



Citizen Science for Naturescapes

A mini-handbook for
transformative change



How to read this mini-handbook

The aim of the mini-handbook is to inspire and encourage a re-thinking of citizen science to include a dimension that allows effective and just nature-based solutions and contributes to transformative societal change, including vulnerable and/or often-excluded groups, to have lasting impact on communities.

The mini-handbook is structured around nine key questions. Each question is accompanied by (1) text that explains the importance of the question, (2) reflective specific questions the reader may ask to develop approaches around citizen science, and (3) 'food for thought' derived from case studies encountered in the NATURESCAPES project.

How to cite this mini-handbook

Möller, I., Lacambra, C., Dubsky, K., Mees, H. & Merfeld, K. (2026). Citizen Science for Naturescapes: A mini-handbook for transformative change. Naturescapes project. www.naturescapes-project.com
DOI: 10.5281/zenodo.21276001

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Glossary

Citizen (Participative) Science: A form of citizen engagement in which citizens and academics collaborate, i.e., members of the public engage in the process of research to generate new science-based knowledge.

Nature-based Solutions (NBS): Interventions designed to use the properties of nature to address multiple sustainability challenges and contribute to biodiversity.

Naturescapes: An assemblage of NBS within a landscape whose character is the result of the action & interaction of natural and societal factors. When in capitals (NATURESCAPES), we refer to our NATURESCAPES project.

Transformation: Societal change leading towards social-environmental transformations. Transformative change can occur by changing the way people think (views), the way society is organized (institutions), or ways of doing (practices).



Introduction

Citizen science can empower, inspire, move, and strengthen individuals and communities, fostering a deeper appreciation and understanding of nature while influencing decision-making and policy.

Even in cities, we live with nature in and all around us. How our naturescape looks is as much a function of our actions as of natural dynamics. How could citizen science transform lives or bring nature back into the fold of our society's thinking? If done well, citizen science can transform communities. It can help recognise, create, and safeguard nature-based solutions (NBS) to address the many challenges we face.

This handbook is for anyone leading a citizen science initiative where people and nature come together in urban areas. It is a companion tool to the many guidebooks on conducting citizen science out there (and we encourage you to read them!). It provides an opportunity to think about how citizen science can contribute to transformation in and through cities by connecting people and nature.

We pose 9 questions for reflection, with illustrative examples from our NATURESCAPES project, to stimulate different ways of thinking about citizen science. The first 3 questions address the 'what?' who? and 'why?', and the following questions address the 'how?'.

We hope this handbook will help you bring nature and people together for a better way of living.

The NATURESCAPES Team

Key Question #1



What kind of change could the citizen science initiative achieve?

In all our NATURESCAPES cases, the main facilitators of citizen science initiatives are citizens, citizen associations, NGOs, governments, and other actors, alongside researchers. All cases provide participants with a sense of belonging and a sense of doing something for nature – this requires structure, clear goals, and inspiration.

Our cases show that it is important to move to ‘beyond foundation’ objectives, that is, not just focusing on restoring biodiversity but on what biodiversity provides to citizens. We see how restoring mangroves can improve fisheries and livelihoods and how citizen science in urban gardens and forests provides food security, joy, positive social interactions, and pride of place (Martinique, Lisbon, and Gothenburg).

Citizen science can be used to foster citizens’ action. In the *Gieß den Kiez* (‘water the neighbourhood’) initiative in Berlin, citizens can adopt trees, look after them, and report on them. In Phoenix, the *Desert Defenders* initiative informs citizens about invasive species and how to identify and eliminate them. Information is used and transformed into action, which is then evaluated, continuing a virtuous loop. Citizen science may also be transformative in shaping how authorities act. Using existing law to protect communities and nature is challenging, but it can drive the transformation of official decision-making.

Food for thought: Lisbon – HortaFCUL

HortaFCUL was started in 2009 at the Faculty of Sciences of the University of Lisbon (FCUL) by students interested in permaculture. It became an umbrella initiative integrating science, education, experimentation, and social impact. Over the years, different initiatives have emerged promoting NBS and the participation of students, teachers, university staff, NGOs, local communities, and other research institutions. The FCULresta, a dense, biodiverse, and multifunctional mini-forest, was planted in 2021 to assess its potential for climate action and ecosystem services in an urban environment.

HortaFCUL's projects align with the UN SDGs (United Nations Sustainable Development Goals) and Agenda 2030 (the United Nations plan of action for people, planet, and prosperity). The governance model is participatory and sociocratic. This means that decisions are made collectively by the group of volunteer "Guardians", with a greater level of involvement and responsibility, and on a basis of trust. Despite the challenges associated with volunteer turnover, horizontal governance with its model for volunteers' participation is one of HortaFCUL's key successes. It ensures continuity through partnerships, funding, and the production of both academic knowledge and materials for the public. Motivations to participate are varied, including scientific interest, residents' desire for agency in the face of climate change, and institutional motivations often aligned with sustainability and community engagement.

Reflections

What change could the citizen science project achieve?

... for people (who?) and communities (which?)?

... for nature and Nature-Based Solutions?

... for organisations?

... for science?

How will this change be achieved? (e.g. measurement, observation, action, other?)

And what will be the evidence of that achievement? (e.g. evidence of new learning, new skills, income generation, food availability, recreational space access and use, mitigation of risk?)



Key Question #2



Who will be involved?

A citizen science initiative can become more transformative when thinking in an open-minded and proactive way about who to involve. It is important to ensure diverse perspectives and consider different types of knowledge so that objectives for more transformative outcomes are grounded in lived experiences.

Across the cases identified in NATURESCAPES, participants and levels of participation vary as widely as the initiatives themselves. Volunteers might support the collection of data, the digging of holes, or the building of information boards, but also the creation of apps (e.g. to identify trees in need of watering, or locate invasive species that need attention). Not everyone needs to be outdoors. It is a team effort and in a diverse group, there may be different volunteers taking water samples, maintaining gardens, building structures, but also filing complaints, teaching, programming, or diagramming, etc. It is possible to seek out people with the necessary skills, directly or through local organisations and institutions (schools, universities, elderly groups, fire brigades, prisons, fishers, religious groups, neighbourhood associations, law schools, etc.).

Organisations can help structure involvement, contribute knowledge about the natural system or an understanding of the social context, financial support, a plot of land to restore, or an opportunity for participants to relax. How people interact and how communication occurs depends on who they are. Both define the transformative potential of a citizen science initiative.

Food for thought: Martinique – Ypiranga Gardens

Weaving together community gardens, workshops, and markets, Ypiranga gardens promote a return to nature, based on traditional Creole values and practices in Fort-de-France, Martinique. Ypiranga gardens strengthen social capacity by empowering local communities to engage in knowledge regeneration and dissemination, fostering food autonomy, and recovering urban soils using a variety of techniques to plant gardens. This NGO initiative runs 14 plant libraries across Fort-de-France in schools, local neighbourhoods, and prisons to promote education on local medicine and nutritive plants.

In this type of initiative, involving participants who can assess potential negative impacts on an NBS is also essential (e.g. through disturbance, overharvesting, or unintended impacts on traditional users who may rely on the resources being extracted).

The involvement of diverse members of society, from kindergarten children to prisoners, empowers the community, creates a sense of caring for nature, promotes food production, restores and disseminates traditional knowledge, connects citizens with nature, and enhances biodiversity. It does this through collaboration, joint work, and group learning. This also restores and re-legitimises historical practices and traditional knowledge.

Reflections

Who is needed to achieve transformational aims (and what is in it for them)?

Who are the people/communities/organisations most relevant to achieving success? How can they get involved, interact, and engage via the communication channels they use?

Who holds knowledge, and what experiences should be valued and included? Is training needed?

How might others perceive those who facilitate the project? How does this affect the way the facilitators interact with them, and how can trust be built?

What communication types can be used, and who might take on which tasks and responsibilities?



Key Question #3



How much information is there?

Understanding how the NBS functions is critical. What information is available or could be obtained and is needed? How could this information be used to achieve transformational change? Is it possible to see the world through the lens of a tree or a coral?

Citizen science can be used to identify a problem or problems in which nature could be part of the solution and to help safeguard the NBS. Whether species or pollution monitoring, safeguarding the need for urban green spaces, or ensuring the survival of traditional knowledge about medicinal plants, a citizen science initiative must be grounded in a sound understanding of NBS and be able to answer the questions *'what?', 'for what?', 'when?', 'with whom?', and 'for whom?'*.

Contextual understanding of how people and nature interact helps participants set realistic expectations and appreciate and communicate the benefits of NBS. In our naturoscapes, citizen science both works with existing and produces new knowledge: traditional, scientific, and technical (e.g. in the food gardens in Lisbon, Fort-de-France, and Gothenburg).

Knowing the NBS is as important as knowing the objectives – both define the initiative's needs, equipment, data, resources, and timetables. Designing a bird survey that requires volunteers to have access to binoculars, recorders, cameras, and paper for a week is one thing; planting trees that require constant maintenance to reduce heat exposure in 25 years is quite another.

Food for thought: Cartagena de Indias – Semillas de Manglar

This initiative brings together several actors working around the coastal lagoon and mangroves in the south-eastern area of Ciénaga de la Virgen, Cartagena. In this area, water quality and mangroves are severely degraded and increasingly encroached on by urban expansion. Consequentially, underserved communities are increasingly vulnerable to the effects of pollution and flooding during severe rains and storms.

Knowledge of natural dynamics and ecosystems, along with frequent monitoring, is enabling environmental restoration. In 2014, communities and other actors prioritized this environmental restoration to support socio-economic development.

Neighbouring communities, fishers' associations, and grassroots organisations led the restoration, species inventories, garbage removal, water monitoring (quality and levels), early warning systems, and eco-tours initiatives, advised by universities and financially supported by privately owned foundations. The initiative enhances environmental awareness and livelihood alternatives to mangrove destruction. Cartagena benefits from improved water and soil quality, fisheries, and biodiversity, with all the associated public health and nature-awareness benefits arising alongside.

Co-designed and co-governed by communities, Semillas de Manglar also builds skills, provides employment, and strengthens community bonds (see also page 27). Schoolchildren and teenagers participate in environmental and cultural activities that enhance their curiosity, keep them active and interested, and feed the knowledge base on the NBS.

Reflections

How does the NBS function and how is it connected with its physical and social context?

What would the world look like through the eyes of the NBS?

What knowledge exists, is needed, or missing to fully understand the NBS?

Can the citizen science project help? Could it damage the NBS in the process?



Key Question #4



How to co-design the initiative?

Building the initiative on a foundation of trust and transparency with all participants is essential. Mistrust can build much more rapidly than it can be overcome, even though some citizen science initiatives may arise from mistrust in institutions.

Strengthening trust and transparency through active communication is easier when a path is mapped out in advance, purposefully identifying phases involving different actors and activities so that expectations can be met along the way. But it is also important to balance this with a flexible, agile, and inclusive approach.

Co-creation is particularly important for restoring, protecting, or implementing an NBS in a shared place, as expectations can be as diverse as the people with interests in the location. If there are people living nearby (e.g. landowners or schools), engaging them can help ensure permanence and sustained maintenance, as the Cartagena case has shown.

Consideration of this aspect of the initiative is closely linked to Questions 2 and 4 above. However, it is important not only to design the initiative into set 'phases' but also to 'co-design' it with all participants. For transformational outcomes, co-design must be embedded from the design phase, jointly planning stages with clear monitoring and review phases that enable nimble adaptation.

Food for thought: Phoenix – Desert Defenders

Desert Defenders is a collaborative, community science program in Greater Phoenix mobilizing citizen science to find, map, and manage invasive plants that threaten the Sonoran Desert's ecosystems and public safety (wildfire, air quality). Desert environments can easily become monocultures, thereby increasing wildfire risk (many invasive species are high-risk). Participants protect the desert's biodiversity by reducing the negative effects of invasive species.

This self-funded network of organisations operates as a partner working group that includes indigenous communities. The network is coordinated through the Central Arizona Conservation Alliance and facilitated by the Desert Botanical Garden, with land managers and nonprofits including Maricopa County Parks & Recreation, McDowell Sonoran Conservancy, White Tank Mountains Conservancy, Friends of the Tonto, and the Cities of Phoenix and Tempe. Public participation is linked to operational management across jurisdictions: locating priority infestations, informing treatment choices, tracking re-treatments, and building local stewardship through training and on-the-ground restoration. Each team runs its own field days and contributes data to shared layers; some groups add experimental plots, while others couple mapping with removal events and restoration. This initiative supports decision-making by providing relevant information to the responsible bodies.

Building on 'co-design', community benefits include ecological skills, leadership (trainer-of-trainers), and public education products.

Reflections

What might be the different steps of the citizen science project, and who will be involved in them? (e.g., phases may include the design, the work itself, the monitoring of the project, and perhaps review and adaptation)

How might we address resistance after the first phase?

How could the project work with the community to build momentum and grow? Who will 'own' its future?

When are additional resources needed – be it in terms of community efforts or new rounds of funding?



Key Question #5



Who will do what?

The ideal team might not exist, and it is also very likely to change over time. Citizen science initiatives mature, grow, and evolve, requiring nurturing and review to ensure participants remain motivated and inspired. Seeing the citizen science activity through the eyes of different participants helps ensure it is fair and benefits everyone involved, making it possible to think carefully about who (and how) the initiative can support, train, and enable.

One way to make transformation happen is to bring together a combination of skills and talents through collaboration. Not everyone wants mud on the boots, eyes on the sea, or arms on the shovel. At different times, the initiative may need data scientists, surveyors, or the elderly to advise on natural cycles and extremes. Some individuals bring skills and others bring time, such as schoolchildren supporting species identification or urban garden maintenance, while gaining skills in the process.

Our NATURESCAPES cases highlight that all professions and technical skills (architects, chefs, fishers, drivers, gardeners, engineers, lawyers, divers, artists, etc.) have a role in citizen science linked to NBS. Importantly, citizen science can allow people's latent skills to be recognised, leading to a greater sense of belonging, efficiency, purposefulness, and achievement.

Food for thought: Mobile – Eagle Reef

The Eagle Reef was launched in 2022 as an Eagle Scout service project by John Shell (Boy Scout Troop 147) to counteract Mobile Bay's habitat loss and declining fish populations due to the degradation of oyster and seagrass beds. In this project, various participants from a team take on specific roles and contribute their skills. The project has grown into a regional environmental initiative supported by Partners for Environmental Progress (PEP), the University of South Alabama, and neighbouring municipalities. Residents and Boy Scouts, homeowners, and fishers volunteer and find locations for the installation of artificial mini-reefs under (private) piers, wharves, and docks, creating habitats for fish and filter-feeding oysters that aid in improving water quality and coastal protection. Homeowners also monitor the reefs, tracking their health and fish populations.

In this case, roles and benefits are diverse. Fishermen benefit from revitalized fish populations, tourists from improved recreational offers, and the University of South Alabama gains research opportunities in marine restoration and water quality monitoring. The cultural value of youth-led environmental action has also increased.

This initiative, started by one person, is now managed by an organisation, funded by private, public, and crowd funding, with tight collaboration across many participants.

Reflections

What is needed in terms of existing (local) knowledge, experience, expertise, assets, and what role(s) could those in the team of volunteers fulfil (e.g., initiator, facilitator, documenter, benefiter?) in the context of the activities they will carry out?

What might be areas of bias that might creep into this process? Who might be favoured, who might need to be given a voice, or which skills might the team lack?

Why would the participants engage in the project?

How can new participants get involved?

What are the benefits of involving them? (awareness, learning, knowledge, employment, food, relaxation, time occupation, kids off the streets....)



Key Question #6



What kinds of time does this project need?

Citizen science initiatives have their own rhythm and timeline. There may be an end date, e.g., a festival and artistic representations, an inventory, or a report. Or perhaps a punctuated, repetitive key time point, e.g., for fish landings. Or the initiative may be long-term and intergenerational, as many of our NATURESCAPES citizen science cases are.

Time is not the same as timing. Timing can be very relevant for permanence (e.g., where the NBS depends on our carefully timed actions). It can also be essential to gather observations; in our Dublin citizen science case, precise weather and tide data were needed to release sewage tracers into the bay from a sewage outfall.

However, optimal timing for nature is not necessarily the same as optimal timing for humans. Restoring coral reefs or forests takes decades, but those involved may wish to see the benefits of their actions sooner. Finding the sweet spot where nature, community, media, and political time align can be a most challenging task. Thinking about timing for nature and people is key. Managing expectations and creating opportunities and benefits for all involved across different time horizons requires combining short-term thinking with long-term planning.

Food for thought: Berlin – Gieß den Kiez

In May 2020, CityLAB Berlin launched Gieß den Kiez, an interactive platform designed to support Berlin's trees by fostering collaboration between volunteers and the city to help them during increasingly dry summer months. The platform maps nearly all of Berlin's 900,000+ city trees, complete with data on age, species, and water requirement. Citizens can create profiles, adopt trees, and mark them as 'watered', making it easy to track through time the contributions to the health of Berlin's trees.

City authorities are very supportive; volunteers support their work, and a website provides additional information to the authorities about the state of trees. Importantly, time is built into the initiative's very essence.

In this 'beyond generational' thinking, timing is crucial to addressing drought and the impact of climate change on Berlin's trees, given limited financial resources: over 10,000 participants now actively water trees in Berlin. The initiative is seen as a multi-generational activity, and its model adopted in other German cities. Gieß den Kiez not only exemplifies a practical response to urban climate challenges but also fosters a sense of shared responsibility and community engagement in caring for urban green spaces.

Reflections

How does the NBS in the citizen science project relate to change over time?

When, over the annual/seasonal cycle, does it make most sense to conduct the project? Does the timing affect the answer to any of the other questions asked above?

By when are outcomes from the project expected and by whom?

What could be the short, intermediate, and long-term objectives, and do these differ for the range of participants or interested groups?



Key Question #7



How do we best work with others in nature?

Outdoor experiences can be transformational. Whether finding invasive species for removal or simply 'feeling' nature, being in nature can lead to step changes in mental and physical health for individuals and communities.

To achieve such a transformational experience, however, it is important to understand participants' physical and mental needs and their safety. Groups have diverse mobility needs, abilities, and prior experience with the environment. Taking them to an NBS can bring novel or unusual risks and emotions. Thinking carefully about these risks and emotions can either make the project a great transformational success – or leave participants feeling they would never want to encounter this environmental setting again (or worse...). Potential risks or negative emotions can include dangerous fauna and dehydration in the Sonoran Desert or missing the rising tide in Dublin!

The aim is to help people feel empowered while also managing foreseeable risks and raising awareness of the dangers of being in a particular space. This also includes alerting participants to any endangered or fragile species they should respect (such as venomous snakes in mangroves, the fragility of corals, and nesting areas). It is important to ensure that participants know how to safeguard themselves, others, and the natural environment around them. Their field experience can then be truly empowering and path-shaping!

Food for thought: Dublin – Coastwatch

Coastwatch works with diverse participants in the field, including preschool children who are led to the dunes of Bull Island in Dublin Bay to appreciate how dunes serve as an NBS and come under pressure in this urban setting.

Facilitators divide children into 4 groups: ‘eyes’, ‘ears’, ‘nose’, and ‘touch’. By exploring the dune in this way, everyone becomes acutely aware of the environment (e.g., discovering ‘soundscapes’, lichen textures, the finest flowers, and bird anvil stones). This teaches respect for the NBS and awareness of what is present at different scales (e.g. from small worms in the sand to large dune chains several meters high).

To avoid field risks, there is always one adult per 1-3 children, and adults co-design the experience (see also Question 6). A briefing is held to alert adults to the risks of children straying from the group and to explain the emergency procedure (notably, this also includes agreements on photographs of the event and their use).

When asked ‘how do you protect all that you saw, heard, and smelled, and all the creatures you encountered?’ the children’s answers show that they have discovered something new that they want to protect.

Reflections

Are there dangerous aspects of the NBS (e.g., physical hazards, animals, or poisonous plants)?

Will participants be working near water bodies or slippery surfaces? Could the tide be coming in? What is the ground like underfoot?

How cold or hot will it be?

How can it be ensured that those with special needs are looked after and assisted?



Key Question #8



How will the initiative sustain transformative citizen science?

Transformative citizen science is captured in more than 'reports' or tangible 'outputs'. It might also include acquiring transferable skills or experiencing personal growth, both of which are hard to measure. It is important to realise that the continuity of transformative change associated with citizen science is not a given – it requires ongoing attention and nurturing, both with participants and the wider community in which the NBS is located. Transformation may include an acquired ability to identify medicinal plants and care for them, an understanding that reefs and seagrasses reduce wave energy, the ability to measure water levels in a coastal lagoon, or the ability to produce honey. It may also be less obvious, such as increased fish populations within restored mangroves in Cartagena and the reefs in Mobile.

Participant engagement in workshops, training events, festivals, and new initiatives arising from their involvement in the true spirit of co-creation is very important.

When participants engage in citizen science initiatives, their interests usually go way beyond co-authoring a scientific paper. Hence, managing participants' expectations regarding expected outcomes and finding ways to acknowledge their contributions in a reciprocal relationship are key to ensuring trust and longevity.

Food for thought: Lima – Birdwatching

Lima's birdwatching initiatives are led by university students "committed to promoting research in ecology, biodiversity, environmental education, and the management of wild birdlife". Birds are identified, and workshops are held to teach the public how to trap, identify, and catalogue them. The archive helps scientists with long-term data collection on migratory birds across different hotspots in Lima. Parallel initiatives organise workshops and guided tours to engage and raise awareness of biodiversity across the city.

Organisers collaborate with municipalities, and most of the data is recorded onto eBird, a global online database. Special events, such as the Global Big Day, allow volunteers to gather at different parks and bird hotspots to identify as many birds as possible and contribute to the local, national, and global bird count.

The longevity of the transformational aspects is now built into the initiative, as municipal and district-level authorities and their respective park and garden activities support and even organise birdwatching activities (especially in Miraflores and La Punta). Goals and principles support biodiversity and green spaces throughout the area, and signage of the different birds in the parks has been placed. The initiative is enhancing Lima's biodiversity and Limeños' respect and love for nature.

Reflections

How can feedback from the project community be effectively gathered and shared? How can all those involved, as well as those outside the project, learn from this?

Can the project empower the community to use the knowledge, data, and insights they have gained in the process to address known inequality or uneven power relations?

Who within the citizen science community may need to be kept in touch with or be followed up with to ensure continued engagement?



Key Question #9



Who knows that the initiative made a difference?

To celebrate and widely share what the citizen science team has achieved is transformative for all. This can be done through shared ownership, the creation and recording of an agreed set of outcomes, or taking forward an agreed set of lessons learnt. What all participants might take forward, individually and collectively, is part of the process of lasting impact.

Recommendations for decision-making or even new policy instruments might arise and offer at least the potential for longer-term governance transformation. It may be, e.g., that citizen science initiatives identify that an NBS is threatened by pollution, prompting efforts to address this through imposing penalties or better waste collection processes.

Regardless of the provision of 'robust' knowledge or data, the initiative can achieve transformational change – either at the individual, group, community, or stakeholder group level – and it is very important that the lessons learnt are shared more widely to scale up this transformation.

This is what becomes the legacy and holds the true power of the desired long-lasting transformative change: the growth of the knowledge generated and, particularly, the transformation achieved, over time. This process should be owned by the community rather than by an external group of 'academics'.

Food for thought: Quotes from projects

"...there's still a lot for me to learn, but just the small amount that I have learned has opened up my eyes that like every little daily just routine is affecting me." – high school student monitoring water quality in Mobile, Alabama

"The people do not invade this ecosystem thanks to the fact of the communal agreement that has stood up, both with the institutions and also with the communities, because if it weren't for it, this wouldn't exist here. This would be full of houses by now, no doubt about it... there is a very nice mangrove there, also beautiful, tall, as tall as that." – Community member Cartagena

"The people that suffer most from issues with invasive species are the underserved communities because their biggest impact is the increase on the wildfire cycle, which means, air pollution and issues with water and all of these other things that it's affecting that hits those underserved communities first, because they don't have the resources that other folks do, even if they're not living next to the parks." – Botanical Garden Phoenix

Reflections

Has there been a measurable response within or outside of the community to the citizen science initiative?

Have the human pressures on the NBS decreased due to the citizen science initiative?

Have the citizen science project results led to real societal change or action on their own or together with others?

How can those who hold or own the new knowledge be given the tools to use it to lead to transformational change?





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**Funded by
the European Union**

The NATURESCAPES project is funded by the European Union under Grant Agreement No 101084341. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.