



Citizen Science

Exploring its trends and its role
in sustainable development

Co_
Lab



Argentina

accelerator
lab

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UNDP recognizes the importance of inclusive language to make gender diversity visible. Thus, the generic masculine and female forms are alternately used in this report.



1. Introduction

Introduction

Citizen science is part of a paradigm that is gaining ground globally and at a national level in Argentina. It is based on the collective creation of scientific knowledge. Citizens can lead, contribute, collaborate, and co-participate with academics (or not) in one or several scientific processes and knowledge-building stages.

Additionally, participatory knowledge building encourages the visibility of issues that traditional research spaces might overlook and/or the formulation of public policies. These characteristics that make citizen science special are also the ones that make it a valuable tool for realizing the sustainable development agenda in Argentina and the formulation of public policies to achieve that purpose.

Throughout 2019, scientists from the team open-seneca of the University of Cambridge provided pieces to assemble open low-cost sensors for measuring air quality. Students from the University of Buenos Aires and the National University of San Martín assembled these sensors during a class in 2019 and measured air pollution while riding their bikes. In April 2020, during the COVID-19 pandemic, at Co_Lab, we saw the opportunity to work with citizens and scholars, both in Argentina and the United Kingdom. This allowed us to coordinate the delivery of 14 sensors to participants who had a special circulation permit during the COVID-19 lockdown. By attaching the sensors to their bicycles, participants measured air pollution in the Autonomous City of Buenos Aires as they moved around the city on their bikes. The data obtained were used by the Ministry of the Environment and Sustainable Development of Argentina and the Government of the Autonomous City of Buenos Aires.

Based on this experience, we became aware of the potentiality of citizen science in Argentina and its acknowledgment by civil society organizations and the public sector. From that moment on, we supported the expansion of air measurements by distributing sensors in other cities. Moreover, we began to understand the potentiality of citizen science to accelerate sustainable development solutions and public environmental policies.

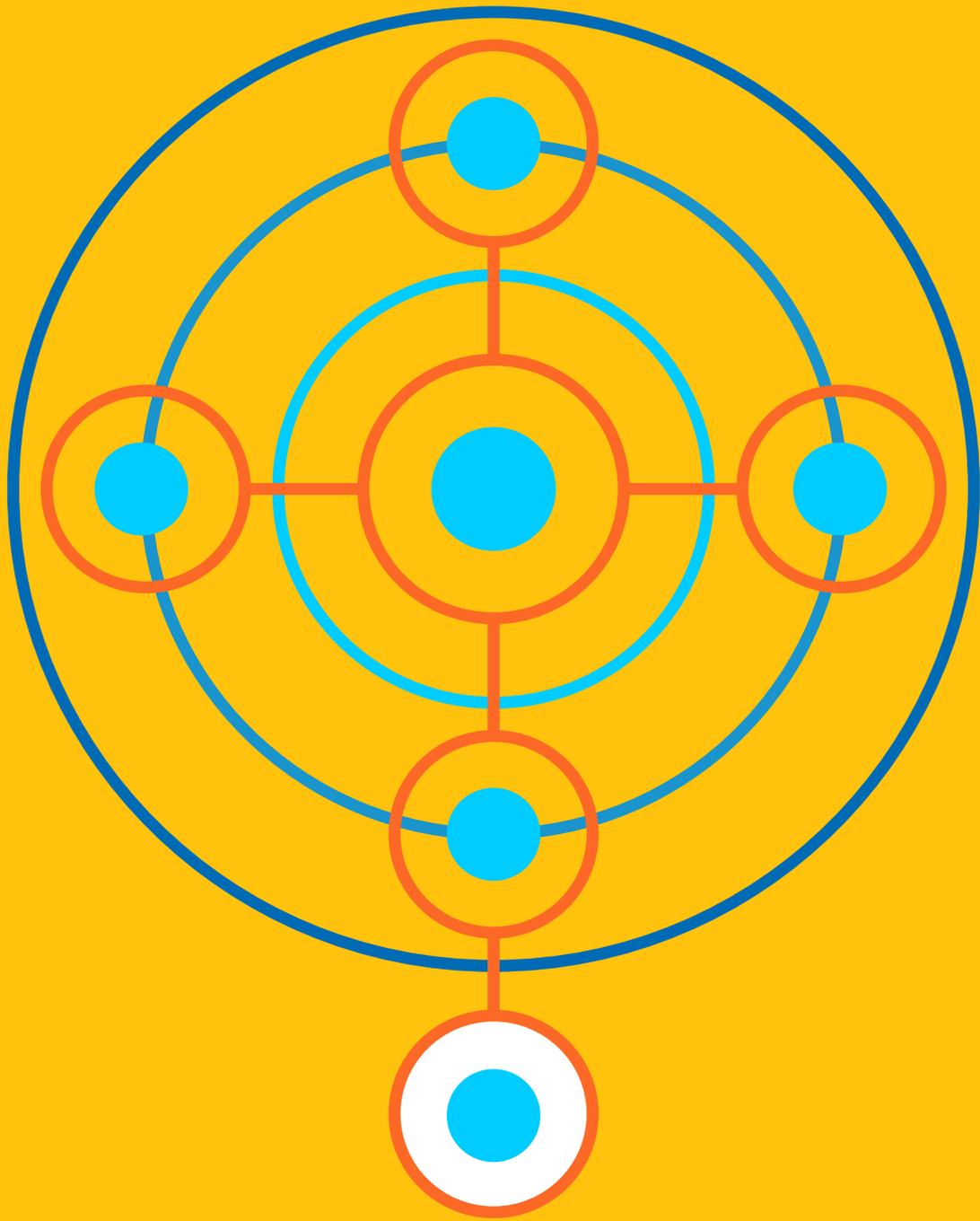
Thus, Co_Lab began a systematic and participatory exploration through bibliographic research, interviews with experts, and collective intelligence methods. We begin this report by defining citizen science and describing its characteristics. We point out that it can contribute

to the academic sector through participatory co-design and/or data collection. Besides, it may be useful for forging partnerships, revealing social or environmental issues, and reaching consensus among stakeholders. We elaborate on how it can promote activism or be used as a tool to implement or monitor policies. Importantly, it can lead to evidence-based solutions and behavioral changes.

In the second section of this report, we explore global emerging phenomena shaping citizen science's present and immediate future. We observed that these trends might be related to the academic sector, civil society organizations, and the public sector. Particularly, we found emerging phenomena related to data collection and analysis methods, such as artificial intelligence, low-cost sensors, and new functionalities in implementing environmental citizen science initiatives using smartphones. We also revealed trends related to recruitment, motivation, commitment, and participation arrangements through technology. Among them, we observed the use of digital mass media, gamification, and bots to facilitate access and promote the commitment of participants, as well as the use of non-technological tools, such as behavioral sciences and new co-creative and collaborative participation arrangements. We also noticed that there are new trends in terms of management and quality, security, and ethics standards for collected data. In the following section of the report, we propose a hypothetical case in which citizen science becomes the mainstream approach to science and uses collective intelligence to reveal its consequences. Specifically, we used the futures wheel with Argentinian and foreign experts. We detected possible consequences related to data biases, global knowledge asymmetries, the development of new professional profiles, and the strengthening of the relationship between citizen science and public policy.

Then we describe the conditions of the citizen science ecosystem in Argentina and its main characteristics. This ecosystem is booming mainly in the Autonomous City of Buenos Aires, the Province of Buenos Aires, and the Province of Córdoba. Most citizen science initiatives originate in the academic sector, although a minority of projects are conceived by citizens themselves or through the collaboration between the academic and public sectors.

The report's final section covers the relationship between citizen science and public policy. We have identified this relationship as an emerging global trend at the peak of its development and with huge growth potential in Argentina. Public policy could strengthen citizen science through institutionalization and direct finance. Likewise, public policy may be strengthened by collective knowledge building because it can be used to design, implement, and assess policies.



2. Definition of citizen science

The emergence of citizen science is quite recent. The term citizen science was used for the first time in the late 1980s (Hacklay, 2021). The first book (Irwin, 1995) that theorized the concepts to understand and develop it was published in the mid-1990s.

Since then, the interest in and the acknowledgment of citizen science has grown. However, despite the large volume of work, it is impossible to define citizen science for all contexts (Eitzel et al. 2017). Therefore, it is understandable that there is still not an international consensus about its definition (Heigl et al. 2019). Definitions vary according to the type of scientific activities or practices, including citizen participation in collecting and monitoring data and even their intervention in the design and implementation of research.

At Co_Lab, we understand citizen science as the formulation of questions or hypotheses, generally associated with social or environmental challenges, which allows us to build knowledge outside traditional academic environments. What differentiates it is the participation of individuals or civil society organizations at some point in the scientific process. It is characterized by a rigorous methodology that people without formal scientific training may entirely develop. Nonetheless, it is often carried out in collaboration with the scientific community. Therefore, citizen science makes it possible to obtain new evidence to address problems that have been acknowledged and, in some cases, to reveal unattended matters and even encourage social activism. It can also promote changes in participants' behavior thanks to the knowledge they gain or the increasing awareness they build when they take part in these actions. This leads to the creation of opportunities to drive the development of people, groups, or communities to solve issues, promote social interests and encourage social awareness.



The European Citizen Science Association suggests that some of the most important characteristics of citizen science are its scientific accuracy, citizen participation, communication of results, ethics in collaboration between participants, and appropriate data management.

It should be noted that reaching a consensus to define citizen science goes beyond a merely academic exercise. According to our key informants, it is critical to have an appropriate definition because it circumscribes what may or may not be considered citizen science, it affects the legitimacy of projects, and it defines the composition of a field of actors who, for example, determine who is eligible for each action and their corresponding subsidies, among other aspects.

Why does citizen science promote development?

After completing an internal collective intelligence exercise at Co_Lab and after interviewing key informants and analyzing several projects in Argentina, we determined that citizen science can:



Contribute to the academic sector through participatory co-design and/or data collection on a particular academic study field, such as, for example, AppEar in biology, OpenTEK in ancestral knowledge, and iNaturalist in biodiversity.



Act as a means of forging alliances to reveal issues and reach a consensus between different social sectors, including the academic, private or public sector, civil society organizations, and the general public.



Encourage climate and/or social activism, facilitate the creation of organizations or an increase in their scale, and promote the protection of natural resources.



Promote interventions to reveal or solve issues that have been collectively uncovered and which would otherwise be excluded from the public agenda



Act as a tool to implement policies or monitor the impact of interventions and solutions from the public and/or private sector, thus giving rise to an effective innovation tool for reducing costs.



Facilitate the creation of solutions based on the knowledge applied by people every day.



Support building knowledge and educating the citizens who take part in projects.



Promote behavior changes that may contribute to sustainable development.

Different emerging trends in citizen science impact the implementation of experiments and other spheres of our society, both locally and globally.

The following is a brief outline of some of these trends, which are organized around three key aspects:



1

New opportunities in data collection and analysis methods.

The development of new technologies makes it possible to increase the efficiency of data collection and analysis at a low cost.



2

Innovations related to recruitment, motivation, commitment, and participation arrangements.

Several initiatives are being implemented to increase recruitment, improve retention and achieve greater participant commitment to citizen science. Such projects include gamification dynamics or virtual partners to improve participation levels.



3

Definition of data quality, security, and ethics standards.

As citizen science grows, the commitment to enforce data quality, security, and ethics standards are reaffirmed. It is becoming more important than ever to consider aspects associated with intellectual property, volunteer security, and financing fund management, among others, when designing the project. The creation of good practice standards and the definition of resilience strategies in data management are key to its expansion.

Figure 1. Emerging phenomena for citizen science with environmental focus identified by Co_Lab.

MARCH 2022
Emerging phenomenon

EXPLORATION
SOLUTION-MAPPING
EXPERIMENTATION

New opportunities in data collection and analysis methods

Affordable low-cost and easy-to-develop sensors



Sensors are becoming more accessible due to their **affordability and low cost**. Many of them can be built by the participants themselves in a DIY manner. In addition to this, **3D printing technology makes it possible to create prototype sensors** more quickly and efficiently, which speeds up their creation and iteration process.

Reference
CanAirIO is a citizen science project which focuses on measuring air quality using low-cost mobile and static sensors and mobile phones. Citizens can use the application and build their CanAirIO measurement device to monitor the air quality in neighboring areas. It does not require any prior training in programming or electronics. Once the participants have registered in the app and have received the necessary materials for the assembly, they can build the device in their homes following a tutorial (CanAirIO, n.d.). The project supported by Co_Lab and open-senseca is also based on some similar concepts.

Source
<https://canair.io/>

Keywords
#CitizenScience

MARCH 2022
Emerging phenomenon

EXPLORATION
SOLUTION-MAPPING
EXPERIMENTATION

New opportunities in data collection and analysis methods

Use of artificial intelligence for greater speed and efficiency in the analysis of information



The integration between citizen science and artificial intelligence (AI) for environmental monitoring greatly benefits the management of environmental policies and scientific research (McClure *et al.*, 2020). AI involves those technologies capable of automating and optimizing tasks such as pattern recognition, analysis execution, or decision making (Kavakoglu, 2020). By complementing these technologies with the features and capabilities of citizen crowdsourcing, and thanks to the analytical capabilities of AI, the collection and processing of data can be accelerated (McClure *et al.*, 2020). This makes it possible to create and process large volumes of data, which would not be feasible with other methods.

Reference
Wildbook is an initiative that offers an open-source software framework to support different citizen science initiatives related to environmental monitoring. It is a scalable and collaborative platform that uses AI to store and manage wildlife data. Thus, Wildbook can build platforms to localize and track several animal species based on data and images provided by voluntary users (WildMe, 2021). There are already some platforms employed to monitor populations of **zebras, giraffes, whales, and dolphins** which use this software.

Source
<https://wildme.org/wildbook>

Keywords
#CitizenScience

MARCH 2022
Emerging phenomenon

EXPLORATION
SOLUTION-MAPPING
EXPERIMENTATION

New opportunities in data collection and analysis methods

Greater penetration and better functionalities of smartphones



Globally, there are more than three billion smartphone users, and it is estimated that this number will continue to grow by several hundred million in the coming years. China, India, and the United States are the countries with the largest number of smartphone users, with 1.46 billion users. In Argentina, smartphones grew from 43% in 2013 to 91% in 2017 (Deloitte, 2017). These are useful tools to record and monitor data, leading to a favorable environment for citizen science.

Reference
Caza Mosquitos (Mosquito hunter): digital application developed by researchers from the National Scientific and Technical Research Council (CONICET, by its Spanish acronym). Its objective is to map different mosquito species found in Argentina with participants. Citizens can take pictures of the mosquitoes, upload them to the application, and identify their species. The data collected through the application is analyzed by members of the Insect Ecology Laboratory at the Institute of Limnology, "Dr. Raul A. Ringuelet", who can draw maps of the mosquito populations based on this information inhabit each region of the country (Gisande, 2018). We provide more detailed information about this solution in our work on [solutions mapping](#).

Source
<https://www.conicet.gov.ar/caza-mosquitos-una-app-cientificay-colaborativa/>

Keywords
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Source: Accelerator Lab of UNDP Argentina.

Figure 1. Emerging phenomena for citizen science with environmental focus identified by Co_Lab.

MARCH 2022

Emerging phenomenon

EXPLORATION SOLUTION MAPPING EXPERIMENTATION

Co_Lab UNDP Argentina

Data quality, security, and ethics standards

Ethics in the use of collected data



Respecting the privacy of participant data has become an issue of growing concern following the Cambridge Analytica and Facebook scandal. The global situation led the European Union to implement the General Data Protection Regulation as of 2016. In citizen science, participants offer to provide data on their initiative to support the project's common objective. Therefore, this is an aspect that is becoming more and more relevant during the project design stage.

Reference
 Eticas Foundation is an association that supports the creation of frameworks that protect the privacy of the data and promote the safe use of technology. They work on different projects related to creating public policies, algorithms, work, education, the development of smart cities, migration, and governance (Eticas Foundation, n.d.).

Source
<https://eticasfoundation.org/governance/impact-on-privacy-and-data-protection-of-citizen-science-projects/>

Keywords
 #CitizenScience

MARCH 2022

Emerging phenomenon

EXPLORATION SOLUTION MAPPING EXPERIMENTATION

Co_Lab UNDP Argentina

Data quality, security, and ethics standards

Good data management practices to promote citizen science



Protecting participants' privacy is not the only issue related to good data management practices within the framework of citizen science projects. Security protection and ethical considerations must be maintained throughout the whole process, including data collection, analysis, curation, storage, and usage (Cavanillas *et al.*, 2016).

Reference
 Some studies warn about biases in the data collection stage of citizen science projects (Tiago *et al.*, 2017). Likewise, the databases often do not meet the comprehensive quality requirements (de Sherbinin, 2021). Based on this premise, the International Science Council (ISC) created the Task Group on Data in Citizen Science, which, among other tasks, developed a guide to help citizen science projects monitor SDGs according to the standards required by international organizations (de Sherbinin, 2021).

Source
<https://codata.org/initiatives/task-groups/previous-tgs/citizen-science-and-crowd-sourced-data/>

Keywords
 #CitizenScience

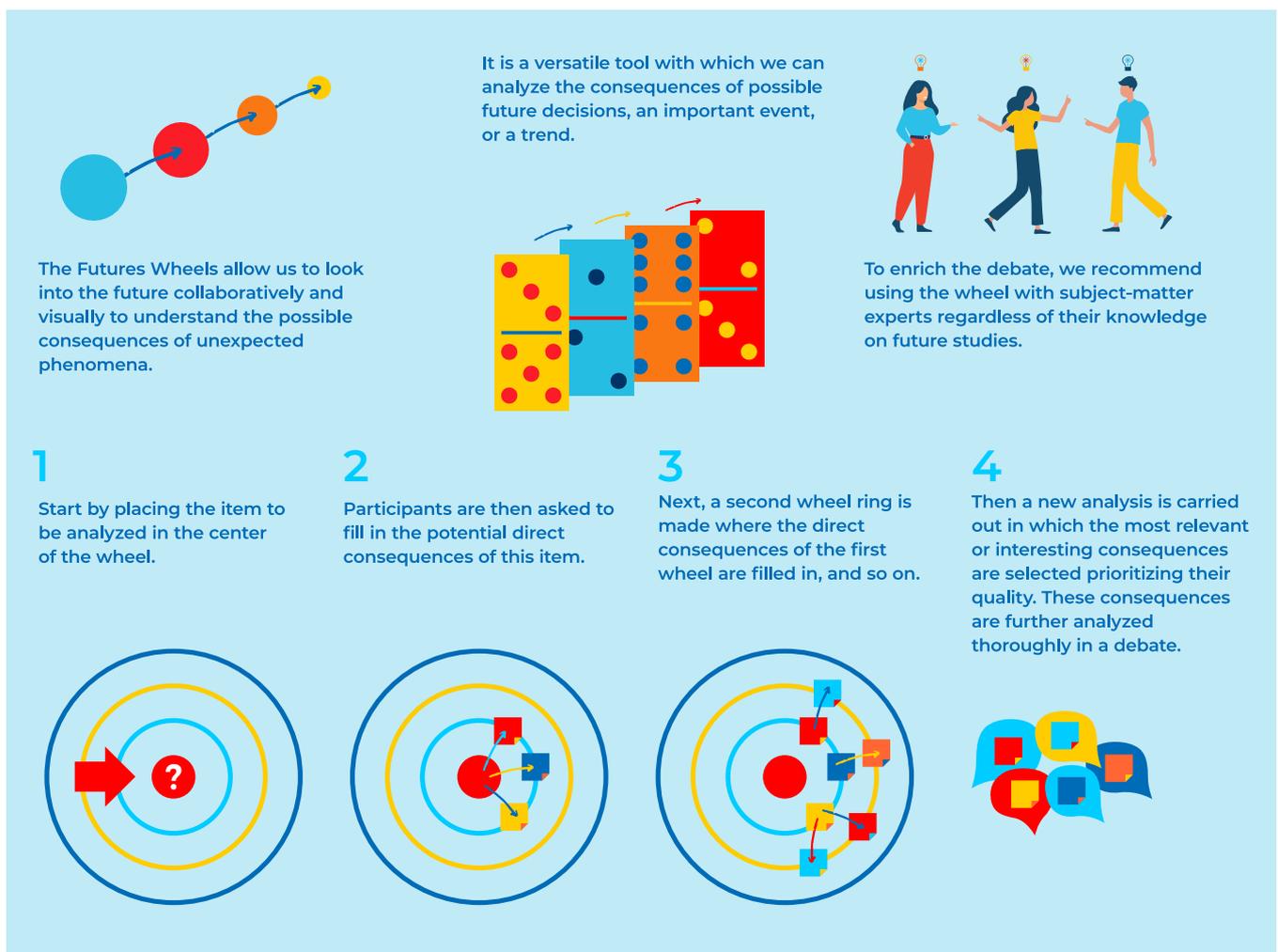
Source: Accelerator Lab of UNDP Argentina.

Collective intelligence: How do we use the futures wheel in citizen science?

In addition to looking for trends, the exploration allows us to obtain evidence about the potential unexpected consequences of events or hypothetical situations.

One of the most used tools for this goal is the futures wheel. This visual tool facilitates the creation of ideas and future consequences, both direct and indirect, associated with a signal of change. Therefore, it is a tool that makes it possible to expand and become acquainted with hypothetical emerging phenomena that could grow and collaboratively expand the analysis performed in the previous section. Moreover, it is a versatile tool to work with groups of people who know specific fields and for different goals, as it can adapt very easily (MindTools, n.d.). Figure 2 shows an infographic explaining how to use it.

Figure 2. Infographic describing how to use a futures wheel



Source: Accelerator Lab of UNDP Argentina.

Figure 3 shows the results of the futures wheel that Co_Lab used with a group of experts with experience in citizen science in different parts of the world. The main hypothetical situation to work on with the wheel was the following:

What if citizen science is recognized as the default research approach accepted by those who fund research?

The participants who took part in this activity were:

- **Professor Muki Haklay.** Extreme Citizen Science (ExCiteS) Research Center, Department of Geography, University of London (United Kingdom).
- **Dr. Susanne Hecker.** Chair at the European Citizen Science Association (ECSA). Head of Science Programme Society and Nature at the Natural Science Museum, Leibniz Institute for Evolution and Biodiversity Science (Germany).
- **Dr. Julieta Arancio.** Associate Researcher at the Centro de Investigaciones para la Transformación (Research Center for Transformation, CENIT, by its Spanish acronym), National University of San Martín (UNSAM, by its Spanish acronym) (Argentina). Co-founder of the Latin American Network of Free Technologies (reGOSH). Postdoctoral researcher at the Fair Tech Collective, Drexel University (United States).
- **Debbie Gonzalez Canada.** Doctoral researcher at the University of Melbourne (Australia).

We noticed that these experts found many different potential consequences in different spheres of society, such as the academic sector, civil society organizations, and the public sector. We analyzed the most important opportunities and threats related to those consequences, which are detailed below:



**Improvement
of public
policies**

If citizen science became the primary scientific methodology, it would promote different scientist profiles. Priority would no longer be given only to the publication of papers, and profiles of scientists with soft skills, such as effective communication, empathy, and leadership, would be promoted.



**New
scientific
profiles**

If more citizen science projects were launched, politicians would have a good opportunity to identify relevant issues for citizens and thus promote initiatives aligned with their communities. Moreover, it would make it possible to analyze and obtain scientific data about the implementation of government projects.

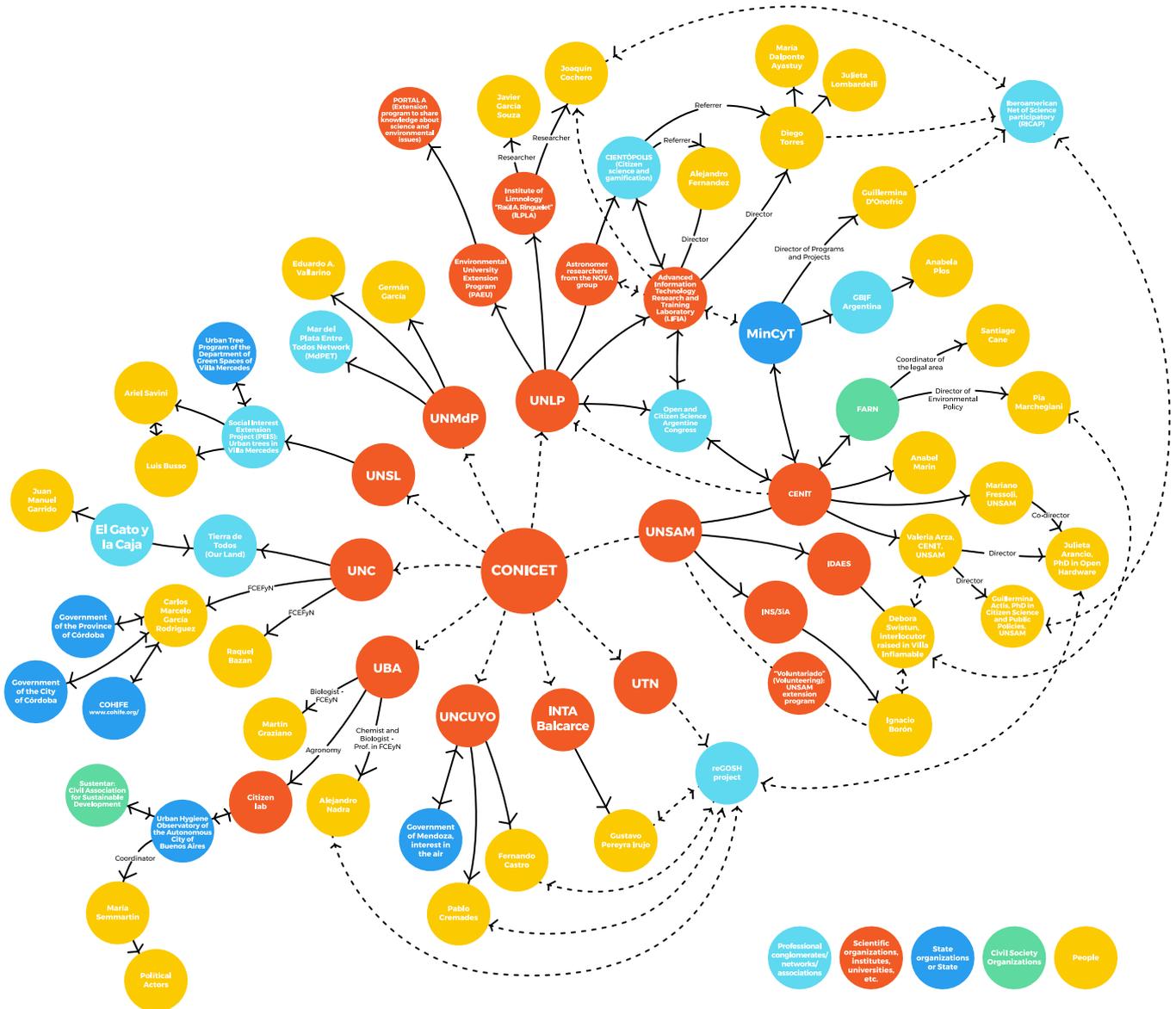


After finding trends in citizen science and the possible future consequences of its expansion, we delved deeper into understanding citizen science in Argentina and its relationship with the emerging phenomena described.

This allows us to know more about our ecosystem and its potential evolution. The diagram in Figure 4, drawn from experts' interviews, shows the citizen science ecosystem as of 2021. This chart is not intended to show all the details of the ecosystem, since this kind of work is out of our scope, but to shed light on some of the actors who have experience in citizen science with a focus on the environment, some of the organizations involved, and their interrelations. We visualize this information to find possible patterns and analyze them in greater depth.

We noticed that, just like in other parts of the world, citizen science projects have multiplied in recent years. But even then, citizen science is still developing, as less than 1% of the scientists at the National Scientific and Technical Research Council (CONICET) work actively on projects of this kind. At the same time, the experts themselves reported a lack of coordination between their work and its dissemination.

Figure 4. Ecosystem diagram showing the main actors of citizen science in Argentina, based on interviews with key informants.



Source: Accelerator Lab of UNDP Argentina.

1. The ecosystem focuses on three regional

where most initiatives are developed: the Province of Buenos Aires, the Autonomous City of Buenos Aires, and the Province of Córdoba. The projects developed in these three hubs are barely correlated. According to Newman et al. (2012), this shows a rather incipient ecosystem that lacks key actors to promote greater integration.

2. This ecosystem is characterized by projects which have been primarily developed in three different ways:

Projects created by scholars

The most predominant projects arise from an academic question or interest, and they involve citizens, either in their early stages, such as its design, or in later stages, such as data collection and/or analysis. Projects which originate entirely in the academic sector usually focus on specific thematic areas and aim at building advanced knowledge. In this case, projects may or may not be formally related to public policy. By formal relation, we mean a possible contribution to the design or the discovery of evidence that may be used to formulate or implement a policy.

Projects created by civil society organizations:

These are projects created by civil society actors. Although fewer of them compared to the previous type, we observed that individuals or networks of people stand out as leaders in each initiative. In this case, the projects originate from a particular interest, an issue, or a local need. These groups, networks, or organizations establish a formal relationship with the academic sector, often through their relations, university extension, and professional training departments, among others. These departments do not necessarily act as research centers but as bridges between the academic sector and the community. As we were told by experts, in this case, projects do not necessarily end with scientific publications. Additionally, these projects usually last longer due to the genuine interest in their continuation shown by the people involved, even when they are no longer in touch with the university. According to the experts, projects that arise from civil society tend to have a higher chance of scaling and enduring. Just as in the previous case, only some of these projects are formally related to public policy and decision-making.

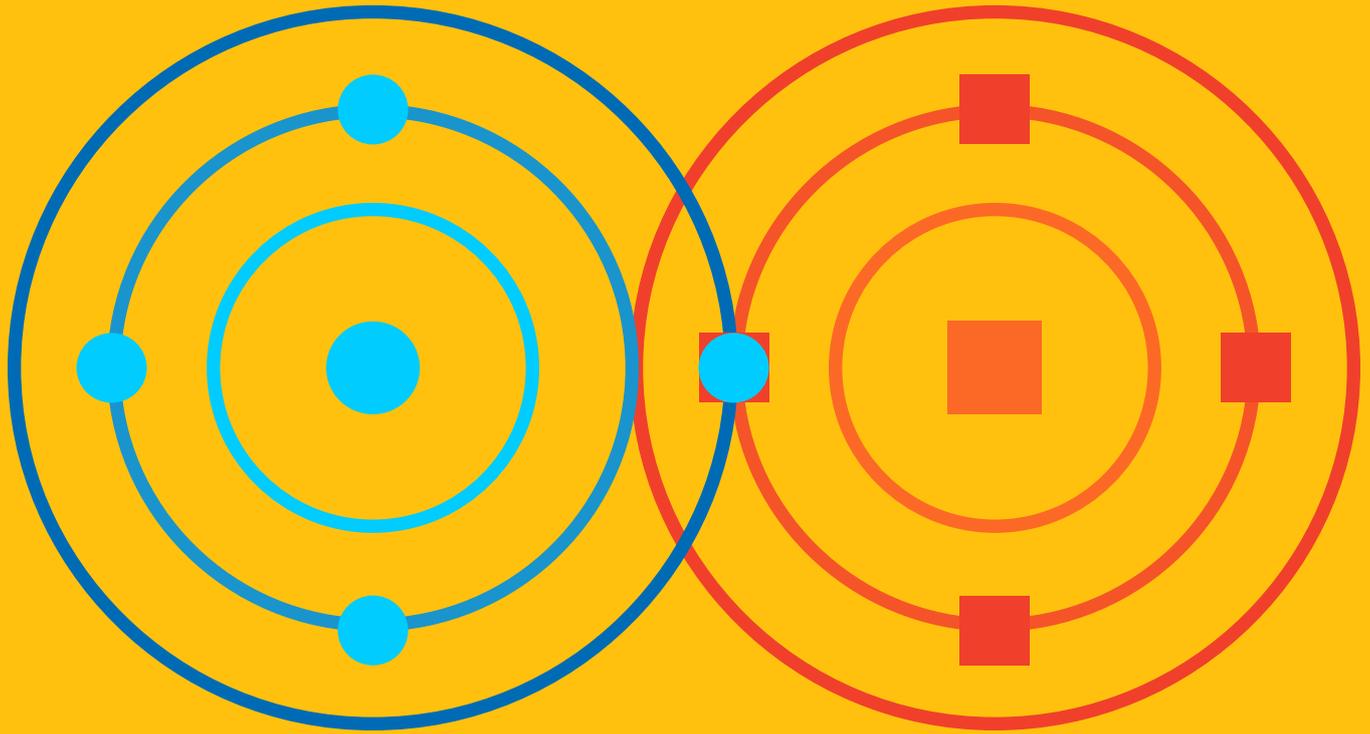
Collaborative projects between the academic and public sectors:

These projects are a minority, and they are created and designed to promote a public policy. In many cases, they involve people to promote policies through participation.

3. The ecosystem is closely related to the public sector.

This is either due to the institutional affiliation of the participating scientists (an area in which the CONICET of Argentina and public universities stand out) or because these projects have been partially or entirely funded with public funds. However, it should be noted that many projects originate without initial financing, or, in many cases, the project's financing does not correspond to other traditional financing methods in the Argentinian scientific system. Instead, funding may come from, for example, social relationships or university extension funds.

We can find similarities and differences between the citizen science ecosystem in Argentina and the emerging global trends we detected in the previous chapter. Various actors actively encourage participation and collaboration in Argentina's data analysis, interpretation, measurement, and dissemination. This also includes projects which involve co-creation in their design and the collaboration of very diverse participants. New data collection methods, such as AI technologies, smartphones, and low-cost sensors, have been implemented in different projects. Moreover, based on our survey with key informants, we noticed that citizen recruitment, motivation, and commitment innovations were not widely used. We have also observed a lack of standardized implementation protocols, which could be useful to assess their accuracy in data quality and access safety or protect their privacy. The last few aspects will possibly start to disseminate as the ecosystem advances and grows in scale.



5. Citizen science and public policy:

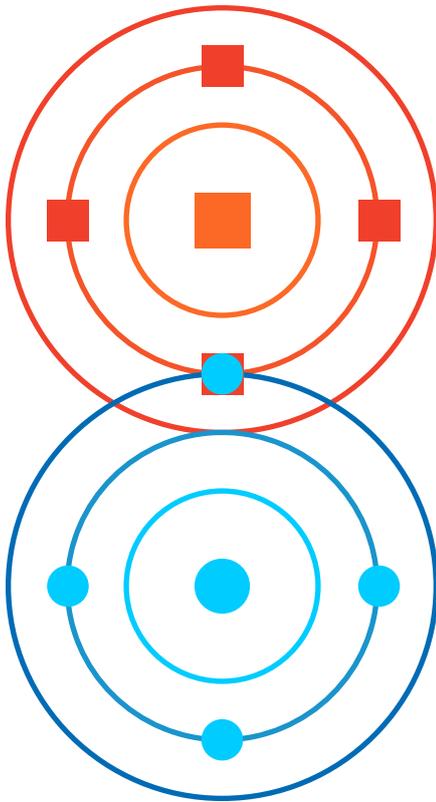
An emerging phenomenon in full expansion in Argentina and other countries

Citizen science is a potential strategy to build bridges between evidence-informed policy-making and scientific evidence.

Moreover, it has two distinctive features: it promotes citizens' involvement and has a great potential for sustainable development (Fritz et al., 2019; Albagli and Iwama, 2022).

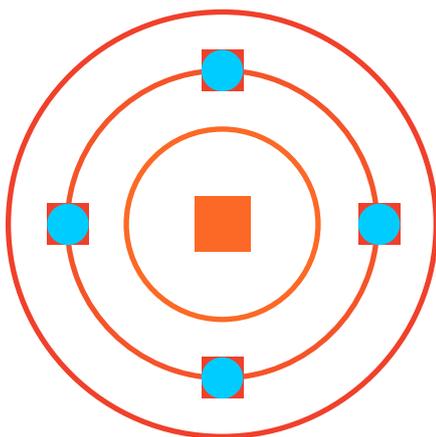
Indeed, after finding the emerging trends specific to citizen science and the ecosystem in Argentina, we believe it is important to emphasize this trend that escapes the citizen science sphere and establishes a connection with public policy. Their relationship is an emerging phenomenon since there are recent studies and instructions on how to encourage it (Schade et al., 2021; Cohen and Doubleday, 2021). Moreover, citizen science ecosystems can be directly correlated with public policy, as in the [European Union](#), the [United States](#), [Canada](#), and [Singapore](#), or even in [Barcelona at a municipal level](#).

To strengthen this emerging phenomenon in Argentina, the experts interviewed pointed out the need to distinguish and work on fundamental aspects that lead to their correlation. On the one hand, it is necessary to strategically encourage a closer relationship between public management and the promotion and development of citizen science. On the other hand, citizen science can support policymaking. At the same time, we must be aware of the potential obstacles. We analyze these three aspects in the sections below.



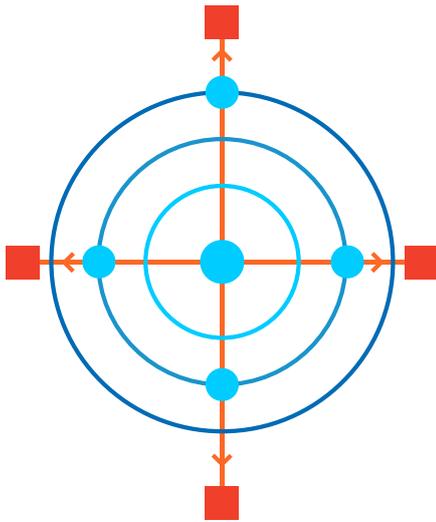
5.1 In what ways could public policy strengthen citizen science?

As observed in the ecosystem diagram in Figure 4, the public sector is linked with citizen science since it provides human resources or funds for most projects through public bodies such as the CONICET of Argentina or universities. In almost every case, funds are limited, and they are granted indirectly through university subsidies associated with extension or social projects. As opposed to other countries, and as interviewees reported, we realized that there are no specific financing or strengthening policies for citizen science to date in Argentina. This proves that, at present, there is no institutionalization of citizen science in the academic system, and there are no scientific policies to promote it. We should point out, however, based on the [collaborative work between Co_Lab and the Ministry of Science, Technology, and Innovation](#) of Argentina, that we have recently started to work on these aspects and on a mapping that gathers the information collected by the different citizen science projects to be used as catalysts for our Sustainable Development Goals (SDGs).



5.2 In what ways could citizen science strengthen public policy?

Citizen science can contribute to the design, formulation, implementation, monitoring, or evaluation of public scientific, educational, environmental, and social policies (Schade et al., 2021).

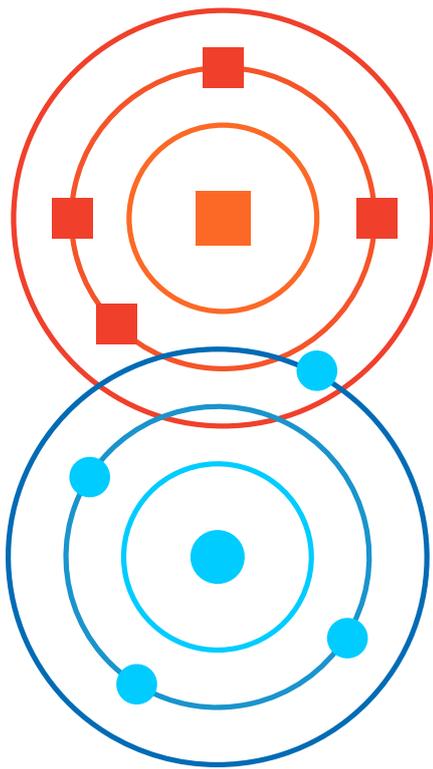


Public policy design and formulation: Citizen science is based on a participatory and collective approach. Hence, it can contribute to discovering scientific evidence with a plural perspective that can consider local needs and aspirations. This can be used for building partnerships and consensus. Moreover, the participation of large groups of people opens the possibility of establishing large data banks that may be exploited to strengthen the available information sites used to feed the design and formulation of public policies. This is very helpful in revealing issues that would not have been considered on the public agenda and addressing socially and environmentally relevant topics. As an example, we can mention the design of public policies for the sustainable management of urban trees in the Municipality of Bragado in collaboration with the Argentinian Network of Municipalities against Climate Change and Co_Lab, or the monitoring of disease-bearing insects, such as the GeoVin project for kissing bugs known as vinchucas in Argentina.

Public policy implementation and evaluation: Citizen science reduces costs and fosters citizen commitment and participation. Additionally, it can develop effective impact monitoring strategies, leading to transparency in evaluating public policies. Since it has the potential to gather large amounts of data through participation, citizen science can help overcome weaknesses during public policy evaluation and monitoring in Argentina, such as a shortage of quantitative data or fund limitations (Aquilino, n.d.).

Our informants reported that one strategy to strengthen citizen science is knowing and considering the political agenda before formulating projects. Public policy contributes to the quality of the projects since it brings them closer to citizens. Moreover, the public sector captured some of the project's scientific talents, which they continue to facilitate joint projects and collaborations with academic stakeholders. However, it should be noted that this path is more like the traditional development of public policies, which is based on a plan with preestablished issues instead of allowing projects to emerge directly from people.

5.3 Potential obstacles to building bridges between citizen science and public policy



We consider it equally important to consider the institutional scenarios in which the public policy stages are negotiated, especially their characteristics related to the degree of openness and consensus (Donadelli, 2020). These factors influence the permeability of the political sphere to scientific contributions. Likewise, some regulatory aspects must be considered before launching citizen science projects from the public sector. Indeed, the two most important recurring challenges that our interviewees mentioned regarding the limitations to the contributions of citizen science to public policies are the characteristics inherent to the political agenda and its transient nature.

Usually, each government has pressing topical aspects and regulations that they follow. If citizen science projects do not adapt to these topics and regulations, it may be difficult for policymakers to use citizen science projects in their work. Additionally, due to the short length of the terms of office, when authorities change, the topics on the agenda change as well. Consequently, in some cases, citizen science projects that are being fully implemented cannot continue feeding the public policy agenda. In other words, every time authorities change, the challenge of trying to reactivate synergies between citizen science projects and policymakers is reestablished. This does not mean that the citizen science projects will necessarily stop, but many times, consequently, they do lose relevance, and the data are never used. The expert interviewees mentioned that many citizen science projects need to be implemented for long periods to be effective in terms of collecting and/or monitoring statistically relevant information. Although these aspects may be applied to the relationship between public policy and science in general, they were mentioned recurrently by experts.

As for its transient nature, our key informants also repeatedly stated that governments often have a genuine interest in promoting citizen science projects, but then it fades away when it is time to analyze data and use it to improve decision-making processes. The disuse of the collected information is accentuated particularly when the evidence contradicts some political stances that public officials have previously established.

There are citizen science trends at a global level that shape citizen science's present and immediate future. They also influence its relationship with the academic sector, civil society organizations, and the public sector. Due to its potential for development, at Co_Lab, we decided to initiate a work cycle focusing on the environment.

Due to its potential for development, at Co_Lab, we decided to initiate a work cycle focusing on the environment. We started our work by placing citizen science within a framework as a participatory knowledge-building process associated with social or environmental challenges. Citizen science leads to building scientifically rigorous knowledge with the participation of citizens and outside traditional environments.

Then we continued our exploratory work by identifying emerging phenomena. We observed data collection and analysis methods related to the emergence of technologies that offer new opportunities, such as artificial intelligence, low-cost sensors, and new functionalities in smartphone implementations. We also noticed innovations in full expansion in terms of recruitment, motivation, commitment, and participation arrangements related to the use of mass media, gamification, and bots to facilitate access to projects and promote participants' commitment. These technologies are optimized by behavioral sciences and co-creative and collaborative participation arrangements. We also noticed that the techniques used for matters related to the collected data's management and quality, security, and ethical standards are also emerging phenomena.

As for citizen science in Argentina, we realized that it is possible to categorize the different initiatives into three major groups: those which originate in the academic environment, those which arise from the citizen's concerns or needs, and, finally, those which are linked to alliances in the public sector. We also noticed that citizen science activities in Argentina are usually concentrated in three nodes. Namely, the Autonomous City of Buenos Aires, the Province of Buenos Aires, and the Province of Córdoba. In the last few years, the number of contributive, collaborative, or co-creative projects in Argentina has multiplied. The degree of institutionalization of citizen science is still incipient, however.

Finally, we observed an emerging phenomenon at an international level and in Argentina: the connection between citizen science and public policy. We emphasize analyzing and establishing a connection between citizen science and policymaking because they have synergies that may contribute significantly to development. We observed that public policies could strengthen citizen science through institutionalization and direct finance since most projects in Argentina today are funded indirectly or through participants' sponsorship. Moreover, by focusing on collective knowledge building, citizen science can promote public policy strategically. For example, in the design and formulation stages, citizen science can contribute to achieving a

consensus and discovering evidence. It can also contribute to policy implementation and evaluation, including data monitoring. Due to the voluntary nature of most participants, the citizen science implementation costs are usually low, which can, in turn, reduce the costs of policymaking implementation or monitoring.

This report reveals citizen science's potential for development, conceptualizes it, shows its trends and its relationship with public policy, and comments on its status in Argentina and the potential future consequences of its evolution. We hope this material can contribute to expanding citizen science and establishing an even closer relationship with participatory public policy for development.

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