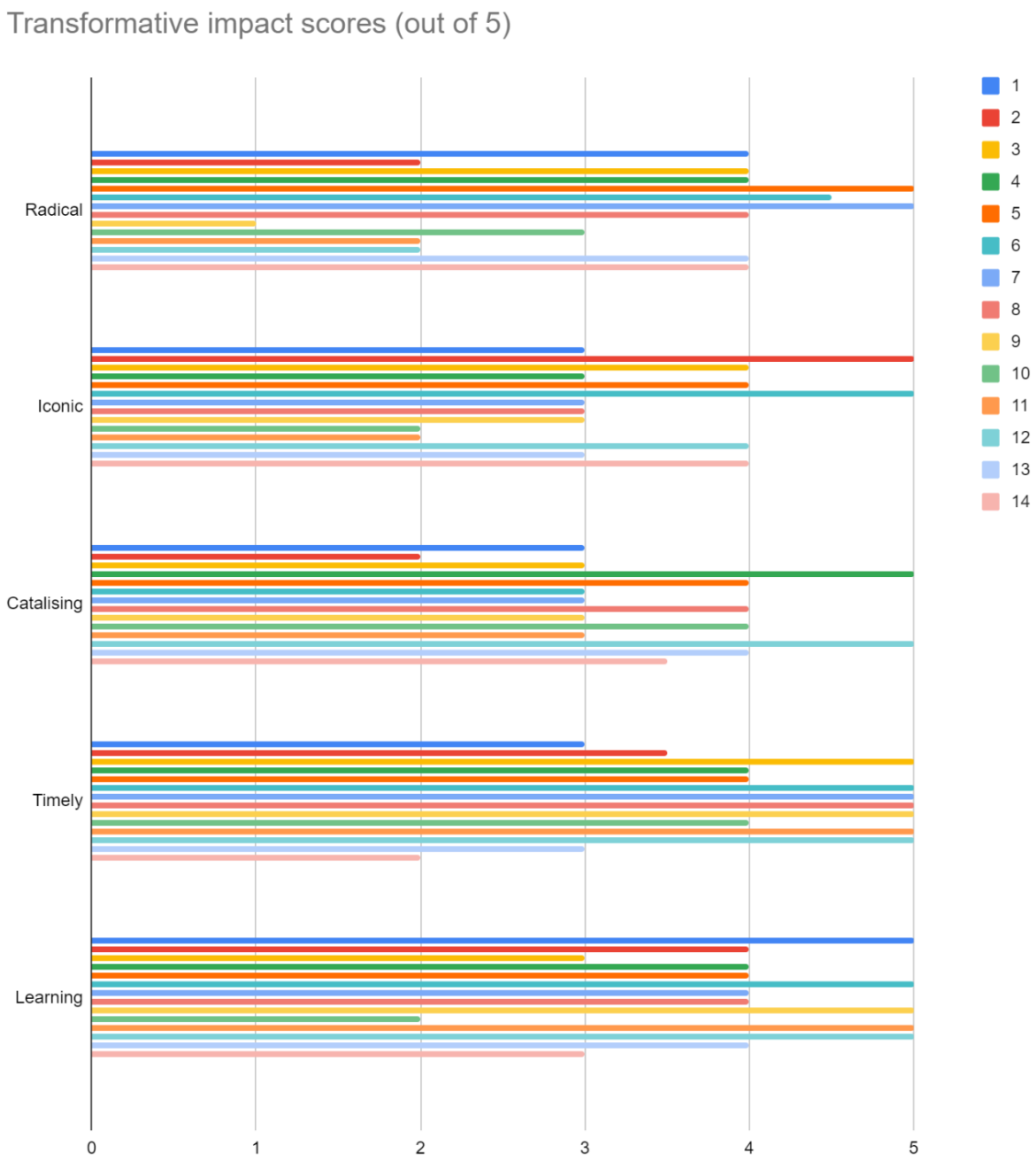

Fig. 9 Transformative impact scores

Most projects have a high transformative impact. In **Errore. L'origine riferimento non è stata trovata.** we show all scores. The average scores per sub dimension are as follows: Radical 3,46; Iconic 3,43; Catalysing 3,53; Timely 4,19; Learning 4,07. We can see that all average scores are above 3, with Timely being the highest, and Iconic the lowest. The high scores indicate that citizen science

projects have a high potential of system transformation. For example, they can contribute to making science more open and citizen-led, they can change the way that society views and deals with pollution, or change the way citizens are involved in environmental issues.

4 Other impacts of the ACTION project

Considering now the impacts of ACTION beyond the ones achieved by the supported pilots, the first impact to mention is the ***scientific*** one. Indeed, the ACTION consortium developed 24 scientific outputs, mainly articles in peer-reviewed scientific journals and posters accepted in conferences. More articles are under evaluation or will be published in the next months. These exceed the expected target of ten publications established at the time of the proposal writing and it is accompanied by 59 talks at conferences and scientific events.

Beside this, we should consider the ACTION final conference "The future of citizen science" as a scientific output too as it was a further occasion for ACTION's researchers to showcase their achievements and results even if the event was mainly a dissemination-oriented one. The conference took place on 24th and 25th November 2021 and it was organised together with the EU-Citizen.Science project; it was carried out online and gathered more than 160 people and more than 30 speakers (of which 7 from the ACTION project) (see Firus et al., 2022 for more details on the conference and for the list of scientific outputs).

The final event was for sure a good opportunity for giving ***visibility*** to project activities and outputs, but it was only the last one of a series of events that the project consortium carried out. Indeed, 47 events were organised (31 events with talks, 7 events with poster presentations, 6 other workshops or other types of meetings, 3 workshops at larger policy events such as the European Week of regions and cities). In terms of visibility, this adds to the dissemination work done online: the ACTION website got 26,7k visitors with more than 82k pages views, the project social media were followed by more than 1500 persons and the partners were alway very active in amplifying the project dissemination work, reaching larger groups of stakeholders.

Coming back to the ***scientific impact***, ACTION partners report different positive impacts on the scientific community beside the ones related to the scientific production. On this, it emerged the capacity of ACTION partners to advocate for CS, increase its visibility and recognition within the scientific community and among decision makers (see next paragraphs for more details on this aspect). Another important aspect is the support provided to CS practitioners and researchers to adopt open science best practices by offering tangible tools and by offering dedicated, free for all, training. Finally, the project contributed to spreading a "culture" of impact assessment and reflexivity in the CS research community fostering exchanges on this topic and offering support to the SwafS community and beyond.

In terms of ***economic impact***, besides the economic value generated by the ACTION pilots, we should mention that, thanks to the new collaborations established through the project, at least 3 new projects have been awarded.

Thanks to the project, 13 new jobs were created (full time equivalent) and out of them, 8 will be active also after the end of the project, indicating the capability of the project to translate project-based job opportunities into long term stable working positions.

In terms of ***political impact***, we must acknowledge the work done through the organisation of the ACTION policy Masterclasses: local or national events dedicated to policy workers. 5 masterclasses were organised in the Netherlands, UK, Spain, Norway and Italy with an overall participation of 111

persons. Each masterclass, thanks to a participative and iterative validation process developed national policy recommendations. Based on the themes that emerged from the recommendations across those five countries, general recommendations to mainstream citizen science were developed: these were validated during an international citizen science policy dialogue masterclass with 75 participants.

This work, very well rooted into local and national needs and specificities results in a dedicated document that has been further disseminated across the EU. As better described here after, this work generated several outcomes at the local level that should be interpreted as a sign of future positive impact, able to contribute to strengthening the role of CS not only at academic level, but also in the decision-making processes.

The work done through the policy masterclasses is accompanied by another relevant output: *the White paper on science innovation in citizen science*. This outputs, generated by overall experience of the ACTION project and especially that of supporting CS pilots, explore the role CS can play in positive impacting the way science is currently done by: increasing equity at organisation level; reducing power asymmetries within the academia and at societal level; increase diversity and social inclusion; challenge colonialist approach that are still present in science towards nature and beyond; promoting open science, participation and transdisciplinarity.

Beside these important achievements, or - better - as a follow up of these, the ACTION partners engaged further in policy dialogue at local and national level.

Indeed, 8 out of the 10 partners declared to be engaged in policy-related activities as a result of ACTION. These take various forms: for example, in Italy and Norway partners are working for the establishment of a national association of CS together with other local stakeholders to create a legally recognised network of CS practitioners. Other partners organised ad hoc meetings and presented project and pilots' results to local and national policy makers in Spain, the Netherlands and Germany advocating for the importance of bottom-up research in pollution and biodiversity monitoring and diversity in citizen science. Additionally, ACTION was presented to the Policy Lab in the UK Cabinet Office, as a consequence, the Cabinet is now exploring CS as a method for their own work, which in turn informs government decisions. ACTION's insights were also used in government consultations, such as the Inclusive Data Taskforce of the UK Office for National Statistics (ONS), where ACTION partners advised on the opportunities of citizen science to increase data equality.

Finally, it is possible to say that ACTION has shown that the approach of cascading funds and acceleration programs is a viable and successful one in supporting more and better CS projects. This impact is testified by the fact that ACTION has been invited in several international events to showcase its model, that the process put in place has been considered and adopted buy several other EU project and that lead to further new projects based on the same model. On this, it is particularly important to mention the Impetus project that will start in a few months and that will support - through open calls, a dedicated acceleration process and an EU prize - more than 125 projects and that can be seen as the scaling up of ACTION.

4.1 Impact of ACTION on project partners

Considering now the impacts of ACTION on the 10 organisations composing the consortium, it is interesting to see that for the majority of the teams, the main impact was on learning. Indeed, 8 out of 10 teams described this as main impact: they learned more, in order of frequency, on open science and data management (4 answers), on project management and related technical skills (4 answers), on citizens' motivations in participating in CS and citizen engagement theory and practice (3 answers), impact assessment (2 answers), communication (1), software development (1), applied research (1) and about participating in EU projects (1).

Besides impact on learning, teams reported a positive impact in terms of visibility and networking (4 answers) and in terms of development of new tools and instruments that will be useful for further activities and projects (2 answers). With reference to the development of new collaborations and enlargement of organisations' networks, overall more than 100 new collaborations were established by ACTION partners as a result of their participation in ACTION. This relevant increment in social capital, is accompanied by an equally relevant increment in symbolic capital, i.e. the recognition of one organisation within the network of relevant stakeholders. In this respect, 10 partners report an increase in recognition in the CS community, 7 in their scientific community and 3 in other relevant communities. The increment of both social and symbolic capital is an important prerequisite for future scientific and economic impact because larger and more diversified networks, combined with good recognition can lead to new projects, new funds and further research endeavours. Indeed, several proposals (approximately 10-12) have been already submitted by project partners and at least three have been financed already, one of which, called Impetus, can be seen as the continuation and scaling up of ACTION.

Positive impact at political level was also mentioned by 3 partners and is related to the fact that ACTION supported the creation or reinforcement of local networks and associations on CS in which ACTION partners are playing an important role.

5 CONCLUSIONS

This report presents the outputs, outcomes and short term impacts of the ACTION project and of the pilots it supported. It complements the work done at methodological level and we hope it can represent, especially with Annex B, a good example of how to apply the ACTION impact assessment methodology. Indeed, if it is true that impact assessment is still a challenge for CS projects, especially due to the lack of time and resources that characterise several CS teams, we hope that the work here reported overcomes the challenges at methodological level. We would like to close this report with a few considerations on the application of the methodology and on the next steps in terms of research in the field.

We observed that the impact assessment framework responds to the needs of citizen science projects: it allows them to translate their impact in terms that policy makers, potential funders, and other interested parties can understand. The time investment needed to perform an impact assessment still proved challenging for some projects, especially when impact on many dimensions was expected. We did see that this challenge was eased when we substituted interviews for self-reported questionnaires - this allowed the projects to better plan their work and, still, measuring many subdimensions can result in long questionnaires, which some project teams found hard to find time for.

We observed a training effect of the impact assessment procedure for the pilots' project teams. It did not only serve as a means for impact assessment, but also induced reflexivity (Back et al, 1994; Beers at al, 2017): it allowed the project teams to reflect on what impact they could achieve and how to do so. An avenue for future development is to make this training effect more explicit and to develop methods for reflexivity during the course of a citizen science project.

We were not able to measure environmental impact. While this seems like an important dimension of impact for citizen science projects, especially in the area of pollution, there should be future research on whether this dimension belongs in an impact assessment framework, and if so, how it should be measured. Indeed the majority of the observed projects carried out research and awareness raising activities on pollution but were not focusing on actual restoration or protection activities. Therefore the environmental impact is probably better observed in the long term, once the political impacts will become more evident, possibly transforming those regulatory frameworks that can have a positive impact on the environment. Another potential pathway to environmental impact is through behavioural changes induced by the CS projects and also this pathway needs to be better observed in the long run. These reflections provide avenues for further development and research.

Finally, it is important to mention that the ACTION toolkit (available on the ACTION website) includes guidelines and recommendations on how to use, adapt and apply the ACTION impact assessment methodology and that the authors of this report remain available for providing support to the CS community on this.

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Annex A: ACTION impact assessment canvas

ACTION citizen science impact assessment canvas

Key problem you want to address	Key research question
What social, economic, environmental problem are you trying to (contribute to) solve? *Example: Air pollution, especially that generated by private vehicles, in Turin (Italy)*	What is the main research question addressed by your CS project? *Example: how does private mobility traffic impact on air quality in specific areas of the city and in specific moments of the day?*

Key stakeholders

- **Researchers**
  Representing which disciplines? Junior or senior?
- **Citizen scientists**
  Do you foresee engaging any specific social group? Is your project working towards inclusiveness? What is the gender distribution in your group of citizens: female/male/not disclosed/other?
- **Policy/decision makers**
  Are you targeting local/national or international policy/decision makers?
- **Business actors**
  Will your project provide input to business actors? Are you collaborating with business actors as part of your project?
- **Other organisations**
  Will you collaborate with other organisations? What kinds of organisations can benefit from the project's activities/results?
- **General public**
  Do you foresee reaching local, national or international audiences?

This project is co-financed by the European Union
Grant Agreement No.: 824603

Input	Activities
• Where are you starting from? • What was there before the beginning of the project? • What are the economic/technical and human resources you will use? How much do they cost? *Example: this project is the continuation of a previous one, we already have 200 CS engaged and 5 lead researchers*	• What will you do? • What do you do to engage your stakeholders? *Example: Air quality monitoring with low-cost DIY sensors. 5 events. 3 training workshops*
Outputs	**Short-terms and long-term impacts**
• What are the tangible results you expect to deliver? • How many people do you aim to engage? • How many people do you aim to reach through communication? • How many policy makers you expect to contact? *Example: a new version of our air quality measurement sensor; a curated dataset; 3 publications. 500 CS engaged. 1k citizens reached.*	• What positive changes do you expect for your stakeholders? • Which areas of impact are more relevant? (see ACTION impact assessment framework in the next page and described in the related PPT) • Which dimensions are more relevant? (see ACTION impact assessment framework in the next page and described in the related PPT) *Example: citizens will be more aware of air quality, better informed on how to reduce their exposure, 10% will change their mobilityg behaviours. Policy makers will change mobility policies. Papers deeply up taken by researchers in the field.*

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Assign a value from 1 to 5 to each areas of impact and to the related dimensions
(1 is not relevant/we do not aspect impacts. - 5 is very relevant/will be a crucial impact)
Definitions of the areas of impact and related dimensions are in the PPT that accompany this canvas

	Value
Scientific impact	*Medium or median value*
Scientific knowledge	
New research fields and interdisciplinarity	
New knowledge resources	
Innovation in education	

	Value
Political impact	*Medium or media value*
Impact on policy process	
Political participation	
Self-governance	
Political support for citizen science	

	Value
Social impact	*Medium or median value*
Community building and empowerment	
Social inclusion	
Researchers and research community's growth and empowerment	
Knowledge, skills and competences	
Changes in way of thinking, attitude and values	
Behavioural change	

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	Value
Economic impact	*Medium or median value*
Impact on employment	
Cost saving	
Income and revenue generation for leading organisations	
Economic impact on the local communities	

	Value
Other impacts	*Medium or median value*
Please specify.....	
Please specify.....	

	Value
Environmental	*Medium or median value*
Impact on ecosystem	
Impact on biodiversity	
Impact on soil quality	
Impact on water quality	
Impact on air quality	
Impact on health	

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Annex B - ACTION pilots impact assessment reports

This appendix reports the results of the final impact assessment of the following ACTION pilots:

- Students, air pollution and DIY sensing
- Citizen scientists, dragonflies and pesticides
- TATORT STREET LIGHT
- LOSS OF THE NIGHT
- STREET SPECTRA
- Sonic Kayak
- NOISE MAPS
- CitiComPlastic
- In my backyard
- Wow Nature
- ReStart
- Water sentinels
- Open Soil Atlas
- Walk-up Aniene
- Mapping mobility

Each of the following subsections is dedicated to a specific pilot. Each pilot is first described with reference to its main activities and characteristics, then the relevance to the impact assessment's areas is reported in a radar chart. *It is important to note* that this chart reports the relevance of the areas of impact according to the pilot project managers as resulted in the impact assessment canvas and does not indicate, therefore, the actual achieved impacts, which are otherwise described in the dedicated sub-sections.

The relevance of the various areas of impact is important because the impact assessment data gathering and analysis activities were performed only for those areas of impact and dimensions that scored 3 or higher in the impact assessment canvas. The radar chart is followed by thematic sub-sections that describe the outputs/impacts achieved on the areas of impact and dimensions considered as most relevant by the pilots' project managers.

Students, air pollution and DIY sensing[6]

Territorial coverage: Oslo and larger Oslo area (Norvegia)	**Type of pollution considered:** air pollution
Revant SDGs 3 - good health and wellbeing, 4 - quality education, 5 - gender equality 11 - sustainable cities and communities, 13 - climate action	

In this pilot, high-school students in Oslo and the greater Oslo area had the opportunity to carry out their own air quality projects - from data gathering to analysis and results presentations (in some of the schools engaged this implied the definition of research questions too, while in others the research question was assigned by the teachers).

For carrying out measurements and collecting data, the students used an Arduino-based air quality sensor platform, equipped with a Nova SDS011 sensor to measure $PM_{2.5}$ and PM_{10} pollution levels. They could add additional components for measuring e.g., relative humidity, temperature, noise or CO_2. The results were presented by the students themselves at a joint student conference. The three rounds of project activities were planned for spring 2019, 2020, and 2021. The project activities in 2019 engaged 7 school classes. In 2020, due to Covid-19, only three school classes completed the activities. A third round took place between April and June 2021 engaging. For more detailed information about how the project was planned and carried out, see D2.7. Furthermore, D2.8 is an evaluation report of the students' learning outcomes.

[6]This part borrows heavily from D2.8: *Passani, A., Janssen, A., Di Lisio, G. Grossberndt, S. (2020), Evaluation report of learning outcomes of high school students after participating in air quality projects*

Impact areas's relevance

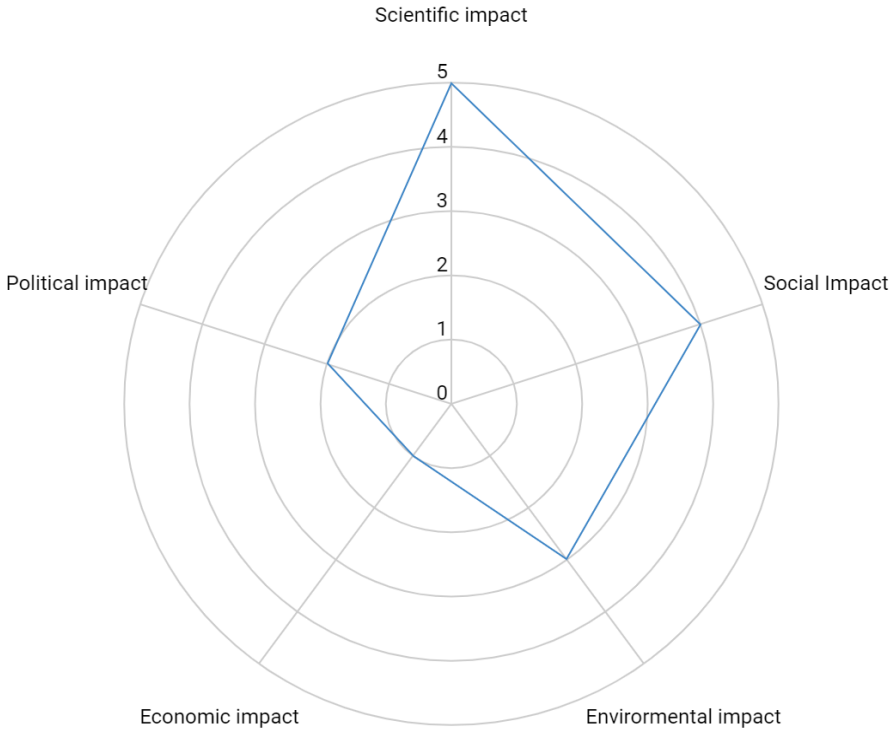


Fig. 10 Relevance of the areas of impact as in the impact assessment canvas

As we can see in Fig. 10 the most relevant impact areas for this pilot are the scientific impact, the social impact and the environmental impact. We'll discuss the scientific and social impact in more detail in the following subsections. As we discussed in chapter 3, we were not able to measure environmental impact.

Scientific impact

Innovation in education

Most of the scientific impact of the project *Students, air pollution and DIY sensing* has been in terms of innovation in education (3,5 out of 5 - project manager's scoring). The project is an innovative way of implementing the current school curriculum, which states that students should learn how to work scientifically. Rather than assigning the students another paper, the project is an immersive way of teaching scientific skills. Also, the project has been highly appreciated by the teachers because of its interdisciplinary character and the students' independence.

Producing project output in terms of datasets has not been the aim of this project. This means that impact on the other subdimensions of scientific impact - knowledge in academia, new research fields and interdisciplinarity, and new knowledge resources - is minimal. The project has, however, managed to produce one scientific paper, as well as a video and educational resource.

Social impact

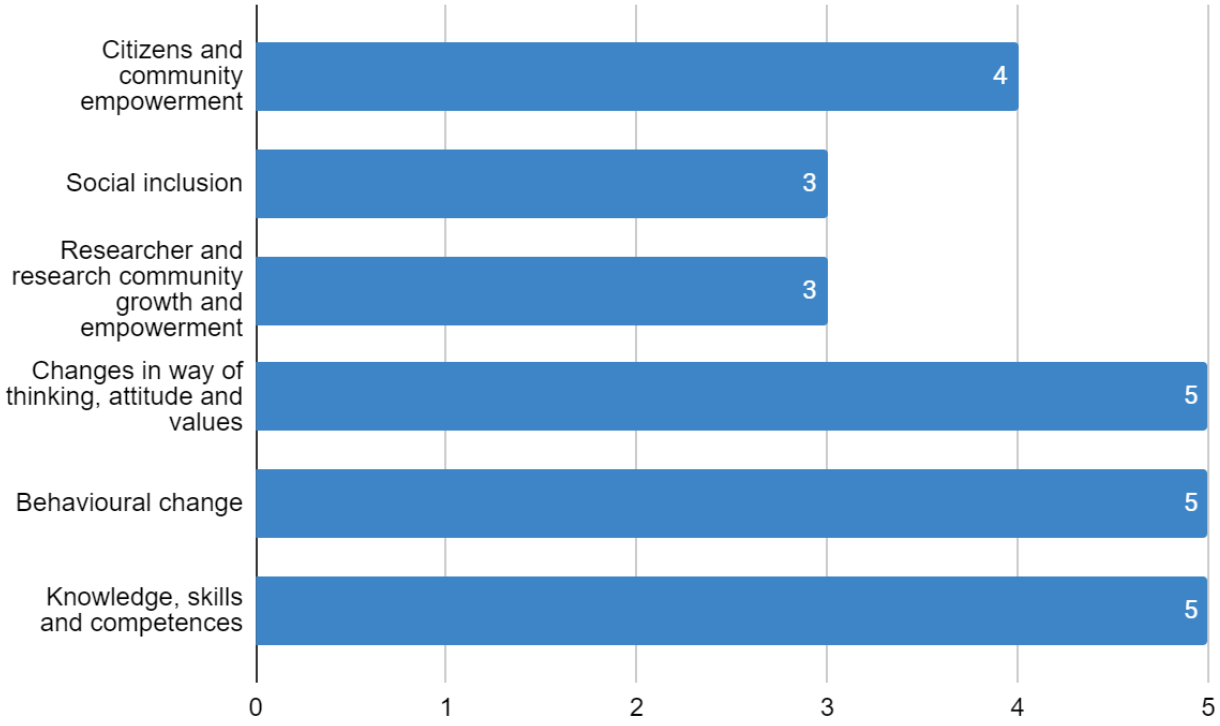


Fig. 11 Social impact

The social impact is the most relevant area of impact for the pilot, especially for the following subdimensions (Fig. 11):

- increase of knowledge, skills and competences
- changes in way of thinking, attitudes and values
- behavioural changes.

We have valued the social impact through the analysis of questionnaires submitted to both teachers and students, at the end (and, for the students, also at the beginning) of each round of the project. In this section we have summarised the results that are more extensively described in D2.8 (Passani, A. et al., 2020).

For what concerns the impacts on teachers in the first round, we have the responses of four of them.

All the teachers affirmed that the project's activities contributed to *increasing students' awareness on air quality issues*, provided both students and teachers with *new skills and competences* and influenced the *way in which students view and value science*. Three out of four of the teachers think that the engagement with the ACTION project team has increased their awareness on air quality issues and that, thanks to the knowledge gained with the activities, they will now have a more pro-environmental behaviour. Two out of four of them think that also students will have a more pro-environmental behaviour.

With reference to the second round, we have collected answers from three teachers out of the four engaged.

All three of them affirmed that the activities of the project:

- positively influenced students' attitude towards science

- provided students with new competences in the use of scientific tools (e.g. sensors)
- improved students' scientific competences (including data gathering and data analysis), students' interest in scientific related careers, students' attitude towards environmental issues and air quality issues, and the relationships within the class.

Two out of three of them think that the activity carried out improved students' scientific reasoning skill and their critical thinking attitude. Only one of them thinks that the activities have improved students' motivation and self-esteem.

Moreover, to measure the impact on teachers, we designed two questions where they had to answer "yes" or "no". Firstly, we asked teachers if the activity and the engagement with the ACTION project team contribute to increasing their awareness on air quality issues. Then, we asked them if the activity and the engagement with the ACTION project team provided them with new skills and competences. All three teachers answered positively to both questions.

For the third round (2021), to measure the impact that the project had on students' skills and attitudes from teachers' perspectives, we used nine questions pointed with the Likert scale (1 = strongly disagree, 5 = strongly agree). In Fig. 12 and Fig. 13 below, we can see the results for skills and attitudes improvement assessment, respectively.

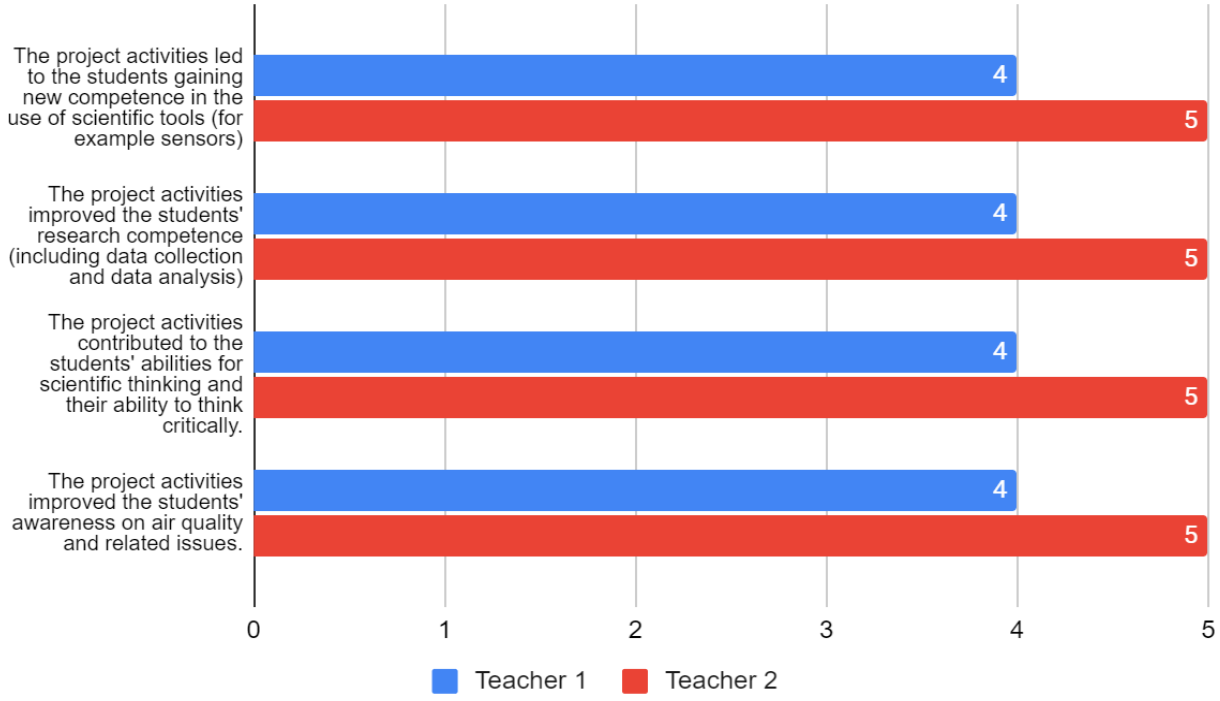


Fig. 12 Impact on students' skills from teachers' perspective, third round.

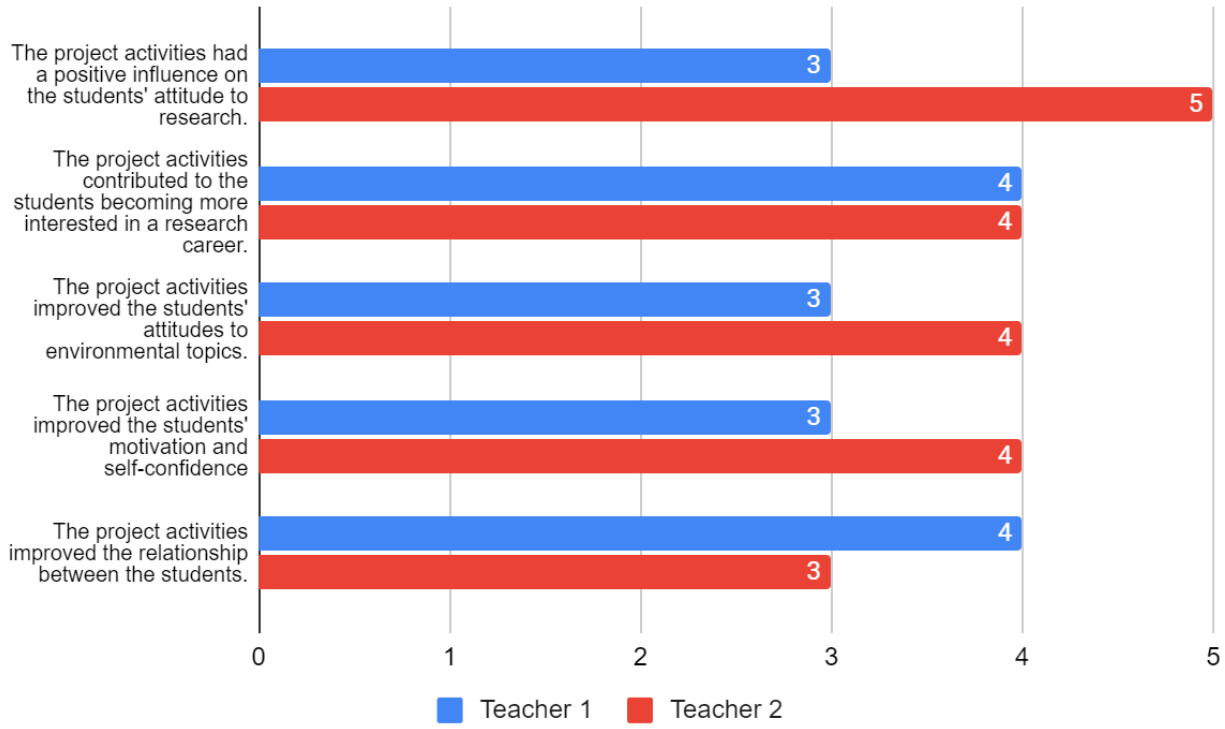


Fig. 13 Impact on students' attitudes from teachers' perspective, third round.

As we can see in the figure above both teachers consider the Citizen Science project experience as very positive for the skills improvement of their students. The teachers' inclination is milder about the impact on students' attitude, although the results are positive.

Then, we asked the teachers if the project has improved their awareness about air quality issues, and if it has had a positive influence on their skills and competencies. Both teachers answered affirmatively to the two questions.

For the students of the first round, we have measured the impact that the pilot activities had on students through specific questions. Figure below shows both questions and answers. We used a 5-point Likert scale.

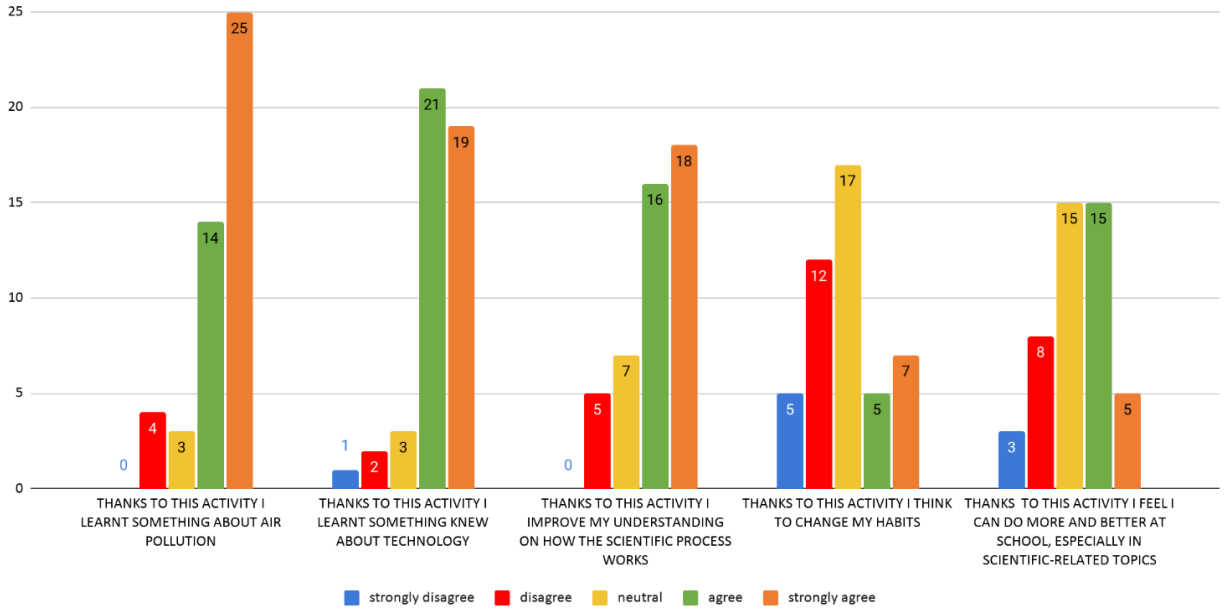


Fig. 14 Impact on students first round

As can be seen, the strongest impact that we have registered is on the learning aspect. 39 out of 47 respondents declare that they learned something about air pollution, 39 that they learned about technology, 43 that they improved their understanding of scientific processes. Only 12 said that they are thinking of changing their behaviours and 20 declared to see a positive impact on how they can do at school in general and especially in scientific topics.

There were 38 students in the second round. For this round, we implemented an ex-ante/ex-post questionnaire. In the ex-ante questionnaire we measured students' opinion and behaviour towards science and environment. We submitted the same questions in the ex-post questionnaires, to check possible changes, plus we used a series of questions to evaluate the overall impact of the project. For example, we used simple questions, to which we applied a dichotomic type of answers ("yes" and "no"). In the figure below we can see the results.

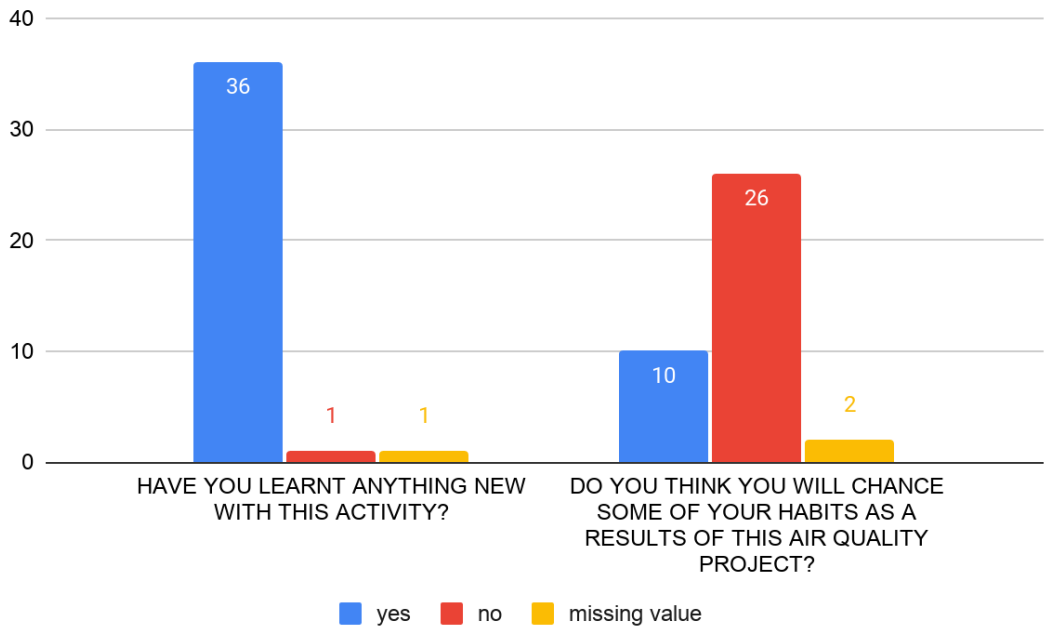


Fig. 15 Impact on students ex-post second round

We can see a positive impact with regard to the learning aspect, but a less positive impact regarding behavioural changes; 36 out of 38 of them answered positively. However, only 10 of them affirmed that they will change some of their habits as a result of the engagement in the project.

To better understand the impact with regard to the learning aspect of the project, we asked the students whether their interest in air quality and in science in general had changed. Fig. 16 and Fig. 17 show the results.

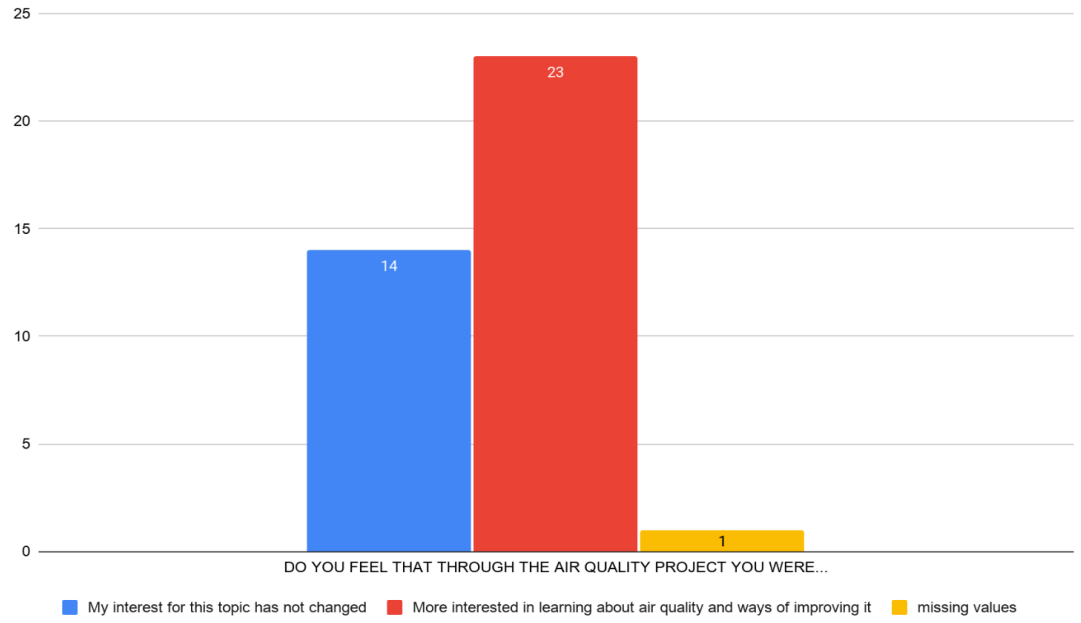


Fig. 16 Impacts on students ex-post second round

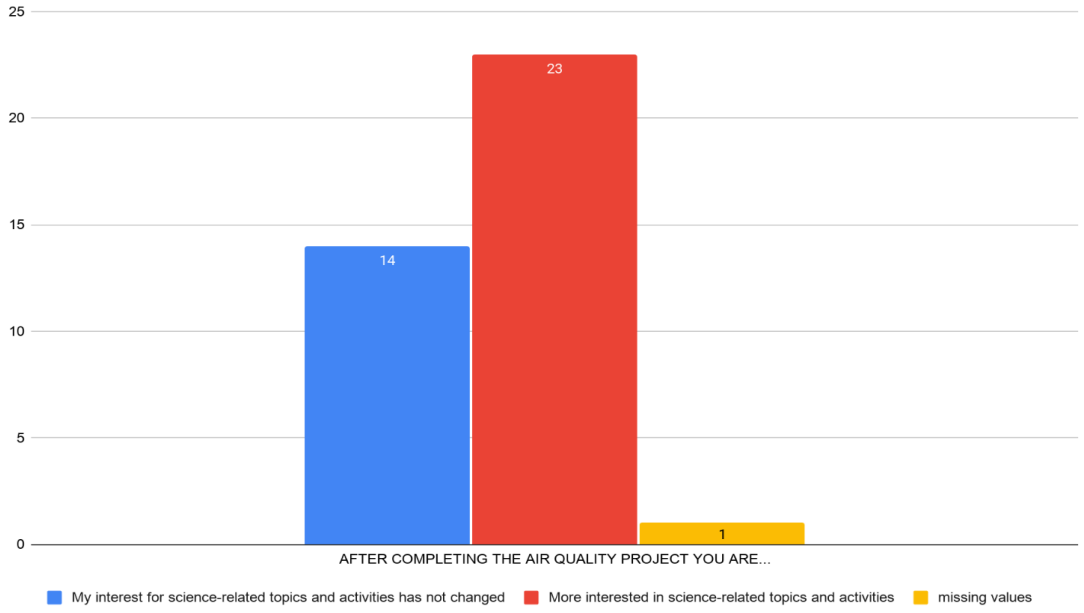


Fig. 17 Impacts on students ex-post second round

As we can see, 23 out of 38 of the students stated that, after completing ACTION project activities, they are more interested in learning about air quality and ways of improving it, and in science related topics and activities.

Third round of the project (2021)

Ex-post data distribution

Also in the third round, to measure the project's impact on learning on students, we used the same questions reported for the second round.

We can see the results in the below.

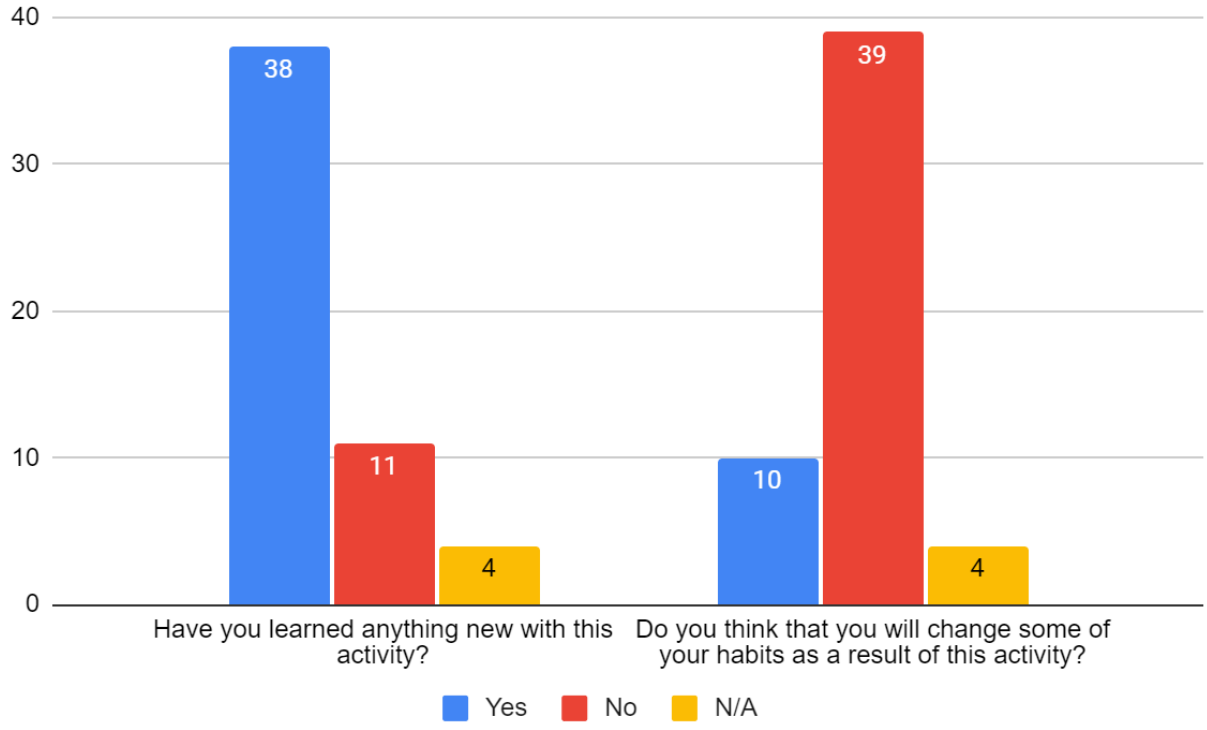


Fig. 18 Impact on students ex-post third round (2021)

We can see that, as for the second round, the impact on learning is bigger than the impact on future habits. 72% of the students affirm to have learned something new thanks to the activities, but 73% of them also affirm that they won't change some of their habits as a result of those activities.

Concerning the students' interest towards learning more on air quality and how to improve it, and the research-related topics, we can see if it has changed in Figures 46 and 67 below.

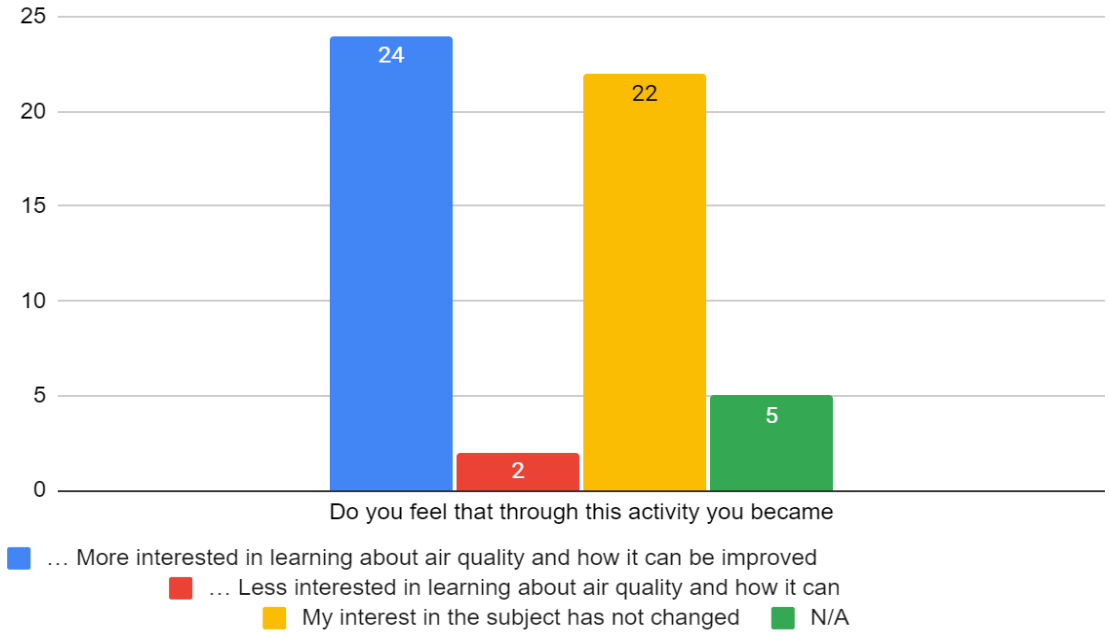


Fig. 19 Impacts on students ex-post third round (2021)

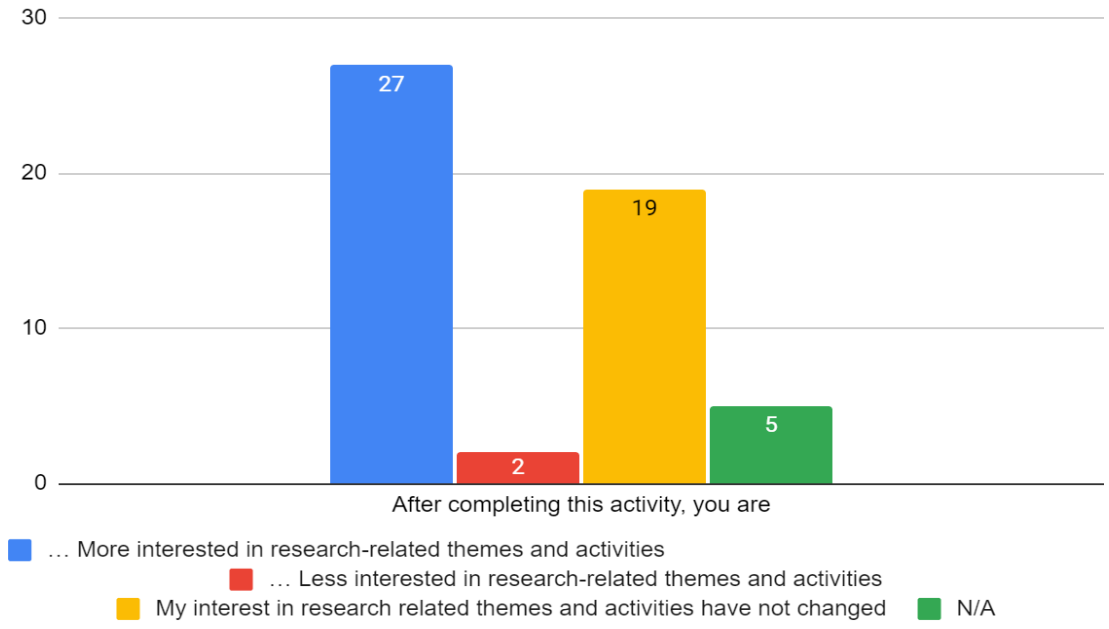


Fig. 20 Impacts on students ex-post third round (2021)

As we can see, 45% of the students affirm that their interest in learning about air quality and how to improve it has increased, while 41% of them state that it hasn't changed.

Moreover, 51% of the students are more interested in research-related themes and activities, while 36% say their interest in the topic hasn't changed.

Social inclusion

Looking now at the diversity among participants, of the 46 students participating in the first round of the pilot activities (2019), the majority were male and ranged between 14 and 19 years old. We haven't any students' cultural background information for this first wave of the pilot project.

For the second round of the pilot (2020), we have gathered data through questionnaires before and after the project implementation.

In the ex-ante phase, 46 students completed the questionnaires. Again, the majority of them were male. Their ages varied from 16 to 19 years old. In order to understand the cultural background of students without asking about their nationality and without mentioning (for ethical purposes) the status of migrant/refugees they might belong to, we asked - as a proxy for nationality - the language used at home. The obtained data show that the large majority of the students speak Norwegian at home, and there is a minority that come from families whose cultural background is different from Norwegian..

In the ex-post phase, we register a smaller number of students compared with the ex-ante assessment. In this phase, 38 students completed the questionnaire, the majority of which were male. Their ages run between 16 and 18 years old. As seen in the ex-ante assessment the majority of the students come from a Norwegian cultural background and speak Norwegian at home.

Also for the third round of the pilot (2021), we have gathered data through questionnaires before and after the project implementation.

In the ex-ante phase, 25 students answered the questionnaires. Data from one class are missed due to the impossibility of distributing the survey for class-related organizational issues. The students are between 16 and 19 years old. In terms of gender distribution, females represent 52% of the total, with male being equal at 48%. Almost all the students are Norwegian, although two students are from a different cultural background.

In the ex-post phase, 53 students answered the questionnaires. They are between 16 and 21 years old. The majority of the students are male (37 versus 14 female) and are Norwegian, but the number of students from a non-norwegian cultural background increase to 7.

Transformative impact

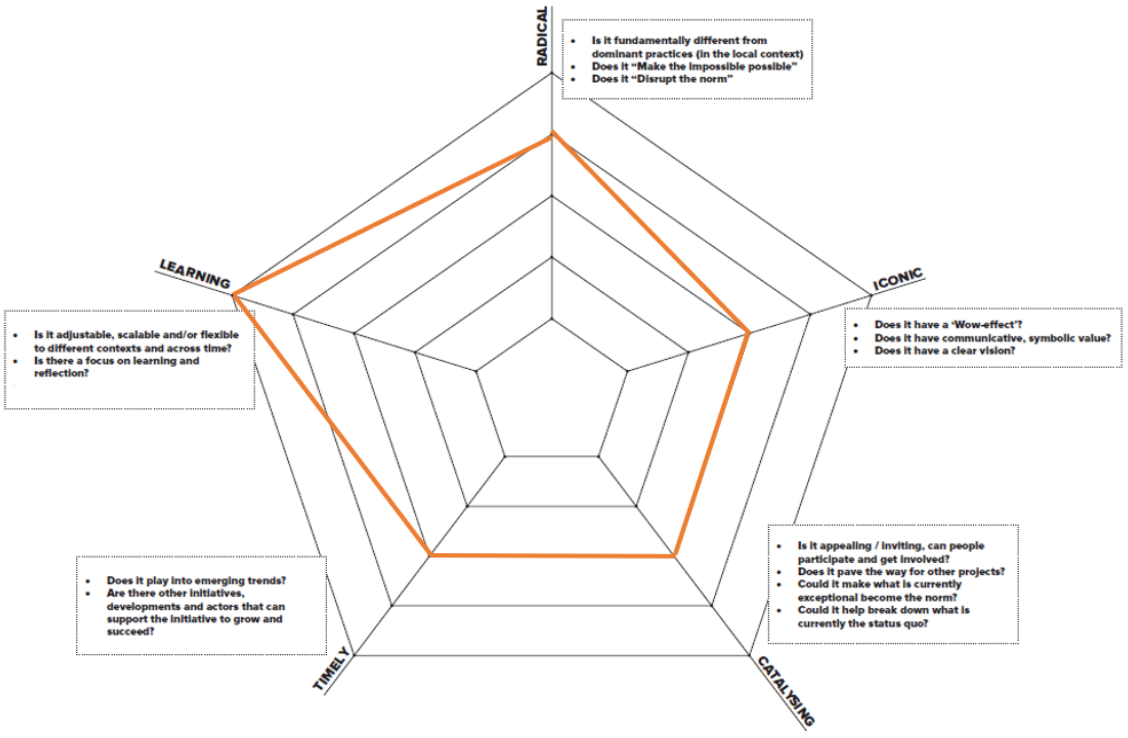


Fig. 21 Transformative impact of Students, air pollution and DIY sensing

In terms of transformative impact, the project scores 4 out of 5 on **Radical**, because it provides a new education format, away from the traditional front-of-class teaching. The interdisciplinary activities cover different topics, from computer science to technology, science and society. Designing their own research project and presenting the results in a scientific manner to professional scientists was highly appreciated by the students and brought them closer to science and scientific thinking. Dealing with the topic of air pollution in a self-exploratory manner will foster a holistic view of a scientific and technological topic with relevance for both, the students themselves and society.

The project scores 3 out of 5 on **Iconic**. While the project does not have an enormous "Wow-effect", the activities have been taken up by the teachers positively and also feedback from the students was positive.

With a score of 3 on **Catalysing**, there are some ways in which the project can inspire other activities that can break down the status quo. The activities have appealed to several teachers who participated with their school classes. The project might not directly "pave the way for other projects", but it might give teachers new ideas for future education topics, to contact researchers from other disciplines to carry out other projects. This however, requires much initiative by the teachers. The activities will probably also not directly "break down the status quo". This would require changes in the curriculum, which is not always easy to implement. But it might have been inspirational for teachers to find ways to carry out similar projects within the given frameworks.

The project is quite **Timely**, scoring 3 out of 5. Focus on the environment is increasing everywhere, also amongst the students. The activities tie in with this development and may foster more pro-environmental behaviour. They might also contribute to engage more female students in technology and research topics/activities.

The highest score is given to the aspect of **Learning** (5 out of 5). The activities cover different topics and students can learn a lot (programming; building sensors; how do sensors work – technology; air pollution – sources, effects on the human body, what can be done to reduce pollution; what are the effects on society, what can we do to avoid emissions to the air; scientific work – also through the poster for the student conference; working independently/exploring topics independently; …). The activities can be adjusted/upscaled/downsized according to the needs of the students and the frame-works given by the curriculum.

All in all, the project scores medium to high on transformative impact, which means the project contributes to changing business-as-usual towards a more sustainable world.

Dragonflies and pesticides

Territorial coverage: The Netherlands	**Type of pollution considered:** water pollution
Revant SDGs 3 - good health and wellbeing, 6 - clean water and sanitation, 12 - Responsible consumption and production	

Water quality has improved quite a lot in the second half of the last century and dragonflies, as aquatic insects, have recovered in this period. However recently numbers have started declining again and this seems to be mostly the case with the common species outside of nature reserves. Within the ACTION pilot “dragonflies and pesticides” DBC, the organisation leading this pilot, wants to figure out if pesticides play a role in this decline, using dragonflies as the flagship species.

In this project DBC selects suitable transects from the Dutch Dragonfly Monitoring Scheme to study the impact of pesticides on dragonflies. Since 1999 Dutch Butterfly Conservation has run a monitoring program for dragonflies where dragonflies are counted along transects by citizen scientists following a protocol. This is done on more than 500 transects a year and allows us to calculate trends in the abundance of dragonflies in the Netherlands. In the pilot project, DBC combines this data with new measurements of pesticides on locations where dragonflies are being monitored, in order to research whether there is a correlation between pesticide presence in water and dragonfly prevalence.

Samples of water are collected from these sites by the same citizen scientists who count the dragonflies. Testing of the samples for pesticides requires sophisticated laboratory equipment, and is carried out by students at the University of Applied Sciences in Leiden. Together this will give insight into what extent pesticides are a threat to dragonflies and which pesticides are most harmful.

Impact areas's relevance

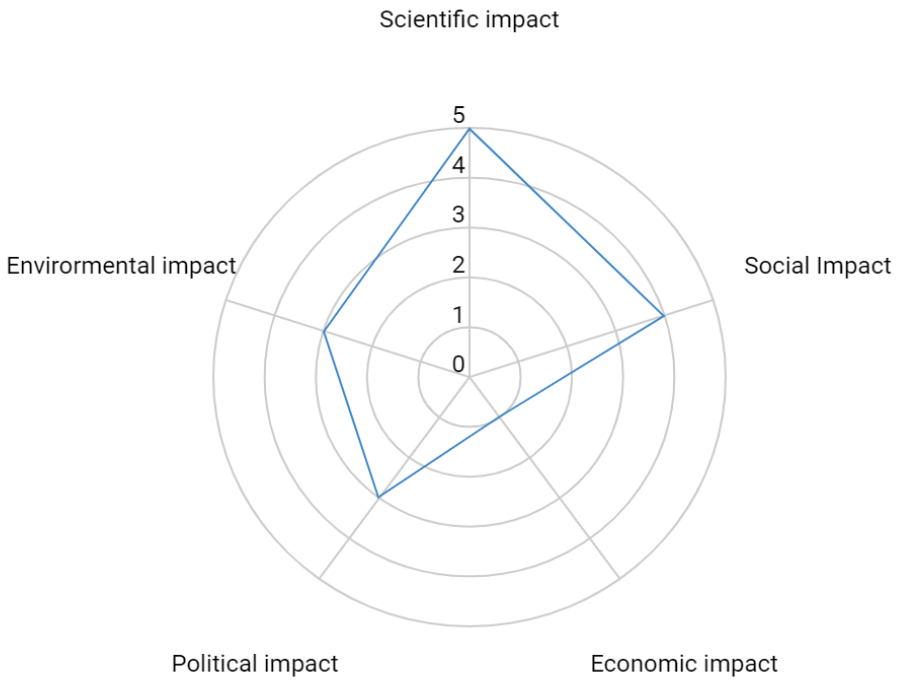


Fig. 22 Relevance of the areas of impact as in the impact assessment canvas

As we can see in Fig. 22, the most relevant impact areas for this pilot are the scientific impact, social impact, environmental impact, and political impact. We'll discuss scientific impact, social impact, and political impact in the following subsections. As we discussed in chapter 3, it was not possible to measure environmental impact.

Scientific impact

In terms of scientific impact, this project has had impact on all subdimensions: innovation in academia, new research fields and interdisciplinarity, new knowledge resources, and innovation in education.

Knowledge in academia

The project Dragonflies and pesticides has a clear scientific impact. There are 40 data points collected by citizen scientists, and the project has published the results - see Tab. 3.

Scientific publications	**1 (peer-reviewed article)**
Non-scientific publications	**2 (news article, newsletter)**

Tab. 3 Number of publications by Dragonflies and pesticides

The **data** have a high **quality** (4 out of 5 indicators), because the task procedures are systematic, and easy for volunteers. The equipment used for measurements is standardised and calibrated across volunteers, and the project records relevant metadata.

In terms of the **openness of the data**, the project also scores high, with 4 out of 5 indicators. The data are available as machine-readable structure, in non-proprietary format, they link to other datasets to provide context, and will be available on Zenodo and GBIF.

The data has medium to high compliance with the **FAIR** principles. The dragonfly data is highly findable (4 out of 5), because it will be in the National database, where all Dutch data on flora and fauna is collected and in GBIF. Water quality data is less easy to find if you do not know it exists. Water quality data will be fully open, dragonfly data in a limited form. That metadata is lacking in the database. Furthermore the detailed data is not publicly available. This means the data has medium accessibility (3,5 out of 5). Both datasets are highly interoperable (5 out of 5). Dragonfly data will be included in the other analyses for trend calculations and follows standard formatting. Measurements of water quality will use universal coding for compounds and coordinates for locations. Dragonfly data is very reusable (4 out of 5) and will be reused regularly. Water quality data is more difficult as the meta data is limited and it is unlikely to often fit the criteria needed for other questions.

The DBC sees some opportunities for increasing the FAIRness of the data. However, one of the problems is that the details of the monitoring transects will not be openly available, this is only on request. The records of the dragonflies will be in the national database but that is currently poorly accessible without a contract with the organization behind it. This will change in the future (although some parts, especially rare species, will not be visible for the general public).

New research fields and interdisciplinarity

The project Dragonflies and pesticides has pioneered some new methods and fields of study: there will likely be a follow up on chemical fingerprinting of ecosystems: the developed method for the analysis of the water samples can now be used at Leiden University for applied sciences. This will also be applied in other contexts.

New knowledge resources

The project generated knowledge that was impossible to generate without citizen science; monitoring of biodiversity is done by volunteers, because there is no capacity for this in academia.

Innovation in education

As mentioned above, the developed method for the analysis of the water samples can now be used at various educational contexts

Social impact

The pilot engaged 40 volunteers and they were not interacting with each other during the project activities. One dissemination event has been organised at the national level, the project also participated in the European Week of Region and Cities, an important event of the EC targeting decision makers and experts and other international events.

With reference to the social impact, the most relevant dimensions, accordingly to the canvas, are:

- Citizens and community empowerment
- Knowledge skills and competences

Citizens and community empowerment

With reference to this dimension, the empowerment relies on the fact that, thanks to the activities carried out, participants are more aware that the data they gather helps protect biodiversity. The volunteers engaged are, in the majority of case elderly, with an high education level, culturally homogeneous, mostly male and interested in nature. Indeed, the project activity is rather time intensive and therefore mostly older people count the transects (transects for rare species that are counted only three times a year, more often have younger vollunteers).

Knowledge skills and competences

The main impact on this dimension is related to awareness, more specifically awareness of the possible impact of pesticides and the omnipresence of them in the environment. Beside this, an increase is self-perfeived efficacy is also reported by the project team.

Economic impact

The project supported the creation of a new service. Indeed, the University for applied sciences in Leiden that supported the water quality analysis of the project, now offers to measure neonicotinoids in surface water. This will be used in education but also offered as a service.

Political impact

Impact on policy processes

The project has some preliminary political impact, because it contributes to the increasing discussion on pesticide use and poor water quality. With the results and assessment of whether dragonflies are affected by pesticides and knowing how much pesticides are found in the water, the project can support the call for stricter regulation on pesticide use.

Transformative impact

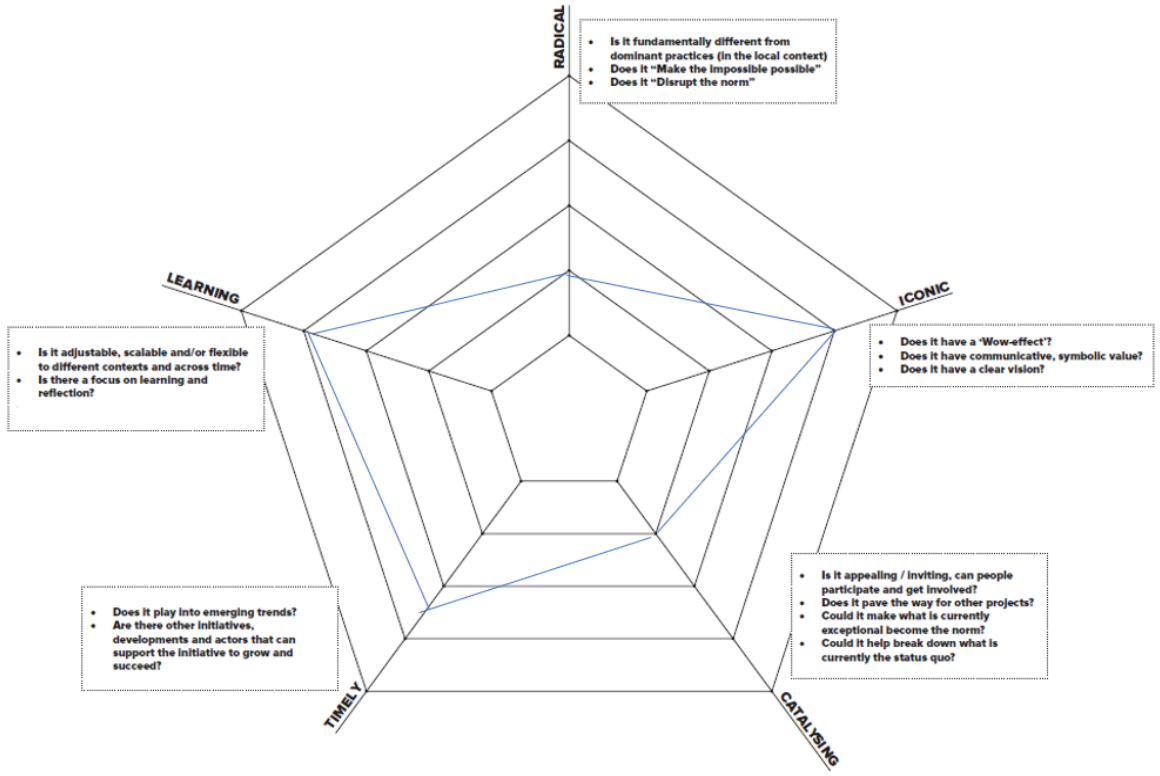


Fig. 23 Transformative impact of Dragonflies and Pesticides Project

Overall, the project Dragonflies and Pesticides has a medium transformative impact (averaging 3.1 out of 5). The project scores 2 on **Radical**, because the monitoring of dragonflies follows an existing protocol and is the state of the art, but not novel. The measuring of pesticides is a field in development but not radical. Combining the two and measuring in the field and trying to link these datasets is new, however.

The project scores 4 on **Iconic**, because many people are not aware that these pesticides end up in many locations in their surroundings. The fact that you can't see them means that they are not on the radar. However, this does not mean they are not there.

The project scores 2 on **Catalysing**, because participation is limited to people that are able to identify dragonfly species and thereby it is not easy for more people to get involved. It might be possible, however, that other groups also start to wonder about pesticides in their surroundings and start similar projects.

The project scores 3,5 on **Timely**. On the one hand, pesticides have been around for a long time and there have been concerns about them for decades. On the other hand there has been a surge in recent attention for insect declines, as chemical analyses are becoming more sensitive and affordable and more citizen science projects are now doing environmental sampling.

The project scores 4 on **Learning**. One part of the project is optimising the analyses of the water samples. If that is developed, linking pesticide levels from environmental sampling is possible in many locations where biodiversity is monitored.

TATORT

Territorial coverage: Germany	**Type of pollution considered:** light pollution
Revant SDGs 4 - quality education, 11- Sustainable cities and communities, 12 - Responsible consumption and production	

Street lighting can severely impair nocturnal flying insects, as many insects are attracted to the light of the luminaires and withdrawn from their actual habitats. The pilot investigates which insects are affected by street lighting and how environmentally sound lighting solutions can help preserve the insects' habitat. It does so by offering a network for citizen scientists and people interested in engaging in the research on how to protect the insect fauna from light pollution.

The project invites amateur entomologists to participate in the research as well as discuss and analyse insect behaviour around street lights and develop ideas for sustainable solutions for night time illumination. The research will provide long term data of the current status of insect occurrence in the four German regions engaged and possibly provide insights on the ongoing biomass decline, i.e., which insect orders and species are most affected and how they can be better protected. For school classes, the project provides opportunities to work with insect specimens and learn about their ecosystems and functions as well as check out technological equipment to measure the impact of street lights on night time brightness.

The investigations into the behaviour of insects on the lights require the help of citizen scientists and the cooperation of science and amateur experts in the fields of ecology, entomology and measurements of night sky brightness. Furthermore, it includes the collection of insects from traps placed at the street lights. These serve to educate students in schools and interested local residents about (a) the taxonomy of insects (b) their importance in ecosystems and (c) sustainable use of artificial light at night.

At the time of writing the pilot is at an **intermediary stage.** The project runs to the end of May 2025, and due to covid-related restrictions, the project needed to postpone and adapt the citizen engagement activities. Therefore the analysis could be considered partial.

Impact areas relevance self-assessment

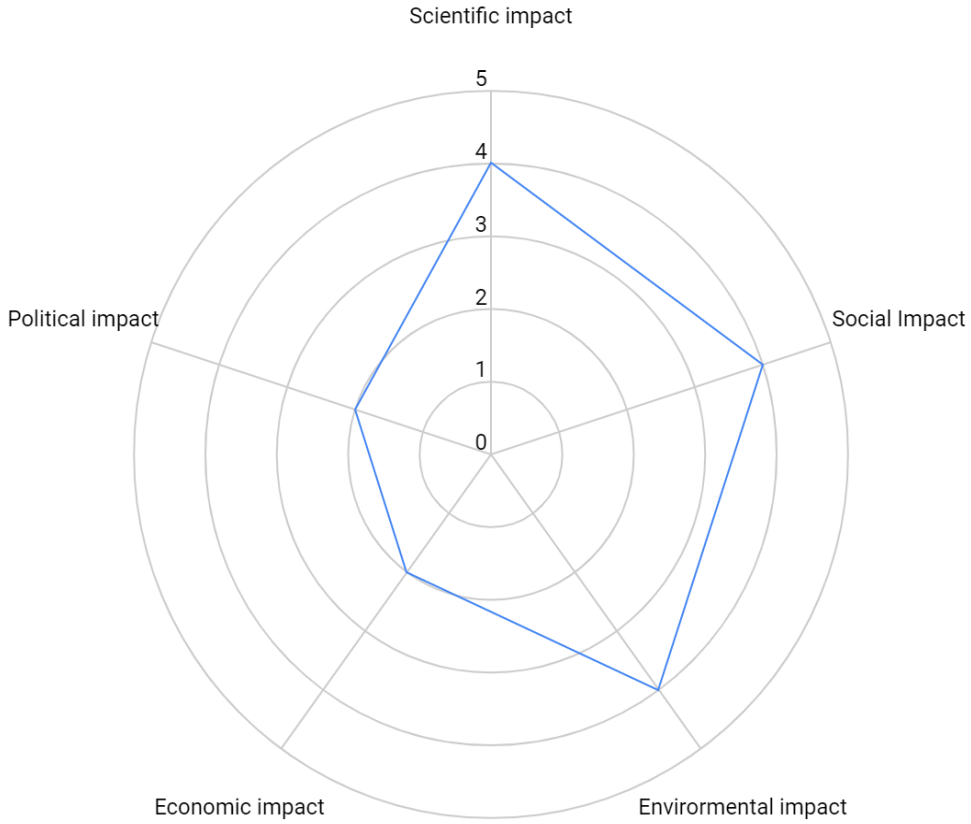


Fig. 24 Relevance of the areas of impact as in the impact assessment canvas

As we can see in the graph in Fig. 24, the most relevant impact areas for this pilot were expected to be the scientific impact, the social impact and the environmental impact. The pilot is still ongoing at the time of writing as its duration is longer than the one of ACTION. So far we observe some scientific impact, social impact, and political impact. Environmental impact is not measurable yet. Two years before and after the transition to new insect friendly road lighting design the data is expected to have high environmental impact as well as political. It is expected to raise the evidence for an insect friendly lighting technology, which can be recommended for modernization and new installations according to the amendment of the federal environmental law (Bundesgesetzblatt, 2021 Part I No. 59, Bonn 30.08.2021).

Scientific impact

Tatort Streetlight has some impact on the subdimensions ‘knowledge in academia’, and on ‘innovation in education’.

Tatort streetlight has done data collection for two years, and will continue to collect data for another two years. The project has had to discard one year’s data set, because the lighting circumstances in that year were not representative: the transfer to the new lighting was postponed by one season, also because the development of the lighting technology was delayed. The data was collected by

trained entomologists, and taxonomic determinations were done mainly by experts employed at institutions, which means that we did not assess data quality, data openness, and FAIRness of data.

The project has produced 3 scientific publications and 15 publications in journals and magazines.

Scientific publications	**3 (articles)**
Non-scientific publications	**15 (articles)**

Tab. 4 Number of publications by Tatort Streetlight

The project has had an impact on innovation in education. Tab. 4 presents the number of workshops, the content and the number of participants. The project is expected to have more impact on education, by organising a workshop for teachers, in which they will be taught how to teach these workshops themselves. More information on these workshops can be found in the next section.

Social impact

Tatort streetlight has had positive social impacts in the subdimensions “Changes in way of thinking, attitudes, and values”, “Knowledge, skills, and competences”, and “Social inclusion”.

Changes in way of thinking, attitudes, and values

The main activities carried out so far have been workshops with students. These activities, that familiarised young people to light pollution and entomology, got positive results: an increase of 10% on the view that the environment has to be protected was observed among participants. In workshops with students who were already scientifically trained, 100% changed their minds about light pollution. It was a new subject for them, and they wanted to find solutions for it.

Besides this, three students are going to do a thesis on entomology for school and developed a special interest for this subject.

Knowledge skills and competences

At site based workshops students visited the location, in the countryside, where the light traps were positioned by the pilot team and got the opportunity to do the whole process of collecting the insects from the traps, identify them with microscopes and classify them with the help of books and teachers. Students were provided an introduction on light pollution too. Insect taxonomic workshops were called from “Iihs to Oohhs” aiming at providing students with a better understanding of the important functions of insects, entomology and related research processes. Indeed, at school the taxonomy of species is only taught rudimentaryly. The decline in insects demands for better training to understand their ecological importance. Students got a preliminary understanding of taxonomic work of entomologists. However, only a few students developed an interest in the subject, for the biggest part students only reduced a disgust against insects. Most of them acknowledged the beauty and ecological importance of the insects, formerly perceived as critters.

The main achievement for this group has been, however, the acquisition of a *new experience in the countryside and of the beauty of nature*. Indeed, for many of them, living in Berlin, it was the first occasion to get in touch with the countryside and being in touch with nature in this way.

Another observable impact is related to the interest of the subject, biology, that emerged as increased after the workshops and a higher trust and feeling of closeness for the teacher was also observed, which could be positively correlated to the increase in interest for the subject.

Another activity carried out was with 5 younger students, aged 11-13 years old. The activity took place at school, during a biology class. The setting of this activity, within a more usual setting and in a smaller and more homogeneous group compared to the one on the site visit, resulted in more focused activities and better results in terms of classification. Indeed students were able, by working in a group and with the help of their teacher, to classify 12 samples which is a very good result.

Finally, another activity was performed with a different school, called “school of nature” in which students are working outside, in nature, on a daily basis. 17 students, aged 10-18 years old were engaged and really appreciated the activity and learned more about entomology and classification.

Summarising, beside age and pre-existing knowledge on the specific subject, variables that resulted as relevant in explaining the success of the activities in terms of learning and skills acquisition are: workshop setting, dimension of students’ groups and pre-existing expertise and confidence in working in a natural setting.

Considering now the *learning for the leading teacher*, this resulted as effective. The lead teacher learned more on how to run a CS workshop, how to adapt the activities to different groups of students, how to motivate the students and how to better teach them insect classification. Also, other teachers involved in the activities as supporters of the main teacher reported a positive impact on learning and skills and are now more interested in citizen science as an effective tool for teaching. In the next months, teaching materials and guidelines will be prepared for them in order to better enable them to run this type of workshop in an autonomous way.

Social inclusion

Considering the diversity dimension of students participating in the activities, it can be said that they were quite diverse in terms of age (as already mentioned) but also in terms of gender and cultural background. The data refer only to students participating in the first workshop in the countryside as no data are available for the others. In that group, on average, male represented 40% of the engaged students against 60% of females. The group was characterised by a high percentage of students from a migrant background (30%) and, considering the income of the families, most of them could be considered middle and low income families with only few wealthy families. There were no students with disabilities.

Political impact

Tatort Streetlight achieved political impact, in the subdimensions: impact on policy processes, and self-governance.

The team is very active in engaging local administrations and decision makers in the activities. Authorities for regional and urban planning are consulting the team for questions about the implementation of sustainable illumination. The Tatort Streetlight team regularly hold workshops with municipalities. They are engaged in the CIE (The International Commission for Illumination) Technical Report 4-61 Artificial Lighting and its Impact on the Natural Environment, in a national working group for street affairs (Research association for streets and infrastructure (FGSV)and are involved in the board of the biggest global NGO for the protection of nightscapes from artificial light at night, the International Dark Sky Association. Results of the project will be directly implemented into the guidelines developed within the global and the national committee.

In a previous project, the team wrote guidelines for sustainable lighting, which influenced the national policy making strategy for reducing light pollution. As part of the current project, the team is re-writing these guidelines, to make them more targeted, and include quality criteria, how to adopt legislation, how to implement and fund them, etc. Because of their strong connections to local and national governments, this new version of the guidelines is expected to have an effect on light pollution policy and legislation. Another way in which the project will influence policy, is through their influence on the education programs for light planners, as part of the Erasmus Skill Alliance program.

The project also increased self-governance: after attending one of Tatort's events, the German association for light was inspired to organise their own events around light pollution.

Transformative impact

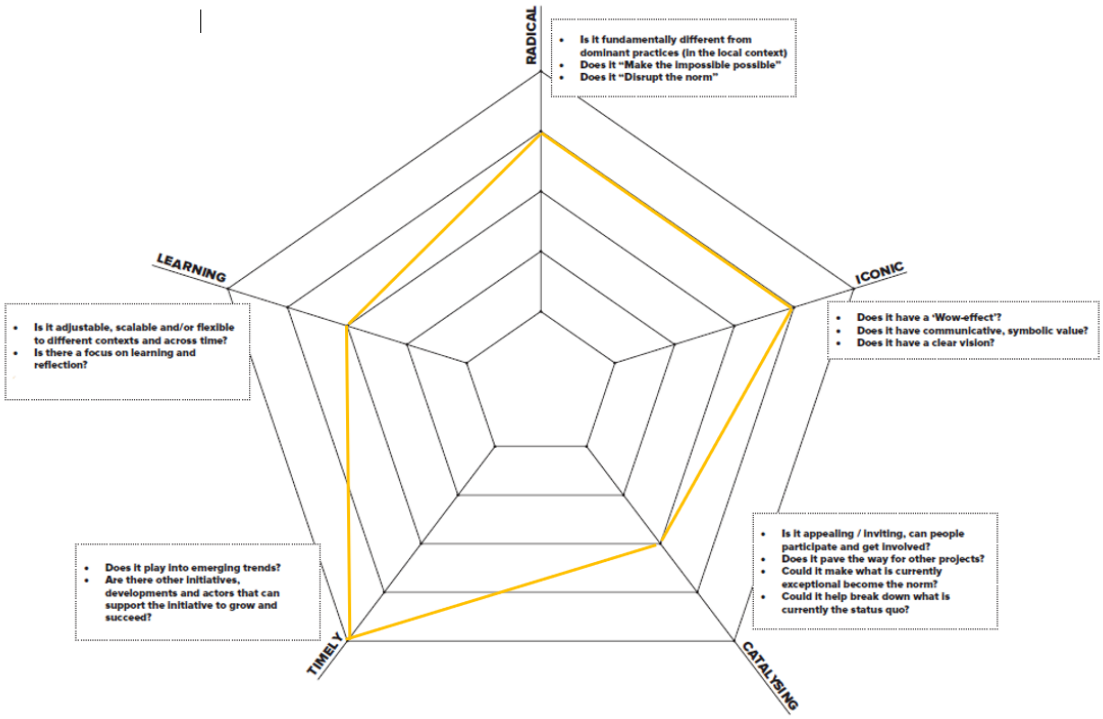


Fig. 25 Transformative impact of Tatort

With an average of 3.8, Tatort scores well on transformative impact. The project is **Radical** (4/5) in the sense that it makes the impossible possible: in changing the standard lighting the project shows that it is possible to protect biodiversity.

The project is **Iconic** (4/5) because lighting is a matter that concerns everybody. The project wants to save the darkness, which is unique for the areas in terms of tourist potential (all areas have or have applied for star park status).

The project is **Catalysing** (3/5) because it has a high potential of changing people's beliefs and habits. The project can increase awareness for the protection of insects and most importantly the use of private lighting. The project does not have the maximum score, because not all people will change habits that have been in place for decades, for example light use and using pesticides in the garden.

The project is **Timely** (5/5) in the sense that we are in a highly dynamic time for communities converting street lighting to LED technology. Secondly, the federal environmental law has launched a draft to strengthen the regulations against light pollution which will become effective in 2022. The geometry of street lighting is one aspect of the new draft for regulations.

The project allows for **Learning** (3/5) because it can offer new knowledge in the field of insect taxonomy, lighting planning and measurements of artificial light at night. These are all subjects that need higher impact in educational education and the project hopes to make a case for the protection of insects and thus biodiversity.

Loss of the Night

Territorial coverage: Worldwide	**Type of pollution considered:** light pollution
Revant SDGs 3 - good health and wellbeing, 10 - reduced inequalities, 13 - climate action	

This is an online citizen science pilot, pre-existing ACTION[7], and based on a dedicated App. It invites citizen scientists worldwide to take part in a research project that measures light pollution by using the human visual system as a light metre. The goal of the project is to track changes in artificial sky brightness in urban areas over the long term (ideally many decades). Specifically, participants are asked to look for specific stars, and report if they can see them from their location. In addition to outshining the stars, light pollution is a signal of energy waste, and it disturbs sensitive nocturnal species. Scientists are concerned that light pollution might have a big impact on nocturnal ecosystems, but they have very little information on how skyglow is changing especially considering the recent transition to LED lighting. This cannot be achieved with current satellites, and in general is difficult to do via remote sensing because satellites look at the ground, not towards the sky. This is why the support of citizens is so important.

The observations are sent anonymously to the Globe at Night project (www.globeatnight.org) where they are archived. Participants can also view the data at http://www.myskyatnight.com.

The research is timely as illumination of the night sky continues to increase annually and the evolution of the observation over time is the most relevant part of the research. The Loss of the Night App is downloadable for free for Android (http://tinurl.com/vdn-app) and iOS (http://tinyurl.com/vdn-ios) in 15 different languages among which: Arabic, Catalan, Chinese, English, French, German, Italian, Japanese, Polish, Romanian, and Spanish.

[7]The App was first released in 2012 as part of the Verlust der Nacht network funded by the Federal Ministry of Education and Research (BMBF). Since then it has been updated and translated into 15 different languages. Currently the App is updated to remove bugs related to GPS location services.

Impact areas relevance self-assessment

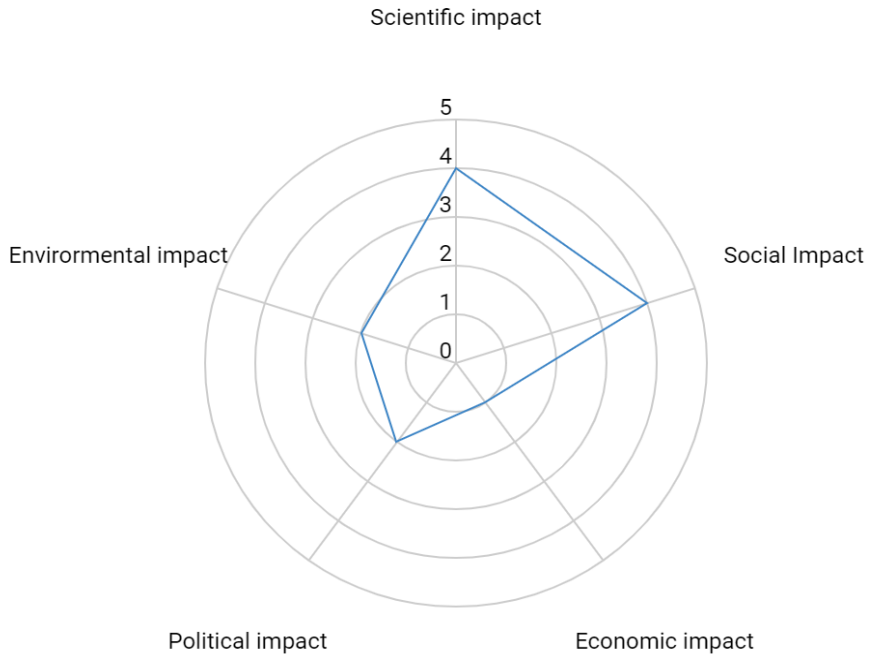


Fig. 26 Relevance of the areas of impact as in the impact assessment canvas

As we can see in the graph in Fig. 26 the most relevant impact areas for this pilot are the scientific impact and the social impact. In the next subsections we report the information collected so far, however it is important to highlight that - during the assessment period - this pilot has been primarily involved in adapting and updating its App (it should be released early spring next year) and in supporting a better management of gathered data. It is also important to acknowledge that, beside the above mentioned activities, the everyday work of scientists on the pilot is on a voluntary basis and this has limited the amount of time available for further interactions and analysis.

Scientific impact

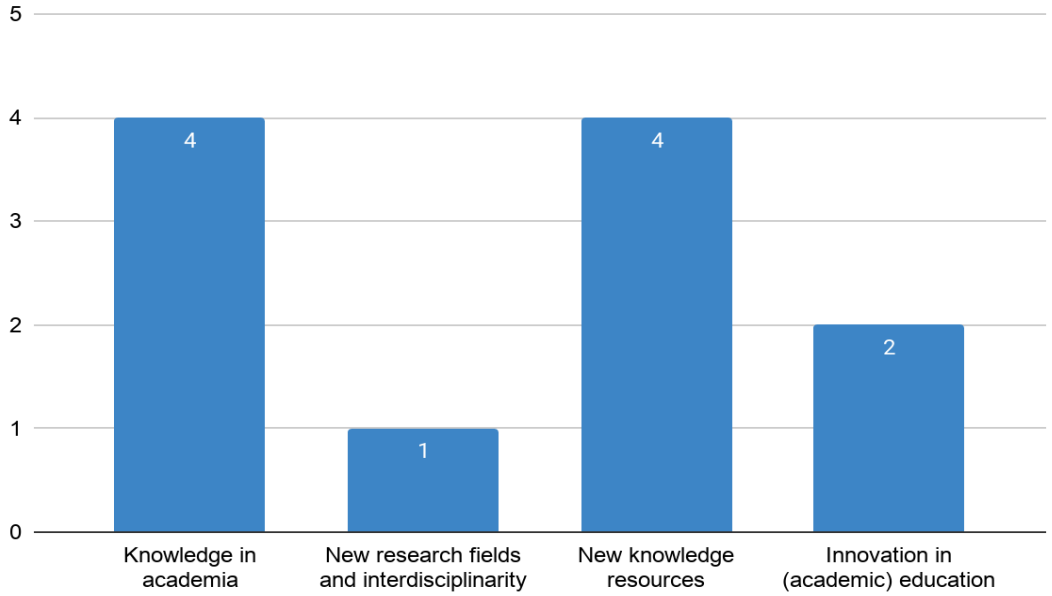


***Fig. 27** Expected scientific impact Loss of the Night as described in the Canvas*

Loss of the Night has a total of 6747 measurements, which means that the App has a substantial impact on **Knowledge in academia**. In 2020, the App noticed a substantial increase of high quality data observations compared to earlier years (168 high quality observations in 2020 compared to 62 in 2019, 65 in 2018 and 61 in 2017). The visualisations for the data are published on the website: http://www.myskyatnight.com/#map. The data collected is sent to a larger international citizen science project called 'GLOBE at Night' which has been collecting and mapping this data since 2006. The value of the data gathered relies, as said, not only on the quantity and quality of data, but on the capability to have historical data and time series of many locations worldwide. As for other CS pilots, collecting these kinds of data with professional researchers would have been very costly if not impossible.

Besides scientific data, the pilot is constantly updating its blog (on a voluntary basis) and releases regular newsletters. Furthermore it is a well known App for teaching about the property of light and light pollution and is reported as an useful tool for engaging both primary and secondary school pupils as well as adults on this topic. Indeed the pilot is present on relevant CS websites and repositories such as SciStarter (https://scistarter.org/loss-of-the-night). To this extent the pilot blog is also recognized for having useful graphs and images to create discussions and develop more understanding about light pollution in teaching activities. Adding to this, the pilot released - thanks to a collaboration with students from the Worcester Polytechnic Institute - two tutorials on how to use the APP, presented the APP at Mitforschen! Festival in Berlin and, during the last ARS Electronica festival presented a 24h measurement campaign. All of this shows a genuine interest from the pilot in keeping the community alive (see the following sub-section) and in promoting accessible science communication.

In terms of data quality and management, Loss of the night developed a new data management plan thanks to the interaction with ACTION which, however, resulted to be difficult to translate in actionable information for other pilot activities. Data is not analysed on a regular basis (as they were at the

beginning of the project in 2010[8]), but still the quality of data is considered high and the data are stored safely. The value of data relies on his long term gathering and the possibility to generate long time series (ideally 10 years or more) so the voluntary work that researchers are still dedicating to the community and the App is considered worth in this sense. At the time of writing the pilot is exchanging with ACTION Open Data experts in order to have an anonymized data set available on the ACTION Open Knowledge Portal (linked with Zenodo).

Social impact

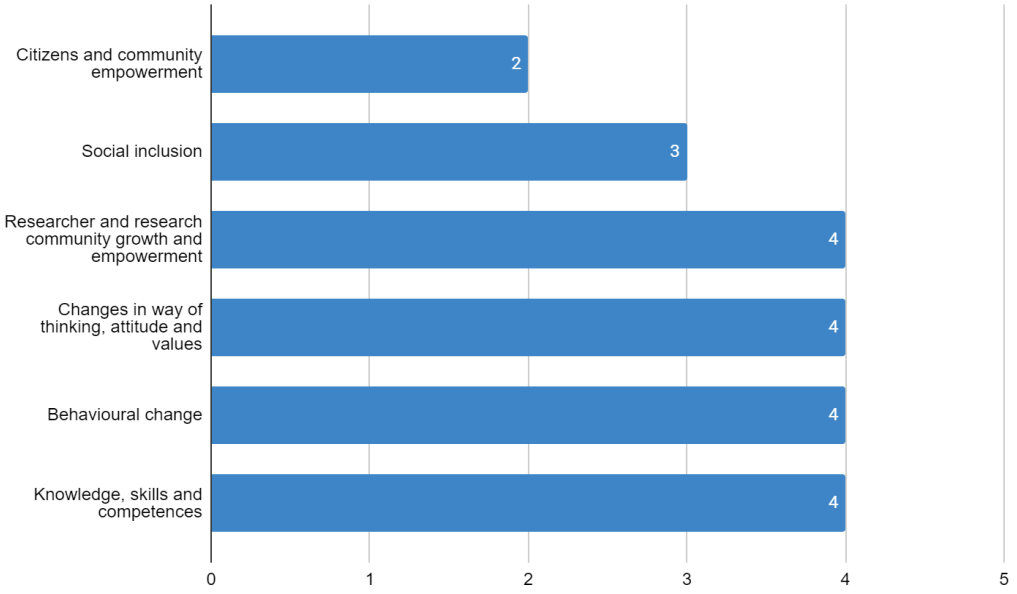


Fig. 28 **E*xpected social impact Loss of the Night as described in the canvas***

Loss of the night can count on a large and international community. Indeed the App has been downloaded by more than 50,000+ considering only the Android users. The monthly newsletter reaches more than 400 subscribers and the CS manager Twitter profile - used for promoting the pilot - has more than 2400 followers. The Pilot Facebook page has 940 persons.

All of the above, and as mentioned in the previous sub-section, show the interest and effort of the researchers to keep alive a community created in 2012. The data gathered, together with the blog posts are the main assets for supporting the scientific community working on light pollution. The pilot is also very well connected with other researchers in the field and the CS managers are constantly launching other CS pilots on the same topic.

In terms of impact on skills, it would be needed to interview the users for having a better understanding on this aspect, and this has not been possible for the time being, but according to the pilot manager the App is a valid tool for becoming experts on stars and astronomy if used regularly. However, the majority of persons that download the App tend to deliver a small number of observations so that impact on learning could be considered effective only to a limited number of users.

[8]The research project Loss of the Night was funded from 2010-2014 by The Federal Ministry of Education and Research and Berlin Senator for Economics, Technology and Research

No data are available at this stage on users so that we cannot comment on impact on social inclusion or impact on way of thinking, values and behaviours. The fact that the App is available in many languages represents a positive asset for including people from several nationalities and cultural backgrounds.

StreetSpectra

Territorial coverage: Worldwide	**Type of pollution considered:** light pollution
Revant SDGs 4 - Quality Education 11 - Sustainable cities and communities 12 - Responsible consumption and production	

Street Spectra is an online citizen science project and focuses on light pollution; it aims to map and characterise public lighting sources. Volunteers use a low cost diffraction grating on top of their smartphones' camera to take pictures of the street lamps and their emission spectra.

The creation of the project has been motivated by the global switch out of the older street lighting to new LEDs which have a negative impact on ecosystems and human health. The database is considered the primary output of the project. It is public and will allow scientists to study the effects of this change on technology onto light pollution.

This pilot was designed to raise light pollution awareness to citizens. In general, people do not have any information about the unwanted and negative effects of artificial light at night, and what is more important, they do not know that there is a light pollution problem.

- The pilot gives information to citizens so they can classify lamps of the street illumination and being doing so acquire the knowledge of the existence of different lighting technologies and how some of the white LEDs (with a fraction of the light emitted in the blue part of the spectrum) have negative impacts
- Although designed for participants of all ages, there is a focus in young people at schools. The designed hands on practical material that the project developed helped to reach this audience (with the help of their teachers) that would be the citizens who will make decisions and write the laws in the future.

Impact areas relevance self-assessment

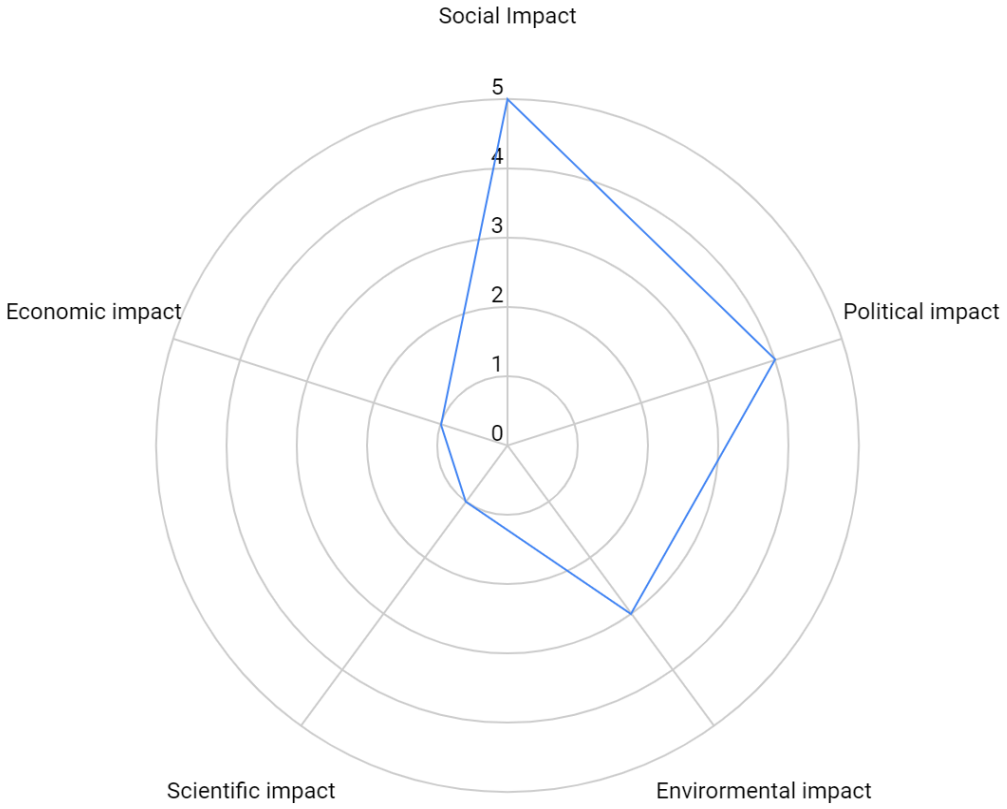


Fig. 29 Relevance of the areas of impact as in the impact assessment canvas

As we can see in Fig. 29, the most relevant impact areas for this pilot are the social impact and the political impact. From discussion with CS managers it emerged that measuring scientific impact was also relevant and indeed it can be considered the most relevant areas of impact at the time of writing. We'll discuss more in detail each impact area in the following subsections.

Scientific Impact

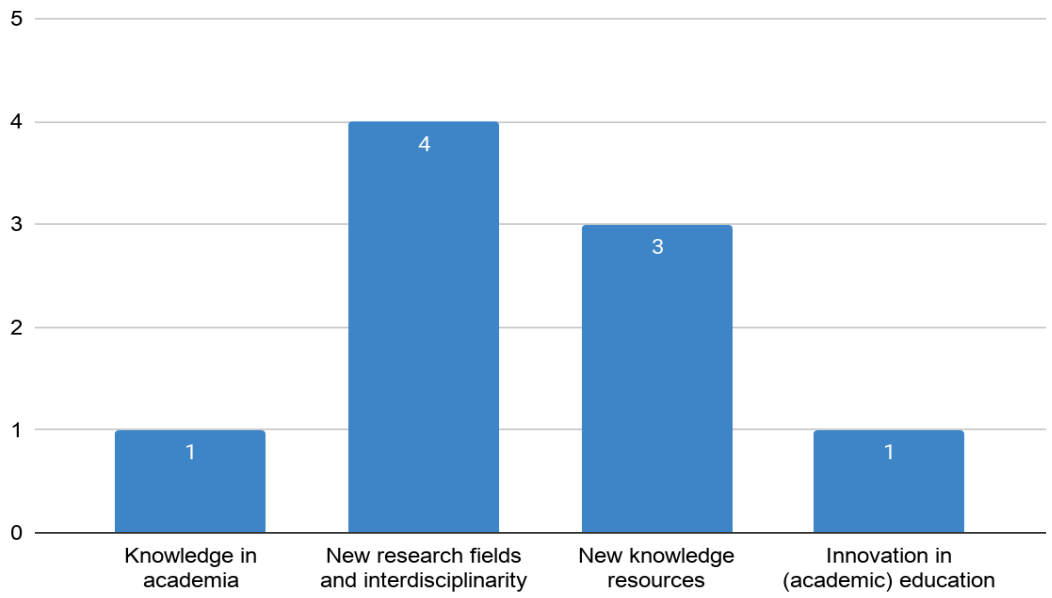


Fig. 30 Expected scientific impact StreetSpectra as described in the Canvas

Citizens mapping the location and kind of lamps are providing a database that will be used by researchers to check the models of light pollution transmission by the atmosphere. The models predict the sky brightness at zenith of a place, which is important information for astronomers. The measurements of this sky brightness at night during a time lapse (monitoring) inform researchers of changes in the light pollution. At the time of writing, CS managers stated that It is soon to obtain scientific results since this is a long-term project to be continued during the years to come, nevertheless the project is already achieving scientific impacts on knowledge in academia, new research fields and interdisciplinarity, and new knowledge resources. For the first sub dimension, knowledge in academia, this is much higher than expected.

Knowledge in academia

StreetSpectra has generated 791 data points, as well as many publications (see table below for an overview).

Peer-reviewed articles	**5**
Non peer-reviewed articles	**5**
Non-scientific publications	**13 (blog posts)**

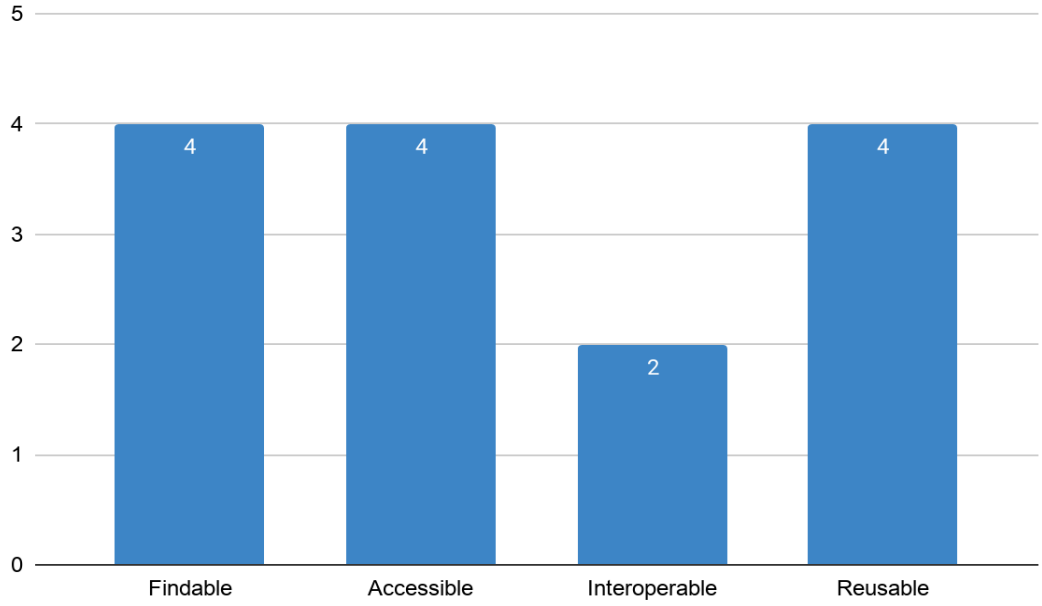
Tab. 5 Number of publications by StreetSpectra

Some of the publications have also been highly visible online, with the teaching materials having been viewed 279 times, and downloaded 65 times, and the Ars Electronica presentation with 98 views and 11 likes on Youtube, and 86 likes, 41 retweets, and 12357 views on Twitter.

The quality of the data is very high (5 out of 5). There is a process for adapting the data collection procedures, and the task procedures are systematic and easy for volunteers. The equipment used for measurements is standardised and calibrated across volunteers, and the project records relevant metadata. Furthermore, the data quality will be more fully assessed after a revision of the contributions, by both experts and trained collaborators.

Openness of the data is also very high, with all indicators positively assessed. The data are available as machine-readable structure, in non-proprietary format, they link to other datasets to provide context, will be available on Zenodo, and follow best practices for open data from W3C.

In terms of FAIRness, the project scores quite high, see Fig. 30. The data is Findable (4/5), because the project will use Zenodo's DOI's for the datasets. The data is accessible (4/5), but not highly Interoperable (2/5), because the project doesn't use ontologies, or domain-specific vocabularies. The data is Reusable (4/5) with a Creative Commons licence: free to share and to adapt.



Tab. 6 FAIRness of the StreetSpectra data

New research fields and interdisciplinarity

The project can be considered quite interdisciplinary, because light pollution is interdisciplinary. For this pilot, lamps characterization is made by analyzing the spectra (Physics, optics), the results are key to determine dispersion of light (Atmosphere science), the light pollution has impact in human health (Medicine), including sleep disorders (Chronobiology) and ecosystems (Biology, fauna and flora).

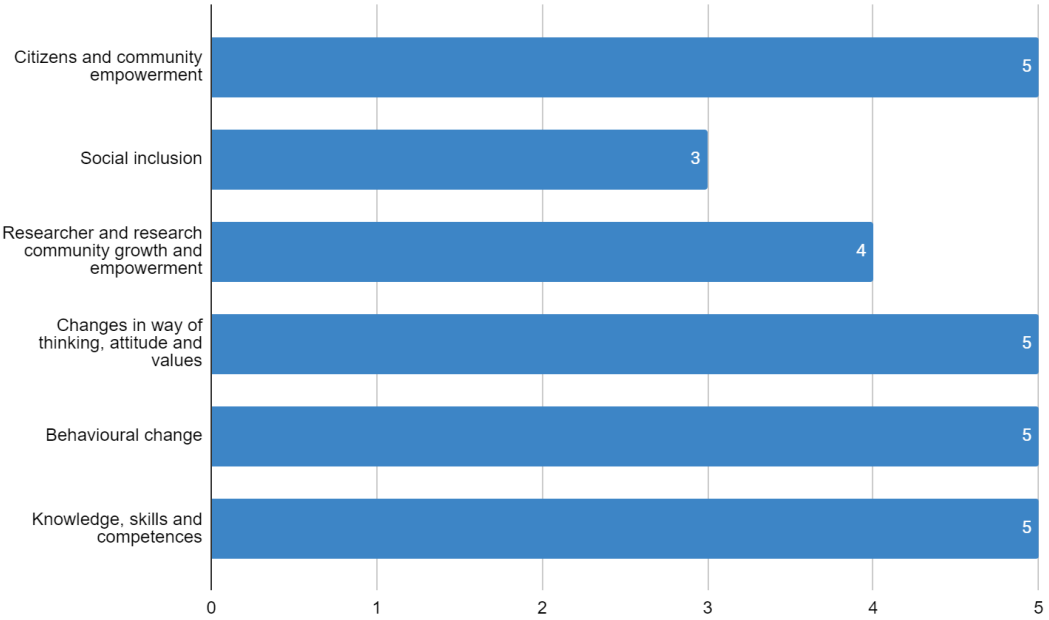
New knowledge resources

The project eases access to the citizens' knowledge about their local environment and practices, by providing methods and reference material (street spectra database of lamps) with a new visualization scheme. The project has also facilitated knowledge creation between societal actors, in the sense that some associations are creating groups for studying and mapping street spectra.

Furthermore, the project has developed new data gathering tools: a simple method to obtain spectra of light sources using a transmission grating and the camera of any smartphone. Because there is no need for other tools or devices, this makes it easy to start contributing.

The knowledge created would have been very difficult to obtain without a citizen science approach, because of the limited capacity of research teams.

Social impact



Tab. 7 Expected social impact StreetSpectra as described in the canvas

The project was established for raising awareness among citizens on light pollution and its impacts on humans and nature, therefore the relevance of the social impact dimension is considered high in all the sub-dimensions considered (all subdimensions scored 3 or higher). As stated by the pilot team *"In general, people do not have any information about the unwanted and negative effects of artificial light at night, and what is more important, they do not know that there is a light pollution problem".*

Citizen and community empowerment

It is difficult to provide a precise quantification of the citizens engaged in the project activities but there are at least 400 volunteers registered in Zooniverse[9] that are contributing to data analysis. The

[9] https://www.zooniverse.org/projects/actionprojecteu/street-spectra

total number is, however, way bigger considering all the people that has not registered but have classified project pictures in Zooniverse and those that have only contributed to the project by taking pictures at Epicollect5. Overall, it is safe to say that at least 500 persons participated in project scientific activities.

Volunteers were engaged, in the first year of ACTION project, through already-existing local astronomy associations, while in the second part of the project an intense activity at school was performed wiht many schools and classes engaged with dedicated activities.

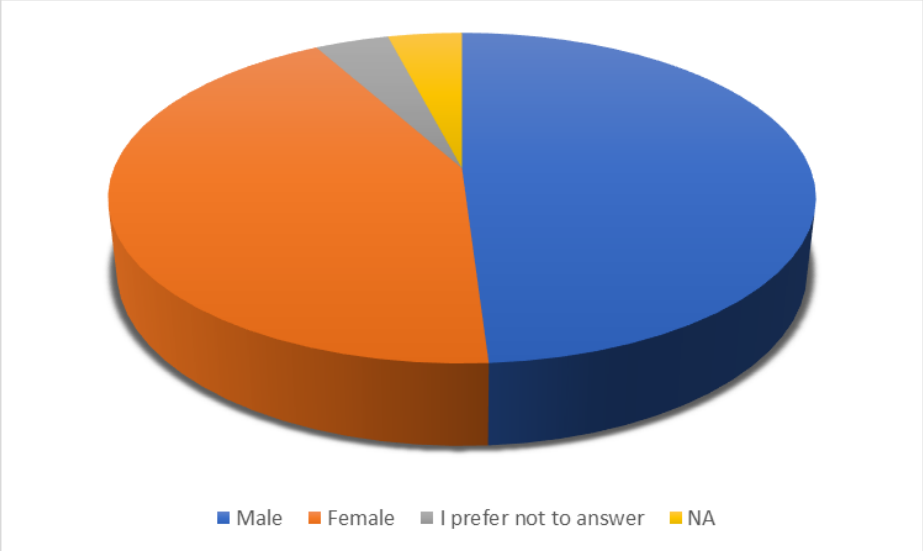
Beside the persons engaged in CS activities, 1000 persons have been engaged in dissemination and awareness raising activities (more than 30) and more than 3500 through social media. The project also participated in the Ars Electronica festival with a dedicated online workshop.

Social impacts

The pilot achieved very positive social impact with the school activities. Indeed, as the data reported here after illustrate, the project was able to engage a well diversified group of students and the majority of them report not only an actual increase in their under-snaring of the light pollution problem but also an increase in interest for the topic and for scientific activity overall. Moreover, the majority are thinking to change their behaviour by reducing light pollution and by choosing better lighting options, in this way reducing light pollution.

A questionnaire has been also submitted to students, participating in the activities of the pilot. 149 students responded to the questionnaire. 73 (42%) respondents are 11 or 12 years old, 19 students are between 13 and 15 years of age (13%); 64 (43%) are between 16 and 18 years old.

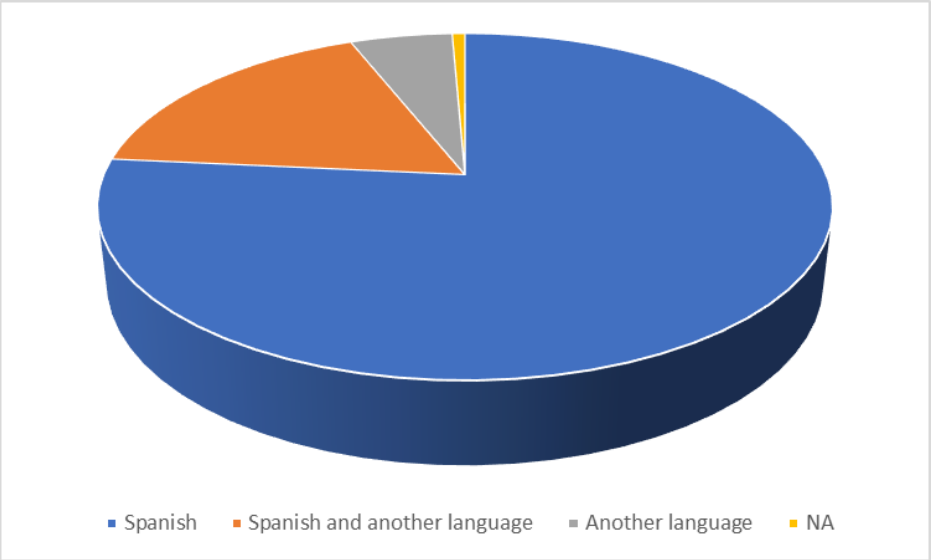
73 (49%) respondents were male, 64 women (43%), and 12 people who declared not to prefer to answer (4%) or did not answer (4%).



Tab. 8 Gender of students participating in the questionnaire.

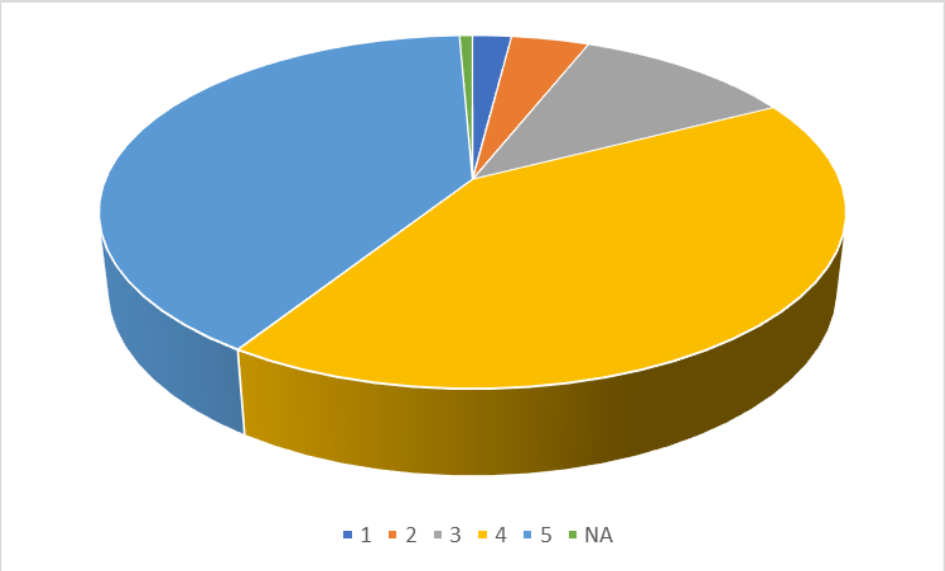
114 (77%) respondents use Spanish (or Castilian) as the main language spoken at home, while some students (26, 17%) mix Spanish with other languages, including Arabic, Romanian, English, Portuguese, German, and Georgian. 8 (5%) respondents do not speak Spanish at home, preferring Arabic (3), Romanian (3), or English (1). This indicate the capability of the project to engage students

from different cultural background and is an indication of a consistent percentage of participants belonging to migrant or second-generation families.



Tab. 9 Main language spoken at home by students participating in the questionnaire.

Students responded they have learnt a lot from this activity. Indeed, 82% of the students scored their learning between 4 (62, 42%) and 5 (60, 40%) on a 1 to 5 scale.



Tab. 10 Learning from this activity of students participating in the questionnaire.

133 students responded that they felt part of something important. Similarly, 104 (67%) students scored between 4 and 5 their participation to contribute to scientific activity on the topic, with 33 students (15%) also ranking 3.

Students appreciated that they learn about the existence of different types of lights and the problem of light contamination, and also the fact they have learnt it in an active and dynamic way (e.g., by making pictures by themselves or using the lenses). 140 (94%) respondents learned something new about the light issues, including the importance of light, the light contamination and its danger for

environmental and human health, as well as that the use of specific lightbulbs can contribute to decrease light pollution and contamination.

101 (68%) students also declared they are going to do something to reduce light contamination, including changing light bulbs in their houses with others more efficient, and reducing light usage when not necessary. In addition, 109 respondents (73%) are more interested in light issues thanks to the activity.

Similarly, 97 respondents (65%) are more interested in scientific activities than before the project, while 40 feel the same as in the past.

A questionnaire was also submitted to teachers. 4 of them responded to the questionnaire. Three of them (75%) are in the range 31-45 years old, while one is between 46 and 60. Three of them are female. All of them speak Castilian. They were also asked how much they learned from the activity. All answers are from 3 to 5.

Among the main reasons to participate, teachers mentioned the motivation for students to research about something, to do something different in the classroom, and to support scientific development. In terms of new knowledge and skills, teachers report high scores for almost all the questions regarding the contribution of the activity in increasing scientific competences, skills and knowledge by students in this way confirming the above mentioned data coming from students' questionnaires.

The teachers have been asked to specify which have been the changes in students. They reported that students have been motivated to do new practical activities that stimulated their curiosity, skills, and citizenship. The activity, indeed, allowed students to understand light contamination and also to improve the school performance.

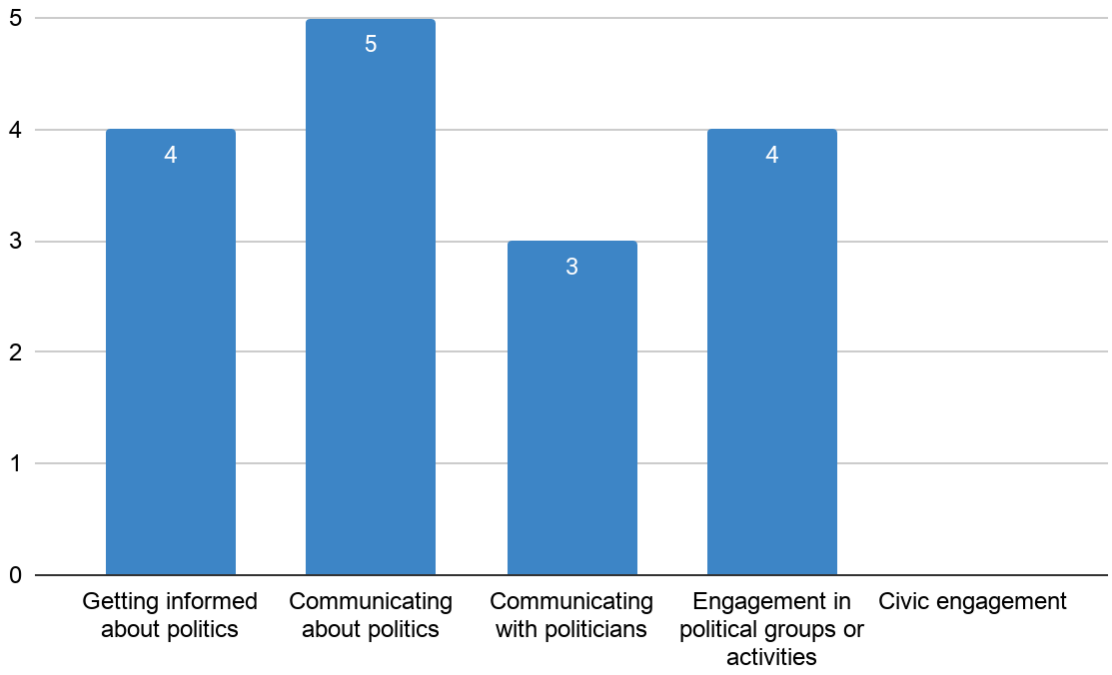
Political impact

StreetSpectra has political impact on three out of four subdimensions: impact on policy processes, political participation, and self-governance. This is mostly in line with the expected impact, except for political support for citizen science. As the project is still ongoing, the impact on this sub dimension might still increase.

There has been some impact on **policy processes**, because the project arranged for a meeting with representatives of the Spanish administration in charge of Street Light reglamentation (Ministerio de Industria Comercio y Turismo and Ministerio para la Transición Ecológica).

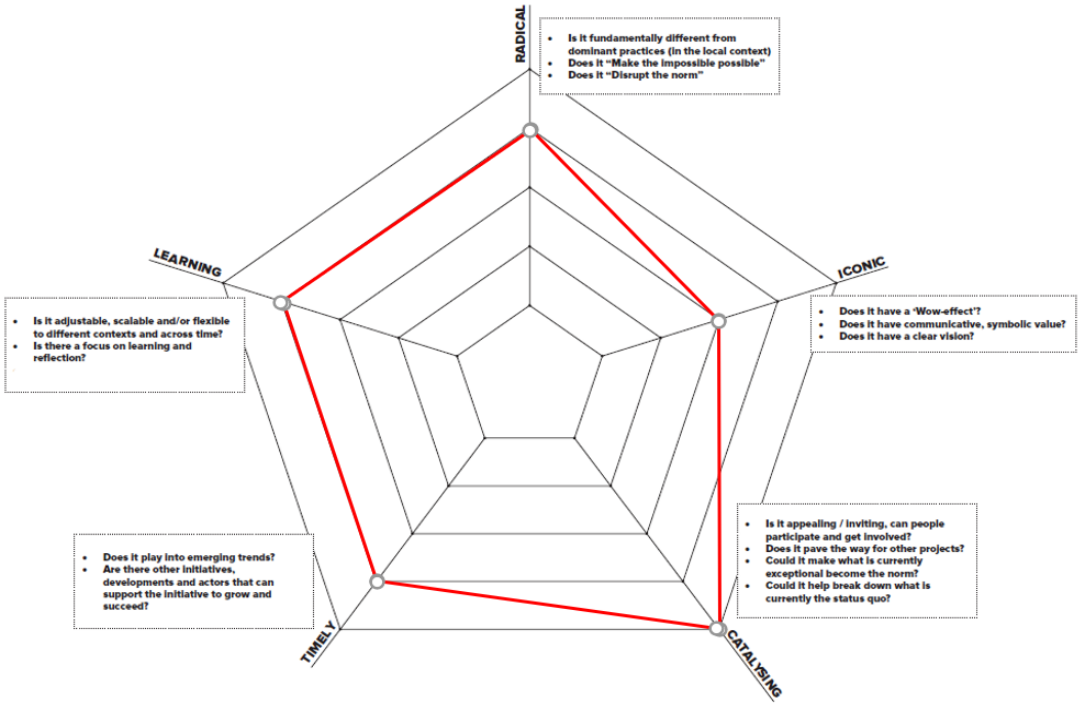
StreetSpectra expects to have increased **political participation** of its citizens significantly (average of 4/5), see figure below for more details.

Last, the project motivated participants to organise events or initiatives to raise awareness about and involve more actors in community projects, which increases the **self-governance** of citizens.



Tab. 11 Increased political participation for citizens of StreetSpectra

Transformative impact



Tab. 12 Transformative impact of StreetSpectra

StreetSpectra has a high transformative impact, with an average score of 4 out of 5. The project tries to break the status quo in disproving that LED illumination is always better. The project is **Radical** (4/5) because to our knowledge there are no other CS projects doing spectra of urban lamp posts. The project is less **Iconic** (3/5) than some other projects, but the spectra pictures are quite remarkable and thus have a wow effect. The project is **Catalysing** (5/5) because it is quite easy to participate, which makes it attractive. The project is **Timely** (4/5) because it can be easily linked to other projects dealing with light pollution. The project allows for **Learning** (4/5) in the sense that the project has a high educational value and has developed teaching materials.

Sonic Kayak

Territorial coverage: South-West England	**Type of pollution considered:** water pollution
Revant SDGs 3 - good health and wellbeing, 6 - clean water and sanitation	

The Sonic Kayak system is a low cost open hardware for gathering and mapping fine-scale marine environmental data while kayaking. Data, which has not been previously possible to obtain, is sonified through an onboard speaker allowing paddlers to seek out areas of interest and gain real time feedback of the data. The system previously included underwater temperature sensors and a hydrophone for measuring underwater sound, recording data every second with GPS, time and date. Working with ACTION, two new environmental sensors were designed and integrated into the existing system (turbidity and air quality), proof-of-principle data were gathered, and the work was published.

Furthermore, the project developed an online citizen science style survey, where people could try out 4 different data sonification approaches and see which was the most straightforward for understanding the underlying environmental data, and also give their preferences on which sounds they liked the best.

Last a project video was made and put online as part of a feedback survey, which was sent to stakeholders (including local conservation groups, local activist groups, the local council, and academic researchers), people who had taken part in project events previously and general audiences via social media.

When the pilot was first planned as part of the ACTION accelerator it was expected to conduct activities using kayaks and gathering/sonifying data while paddling in selecting sites. Members of a local association working with visually impaired people were expected to engage in this activity. However, due to Covid-19 restrictions it was not possible to organise such group events and visually impaired people (two persons) participated in the above mentioned survey on sonification approaches.

Impact areas relevance self-assessment

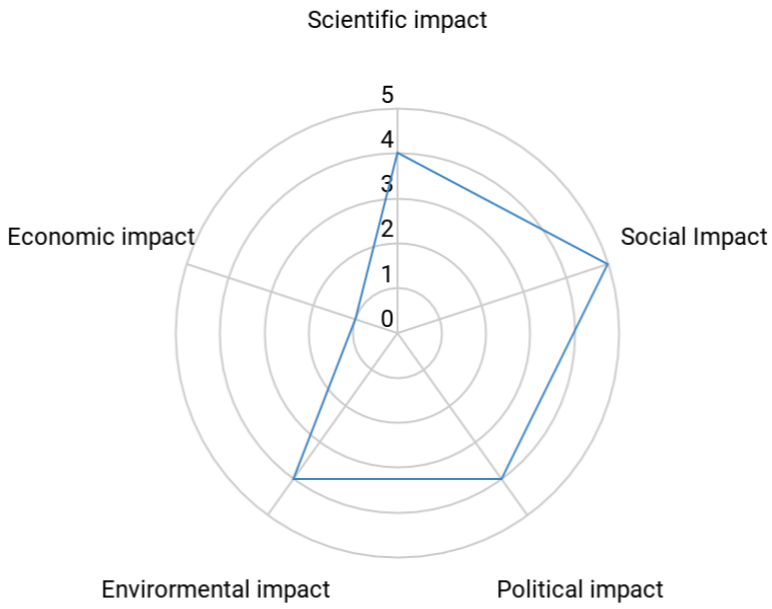


Fig. 31 Relevance of the areas of impact as in the impact assessment canvas

As we can see in the graph in Fig. 31, the most relevant impact areas for this pilot are the scientific impact, the social impact, the political impact and the environmental impact. Economic impact, even if not considered relevant at the time when the canvas was filled in, resulted in some relevance too. We'll discuss more in detail each impact area in the following subsections, except for environmental impact.

Scientific impact

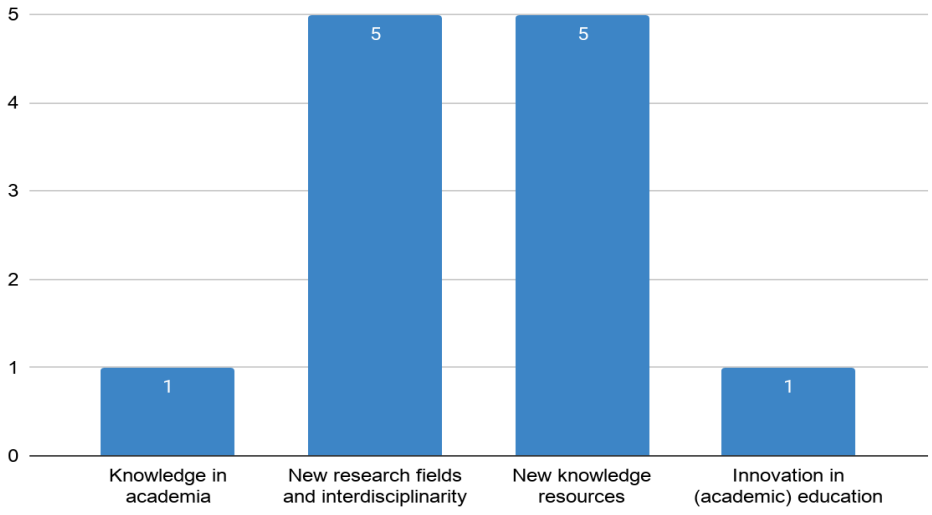


Fig. 32 Expected scientific impact Sonic Kayak as described in the canvas

Sonic Kayaks has a substantial scientific impact on knowledge in academia, new research fields and interdisciplinarity, and new knowledge resources. The impact on knowledge in academia is much better than expected.

Knowledge in academia

Sonic Kayak generated 35.052 data points, as well as several (non-scientific) publications (see Tab. 13).

Non-scientific publications	**5 (1 article, 2 blog posts, a video, and 1 instruction manual)**

Tab. 13 Number of publications by Sonic Kayaks

The **quality of the data** is very good - with at least 4 out of 5 indicators positive. The project adapted their process of data collection, by developing four versions of the data sonification and they have collected people's feedback in terms of waterproof quality and temperature. Furthermore, they have processed a lot of data before they started to gather the data, and had redundancy built in (3 systems).

The tasks for the volunteers were quite challenging, but at the same time easy to get it right. The volunteers were on their own doing simple tasks, like stopping every 200m with the GPS. Task procedures and data entry were systematic. The equipment used for measurements was mostly standardised and calibrated across volunteers. They tested two quality sensors in parallel before gathering proof-of-principle data. The hydrophone is a mid-range one, but they have already used it to gather data that have been published, and they have replicated the same conditions in different situations and the experiments always have worked. So, the quality is good enough. The project also records relevant metadata (GPS).

Project scores well on **openness of data**, with at least 3 out of 5 indicators positive. Data are available on Zenodo with an open licence, as machine-readable structure in a non-proprietary format. The data does not link to other data because they are not easily comparable to other datasets.

New research fields and interdisciplinarity

Sonic Kayaks is strongly interdisciplinary: it combines music and environmental sensors to monitor water quality. The project has also created a new research group as part of their long term strategy.

New knowledge resources

The Sonic Kayak system is a new and innovative data gathering tool that has already gained quite some interest and traction from other parties. Indeed during the ACTION acceleration period, the sonic Kayak team developed and integrated two new sensors: a water turbidity sensor and air particulate matter sensor, in addition to the pre-existing temperature sensor and hydrophone. The team also wrote the software for this system.

Social impact

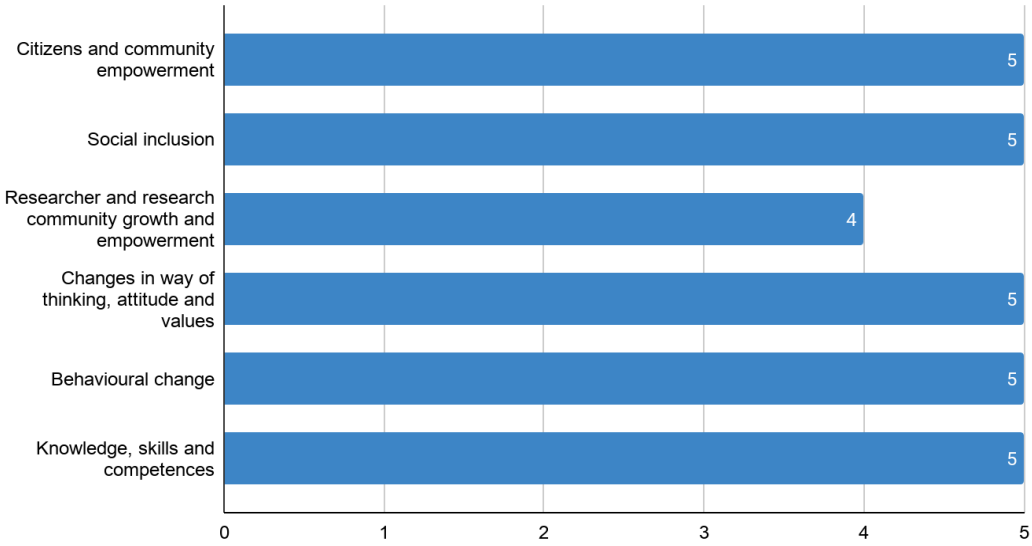


Fig. 33 Expected social impact Sonic Kayak as described in the canvas

As mentioned in the introduction of this subsection, the pilot engaged volunteers at different stages of the process: 49 people responded to the sonification survey while 27 people to the video-related one. Besides the people directly engaged in CS activities, the pilot reached a wider audience through their social media channels (more than 12.000 followers on twitter accounts and 590 Instagram followers) and blog posts. The team does not usually map the numbers of views to their blog as they prefer focusing on the quality of interaction that is timely and accurate. Indeed this pilot is based on previous, related CS activities and can count on an interested community of persons caring about the environment or interested in the artistics aspects of their work. As a result of the pilot, they have been invited for an article in The Raspberry Pi magazine (https://magpi.raspberrypi.org/issues/98/pdf) a well know journal for makers, especially young ones with more than 300,000 monthly readers, and 800,000 monthly page views. Besides this, their work was published also on HackSpace magazine, which has 13.9k twitter followers.

With reference to participants to the sonification survey, the project team mapped the respondents's profiles considering different profiles and the results are the following (Griffiths, A. 2020):

1. Those who selected '*I work or have worked in scientific research*' but not 'I work or have worked in a sound-related job' or 'I am a musician (either professional or hobby)' (n = 14)
2. Those who selected either '*I work or have worked in a sound-related job*' or '*I am a musician* (either professional or hobby)' but not 'I work or have worked in scientific research' (n = 9)
3. Those who selected both 'I *work or have worked in scientific research' and either* '*I work or have worked in a sound-related job*' or '*I am a musician* (either professional or hobby)' (n = 9).
4. Those who selected 'I have a visual impairment' (n = 2).

The results show how the respondents are close to the interests embedded in the pilot and, in some cases, have a professional profile linked to them. At the same time, the project succeeded in empowering people to collect data and in having more people engaged in doing data collection. This will support them and the local community in having evidence on pollution and act for improving the situation.

Social inclusion

As already mentioned this pilot was planned to have a strong emphasis on social inclusion, especially engaging people with visual impairments. This has proven to be almost impossible due to the Covid-19 restrictions, nevertheless a genuine effort was put in making this happen despite the difficult situation and two people with visual impairment participated in the sonification survey. Some of them also participated in the following activities and ad hoc conference call for discussing the project results. The online surveys were checked over by a blind audio and accessibility expert (Power Audio Productions) to make sure it would work for people with visual impairments who use screen readers.

Knowledge, skills and competencies

The CS managers report that the project had a positive impact on participants in terms of knowledge, skills and competencies acquisition. Most of them learned more on sonification procedures and how data is developed in this context and they increased their understanding of air and water pollution. This is also testified by a video made by participants on how the sensors work and how to measure air and water pollution.

Besides, artists involved in the pilot increase their motivation in participating in alike activities learning new things related to pollution and the scientific process. As one the team member described: the pilot "*taught artists about measurement and scientists to listen and learn music. There is an interdisciplinary learning exchange*".

Changes in way of thinking, attitude and values and behavioural change

Most people were already motivated and interested in air and water pollution so that changes in way of thinking, attitudes, values and related behavioural wasn not that relevant in this context.

Economic impact

The project was effective for the pilot team in increasing their recognition in the field and generated spill-oever effects. Indeed, as a result of the pilot, the team of another ACTION pilot, involved the Sonic Kajaks team in a proposal for a local council grant as trainers on how to build sonic kayaks. Then, a marine noise researcher has commissioned the team to train her to build a sonic kayak too, she used the training in writing a 5 years fellowship project based around the Sonic Kayaks, using them at the Great Barrier Reef (the project was not financed but she will re-apply in 2022).

Additionally, some of the Sonic Kayaks technology has been used in an artists installation by Kaffe Matthews and Lisa Hallm called *no scent or colour*[10] to measure air pollution and help people hear

[10]https://www.kaffematthews.net/project/no-scent-or-colour-2021

and experience the levels of air pollution they record while biking. Finally, new funds (6k Euros) were attracted as a consequence of the project participation in ACTION.

All these new initiatives definitely demonstrate the high appreciation of their work in the community and are occasions for further future income generation opportunities.

Political impact

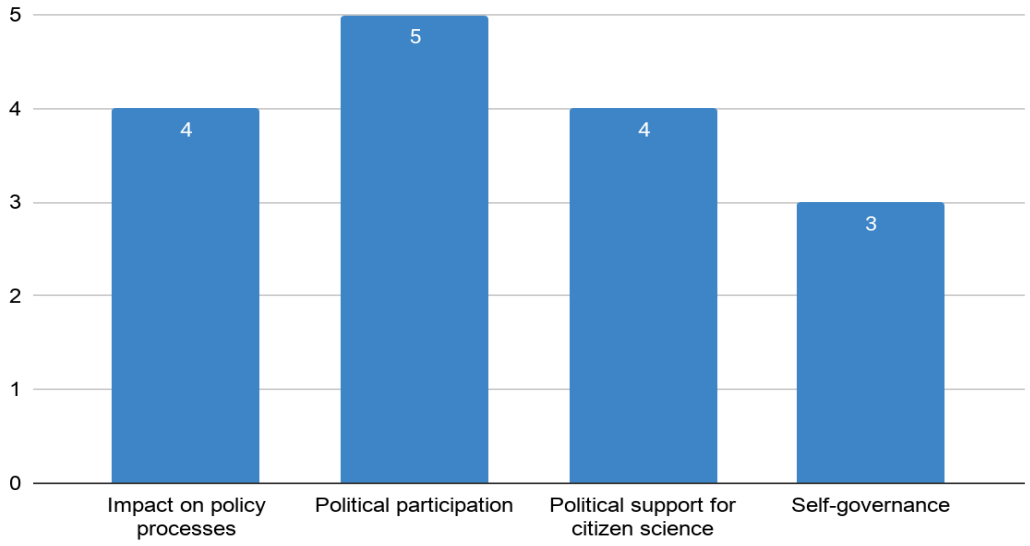


Fig. 34 Expected political impact Sonic Kayak as described in the Canvas.

Sonic Kayak has a potential impact on policy processes. Overall, the political impact is lower compared to the expected political impact. This can be partly explained by the adaptations the project had to undergo due to the pandemic.

Impact on policy processes

The project has a potential lead for impact on policy processes. A connection with the local Cornwall Council has been made through the Helford Marine Conservation Group. This group is interested in using both the data that the project collected and potentially in using the technology on the boats they currently use for surveying. The group's main interest is the interface between recreational users and the features (wildlife and habitats) of the Special Area of Conservation, and they are specifically working on policy change with local government.

Another way in which the project has an impact on policy processes is in supporting other organisations that are pushing for change. For example, the local activists' group Extinction Rebellion asked to use technology and volunteers from the Sonic Kayak project team for their data collection on air pollution.

Transformative impact

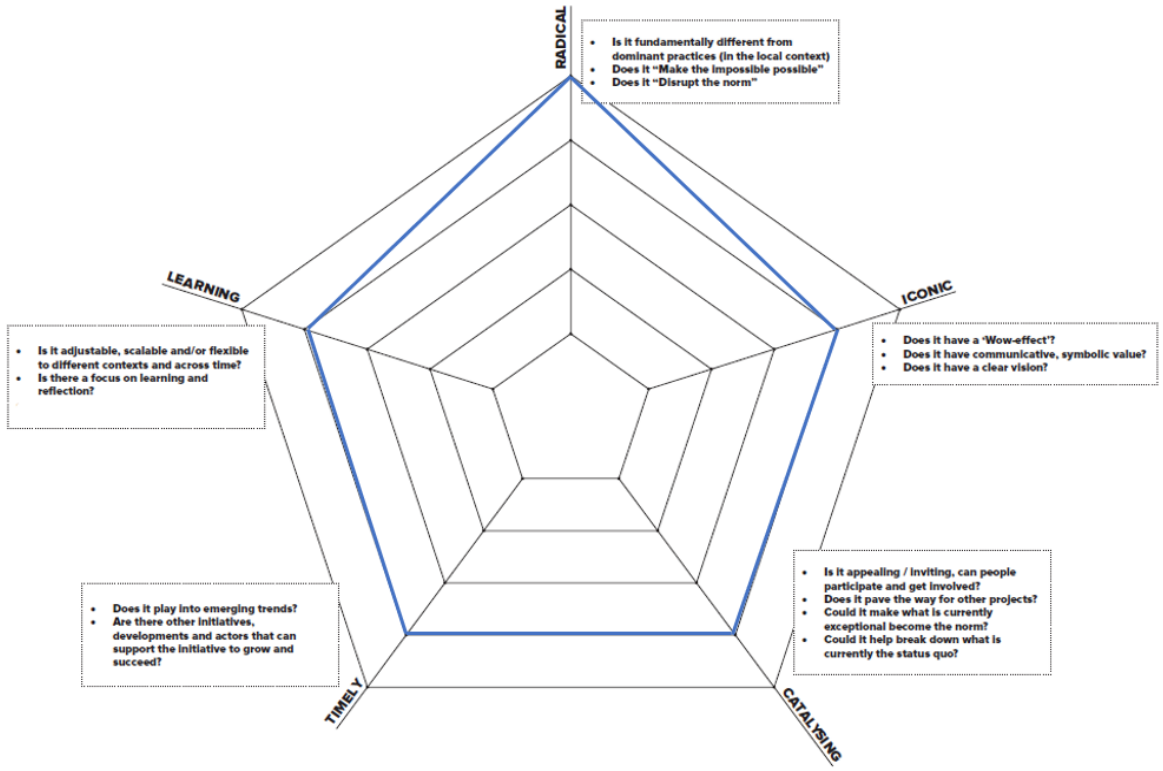


Fig. 35 Transformative potential of Sonic Kayak

Sonic Kayak has a high transformative potential, with an average score of 4.2 out of 5. The project is **Radical** (5), because it is a very different way of approaching environmental issues. It is **Iconic** (4), in that it has a clear vision and a high wow-effect. It is **Catalysing** (4) because the technology can be used in different settings, even though it is quite complicated technology. The project is **Timely** (4) because it plays into the emerging trend of becoming aware of air pollution, and being concerned about it. The project allows for **Learning** (4) in the sense that the technology can be adjusted to be used in different settings (such as the Sonic Bike).

NoiseMaps

Territorial coverage: Barcelona (Spain)	**Type of pollution considered:** noise pollution
Revant SDGs 3 - good health and wellbeing, 4 - quality education, 11 - sustainable cities and communities	

The Noise Maps project focused on deploying a citizen science process in the neighbourhoods of Sagrada Familia and the Raval to address the challenge of noise pollution, a serious problem related to health problems (lack of sleep, psychological ailments, cardiovascular disease, risk of higher stroke) and negative social effects (weakness of social cohesion and coexistence, reduced quality of life, loss of cultural diversity). Noise pollution was an urgent problem in the pilot areas, with active community groups on the lookout for a solution to help improve their living conditions. Indeed the community can be seen as the project initiator asking support to researchers after a link created by the public administration CS office.

The Noise Maps pilot was deployed for 6 months in the neighbourhoods of Sagrada Família and El Raval, and developed over three phases. In the Planning phase, representatives of local communities validated the pilot plan. During the Implementation phase, members of the volunteer community became citizen-scientists and learnt to deploy, calibrate and operate their sensors from their home windows and balconies according to scientific standards, as well as to make street-level recordings at local points of interest with portable high definition sound recorders. And in the Evaluation phase, citizens actively took part in workshops to collectively analyse and make sense of the collected data, generating valid scientific results and public policy recommendations.

Audio recordings were made by citizens who participated in 5 citizen science field workshops. These field workshops, in the shape of ‘sound hunting safaris’, involved street-level collection of sounds at a set of the most representative streets, avenues and squares of the neighbourhood, locations which had been selected and agreed upon by the community council of citizen scientists. It is worth mentioning that the first set of workshops were conducted in May 2020, in social conditions of strict confinement, and thus were able to document both areas’ unusual sound signatures at a historic moment. Second, a network of acoustic sensors (Audiomoths) were delivered to citizen science volunteers, who learnt to operate them and installed the sensor that had been given out to their care on the balconies of their suitable private homes to take sound samples from public space.

Right after the end of the final round of pilot sound data sampling in mid September, a workshop was carried out to analyse the pilot data and co-create the pilot results with Raval volunteers, including the next steps to generate bigger impact and upscale results. Also, the pilot results were shared with public officers and city council services with the aim of feed citizen-generated recommendations into public policy and urban regulations.

After the end of the pilot supported by ACTION, the team was able to deploy the project at a public library in Tortosa, and they are looking for ways to have the same activity with the same community at a much larger scale and with government engagement.

Impact areas relevance self-assessment

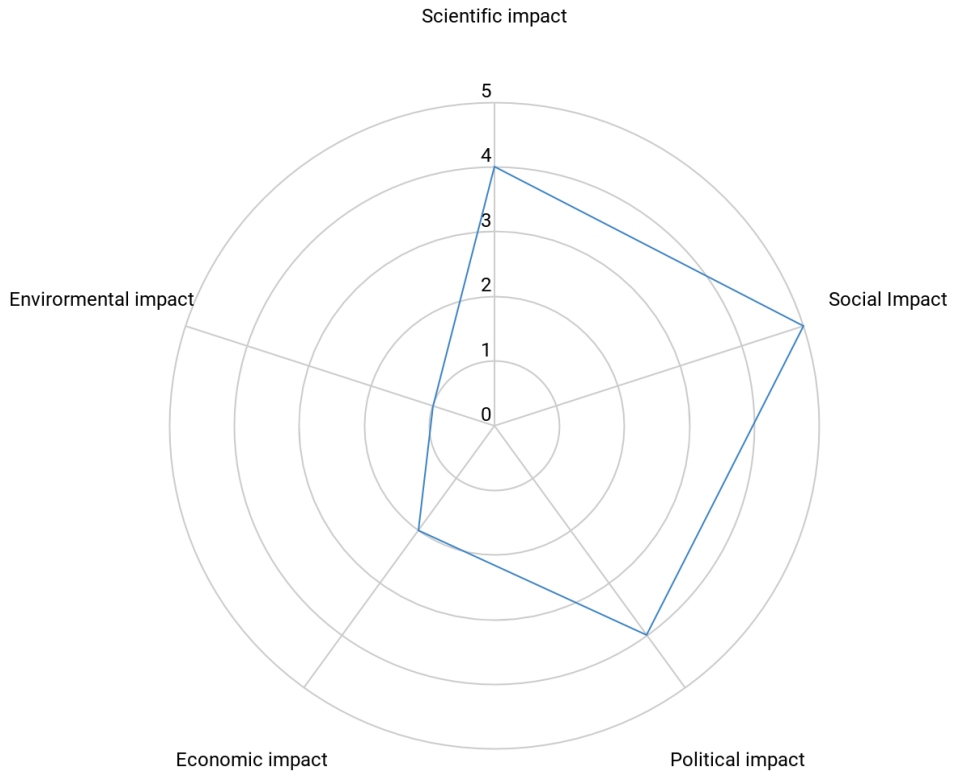


Fig. 36 Relevance of the areas of impact as in the impact assessment canvas

As we can see in the graph in Fig. 36, the most relevant impact areas for this pilot are the scientific impact, the social impact and the political impact. We'll discuss more in detail the most relevant areas of impact and subdimensions in the next paragraphs.

Scientific impact

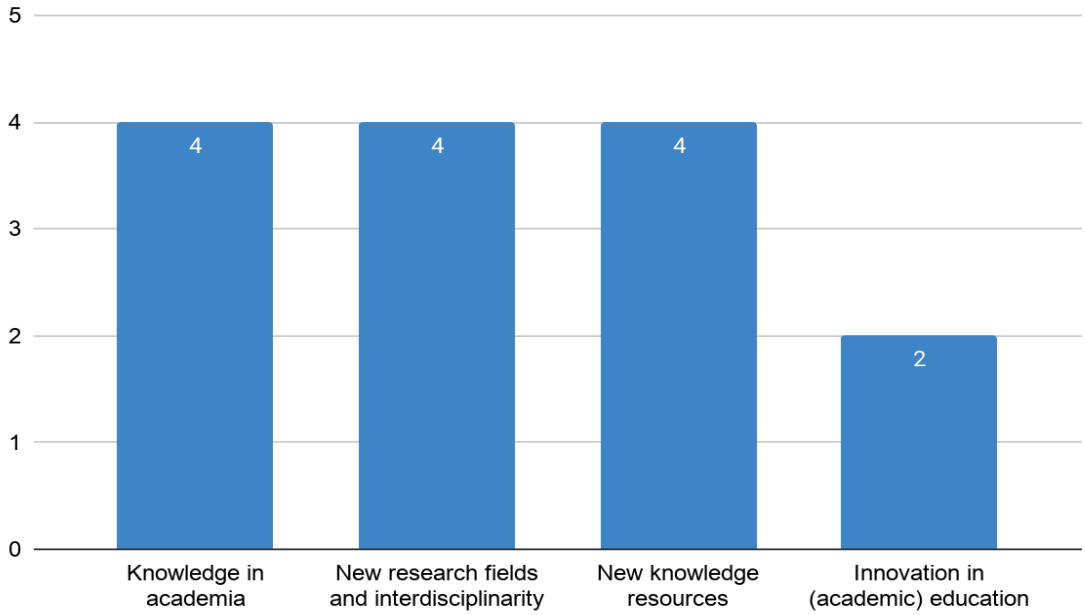


Fig. 37 Expected scientific impact NoiseMaps as described in the canvas

NoiseMaps has had a high scientific impact on knowledge in academia, new research fields and interdisciplinarity, and new knowledge resources. This impact is in line with the expected scientific impact.

Knowledge in Academia

The project generated a large **amount of data**, with 1883 rows (and 25 columns). It also **published** a number of documents with their results, as well as an extensive toolkit with more information on how to carry out a sound documentation and citizen science project - see table below. Furthermore, the project is preparing a scientific article for publication.

Non-scientific publications	**5 (3 maps, 1 toolkit, 1 video)**

Tab. 14 Number of publications by NoiseMaps

The data quality generated by NoiseMaps is very high, with 5 out of 5 indicators. The procedure for adapting the process of data collection was based on piloting. The tasks for volunteers were initially very challenging. This led the project to adopt two strategies: one group of volunteers followed extensive training, and for another, task processes were automated. Data procedures are systematic: the project put a lot of effort in prototyping the data pipeline, from the point of generation at the audiomot sensor, to the point of the data visualisation maps. The equipment used for measurements is standardised and calibrated across volunteers, and the project records relevant metadata.

The **openness of data** scores well: 3,5 out of 5. The dataset is published on Zenodo, and some of the audio files are published. The project did not publish most raw audio files, because there were some problems with privacy. The data visualisation is available on the ACTION dataportal. The data of the audio recorded from the balcony are available only through the mathematical representation (open data, not open content). The data is available as machine-readable structure in non-proprietary format, and links to other datasets to provide context.

New research fields and interdisciplinarity

NoiseMaps is strongly interdisciplinary: it combines sound documentation (technical, scientific point of view) with citizen participatory innovation. Furthermore, there is a cultural dimension in documenting the soundscape of the city, the artistic side (soundscape), and city scaping. All in all, the project contains an intersection between urban anthropology, science, citizen participatory innovation, art, urbanism and (co-design) cityscaping.

New knowledge resources

The project eases access to traditional and local knowledge resources, by publishing the sound maps about the neighbourhoods - allowing residents to understand their neighbourhood in different ways. Furthermore, it facilitated knowledge creation among societal actors and groups by running the co-creation workshops.

NoiseMaps also created new data-gathering tools by making new firmware of the AudioMoth sensor, which allows anybody to generate sound data automatically. This new version of AudioMoth is calibrated in a different way, which improves data quality to such an extent that it is suitable for policy impact - the city council cannot disregard these data.

Innovation in academic or school curricula

No impact is recorded within the accelerator period, but the project did run a number of workshops between January and June 2021 in high school groups.

Social impact

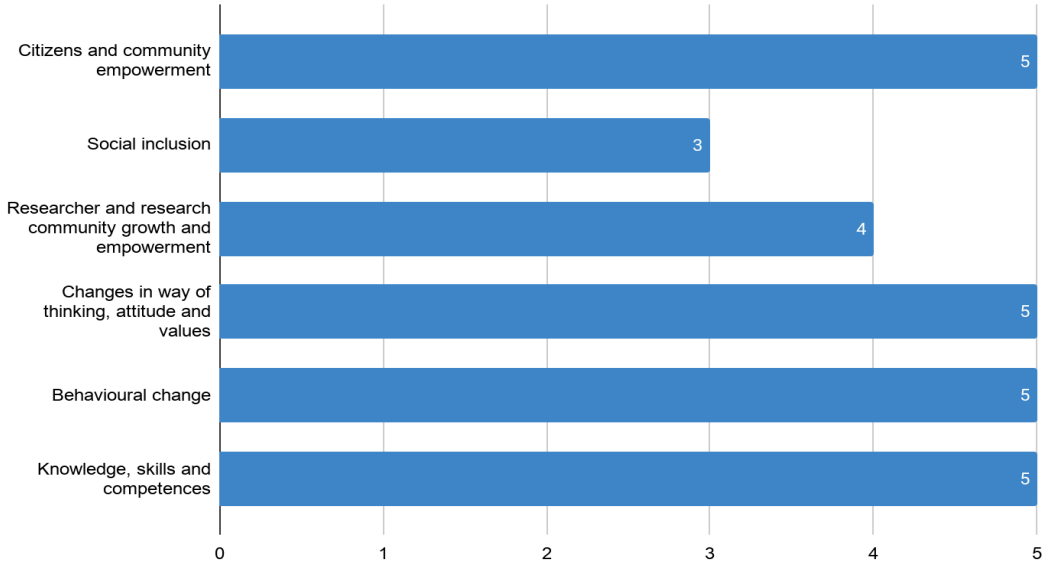


Fig. 38 Social impact NoiseMaps

Citizen community and empowerment

The project engaged 14 persons in Raval and 6 in Sagrada Familia (two neighbourhoods of Barcelona). All of them have been engaged in CS activities, more specifically they were involved in the following activities:

- Develop data gathering instruments;
- Collect Data;
- Pre-process and Curate data;
- Analyse data; Interpret data;
- Share and Communicate results;
- Policy Agenda Setting;
- Community Sustainability.

While 20 people participated in the activities and exchanges with the researchers team, more people have been involved since Audio Moth has installed households balconies so that, very probably other elements of the families have been interacting with the sensors and contributed to the activities. Beside this, the project reached more people through Twitter (more than 450 followers) and dissemination activities such as the participation to Ars Electronica in which two online workshops were organised by the team.

Initially, the citizen scientists were expected to interact with one another, but, because of Covid-19 restrictions, this was not possible in the way originally planned. They had interactions in the online workshops, and in small groups during a face to face workshop held in September 2020. The project's manager reported that the project increased the level of trust among participants even if they were already part of a local association and the project might have attracted more members to it.

Furthermore, the project improved the citizen scientists' perceived *self-efficacy*; i.e. the perception of a person to be able to make a difference in a given context. Indeed, at the beginning of the pilot, participants were struggling on how to interact with the local governments in order to improve the situation of their neighbourhoods in terms of noise pollution which constituted a real problem for them. They felt frustrated by the situation, but this changed during the pilot. First of all, now they have data, and this puts them in a better position for talking with the decision makers with solid evidence of the situation. At the same time they appreciated the process and are willing to record more sounds, not only the noise related one but those linked with the immaterial cultural heritage of their neighbourhoods that they now appreciate more. As the project manager declared: "*Participating in the whole pilot makes them realise their power to produce knowledge*".

Social inclusion

In terms of participation, two persons with a physical disability were engaged in the project activities. Participants' age is between the late 20s and 60s/70s, with a mixed-gender composition. Most of the people involved are highly educated, and most of the participants were born in Catalunya and are long-term residents of Raval neighbourhood, although there were participants that come from Italy and Pakistan. In terms of value orientation, participants mostly have a post-materialistic view, with interest for the environment and sustainability, but there were also people, especially elderly, which were more traditional in terms of value orientation and participated in the project activity for improving their personal and community situation (for example for having back the possibility to sleep at night and to preserve the old Raval from gentrification). The project's manager didn't use a dedicated strategy for social inclusion, but the use of a snowball approach to citizens engagement resulted in quite a mixed group. The pilot planned ad hoc activities and workshops with children, especially from economically disadvantaged and/or migrant families by collaborating with a local association supporting them in after school activities. Unfortunately the Covid-19 restrictions made these activities impossible.

Knowledge, skills and competences

Participants of the project improved their understanding of scientific processes, indeed they have been engaged in several steps of such a process and not only in data gathering. They developed skills on the use and understanding of technology and on sound. Moreover, they learned how to interact with public authorities to be heard (see Political impact subsection here after).

Changing in way of thinking, attitudes and values

As mentioned earlier, the majority of participants was already very interested in the topic before the beginning of the activities (indeed the project was initiated by the local community who "engaged the research team"). Nevertheless, the project had an impact on external-to-the-pilot people as participants talked about the activity with families and friends and supported the awareness raising of the community with regards to noise pollution.

Behavioural changes

The project had an impact on participants' behaviours both at an individual and collective level. Individually, they become aware of day to day behaviour that can generate sound pollution. Collectively, the project prototypes a new way of engaging people politically. Citizens now have the pipeline to generate quality data, to create and bring evidence to the city council in order to change rules or reflect on the problem. As stated by the project manager: "*Through the gathering of the sound of actual public space we can direct public space social usage*".

Economic impact

After the end of the ACTION acceleration and as a resul of it, the project team was able to write 7 new project proposals, out of which three were succesful and assure new funds (16.600 Euros). Indeed, the result of the project generated new similar activities in other part of Barcellona nd in other Spanish cities.

Political impact

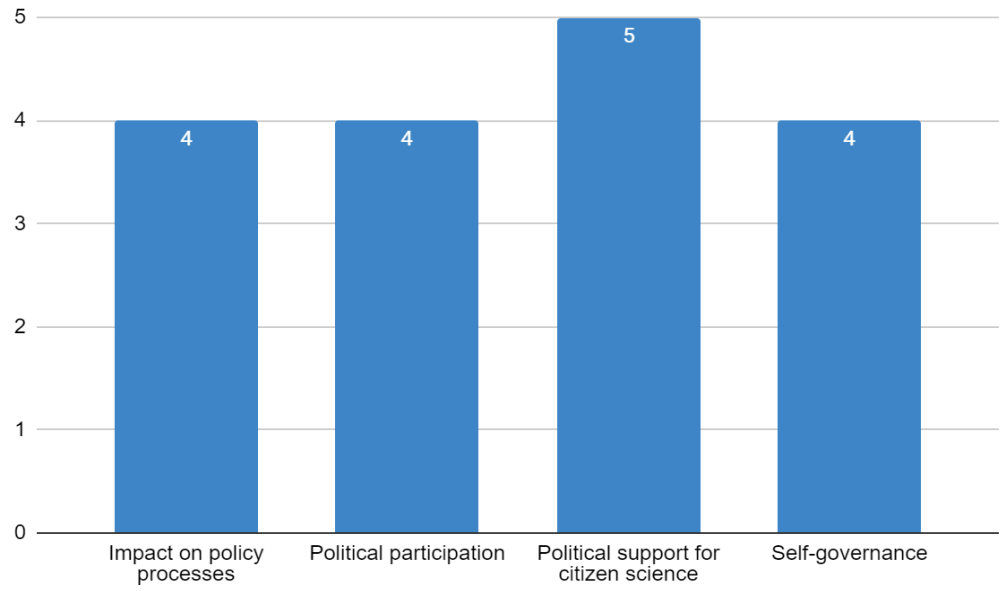


Fig. 39 Expected political impact NoiseMaps as described in the canvas

NoiseMaps has had political impact on all four subdimensions, which is in line with the expectations as described in the canvas. Beside this they are in an active dialogue with the city council to deploy Noise Maps in Les Rambles (another area of Barcelona), as a citizen network of sound mapping devices which generate sonic data that can be used by city planners to manage complex urban environments. If successful, this will become a long-running testbed to develop citizen science as a policymaking instrument. Moreover, the team lobbied directly via the Barcellona Office of Citizen Science, and indirectly via awareness raising of noise pollution and soundscaping as a valid approach in several events and meetings where city officers were present.

Impact on policy processes

It is too early to tell whether this project has had an impact on policy processes, although the team already had some meetings with the city council. The team tries to engage with politicians and public officers, but it is difficult to get attention from them during the pandemic.

Citizen empowerment.

There was a community in Raval who had problems with sound pollution. NoiseMaps empowered these citizens with skills: open technology and know-how, in order to be able to collaborate with the

city. This empowerment entails changes in their way of thinking, how they approach this problem and also transforms their outlook. It was a contentious relationship, and the community started out very angry. The project was able to build bridges between citizens and the city council, and change the attitude of both parties to one of collaboration. The citizens even loved the processes so much that there was willingness to continue the research – they wanted to record noise but also other sounds that they now considered very interesting.

Self governance

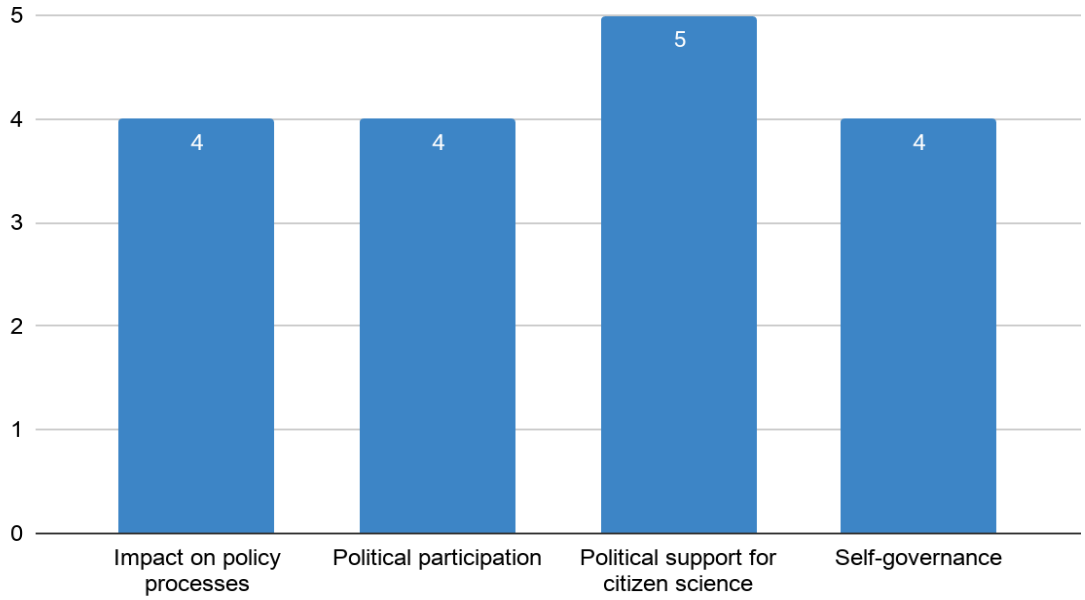


Fig. 40 Policy impact NoiseMaps

NoiseMaps allows citizens to have an evidence based-voice. Although the participating citizens were already quite engaged in politics (they already vote, etc), the project increased the participant' civic engagement, because they are able to show the evidence of noise pollution.

Political support for CS

The project has received positive feedback from the city council – they are keeping track and are interested. NoiseMaps even became one of the official citizen science projects in the Citizen Science office of Barcelona. The project is a success story that spreads via public administration.

Transformative impact

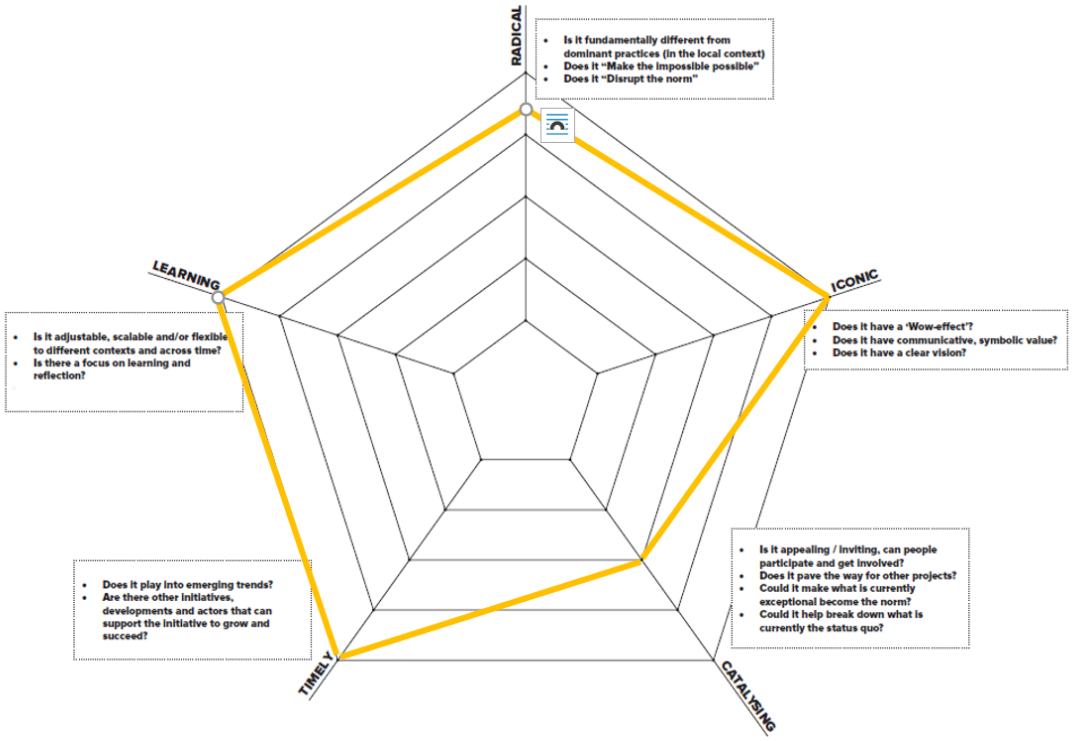


Fig. 41 Transforative potential of NoiseMaps

The project has a very high transformative impact, with an average score of 4,5 out of 5. The project is **Radical** (4,5) in the sense that it democratises complex tech, and in that it has the potential to change the way citizens interact with the government. The project is very **Iconic** (5): it is powerful in terms of visualisation, as shown by the maps. The project is **Catalysing** (3), but there are also some barriers. It should be democratic for everyone, but currently it is not, because there are barriers for participating. The project is very **Timely** (5), because it aligns with two big trends. First, with the realisation that technology needs to deliver for all, because if it does not, it can lead to bigger gaps between people. Second, there is pushback against gentrification and tourists - the city is not just a playground for global capital. Last, the project scores very high on **Learning** (5). The project is built in a modular way, which means there are a lot of different options on how you want to set up the project. The project can fit in different contexts.

CiticomPlastic

Territorial coverage: Oslo (Norway)	**Type of pollution considered:** Plastic/bio-plastic (Soil)
Revant SDGs 3 - good health and wellbeing, 11 - sustainable cities and communities, 12 - responsible consumption and production	

CitiComPlastic focused on bioplastic PLA (polylactic acid) waste management engaging volunteers in experimenting with home-scale composters in order to understand how and to what extent it can be properly disposed of and how it can be effectively biodegraded. The project was implemented by Nabolagshager, an Oslo-based think tank established in 2013. They work on green and social entrepreneurship projects following a LivingLab approach to promote a shift to sustainable futures and involve as many people as possible in the opportunities around this. The pilot was originally designed to take place in a specific neighbourhood of Oslo, a disadvantaged one, characterised also by a high rate of youths from a migrant background. Unfortunately, due to the Covid-19 related restrictions the project could not carry out the face to face activities originally planned and needed for interacting with this community so that citizens scientists have been recruited through a social media campaign.

Citizen scientists were given all the materials they needed for the experiments: PLA tableware and PLA glasses, sugarcane plates and horse manure. In terms of equipment, the citizen scientists received a composter, a compost mixer, a compost thermometer and gloves. After the distribution of materials and equipment, the citizen scientists received instructions for making compost and managing it. Throughout the experiments the citizen scientists collected temperature, visual and smell data. Thanks to the instructions guide, some of the citizens uploaded the data on epicollect 5. Others either published on the project's Facebook page or emailed the pilot manager the data they collected along with pictures. Constant communication and support was offered to citizen scientists by the project team.

Impact areas relevance self-assessment

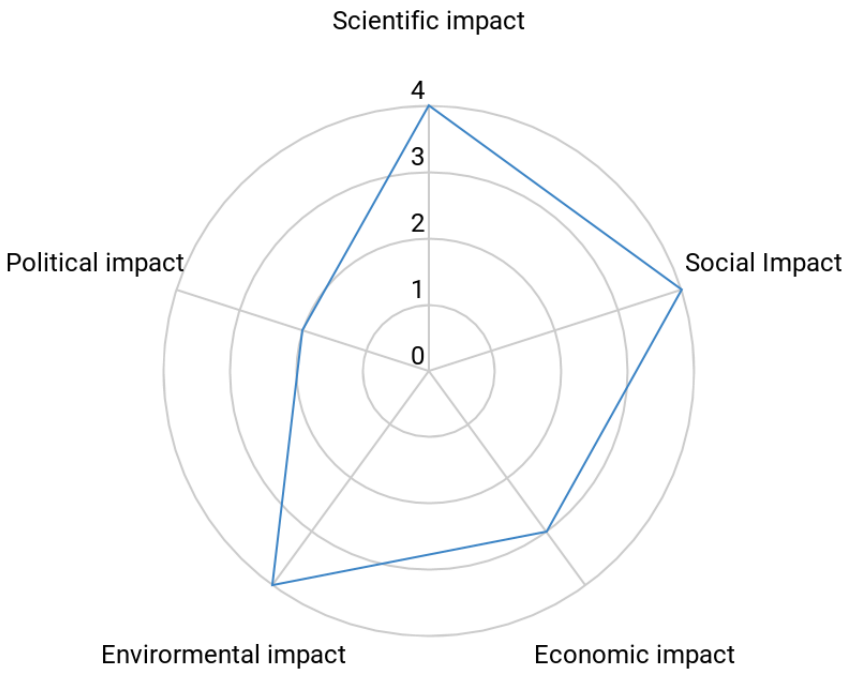


Fig. 42 Relevance of the areas of impact as in the impact assessment canvas

As we can see in the graph in Fig. 42, the most relevant impact areas for this pilot are the scientific impact, the social impact and the economic impact. The political impact showed to be relevant as well when engaging with the project managers in the interview. We'll discuss more in detail each impact area in the following subsections.

Scientific impact

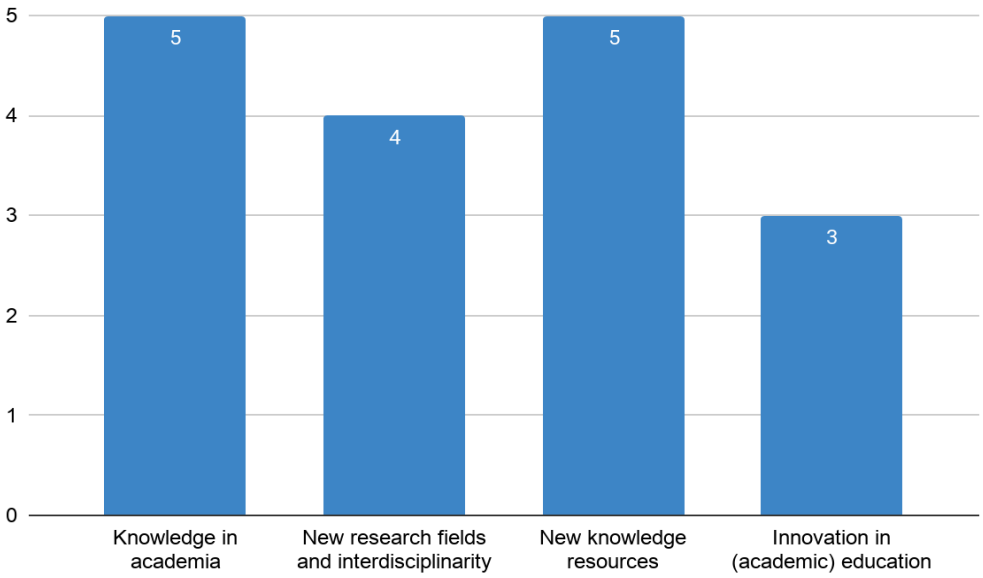


Fig. 43 Expected scientific impact CiticomPlastic as described in the canvas.

CiticomPlastic has scientific impact on the subdimensions: new research fields and interdisciplinarity, and new knowledge resources. Especially for knowledge in academia, this is lower than expected. This can partly be explained by the changes the project had to undergo due to the pandemic.

Knowledge in academia

In this project, 33 data points were collected, consisting of temperature measurements and visual observations of how the material was changing in the composters. Some of the data was published on Epicollect and the project also published a video.

The project scores 2 out of 5 on data quality. The tasks for volunteers were easy and they were given clear instructions. Furthermore, the thermometers are of reasonable quality. There was no procedure for adapting the data recording procedure, data entry was not systematic, and no metadata was recorded.

The openness of data scores 2 out of 5. The data are available on Zenodo, with a machine readable structure.

Non-scientific publications	**1 video**

Tab. 15 Number of publications by Citicom Plastic

New research fields and interdisciplinarity

This project is strongly interdisciplinary: it combines political activism with chemistry and environmental science. Furthermore, it draws on interdisciplinary research methods, targeting the gap between knowing and doing. It is an action-based project by citizens, with an action learning methodology.

A research institution called Nibr (the Norwegian institute of bioeconomy research) is interested in the results, and also in the way the experiment has been set up. This institute is collaborating with the waste management world and they are interested in solving societal problems.

New knowledge resources

Through the project, citizens are more aware of where their waste comes from and where it is going. They now know where and how bioplastic is created and sold, and know of the problems in composting it.

Social impact

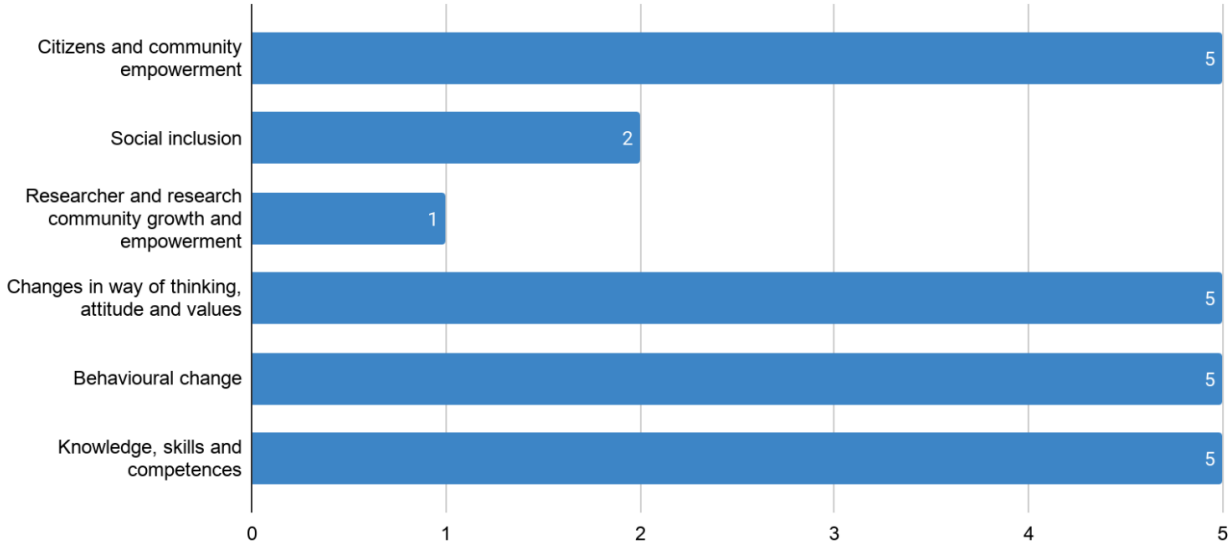


Fig. 44 Social impact CiticomPlastic

The pilot engaged four citizen scientists in the data gathering process with composters, while more people have been reached through awareness raising and dissemination activities. Indeed the recruitment process was based on a social media campaign on the organisation accounts, especially Facebook which showed 7701 followers and Instagram with 429 followers. 32 people participated in the kick off event while the final one took place in a local festival with thousands of participants. The pilot also participated in Ars Electronica festival as part of their incubation within ACTION.

Citizens and community empowerment

The need to rethink the pilot due to the Covid-19 situation limited the possibility to work with a local community, but participants built a small community as a result of the project. Indeed participants increased the number of their social relationships, became friends on Facebook, and they met each other on Zoom. The pilot was also an occasion for the participants to get introduced, by other volunteers, to new persons in the local community. Beside the 4 citizen scientists which were directly connected with the pilot management team, other people participated in the activities as other family members, including childrens. It is probable that the work around composting becomes a social activity for the engaged families to spend quality time together, especially during the Covid-19 situation. One of the participants was a teacher and shared the activities and related results also with her students.

No direct data were gathered from the volunteers about the empowering aspects of the pilot, but from the pilot manager point of view, they got exposed to opportunities to exercise their agency and do something together on the addressed topic. Some were interested and engaged in this potential aspect of the pilot, while others showed a lower interest in it.

Social inclusion

As mentioned, the original project was planned in an area of Oslo with low socio-economic status compared to the average in Oslo and a high rate of migrants. At the kick off with this community the

majority were women, all migrants, speaking many different languages. They normally do not interact with local social services and the pilot was seen also as a way to better link the community with the public services. Unfortunately, it was not possible to carry on the pilot within this community due to Covid-19 restrictions to social interactions, but the communication flow with them on this topic remained and at the end of the pilot, results were presented to a diverse, mixed group of citizens from this community. The project team is willing to carry on the activities with this community in the future would opportunities emerge.

The citizen scientists actually engaged in the pilot, recruited online all female, aged 30-40 year old, well educated and with a medium-high income rate. They are mixed in terms of nationality (two norwegian, two from other countries); they show a pro-environmental concern and attitude and are already interested in CS and composting. It is interesting to observe that, through online engagement, the difficulties in assuring socio-cultural differences among participants and supporting social inclusion seams to be increased.

Knowledge skills and competencies

Participants showed an increased interest and understanding for composting "science" and practices while their interest and knowledge on the scientific process was already high due to their level of education. On this, one of the volunteers already had some experience. For two of the volunteers that live in a farm, soil quality was also an important topic as they were looking to use the results of the composting for their farming activities. Unfortunately this was not possible, but all learned a bit more on soil quality. Considering soft skills, volunteers have been involved in interviewing local administrators and waste management experts and this gave them the opportunity to improve their skills in terms of qualitative data collection.

They learned about materials and also got a better understanding of the waste management processes in Norway, discovering that the country is not recycling as much as expected and that waste management could be and needs to be improved.

Change in way of thinking, attitudes and values

This is one of the most interesting impacts of the pilot, indeed volunteers changed their opinion on bioplastic and waste management systems. They - as well as the CS project manager - were all thinking waste management was at a high level of quality and professionalisation in Oslo, but this resulted to be less so. As the CS manager reported "*we were shocked about what we learned, we were disoriented and this led to changes*". The main achievement was to support critical thinking on materials among participants and among the persons reached through dissemination activities. They changed the way of reasoning about materials: not considering only the materials that are used for creating them (bio materials, as in the bio-plastic case), but also on how they can be re-used or recycled after usage.

Behavioural change

What volunteers learned and the difficulties in properly managing bio-plastic lead them to changes in their behaviours, especially in their willingness to inform others about compostability of materials and provide right information on bioplastic. In terms of purchasing behaviours participants changed their habits by bringing recycled plastic instead of bio-plastic, reducing single use plastic and bringing cups and plates from home as much as possible when consuming food and beverage outside.

Economic impact

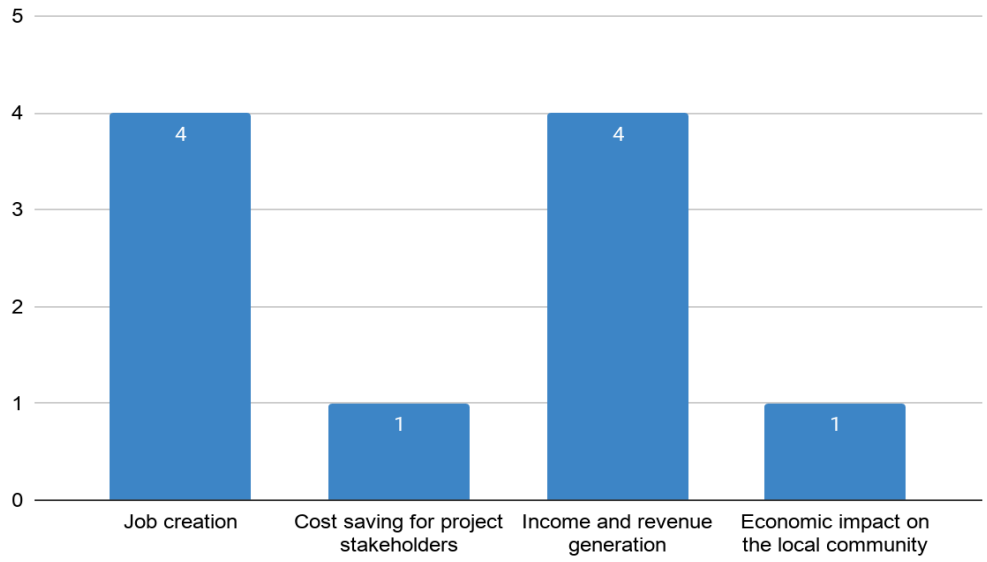


Fig. 45 Expected economic impact CiticomPlastic

The pilot leading organisation was very interested in developing entrepreneurial and job opportunities around bioplastic management and composting. For this an initial business model canvas has been developed hightlithing costs and benefits and funding opportunities. This option of building a start-up engaging migrant youth as social entrepreneurs is still of interest for the pilot leading organisation that will keep working on this in the future. Now they have a much more close understanding of the related costs and challenges and ways to overcome them and are looking for additional, ad hoc, fundings.

Beside this, the pilots connected local organisations that can work together now like a waste management facility and research institute. This link was established thanks to the municipality. This can lead to income generation for them, which - even if not directly linked to the pilot - can represent a positive impact on the local economy.

Finally, the pilot leading organisation acquired new competencies on CS that will be applied to other fields, such as agriculture, for example in the Oslo urban incubator agriculture space in which they are engaged.

Political impact

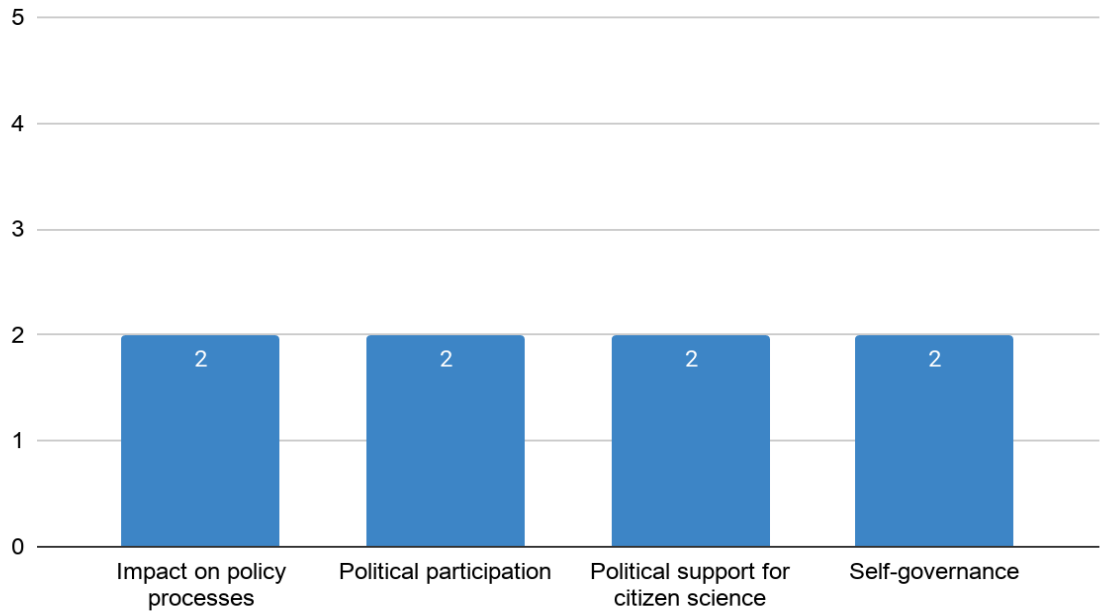


Fig. 46 Expected political impact CiticomPlastic as described in the canvas

While the expected political impact of CiticomPlastic was low (see Fig. 46), there is in fact some impact on policy processes.

Impact on policy processes

The core team of CiticomPlastic started up a conversation with the municipality through a couple of meetings with them. They talked to the waste manage department and the city environment department. Through this they became aware that the municipality does not have any plans to deal with bioplastic waste, and it is not a priority to them. The project might have initiated a process at the municipality, because just after these meetings the municipality started issuing articles on the topic of bioplastics.

Transformative impact

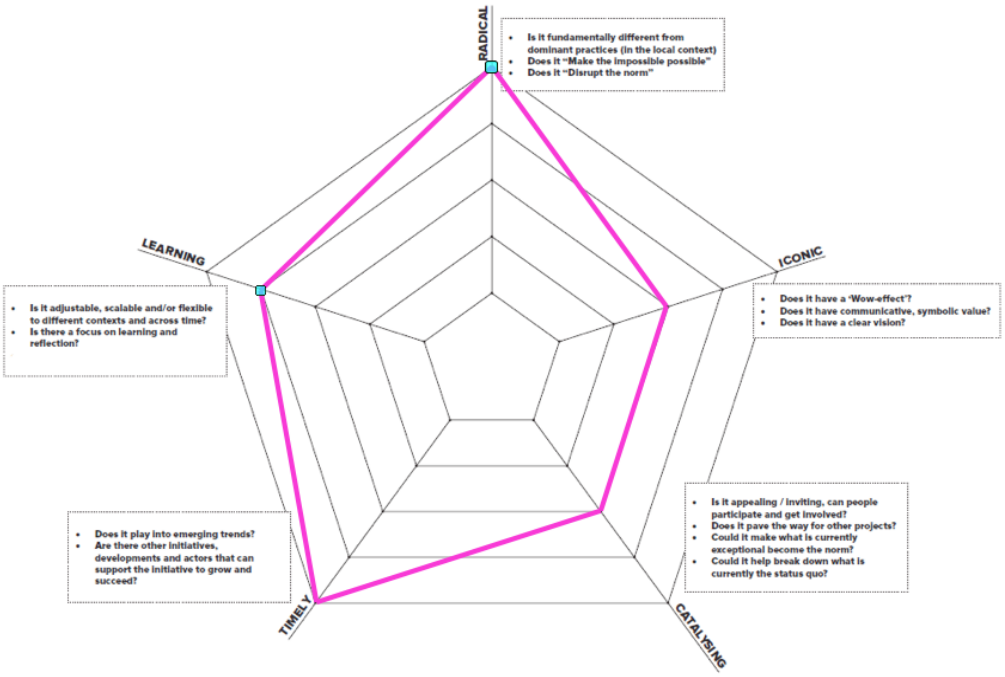


Fig. 47 Transformative potential of CiticomPlastic

CiticomPlastic has a high transformative impact, with an average score of 4 out of 5. The project is **Radical** (5/5) because it is completely new, unheard of, and intended to disrupt the current practices. It is quite **Iconic** (3/5), though the vision had to be adapted to be realistic. It is quite **Catalysing** (3/5), because the project has the capacity to enable collective engagement and diverse participation since composting can be a collective activity. However due to Covid it is not realistic to have a collective scheme. The project is very **Timely** (5/5) in that it aims to raise awareness and come up with solution strategies for an emerging waste product which is very new in our lives. The project allows for **Learning** (4/5) because the project can be scaled up and carried into different contexts. There are researchers all around the world who are already looking at the same problem in their own contexts, the most potential collaborators, but very little citizen action oriented towards coming up with solutions.

In my Backyard

Territorial coverage: Esposende municipality (Portugal)	**Type of pollution considered:** soil pollution
Revant SDGs 2 - zero hunger, 3 - good health and wellbeing, 12 - responsible consumption and production	

The project is implemented by the NGO Rio Neiva in collaboration with the Esposende Environmental Education Centre. The aim was to understand and map the use of pesticides and fertilisers in the context of home farming and gardening. Simultaneously, it aimed to disseminate information on the topic with the final aim of reducing the use of pesticides and fertilisers.

The pilot area is the Neiva river mouth area, in the municipality of Esposende, Portugal, just within the Northern Littoral Natural Park, working with a community of home farmers and gardeners.

The activities carried out include on-site visits to domestic backyard based on an ethnographic approach coupled with questionnaires, and an online survey. With reference to the on-site visits, project managers were able to see 25 backyards, talk with the owners and discuss with them their gardening practices in detail. The online survey, based on a convenient sample, reached 110 persons and investigated motivation about gardening and the used techniques such as their way of watering, the frequency, the use of pesticides, the use of sustainable practices for detailing with insects and other gardening-related issues and use of composting.

Beside this, 11 dissemination and capacitation meetings with local community members. The meetings provided participants with detailed information on sustainable home gardening practices, including how to create fertilizers in a do-it-by- yourself way.

Impact areas relevance self-assessment

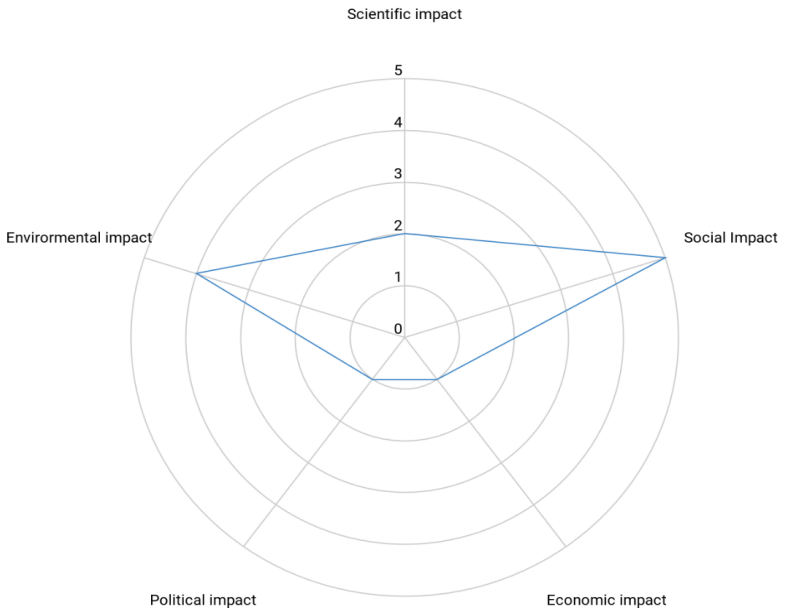


Fig. 48 Relevance of the areas of impact as in the impact assessment canvas

As we can see in the graph inFig. 48, the most relevant impact areas for this pilot are the social impact and the environmental impact, but also the scientific one emerged as important while talking to the project managers during the interview. We'll discuss more in detail each impact area in the following subsections.

Scientific impact

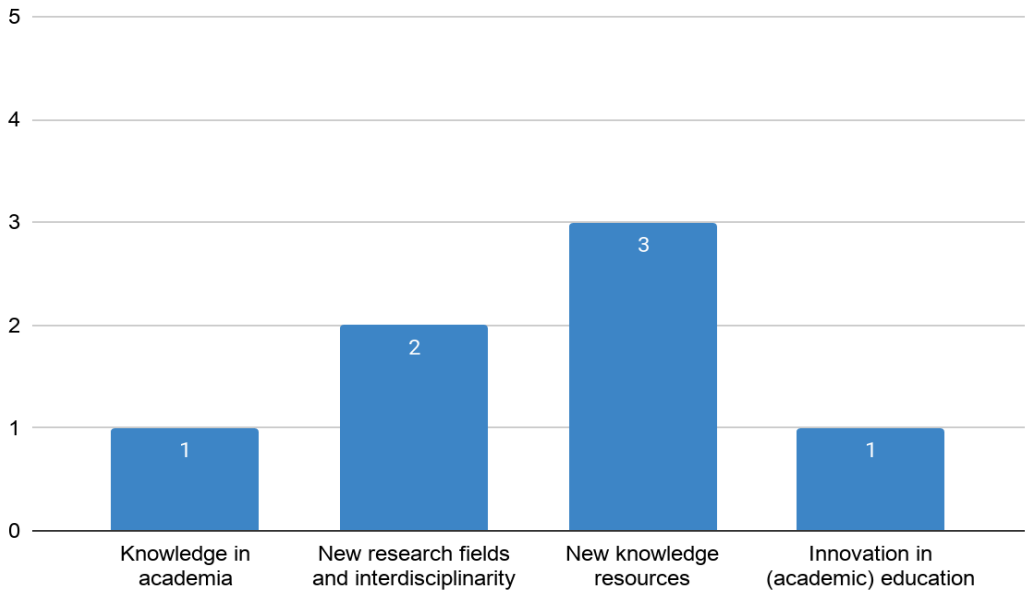


Fig. 49 Expected scientific impact In My Backyard as described in the canvas

In My Backyard has a reasonable scientific impact, with some impact on knowledge in academia and a substantial impact on new knowledge resources. With this, the impact on knowledge in academia was higher than expected.

Knowledge in Academia

In My Backyard has a reasonable scientific impact, with roughly 6500 data points through online surveys (110) and on-site visits (25), and a good number of publications: a scientific report on data analysis, a documentary about their project, and some other non-scientific documents on data analysis and ethnographic analyses from onsite visits. The results are published on Zenodo and the project's website.

Non-scientific publications	**7 (1 documentary, 1 booklet, 1 report, 4 articles on magazines and online portals)**

Tab. 16 Number of publications by In my Backyard

New knowledge resources

In my backyard eased access to traditional and local knowledge resources in the sense that they enhanced citizen's knowledge about their own backyard practices. The onsite visits are (unexpectedly) creating awareness on the topic. Also, the team is organising a special workshop on the argument on how to improve backyard practices.

Furthermore, the project facilitated knowledge creation among societal actors and groups. This started from the beginning during a workshop and a dinner, when people started to discuss among themselves what the best practices are for growing food in their backyard.

Social impact

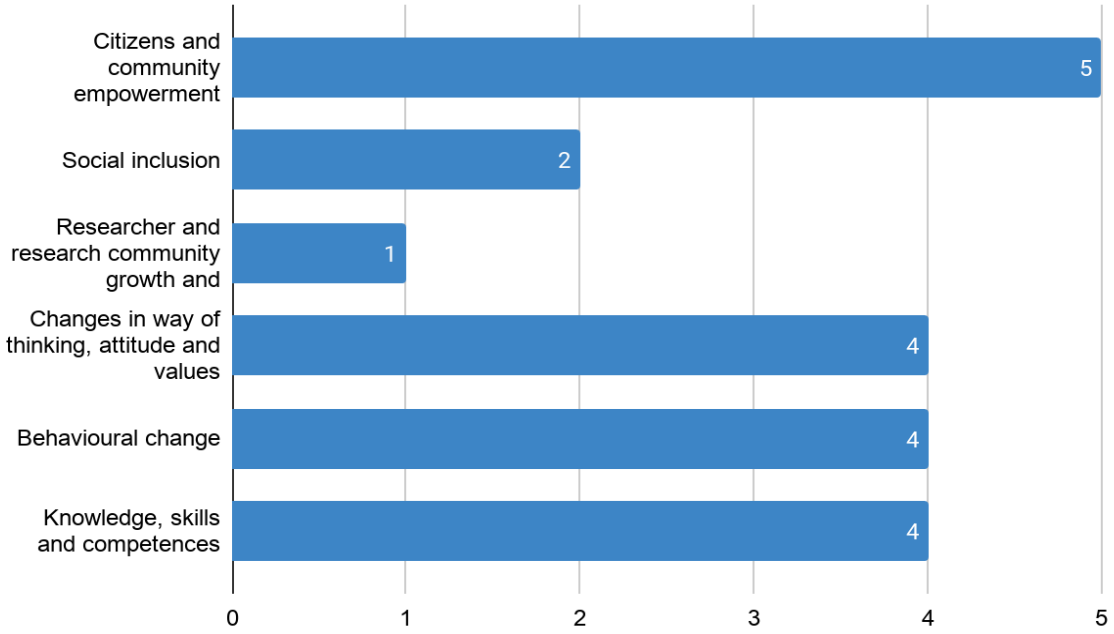


Fig. 50 Expected social impact In My Backyard

Citizens and communities empowerment

The project engaged 25 families through home visits which implied persons to show their backyards practices, answering a questionnaire and talking with CS project managers. 110 persons have been engaged through an online survey.

More people have been reached through capacitation and dissemination online and face to face events. Indeed, 689 persons participated in the 11 events organised during the pilot period; this includes also the persons engaged in the home visits and the same persons could possibly participate in more than one event. The project attracted the attention of specialised and mainstream media which added to the persons reached through social media and other dissemination events (European Week of Cities and regions, Citizen Science sustainable development goal conference) for a total of approximately 10.000 people.

Some of the participants knew each other already before the beginning of the pilot activities as some belong to local associations. The project didn't have a visible impact on the participants' social capital in terms of increasing the number or the quality of the interactions among participants but the atmosphere of the events has been reported as light and cheerful and the level of trust among participants was probably increased by the interactions and it also increased the trust of participants for the pilot leading organisation.

The pilot supported participants in increasing their self-perceived efficacy by providing them with new information and actionable solutions for sustainable home gardening that they were not aware of before.

Social inclusion

Social inclusion was not considered a relevant impact dimension at the time when the project managers filled in the ACTION impact assessment canvas, nevertheless some data are still worth to be considered. From a cultural point of view the participants are homogeneous, with only very few participants to the events with nationalities different from Portugues. Considering the gender dimension, in the home visits 19/20 out of 25 of persons were female, but they could be representing families with sons and husbands. Also participants in the online survey show a slightly higher percentage of females (58,2%) than males (41.8%) (see figure below)

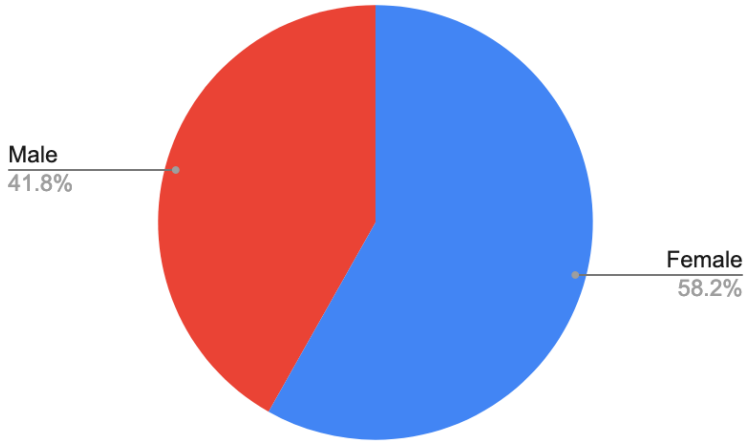


Fig. 51 Online survey respondents' gender distribution

Considering the participants' education level, as shown in Fig. 52, with reference to the respondent to the online survey, the majority have a high level of education (university degree or similar).

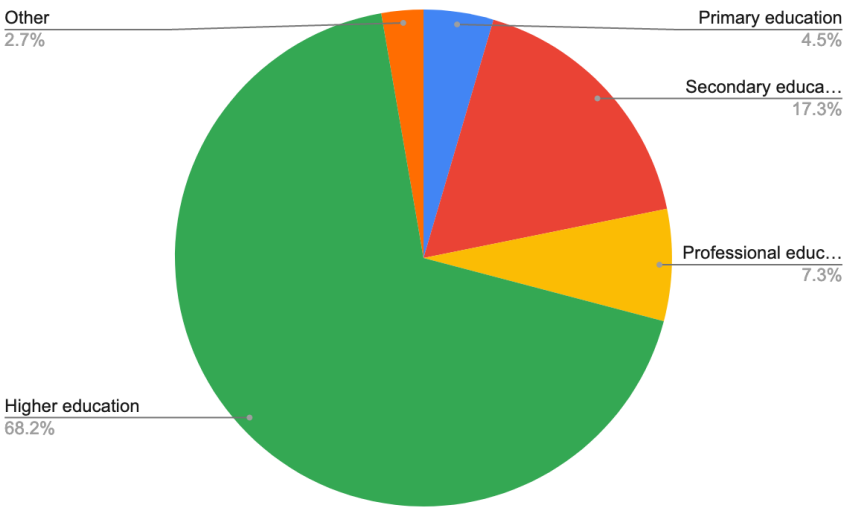


Fig. 52 Respondents' level of education

Considering the participants to the home visit, half of the respondents to the related questionnaire report to have a primary education degree, while the other half includes respondents with a secondary education and a higher education degree. However, only half of the persons engaged in the home visit provided information on this topic so these data should be considered as partial.

Knowledge skills and competencies

The workshops organised by the project team were the main occasion for learning and skill acquisition; indeed home visit follows an ethnographic approach aiming at observing the gardening proactive with a free-of-judgement profile. This supported the team in gathering the needed information; adding a "teaching" moment to the home visit would have risked losing volunteers' trust considering that some of them were already concerned by the possible criticism an environmental NGO could have on their gardening practices.

The pilot team reports two levels of impact: an increment in awareness and understanding for sustainable gardening practices and an increased technical capacity in sustainable pesticide self-production. On the first level it is interesting to report that some of the home visits made evident that people were using harmful chemicals without being aware of the related danger for health and for the environment. In addition, some of them were creating domestic recipes that actually pollute the soil without knowing it.

The pilot increased participants' interest and attention for the environment but did not have an impact on interest for science; scientific thinking indeed was not explicit in the workshop programs, but it was in the background.

Considering the impact on the project team, the accelerator was for them a new way of learning and doing, following the scientific principles of citizen science, which we have been ever since embedding in other two projects. The interaction with ACTION helped the team to better deal with uncertainties, especially taking into account we were using a citizen science methodology on the verge of 'current typified methods'.

Change in way of thinking, attitudes and values

From a point of view of values and orientation, most online respondents were already environmentally conscious, and this is probably due to the fact of using online surveying which engages people already into the topic of environmental impact. For the home site visit, a snowball sampling approach was used, but direct data gathering on this aspect was not carried out so that it is difficult to describe them from this point of view. The fact that some were worried about showing their practices to the pilot team could indicate that they weren't into environmental protection issues before the pilot, but more in depth analysis would be needed in this regard.

It is reported that most of the participants at the workshop left with new ideas on urban farming and gardening and a different attitude towards pesticides.

Behavioural change

We didn't carry out an ex-ante-ex-post analysis of the gardening practices of engaged families, but the CS managers, considering the interactions they had with volunteers, are confident that they were going to adopt more sustainable practices as a result of the pilot.

Economic impact

No direct economic impact has been registered but, after the participation in ACTION the team submitted three proposals and thanks to the new skills acquired they have managed to establish a new organisational dynamic. Thanks to this they carried out 12 projects in 2021, as opposed to 6 in 2020, before the ACTION accelerator. Indeed the team reports as a relevant impact of ACTION of capacitating small NGO, usually distant to bigger funding opportunities, and most importantly, usually distant to scientific and innovative approaches that could lead to higher economic impact.

Political impact

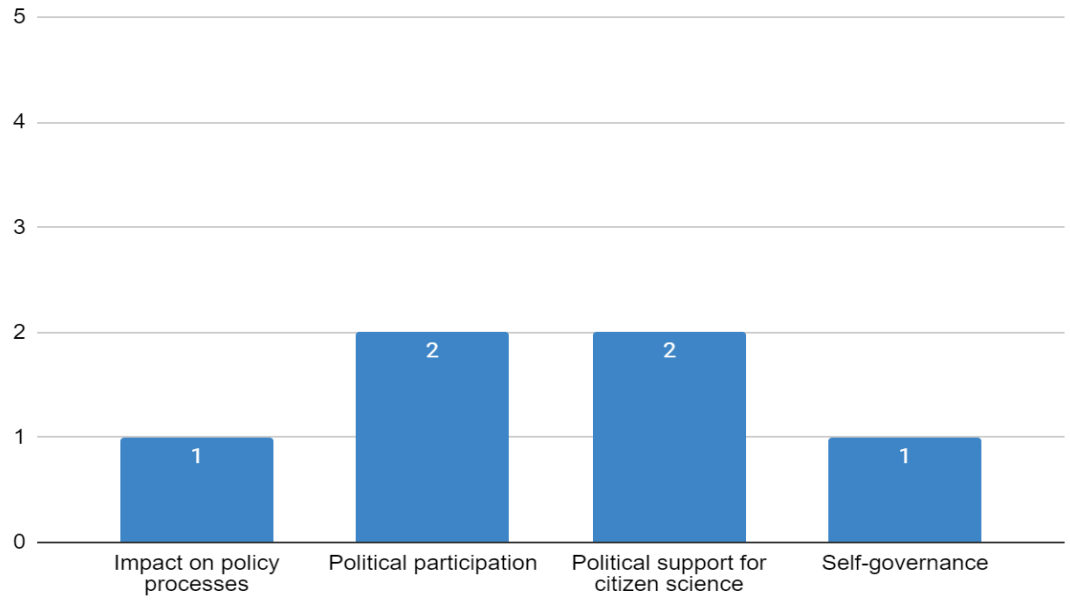


Fig. 53 Expected political impact In My Backyard as described in the canvas

In my Backyard had a positive political impact in terms of impact on policy processes, and political support for citizen science. This is higher than expected and continued after the end of the ACTION accelerator. Indeed, the team is now in a better position to discuss ideas and establish joint activities with the local authorities and have been working with the local municipality in two more funded projects.

Impact on policy processes

The In my backyard team has involved the municipal authority on environmental education as a partner in their project. Before, they never had projects together. The municipal authorities helped to develop the survey, because some data about people's behaviour are critical to them too. As a result, they have begun to change environmental policy in the municipality.

Political support for citizen science

Because of this collaboration, the municipality is now much more aware of citizen science. The team even had a meeting with the major, who now knows what citizen science is.

Transformative impact

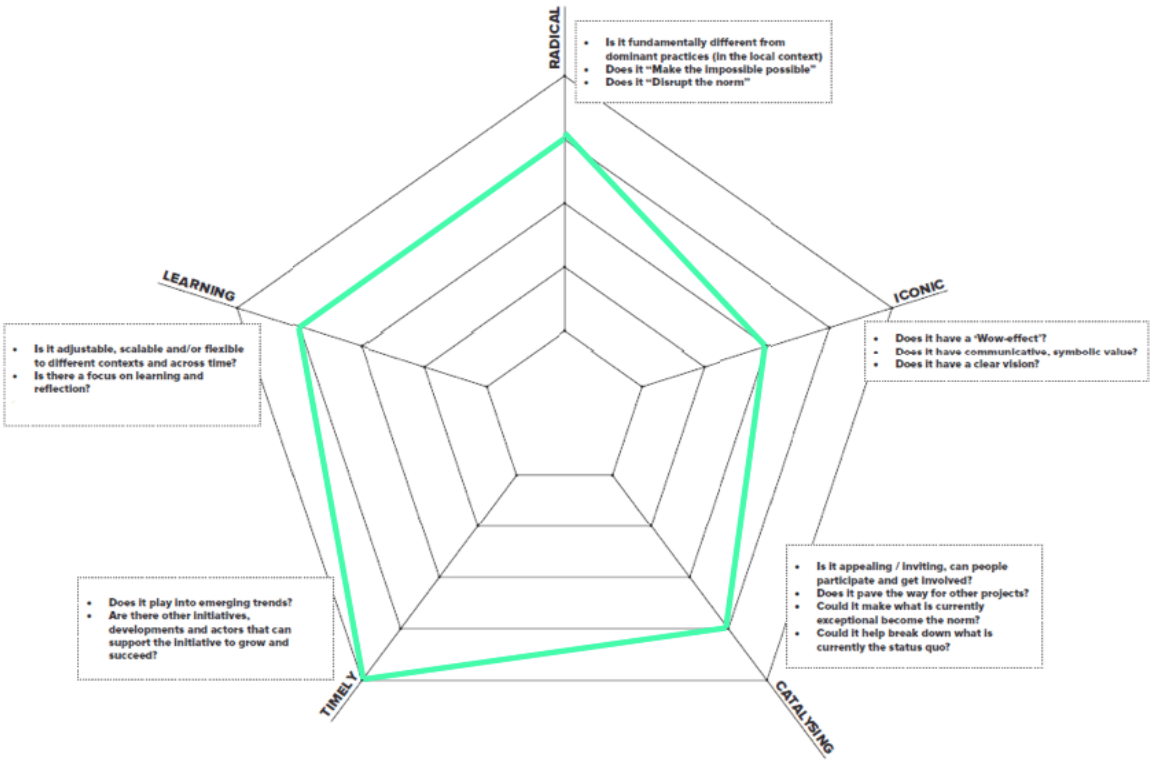


Fig. 54Transfortive potential of In My Backyard

In my backyard has a good transformative potential, with an average score of 4 out of 5. It scores 4 on **Radical**, because it has the potential to change behaviours, which are very different from current practices. The project scores 3 on **Iconic:** although it is difficult to score, everyone involved believes the project is interesting, important, and enjoyable. The project is **Catalysing** (4/5) in the long term. The next steps are to ensure replication in other places in an open way. The project is very **Timely** (5/5), because there is a lot of focus on the environment and on soil at the moment (for example in the European Green Deal). The project allows for **Learning** (4/5), in a way that the core and the principles and the openness can be used in other places.

Wow Nature

Territorial coverage: Po Valley (Italy)	**Type of pollution considered:** Air pollution
Revant SDGs 3 - good health and wellbeing, 11 - sustainable cities and communities, 12 - responsible consumption and production	

The Po Valley in Northern Italy has one of the worst air qualities in Europe, with many of its cities regularly surpassing the threshold levels for PM concentrations considered safe for human health. Trees can play a role in tackling this problem; indeed, studies all over the world are demonstrating the ability of trees in capturing PM, but evidence is needed at the local level. The project measured air pollution with innovative sensors within and outside urban forests in order to assess their efficacy as a mitigation measure for air pollution, facilitate their funding and educate and engage with citizens. Citizens have been involved throughout the project, participating in data collection and in co-developing solutions and policies proposals. Project activities included education and dissemination activities as well. The pilot is led by Etifor, a consultancy spin-off of the University of Padova. Data were gathered using Wiseair's air quality sensors in forests run by citizens' groups and organisations and financed through WOWnature, a web-based platform for forest finance anonymous with the pilot under analysis.

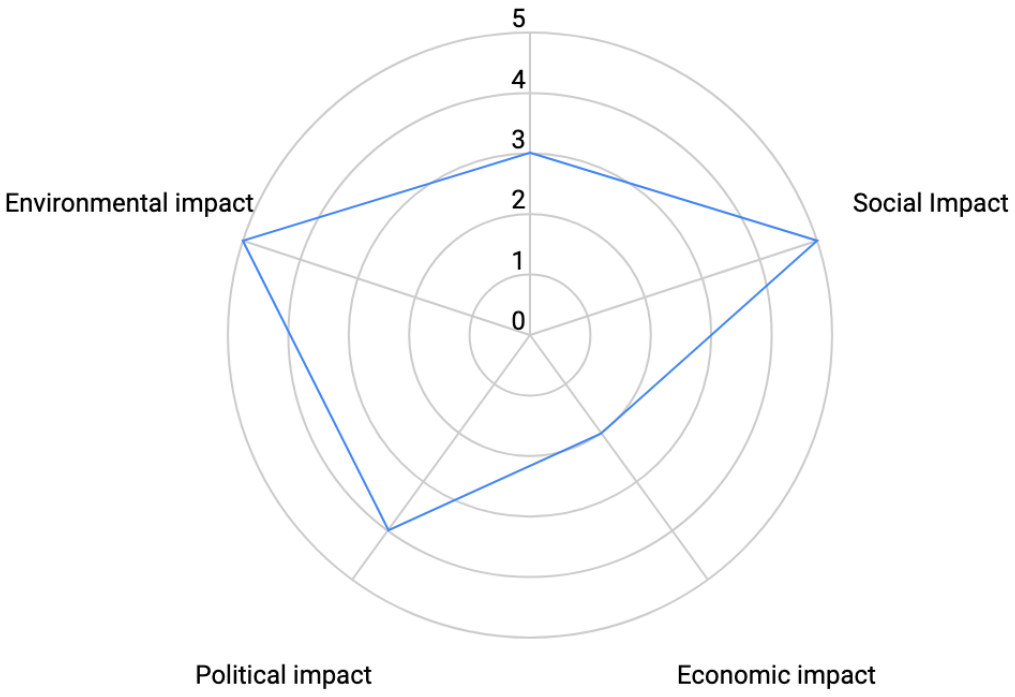


Fig. 55 Relevance of the areas of impact as in the impact assessment canvas

Scientific impact

WowNature has had a high scientific impact on knowledge in academia, new research fields and interdisciplinarity, and new knowledge resources.

Knowledge in Academia

The project generated a large **amount of data**: 50.000 data points. It also **published** a number of documents with their results - see the table below. The volunteers were well involved: they contributed to experiment design, data collection, safeguarding and substitution of damaged sensors, and dissemination of results. Volunteers were recognised for this participation in the publications.

Non-scientific publications	**6 (3 reports, 1 newsletter, 1 video, 1 blog-post)**

Tab. 17 Number of publications by WowNature

The data quality generated by WowNature is high, with 4 out of 5 indicators. The procedure for adapting the process of data collection was to check the data monthly to identify possible problems. In some cases, malfunctions were identified and some sensors replaced. The tasks were not difficult from a technical perspective, but reaching the sensors in the middle of the forests required considerable effort. Volunteers were well-trained: in person when the sensors were placed at the beginning of the study, then they were provided with a manual (pdf format) with step by step instructions, and they were also sent an email summarising the main steps to be carried out. Data procedures are systematic: Data were automatically collected by sensors and were to be retrieved with the same procedure each month. The equipment used for measurements is standardised and calibrated across volunteers. The project did not record relevant metadata.

The **openness of data** scores well: 3 out of 5. The dataset is published on Zenodo. The data is available as machine-readable structure in non-proprietary format.

The data has medium to high compliance with the **FAIR principles**. The data is Findable (3 out of 5), because they are published on an open access repository (Zenodo). The data is Accessible (5 out of 5), because anyone can access it anytime. The data are not very interoperable (2 out of 5): they are not integrated with, for instance, data collected by local meteorological stations. The data are Reusable (3 out of 5), because anyone can use the data to perform other kinds of analyses (e.g., effect of predominant winds, etc.)

New research fields and interdisciplinarity

WowNature is somewhat interdisciplinary: the project and its results link the forestry science with issues related to air pollution, people wellbeing, and urban planning.

New knowledge resources

The project facilitated knowledge creation among societal actors and groups: this knowledge was possible only with the support of different societal actors and groups (NGOs, public representatives, businesses, associations, etc.)

Social impact

28 citizens were engaged in scientific activities, specifically 20 in experiment design and 8 in data collection. Additionally, 20 people were involved in two awareness raising/dissemination events, one organised before the pandemic period during the placement of sensors to explain forests' benefits, and others online during the pandemic period. In addition, several people have been reached on social media, including 7500 with the live stream during the placement of sensors, 5700 with the final video, and others through social media posts.

Citizen scientists had a good interaction with each other. Indeed, they came all together for the experiment design and placement of sensors, and they also interacted (usually in couples) to download the data.

The project did not foster the creation of new groups at the local level, as some consolidated groups already existed; however, it was useful for citizens to have the chance for meeting each other. The project was also able to improve the citizen scientists' self-efficacy. Indeed, by being engaged in this new topic, in particular after the moment when participants had to change their way to actively participate in the NGO's activities due to the pandemic, the pilot reinforced their connection with the people within the NGOs and their trust on their skills to keep on working for environmental protection.

We have administered a survey to local organisations that have collaborated with Etifor in the Wow Nature project; the aim was to understand the impact of Wow Nature on the organisations' activities. Two organisations reported to have had political impacts thanks to the project, including grant hunting for urban forests and a renewed attention for the role of forests as carbon storage and filter from road pollution. Organisations also responded that WoW Nature supported them in creating new communication and information material that can be used for future activities. In particular, WoW Nature supported the organisations in monitoring aspects of sustainable economy, as well as provided organisations with data useful to understand the ecosystem service potential of the forests and with baseline data for future activities of the organisations. In addition, WoW Nature also represented for these organisations an occasion to create new collaborations, including partnerships with local institutions about climate change mitigation in infrastructure and monitoring and raising awareness of environmental issues.

A strategy for social inclusion was applied, by engaging all the groups having a stake in the forests regardless of their status and interests, including therefore environmental NGOs, businesses, local associations, and so on.

Thanks to the project, a new collaboration was established with other organisations working on a similar topic, and called Wiseair.

Considering the impact on the project team, on a 1-5 range, the pilot had an impact on knowledge, skills and competences equal to an average of 3.5, with higher value (4) for citizen engagement, output communication and dissemination, and valorization of project results (including interaction with decision makers). Considering now the impact of the project on the citizens engaged in the activities, we administered a questionnaire and gathered 8 answers. We asked respondents how

much the project increased their skills and understanding about scientific knowledge on a range 1-5. All respondents value most of the questions with a 5, with an average of 4.

According to the project team, the project had an impact on participants' way of thinking, attitudes and values, as by creating additional evidence, it contributed to strengthening some values and ideas that were already rooted in them (importance of forests, interest on air quality issues, etc.). This is confirmed by the volunteers' survey results: indeed the majority of respondent didn't change they ideas on air quality and environmental issues as they were already aware of the issue and engaged in the topic, but 3 out of 8 of them have changed their behaviours in order to reduce their impact on the environment and their exposure to air pollution.

Participants also declared that thanks to the project they created new social links, that these new interactions are characterised by diversity in terms of age, level of education and and/or social cetus so confirming the success of the inclusivity and diversity management strategy pursued by the project team. The activities also increase the trust of the project team, for the local community and for other participants. All of these, even if the number of answers we got in the volunteer survey is lower than that of participants (8 of 22) is a positive result in terms of impact on social capital.

In addition, the activity also led the respondents to be more involved into civic society and being engaged into community life and organisations.

Economic impact

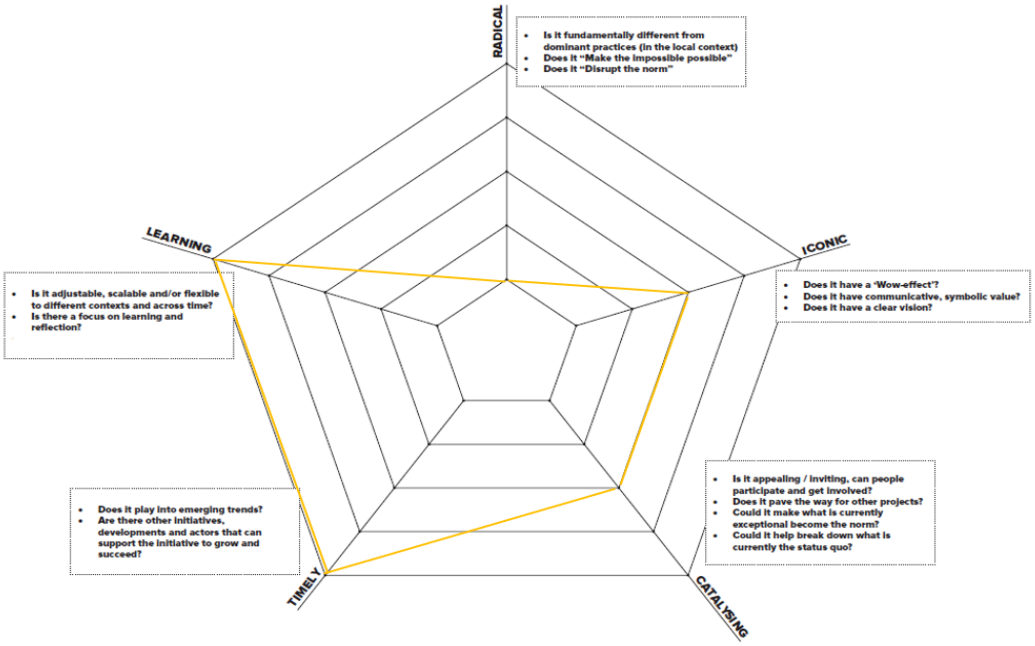
The pilot is in a good position for achieving positive economic impacts on the local community. Indeed, it is expected that the results of the project increase the willingness to pay for forests' creation and/or maintenance of donors/investors (e.g., private companies, municipalities, etc.). In this regard, some funds have already been collected for the forests involved in the pilot.

Political impact

Impact on policy processes

WowNature raised political awareness on the benefits of forests and trees as an effective mitigation measure for air pollution, especially in proximity to roads or similar sources of pollution The team did this by including some people of the local municipality as volunteers and by trying to raise their awareness on the topic. Furthermore, the project worked together with many external organisations that were made aware of the benefits of forests and trees, including the municipality of Vicence, a kindergarten in the forest, as well as an environmental education association who will now include air pollution in their education.

Transformative impact



Tab. 18 Transformative potential of WOW Nature

The project has a medium to high transformative impact, with an average score of 3,5 out of 5. The project is not **Radical** (1) is not creating something new - forests, and the benefits they provide, have been around for ages. Rather, the project is about adding knowledge on these benefits (especially at the local level, where they were missing). The project is **Iconic** (3): the project dealt with trees, which are "trendy" and "wow" at the moment, highlighting one of the benefits they provide which is seldom known by people. The project is **Catalysing** (3), but it could have been made easier for citizens to participate. The project is very **Timely** (5), because trees and forests are related to several global agenda targets and EU policies (e.g., climate strategies, green new deal, biodiversity policies). Last, the project scores very high on **Learning** (5) because the project is scalable and can be easily replicated everywhere there is a forest.

ReStart Data Workbench

Territorial coverage: Worldwide	**Type of pollution considered:** Soil pollution, waste reduction/management
Revant SDGs 11 - sustainable cities and communities, 12 - responsible consumption and production	

Restart Data Workbench is run by The Restart Project and addresses the global dimensions of pollution and consumerism, including the impacts of our take-make-throw economy.

Many imported goods indeed have really short lifespans, which the Restart project tries to extend at their community repair events. Around 80% of a small electronic devices' carbon footprint is emitted before it even reaches European shores, therefore the pilot aimed at understanding what happens if we can use our goods for longer by fixing it, in particular if these products are impossible to repair by design, and which are the real impacts of this on the environment and on people across the planet.

The pilot engaged the repair community and organised online microtasks to analyse data about attempted repairs as emerging in the community repair events, in order to investigate the environmental impacts of the products repaired and to use results to influence policy discussions. The pilot launched specific activities such as "TabiCat", a fun opportunity to collaboratively analyse data on over 900 tablets brought to repair events around the world, and BattCat, a people-powered investigation into why devices with battery problems can be so difficult to fix.

Scientific impact

Knowledge in Academia

ReStart has had a high scientific impact on knowledge in academia. The project generated a large **amount of data**, with 13.444 data points across two datasets, one with environmental data, and another with microtask data. It also **published** a number of documents with their results, and contributed to an environmental impact measuring tool - see table below. For both the environmental data and microtask data, participants were responsible for sourcing or providing 100% of the data produced by the project. In the case of our microtasks, this data was itself an analysis of existing source data. In both cases, the core project team led on the final analysis and dissemination of the project data. Participants were **credited** in all communications about the project results/outputs and in the case of the environmental data, directly in the source data file itself.

Non-scientific publications	**6 (4 articles, 1 tool, 1 blogpost)**

Tab. 19 Number of publications by ReStart

The data quality generated by ReStart is very high, with a positive rating on all relevant indicators. The procedure for adapting the process of data collection was as follows. For both datasets the team worked closely with participants, gathering feedback and offering support. They were able to adjust how the project was run dynamically according to the needs of participants. The environmental data part of this project was challenging, but the microtask element was more simple. For the environmental data part of this project the team spent a lot of time with all the participants providing information, guidance and advice about the task. Training for microtask work changed over time, and ranged from some guidance in the beginning, to clear and easy guidance in the end. Where applicable, all relevant metadata was collected.

The **openness of data** scores are very high: 5 out of 5. The dataset is published on Github, the project website, and on a general repair data website. The data is available as machine-readable structure in non-proprietary format, follows the Open Repair Data Standard, and links to other datasets to provide context.

The data has high compliance with the **FAIR principles**. The data is Findable (4 out of 5), because all data are described by metadata where possible and relevant and are presented on multiple pages indexed by search engines. The data is Accessible (4 out of 5), because all data are available via multiple permanent links. Metadata and prose descriptions are provided to give context and help the viewer understand the sources, nature, format and purposes of the data. The data are interoperable (4 out of 5): all data are available in non-proprietary formats accessible via any web browser and can be viewed with free and open source software and reference external (meta)data when required. The data are Reusable (5 out of 5), because all data are licensed under a Creative Commons Attribution Share-Alike 4.0 licence and microtask data are additionally compliant with the Open Repair Data Standard.

Social impact

Community building and empowerment

300 citizens have been engaged in the project activities, including data collection, data analysis & project design. Meanwhile, 2 people have been involved in raising awareness/dissemination events. In addition, 3 raising awareness/dissemination events have been organised, with 80 participants. For the project activities related to the Life Cycle Assessment (LCA) analysis, weekly online project meetings were organised to catch up with all participants and share progress, address challenges and coordinate activity. For the microtask projects, participants were instead encouraged to share questions and feedback via the pilot online community platform. An online community social event was also run to work together on a microtask. In addition, over 8000 people have been reached on social media through different means.

The project improved the citizen scientists' self-efficacy. Indeed, the LCA data project demonstrated that it is easy to reach the limit of publicly available information about the environmental impact of consumer products. Therefore, making participants able to expand the available information in a meaningful way, is necessary. Since completing microtasks, there are new stories to tell about how this data can be used to promote pro-environment repair in the policy agenda.

Social inclusion

A dedicated strategy for social inclusion was applied. Specifically, a recruitment strategy was implemented in three parts: 1. Blanket recruitment calls via community, social media and email lists designed to be as accessible to as many people as possible (using plain English, avoiding jargon, using strong calls to action etc.); 2. Identifying and approaching individuals and organisations that might be interested and were underrepresented in the wider efforts; 3. Working with partner organisations to reach their communities (e.g. in other countries). This allowed, for example, to have a rate of 33.3% participants in the LCA project coming from underrepresented groups, with a male and female being equally represented at 50% each. A survey on volunteers was also conducted. Out of 5 respondents, 3 (60%) were male and 2 (40%) female. 4 respondents (80%) were of UK nationality, while one had Australian citizenship. 3 of them had a bachelor degree, with one holding a doctorate and one a vocational training course.

Knowledge, skills and competences

On a range 1-5, the pilot had an impact on knowledge, skills and competences of the team equal to an average of 3.1, with higher value (5) for data curation (open data, FAIR principles, etc.).

We have also asked volunteers to describe their takes out in terms of increment in understanding of the scientific process and methods in relation to the project. Out of 5 respondents, 3 reported to have already a good understanding of the scientific process, while 1 was already an expert.

We also asked volunteers if they had participated in other citizen science projects or in scientific activities before, and the majority responded they had already participated.

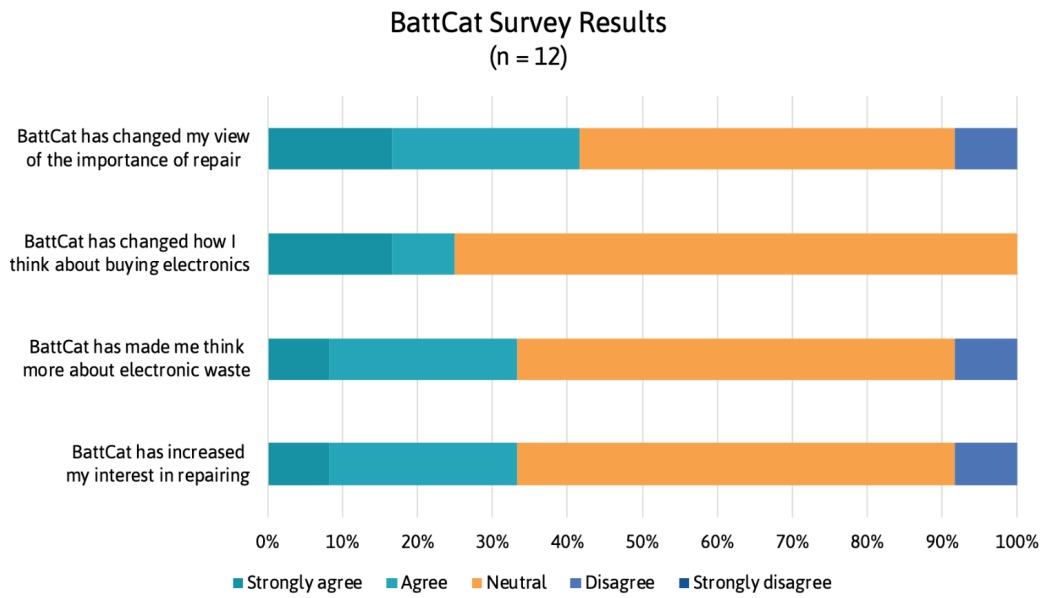
Finally, we also asked if volunteers had previous experience with the carbon savings of electronic repairs. 2 had previous experience, while for one participant it was the first time.

We also asked volunteers whether participating in the project had an impact on their skills and competences and, more generally, on their motivation and interest for science and the environment. On a scale 1-5, most of the respondents generally provided responses higher than 4.

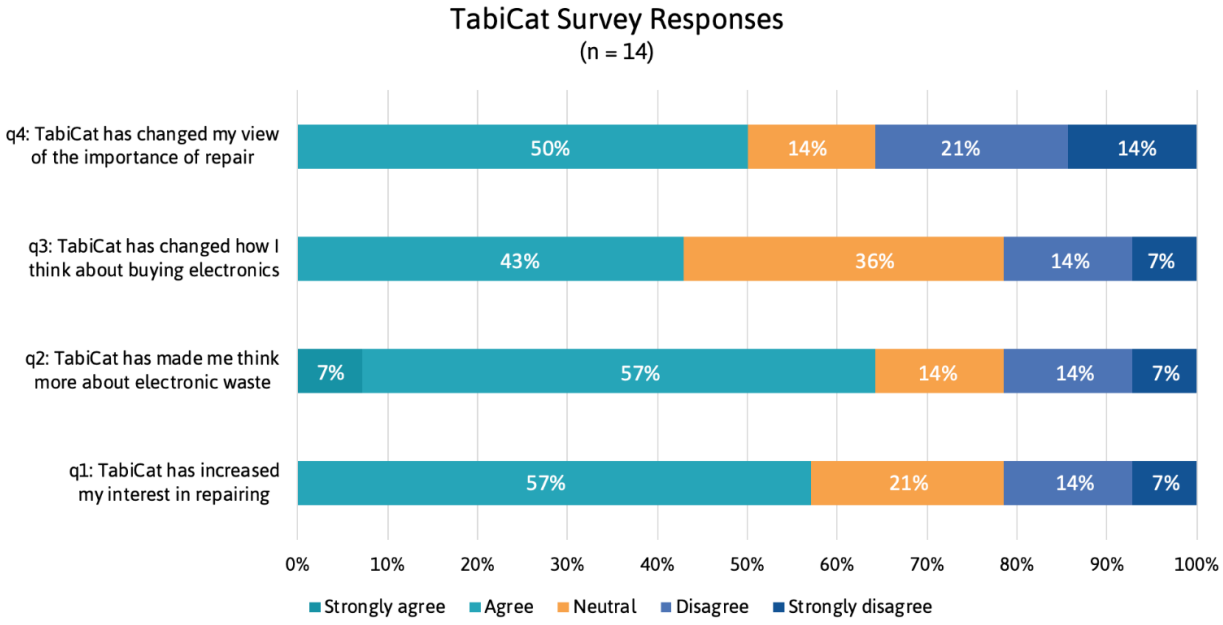
We also asked if they would participate in the future into CS projects, and all of them answered positively.

Changes in way of thinking, attitude and values

ReStart also contributed to changing the way of thinking, attitude, and values of participants. The tables below report a survey with declared changes from participants to the microtask activities (called BattCat and TobiCat). For example, while for both surveys in all the four questions on changes there is a large part of neutral respondents, almost 40% of the respondents in the BattCat and over 50% in the TabiCat survey agree or strongly agree on the contribution of the activity in changing their view on the importance of repair. Similarly, over 30% in the BattiCat and 57% in the TabiCat survey agree or strongly agree on the contribution of the activity in letting participants think more about electronic waste or in increasing their interests in repairing.



Tab. 20 Behavioural change (BattCat volunteers)



Tab. 21 Behavioural change (TabiCat volunteers)

These should be considered positive results considering that most of the participants were already interested and/or engaged in the repair/waste management topic, show pro-environmental behaviours and way of thinking.

Behavioural changes

There have been behavioural changes among participants in ReStart; indeed, many of them reported that they would be more likely to consider repair when devices break (as opposed to buying a new replacement) in the future.

Economic impact

The number of hours volunteers dedicate to the project are 150 with a value of 2,820 EUR, while the number of hours dedicated by the team to citizens' engagement and support is equal to 40, therefore to 752 EUR. In this sense the cost saving for the team is positive, showing the good potential terms of time/cost saving of applying microtask in CS projects as done by this pilot.

Political impact

Impact on policy processes

ReStart has had some impact on policy processes and more will have in the future. The team was invited to an EU policy meeting about upcoming regulations for smartphone repairability. Using the data emerged by the pilot, they were able to correct false claims made by a lobbyist representing big tech firms. This will hopefully help with devising better repair rules and policy at EU level.

Environmental impact

The project has indirect environmental impact. By contributing knowledge to the repair community, the products will be easier to repair, leading to less waste and emissions for manufacturing new products. Furthermore, by calculating the environmental impact of different products, repair can be even more efficient and targeted. By pushing for policy change, the project might also increase its environmental impact in the future.

Transformative potential

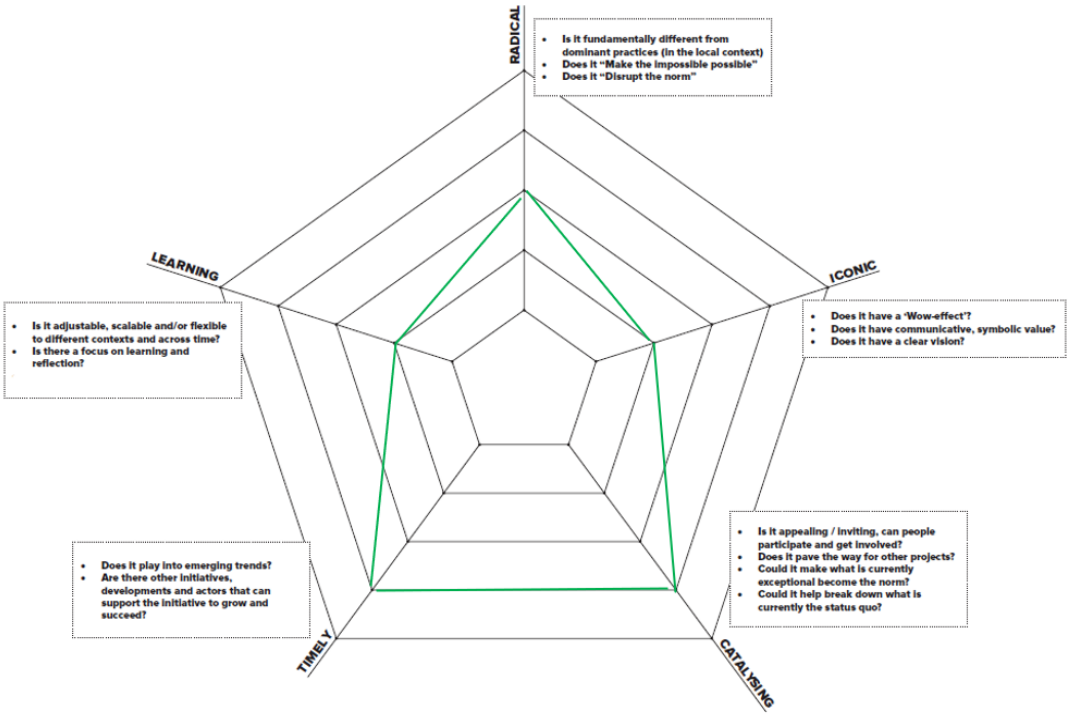


Fig. 56 Transformative potential of ReStart

The project has a medium transformative impact, with an average score of 3 out of 5. The project is **Radical** (3), because in most of Europe and North America, the default response to a product breaking tends to be to replace it with a new one. The project aimed to challenge this attitude. The project is somewhat **Iconic** (2): for many, the link between consumption and greenhouse gas emissions is not obvious. The project aimed to challenge this by telling a clear story about where our products come from and why systemic change is needed to change our relationship with the things we buy.The project is **Catalysing** (4), because it aimed to open up access to this work to ask many people as they could, by inviting them to explore our community-sourced data through online microtasks. The project is **Timely** (4), because the issue of consumption emissions has never been more relevant, especially given the high-profile coverage of the climate crisis throughout 2021. And yet, consumption emissions is still an area that is under-discussed/reported. Last, the project allows for some **Learning** (2), because through the microtask methodology developed, they can now respond more dynamically to upcoming policy opportunities, allowing them to target and scale their work more effectively.

Water Sentinels

Territorial coverage: Sado river estuary areas (Portugal)	**Type of pollution considered:** water pollution
Revant SDGs 4 - water education, 5 - gender equality, 13 - climate action, 14 - life below water	

"Water sentinels" is a community project that empowers people from coastal communities to play a role as citizen scientists for water quality.

This project is rooted with the wider aim of the conservation and restoration of seagrass meadows in the Sado Estuary area (Portugal) and is promoted by OceanAlive. The pilot engages 20 citizens from the fishing community to detect pollution events (historical and current) that may have been failing to be detected with the current water monitoring networks. Through dedicated training, participants have collected data on water quality in the Sado estuary. These data are now available to the public through the pilot lead organisation website and on the COASTNET geoportal.

Two scientific partners are involved in this pilot: Centre for Energy and Research (CINEA, Polytechnic Institute of Setúbal) and MARE Marine and Environmental Research Centre (University of Lisbon). Together with historical information obtained from questionnaires, "Water sentinels" provides valuable information to researchers, managers and decision-makers. The project also engages relevant stakeholders in a water quality workshop. A community guide for water quality assessment, a layman's report and a video have been produced as tools to enhance engagement and participation of other community members on water quality assessment.

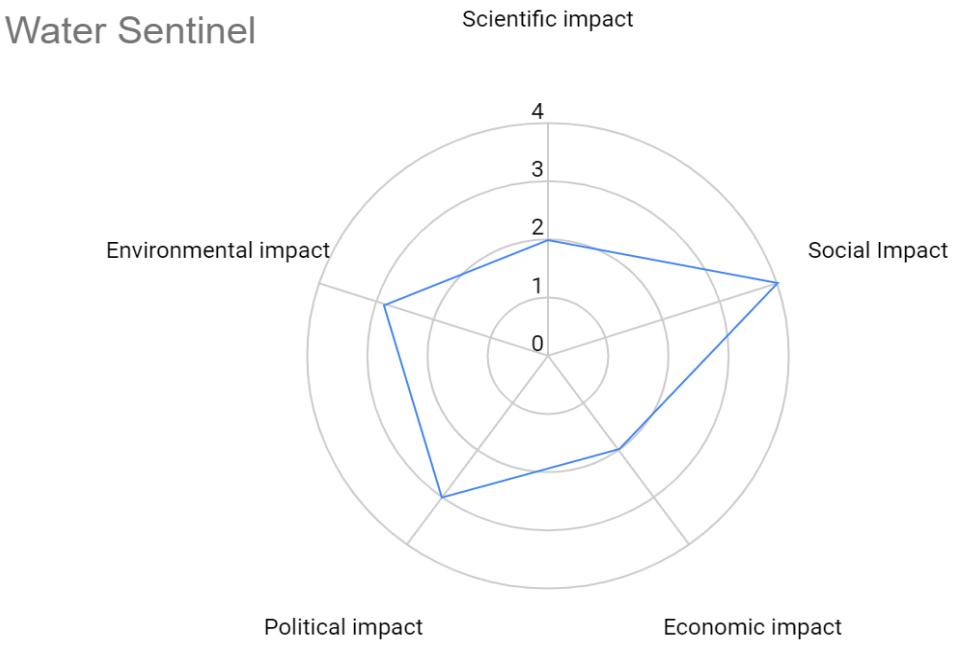


Fig. 57 Relevance of the areas of impact as in the impact assessment canvas Scientific impact

Water Sentinels have had a scientific impact on knowledge in academia, and new knowledge resources.

Knowledge in Academia

The project generated **data**, which consisted of 18 water samples and 21 questionnaires. It also **published** a number of documents with their results and about the project - see table below. The citizens did not contribute to the scientific output, and could not be publicly acknowledged due to privacy issues.

Non-scientific publications	**3 (1 report, 1 community guide, 1 video)**

Tab. 22 Number of publications by Water Sentinels

The data quality generated by Water Sentinels is adequate, with 3 out of 5 indicators. The procedure for adapting the process of data collection was as follows: during the protocol development and citizens training for sample collection and water analysis, a feedback loop between citizens, project promoter and scientific team allowed to minimise errors. The tasks for volunteers were not too hard, and they were trained by the project team at an individual level, so their training was effective. Data procedures were not systematic, because they needed to be adjusted to each individual's skills. The equipment used for measurements was not standardized and calibrated across volunteers, but the project did record relevant metadata.

The **openness of data** scores well: 3 out of 5. Results from water sample analysis are available through Zenodo and will be on Coastnet online platform. However, historical data will not be made openly available, since it raises privacy and sustainability issues. The data is available as machine-readable structure in non-proprietary format.

The data has high compliance with the **FAIR principles**. The data is Findable (4 out of 5), because It is available on the project website, Zenodo and will be also on Coastnet (different target public); communication will be made on social media to share these locations. Tags/keywords will be added to promote make data findable for search engines (like google). The data is Accessible (3 out of 5), because the data is presented in English, to enhance its use by researchers. Although it will be easily accessible for people with scientific understanding, good English and digital skills, it is not easy to understand or access for people out of this range. The data are interoperable (4 out of 5): the metadata files were created using GeMA software by recommendation of the national General-Directorate for the Territory (DGT). The data are Reusable (5 out of 5): the project attributed a creative commons licence (CC BY 4.0) to the data.

New knowledge resources

The project scores very high on easing access to traditional and local knowledge resources. By working closely with local communities, one of the project's strengths is to provide access to their ecological traditional knowledge and local knowledge. This was achieved by training local people to perform water sampling, and including them on the sampling design decisions. Also, one of the project's tasks was accessing community perceptions and local knowledge through surveys. Furthermore, they facilitated knowledge creation between citizens and researchers, and also raised awareness on water quality among stakeholders.

Social impact

Community building and empowerment

In terms of project activities, 5 citizens were engaged in training for water sample collection (but only 4 succeeded to participate by collecting samples) while 21 citizens were engaged in activities to evaluate perceptions towards water pollution and collect historical data about water pollution locations. Meanwhile, 4 citizens were included into scientific activities that include data collection (water sampling) and sampling strategy design. 3 people from the community and 3 students were also involved in the development of the pilot video.

One awareness/dissemination event was organised, with 20 participants.

Several people have been reached on social media through different means. 5 posts on social media got a total of 19,375 views, including 12,708 on Facebook, 4,845 on Instagram, 1,781 on LinkedIn, and 41 on YouTube.

The project improved the citizen scientists' self-efficacy. Indeed, by being engaged in this new topic and at the time when they had to change their way to actively participate in the NGO's projects (due to the COVID-19 pandemic), this pilot reinforced the connection of the participants with the NGO, as well as their trust on their skills to keep on their work for the estuary protection.

Social inclusion

In terms of class age, 21 people answered the questionnaire. 71,4% of the respondents are male and 28,6% are female. In terms of class age, 4.8% people are in the class 21-30, 9.5% in the class 31-40, 23.8% in the class 41-50, 33.3% in the class 51-60 and 28.6% are >61 years old. In terms of education, 38,1% had 4 years of education, 19% six years of education, and 28,6% nine years of education. 9,5% completed the 12 years of education, and 4,8% had a university degree.

As the above-mentioned data illustrate the project was very successful in engaging a community that, due to age and educational level characteristics, is usually difficult to engage in scientific activities and this was possible for the long-lasting activity that the project team has in working with the local community and should be considered a positive impact in terms of social inclusion.

Knowledge, skills and competences

On a range 1-5, the pilot had an impact on knowledge, skills and competences equal to an average of 3.65. The highest score 5 has been reported for the impacts on the team in terms of Data curation.

Meanwhile the highest score was also recorded for the new competences of the volunteers in terms of scientific tools (for example environmental monitoring protocols), scientific knowledge (e.g., data gathering and data analysis), and specific knowledge on water issues.

The activity carried out on water sampling provided volunteers with new competences in the use of scientific tools, e.g. the water quality sample kits. The activity carried out also improved the volunteers' scientific competences, including data gathering and data analysis, and their knowledge about water pollution and related issues. In addition, the activity improved the volunteers' 'motivation and self-esteem, as participants reported improved knowledge about this issue.

In addition, it also increased their motivation and self-valuation for acquiring new skills. Since the pilot happened after a period of slow down on NGOs activities, all participants became more active and wanted to act on different topics, including raising awareness on others. This is still more relevant if we consider that although participants have low scientific literacy, they showed interest in seagrass conservation and water quality, and were motivated to improve the local ecosystem. Given their motivation to act and learn new things, these participants were also selected to be included in the "umbrella" project "Keepers of the sea". Indeed, when participants had to face a new challenge that can bring new skills and new ways of collaborating with science, they were happy to work with the team and do their best to fulfil what they were asked for. Also, given their trust in the research team and that they knew the team was open to their inputs, participants were happy to give their thoughts to do things in the best possible way.

Change in attitude and values

The project had an impact on participants' way of thinking, attitudes and values, as they revealed to be more aware about water pollution events and related issues.

Behavioural changes

No specific behavioural changes have been reported among participants, although the pilot has certainly reinforced awareness and triggered people to act, after a period of slow down on the activities (namely about marine litter).

Economic impact

There is the possibility for the pilot to achieve economic impacts for the local community in the long period. Indeed, by training people with these new skills, it is possible (but not highly probable in the short term) future opportunities will arise to bring some economic revenue in other collaborations. Also, by having these new skills, participants may be able to share them with students on educational activities (which generate revenue for members from the community who work with the team).

Political impact

Impact on policy processes

Water Sentinels has had some impact on policy processes. The team raised concerns about water pollution in a meeting with a candidate for the elections of the local government, who manifested clear interest, and suggested a follow-up scientific event on the topic to be held. The team also

organised an online workshop for stakeholders and invited local and national decision-makers related to this issue.

Transformative potential

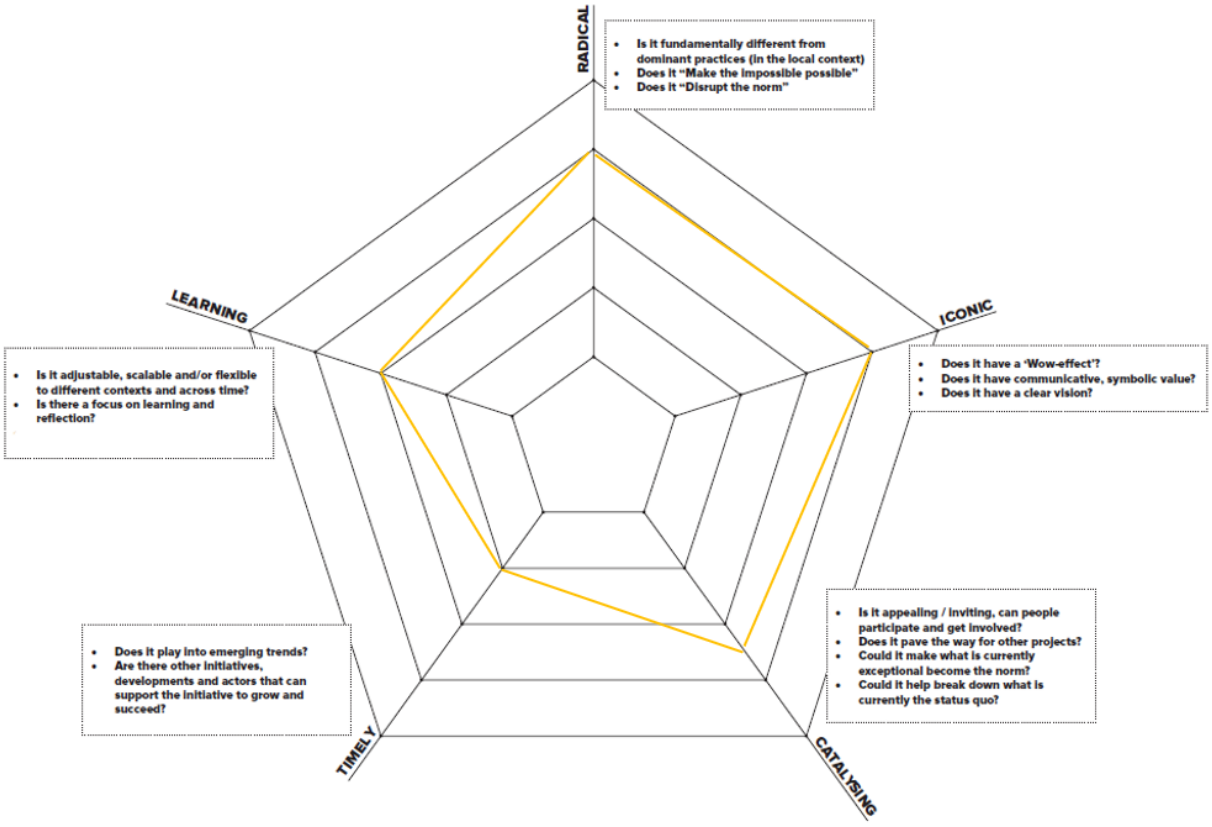


Fig. 58 Transformative potential of Water Sentinels

The project has a medium to high transformative impact, with an average score of 3,3 out of 5. The project is **Radical** (4), **Iconic** (4), **Catalysing** (3,5), somewhat **Timely** (2), and allows for some **Learning** (3). Unfortunately the project team did not provide explanations of these scores.

Open Soil Atlas

Territorial coverage: Berlin (Germany)	**Type of pollution considered:** soil pollution
Revant SDGs 11 - sustainable cities and communities, 13 - climate action, 15 - life on land	

Open Soil Atlas created an open-source co-learning centre for the local community of Berlin. It consists of a website presenting guidelines in a textual and infographic form to educate the public and raise awareness about soil quality and fertility and the correlation between healthy soil and healthy communities. The online material was combined with a series of free workshops, where citizens have been taught how to make observations, test the soil, interpret results and draw conclusions. Soil quality data and GPS locations were then uploaded to a digital entry form.

Citizens' observations generated a high-resolution soil quality map. Findings from this pilot also provide policymakers and urban ecology initiatives with indicators as to which areas are best suited for agricultural purposes and which require remediation activities. The entire research and data collection process can then be replicated and expanded worldwide, in order to engage different communities and spread the analysis to new and different sites all over the world. The project builds on the Feld Food Forest project and is promoted by its community.

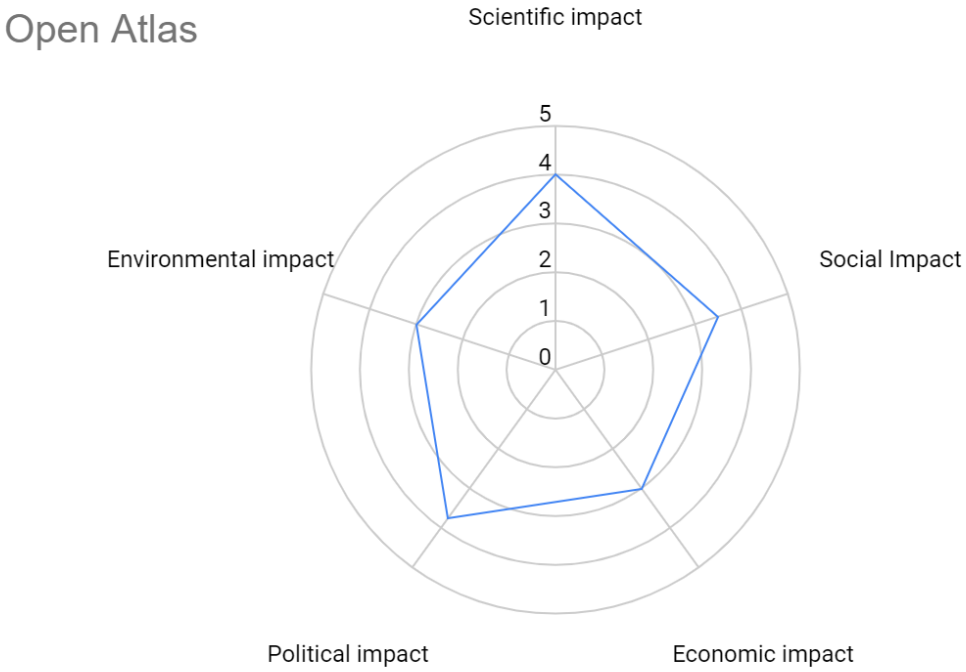


Fig. 59 Relevance of the areas of impact as in the impact assessment canvas

Open Soil Atlas has had scientific impact on knowledge in academia, new research fields and interdisciplinarity, new knowledge resources, and innovation in education.

Knowledge in Academia

The project generated **data**, 121 data points. It also **published** their insights - see table below. Apart from being part of the data collection process and implementation of the tools, some volunteers also participated in the elaboration of the final paper and the general understanding of the collected data, and were acknowledged for this.

Non-scientific publications	**2 (webinar, paper)**

Tab. 23 Number of publications by Open Soil Atlas

The data quality generated by NoiseMaps is high, with 4 out of 5 indicators. The procedure for adapting the process of data collection was based on feedback. The tasks for volunteers were not easy, but volunteers received extensive training. Data procedures are systematic, the equipment used for measurements is standardised and calibrated across volunteers, and the project records relevant metadata.

The **openness of data** scores well: 3 out of 5. The dataset is published on Epicollect. The data is available as machine-readable structure in non-proprietary format.

The data has medium compliance with the **FAIR principles**. The data is Findable (2 out of 5), because it is available on Epicollect and the project website. The data is Accessible (3 out of 5), because the data use a simple language (accessibility to citizens) and relate to standard categories for soil science (accessibility to academica). The data are interoperable (2 out of 5): while not giving direct links to other data sources, the data can be easily interoperated in combination with other data sources (e.g. open street maps), through GIS technique. The data are Reusable (2 out of 5), because the data are clear and simple for any user. The data collection procedure is clearly described on our platform and could support people while reusing the data..

New research fields and interdisciplinarity

Open Soil Atlas is strongly interdisciplinary: it combines insights from soil science with anthropological and social aspects (engagement and empowerment of citizens, informal education, EDI, community building).

New knowledge resources

The project eases access to traditional and local knowledge resources and facilitates knowledge creation among societal groups, by engaging gardeners and practitioners in the knowledge sharing and knowledge generation process. The project tried to build a network of expertises, working together to inspire and educate people on specific (e.g. specific indicators of soil quality) and more

general topics (e.g. composting). Important was also showing citizens what the problems were and how people are actively coming up with solutions. In this way the project raised awareness, inspired transformation and connected people with each other and with their environment.

Open Soil Atlas also created new data-gathering tools: the soil testing protocol that was developed allows for the collection of very specific and detailed data on a very high scale. This process is not affordable for the academic field and fits the citizen science approach perfectly.

Innovation in education

The project created innovation in educational or training methods. The project developed informal education approaches, targeted to people from whichever background. The mutual learning-and-teaching approach worked well: people started as learners and quickly became trainers for other participants. That motivated them to learn and gave them the possibility to generate knowledge in a team, while supported by experts.

Social impact

Community building and empowerment

171 citizens were involved in project activities, out of them, 140 participated in scientific activities, specifically in data collection, development of the tools, data curation and analysis, elaboration of the results, and knowledge sharing. 25 raising awareness/dissemination events were organised and 5000 people have been reached on social media through different means.

Citizen scientists also had a good interaction with each other; they were able to conduct mutual training, share interesting material, and mutually support each other in the data collection process. In addition, the project did foster the creation of new local groups, like the Telegram group that counts 59 members and is a space for sharing ideas, organising other activities (e.g. workshop), food sharing, etc.

The project also enlarged local communities, as for example the Feld Food Forest community that got new people joining; other initiatives (e.g. community gardens) got advertised and saw more people joining. The project improved the citizen scientists' self-efficacy. Indeed, people were very keen on being part of the data collection and result generation process, as they can lobby for transformational actions in the city and contribute to community wellbeing. In addition, the potential of capturing CO2 in the soil stimulated interest in the topic and desires to contribute to have better soils.

Finally, it is important to mention that the project was managed following the principle of sociocracy, i.e. fostering democratic decision making process and participative management practices. This can result in another form of empowerment for citizens participating in the activities and for the Open Soil Atlas community overall.

Social inclusion

In terms of social inclusion, very few people were from underrepresented groups. 48 people were younger than 30 years old, 81 were in the 30-60 age groups, and 3 were older than 60. In terms of

gender, the group of participants was well balanced. The majority of the people have a high school degree/diploma, a bachelor degree and a master degree (in equal proportions).

A strategy for social inclusion was also applied by engaging all the groups having a stake in the urban forests, regardless of their status and interests and therefore including environmental NGOs, businesses, local associations. Attempts to bridge and collaborate with local organisations working with under-represented groups were made but they were not operational, also due to the covid situation that didn't facilitate networking at local level.

According to some of the respondents to our survey, the pilot has been a "*perfect way to get in touch with science and soil, and have knowledge and awareness of the environment and the impact of human behaviour and treatment*". For others it has also been a "*perfect way to meet people on an absolutely non-judging level but all with a common interest"*. In addition, it has been "*a perfect way to make people feel that as a community you are strong, responsible and able to make a change*". Therefore, it was an "absolutely encouraging and motivating project".

Researchers and research community growth and empowerment

Three new collaborations were established thanks to the project with other researchers/research organisations, while 10 new collaborations were established with organisations not related to research. The researchers engaged in the project were also able to reflect on their career path. For example, another academic project applied for funding for the replication of open soil atlas in Brazil, inspired from a workshop we offered within a master class in geography.

Knowledge, skills and competences

On a range 1-5, Open Atlas had an impact on knowledge, skills and competences of the project team equal to an average of 4.3, with highest value (5) for data curation (open data, FAIR principles, etc.), citizen engagement and output communication and dissemination.

With reference to the impact on this dimension for citizens, we only have few respondents to our questionnaire (5 out of 141 participants) so we cannot draw any conclusion on this but it is important to mention that many of the participants were already interested in the topic of soil quality, who pro-environmental and pro-science attitudes but were new to the actual activities of soil testing so that learning on this should be considered as relevant.

Behavioural changes

The project had an impact on participants' way of thinking, attitudes and values, as they got more connected with the environment, aware the importance of the soil, stopped misbehaviours and got motivated for improvement.

The project also contributed to policy implementation (see next paragraphs). Indeed, awareness was raised about the instability that eco-initiatives face in the city, as well as about the quality of the soil and the need for regeneration. In this regard, meetings were organised for influencing policymakers, in this case by having a meeting with a representative of the Senate, which was then invited to the final event.

Economic impact

There is a possibility for economic impact on the local community. Indeed, several soil testing activities have been conducted in Garden Café or community gardens which also had an economic activity (e.g. bar, restaurant, etc.), therefore these supported the local economy and also brought new people and clients.

Political impact

Open Soil Atlas has had political impact through impact on policy processes and in increasing political support for citizen science.

Impact on policy processes

Open Soil Atlas raised awareness about the instability that eco-initiatives face in the city, by raising awareness of policy makers about the quality of the soil and the need of regeneration. The team managed to meet with a representative of the Senate.

Political support for citizen science

After the first contact with the Senate representative, the project was promoted through the Senate newsletter. The project also got in touch with the quartier management in the city and is still in contact with them.

Transformative potential

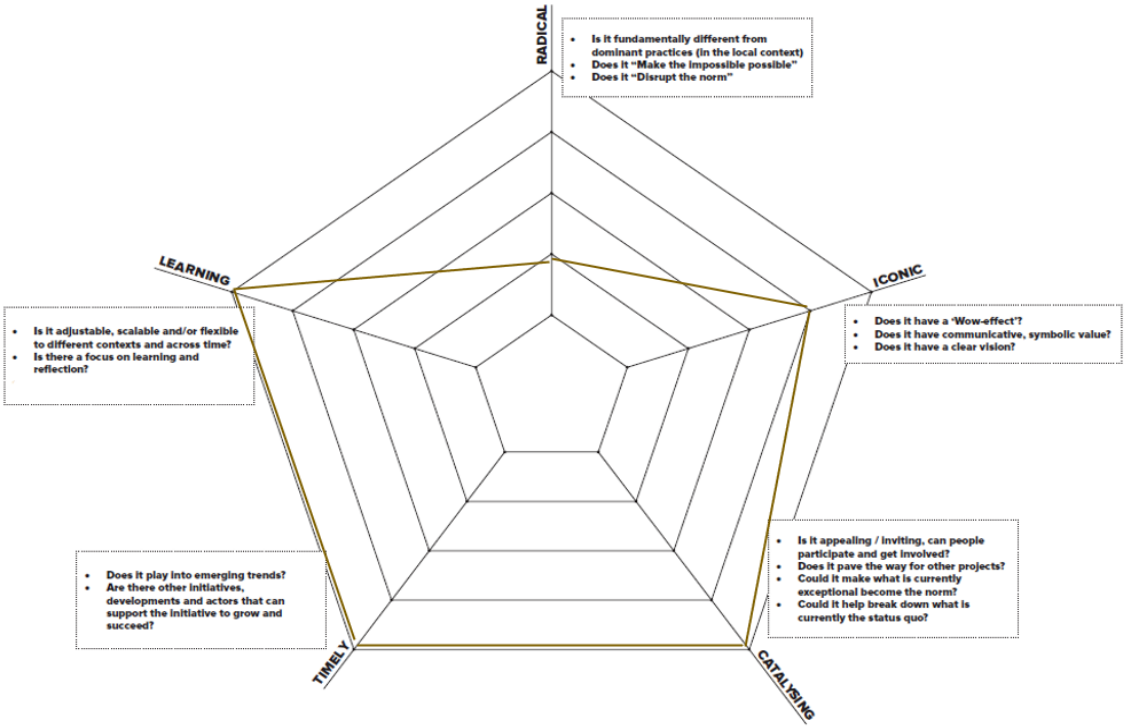


Fig. 60 Transformative potential of Open Soil Atlas

The project has a high transformative impact, with an average score of 4,2 out of 5. The project is not very **Radical** (2): despite the innovation of using citizen science for soil testing, urban planning and advocating the impact of eco-initiatives, countermapping has been a common practice in Berlin in the past as well. The project is **Iconic** (4) because the project has a clear vision and the activities usually have a "Wow-effect". The project is **Catalysing** (5): people participated very enthusiastically, and the project could allow very interesting development in the future and could change things for eco-initiatives, the community and the urban environment. The project is **Timely** (5), because it plays into emerging trends. For example, urban gardening, community gardening, attention to the environment, need of nature and productive landscapes in the city, and seeking connection with the natural environment are very common topics in the Berliner community. Last, the project allows for **Learning** (5): replicability and scalability have shaped the project since the beginning and the project could now be easily replicated everywhere in the world.

Walk-up Aniene

Territorial coverage: Rome (Italy)	**Type of pollution considered:** water and soil pollution, biodiversity monitoring
Revant SDGs 11 - sustainable cities and communities, 12 - responsible consumption and production	

Walk Up Aniene implemented its activities in the Aniene Valley Nature Reserve, which is located in the North East periphery or Rome (Italy). Participants were engaged in individual observation and data gathering through mobile technologies. This provides key data on an essential natural area resisting urbanisation and anthropic pressure.

With the help of citizens it was possible to map environmental criticalities and support responsible institutions to plan environmental restoration measures. The pilot aimed at analysing the environmental quality of the river riparian area while enhancing participation at local level. Monitoring activities provided data to develop a report on the Nature Reserve of the Aniene Valley and a GIS map that highlights areas of main criticalities to be addressed, restoration needs and valuable areas to be protected. On the basis of existing protocol and questionnaire for biodiversity monitoring, the Walk Up Aniene team has developed simplified questionnaires adequate for data gathering by citizens. To facilitate data collection, georeferencing, pictures and sound gathering, Epicollect has been used.

The pilot is Lead by A sud, with the support of Insieme per l'Aniene and CDCA – Centro Documentazione Conflitti Ambientali (centre for the documentation of environmental conflicts).

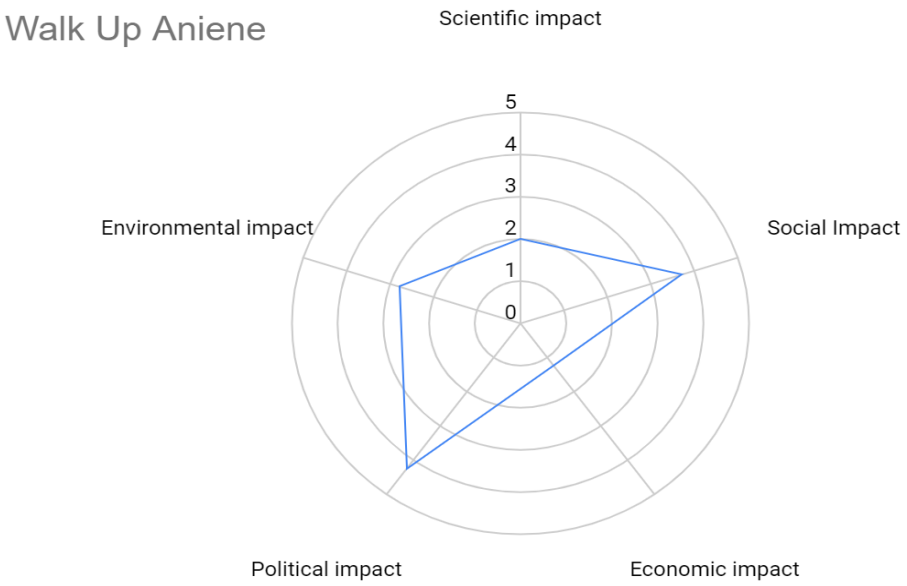


Fig. 61 Relevance of the areas of impact as in the impact assessment canvas

Walk Up Aniene has had a scientific impact on knowledge in academia, new knowledge resources, and innovation in education.

Knowledge in Academia

The project generated a good **amount of data:** 72 data points. It also **published** a number of documents with their results, - see table below. The citizens did not really participate in the scientific output, but were thanked for their data gathering in the article with the results.

Scientific publications	**1 (article)**
Non-scientific publications	**3 (1 article, 2 blogs)**

Tab. 24 Number of publications by Walk-up Aniene

The data quality generated by WalkUp Aniene is high, with 3 out of 4 relevant indicators. There was no procedure for adapting the process of data collection. The tasks for volunteers were not really hard, but the data collection questionnaire was long and more isolated observation points were not easy to reach for everyone. In order to train volunteers there have been 4 online lessons (2 were compulsory) and 1 field visit/training on the site (non compulsory). Other 3 field visits/training on the site were organised further on during the pilot. Data entry procedures were systematic. The equipment used for measurements did not need to be standardised or calibrated across volunteers, and the project recorded relevant metadata.

The **openness of data** scores well: 3 out of 5. The dataset is published on Epicollect and on the project website. The data is available as machine-readable structure in non-proprietary format.

The data has good compliance with the **FAIR principles**. The data is Findable (3 out of 5) for humans, but not specifically designed for machines or computers. The data is Accessible (4 out of 5), because the data will be fully accessible online from project websites and from Epicollect. The data are interoperable (3 out of 5): the data used have been remodelled with a basic language and are therefore understandable to all. The data are Reusable (4 out of 5): they can be reused for future comparisons on the state of health of the Aniene River.

New knowledge resources

The project eases access to traditional and local knowledge resources, by providing knowledge about a nature reserve less known or accessible. Furthermore, it facilitated knowledge creation among societal actors and groups: citizens participants have increased their knowledge about the environmental state of the Nature Reserve, through their direct participation in data collection and through the training as well.

Innovation in education

The project provided blended training on citizen science and data collection to citizens which is not at all a traditional nor widespread training activity in Rome/Italy.

Social impact

Community building and empowerment

100 citizens were engaged in project activities, out of which 55 were engaged in scientific activities including training on the field data collection (eye observation and compilation of dataset/questionnaire), review of preliminary results and development of proposals for decision makers and discussion meeting, motivation and impact evaluation. 150 people were involved in the 6 awareness raising/dissemination events organised.

42000 people have been reached on social media through different means.

Citizen scientists had a good interaction with each other, in particular during field visits, as some did collect information togethers and also through the Whatsapp group. The project, indeed, did foster the creation of new groups and enlarged existing groups.

In addition, the project was also able to improve the citizen scientists' self-efficacy.

Researchers and research community growth and empowerment

The pilot contributed to the growth and empowerment of the researchers and research community, particularly by creating new relationships between the researchers and the local communities.

In addition, the project led researchers to rethink their research. Indeed, the project was an opportunity for the researchers involved to find out which ecomorphological aspects of the green area needs to be investigated. This implies for researchers to look out to develop new competences through specific training courses and/or to organise further research.

Knowledge, skills and competences

By participating in the project, the team's skills increased. On a scale 1-5, the average score has been 3.9. The areas that received the highest score have been Research design, Data gathering process, and Data curation.

This participation also increased volunteer skills. Unfortunately only 14 persons (out of 140 participating in the activities) answered to our questionnaire but it is nevertheless possible to say - also thanks to the information provided by the project team - that that project got a positive influence on the volunteers' attitude towards science, their competences, and their attitude and knowledge about environmental quality of riparian ecosystems. Indeed, the majority of respondents to our survey were not experts of scientific process and environmental monitoring before the project and it was their first time participating in a CS project. Moreover, respondents also mention positive impacts in the acquisition of new skills in terms of critical thinking and on the use of technology, possibly linked to the use of the Epicollect tool.

Almost all respondents refer to having increased their interest for the topic covered by the project and for science and related activities.

Changes in way of thinking, attitude and values

The project had an impact on participants' way of thinking, attitudes and values, and participants know more about the places and elements that shape the river ecosystem.

Behavioural changes

The project also had impacts on participants' behaviours, increasing their sense of respect for the environment and promoting a more conscious use of the river park. Almost all respondents to our questionnaire refere that they will change their behaviour by becoming more active in environmental monitoring and protection, by caring more about the river area, by talking about the project and its outputs with friends and relatives and bringing more people to similar projects and in learning more on the topic.

Economic impact

The project led to the development of new products, in this case a new simplified version of the monitoring questionnaire to evaluate the river geomorphic quality. It also improved an existing service, as it enlarged the offer of participative activities oriented at citizen science and the promotion of the defence of green areas and natural resources in the city.

The increased capacity to develop citizen science intervention also created expectations for the increase of revenue in the next 2-3 years for the organisations involved in the project, although there is no economic target set for this. There is also a possibility for economic impact on the local community. Indeed, some suggested activities to improve the nature Reserve state will be implemented in the coming years, and in this sense this will improve its attractiveness.

Political impact

Walk-up Aniene has had political impact through impact on policy processes and in increasing political participation.

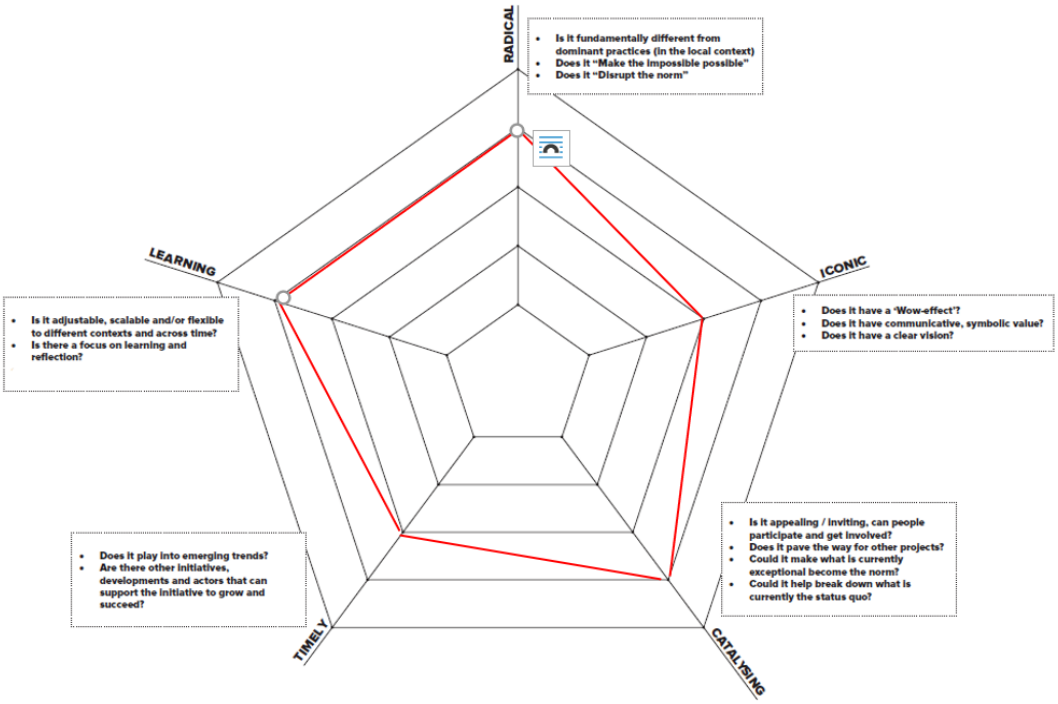
Impact on policy processes

Walk-up Aniene raised awareness among participants regarding the reserve challenges, raising public awareness around the importance of the nature reserve in the city. The team also attended several meetings to influence policymakers and push for a new management plan for the river.

Political participation

The project increased the time spent by participants in communicating about politics (issues, candidates etc.) with their family or friends, and also increased the participants' civic engagement (e.g. membership in voluntary associations, charities or environmental groups).

Transformative potential



Tab. 25 Transformative potential of Walk-Up Aniene

The project has a high transformative potential, with an average score of 3,6 out of 5. The project is **Radica**l (4), because it is built up and realised by civil society organisations and is meant to support local struggles for environmental justice. The project is **Iconic** (3): while the core of the data collected in itself (i.e eco geomorphological state of the reserve) is not the most "iconic", fortunately the topic of urban nature areas is more trendy. The project has a clear vision and the activities usually have a "Wow-effect". The project is **Catalysing** (4), because the project had good response in terms of participation and interest from citizens and paved the way for other similar activities in other places or follow-up activities in the reserve itself. Also the action has supported an empowered position of civil society organisations with regards to the dialogue with institutions in charge. The project is **Timely** (3). Trends in citizen science development in Rome are not particularly strong yet but it surely will grow in time, in particular in the relation with local administrations. It is one of the project's aims to build dialogue and political initiatives to reinforce the position of citizen science as a participation tool for environmental governance. Last, the project allows for **Learning** (5), because it is surely scable and adjustable and could be replicated with some modification as well as adjusted towards follow-up activities.

Mapping Mobility

Territorial coverage: Rugeley, Staffordshire (England)	**Type of pollution considered:** air pollution
Revant SDGs 3 - good health and wellbeing, 11 - sustainable cities and communities,13 - climate action	

This project focused on engaging citizens in collecting spatially referenced mobility data pertaining to their patterns of active travel within their community. Citizens use the outputs from this data to encourage and educate their community and local authorities about sustainable travel opportunities/barriers for the town, thus tackling issues of local transport-related pollution. There were two levels of engagement. Firstly, through contributors who map the most effective/ relative quality of local routes. Secondly, citizen scientists have been trained as to how to collect, analyse and generate visualisations using a Geographic Information Systems approach. The data are produced by the community for the community to encourage modal shifts in travel.

The pilot builds on the previous Zero Carbon Rugeley project that works towards an innovative design for a town-wide Smart Local Energy System (SLES) in Rugeley (West Midlands, England). The pilot was led by the Institute for Sustainable Futures at Keele University.

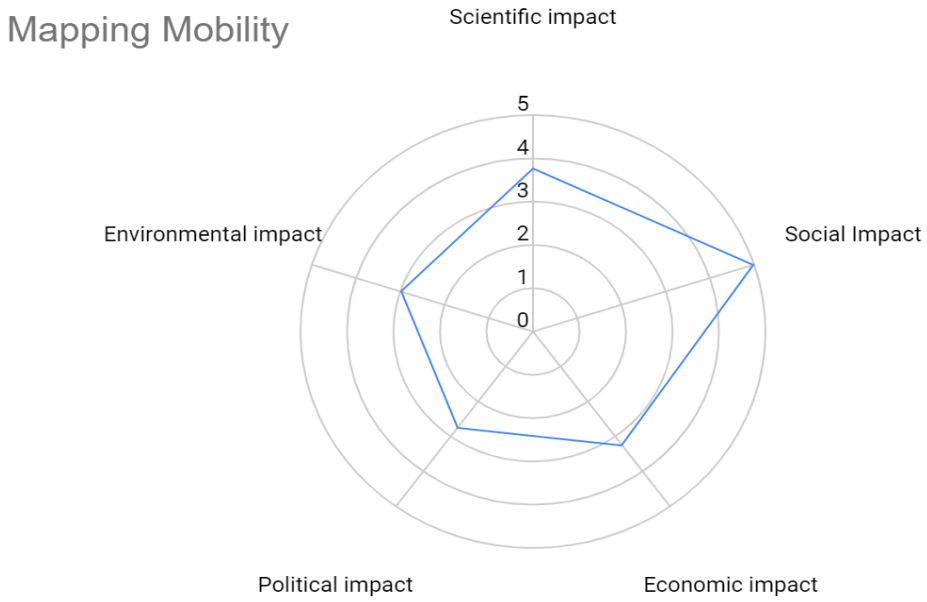


Fig. 62 Relevance of the areas of impact as in the impact assessment canvas

Scientific impact

Knowledge in Academia

The project generated a good **amount of data**, with 41 data points. It also **published** a number of documents, such as project guides - see table below. Volunteers participated in the project output to a limited extent and remained anonymous in the report.

Non-scientific publications	**7 (6 project guides, 1 video)**

Tab. 26 Number of publications by Mapping Mobility

The data quality generated by NoiseMaps is high, with 4 out of 5 indicators. There was no procedure for adapting the process of data collection. The data collection was easy, the analysis is more complex and requires more training. This is why the participants were sent detailed walkthroughs and guides. Data procedures are systematic: the process is very structured, with automatic data submission and collection, and the guides/ processes are also very structured. The equipment used for measurements is standardised and calibrated across volunteers. However, because it is dependent on an individual's phone settings, this can reduce how standardised the equipment is. The project records relevant metadata.

The **openness of data** scores well: 4 out of 5. The data is available as machine-readable structure in non-proprietary format, and follows open data guidelines.

The data has good compliance with the **FAIR** principles. The data is Findable (2 out of 5) on the web, though the project will not advertise it. The data is Accessible (3 out of 5), because it is easy to download. However, you need knowledge of the file type and GIS to really do anything with it. The data are interoperable (4 out of 5): GIS makes it easy to integrate the data with various other data sets. The data are Reusable (3 out of 5): it provides a coverage of mobility patterns in the area. Until there are local active travel interventions (such as new cycle lanes built) this data will be useful. However, it is a current snapshot in time – the data may not age well.

New knowledge resources

The project eases access to traditional and local knowledge resources. Participants recorded the routes they take, so the project/ data is dependent on local knowledge and activities. Furthermore, it facilitated knowledge creation among societal actors and groups, because local stakeholders were involved. Local councils have approached the team about embedding the project in their health ambitions. The Zero Carbon Rugeley consortium will use the data. The project is contingent on local knowledge, thus, the data would not exist without citizen science engagement.

Social impact

Community building and empowerment

9 citizens were engaged in project activities overall, while other 9 were engaged in scientific activities. One raising awareness/dissemination event has been organised. 300 people have been reached on social media through different means.

Social inclusion

A strategy for social inclusion was applied by creating an ad hoc role for those who a) may not want to take part in data collection/analysis but still want to be involved, and b) those physically/digitally excluded by the nature of the project. This had no uptake, but the opportunity was provided and it is of interest for future projects in this or in other locations.

10% of participants belong to an underrepresented group. In terms of gender, 20% of the participants were male and 80% female, both elements are promising in terms of social inclusion.

Knowledge, skills, and competences

The project impacted on skills and competences of the team, as it was a good insight into the complexities of managing a citizen science project, including developing appropriate training material and navigating the ethical aspects of a CS project.

Economic impact

The project can be considered more a proof of concept than a fully deployed CS projects as - due to many factors, mainly organisational and out of the control of the project team - the project didn't got enough time to reach its full potential but the investment was made to carrying out more CS activities in the future. There is also a possibility for economic impact on the local community and for those participants that acquired new skills in georeferenced data. It has helped spark conversations around active travel and might help improve arguments for improving local bike infrastructure.

Political impact

Mapping Mobility has had a political impact on policy processes as well as political support for citizen science.

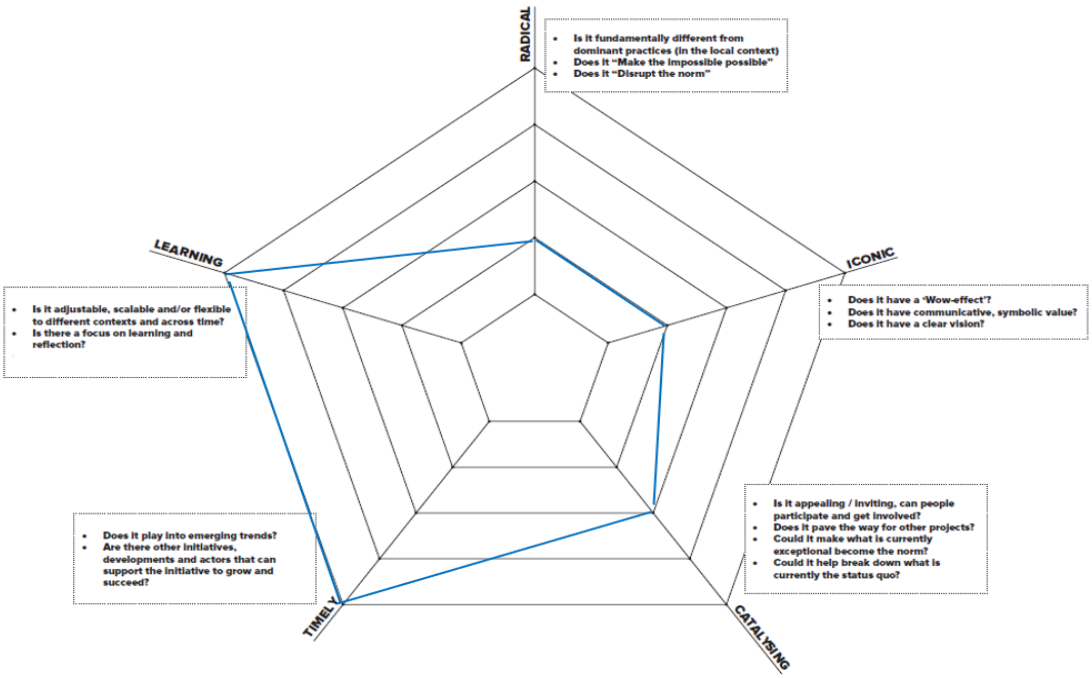
Impact on policy processes

The project team has been invited to present the project at the Decarbon8 conference, and has also been invited to work with Cannock Chase District Council to develop the project further.

Political support for CS

As mentioned above, public administration has interest in developing the project, which could involve future funding.

Transformative potential



Tab. 27 Transformative potentail of Mapping Mobility

The project has a high transformative potential, with an average score of 3,4 out of 5. The project is somewhat **Radical** (2): it is innovative in its GIS mapping approach but the actual foundations of tracking 'mobility' patterns is not novel. The project is somewhat **Iconic** (2): it has a clear vision, but the 'wow factor' is probably missing. The project is **Catalysing** (3), because it is easy to participate in many respects, though the GIS component might be more difficult. It certainly could pave the way for similar projects that use GIS. The project is **Timely** (5), because increasing active travel is critical to decarbonisation and GIS is a booming industry. Last, the project allows for **Learning** (5): the project is very scalable in different contexts due to flexibility of app use and GIS. The focus of the project is on upskilling participants, but also on learning from local knowledge of participants.