About This Tool

We are living in a time of tremendous change. In recent years the world has battled extreme storm events, destructive earthquakes, uncontrollable wildfires, and a global pandemic. But we are also living in a time of tremendous opportunity—where new technologies and communication channels are helping to spread ideas and ingenuity. The result is the growth of an organic movement of ordinary people, organizing through science and engineering to help disaster response and recovery. We refer to this as disaster citizen science. Using scientific principles and tools, communities are investigating, influencing, and informing policy and decisionmaking alongside the professional scientific establishment.

The world’s experience with the global pandemic of COVID-19 has made clear the importance of scientific research. Citizen science is helping to build the knowledge base surrounding COVID-19 in real time through such activities as contributing data to COVID-19 symptom trackers and sharing patient experiences with the virus in social media and other forums. Similar citizen science efforts helped inform policy after previous disasters, such as the Deepwater Horizon oil spill, Superstorm Sandy, and the Fukushima nuclear power plant meltdown. Individuals and communities might decide to become involved in disaster citizen science for any number of reasons, including a desire to help their families or others, an interest in testing out new technologies, or a focus on expanding participation in the scientific process. Regardless of the specific motivation for becoming involved, community groups can benefit from having a thorough understanding of how to design and implement a high-quality disaster citizen science project.

The goal of this toolkit is to provide guidance to community groups about engaging with disaster citizen science. We developed the toolkit because of the growing threat to communities posed by all types of disasters, large and small, both manmade and natural, such as hurricanes, earthquakes, wildfires, oil and gas spills, chemical contamination, climate change, and pandemics. The guidance throughout is not disaster-specific. The toolkit was designed for use by a broad range of community groups (e.g., volunteer or faith-based institutions, social service organizations, advocacy organizations, private or other non-profit organizations). It may also have relevance for informal groups of individuals who quickly come together to pursue citizen science.
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Introduction
Each year, communities across the United States are threatened by, and may experience, a disaster or other emergency. In the past decade alone, communities have faced a number of major disasters, including the Deepwater Horizon oil spill (2010), Superstorm Sandy (2012), Hurricane Harvey (2017), severe wildfires (2019), and—in the year this toolkit was written—a global pandemic caused by a novel coronavirus (COVID-19, 2020). Many of these disasters, such as tornadoes and earthquakes, strike suddenly, while others, such as a public health crisis brought about by elevated chemical levels in the water or air, may intensify over time. Warming temperatures have amplified the effects of some disasters, contributing to the spread of diseases carried by insects, such as ticks and mosquitoes.

Disasters have profound effects at the local level, and communities therefore form the backbone of disaster preparedness, response, and recovery. Before an event a community might ask: What should people do to prepare? What supplies and resources do people need? During and immediately after an event, a community might ask: Who is most affected and how? What kinds of operations, services, or medical treatments are needed to save lives? When is it safe to reopen communities to business as usual? Long after disasters recede, a community might wonder about long-term harms and how best to recover from lingering economic, social, emotional, and health-related damages.

The answers to such questions can often be informed by science. Research—including work in the field of disaster science—has played a key role in informing decisions about how to help communities prepare for, respond to, and recover from disasters. Research is needed to understand and characterize disasters—how they arise, how they
evolve, and where and when they are likely to strike. Research is needed to understand the effects a disaster might have—to identify vulnerable groups or uncover the mental and physical health impacts of a disaster. Research is needed to develop medicines, technologies, and strategies to prevent disasters or stop them in their tracks, and to help people respond and recover. Findings from research feed into decisions about the resources and services needed in a community.

Although most disaster science work has typically been performed by professional researchers working in their chosen fields, in recent years the public has taken on an increasing role in asking and answering their own research questions. Such efforts can collectively be referred to as citizen science—sometimes called community science or street science—which can be defined as public engagement in scientific research as scientists rather than just as study participants. When applied to disasters, we call the field disaster citizen science (see Box I.1).

The concept of public participation in science is not new. Astronomer Carl Sagan said, “Everybody starts out as a scientist. Every child has the scientist’s sense of wonder and awe” (quoted in National Research Council, 1998). Recent advances in technology, now widely available, have provided communities with greater access to the knowledge, tools, and methods necessary to support citizen science. By harnessing these advancements, community groups can obtain data and answer critical questions while using an approach designed to promote public participation, education, and understanding of science. Everyone can benefit.

About This Toolkit

This toolkit was developed by the RAND Corporation under contract with the Centers for Disease Control and Prevention (CDC) to provide guidance to community groups on engaging in disaster citizen science. The toolkit is designed to

• raise awareness of the types of disaster citizen science activities that community groups and others have engaged in
• provide guidance on how to design a disaster citizen science project and identify resources to support activities
• facilitate partnerships between community groups and other entities, such as government or research institutions, to carry out disaster citizen science activities.

The toolkit is designed for use by a broad range of community groups: volunteer or faith-based institutions, social service organizations, advocacy organizations, private or other nonprofit organizations, and others. It is primarily directed toward groups interested in creating and leading their own disaster citizen science projects. However, groups not ready to lead a research project can still use the toolkit to learn.
more about disaster citizen science and how they might become involved. The guidance in this toolkit presumes that some existing infrastructure and access to resources are important for carrying out high-quality research. However, the toolkit may also have relevance for informal groups that come together quickly: These groups can use the toolkit to learn about the kinds of resources and structure needed to support robust citizen science activities.

**The toolkit is organized into two main chapters:**

- The first chapter, Learn, is a primer on disaster citizen science, explaining why citizen science is important, providing organizational models of citizen science, and offering examples of existing citizen science projects.

- The second chapter, Act, describes a five-step approach for planning and designing disaster citizen science projects and describes common challenges that may arise.
How to Use the Toolkit

This toolkit will walk you through the steps necessary to design a high-quality citizen science project of any size or scope. (See Box I.2 for more details.) Although individuals can use the toolkit on their own, if you are working with a team, we recommend going through the toolkit together. The toolkit contains many interactive elements, including exercises, that can help your team reflect on what you learn and worksheets to help you design a research project and document the decisions made. It is important for everyone on your team to be on the same page and to have a shared understanding of the problem the team wants to tackle and the direction to take. To accommodate larger groups, we have provided extra copies of the worksheets in an appendix in the back of the toolkit and have also made these available on the RAND website (www.rand.org/t/TLA175-2). The appendix also includes a compilation of all the disaster citizen science project examples described in the toolkit.

BOX I.2
Using the toolkit: Common questions

**Does this toolkit apply to big projects or small projects?**

The toolkit aims to help you design a project that fits your needs. For any disaster, a citizen science project can be constructed as large or small—you may wish to enlist large numbers of people to engage in observations, or you may wish to work with a small group to measure some defined phenomenon.

Although the guidance in this toolkit applies to any disaster citizen science project, it does lean toward providing enough information for groups wanting to carry out large-scale research projects. To support larger projects, the guidance in the toolkit emphasizes research that might be used to change or further inform a policy or practice, and the toolkit was designed using a *fitness-for-use concept*, which means that the quality of the data is suitable for the project’s intended purpose and scope (Holdren, 2015). However, the toolkit is still applicable to smaller research efforts (e.g., to raise public awareness, show the need for more research, educate people). Although the toolkit describes steps that apply to any project, your answers in the worksheets should reflect your own research purpose, as well as the scope or size of your project.

Keep in mind that the toolkit is also intended to help community groups get comfortable with the broader goals and terminology behind citizen science. Even if you run a small project, having this broader understanding should help you communicate with a wide variety of stakeholders and can enhance your capabilities in future activities.

**What kinds of disasters does the toolkit apply to?**

The toolkit applies to many different types of disasters, from large events that affect lots of people (e.g., a hurricane, earthquake, wildfire), to small, localized issues (e.g., an oil or gas spill in a community). The toolkit applies to rapid-onset events that have a beginning and an end, as well as to chronic, slow-moving disasters whose effects are revealed over time (e.g., chemical contamination, climate change).

For example, your project might be geared toward helping your community prepare for or prevent an event (e.g., surveillance and monitoring studies), enlisting volunteers in real-time data collection during disaster response (e.g., real-time damage assessments), or working with others to identify recovery needs (e.g., participatory research studies with small, vulnerable groups).

**Is the toolkit for organizations or informal groups?**

The toolkit is designed for both established organizations and informal groups. Existing organizations may be better resourced and therefore better suited to carry out some kinds of projects, and some aspects of the toolkit (e.g., organizational support) might not be relevant for informal groups. Nonetheless, discussions of group leadership and culture apply to groups of all sizes, and the toolkit discusses partnerships and other options that can help informal groups access additional personnel and resources.
Notes About Toolkit Development

The content and guidance in this toolkit were informed by a synthesis of information gathered by five methods:

- **interviews** with 63 people involved in different areas of disaster citizen science, including community organization leaders; citizen scientists; academics; technology developers; federal, state, and local government officials; and entrepreneurs—interviews were designed to gather different perspectives on the promise and challenges of disaster citizen science, and quotes from these interviews appear throughout the toolkit.

- **a review of the scientific literature** to understand the state of published knowledge on disaster citizen science.

- **a catalog of disaster citizen science projects** across the globe that provides real-world examples of disaster citizen science in action.

- **a nationally representative survey** of 272 local health departments to understand the perspectives of local government organizations with significant roles in disaster preparedness.

- **discussions with an advisory board** consisting of community organization leaders and local government officials to provide guidance on toolkit development.
CHAPTER 1. LEARN

A Primer on Disaster Citizen Science

Why Become Involved in Disaster Citizen Science?

Research is critical to aid in understanding the characteristics of a disaster, document adverse outcomes, and test strategies for preventing disasters and reducing their harms. Citizen science is especially important following disasters, when timely action is needed and response professionals, such as first responders and local government, are often stretched thin.

A citizen science model has many benefits for disaster research. For example, in the immediate aftermath of a disaster, local community groups engaging in citizen science can help collect data to inform disaster-related operations and real-time decisionmaking for response. Local community groups with citizen science plans in place may be able to gather valuable information about conditions on the ground (e.g., neighborhoods with greater damage, vulnerable residents requiring rescue or services, areas with potential environmental contamination). This is especially important in situations where professional scientists are not able to get into the field quickly or do not have the resources to access all the places where data need to be collected.

Community groups can also draw on their knowledge of local neighborhoods and credibility with residents. Local groups have firsthand knowledge about their own neighborhoods that response professionals and outside scientists may lack. In addition, local community groups are often best positioned to serve as trusted messengers with the wider community.

Community groups can also help to fill gaps and build a collective understanding of a disaster and its impacts to aid in prevention and recovery. Community groups often know which research questions are of particular interest to the local region and can ensure that these issues are addressed. Rather than waiting for academic or government scientists to define questions and collect data, local groups can jump-start the process by prioritizing the questions important to community members, taking environmental measurements (e.g., air- or water-quality samples) before or after a disaster, or surveying residents about experiences, impacts, and needs. Such information may help communities and public officials to fully understand the scope of a disaster and its effects, identify areas of need to speed up recovery, and determine possible actions to prevent or reduce the harm caused by future disasters.

So far we have focused on the benefits of citizen science research for disaster-related operations and decisionmaking. However, disaster citizen science might also provide additional benefits for communities (Figure 1.1) (Den
Broeder et al., 2018). Citizen science could enhance public education and bolster science literacy in the community. Because citizen science involves individuals or groups working together for a common cause, it could also build a community’s social capital or connectedness. Engaging in citizen science might promote knowledge development among participants and increase the knowledge resources available in a community. Citizen science could provide an avenue through which leadership traits are developed. At the same time, citizen science is democratizing—it could open up a path for more voices, and a greater diversity of voices, to participate in scientific discussions around disaster preparedness and response (Haywood, 2014; Den Broeder et al., 2018). All these benefits, in turn, have the potential to increase community resilience to withstand and overcome the many harms caused by a disaster.

A public health official we interviewed said,

> First of all, [disaster citizen science] accelerates the pace and decreases the cost of data collection. Secondly, I think very often it opens your eyes or the eyes of officials involved to new issues and new problems, and often helps alert you to issues that you might not have thought of, that need to be addressed. Really importantly, it helps address anxiety and gives people a sense of purpose, if they’re actually doing something. So if you look at something like the Deepwater Horizon oil spill, and all those people that went out and tagged all the birds with oil and got them cleaned off, not only was it great for the environment, but it gave an awful lot of people who were otherwise devastated and upset a purpose and a way to channel their anger and anxiety into something really constructive. And so from that perspective, it helps resilience. Often, citizen science communities are another way of creating social connectiveness. I think it has these benefits across the whole continuum from that perspective.

**FIGURE 1.1**

Potential benefits of disaster citizen science for community health and well-being

<table>
<thead>
<tr>
<th>Education and scientific literacy</th>
<th>Social capital</th>
<th>Knowledge resources</th>
<th>Future leaders</th>
<th>Democratic decisionmaking</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
</tbody>
</table>

Community health and well-being
Participation in and Organization of Disaster Citizen Science Projects

Many types of people and groups engage in disaster citizen science, most often working in partnership. Key participants can include community organizations; advocacy groups; private businesses; informal networks of neighborhood volunteers (virtual or in person); research scientists in academic organizations; local, state, or federal government officials or scientists; technology developers; activist groups; the media; and an oversight community. Table 1.1 describes the roles each group may play and the resources or skills they typically bring to partnerships. Note that this is not an exhaustive list. Our research has identified the groups listed in Table 1.1 as the most-prominent players in disaster citizen science today, but any entity may have an interest in citizen science and unique skill sets to share.

TABLE 1.1

<table>
<thead>
<tr>
<th>Entity</th>
<th>Primary capabilities and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citizen scientists and community organizations</td>
<td>Community leadership and trust, local knowledge, communications, advocacy, labor and source of volunteers</td>
</tr>
<tr>
<td>Research scientists</td>
<td>Scientific and technical knowledge, research funding</td>
</tr>
<tr>
<td>Government</td>
<td>Policy and funding decisionmaking experience, research and program funding, scientific and technical knowledge</td>
</tr>
<tr>
<td>Technology developers</td>
<td>Technical knowledge, tool development, equipment supply</td>
</tr>
<tr>
<td>Private businesses</td>
<td>Technical knowledge, tool development, equipment supply, material resources</td>
</tr>
<tr>
<td>Activists</td>
<td>Communications, political knowledge, advocacy</td>
</tr>
<tr>
<td>Media</td>
<td>Communications, dissemination</td>
</tr>
<tr>
<td>Oversight community</td>
<td>Ethics, regulatory, administrative knowledge</td>
</tr>
</tbody>
</table>

Most disaster citizen science projects involve collaborations among different combinations of entities. Some community groups have scientific resources in-house but partner with government entities to ensure that findings inform some policy or decision. More often, community groups may lack extensive research capacities and therefore partner with academic institutions or individual scientists to fill those gaps. Mutual benefits arise when groups work together. Partnerships can increase knowledge and resource capacity, foster growth, and build the skill sets of the collaborating entities.

Disaster citizen science projects can be organized in various ways. We focus here on three common organizational models: contributory, collaborative, and collegial (Shirk et al., 2012). These models differ in terms of who initiates the disaster citizen science project, who leads it, and who performs research tasks. Table 1.2 describes the contributory,
Learn collaborative, and collegial models. All models involve engagement of the public in one form or another. The contributory model is most common and primarily involves community members as data collectors or analyzers. In contrast, the collaborative and collegial models are defined by greater opportunities for community participation, leadership, and control over scientific activities. The choice of model depends on project goals, available resources, and an assessment of the strengths and limitations of each for answering the questions a community group wants to answer.

RESEARCH FINDINGS
Who leads disaster citizen science projects?

Our 2019 inventory of disaster citizen science projects found that most projects were led by

- 45% Academic or research groups
- 26% Government agencies
- 24% Technology groups*
- 11% Advocacy organizations

SOURCE: Chari et al., 2019.
NOTE: Projects could have multiple leads, so percentages do not sum to 100.

* Organizations focused on the development or deployment of technological resources, such as equipment or online platforms.
### Models of citizen science

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
</table>
| **Contributory: Science that leverages the people** | Contributory citizen science activities are typically initiated by research institutions or government agencies (e.g., a health department), while members of the public contribute time and skills through such tasks as interpreting imagery, collecting or analyzing data, or transcribing documents.  
Example: The U.S. Geological Survey’s Did You Feel It? program collects reports on earthquake location, perceived intensity, and damage from people around the world, which are used to create maps of earthquake intensity. Scientists also use the data to study such topics as the extent to which people feel earthquakes (U.S. Geological Survey, undated). |
| **Collaborative: Science done with the people** | Collaborative citizen science activities are typically initiated or led by research institutions or government agencies in partnership with the public. Community members may be involved in defining the problem, designing the study, and collecting, analyzing, and interpreting data.  
Example: In response to an emerging influenza (H1N109) pandemic, a participatory action research approach, in which communities and scientists collaboratively work together, was carried out in Australia to understand barriers to interventions in Aboriginal and Torres Strait Islander communities. The project also aimed to develop culturally appropriate and effective strategies to reduce influenza risk. To carry out the project, community members worked with researchers to identify the research problems, plan study approaches, prepare data collection instruments, and collect and analyze data. The project identified barriers that would limit the effectiveness of general Australian influenza containment policies but also elicited several strategies for reducing disease spread in the Indigenous communities (Massey et al., 2011). |
| **Collegial: Science done by the people** | Collegial citizen science activities are controlled and led by community groups or members, either entirely independently or in partnership with others (e.g., government agencies, research institutions). Unlike collaborative citizen science, in collegial citizen science, members of the public retain control over scientific or data collection processes.  
Example: The Louisiana Bucket Brigade, a nonprofit environmental health and justice organization, addresses petrochemical pollution in the state. One aspect of Louisiana Bucket Brigade’s work is to engage residents to collect air samples in their neighborhoods using an inexpensive, Environmental Protection Agency–approved “bucket.” The bucket is an easy-to-use air-sampling device. Residents then send these air samples to a lab for analysis. The Louisiana Bucket Brigade also facilitates crowdsourcing of pollution via its online “iWitness Pollution Map,” which was set up with the help of academic partners. Although the organization makes use of professional and scientific assistance, its staff and volunteers, who are community members, lead its scientific efforts (Louisiana Bucket Brigade, undated). |
Disaster Citizen Science: Making an Impact

Although disaster citizen science is a fairly new area, many of its activities have already had positive impacts. Disaster citizen science has

- increased awareness or knowledge of problems among the public and decisionmakers
- directed interventions by government at the local, state, or federal level
- prevented or mitigated the potential for negative health outcomes
- changed the direction of scientific research
- enhanced community networks and the strength and quality of community partnerships
- spurred the creation of new technologies.

Below, we present numerous examples of community or volunteer groups who engaged in disaster citizen science and made these impacts in their communities and beyond.

In Flint, Michigan, community members partnered with a university and collected drinking water samples that documented high levels of lead in the water. Community-generated data forced state officials to acknowledge the problem and to begin implementing mitigation actions.  
**Model:** Collaborative  
(Ruckart et al., 2019)

In Tonawanda, New York, community members organized to collect air samples that demonstrated harmful pollution levels from a nearby factory. The evidence helped spur state and federal agencies to take their own measurements and ultimately resulted in legal action and the closure of the factory.  
**Model:** Collegial  
(Citizen Science Community Resources, undated)
The Surfrider Foundation oversees a national network of volunteers, the Blue Water Task Force, that performs water-quality testing of recreational waters in communities.

Water-quality data from many Blue Water Task Force chapters, such as the San Luis Obispo chapter, have been used to communicate to the public about risks and inform local government decisions about beach safety (e.g., public warnings).

**Model:** Collegial

(Surfrider Foundation, undated)

In Fukushima, Japan, community members measured radiation levels after a nuclear power plant meltdown.

Community members created a type of radiation detector that people could build on their own to collect their own data. They formed Safecast, an organization that now houses the largest data set of background radiation levels in the world.

**Model:** Collegial

(Safecast, undated)

During the Deepwater Horizon oil spill, community members captured data with balloon-generated maps and home test kits.

The drive of community members to understand for themselves the extent of the oil spill led to the grassroots creation of Public Lab, which supported centralized platforms for ideas and knowledge exchange, innovative do-it-yourself technologies to measure oil in the environment, and crowd-sourcing apps to collect community reports and observations.

**Model:** Collegial

(Public Lab, undated)

In the aftermath of Hurricane Floyd and severe flooding, a community-university partnership was formed in rural eastern North Carolina to respond to the needs of survivors.

A community-based participatory research project was carried out to document the experiences of displaced survivors and potential health and social threats. As a result of the project, the state granted the displaced survivors additional time to stay in temporary sites while locating permanent housing and invited a community representative to monthly state emergency management meetings.

**Model:** Collaborative

(Farquhar and Dobson, 2004)
During the early years of the AIDS epidemic, activists fought for better health care research and treatment by engaging with scientists.

By directly engaging and challenging the scientific establishment, the activists changed the nature of clinical trials for AIDS drugs and helped save lives.

**Model:** Collegial

( Epstein, 1995)

Following a train crash in Graniteville, South Carolina, that resulted in chlorine gas exposure, community groups in Graniteville partnered with the South Carolina Department of Health and Environmental Control to track recovery efforts.

Community partners and the health department performed environmental sampling to identify residents’ exposure to chlorine gas and established a community health tracking program to monitor the occurrence of health effects over time.

**Model:** Collaborative

(Svendsen et al., 2010)

These examples focus on collaborative and collegial citizen science models. Contributory models can also be effective for communities even if the actual community role is limited to gathering or analyzing data. We identified many contributory projects that use crowdsourcing as a way to gather large amounts of observations, photos, or environmental materials (e.g., soil) from the public on disasters, such as floods, harmful algal blooms, landslides, earthquakes, volcanic eruptions, vector-borne disease (e.g., mosquitoes, ticks), and infectious disease. Many of the apps are freely available for anyone to download on their smartphones or computers, and data are also freely available. Community groups could take advantage of existing and ongoing contributory projects by enlisting members of their communities to use these apps for data collection. Groups could start a local effort by joining an existing citizen science project with relevance to the community. Table 1.3 provides an example list of disaster citizen science apps that are already built to receive data from the public. Those interested in finding more projects should see such online communities as SciStarter (https://scistarter.org/), which provides an inventory of many different types of citizen science projects, including disaster-relevant ones, for anyone to join.
TABLE 1.3
Example contributory disaster citizen science apps for data collection

<table>
<thead>
<tr>
<th>Condition to monitor</th>
<th>App or website</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmful algal blooms</td>
<td>bloomWatch</td>
<td>bloomWatch engages volunteers in helping to report when and where cyanobacteria blooms appear. Data are submitted to a crowdsourced database, as well as participating state water-quality agencies (<a href="https://cyanos.org/bloomwatch/">https://cyanos.org/bloomwatch/</a>).</td>
</tr>
<tr>
<td>Weather, drought</td>
<td>Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS)</td>
<td>CoCoRaHS is a community-based network of volunteers who measure and map precipitation (rain, hail, and snow) using low-cost tools to provide data for numerous apps. Reports are available for viewing on the website. The data are used by many entities, including scientists and public health officials (<a href="https://www.cocorahs.org/">https://www.cocorahs.org/</a>).</td>
</tr>
<tr>
<td>Weather, drought</td>
<td>Meteorological Phenomena Identification Near the Ground (mPING)</td>
<td>mPING collects weather information from the public through mobile devices with GPS location capabilities to improve weather predictions and forecasting and aid in weather-related decisionmaking. Reports are available online (<a href="https://mping.ou.edu/static/mping/access.html">https://mping.ou.edu/static/mping/access.html</a>).</td>
</tr>
<tr>
<td>Disease vectors</td>
<td>GLOBE Observer: Mosquito Habitat Mapper</td>
<td>The Mosquito Habitat Mapper supports the public in mapping, counting, and identifying mosquito larvae found in breeding sites, eliminating the breeding sites to reduce disease risk, and sharing the data with scientists and public health authorities to reduce and manage disease risk. An open data set is available (<a href="https://observer.globe.gov/do-globe-observer/mosquito-habitats">https://observer.globe.gov/do-globe-observer/mosquito-habitats</a>).</td>
</tr>
<tr>
<td>Disease vectors</td>
<td>Kissing Bug Citizen Science Program</td>
<td>The Kissing Bug Citizen Science Program invites the public to submit kissing bug specimens to researchers. Data are mapped on the website and publicly available (<a href="https://kissingbug.tamu.edu/">https://kissingbug.tamu.edu/</a>).</td>
</tr>
<tr>
<td>Disease surveillance</td>
<td>Flu Near You</td>
<td>Flu Near You asks the public to voluntarily submit information about illness status and provides real-time information about influenza-like illness by zip code. Results are mapped and freely available online (<a href="https://flunearyou.org/#/">https://flunearyou.org/#/</a>!).</td>
</tr>
<tr>
<td>Landslides</td>
<td>Landslide Reporter</td>
<td>Landslide Reporter invites the public to provide reports of landslides that are reviewed and approved by NASA scientists before being posted online. Data are freely available (<a href="https://gpm.nasa.gov/landslides/index.html">https://gpm.nasa.gov/landslides/index.html</a>).</td>
</tr>
<tr>
<td>Earthquakes</td>
<td>Did You Feel It?</td>
<td>Did You Feel It? collects information from individuals who experience earthquakes to create maps about the experiences and damage. Data are available on the website (<a href="https://earthquake.usgs.gov/data/dyfi/">https://earthquake.usgs.gov/data/dyfi/</a>).</td>
</tr>
</tbody>
</table>

As of this writing, many of the citizen science projects focused on COVID-19 used the contributory or collaborative models to detect early outbreaks, track disease transmission, monitor inventories of personal protective equipment and other essential goods, and develop robust medical and public health solutions. Table 1.4. lists examples of disaster citizen science apps for COVID-19.
<table>
<thead>
<tr>
<th>App or website</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>COVID Near You</td>
<td>A crowdsource-based tool developed by Harvard University, Boston Children’s Hospital, and volunteers that maps user-submitted reports of flu and COVID-19 symptoms for the purpose of early detection. Similar tools have been developed using smart thermometers (e.g., Kinsa) that automatically map observed illness and atypical illness (<a href="https://covidnearyou.org/#/">https://covidnearyou.org/#/</a>).</td>
</tr>
<tr>
<td>Foldit</td>
<td>An online citizen science gaming app developed by the University of Washington that challenges users to design virtual proteins that could disrupt the infective ability of the COVID-19 virus or be used in antiviral treatments (<a href="https://fold.it">https://fold.it</a>).</td>
</tr>
<tr>
<td>COVID-19 Citizen Science</td>
<td>A study led by the University of California, San Francisco, that enlists the public to download an app on smartphones that will prompt individuals to self-report their symptoms daily, complete surveys about daily habits, and, if they agree, provide location data to assist in analyzing disease spread. By pooling location, symptom, and behavioral data, researchers hope to identify ways to predict and reduce infections (<a href="https://covid19.eurekaplatform.org">https://covid19.eurekaplatform.org</a>).</td>
</tr>
<tr>
<td>Patients Like Me</td>
<td>A health network that helps connect individuals suffering from the same ailments. The site recently created a community for patients who have recovered from COVID-19. Patients generate data by sharing information about symptoms, treatments taken, perceived effectiveness, side effects, and other experiences. Amassing large data sets of patient experiences for COVID-19 will be useful for research purposes (<a href="https://www.patientslikeme.com/">https://www.patientslikeme.com/</a>).</td>
</tr>
<tr>
<td>CoronaReport</td>
<td>A crowdsourcing project developed by SPOTTERON and the Scottish Collaboration for Public Health Research and Policy at the University of Edinburgh that invites individuals to create public reports about their experiences with the COVID-19 virus and provide observations on the virus’s effect on communities (<a href="https://www.coronareport.eu/">https://www.coronareport.eu/</a>).</td>
</tr>
<tr>
<td>Codevid-19</td>
<td>A hackathon for developers, designers, and content experts interested in developing solutions to support crisis response, pandemic dynamics, physical-distancing practices, and scarcity and economic issues (<a href="https://codevid19.com/">https://codevid19.com/</a>).</td>
</tr>
</tbody>
</table>

NOTES: For more information about COVID-19 citizen science projects, check out the Citizen Science Association’s “Covid-19 Resources” webpage (https://www.citizenscience.org/covid-19/) and SciStarter, an online community that hosts citizen science projects (https://scistarter.org/). The information in this table is up-to-date as of summer 2020. The situation with COVID-19 has been changing rapidly, however. There may be more projects that become available or listed projects that become unavailable.
Exercise

Test your knowledge for Chapter 1

Chapter 1 introduced the concept of disaster citizen science and provided numerous examples of community groups and others performing research to address issues of community importance. Below, we present four questions that cover the main points of this chapter. Feel free to test your understanding of disaster citizen science by answering the questions. If you are using the toolkit with a team, discuss the questions together to determine whether everyone has a shared understanding of disaster citizen science before moving ahead to Chapter 2, Act.

- What are some benefits of citizen science for disaster preparedness?

- What are the three models of citizen science?

- What kinds of stakeholders engage in disaster citizen science and why?

- What are three examples of disaster citizen science projects?
Implementing Disaster Citizen Science Activities

Now that you know what disaster citizen science is and how it can benefit communities, the next step is to design and implement a project. Your group may be eager to jump right in, but keep in mind, “Ideas are easy. Implementation is hard” (Guy Kawasaki, quoted in Alboher, 2008). For every success story, there are countless efforts that never leave the ground. There are many reasons why projects may fail, and in later sections we describe common challenges faced by those who have implemented disaster citizen science activities. But, first and foremost, proper planning is critical to project implementation. This chapter describes a five-step approach to get you ready for disaster citizen science implementation (also see Figure 2.1):

**STEP 1** Determine your goals for engaging in disaster citizen science.

**STEP 2** Select the best approach for achieving your goals.

**STEP 3** Build your team.

**STEP 4** Assess your readiness to implement a disaster citizen science project.

**STEP 5** Plan for action.

The following sections go through each step in order. Each section poses a series of key questions you should ask yourself or your team. Worksheets are provided to help you think through the questions and come up with answers.

**FIGURE 2.1**
Five-step approach for project planning
Given that Chapter 2 focuses on design and implementation of disaster citizen science activities, Box 2.1 offers guidance if you feel you are not yet ready to lead a project.

**BOX 2.1**

**What if you’re not ready or are unable to lead a disaster citizen science project?**

There may be many reasons you feel that you aren’t ready to lead a disaster citizen science project. Resources may be tight, or labor may be an issue. If you are part of an organization, your leadership might not yet be convinced that citizen science is worth pursuing. Even if you are not leading, there are still many opportunities to engage. You may want to reach out to professional scientists at a local college or university, research organization, or government agency to consider options for collaboration. Community groups can play a variety of roles in disaster citizen science projects and should explore those roles prior to deciding not to participate. For example, instead of leading and designing projects, communities or community groups can be part of collaborative projects in which you partner with other institutions or can engage through contributory models in which you are involved mainly in data collection or analytic activities.

Such projects may yield benefits for communities as well. For example, findings can be used by organizations to advocate for change. The experience of engaging in scientific research projects can help build scientific skills and can serve as an educational opportunity. These experiences can also help build relationships and networks—and ultimately enhance your group’s reputation and credibility when it comes to using or presenting scientific research for advocacy or other purposes in the future.

Check out such resources as SciStarter (https://scistarter.org/), a site that provides an inventory of many types of citizen science projects, including disaster-relevant ones, that anyone can join. This could be a fun way to learn more about citizen science and research processes before diving into a project of your own. Note that, even if you feel that you are not able to lead a project at this time, it may still be useful to read through Chapter 2 and do the exercises and worksheets. If you engage with disaster citizen science in some way, understanding the process of thinking through a research project will better prepare you to serve as a partner or to carry out data collection.
STEP 1 Determine your goals for engaging in disaster citizen science

The first step is to lay out your goals for engaging in disaster citizen science. These goals can be narrow (e.g., characterize storm damage), broad (e.g., achieve community-level outcomes, such as increased resilience or education), or anything in between. The key point is that goals should not only focus on the project you want to conduct or the outcome you hope to achieve but also address why you want to involve your community in data collection and analysis.

Questions to ask yourself or your team:

1a. What is the problem you are facing that could benefit from disaster citizen science? Is there something that citizen science can uniquely contribute, for example, that would not be possible otherwise?

1b. What do you want to achieve?

1c. What has been done before to address the problem?

The following worksheets (Worksheets 1a–1c) are designed to help facilitate thinking and discussion either individually or in teams. Print and fill out each worksheet and have others on your team do the same. At this point in the process, it is okay to think creatively and to put all your ideas down, regardless of their ability to be implemented or achieved.

1a. What is the problem you are facing that could benefit from disaster citizen science?

To define your problem, answer the following questions in as much detail as possible, using Worksheet 1a. Think of these questions as providing an overall synopsis of the problem:

- What is the problem you are trying to solve?
- Whom does the problem affect?
- When does the problem need to be solved?
  - Consider your timeline. Is the problem time-sensitive? Does it require an immediate solution? Is it something that could be addressed over a longer period?
- Where does the problem occur (e.g., is it a local issue, or does it cross local or state lines)?
- Why is the problem happening?
- Is there something that citizen science can contribute that would not be possible otherwise?
Worksheet 1a
What is the problem you are facing that could benefit from disaster citizen science?

Describe the problem your community faces in as much detail as possible. Answer the following questions:

• What is the problem you are trying to solve?

• Whom does the problem affect?

• When does the problem need to be solved?

• Where does the problem occur?

• Why is the problem happening?

• Is there something that citizen science can contribute that would not be possible otherwise?
1b. What do you want to achieve?

Put into words the expected goals and outcomes you wish to achieve by addressing or solving the problem you have defined. To do this, consider creating a logic model. A logic model is a diagram that illustrates how a project uses available resources (also called inputs) and planned activities to achieve both short- and longer-term goals. It is a useful diagnostic and planning tool that can help you think clearly about the causal chain that connects your goals to the activities and resources you will need to achieve those goals. By forcing you to think about the inputs necessary for meeting project goals, a logic model can help your team understand how a project is intended to achieve its effects and can help you decide what to evaluate to determine success. A logic model also helps to get everyone on the same page with respect to assumptions, goals, activities designed to reach goals, and the rationale of the overall project. A logic model is therefore a good way to check whether your plans make sense. With the model, you can think about what you want to achieve in both the short term and the long term.

Worksheet 1b lays out a logic model template for you to use. The logic model table includes the following columns:

- **inputs**: resources your project needs to achieve the outcomes (e.g., funding, partnerships, equipment, better knowledge of the problem, volunteers)
- **activities**: what your project is planning to do to achieve the outcomes (e.g., raise funds, develop partnerships, perform data collection)
- **outputs**: the products or results of your project activities (e.g., funds raised, partnerships developed)
- **short-term outcomes**: the changes you expect to occur in the near future (e.g., one to five years) if project activities are carried out as intended
- **medium-term outcomes**: the changes you expect to achieve in the intermediate future (e.g., five to ten years) if project activities are carried out as intended
- **long-term outcomes**: the changes you expect to achieve in the far future (ten-plus years) if project activities are carried out as intended; long-term outcomes can also be thought of as ultimate or even aspirational goals that could be met only by first achieving short- and medium-term outcomes.

Using Worksheet 1b, fill in the outcomes you would like to achieve through your citizen science project (the three columns on the right). Step 2 of the toolkit will explain how to work backward from these outcomes to determine the inputs, activities, and outputs needed to meet these goals. For now, we recommend that you focus only on project outcomes.
**Worksheet 1b**

**What do you want to achieve?**

Use a logic model to map out what you wish to achieve from your project.

**Problem description** (Use this space to provide a one- or two-sentence description of the problem to help you stay organized and focused.)

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Activities</th>
<th>Outputs</th>
<th>Short-term outcomes</th>
<th>Medium-term outcomes</th>
<th>Long-term outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>What resources do you need to achieve the outcomes (e.g., funding, partners, equipment, better knowledge of the problem, volunteers)?</td>
<td>What activities are you planning to do to achieve the outcomes?</td>
<td>What resulted from your activities (e.g., products developed, services performed, events undertaken, targets achieved)?</td>
<td>What outcomes can you expect in the near term (e.g., 1–5 years) if project activities are carried out as intended?</td>
<td>What outcomes can you expect in the intermediate term (e.g., 5–10 years) if project activities are carried out as intended?</td>
<td>What outcomes can you expect in the long term (e.g., 10+ years) if project activities are carried out as intended?</td>
</tr>
</tbody>
</table>

You can add notes in the space below.
Example disaster scenario for toolkit exercises: Guidance on filling out outcomes for the logic model in Worksheet 1b

Below we present a hypothetical disaster scenario that will be used throughout the toolkit to illustrate how you might think through a research project and fill out the worksheets. In our example scenario, a group has come together around an identified problem that it considers to be an ongoing disaster: dangerous levels of air pollution experienced by the community because of emissions from a nearby factory. The toolkit presents a number of worksheets filled in with answers using this scenario.

In Worksheet 1b you can start developing your logic model by focusing on the outcomes you would like to achieve. In thinking about potential outcomes for our example scenario, you might list the following:

- More people learn about pollution and its harms.
- Air-quality monitoring by local government increases.
- Government acts to enforce factory compliance with regulations.
- Factories take actions to comply with air-quality regulations and control emissions.
- Factory emissions decline.
- Community health improves because of reduced air pollution.

We note that these outcomes are just examples for illustrative purposes. Your team will need to decide on the most desired outcomes for your particular disaster issue.

In Example Worksheet 1b, we show how the example outcomes described above can be categorized as short-, medium-, or long-term outcomes in a logic model, depending on what would need to be achieved first to reach the ultimate goal of better community health. Understanding and defining your outcomes in step 1 will then help you determine what methods and approaches you could use to address your problem and what resources you will then need to actually carry out a project (step 2). Therefore, we recommend filling out the outcomes now and then revisiting Worksheet 1b at the end of step 2 to fill out inputs, activities, and outputs.
### Worksheet 1b

**What do you want to achieve?**

**Filling out logic model outcomes**

Use a logic model to map out what you want to achieve from your project.

**Problem description** (Use this space to provide a one- or two-sentence description of the problem to help you stay organized and focused.)

**Dangerous levels of air pollution experienced by our community because of factory emissions.**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Activities</th>
<th>Outputs</th>
<th>Short-term outcomes</th>
<th>Medium-term outcomes</th>
<th>Long-term outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>What resources do you need to achieve the outcomes (e.g., funding, partners, equipment, better knowledge of the problem, volunteers)?</td>
<td>What activities are you planning to do to achieve the outcomes?</td>
<td>What resulted from your activities (e.g., products developed, services performed, events undertaken, targets achieved)?</td>
<td>What outcomes can you expect in the near term (e.g., 1–5 years) if project activities are carried out as intended?</td>
<td>What outcomes can you expect in the intermediate term (e.g., 5–10 years) if project activities are carried out as intended?</td>
<td>What outcomes can you expect in the long term (e.g., 10+ years) if project activities are carried out as intended?</td>
</tr>
<tr>
<td>The community learns more about air pollution and its harms</td>
<td>Monitoring by local or state environmental protection department is increased</td>
<td>Government takes action to enforce compliance</td>
<td>Factories take action to control emissions</td>
<td>Community health is improved</td>
<td></td>
</tr>
</tbody>
</table>

You can add notes in the space below.
To provide more guidance on developing outcomes, Box 2.2 presents the SMART framework. The SMART framework is a tool used to construct outcomes that will help you measure, track, and evaluate whether your project meets its goals. For additional resources on developing logic models and SMART goals, also see the following references (full citations are in the reference list at the end of the toolkit): Knowlton and Phillips, 2013; Ebener et al., 2017; Centers for Disease Control and Prevention, 2017; Centers for Disease Control and Prevention, 2018; Community Tool Box, undated-a).

**BOX 2.2**
Being SMART about your outcomes

Use the SMART framework to construct your project goals. Well-written outcomes should be

**Specific**
Outcomes should identify concrete changes that will take place.

**Measurable**
Outcomes should specify the amount of change that will take place.

**Achievable**
Outcomes should make logical sense.

**Realistic**
Outcomes should specify how change will be met with available resources.

**Time-based**
Outcomes should specify the time within which the outcome will be achieved.

Making the outcomes in **Worksheet 1b** SMART: Examples of SMART outcomes are shown on the right

<table>
<thead>
<tr>
<th>Example Worksheet 1b outcomes</th>
<th>SMART outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>The community learns more about air pollution and its harms</td>
<td>Within two years, surveyed community members will self-report greater levels of understanding about air pollution and its harms, compared with baseline.</td>
</tr>
<tr>
<td>Monitoring by local or state environmental protection department increases</td>
<td>Within two years, the local or state environmental protection department will increase agency monitoring of areas around the factories by 25 percent, compared with baseline.</td>
</tr>
<tr>
<td>Government takes action to enforce compliance</td>
<td>Within two years, the government will issue fines and threaten other punitive actions for factories that are in noncompliance of regulatory air standards.</td>
</tr>
<tr>
<td>Factories take action to control emissions</td>
<td>Within four years, 100 percent of factories will come into compliance with regulatory air standards.</td>
</tr>
<tr>
<td>Factory emissions are reduced</td>
<td>Within five years, factory emissions are reduced by 50 percent, compared with baseline.</td>
</tr>
<tr>
<td>Community health is improved</td>
<td>Within ten years, incidence of respiratory illnesses in the community will be reduced by 50 percent, compared with baseline.</td>
</tr>
</tbody>
</table>

Why are the outcomes SMART?

By describing your outcomes like those in the right-hand column, you provide your team with a guide for planning your project, tracking your progress, and ultimately achieving your goals. SMART outcomes are **specific** about the change you desire, which means they are narrow and targeted in a way that allows you to plan efficiently. SMART outcomes are **measurable** so that you can evaluate your progress and make changes, if necessary, if you are not meeting your goals. SMART outcomes are **achievable**, meaning they are tied into what you feel you can actually accomplish. SMART outcomes are **realistic** in that they take into account your resources and abilities to meet your goals. Finally, SMART outcomes are **time-based** to provide motivation and help with planning and prioritization of tasks.
1c. What has been done before to address the problem?

Some background research might be needed to understand what others have done to address problems similar to yours. You will want to explore what has happened not only locally in your community but also elsewhere. Your background research may include online searches, library research, interviews with people you know, informal surveys, or even a trip to the local health department to review or get input on past actions taken by government agencies or community-based organizations. The point of this question is to ensure that you have a solid understanding of what has already been tried, what has or has not worked, and who may have knowledge to draw on. In this way, you do not have to “reinvent the wheel” and are able to learn from others’ experiences.

Worksheet 1c provides a way to organize your background research.
**Worksheet 1c**

What has been done before to address the problem?

Describe other efforts to address either your problem or similar problems. Look beyond your community to see whether others have addressed similar issues. You can use online searches or reach out to known contacts to conduct such background research. On the basis of your research, you can look for gaps that your project could fill.

<table>
<thead>
<tr>
<th>Group leading the past activity (list your groups and their names below)</th>
<th>What was done</th>
<th>What worked</th>
<th>What didn’t work</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

You can add notes or your conclusions in the space below.
Example disaster scenario for toolkit exercises: Guidance on filling out Worksheet 1c

In Example Worksheet 1c, we illustrate how you could fill in Worksheet 1c using the factory emission scenario discussed previously. The sample answers are provided as examples of how you might respond to each worksheet item based on your own background research.

**Worksheet 1c**

**What has been done before to address the problem?**

Describe other efforts to address either your problem or similar problems. Look beyond your community to see whether others have addressed similar issues. You can use online searches or reach out to known contacts to conduct such background research. On the basis of your research, you can look for gaps that your project could fill.

<table>
<thead>
<tr>
<th>Group leading the past activity (list your groups and their names below)</th>
<th>What was done</th>
<th>What worked</th>
<th>What didn’t work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community group 1 (name)</td>
<td>Surveyed residents living near factories and mapped reported health outcomes</td>
<td>Mapping showed lots of people with cancer, respiratory, and heart disease in the area and raised community awareness</td>
<td>Using results to get attention from local department of environment was not effective</td>
</tr>
<tr>
<td>Community group 2 (name)</td>
<td>Built and tested homemade air pollution monitors using designs found online</td>
<td>A lot of young people became involved in the monitoring effort</td>
<td>Quality of monitors was not great</td>
</tr>
<tr>
<td>Local health department (name)</td>
<td>Held a public meeting to address community complaints about factory emissions</td>
<td>There was a big turnout; health department was receptive and will look into conducting a health study</td>
<td>No factory representatives attended meeting; the next steps are unclear</td>
</tr>
<tr>
<td>Local university (name)</td>
<td>Did an epidemiological study looking at associations between asthma and factory emissions</td>
<td>Study found strong associations between emissions and asthma in surrounding neighborhoods</td>
<td>Did not engage community to find out concerns; did not look at all health outcomes of interest</td>
</tr>
<tr>
<td>Other university (nonlocal) (name)</td>
<td>Did a study to measure factory emissions that included sampling soil and water bodies in surrounding areas</td>
<td>Focus groups with community members provided input on where to measure and health concerns</td>
<td>Never published results; never let community know what happened with findings</td>
</tr>
</tbody>
</table>

You can add notes or your conclusions in the space below.
When you organize your background research in this way, you can more easily synthesize the information to guide your own project. First, look across the columns and ask yourself what is missing. We can see in the example scenario that there have been efforts to measure health effects, but the results either went nowhere or were too limited in scope to address community concerns. Efforts to monitor factory emissions were limited by poor-quality technology. Overall, it does not appear that there has been much community engagement in research nor involvement of the factories in any research or public outreach.

On the basis of this synthesis, you might start thinking about how your project could address these gaps. For example, your project could focus on improved monitoring efforts, developing deeper partnerships with universities or local government, looking for partners who could help in communicating research results, or even reaching out to factory representatives to see whether they might be receptive to participating in your project.
**STEP 2** Select the best approach for achieving your goals

Once you have defined your problem and established what you want to achieve, you can now focus on **how** to achieve your goals. In this section of the toolkit, we take you through four questions to help you decide what your disaster citizen science approach should be:

2a. How do you focus your research question?

2b. What data collection methods should you use?

2c. What skills and resources do you need?

2d. How do you ensure the quality of your citizen science research project?

Step 2 ends by using the information learned to complete the logic model (**Worksheet 1b**) started in step 1.

**2a. How do you focus your research question?**

To move from the outcomes you developed in **Worksheet 1b** to identify both a research question and methods to use in a project, you can develop a **theory of change** (Center for Theory of Change, 2019). A theory of change is a descriptive explanation of how and why project activities will lead to achievement of your desired outcomes. **Worksheet 2a** provides a space in which to create a theory-of-change story for your identified problem and the outcomes you are interested in. On the next few pages we provide guidance for filling out the worksheet.

For additional resources on theory of change, also see the following references (full citations are in the reference list at the end of the toolkit): University of Arizona Rural Health Office and College of Public Health, 2000; Center for Theory of Change, undated; BetterEvaluation, undated.
**Worksheet 2a**

How do you focus your research question?

Use the outcomes listed in your logic model in **Worksheet 1b** to create theory-of-change stories. Choose one outcome at a time and work backward, asking yourself how or why a change or achievement might have occurred. Work backward until you have a logical explanation for how a research topic or question might have led to the original outcome selected. You may use the block design shown in the toolkit to construct your story or any diagram you are comfortable with using to show a sequence of events.

Use the space below to create your theory-of-change stories.
Example disaster scenario for toolkit exercises: Guidance on filling out Worksheet 2a

Let's revisit the logic model started in step 1. Recall that Worksheet 1b was designed to help you focus on what you want to achieve by listing short-, medium-, and long-term outcomes. Example Worksheet 1b presented example outcomes (listed below) based on the factory emissions scenario.

Short-term outcomes
- The community learns more about air pollution and its harms.
- Monitoring by local or state environmental protection department is increased.
- Government takes action to enforce compliance.
- Factories take action to control emissions.

Medium-term outcomes
- Factory emissions are reduced.

Long-term outcomes
- Community health is improved.

In our Example Worksheet 1b, we list the one long-term outcome identified: community health is improved. Then, using the theory-of-change framework, we ask: What needs to happen to achieve that goal? To do this, we work backward from the outcome to tell a story of how community health is improved. Drawing from the outcomes listed in the logic model in Example Worksheet 1b, we illustrate in Figure 2.2. how to build a story, one block at a time.
In *Example Worksheet 1b*, we listed one medium-term outcome as a precursor to improved community health (box in red). We can now ask the question: How could a reduction in factory emissions occur? The next row in the figure (story block) provides a possible answer.

*Example Worksheet 1b* listed several short-term outcomes. For this story, we choose the outcome most directly related to factory emissions (box in red). So, now we ask: Why would factories start to control emissions? See the next block in the figure.

*Example Worksheet 1b* showed that government took actions as well, which likely influenced factory behaviors (box in red). But why might government take action? See the next block in the figure.

We come up with a theory (box in red). But what convinced them? See the next block in the figure.

By working backward, our theory of change has led to an outcome based on data collection and analysis. We now ask: Why might this research have been conducted? The answer leads to a possible research question for our example scenario: Do local factories release emissions at levels dangerous to community health?
There is no one right way to create a theory-of-change story. Use the background research you did with Worksheet 1c or rely on your own experiences and assumptions to tell as many stories as you like. The stories could consist of as many “boxes” as you need to arrive at a research topic or question you can study.

Citizen science projects consist of a variety of study types. After determining your research questions, ask yourself: What type of study might be carried out to answer the question? Common study types include

- health or environment monitoring (routine assessment of hazards, exposure, or disease)
- community risk or vulnerability assessments (identification and prioritization of risks or vulnerabilities in the community)
- intervention or program development (creating or expanding services or policies designed to improve a condition)
- program evaluation (collecting, analyzing, and using data to understand the effectiveness and other benefits of a program, project, or policy)
- epidemiological investigations (assessment of associations between exposure and disease)
- population needs assessment (determining the gaps between what a community has and what it needs)
- damage assessments (determining the extent of damage to a community after a disaster)
- participatory action research (collaborative research that is meant to result directly in community actions).

Our example research question—about determining whether factory emissions are dangerous to community health—could be conceived as a monitoring study or an epidemiological investigation. A monitoring study would measure air emissions only (exposure data), while an epidemiology study would measure both air emissions (exposure) and health outcomes. Identifying what type of study you want to conduct will influence the methods you choose and the activities you perform. To decide on a study type, consider the costs, labor, and resources needed; the expertise required; and the degree to which a particular study type is critical to achieving project outcomes. For our air pollution example, an epidemiology study would be more resource-intensive than a monitoring study and results would likely not be more effective. Therefore, a monitoring study may make the most sense. You can continue with the theory-of-change story to ask next: How could you conduct a monitoring project? The answers could include different methodological options for the project, one of which could be a citizen science approach—enlisting community members to help measure air emissions.

Creating theory-of-change stories will take practice, but community groups have successfully used this approach. Box 2.3 provides an example of one
group that found a theory-of-change approach to be helpful for their project goals.

The development of theory-of-change stories, logic models, and SMART goals is an important beginning step that will ensure that your project is built on a solid foundation. Better planning at the outset, before starting any research or data collection project, will increase the chance that your project will be a success.

BOX 2.3
CASE STUDY IN DETERMINING YOUR GOALS AND CREATING A THEORY OF CHANGE
BISCO’s citizen science oil spill monitoring project

Some coastal communities in Louisiana regularly experience oil spills from nearby refineries. Spurred by the 2010 Deepwater Horizon oil spill, the Bayou Interfaith Shared Community Organizing (BISCO), along with the support of partners and donors, provided citizen science training to 30 community residents on soil, water, and air sampling for oil contaminants. BISCO partnered with scientists who trained the volunteers over three days and certified them to collect and test samples.

Following the training, participants expressed interest in staying organized and wanted to plan a project in which they could use their new skills. The trainees went through a goal-setting process in which, as a group, they first brainstormed a list of community problems related to oil spills and contamination. Each participant then ranked the top-five problems he or she wanted to address. Participants divided into three groups to discuss the three problems that got the most votes. Each group came up with a theory-of-change story by first defining the goals for the project, then working backward to figure out how sampling for oil contaminants could help achieve those goals. After each group presented the stories, the participants decided to move forward with one project: establishing a baseline for oil contamination in the community. The group as a whole decided that a baseline was needed, first to understand what the present levels of exposure and risk might be and, second, because if a future event happened, such as an oil spill or flooding, having a baseline would show decisionmakers whether the event raised the community’s risk and whether interventions would be required. As described by a BISCO representative:

This group was so interested, they agreed to, as long as we could plan it, to doing some . . . baseline testing. That actually went beyond the grant, where we now have a baseline of areas in two different parishes. . . . We have 70 samples of the soil in those areas, so that should a flood or an oil spill happen, we have that. . . . The impression was that the impact on the people, the people now feel because we went out afterwards and did these samples, they were excited to know, “Hey, we really did it! We can do it.” That was helpful too in not just learning it, and trying it out while you’re learning it, but then actually doing a project after that felt successful.

For more information, see Copp, 2016.
2b. What data collection methods should you use?

There are many different data collection methods that citizen science projects can use to address community problems. Choosing a method is the first step in developing activities in the logic model. Below, we describe different methods and how they can be used in citizen science projects.

(For information and guidance on data quality, see the toolkit section “Designing and Implementing a Citizen Science Project: Challenges and Solutions.”)

Physical collection and measurement

Measurements can be obtained through physical collection of environmental media (e.g., soil, water, larvae). Samples of media can be collected and analyzed for chemical and physical agents or measured for their volume, mass, or other quantitative characteristics.

The project Citizen Hydrology (CITHYD) enlisted volunteers in collecting data on water levels in big rivers and small streams in Italy to build a public-use database to support dialogue on flood protection and river restoration (Galimberti and Balbo, 2017).

Measure the Muck is a project in Virginia in which volunteers take water samples from flooded areas along the Lafayette River watershed to test for harmful bacteria and pollutants. The intent is to measure the pollution that flows into the Chesapeake Bay as a result of coastal flooding, which may act as fuel for algal blooms (Old Dominion University, 2018).

Sensor measurement

Environmental measurements can be obtained from readings collected from sensors. Sensors can be installed on a building (e.g., inside or outside the home) or mobile device (e.g., a smartphone) to detect quantitative changes in measures of interest in the environment.

MyShake aims to build a worldwide early-warning network for earthquakes by having volunteers download an app to their smartphones that uses the phone’s sensors to detect earthquake shaking. Volunteers can also submit damage and shaking reports and view other people’s reports (University of California, Berkeley, undated).
Text-based observation

Written or text-based observations provide descriptive data about surrounding environments. Such observations can serve as a stand-alone data source or can provide additional context to an environmental measurement. Observations may be informed by the unique perspective of the observer, and, therefore, can vary across observers. Text-based observations can be collected through a variety of methods, including diaries and social media platforms.

Community organizations and individuals in the Santa Barbara, California, area shared observations about the 2007–2009 wildfires. In addition to photos and videos, people contributed written reports to websites run by local newspapers and community groups. In response to the May 2009 Jesusita fire, the groups compiled these data and presented them as part of online maps that gave information about the fire's location. The most popular maps had more than 600,000 visits. Authorities used these data to update official reporting on the location of the fire's perimeter (Goodchild and Glennon, 2010).

Survey

Similar to text-based observations, survey data can provide descriptive information about the surrounding environment or a respondent's personal experience, including physical and emotional health.

In Atlanta, teams of students and community members carried out neighborhood surveys to document the prevalence of asthma and associated environmental exposures in two flood-prone communities (Effert et al., 2016).

Interview

Similar to survey data, interview data can provide information about community members' observations and experience. Interview data often provide a more detailed picture of the observation or experience than survey data.

A project in Christchurch, New Zealand, used semistructured interviews to examine the value of Maori cultural attributes for informing and innovating disaster preparedness and integrated risk management strategies (Kenney et al., 2015).
Photo and video

Observations of the surrounding environment can be represented visually through photos and video. Visual observations can be used alone or in combination with text-based observations. Photo and video data can also be used to document an individual’s personal experience.

The RiskScape Project used photos of flooding, which were contributed by volunteers, to develop a flood hazard model and calculate flood risk and potential losses across Christchurch (Collins, 2014).

An ethnographic project used a participatory photo approach to document and interpret the experiences of marginalized women in post-Katrina New Orleans (Lykes and Scheib, 2016).

Mapping

Observational data (e.g., text, photos, videos, interviews, sensor measures) can also have a spatial component. These data types can provide information about people’s relative proximity to a disaster or hazard source and depict how disaster effects vary by location or geography.

A project led by the faith-based group Churches Supporting Churches, in New Orleans, combined community mapping, enhanced geographic information system (GIS) methods, and public policy advocacy to help pastors display uneven redevelopment patterns of selected neighborhoods following Hurricane Katrina (Duval-Diop, Curtis, and Clark, 2010).

Worksheet 2b has been designed to help you think through the data collection methods available to address your research question and study type.
Worksheet 2b
Choosing data collection methods

Describe your research question and select the type of study you will conduct. The methods flowchart presents a series of questions to guide you to methods (in red boxes) that may be well suited to your study.

What is the research question?

What type of study are you conducting?

☐ Health or environment monitoring (routine assessment of hazards, exposure, or disease)
☐ Community risk or vulnerability assessment
☐ Intervention or program development or testing
☐ Program evaluation
☐ Epidemiological investigation (assessment of associations between exposure and disease)
☐ Damage or population needs assessment
☐ Participatory action research (collaborative research meant to result in community actions)

Other, describe:

Does the study need data collected from people?

Does the study need data collected from the environment?

Can hazards of interest be measured by observations (photos, video, text), sensor, or physical collection? Check all that apply.

Methods: observation, sensor, and/or physical collection design
☐ Observations
☐ Sensor
☐ Physical collection

Does the study need control over participants (e.g., careful selection, defined population)?

Does the study need a large number of participants or data points (>100)?

Does the study need to dive deeply into topics?

Does the study need visual (photos/videos), text, or geographic data? Check all that apply.
☐ Visual
☐ Text-based
☐ Geographic

Methods: crowdsourcing study or survey sampled participants; collects visual, text, and/or geographic data

Methods: crowdsourcing study or survey open to the public; collects visual, text, and/or geographic data

Methods: participatory study; collects interview, visual, text (e.g., diaries), and/or mapping data

Methods: survey or mapping designs; collects visual, text, and/or geographic data
In the example factory emission scenario, the theory-of-change story led to a decision to conduct a monitoring study in which we would measure factory emissions using a citizen science approach. Using the flowchart, we ignore the questions that ask about data collection from people and focus on the questions about data collection in the environment. There is one further question about whether the pollutants of interest can be collected by observation (e.g., photos, video, text), sensor devices, or physical collection (e.g., sampling). The answer ultimately depends on what you choose to measure and which measuring tools are available to you. Background research may be needed to answer the questions.

2c. What skills and resources do you need?

Once you know your research question and project methods, you can start to identify the skills and resources you will need to design and carry out the project. We have grouped these resources into three “bins”: foundational resources, personnel resources, and technical and management skills. These bins are applicable to groups that may have more capacity or structure than an informal coalition of community members just starting out. A lack of these resources should not be considered a barrier to initiating a project.

Foundational resources

- **Funding:** Although some collegial projects begin as self-funded or unfunded projects, financial resources are needed to support the design and execution of any disaster citizen science project.

- **Infrastructure and technologies:** Infrastructure and technologies consist of the physical or organizational resources that support citizen science activities (e.g., equipment, data collection and analysis tools, data cyberinfrastructure, physical space or facilities).

- **Training and educational materials about the project:** Materials that explain the project and the roles and responsibilities expected of volunteers and other community participants are necessary to ensure the collection of high-quality data and the overall credibility of the project.

Personnel resources

- **Strong leadership:** Successful citizen science projects depend on leaders who are committed and determined to see projects through, even in the face of challenges. Given the newness of the field, it may be especially important for leaders to demonstrate flexibility, adaptability, and creativity when moving projects forward. When projects are neighborhood- or community-based, these leaders often identify themselves simply by beginning the work without a formal plan, partners, or funding.

- **Organizational culture:** A supportive organizational culture is important to ensure that the citizen science activities have the
necessary financial, administrative, physical, or human capital resources.

• **Labor:** Depending on the methods chosen and the size or scope of the project planned, adequate staffing or labor is a core resource to consider. Staff may take on different roles, depending on the technical and administrative skills required for your project (see below).

• **Volunteers:** Most citizen science projects require volunteer participation in some form. Effectively recruiting, motivating, and retaining volunteers will be important in the success of many efforts.

• **Partnerships:** Partners may be needed to provide skills, resources, reputational legitimacy, or expertise not already contained in the group conducting the citizen science project. As described in Chapter 1, many types of people and organizations are involved in citizen science. Depending on the project’s needs, your partners may include academia, government agencies, other individuals or community organizations, the private sector, technology developers, activists, legal entities, and even the media.

**Technical and management skills**

• **Scientific and technical skills:** A range of scientific and technical skills may be needed to carry out a citizen science project. These include capabilities in
  - data or statistical analyses
  - study design (e.g., epidemiological, monitoring, community-based participatory research, participatory action research, crowdsourcing)
  - design of measures or data collection instruments
  - data collection, management, and governance (e.g., data use, administrative protocols) procedures
  - software or programming apps
  - device or hardware use and maintenance
  - ethical conduct of citizen science projects
  - legal, safety, and privacy concerns
  - communication of scientific ideas or results to different audiences.

• **Project and people management skills:** Given that citizen science projects can be complex and typically involve many partners and individuals, both project management and social skills are required. Team members with experience in partnership building, volunteer management, and cultural competencies are critical.
Funding disaster citizen science projects

Funding is often a big hurdle to readiness for disaster citizen science activities. Community groups that have carried out citizen science projects reported getting funding from existing program budgets, grants, or partnerships with research institutions that obtained funding or using a combination of funding from the above, along with in-kind goods, donations, or services provided by partners. Fundraising activities, including crowdfunding (e.g., GoFundMe), are also popular mechanisms for soliciting contributions for a wide variety of causes. The National Council of Nonprofits provides a number of resources for nonprofit organizations, including tips and guidance for fundraising (https://www.councilofnonprofits.org/).

For community groups that are not officially organized (e.g., 501[c](3)), consider your capacity to solicit and receive donations. If your group is not adequately prepared, a large influx of resources may be difficult to manage. Another issue to consider is the need to provide potential donors with the incentive of tax-exempt donations. Fiscal sponsorship models may be worth exploring to address these issues. Fiscal sponsorship involves an agreement between individuals or groups and a nonprofit organization that acts as the fiscal sponsor. Depending on the type of agreement made, the nonprofit could provide administrative services for the project and may assume some level of responsibility for legal and financial matters. The National Network of Fiscal Sponsors provides more information on fiscal sponsorship, along with guidelines (https://www.fiscalsponsors.org/).

Regardless of resources available, a common element of all successful projects is an unwavering commitment on the part of either individuals or a small group of leaders to make citizen science work. In some cases, beginning the work is the most important step, and resources may come in once a project has started.

**Worksheet 2c** is designed to help you think through the resources and skills you think are important for implementing the project. You can start with the resources described above and add others that you think are relevant.
# Worksheet 2c

**Skills and resources needed to carry out a disaster citizen science project**

List the skills and resources you believe that your project needs. Also determine whether you already have the resources and, if not, what your plan might be to get them.

<table>
<thead>
<tr>
<th>Resource list</th>
<th>Do you need this resource?</th>
<th>Do you have this resource?</th>
<th>Where could you get the resource if you need it and don’t have it?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

You can add notes in the space below.
Example disaster scenario for toolkit exercises: Guidance on filling out Worksheet 2c

Below we provide guidance on how to fill out Worksheet 2c using the factory emissions scenario. The sample answers are provided as examples of how you might respond to each worksheet item. We used the resource lists provided in this section to fill out the first column.

### Worksheet 2c

**Skills and resources needed to carry out a disaster citizen science project**

List the skills and resources you believe that your project needs. Also determine whether you already have the resources and, if not, what your plan might be to get them.

<table>
<thead>
<tr>
<th>Resource list</th>
<th>Do you need this resource?</th>
<th>Do you have this resource?</th>
<th>Where could you get the resource if you need it and don’t have it?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funding</td>
<td>Yes</td>
<td>No</td>
<td>We can look for grant funding; we can partner with a university with greater financial resources for research</td>
</tr>
<tr>
<td>Technology: sampling equipment</td>
<td>Yes</td>
<td>No</td>
<td>With funding, we can purchase air-monitoring equipment; we could try to partner with companies that develop devices and may donate them to the project or reduce the cost</td>
</tr>
<tr>
<td>Training materials</td>
<td>Yes</td>
<td>No</td>
<td>We can develop these materials in-house</td>
</tr>
<tr>
<td>Educational materials</td>
<td>Yes</td>
<td>Yes</td>
<td>We have already developed materials as part of other community air-quality campaigns</td>
</tr>
<tr>
<td>Strong leadership</td>
<td>Yes</td>
<td>Yes</td>
<td>Our team is dedicated to this work</td>
</tr>
<tr>
<td>Supportive organizational culture</td>
<td>Yes</td>
<td>Yes</td>
<td>Our organization is dedicated to this work</td>
</tr>
<tr>
<td>Labor</td>
<td>Yes</td>
<td>Yes</td>
<td>Our organization is fully staffed to support the project</td>
</tr>
<tr>
<td>Volunteers</td>
<td>Yes</td>
<td>No</td>
<td>We can recruit from existing networks</td>
</tr>
<tr>
<td>Partnerships</td>
<td>Yes</td>
<td>Some</td>
<td>We can reach out to potential partners, such as universities</td>
</tr>
<tr>
<td>Technical skill 1: emission health effects</td>
<td>Yes</td>
<td>No</td>
<td>We can reach out to professors at the local university who do work in this area</td>
</tr>
<tr>
<td>Technical skill 2: emission measurement</td>
<td>Yes</td>
<td>No</td>
<td>We can reach out to professors at the local university who do work in this area</td>
</tr>
<tr>
<td>Management skills</td>
<td>Yes</td>
<td>Yes</td>
<td>Our organization has expertise in project and program management</td>
</tr>
</tbody>
</table>

You can add notes in the space below.
How do you ensure the quality of your citizen science research project?

As with any research project, it is critical to ensure the quality of disaster citizen science research, particularly for projects that are designed to lead to actionable outcomes. Citizen science programs often focus on data quality—working to ensure that data produced accurately represent what they are supposed to.

This section focuses more broadly on research quality. For instance, a project might collect high-quality data but in a manner that is unethical. In this case, the overall quality of the research would be compromised despite the accuracy of the data. We discuss three research quality areas: Projects should ensure that their work is of high scientific and technical quality when using volunteers, meets ethical and legal standards, and is viewed as credible. Box 2.4 provides tips for improving engagement, and Box 2.5 illustrates how volunteer engagement may be affected by project characteristics.

Ensuring the scientific and technical quality of research involving volunteers

In citizen science research, you may be working with volunteers who want to contribute to research, whether in large numbers (e.g., crowdsourcing studies) or through smaller activities (e.g., participatory research projects). Regardless of the number of participants, volunteer training is vital to citizen science projects. If volunteers are invited to participate as data collectors, training is needed to ensure that they understand proper procedures and collect and handle data in a consistent and uniform way.

When designing your training procedures, consider the level of technical knowledge and experience required by volunteers. Also keep in mind that some citizen science methods may require more-elaborate training procedures than others. For example, performing environmental monitoring (e.g., air, water, soil) may require training volunteers in sampling protocols to ensure the integrity of the samples from initial collection to storage. In contrast, carrying out a crowdsourcing study in which volunteers provide data in the form of photographs or text-based observations of hazards (e.g., algal blooms, mosquito habitats) might require a relatively lower burden of training, which might consist of educational materials explaining how to identify hazards of interest and how to record necessary information.

As with any research effort, citizen science projects require management and oversight both to properly develop training materials and to ensure that protocols are followed and the quality of the data collected is sound. Ideally, you should pilot-test and refine training materials and all other documents with a small group of volunteers before scaling up a project. Regardless of how well your training process is, mistakes are bound to happen. Therefore, it will also be helpful to consider strategies for verifying
or validating volunteer-generated data or for integrating protocols for data collection redundancy into your project.

It is also important to consider the size and diversity of your volunteer workforce. Scientific quality relates not only to the technical aspects of data collection but also to the ability to ensure that observations and measurements are representative of communities and that certain groups, areas, or viewpoints are not underrepresented. Engaging a robust and diverse volunteer community may help in overall recruitment and then retention of volunteers. As noted by the leader of a community organization we interviewed,

I think it’s important for community members to feel like they can do this and to be proud that their skills and their talents lead to a better decision . . . because they live in these communities. And to also prove to the scientists that we could be trained and we’re willing and able. It was really exciting to see the people that we trained were people that were young, in high school, some in college all the way to 80-year-old grandmothers. And in each case we all have different learning skills, and everyone was able to learn how to use equipment and how to be able to make a difference and understand what’s happening in their own environment. We had a medical doctor, and we had several master’s-level people, and we had people who only finished high school. We were diverse in the community members that were in involved and what we wanted for them to learn is that we all could make a difference.

Keep in mind that a dwindling base of volunteers over time can compromise research quality. If you lose many of your volunteers, data collection efforts will suffer in later phases of the project. Since citizen science projects involve people who are volunteering their time, retention can be an issue. Successful disaster citizen science projects often start by identifying volunteers with intrinsic motivation (e.g., individuals personally affected by the issue the project addresses). However, even when intrinsic motivation is initially high, maintaining the same level of commitment over time can be challenging.
CASE STUDY IN VOLUNTEER ENGAGEMENT
A comparison of three projects

The type of project you run may affect the level of volunteer engagement, as described in a comparison of three projects:

• In 2010, in response to the Deepwater Horizon oil spill, SkyTruth, a nonprofit environmental organization, launched the Oil Spill Tracker, a crowdsourcing platform that collected public reports of oil spill impacts along the Gulf Coast. A similar effort was launched after Hurricanes Harvey and Irma to allow for public reporting of hazardous releases and other pollution incidents in Texas, Florida, and the Caribbean. The goal of the projects was to inform recovery efforts by response groups and raise public awareness (SkyTruth, 2017; Amos, 2017).

• Following landfall of Hurricanes Irma and Maria in the Caribbean in 2017, the Planetary Response Network (PRN), a digital humanitarianism project, deployed its network of volunteers to analyze satellite imagery of disaster-affected areas and perform damage assessments. The goal of the project was to provide a relief group with priority areas for response (Zastrow, 2016; Zooniverse, undated).

• Soon after Hurricane Maria hit Puerto Rico in 2017, the Rincón chapter of the Surfrider Foundation, a nonprofit organization dedicated to protecting oceans and beaches, resumed its Blue Water Task Force program, performing water-quality testing at beaches and freshwater sources. The goal of the project was to inform the public and government officials about safe and unsafe water supplies (Cutraro, 2017).

Although all three projects demonstrated success in meeting goals, SkyTruth and Surfrider Rincón noted some difficulties in sustaining volunteer engagement. The PRN, however, was able to engage more than 5,000 volunteers, who produced 650,000 image classifications. There are several differences in the PRN project compared with SkyTruth and Surfrider Rincón that might have affected engagement. First, PRN tasks were more time-limited (a few weeks), compared with SkyTruth and Surfrider tasks, which might have helped with retention or with keeping people’s attention over time. Second, PRN had a specific audience for the results—one relief organization that had requested the deployment and would directly use the findings to focus operations. In contrast, SkyTruth and Surfrider had broader audiences and applications for their data, including raising public awareness and education. Knowing who would use project results and exactly how those results would be used might have been highly motivating for PRN volunteers. Third, PRN tasks could be performed by anyone with an internet connection across the world. SkyTruth and Surfrider Rincón tasks, however, depended more on volunteers within the disaster-affected areas; individuals who were affected by the storms themselves likely had competing priorities or limited attention. Finally, Surfrider Rincón tasks, as compared with PRN tasks, were also more intensive, requiring volunteers to go out in the field. Therefore for Surfrider, potential volunteers might have faced more constraints, particularly after suffering through a disaster event.

We point out these differences in volunteer engagement solely to demonstrate that different project types will require different strategies for engagement. All three projects listed above were highly important and impactful despite experiencing some engagement challenges. As you plan your own projects, consider what aspects of your methods or approach may affect volunteer experiences or motivations and build in multiple strategies to keep people engaged.

For more information, see Chari et al., 2019.
Addressing ethical and legal considerations

Professional researchers need to ensure that their work follows ethical and legal standards, and institutions have created structures to govern scientific conduct. Studies in human populations are reviewed by institutional review boards (IRBs), which ensure that the rights and welfare of research subjects are not violated. These safeguards are in place because the history of scientific research, unfortunately, includes many instances in which the safety and health of research participants were disregarded under a belief that the ends justified the means.

Citizen science research led by academic or government institutions is governed by the same ethical and legal rules applicable to traditional human subjects research. But citizen science research led by community groups or others outside the regulated worlds of academia and government currently lacks mechanisms for oversight of ethical and legal issues, leaving it to community groups or individuals to understand and monitor these issues on their own (Stone, 2013). Box 2.6 provides guidance and resources for community groups on consulting with IRBs.

Ethical and legal considerations can be complex. As noted earlier, the quality of your data might not matter if the manner in which you obtained the data runs afoul of ethical principles or legal regulations. In citizen science research led by professional scientific institutions, volunteers can also be research subjects if a project is interested in evaluating outcomes associated with the citizen scientists (e.g., learning outcomes, attitudes, beliefs). Thus, the same principles that govern conduct toward research subjects would also apply to volunteers:

1. **Respect for persons:** People should be treated as autonomous agents with the right of self-determination. In research, this principle leads to the concept and practice of informed consent. Every research subject (or volunteer) should enter into research voluntarily and with adequate information. Individuals with diminished autonomy should be protected by project leaders from exploitation and harm.

2. **Beneficence:** The well-being of research subjects is paramount, and project leaders should carry out research in a manner that does no harm and maximizes benefits to the research subjects while minimizing harm.

3. **Justice:** The benefits of research and its burdens should be distributed equitably or fairly among research subjects.
Resources and guidance on institutional review boards for citizen science research

IRBs are tasked with protecting the rights and welfare of people involved in research. Approval from an IRB is required for federally funded and many privately funded research projects that involve humans. Even if funders do not require IRB approval, it may be beneficial to participate in some form of review to understand potential ethical issues that might arise.

Community groups engaged in research activities should consider seeking IRB approval prior to starting a project. Collaborating organizations, such as academic institutions, may also need to obtain IRB approval. A critical first step is to consult an IRB (e.g., an IRB at a local university with experience in community-engaged research) or researcher familiar with IRBs at a partner organization to determine whether a full application is required, given the scope and activities of the proposed project. If you are unsure where to find an IRB, you can search the Database for Registered IRBs from the U.S. Department of Health and Human Services’ Office for Human Research Protections (https://ohrp.cit.nih.gov/search/irbsearch.aspx). In some cases, local universities may affiliate with an IRB that works closely with community-based organizations. For example, the Healthy Flint Research Coordinating Center in Michigan maintains the Community Ethics Review Board (https://www.hfrcc.org/cerb/).

Community groups that do not have access to an academic IRB should explore the availability of community-led IRBs or ethics review groups. For example, the Bronx Community Research Review Board (http://bxcrrb.org/who-we-are/mission-vision/) in New York is an independent review board that seeks to address the concerns of community residents in research activities. Similarly, Special Service for Groups (http://www.ssg.org/programs-and-services/research/) in Los Angeles maintains an IRB to review and support the activities of community-based partners. These types of community-focused ethics review boards are increasingly common.

Organizations interested in developing their own IRB should consider available resources, including Community IRBs and Research Review Boards: Shaping the Future of Community-Engaged Research (Albert Einstein College of Medicine, Bronx Health Link, and Community-Campus Partnerships for Health, 2012).

To address ethical and legal considerations in your disaster citizen science project, you need to determine, when designing your project, whether your research will collect data from people. For example, you may be interested in doing a health survey of your neighborhood following a disaster. If your project uses volunteers to collect data from people, then you should consider ethical and legal issues for both populations. Below, we discuss issues relevant to research subjects and volunteers who may also be research subjects.

Data privacy and safeguarding

Research with human subjects will result in data about individuals, and, depending on what a project is studying, some of those data, if released
publicly, might cause harm or embarrassment to a person. For example, if you conduct a health survey in your area, some residents might not want others to know that they have a particular health condition.

To protect individuals from unwanted release of their personal data, professional researchers develop and follow a data privacy and safeguarding plan. At a minimum, such a plan would ensure that data are collected and stored in a secure fashion, whether you are using paper-based tools or electronic apps with data stored in the cloud. For paper-based tools or data stored on physical hard drives, you should invest in secure storage solutions, such as lockboxes or safes. For electronic apps, you should research the track record and security capabilities of the vendors. In addition, research subjects should ideally be informed prior to agreeing to join the study about any data privacy risks and about plans that will be used to safeguard information. Table 2.1 provides a list of resources for further exploring data privacy issues.

There are ethical and legal dimensions to protecting people’s data, and there is a practical dimension as well. If you want government or other institutions to use and act on your research, it helps to provide them with data that meet the criteria and standards that the institutions are legally bound to follow. For example, health data are considered highly sensitive and governed under the Health Insurance Portability and Accountability Act (HIPAA):

HIPAA was passed by Congress in 1996 (Public Law 104-191). HIPAA requires the protection and confidential handling of protected health information (PHI), which refers to information about health status, care received, or payment for health care that can be linked to a specific individual. HIPAA applies to projects that collect, receive, handle, or share PHI, including PHI on the volunteers involved. Projects with health department involvement will need to ensure compliance with HIPAA and develop and follow procedures that ensure the confidentiality and security of PHI (U.S. Department of Health and Human Services, 2013).

Although it might be difficult to comply fully with all HIPAA standards, simply showing that you have an understanding and appreciation of the legal and regulatory constraints faced by institutions will signify the seriousness of your work and enhance its credibility.

**Ethical and legal issues in volunteer management**

The same data safeguards used to protect research subjects also apply to volunteers. For example, if you conduct a project evaluation, part of the activity may include collecting data from your volunteers to assess and improve project activities—for example, determining whether training protocols or recruitment procedures are effective or whether participation in the project resulted in any benefits to the volunteers themselves (e.g., learning outcomes). Data safeguards should cover such data collection efforts.

Another issue that is especially relevant for disaster citizen science is volunteer safety. Disaster settings can be dangerous, because of either characteristics of the disaster itself (e.g., hurricane winds) or the conditions a disaster
leaves behind (e.g., toxic contamination, falling debris). Depending on the type of disaster research you wish to conduct, volunteers may face varying degrees of danger. For example, volunteers who monitor or chase severe storms may face significant risk. Even a seemingly innocuous activity, such as collecting water samples in a public park, might pose risks, such as injury, to volunteers. Therefore, research plans should include volunteer safety protocols and any other measures needed to reduce the chance of harm. In addition, people should be informed of the potential safety risks prior to agreeing to volunteer.

Fully disclosing risks and obtaining some kind of documentation of consent may help decrease your liability in the event that a volunteer gets hurt. In addition, you could offer some kind of insurance coverage to your volunteers if you know that your project carries significant risk. Most states do not allow volunteers to be covered under workers’ compensation policies, although you should research the situation in your own state. You might also consider volunteer accident insurance for medical costs and general liability insurance. If insurance coverage for your volunteers is unfeasible (e.g., too costly, burdensome, unavailable), you should consider having volunteers sign waivers of liability or hold harmless agreements.

Other issues with an ethical dimension that might arise relate to the products of the research. Prior to enlisting volunteers, consider developing a terms of agreement document for them to sign. This agreement would include policies on data collected (e.g., data ownership, data reuse agreements, whether data will be made public) and on products developed from the research (e.g., authorship or acknowledgment plan, ownership of intellectual property).

Discussions about the ethical and legal dimensions of citizen science research can quickly become dense and complicated, but the underlying principles are quite simple:

- Respect your volunteers and research participants.
- Disclose risks and obtain consent.
- Secure people’s data.
- Keep your volunteers and research participants safe.
- Protect people’s rights.

Any steps you can take to integrate these principles into your project will go a long way in helping you protect not just your volunteers and research participants but yourself as well. Use the resources in Table 2.1 to learn more. If you feel that you cannot guarantee these principles and are planning a particularly risky project, consider partnering with an institution or individual with access to an IRB and the capacity to safeguard data.

Understanding research quality trade-offs: The concept of fitness for use

We note that many of the project examples described in the toolkit may seem bigger than what you are considering. Perhaps you want to start with a small
 Act

water- or air-quality testing project or community health survey and find that this information about data quality, privacy, safeguarding, IRBs, ethics, etc. is more involved than you expected. We designed this toolkit assuming that community groups are interested in carrying out a project that could change decisionmakers’ minds and spur them to action. The best way to do that is with a rigorously designed study. However, if you want to pursue a smaller project, you can still use the process we laid out to determine your goals and select the best approach.

In addition, there is another important outcome to consider, one that applies to projects of all sizes and scopes. This is the concept of fitness for use, which we mentioned in the beginning of the toolkit. It means the degree to which data are suitable for a particular purpose—that is, that they should have the appropriate level of quality for their intended use (Holdren, 2015). If your goal is to get a government agency to change a policy or enforce a regulation because of your data, then your project needs to be of high quality. But if your goal is to get a government agency to do more research on a problem in your community (e.g., take air or water samples), then the quality of your project does not need to meet the highest standards. Instead, you just need to demonstrate the possibility of a larger problem.

For many collegial projects, data quality will be an issue. High-quality equipment for measuring environmental conditions is very expensive. Working with volunteers and conducting training take a lot of time and resources. Using less expensive, but lower-quality, equipment or accepting that some degree of mistakes will be made by volunteers is perfectly fine, as long as your expectations about what the data can and cannot do align with the quality of the resulting data.

Importantly, by using the toolkit, you should be able to understand and communicate both the strengths and the limitations of your research project. If you can communicate about your research to a wide variety of stakeholders—knowing its strengths and limitations and what you could do better if you had the resources—you will earn as much credibility as if you had carried out a citizen science project of the highest rigor. Do not underestimate the importance of your voice and your ability to make an impact.

Ensuring the credibility of your research

Research quality is also related to its credibility—whether stakeholders trust the way the work was performed and consider the results to be relevant and useful. In addition to following good design principles, the main way to ensure the credibility and the quality of your research is to evaluate it. Two of the most common evaluation types are process and outcome evaluations. Process evaluations determine whether a project was implemented successfully. Outcome evaluations determine whether a project was effective in achieving its goals. Process evaluations are ongoing throughout a project, and the lessons learned can be fed back into project activities in real time for continual improvement. Both evaluations together will help demonstrate that any change in the outcome of interest was due to your project—in short, that the research accomplished what you said it would. Strong evaluations make research results harder to challenge.
<table>
<thead>
<tr>
<th>Subject</th>
<th>Reference</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ethical and legal issues in research</strong></td>
<td>European Citizen Science Association, 2015</td>
<td>“The Ten Principles of Citizen Science”</td>
</tr>
<tr>
<td></td>
<td>International Federation of Red Cross and Red Crescent Societies, 2020</td>
<td><em>The Fundamental Principles of the International Red Cross and Red Crescent Movement: Ethics and Tools for Humanitarian Action</em></td>
</tr>
<tr>
<td></td>
<td>National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979</td>
<td><em>The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research</em></td>
</tr>
<tr>
<td></td>
<td>Clinical and Translational Science Institute, University of Pittsburgh, undated</td>
<td>“Community Partners Research Ethics Training”</td>
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<tr>
<td></td>
<td>Hoffman, 2015</td>
<td>“Citizen Science: The Law and Ethics of Public Access to Medical Big Data”</td>
</tr>
<tr>
<td></td>
<td>Community Tool Box, undated</td>
<td>“Increasing Participation and Membership”</td>
</tr>
<tr>
<td></td>
<td>Clinical and Translational Science Institute, University of California, San Francisco, 2013</td>
<td><em>Community-Engaged Research: A Quick-Start Guide for Community-Based Organizations</em></td>
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<tr>
<td></td>
<td>Division of Prevention Science, University of San Francisco, undated</td>
<td>“Community Based Participatory Research Toolbox”</td>
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<td></td>
<td>Engage for Equity, undated</td>
<td>Tools and resources webpage</td>
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<td></td>
<td>Center for Science and Democracy, Union of Concerned Scientists, 2016</td>
<td><em>Scientist-Community Partnerships: A Scientist’s Guide to Successful Collaboration</em></td>
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<tr>
<td></td>
<td>Center for Science and Democracy, Union of Concerned Scientists, 2014</td>
<td>Citizen Science Toolkit: Build a Community</td>
</tr>
<tr>
<td></td>
<td>Collective Impact Forum, 2017</td>
<td>Community Engagement Toolkit</td>
</tr>
<tr>
<td><strong>Volunteer management</strong></td>
<td>West and Pateman, 2016</td>
<td>“Recruiting and Retaining Participants in Citizen Science: What Can Be Learned from the Volunteering Literature?”</td>
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<td></td>
<td>Clyde and Eberhardt, 2015</td>
<td>“Tips for Working with Citizen Science Volunteers”</td>
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<tr>
<td></td>
<td>Kragh, 2016</td>
<td>“Motivations of Volunteers in Citizen Science”</td>
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<tr>
<td></td>
<td>Texas Health and Human Services, undated</td>
<td>“The 4 R’s of Volunteer Management Toolkit”</td>
</tr>
<tr>
<td><strong>Data quality, management, and safety</strong></td>
<td>Environmental Protection Agency, 2019</td>
<td><em>Quality Assurance Handbook and Guidance Documents for Citizen Science Projects</em></td>
</tr>
<tr>
<td></td>
<td>CitizenScience.gov, 2015c</td>
<td>“Step 4—Manage Your Data”</td>
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<tr>
<td></td>
<td>Wiggins et al., 2013</td>
<td><em>Data Management Guide for Public Participation in Scientific Research</em></td>
</tr>
<tr>
<td></td>
<td>National Committee on Vital and Health Statistics, 2015</td>
<td>Toolkit for Communities Using Health Data: How to Collect, Use, Protect, and Share Data Responsibly</td>
</tr>
<tr>
<td></td>
<td>Bowser, Wiggins, and Stevenson, 2013</td>
<td><em>Data Policies for Public Participation in Scientific Research: A Primer</em></td>
</tr>
<tr>
<td><strong>Evaluation</strong></td>
<td>Phillips et al., 2014</td>
<td><em>User’s Guide for Evaluating Learning Outcomes from Citizen Science</em></td>
</tr>
<tr>
<td></td>
<td>National Institute of Environmental Health Sciences, 2018</td>
<td>“Evaluation Metrics: Partnerships for Environmental Public Health”</td>
</tr>
<tr>
<td></td>
<td>Community Tool Box, undated</td>
<td>“Evaluating the Initiative”</td>
</tr>
<tr>
<td></td>
<td>Centers for Disease Control and Prevention, 2016</td>
<td>“CDC Evaluation Resources”</td>
</tr>
</tbody>
</table>
Exercise

Completing the logic model

In step 1b, we introduced the concept of logic models and asked you to fill out the intended goals, or outcomes, for your project in Worksheet 1b. Recall that the other elements of a logic model are inputs (the resources you need), activities (the things you need to do), and outputs (the products or results of activities). In this exercise, we will help you complete the logic model in Worksheet 1b.

In step 2a, we discussed how a theory of change can inform your logic model by helping you think through how you might achieve your outcomes. Using the theory of change, you should think about what your project needs in terms of resources and activities to achieve the outcomes. Section 2c provided a list of common resources that you can use to fill in the inputs column of your logic model. Not all resources may apply to you, and there may be others you would like to add.

In step 2b, we discussed methods that are used in citizen science. Choosing a method will help you determine your activities. To figure out activities, think about what you need to do to (1) obtain any needed resources, (2) carry out the project methods, and (3) get to the outcomes you specified.

Once you have determined your activities, you next develop the outputs. Outputs are the products or results of your activities. Constructing outputs will help you think through what you hope to accomplish with each activity. To help with your work plan, try to specify targets for each output (e.g., number of products developed, number of services performed, number of events undertaken), whenever possible. Targets can be based on your theory of change and what you believe is needed to achieve the outcomes, but targets are also affected by the resources you have.

Finally, remember that the logic model is a living tool to help you create your project, and it may change over time. As you go through the process of designing and implementing a project, you can update the model based on new information or directions.

Example disaster scenario for toolkit exercises: Guidance on filling out inputs, activities, and outputs for the logic model in Worksheet 1b

For the factory emissions scenario we provided, our theory of change was that high-quality air-sampling data that showed dangerous emission levels would spur the government to take actions to enforce compliance, which in turn would lead to decreased factory emissions and better community health. To fill in the inputs column, we simply referred to the resources listed in Section 2c and used our answers in Example Worksheet 2c (about the skills and resources needed to carry out a disaster citizen science project).

To fill out the activities column, we determined what was needed to (1) obtain resources, (2) carry out project methods, and (3) achieve the outcomes. We included activities to obtain resources, such as funding (e.g., hold fundraisers) or technical expertise (e.g., find an academic partner). We knew from our theory-of-change story that air sampling was the method of choice. Thus, for activities associated with project methods, we included the need for volunteers who are trained in air sampling and other activities associated with data collection and analysis. Finally, to achieve the outcomes, we needed activities that reflected what we would do with the data (e.g., conduct outreach to the public and government officials).

To determine the outputs, we thought about what each activity should accomplish. For example, one activity was to hold training sessions, so two desired outputs would be to make sure that the sessions actually took place and to train a specified number of people. Other desired outputs might be to ensure that the trainings were well received by volunteers and that they were effective in teaching volunteers the skills they need. In Example Worksheet 1b, we also specify targets for each output to help with planning and evaluation.
### Worksheet 1b

**What do you want to achieve? Completing the logic model**

Use a logic model to map out what you want to achieve from your project.

**Problem description** (Use this space to provide a one- or two-sentence description of the problem to help you stay organized and focused.)

**Dangerous levels of air pollution experienced by our community because of factory emissions.**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Activities</th>
<th>Outputs</th>
<th>Short-term outcomes</th>
<th>Medium-term outcomes</th>
<th>Long-term outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>What resources do you need to achieve the outcomes (e.g., funding, partners, equipment, better knowledge of the problem, volunteers)?</td>
<td>What activities are you planning to do to achieve the outcomes?</td>
<td>What resulted from your activities (e.g., products developed, services performed, events undertaken, targets achieved)?</td>
<td>What outcomes can you expect in the near term (e.g., 1–5 years) if project activities are carried out as intended?</td>
<td>What outcomes can you expect in the intermediate term (e.g., 5–10 years) if project activities are carried out as intended?</td>
<td>What outcomes can you expect in the long term (e.g., 10+ years) if project activities are carried out as intended?</td>
</tr>
<tr>
<td>Funding</td>
<td>Labor</td>
<td>Technical expertise partners</td>
<td>Sampling equipment</td>
<td>Volunteers</td>
<td>Training and educational materials</td>
</tr>
<tr>
<td>Hold 2 fundraisers</td>
<td>Partner with local university for technical expertise</td>
<td>Research air-sampling equipment</td>
<td>Recruit 30 volunteers</td>
<td>Develop training protocol and materials</td>
<td>Hold 2 training sessions</td>
</tr>
<tr>
<td>Gather 50 air samples</td>
<td>Analyze 50 air samples</td>
<td>Hold 2 briefings with organization leaders</td>
<td>Hold 4 public meetings on findings</td>
<td>Hold 2 meetings with government officials on project and findings</td>
<td>2 fundraisers held</td>
</tr>
<tr>
<td>1 university partnership developed</td>
<td>Partner shows high satisfaction with roles and communications</td>
<td>2 air monitors procured</td>
<td>25 volunteers recruited</td>
<td>Volunteers show high satisfaction with recruitment process</td>
<td>Training materials developed</td>
</tr>
<tr>
<td>1 sampling plan developed</td>
<td>50 air samples obtained correctly</td>
<td>50 air samples analyzed correctly</td>
<td>2 briefings with organization leaders held</td>
<td>Organization leaders show more-positive attitudes toward citizen science than before</td>
<td>1 sampling plan developed</td>
</tr>
<tr>
<td>2 briefings with organization leaders held</td>
<td>4 public meetings held</td>
<td>Public shows more-negative attitudes toward factory emissions than before</td>
<td>2 meetings with government held</td>
<td>Government shows more-negative attitudes toward factory emissions than before</td>
<td></td>
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</tbody>
</table>

You can add notes in the space below.
STEP 3 Build your team

By this point, you have thought about the outcomes you want to achieve with a disaster citizen science project, the activities you will carry out, and the inputs and resources needed. One critical resource, of course, is partnerships. In step 3, you will clarify exactly who should be part of your project and why. You may find it useful to refer back to the logic model and worksheets you have filled out for previous exercises, particularly Worksheets 1c (what has been done before) and 2c (skills and resources needed).

Identifying and assessing potential partners

In this step, we provide two ways to identify potential partners. First, you can identify partners by thinking about what resources you need and who can help you. We call these groups resource providers. Second, you can identify partners by thinking about who might have an interest, concern, or stake in your project and its results. These are your project stakeholders.

To determine your resource providers, first revisit Worksheet 2c. Look at the resources and skills you listed, and pay close attention to those resources you marked as “yes” for needing and “no” for having. You might have already specified groups in the last column as sources for obtaining a resource. If you have not, go through Worksheet 2c again and think about whether a group or entity could help you obtain each of the needed resources. If so, write down the type of group or entity required (or specific names if you already have people in mind). Transfer your list of potential resource providers to Worksheet 3.

To determine your stakeholders, think about the problem you have defined, your research questions, and the outcomes you wish to achieve. Use Worksheet 3 to list all the people or groups that are (1) in a position to take action on the problem or (2) affected by the problem and in a position to benefit (or lose something) if intended impacts are achieved. These are the stakeholders. Every group you listed back in Worksheet 1c is a stakeholder. Think of other groups that fit either of the two stakeholder criteria above. As a guide to identifying stakeholders, you can think about different sectors from which partnerships may be drawn, such as government, academic institutions, cultural and faith-based groups, education, health care, business, media, emergency management, social services, or community-based organizations (Centers for Disease Control and Prevention, 2019). Also consider issues of diversity when identifying potential partners. Earlier in the toolkit, we noted the importance of a diverse volunteer force in enhancing research quality. The same holds true for the partners you select. By engaging a diversity of voices, you will ensure that your project includes observations and measurements that are representative of communities and produces relevant and equitable outcomes (Mervis, 2018; National Academies of Sciences, Engineering, and Medicine, 2018).

After making your list of resource providers and stakeholders, you should characterize their potential as partners by answering four questions. For each entity, consider the following:
1. How are they involved in the problem?
2. What is their position or motivation?
3. How might they be engaged with the project?
4. What constraints might keep them from helping to address the problem?

How have potential partners been involved in the problem?
The background research you perform with Worksheet 1c will help you determine what groups have already been involved with the problem you are trying to address and what they have done. This in turn will support your deliberations about what the motivations of these partners might be and also how they could be engaged with the project.

What are the positions or motivations of the potential partners on the problem?
Knowing your potential partners' positions on the problem or what motivates them to be involved will help you assess whether you will have a shared understanding of the problem and vision for the project. Consider what you know or could find out about potential partners' interests, worldviews, or personality traits (e.g., political or religious views, core beliefs, risk-taking or risk-aversion traits). Understanding these characteristics could reduce the possibility of conflicts and misunderstanding in a partnership.

How might potential partners be engaged with the project?
There are many ways to engage partners in a project, as shown in Figure 2.3. You can inform or tell potential partners about the work you are doing without expecting them to contribute in substantial ways. These groups might be more involved as the end users of your research in bringing results to action or helping to promote or disseminate. You can consult with potential partners to obtain feedback on project plans and design. You can involve potential partners more deeply in different aspects of the project (e.g., design, methods development, data collection or analysis, education or dissemination efforts) by asking potential partners to commit to performing certain tasks or activities. You can collaborate with potential partners by inviting them to work together on some or all parts of a project. Finally, you can co-lead with potential partners by including them in leadership roles and as equal partners in all aspects of the research process (Clinical and Translational Science Awards Consortium, 2011; National Advisory Council for Environmental Policy and Technology, 2018).
What constraints might keep potential partners from helping to address the problem?

To identify any constraints that might keep potential partners from helping, you should make sure you understand some background information about each identified resource provider or stakeholder group, such as how an organization operates and what its mission is, the service area it covers, the amount of resources it has, and any legal or ethical obligations it needs to follow. Groups might not be able to enter partnerships because of practical barriers, such as lack of funds, time, or labor, or because a proposed project does not fall within its mission areas. You should also consider the politics or any sensitivities around a problem that might prevent or restrict a potential partner's involvement in the project.

Answering these questions for all potential partners will require more background research. Much of the information should be available online on organization websites, but you may need to talk to organizational representatives directly to truly understand the constraints.

Worksheet 3 provides a template to help you think through the four questions above and determine what groups might make good partners.
### Worksheet 3

**Identifying and evaluating potential partners**

List the people or groups who could provide your project with needed resources (resource providers). Also list project stakeholders. Stakeholders are (1) in a position to take action on the problem or (2) affected by the problem and in a position to benefit, or lose something, if impacts are achieved. You can start with the groups you listed in **Worksheets 1c and 2c** and then add more as necessary. Fill in the cells and use the information to make a decision about the suitability of each group as a partner. Entities that are marked as “yes” or “maybe” for potential partners should be pursued further.

<table>
<thead>
<tr>
<th>Stakeholder group</th>
<th>How group is involved</th>
<th>Group’s position</th>
<th>What group could do</th>
<th>Group’s constraints</th>
<th>Potential partner?</th>
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</tbody>
</table>

You can add notes or your conclusions in the space below.
### Worksheet 3

**Identifying and evaluating potential partners**

List the people or groups who could provide your project with needed resources (resource providers). Also list project stakeholders. Stakeholders are (1) in a position to take action on the problem or (2) are affected by the problem and in a position to benefit, or lose something, if impacts are achieved. You can start with the groups you listed in *Example Worksheets 1c and 2c* and then add more as necessary. Fill in the cells and use the information to make a decision about the suitability of each group as a partner. Entities that are marked as “yes” or “maybe” for potential partners should be pursued further.

<table>
<thead>
<tr>
<th>Stakeholder group</th>
<th>How group is involved</th>
<th>Group's position</th>
<th>What group could do</th>
<th>Group's constraints</th>
<th>Potential partner?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community group 1</td>
<td>Lives in area; did health survey</td>
<td>Reduce emissions</td>
<td>Help in organizing</td>
<td>Funding; time</td>
<td>Yes; service area does not overlap</td>
</tr>
<tr>
<td>Community group 2</td>
<td>Lives in area; built monitors</td>
<td>Reduce emissions; shut down factories</td>
<td>Help with youth engagement</td>
<td>Funding; labor</td>
<td>No; do not agree with their position</td>
</tr>
<tr>
<td>Local health department</td>
<td>Concerned with health; responds to community needs</td>
<td>Need to establish links between emissions and health effects</td>
<td>Carry out health study; fund studies; convene community meetings</td>
<td>Funding; labor; mission area</td>
<td>Maybe; proposed project may fall outside its lane (need to research)</td>
</tr>
<tr>
<td>Local university</td>
<td>Did epidemiology study</td>
<td>More research is needed</td>
<td>Provide expertise</td>
<td>Funding; time</td>
<td>Maybe; depends on willingness to involve community in research</td>
</tr>
<tr>
<td>Other university (nonlocal)</td>
<td>Measured emissions</td>
<td>More research is needed</td>
<td>Provide expertise</td>
<td>Funding; time</td>
<td>No; based on past experience</td>
</tr>
<tr>
<td>Monitoring equipment companies</td>
<td>Developed emissions measuring tools</td>
<td>More research is needed</td>
<td>Provide equipment</td>
<td>Money</td>
<td>Yes; explore potential for donating equipment or reducing cost</td>
</tr>
<tr>
<td>State and local environment departments</td>
<td>Regulate and enforce standards</td>
<td>Mandate is to ensure compliance with regulations</td>
<td>Carry out exposure and health studies; ensure compliance</td>
<td>Funding; labor; mission area</td>
<td>Yes</td>
</tr>
<tr>
<td>Factory 1</td>
<td>Is an emissions source</td>
<td>There is no problem; already complying</td>
<td>Ensure compliance; put in controls to reduce emissions</td>
<td>Money</td>
<td>Maybe; has shown willingness to listen in past</td>
</tr>
<tr>
<td>Factory 2</td>
<td>Is an emissions source</td>
<td>There is no problem</td>
<td>Ensure compliance; put in controls to reduce emissions</td>
<td>Money</td>
<td>No; not a willing partner in the past</td>
</tr>
<tr>
<td>Community members</td>
<td>Are exposed to emissions</td>
<td>Reduce emissions</td>
<td>Volunteer for project</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Area health care providers</td>
<td>Treat ailments possibly related to emissions</td>
<td>Health effects are concerning; need to establish links between emissions and health effects</td>
<td>Provide information on health effects</td>
<td>Time</td>
<td>No; project outside their expertise</td>
</tr>
</tbody>
</table>

You can add notes or your conclusions in the space below.
Developing partnerships can be challenging, as it may require connecting with people you do not know, thus slowing down the planning process. However, it can help ensure that your project is successful. Clarifying for yourself what different entities can bring to the project will help when you develop new partnerships or approach established partners. Roles and responsibilities can change as you engage with various potential partners, who may offer new ideas worthy of consideration. But having a starting point gives the group clarity regarding expectations and can help facilitate discussions and negotiations around roles.

Worksheet 3 asks you to consider partner motivations, positions, and constraints. Understanding these issues will be critical as you move forward in partnership development. Although it is important to clarify your expectations about partnership roles, it is equally as important to clarify expectations about goals, intended outcomes, and partner capabilities. For example, developing a partnership solely because you need a specific type of technical expertise could ultimately backfire if your partners have different (and conflicting) ideas about how to use the data collected or how to interpret and communicate the data. This is why it is vital for you to fully understand a potential partner's history with the problem of interest, position on the problem, motivations for partnering, constraints, and vision for how results should be used. Remember that the logic model you developed is key to clarifying your own positions, motivations, constraints, and vision for the project. The outcomes and outputs you define indicate what is important to you. For example, if increased community capacity is listed as an outcome and a leadership role in research is listed as an output, it is clear that building community capacity is an important value for you. Therefore, you should ideally look for partners who share the value. The more your partner groups overlap in a shared understanding and vision of the project with you, the smoother the partnership development process will be.

That being said, while it is easier to achieve project harmony by selecting partners with similar motivations and vision, it is also important to understand the perspectives of those who might disagree with you in some way (e.g., in project aims, design, methods, use of results). If true collaborative or co-leadership partnerships are difficult to establish with such groups, consider establishing an advisory body for a wider range of partners who could be engaged in a consultative capacity. An advisory body can provide a structured way to foster dialogue with your challengers and find areas of common ground.
Box 2.7 provides an example of a citizen science program that relies on robust partnerships to achieve its aims. Table 2.2 provides additional resources on developing and fostering partnerships.

**CASE STUDY IN PARTNERSHIPS**

**University of Rhode Island’s Watershed Watch**

Since 1988, the University of Rhode Island’s Watershed Watch program has engaged the public to monitor water quality. The program has partnered with community organizations, including lake and watershed associations, sporting associations, and town conservation commissions. These organizations sponsor the monitoring of particular bodies of water. In turn, they use the data to understand the health of those bodies of water and to control pollution sources. Towns have passed septic system and wastewater management ordinances as a result. Some groups have worked with schools to integrate the data in curricula—for example, in math classes as a way to work with real-world examples. The partnership also allows Watershed Watch to connect with community organizations’ volunteers and vice versa. Some of the community organizations handle volunteer recruitment and management themselves.

The project has also partnered with the state’s Department of Environmental Management for funding and dissemination of data. Watershed Watch notifies the department of algal blooms. The Department of Environmental Management has also used Watershed Watch’s data to remove sites from the impaired-waters list and to conduct supplemental monitoring when data indicate poor water quality.

Lastly, the project partnered with a citizen science initiative called the Cyanobacteria Monitoring Collaborative, composed of three projects—bloomWatch, cyanoScope, and cyanoMonitoring. Watershed Watch volunteers report algal blooms using the collaborative’s bloomWatch app. Some volunteers also regularly sample and analyze water at sites through the collaborative’s cyanoMonitoring program to help identify when a bloom will likely develop. According to a Watershed Watch representative:

> Our partnerships are . . . very diverse. . . . The program got started with one watershed organization, and so that was a true partnership because they had a data need, and we had the resources and the institutional support to get the program up and running. And then, once the program was discovered by other folks, other conservation commissions, and other watershed groups wanted to participate as well, so we work with the groups in a variety of ways depending on what their needs are and their abilities and funding.

For more information, see bloomWatch, undated; cyanoMonitoring, undated; cyanoScope, undated; University of Rhode Island, undated.
TABLE 2.2
Resources for partnerships

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Association of County and City Health Officials, 2017</td>
<td>Local Health Department-Community Health Center Collaboration Toolkit</td>
</tr>
<tr>
<td>National Association of County and City Health Officials, undated</td>
<td>“Partnerships and Coalitions”</td>
</tr>
<tr>
<td>Homeland Security Studies and Analysis Institute, 2013</td>
<td>The Resilient Social Network</td>
</tr>
<tr>
<td>National Institutes of Health, undated</td>
<td>“Tools and Resources”</td>
</tr>
<tr>
<td>Tamarack Institute, undated</td>
<td>“Tool</td>
</tr>
<tr>
<td>Collective Impact Forum, 2017</td>
<td>Community Engagement Toolkit</td>
</tr>
<tr>
<td>Center for Science and Democracy, Union of Concerned Scientists, 2016</td>
<td>Scientist-Community Partnerships: A Scientist’s Guide to Successful Collaboration</td>
</tr>
<tr>
<td>National Quality Forum, 2016</td>
<td>Improving Population Health by Working with Communities: Action Guide 3.0</td>
</tr>
</tbody>
</table>
**STEP 4 Assess your readiness to implement a disaster citizen science project**

Before implementing your project, it is useful to consider the readiness of your team and organization to start implementing a disaster citizen science project. There are different components to consider when assessing readiness, and it is important to think through all of them, because not being ready in a particular area can undermine your wider efforts. Even if you as an individual or a group are excited about a particular project, your organization might not be in a position to support such an effort at this time. Assessing the organization’s overall readiness and knowing where the group’s readiness might be lacking will help you understand where to focus your energies. Informally organized groups that are not part of any institution can still find the readiness assessment relevant. Skip the questions focused on organizational support.

This section provides a readiness tool (Worksheet 4) that assesses readiness across seven dimensions, which have been discussed in prior sections of the toolkit:

- goals and motivations
- project leadership
- resources and administration
- partnerships
- knowledge and skills
- volunteer management
- organizational culture and support.

Worksheet 4 uses a color system to indicate which readiness criteria are critical (green) before starting project implementation and which criteria are “good to have” (yellow) but not necessary for startup. There are 17 criteria considered critical for readiness. Critical criteria focus on having a clear understanding of goals and project needs, strong project planning, and key supports in place (e.g., project leadership). Many of the 11 yellow-coded criteria relate to having past experiences in an area or success in obtaining all project resources needed. A lack of experience is not an implementation deal breaker, but the more yellow-coded criteria you meet, the better positioned you may be in dealing with challenges that arise. You may find your team to be more resilient to setbacks because of your ability to draw on the lessons learned from these experiences. Note that, depending on your project, some of the criteria might not be relevant (e.g., you might not have volunteers, partners, or be part of a formal organization).

After taking the readiness assessment, if you find you answered “no” to any of the green-coded critical criteria that are relevant to your project, you should consider delaying implementation to first focus on fully achieving readiness. If you did not meet the majority of the critical criteria, another option is to encourage a different group to take the lead, with your group playing a supporting role.
### Worksheet 4

**Readiness assessment**

Note: *We* refers to the core project team or those responsible for project design and implementation. Green indicates readiness criteria that are critical before starting project implementation; yellow indicates criteria that are good to have but not necessary for startup.

#### Goals and motivations

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>We have clearly defined the problem we are facing and what we wish to achieve using a disaster citizen science approach.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have a clear understanding of how a citizen science project will help achieve our goals.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Project leadership

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>We have identified project leaders who will take ownership of the effort.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project leaders are committed to implementing disaster citizen science activities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project leaders are, or will be, involved in all planning steps.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Resources and administration

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>We have a thorough understanding of all the material, administrative, and labor resources needed for the project (including, if relevant, funding, technologies, infrastructure, staffing, training and educational materials, and volunteer force).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plans are in place to obtain all resources necessary for the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have obtained all resources necessary for the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have the capacity to obtain materials, labor, and other resources quickly if needed.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Partnerships*

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>We have a thorough understanding of important challenges we might face in developing and maintaining partnerships for the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plans are in place to establish all partnerships necessary for the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have established all partnerships necessary for the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have a demonstrated track record of high-quality, long-term partnerships.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have a proven ability to develop partnerships with individuals and groups from different cultures, professional backgrounds, or industries.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Knowledge and skills

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>We have a thorough understanding of all the technical and scientific skills needed for the project (including, if relevant, skills needed in data or statistical analyses; study methods; data collection, management, and governance procedures; software or programming apps; and device or hardware use and maintenance).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plans are in place to obtain all technical or scientific skills necessary for the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have obtained all technical or scientific skills necessary for the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have a thorough understanding of the ethical and legal issues facing our project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have plans in place to deal with ethical and legal issues facing our project.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Volunteer management**

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>We have a thorough understanding of the roles and resources it takes to manage volunteers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have experience training volunteers for health department activities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We regularly engage volunteers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We are trained in cultural competencies.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Organizational support***

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project leaders have management support to engage in the effort.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Our organization will provide sufficient staff to support the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Our organization will give us time to prepare and work on the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efforts to generate support with leadership efforts are under way.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Our organization already performs citizen science (or citizen science–like) activities.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

* Only relevant if your project requires outside partners.
** Only relevant if your project plans to use volunteers.
*** Only relevant if you are part of an organization.
Interpretation guidance: Criteria in green are critical for starting project implementation. Criteria in yellow are “good to have” before starting implementation but not necessary. There are 17 critical readiness criteria (although some might not be relevant to you). If you answer “no” to any of the critical criteria relevant for you, you should consider delaying implementation to first focus on achieving readiness.

A note about readiness and overall capacity building

The readiness assessment is meant to help you understand whether you have all the components in place to start a disaster citizen science project. But getting ready to implement a project will yield benefits that go beyond one individual project. By articulating your goals for disaster citizen science, getting dedicated project leaders in place, obtaining resources or planning how to get them, developing or strengthening partnerships, taking stock of your team’s knowledge and skill sets, and seeking organizational support if applicable, you are also building your group’s overall capacity to take advantage of disaster citizen science—if not now, then in the future. At the very least, going through the process to get to readiness will be an invaluable learning experience. You will perhaps become aware of resources that your group has access to that you did not know about before, and you will become familiar with ethical, legal, or regulatory constraints that might impede the work. In addition, you may learn more about resources available in the community and good partnerships to pursue. Many community groups reported building networks with local universities, government organizations, private businesses, and volunteer organizations, such as the Red Cross. In the end, putting the pieces in place for an individual project is the first step to building greater capacity in your group. As noted by a community volunteer leader we interviewed,

A community that already has developed some degree of technical capacities and management or organizing experience tends to suffer less under unexpected or disastrous conditions, is able to recover faster, and is in a better position to effectively help neighboring areas to recover. That, in itself, is sufficient justification to promote disaster citizen science efforts further.
STEP 5 Plan for action

In step 5, we provide guidance on how to assemble an implementation plan and a communication and dissemination strategy for your disaster citizen science project.

Developing and implementing a plan for action

An implementation plan consists of the detailed action steps that clarify otherwise complex tasks, milestones, and goals. The plan ensures that key program activities are prioritized and that the resources needed to accomplish those activities are well understood. Developing a work plan gives you the opportunity to carefully think through:

- the key components, milestones, activities, and tasks within your project
- the expectations related to project roles and communication within your team
- your partners’ level of preparedness in implementing activities
- the context in which your team is working
- the capabilities and responsiveness of the stakeholders or volunteers you plan to engage
- contingencies in the face of unplanned events, such as natural disasters or abrupt policy actions.

Use the template in Worksheet 5 to develop a work plan for your project. To develop a detailed plan, you should consider the following questions:

- What are the key activities needed to accomplish your goals?
- What are the timelines for accomplishing activities?
- Who is responsible for each activity?
- What resources are needed to accomplish each activity, and how will you acquire or develop those resources?
- How will you improve your readiness and adapt to changes that might arise?

You can use your logic model to list the activities in Worksheet 5. To enhance accountability, work plans should articulate a timeline for each activity, along with task leads. Plans should also indicate what resources are needed to accomplish each activity (e.g., budget, equipment). Budget expectations regarding personnel, program materials, travel, and outreach are important to help with financial tracking. Work plans should be distributed to team members to ensure a shared understanding of the steps needed to achieve goals.
**Worksheet 5**

**Develop a work plan**

Use your logic model to list your activities and then decide on a timeline for each activity, along with task leads and other labor. Plans should also indicate what resources are needed to accomplish each activity (e.g., budget, equipment). Budget expectations regarding personnel, program materials, travel, and outreach are important to help with financial tracking. Also consider what alternatives might be necessary in terms of timelines and labor and other resources if emergencies or unplanned events should occur.

<table>
<thead>
<tr>
<th>Activity</th>
<th>When will the activity be done? How will you know when it is done?</th>
<th>Who is responsible? What staff will be involved?</th>
<th>What resources are needed for the activity?</th>
<th>What alternative scenarios should you prepare for?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

You can add notes or your conclusions in the space below.
Preparing for unplanned events

Given the unpredictable nature of a disaster response, it can be helpful to plan for emergencies or develop alternative scenarios that account for changes in the environment or context in which the effort is to be carried out. For example, plans should identify a range of partners (e.g., government agencies and offices, academic departments and centers) and consider alternatives in case certain partners are nonresponsive or unable to help. Projects that rely on broadband access, electricity to charge personal devices, or access to certain types of equipment should also consider whether these required resources might be unavailable during an emergency and should develop contingency plans accordingly (e.g., paper forms for data collection).

In some cases, media coverage of a disaster or an ongoing disaster citizen science project can result in unplanned surges in volunteer capacity. As an example, the organization SkyTruth, which works with volunteers to classify satellite imagery, received several hundred volunteers following an article about its work that was published in a major news publication. This publicity allowed the team to leverage its platform to process more than 90,000 tasks in just three weeks. However, this success was possible only because SkyTruth had scalable software and enough work for volunteers to do at that time.

Developing a communication and dissemination strategy

To create a communication and dissemination strategy for your research findings, you need to understand the who, what, when, where, and why of your communications. First, who are your target audiences and why? Second, what do you want to tell them? Third, when do you want to start your messaging? Finally, where will your messages be sent from? We summarize each consideration below.

Who? Why? Identifying your target audiences is the first step, and knowing why you want to connect with them, what you expect from them, and what you think their reaction will be is important to understand before you start crafting and releasing messages about your project. How you approach these audiences will also depend on whether you have an existing relationship or whether you are meeting for the first time.

What? For each audience, you should first determine what your desired outcomes are (e.g., change attitudes, inform a policy change, persuade an action). Next, framing and tailoring your messaging to the different audiences will increase the likelihood that the messages you disseminate are received in the ways you intend. For example, materials prepared for professional audiences, such as academics or government agencies, should include details on data collection and analysis methods and impacts that correspond to a target agency’s mandate. Depending on your other audiences, you may want to play up other benefits of disaster citizen science, such as educational aspects, effects on community preparedness, or building of community capacity to use research for action.
When? Establishing a timeline of when messaging should be released and when different audiences should receive communications will help to ensure that you are in charge of the messaging. This gives you time to refine your strategy between communications if you find that your messages are not resulting in their intended outcomes. Order of outreach may be an important consideration. For example, if one of your desired outcomes is for a government agency to take a particular action, you may want to disseminate to that agency first. This can help prevent the agency from feeling “ambushed” or put on the defensive, which might occur if they start hearing your messages before you have the chance to talk with them.

Where? There are many avenues for disseminating your messages (e.g., in-person meetings, public town halls, media coverage, social media [including blogs and podcasts], scientific conferences). Your choice of communication channel will depend on the target audience and your dissemination goals.

Finally, your project may involve many different partners and stakeholders, and each may talk about the project in different ways. It is important that the main messages about the project are agreed to by all parties. A situation in which team members publicly contradict or disagree with each other’s communications will undermine your work. Therefore, although different partners might target different audiences, seek to speak with one voice in describing the content of the study and the bottom line for the research findings.

Box 2.8 describes the importance of dissemination for one citizen science program. For more resources on dissemination see Mea et al., 2016; Brownson et al., 2018.
Established in 2012 by the Alaska Native Tribal Health Consortium (ANTHC), the Local Environmental Observer (LEO) Network is a web-based platform with members consisting of science experts and Indigenous people with local knowledge. LEO Network members in Alaska and around the globe report on-the-ground observations of unusual phenomena in the environment, with rich descriptions of impacts and photos. The communication and the dissemination of data are the central feature of the project. After review, the observations are published on an online map to be shared with the network. Local residents and experts can explore the map using a search engine, as well as filter by location, type of phenomenon, and date. Observations are also shared with interested experts, and sometimes these experts and volunteers consult with each other to learn about the event and related scientific phenomenon in more depth. Members can also submit news articles to track local events and environmental change. LEO Network disseminates a selection of the published posts to a broader audience through its weekly newsletter, Northern Climate Observer. ANTHC hosts an annual conference in Anchorage, during which LEO Network observations are communicated to local residents.

In Alaska, findings are communicated to local, state, federal, and tribal organizations through a quarterly meeting and webinar. Western Canada agencies are also regular participants. LEO Network creates custom maps with the CDC’s Arctic Investigations Program, which compiles observations relevant to the One Health working group. The aim of the group is to improve human health by focusing on the ways in which it is tied to the health of the environment. The working group uses the maps to review the types of events occurring and, in turn, suggests ways to improve LEO’s systems to better understand changes in the environment. As described by a LEO Network representative:

We hosted a monthly webinar. We began to send out these observations in a weekly newsletter to the science community. We were trying to figure out a way to send a regular signal saying local knowledge is something that you can use . . . . We had to figure out a way to develop a conversation ourselves, and so that’s why we created a weekly newsletter to send out a signal of the things we were interested in. We included the LEO posts in there. . . . We began to send out regular reports directly to . . . citizen science [leaders] or agencies or academic researchers and say, “Here’s something we think you’d be interested in,” and they began to realize that these observations were very informative. They also began to engage in a conversation with the observer.

For more information, see Alaska Native Tribal Health Consortium, undated.
Putting the Five Steps Together: How a Community Came Together After Hurricane Katrina

In the aftermath of Hurricanes Katrina and Rita, Denise Thornton established the Beacon of Hope (BOH) Resource Center in 2006 to assist in rebuilding her neighborhood. In an interview with a BOH representative, we walked through how BOH approached different steps in its project design and implementation.

What was the problem BOH was facing?
BOH wanted government to assist in reducing blight in New Orleans in the aftermath of Hurricanes Katrina and Rita but realized that the city’s 311 telephone line and other programs were ineffective.

What did BOH want to achieve?
BOH sought to combat blight and spur investment in communities. Thornton realized that BOH needed to track the condition of community properties and utilities.

What data collection methods did BOH use?
In addition to conducting targeted outreach to key government, nonprofit, and community stakeholders, BOH worked with residents directly to collect useful information. To do this, BOH invited residents to observe and identify the conditions of properties in their vicinity by marking their location on color-coded maps representing the property “parcels” or plots that made up their area. Blighted property was colored red, property in renovation was colored blue, property for sale was colored yellow, and occupied property was colored green. To demonstrate community strength and potential, BOH held large-scale events with open houses that showcased mapping data for residents and businesses to examine. Additionally, BOH wanted to use data to inform its volunteers’ own efforts in carrying out property improvements.
What skills and resources did BOH need?

BOH needed funding to cover administrative costs and costs associated with buying and maintaining common equipment and supplies. BOH received donations from such organizations as United Way and Blue Moon Foundation, as well as individual donors. With these additional donations, BOH expanded into other New Orleans neighborhoods. To then carry out the project across multiple neighborhoods, BOH needed expertise on survey and mapping methods and a trained group of volunteers.

How did BOH ensure the quality of the research project?

To maintain data quality, multiple resident volunteers mapped the same area and maps were updated monthly. BOH volunteers were intrinsically motivated to rebuild the communities they lived in. BOH took multiple steps to make sure that volunteers stayed engaged so that data quality did not suffer over time. BOH members held community meetings where they reviewed data and planned community actions, provided volunteer insurance, and included young people with a lot of enthusiasm. Volunteers were given clear roles related to their geographic area. Each neighborhood had an administrator who was responsible for managing and supporting the activities of block captains, who in turn collected data on status of property and neighborhood amenities.

Who or what groups were identified as partners for the project?

BOH collaborated with several academic partners, including the University of Washington, which assisted in using geographic mapping tools, and University of New Orleans, which conducted project management and training on survey and mapping methods and topics such as survey standardization and data maintenance. In addition, BOH identified community members, businesses, City Hall, the New Orleans Redevelopment Authority, and the Road Home Program as important stakeholders and partners. BOH wanted to encourage community members and businesses to return to the neighborhood. BOH, armed with maps and photographs, went directly to adjudication hearings at City Hall. BOH partnered with New Orleans Redevelopment Authority to support the Lot Next Door program, which would buy vacant lots and facilitate neighboring residents in purchasing them. BOH also met with Road Home officials to inform them about blight and population concentration.

For more information, see esri, 2010; Beacon of Hope Resource Center, undated.
Designing and Implementing a Citizen Science Project: Challenges and Solutions

So far, we have gone through the steps necessary to plan, design, and implement a disaster citizen science project. As your organization participates in such efforts, you will likely find that some projects progress without much difficulty. However, you may sometimes face challenges in designing and leading a disaster citizen science project. Many such challenges have been identified in the scientific literature. In this section, we focus on four especially common challenges that can pose a threat to project success and describe options for overcoming them.

Challenge 1: Lack of support from your organization’s leadership

Although you may be enthusiastic about disaster citizen science and committed to a project, you may find that your organization’s leaders are uninterested or even opposed to it. The buy-in of senior leadership is critical for project success, and this is especially the case when a project is likely to divert attention from other job responsibilities or may require resources that could be applied to other activities. There are many reasons why leaders might not support disaster citizen science activities:

- Leaders might not be aware of citizen science or understand that groups such as yours can do citizen science.
- Leaders might not support research in the context of disaster (i.e., when the focus is on meeting immediate emergency response needs).
- Leaders might like the idea of disaster citizen science but feel that getting involved is too low on their list of priorities given competing demands.
- Leaders might be concerned about responsibility and liability, such as ensuring the safety of staff or volunteers who go out into the field.
- Leaders may fear that they cannot adequately safeguard data.

So, what should you do?

As a first step, it is important to figure out why leaders are opposed to the project. Their opposition may be due to some of the reasons stated above, or there may be other issues you need to identify. Once you have determined the cause(s) of leader reluctance, you will be better prepared to select a course of action. Some promising strategies that have been used to gain leadership support for a disaster citizen science project include the following:

1. Clearly articulate the benefits of the disaster citizen science project. When possible, link project goals and benefits to broader organizational priorities or strategic planning efforts.
2. Approach leadership with clearly stated plans rather than "half-baked" ideas that are easy to dismiss. Clarify how your organization can engage in citizen science.

3. Share examples of successful disaster citizen science projects led by groups similar to yours. Use examples from the toolkit (see the appendix for a compiled list) or find others by networking.

4. Find a way to incorporate citizen science into one of your organization’s existing activities. Explain why using a citizen science approach would provide greater value to the organization than the status quo or other approaches.

To organize a strategy, consider developing an influence plan to anticipate and respond to the critiques your leadership is likely to express. Use Worksheet 6 to identify your planned response. Tailor your approach on the basis of whether leadership is typically eager to adopt new ideas, somewhat open to new opportunities, or reluctant to adopt new ideas. For early adopters, frame your project as an opportunity to demonstrate innovation and leadership. For leaders who are somewhat open to new opportunities, provide examples of similar community groups engaged in citizen science activities. For late adopters, consider framing your citizen science activities as concrete solutions to distinct problems.
Worksheet 6
Develop an influence plan

List the leadership or other groups you wish to influence in some way and determine what it is you want from them (e.g., make a decision, gather support, change minds, obtain resources). Consider different scenarios for how they might respond and what critiques or arguments they might make. Come up with different ways to respond to each scenario.

<table>
<thead>
<tr>
<th>Key leadership group</th>
<th>What does the group need to do differently?</th>
<th>How will the group respond?</th>
<th>What critiques might the group have?</th>
<th>What is your planned response?</th>
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You can add notes or your conclusions in the space below.
Challenge 2: Insufficient resources

Most organizations are familiar with the need to operate within budget constraints and with limited resources. It is not uncommon for community groups to lack the staff and funding to pursue activities beyond their critical functions. As with any new initiative, a disaster citizen science project is likely to demand staff time and dedicated funding, which can be difficult to obtain. It is particularly time-consuming to manage new partners and recruit, train, and manage volunteers. As a result, a community group may find that it has the will to pursue a disaster citizen science project, but just does not have the resources to support the effort.

So, what should you do?

In cases in which there is insufficient funding to lead a disaster citizen science project, you should consider whether there are options for doing “more with less”—that is, asking partners or volunteers to take on a larger role in the effort than originally envisioned. For example, an academic or other organizational partner might be willing to lead the effort, or enthusiastic volunteers might be willing to play roles in coordination and communication, as well as data collection. By expanding the roles of partners and volunteers, a community group can reduce the amount of time staff must commit to the project. We note, however, that project leaders should be careful about overextending or unintentionally exploiting volunteers from communities affected by disasters. The project must strike a balance between being led by those most affected and not requiring too much of them. Instead, organizations could seek volunteers representing the broader community of affected or concerned community members.

Finally, your organization can consider partnering with private-sector entities. Private-sector organizations can encourage their employees to volunteer, donate equipment, and provide resources, such as like cloud services for data sharing and facilities for meetings.

Box 2.9 presents an example of how one group dealt with resource challenges.

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**CASE STUDY IN RESOURCE CHALLENGES**

Surfrider Rincón and Hurricane Maria

After Hurricane Maria devastated Puerto Rico in 2017, the Surfrider Rincón chapter of the Surfrider Foundation, a nonprofit organization dedicated to protecting oceans and beaches, expanded its Blue Water Task Force water-quality testing program by going into new geographic areas and testing for additional contaminants. Surfrider Rincón expanded its scope because of the extent of the damage in Puerto Rico and the need for communities to know whether their water supplies were safe. Despite limited resources, Surfrider was able to expand by leveraging community assets through partnerships. For example, Surfrider’s regular lab for running water-quality samples required electricity, which was out. The chapter approached the health center in the area, which had a generator, and set up the testing equipment there. The health center partnership had additional benefits—by housing the lab within the center, it created an impression in the community that Surfrider was addressing a health threat and not just collecting data. Surfrider Rincón also faced challenges in getting equipment and testing supplies. It established another partnership with the Rincón Beer Company, which had transformed into a relief center and could accept donations and goods. The national Surfrider office was then able to send supplies. The relief center ended up becoming a “community hub” for recruiting and training volunteers and for communicating testing results to the public. According to a representative of the Surfrider Foundation:

> They did a really great job of just connecting the dots with all the resources that the community had [and] having . . . the relationships that they were able to build within the community. A lot of people really started to see the Rincón chapter’s value, the Blue Water Task Force’s value, down there.

For more information, see Cutraro, 2017; Chari, Blumenthal, and Matthews, 2019.
Challenge 3: Conflicts with partners

In some cases, your organization might encounter difficulties in initiating or sustaining engagement with other community groups or in reaching consensus with partners. These conflicts can stem from various sources, including

- preexisting mistrust between government, community-based groups, research institutions, or private businesses because of a prior history of engagement, cultural beliefs regarding certain practices or industries, or political conflicts between local, state, or national government agencies
- disputes over who is paid and who is not
- perceptions that certain organizations, such as universities or government, do not value community input or community-generated data
- perceptions that different organizations have conflicting incentives or motivations or are not accountable to community stakeholders
- perceptions that the lived experiences of community members and affected individuals are not taken seriously by larger institutions, such as government or research organizations
- concerns regarding ownership and reporting of collected data and territorial issues.

So, what should you do?

Your approach to handling conflicts will vary depending on the source of the conflict. To anticipate potential conflicts attributable to a prior history of engagement, consider examining prior successes and failures and reaching out to partners to better understand current sentiments about participating in disaster citizen science projects. A similar approach might be used to address perceptions that a university or government entity does not value community input or community-generated data. To address perceptions regarding misaligned incentives, accountability, or data ownership and reporting, your group should consider developing a memorandum of understanding (MOU), which delineates roles for each partner, clearly articulates the group’s motivation for engaging in citizen science, demonstrates areas of overlap between your mission and those of potential partners, and explains how data collected from volunteers will be used. But make sure that such efforts involve two-way communication with partners. To avoid conflict with government agencies, an effort should be made to openly communicate data collection plans and dissemination activities, so as to minimize the potential for surprise and provide opportunities for input.

To address more-complex conflicts, consider reviewing conflict management resources, such as resources from the National Institutes of Health’s Center for Cooperative Resolution (National Institutes of Health, 2020; also see Table 2.2 in step 3) or try a polarity-mapping approach (e.g., the Tamarack Institute’s “Polarity Coaching” tool (Tamarack Institute, undated; also see Table 2.2 in step 3). Polarity mapping encourages groups with conflicting perspectives to take a wider perspective that incorporates both sides of the conflict; people thus gain confidence in talking with those who have a different viewpoint and identify opportunities for balance.
Challenge 4: Data quality and credibility

Government agencies and professional scientists may have concerns about the quality and credibility of data collected by community members or the general public. In our survey of local health departments, we found that 56 percent of respondents would not trust data collected by citizen scientists as much as data collected by professional scientists. These negative perceptions may be due to a belief that only formally trained researchers should engage in data collection and analysis or prior negative experiences related to citizen science. It is easy for decisionmakers to dismiss data sources they are unfamiliar with, especially if the stakes are high. However, there are many examples of scientifically rigorous and robust citizen science projects that belie these claims. To address these negative perceptions, community groups and their partners should anticipate potential criticism and employ a variety of strategies to maximize data quality, build credibility, and transparently communicate their approach.

So, what should you do?

For groups developing a new project, it may be helpful to reach out to government agencies or potential partners at scientifically rigorous institutions, such as local universities, to ensure that proposed project plans, sampling methods, and data collection instruments are valid and that necessary quality-control strategies are considered. For existing projects, there are a variety of strategies that can be used to improve data quality and credibility:

- Where possible, adapt existing instruments or training protocols that have been used in research settings.
- Develop robust training materials and processes to enhance the capabilities of volunteers engaged in data collection.
- Have multiple volunteers do the exact same task to provide multiple measurements.
- Downgrade or appropriately qualify the value of data from newer, less experienced volunteers or data that may contain errors.
- Develop protocols on how to identify suspicious data points and when or how to do extra validation or consult with external evaluators.
- Incorporate credible experts (e.g., researchers employed in local universities) into project teams to assess proposed methods and instruments.
- Be honest about the limitations of your data, describe strategies employed to address limitations, and consider alternative explanations for findings.
- Document and explain your data collection, quality, and security procedures.
- Engage decisionmakers or other stakeholders early and alert them to how you intend to use data from your project.
Given emerging concerns about hacking and data security, particularly in the context of high-profile disasters, it is important to plan for data safeguards (e.g., data storage safety, quality checks for data submitted online), as we discussed earlier in this toolkit.

Box 2.10 presents an example of how one group dealt with data quality challenges.

## BOX 2.10
**CASE STUDY IN DATA QUALITY CHALLENGES**
**The King Tides Project**

The King Tides Project is an organization that enables individuals around the globe to share images of and provide details about *king tides*—the highest tides in a year. These data are useful for documenting flood risk in coastal areas, visualizing the impacts of future sea-level rise in communities, validating climate change models, and providing historical records. However, the project faced several challenges. One challenge was that volunteers did not always correctly follow the protocol for taking photos of king tides, which required photos to be taken within a short window of time during the day and to include a point of reference—such as a pier or a building—to help identify the height of the tide. The organization addressed this, in part, by collecting submissions from groups that were closely guided by knowledgeable and experienced organizers. For example, some local King Tides organizers took groups of volunteers on walks to take photos together. In other cases, teachers trained and guided groups of high school students. When using photos to validate climate change models or for other purposes, the organization uses only those photos whose metadata indicate that the volunteer followed the protocol. As described by a King Tides Project representative:

> We realized that there was also a really good opportunity to work with high school science students and get them directly involved in real-world projects that impacted their community. . . . We did that, and some of the problems about data collection came up pretty quickly. Your data is only going to be as good as your protocol and the people who follow it. . . . It was interesting to me that even though it was as simple as, “Take your phone out of your pocket and take a picture,” it wound up being this whole different set of needs that weren’t necessarily being met until we got better with our instruction.

For more information, see King Tides Project, undated.
Voices of Disaster Citizen Science Project Leaders: Advice from the Front Lines on Implementing Citizen Science Projects

We interviewed 63 people involved in disaster citizen science: community organization leaders, citizen or community scientists, academic researchers, technology developers, government officials, and entrepreneurs. We heard many different perspectives on the promise and challenges of disaster citizen science.

- Seek out diverse funding early on and rely on scalable, easy-to-train methods to collect data. Plan for the fact that one or more critical sources of funding will run out. In addition to seeking out diverse funding sources, your group should develop processes and protocols that can be sustained in case you do not get additional funding or existing funding sources dry up. One academic citizen science project leader said:

  A lot of times, programs get started because there’s a grant available, and people are really excited and engaged in this particular area. And so, people jump in with both feet and suddenly realize, “Okay. This grant is ending. Now what?” So, trying to start right from the beginning with developing diverse funding sources and those partnerships I think are really, really, important.

- Consistently engage volunteers. Empower volunteers to take ownership. For example, you can ask volunteers to do more than just collect data; you can task existing volunteers with recruiting new volunteers. It is also important to have ongoing communication with enthusiastic volunteers and routinely engage them during periods of inactivity. Volunteers will lose interest or even become alienated if they do not see the impact or do not feel that they have a stake in the work. One citizen science project leader from government said:

  People get really irritated, especially the public, when they invest a lot of time and energy and they don’t see any results.

- Invest resources in volunteer management. Managing volunteers is labor-intensive. Ensure that you have invested time and money to do this properly, and do not spend all of your resources on technology, equipment, and training. Make sure to educate funders about the importance of budgeting for volunteer management. One community project leader said:

  We got a lot of funding, but no money was allocated towards the management of volunteers, and we had 500 of them!

- Develop a data-sharing agreement when working with government to increase the impact of your disaster citizen science project. Data quality and credibility are major concerns for local decisionmakers. Accordingly, community groups and government agencies should work
together to ensure that methods and data collection instruments and plans are valid and that overall quality-control strategies are agreed on. For example, one approach is to develop a data-sharing agreement. Having an agreement in place may help avoid conflicts and misunderstandings regarding expectations of how data will be assessed and ultimately used. One health department project leader said:

Partner with your agencies early on. Find a champion, someone you can connect with.

- **Be honest about the limitations of your data, and consider alternative explanations for findings.** To increase the likelihood that decisionmakers will accept or act on your data, explain your data quality procedures, identify and describe alternative explanations for your findings, and discuss the limitations of your approach. Describe specific strategies you applied to address those limitations. One citizen science project leader from a health department said:

Ask questions about the data like: What else could be causing this?
Exercise

Test your knowledge for Chapter 2

Chapter 2 described a five-step planning approach for designing and implementing a disaster citizen science project and discussed common challenges that projects may face. Below, we present seven questions that cover the main points of this chapter. Feel free to test your understanding of project development by answering the questions. If you are using the toolkit with a team, discuss the questions together to determine whether everyone has a shared understanding about planning for a disaster citizen science project.

• What are the five steps in planning a disaster citizen science project?

• What is a logic model, and what are its components?

• What are the four steps associated with selecting the best approach for achieving your goals?

• What are three ways to ensure research quality?

• What are five ways to assess whether pursuing a partnership makes sense?

• What are four common challenges faced by disaster citizen science projects?

• What is at least one solution to each of the four challenges?
Conclusion
Conclusion

The need for community involvement in disaster research has been a long time coming. Despite the inevitability of disasters, many communities remain unprepared for what might happen and unsure about how to deal with the threats of today. Scientific research is key to filling in those gaps in knowledge and capabilities; today, the tools, approaches, and opportunities to engage in such research are more widely available than ever before.

For community members, there are now opportunities to carry out data collection efforts, to have a strong voice as an equal partner in academic research, and to support existing projects by joining crowdsourcing efforts. Collegial, collaborative, and contributory citizen science models of research all have their strengths and together present numerous ways communities can approach scientific research for disasters.

This toolkit aimed to provide an overview of disaster citizen science, as well as guidance for those interested in carrying out a project. For the latter, we described a process for determining your research goals and questions, selecting approaches, assessing potential partnerships, evaluating your readiness to move forward, and planning for action. The toolkit also provided guidance on overcoming challenges.

We hope that the information in the toolkit will help you determine the role your community group might play in the world of disaster research. When it comes to making decisions that prepare and protect communities from harm, the voices of those who are on the front lines are needed the most. And those voices can be amplified through the language of data and results of research. Citizen science may be the key not only to improving the scientific research base surrounding disasters but to ensuring that the resulting actions benefit us all.
Glossary

**Centers for Disease Control and Prevention (CDC):** a division within the U.S. Department of Health and Human Services responsible for protecting public health through the prevention and control of disease

**citizen science:** the use of scientific methods by the general public to answer questions about the world and solve problems of concern

**collaborative citizen science:** activities typically initiated or led by a government agency or research institution in partnership with the public. Community members may be involved in defining the problem, designing the study, and collecting, analyzing, and interpreting data.

**collegial citizen science:** activities controlled and led by community groups or members, either wholly independently or in partnership with others (e.g., government agencies, research institutions). Members of the public in collegial citizen science retain control over scientific or data collection processes.

**contributory citizen science:** activities typically initiated by research institutions or government agencies (e.g., health department), with the public contributing time and skills through such tasks as interpreting imagery, collecting or analyzing data, or transcribing documents

**COVID-19:** an abbreviation of coronavirus disease 2019, which was first identified in December 2019 and has spread globally since

**disaster preparedness:** actions or policies taken to prepare for and reduce or mitigate the effects of disasters

**disaster recovery:** actions or policies taken to help communities continue operations and restore health, social, and economic functioning after a disaster

**disaster response:** actions taken during a disaster event to provide immediate assistance to affected populations to maintain life and protect the health and social welfare of the public

**fitness-for-use:** the degree to which data are suitable for a particular purpose. Data should have the appropriate level of quality for its intended use.

**geographic information system (GIS):** a framework for capturing and analyzing geographic and spatial data

**Health Insurance Portability and Accountability Act (HIPAA):** an act passed by Congress in 1996 (Public Law 104-191). HIPAA requires the protection and confidential handling of protected health information (PHI). HIPAA will apply to projects that collect, receive, handle, or share PHI, including PHI on the volunteers involved. Projects will need to ensure compliance with HIPAA and develop and follow procedures that ensure the confidentiality and security of PHI.

**institutional review board (IRB):** an administrative body tasked with protecting the rights and welfare of people involved in research. Approval from an IRB is required for federally funded and many privately funded research projects that involve humans.

**logic model:** a diagram that illustrates how a project uses available resources (or inputs) and planned activities to achieve both short- and longer-term goals. It is a useful diagnostic and planning tool for understanding the causal chain that connects a group’s goals to the activities and resources needed to achieve those goals.

**memorandum of understanding (MOU):** a written agreement on the expectations and intent of multiple parties that are working together to achieve a particular goal

**National Institutes of Health (NIH):** a division of the U.S. Department of Health and Human Services and the main agency of the U.S. government responsible for health and biomedical research

**outcome evaluation:** a process for determining how well a program has achieved its objectives by measuring results

**process evaluation:** a process for determining whether program activities have been implemented as intended

**protected health information (PHI):** information about health status, care received, or payment for health care that can be linked to a specific individual

**SMART:** a set of criteria (specific, measurable, achievable, realistic, time-based) for guiding the development of program or project outcomes and objectives

**theory of change:** a description of how and why a desired change is expected to occur as a result of programs, projects, or policies that are put into place
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APPENDIX

Worksheet Pullouts

**Worksheet 1a.**  What is the problem you are facing that could benefit from disaster citizen science?

**Worksheet 1b.**  What do you want to achieve?

**Worksheet 1c.**  What has been done before to address the problem?

**Worksheet 2a.**  How do you focus your research question?

**Worksheet 2b.**  Choosing data collection methods

**Worksheet 2c.**  Skills and resources needed to carry out a disaster citizen science project

**Worksheet 3.**  Identifying and evaluating potential partners

**Worksheet 4.**  Readiness assessment

**Worksheet 5.**  Develop a work plan

**Worksheet 6.**  Develop an influence plan
Worksheet 1a

What is the problem you are facing that could benefit from disaster citizen science?

Describe the problem your community faces in as much detail as possible. Answer the following questions:

• What is the problem you are trying to solve?

• Whom does the problem affect?

• When does the problem need to be solved?

• Where does the problem occur?

• Why is the problem happening?

• Is there something that citizen science can contribute that would not be possible otherwise?
**Worksheet 1b**

**What do you want to achieve?**

Use a logic model to map out what you wish to achieve from your project.

**Problem description** (Use this space to provide a one- or two-sentence description of the problem to help you stay organized and focused.)

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Activities</th>
<th>Outputs</th>
<th>Short-term outcomes</th>
<th>Medium-term outcomes</th>
<th>Long-term outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>What resources do you need to achieve the outcomes (e.g., funding, partners, equipment, better knowledge of the problem, volunteers)?</td>
<td>What activities are you planning to do to achieve the outcomes?</td>
<td>What resulted from your activities (e.g., products developed, services performed, events undertaken, targets achieved)?</td>
<td>What outcomes can you expect in the near term (e.g., 1–5 years) if project activities are carried out as intended?</td>
<td>What outcomes can you expect in the intermediate term (e.g., 5–10 years) if project activities are carried out as intended?</td>
<td>What outcomes can you expect in the long term (e.g., 10+ years) if project activities are carried out as intended?</td>
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</tbody>
</table>

You can add notes in the space below.
**Worksheet 1c**

*What has been done before to address the problem?*

Describe other efforts to address either your problem or similar problems. Look beyond your community to see whether others have addressed similar issues. You can use online searches or reach out to known contacts to conduct such background research. On the basis of your research, you can look for gaps that your project could fill.

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<thead>
<tr>
<th>Group leading the past activity (list your groups and their names below)</th>
<th>What was done</th>
<th>What worked</th>
<th>What didn’t work</th>
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You can add notes or your conclusions in the space below.
**Worksheet 2a**

**How do you focus your research question?**

Use the outcomes listed in your logic model in *Worksheet 1b* to create theory-of-change stories. Choose one outcome at a time and work backward, asking yourself how or why a change or achievement might have occurred. Work backward until you have a logical explanation for how a research topic or question might have led to the original outcome selected. You may use the block design shown in the toolkit to construct your story or any diagram you are comfortable with using to show a sequence of events.

Use the space below to create your theory-of-change stories.
Worksheet 2b
Choosing data collection methods

Describe your research question and select the type of study you will conduct. The method flowchart presents a series of questions to guide you to methods (in red boxes) that may be well suited to your study.

What is the research question?

What type of study are you conducting?

- Health or environment monitoring (routine assessment of hazards, exposure, or disease)
- Community risk or vulnerability assessment
- Intervention or program development or testing
- Program evaluation
- Epidemiological investigation (assessment of associations between exposure and disease)
- Damage or population needs assessment
- Participatory action research (collaborative research meant to result in community actions)

Other, describe:

Does the study need data collected from people?  
Does the study need a large number of participants or data points (>100)?  
Does the study need control over participants (e.g., careful selection, defined population)?  
Does the study need data collected from the environment?  
Can hazards of interest be measured by observations (photos, video, text), sensor, or physical collection? Check all that apply.

Methods: observation, sensor, and/or physical collection design
- Observations
- Sensor
- Physical collection

Does the study need to dive deeply into topics?

Does the study need visual (photos/videos), text, or geographic data? Check all that apply.
- Visual
- Text-based
- Geographic

Methods: crowdsourcing study or survey sampled participants; collects visual, text, and/or geographic data

Does the study need interview, visual (photos/videos), text, or geographic data? Check all that apply.
- Interview
- Visual
- Text-based
- Geographic

Methods: participatory study; collects interview, visual, text (e.g., diaries), and/or mapping data

Does the study need visual (photos/videos), text, or geographic data? Check all that apply.
- Visual
- Text-based
- Geographic

Methods: survey or mapping designs; collects visual, text, and/or geographic data
## Worksheet 2c
Skills and resources needed to carry out a disaster citizen science project

List the skills and resources you believe that your project needs. Also determine whether you already have the resources and, if not, what your plan might be to get them.

<table>
<thead>
<tr>
<th>Resource list</th>
<th>Do you need this resource?</th>
<th>Do you have this resource?</th>
<th>Where could you get the resource if you need it and don’t have it?</th>
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You can add notes in the space below.
Worksheet 3

Identifying and evaluating potential partners

List the people or groups who could provide your project with needed resources (resource providers). Also list project stakeholders. Stakeholders are (1) in a position to take action on the problem or (2) affected by the problem and in a position to benefit, or lose something, if impacts are achieved. You can start with the groups you listed in **Worksheets 1c and 2c** and then add more as necessary. Fill in the cells and use the information to make a decision about the suitability of each group as a partner. Entities that are marked as “yes” or “maybe” for potential partners should be pursued further.

<table>
<thead>
<tr>
<th>Stakeholder group</th>
<th>How group is involved</th>
<th>Group’s position</th>
<th>What group could do</th>
<th>Group’s constraints</th>
<th>Potential partner?</th>
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You can add notes or your conclusions in the space below.
Worksheet 4
Readiness assessment

Note: *We refers to the core project team or those responsible for project design and implementation. Green indicates readiness criteria that are critical before starting project implementation; yellow indicates criteria that are good to have but not necessary for startup.*

### Goals and motivations

<table>
<thead>
<tr>
<th>Question</th>
<th>Y</th>
<th>N</th>
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<tbody>
<tr>
<td>We have clearly defined the problem we are facing and what we wish to achieve using a disaster citizen science approach.</td>
<td></td>
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<tr>
<td>We have a clear understanding of how a citizen science project will help achieve our goals.</td>
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</table>

### Project leadership

<table>
<thead>
<tr>
<th>Question</th>
<th>Y</th>
<th>N</th>
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<tbody>
<tr>
<td>We have identified project leaders who will take ownership of the effort.</td>
<td></td>
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<tr>
<td>Project leaders are committed to implementing disaster citizen science activities.</td>
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</tr>
<tr>
<td>Project leaders are, or will be, involved in all planning steps.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Resources and administration

<table>
<thead>
<tr>
<th>Question</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>We have a thorough understanding of all the material, administrative, and labor resources needed for the project (including, if relevant, funding, technologies, infrastructure, staffing, training and educational materials, and volunteer force).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plans are in place to obtain all resources necessary for the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have obtained all resources necessary for the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have the capacity to obtain materials, labor, and other resources quickly if needed.</td>
<td></td>
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</tbody>
</table>

### Partnerships*

<table>
<thead>
<tr>
<th>Question</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>We have a thorough understanding of important challenges we might face in developing and maintaining partnerships for the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plans are in place to establish all partnerships necessary for the project.</td>
<td></td>
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<tr>
<td>We have established all partnerships necessary for the project.</td>
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<tr>
<td>We have a demonstrated track record of high-quality, long-term partnerships.</td>
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<tr>
<td>We have a proven ability to develop partnerships with individuals and groups from different cultures, professional backgrounds, or industries.</td>
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</tbody>
</table>

### Knowledge and skills

<table>
<thead>
<tr>
<th>Question</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>We have a thorough understanding of all the technical and scientific skills needed for the project (including, if relevant, skills needed in data or statistical analyses; study methods; data collection, management, and governance procedures; software or programming apps; and device or hardware use and maintenance).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plans are in place to obtain all technical or scientific skills necessary for the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have obtained all technical or scientific skills necessary for the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have a thorough understanding of the ethical and legal issues facing our project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have plans in place to deal with ethical and legal issues facing our project.</td>
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</tr>
</tbody>
</table>

### Volunteer management**

<table>
<thead>
<tr>
<th>Question</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>We have a thorough understanding of the roles and resources it takes to manage volunteers.</td>
<td></td>
<td></td>
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<tr>
<td>We have experience training volunteers for health department activities.</td>
<td></td>
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<tr>
<td>We regularly engage volunteers.</td>
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<tr>
<td>We are trained in cultural competencies.</td>
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</tbody>
</table>

### Organizational support***

<table>
<thead>
<tr>
<th>Question</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project leaders have management support to engage in the effort.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Our organization will provide sufficient staff to support the project.</td>
<td></td>
<td></td>
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<tr>
<td>Our organization will give us time to prepare and work on the project.</td>
<td></td>
<td></td>
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<tr>
<td>Efforts to generate support with leadership efforts are under way.</td>
<td></td>
<td></td>
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<tr>
<td>Our organization already performs citizen science (or citizen science–like) activities.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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* Only relevant if your project requires outside partners.

** Only relevant if your project plans to use volunteers.

*** Only relevant if you are part of an organization.
Worksheet 5
Develop a work plan

Use your logic model to list your activities and then decide on a timeline for each activity, along with task leads and other labor. Plans should also indicate what resources are needed to accomplish each activity (e.g., budget, equipment). Budget expectations regarding personnel, program materials, travel, and outreach are important to help with financial tracking. Also consider what alternatives might be necessary in terms of timelines and labor and other resources if emergencies or unplanned events should occur.

<table>
<thead>
<tr>
<th>Activity</th>
<th>When will the activity be done? How will you know when it is done?</th>
<th>Who is responsible? What staff will be involved?</th>
<th>What resources are needed for the activity?</th>
<th>What alternative scenarios should you prepare for?</th>
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</tbody>
</table>

You can add notes or your conclusions in the space below.
## Worksheet 6

Develop an influence plan

List the leadership or other groups you wish to influence in some way and determine what it is you want from them (e.g., make a decision, gather support, change minds, obtain resources). Consider different scenarios for how they might respond and what critiques or arguments they might make. Come up with different ways to respond to each scenario.

<table>
<thead>
<tr>
<th>Key leadership group</th>
<th>What does the group need to do differently?</th>
<th>How will the group respond?</th>
<th>What critiques might the group have?</th>
<th>What is your planned response?</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

You can add notes or your conclusions in the space below.
Compilation of Disaster Citizen Science Projects Described in the Toolkit

Altogether, there are 44 disaster citizen science projects mentioned in the toolkit (contributory projects = 20; collaborative projects = 12; collegiate projects = 12). In Table A.1, we organize the projects by model and disaster and provide the page numbers where the project is referenced.

**TABLE A.1**  
Citizen science projects described in the toolkit

<table>
<thead>
<tr>
<th>Name</th>
<th>Model</th>
<th>Disaster</th>
<th>Page</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flu Near You</td>
<td>Contributory</td>
<td>Infectious disease</td>
<td>16</td>
<td>A crowsource-based tool developed by Harvard, Boston Children’s Hospital, and the Skoll Global Threats Fund that engages the public to voluntarily submit information on illness status and provides real-time information about influenza-like illness by zip code  &lt;br&gt;<a href="https://flunearyou.org/#/">https://flunearyou.org/#/</a></td>
</tr>
<tr>
<td>Mosquito Habitat Mapper</td>
<td>Contributory</td>
<td>Infectious disease</td>
<td>16</td>
<td>A program from NASA GLOBE Observer that enables volunteers to map, count, and identify mosquito larvae found in breeding sites; eliminate breeding sites to reduce disease risk; and share the data with scientists and public health authorities  &lt;br&gt;<a href="https://observer.globe.gov/toolkit/mosquito-habitat-mapper-toolkit">https://observer.globe.gov/toolkit/mosquito-habitat-mapper-toolkit</a></td>
</tr>
<tr>
<td>COVID Near You</td>
<td>Contributory</td>
<td>Infectious disease</td>
<td>17</td>
<td>A crowsource-based tool developed by Harvard, Boston Children’s Hospital, and volunteers that maps user-submitted reports of flu and COVID-19 symptoms for the purpose of early detection  &lt;br&gt;<a href="https://www.covidnearyou.org/#/">https://www.covidnearyou.org/#/</a></td>
</tr>
<tr>
<td>CoronaReport</td>
<td>Contributory</td>
<td>Infectious disease</td>
<td>17</td>
<td>A crowdsourcing project developed by SPOTTERON and the Scottish Collaboration for Public Health Research and Policy at the University of Edinburgh that invites individuals to create public reports about personal experiences with COVID-19 and provide observations on the virus’s effect on communities  &lt;br&gt;www.coronareport.eu/</td>
</tr>
<tr>
<td>COVID-19 Citizen Science</td>
<td>Contributory</td>
<td>Infectious disease</td>
<td>17</td>
<td>A study led by the University of California, San Francisco, that enlists the public to download an app on smartphones that will be prompt individuals to self-report their symptoms daily, complete surveys about daily habits, and, if agreed to, provide location data to assist in analyzing disease spread  &lt;br&gt;<a href="https://covid19.eurekaplatform.org/">https://covid19.eurekaplatform.org/</a></td>
</tr>
<tr>
<td>Name</td>
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<tr>
<td>Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS)</td>
<td>Contributory</td>
<td>Severe weather</td>
<td>16</td>
<td>A community-based network of volunteers who measure and map precipitation (rain, hail, snow) using low-cost measurement tools to provide data for numerous applications. <a href="https://www.cocorahs.org/">https://www.cocorahs.org/</a></td>
</tr>
<tr>
<td>Meteorological Phenomena Identification Near the Ground (mPING)</td>
<td>Contributory</td>
<td>Severe weather</td>
<td>16</td>
<td>A program that collects weather information from the public through mobile devices with GPS location capabilities to improve weather predictions and forecasting and aid in weather-related decisionmaking. <a href="https://mping.nssl.noaa.gov/">https://mping.nssl.noaa.gov/</a></td>
</tr>
<tr>
<td>Watershed Watch</td>
<td>Contributory</td>
<td>Climate change, algal blooms</td>
<td>65</td>
<td>A water-testing program, started in 1988 by the University of Rhode Island, that engages the public to monitor the quality of surface-water resources across the state. Trained volunteers take weekly measurements at various water bodies. <a href="https://web.uri.edu/watershedwatch/">https://web.uri.edu/watershedwatch/</a></td>
</tr>
<tr>
<td>King Tides Project</td>
<td>Contributory</td>
<td>Climate change, flooding</td>
<td>83</td>
<td>A project that enables individuals around the globe to share images of and provide details about king tides—the highest tides in a year. Data are used to document flood risk in coastal areas, visualize impacts of future sea-level rise in communities, validate climate change models, and provide historical records. <a href="http://kingtides.net/">http://kingtides.net/</a></td>
</tr>
<tr>
<td>bloomWatch</td>
<td>Contributory</td>
<td>Algal blooms</td>
<td>16, 65</td>
<td>A project that engages volunteers in helping to report and photograph when and where cyanobacteria blooms appear using a mobile app. Together with cyanoScope and cyanoMonitoring, the three projects make up the Cyanobacteria Monitoring Collaborative. <a href="https://cyanos.org/bloomwatch/">https://cyanos.org/bloomwatch/</a></td>
</tr>
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<td>Name</td>
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<tr>
<td>cyanoScope</td>
<td>Contributory</td>
<td>Algal blooms</td>
<td>65</td>
<td>A project that engages trained volunteers and water-quality managers to understand where and when cyanobacteria species occur. Volunteers collect cyanobacteria, prepare microscope slides, identify cyanobacteria in the sample, and submit findings. Together with bloomWatch and cyanoMonitoring the three projects make up the Cyanobacteria Monitoring Collaborative. <a href="https://cyanos.org/cyanoscope/">https://cyanos.org/cyanoscope/</a></td>
</tr>
<tr>
<td>cyanoMonitoring</td>
<td>Contributory</td>
<td>Algal blooms</td>
<td>65</td>
<td>A project that engages volunteers to help determine the environmental factors that cause algal blooms by monitoring cyanobacteria populations and tracking seasonal patterns in waterbodies over time. Volunteers collect and analyze water samples and submit findings. Together with bloomWatch and cyanoScope the three projects make up the Cyanobacteria Monitoring Collaborative. <a href="https://cyanos.org/cyanomonitoring/">https://cyanos.org/cyanomonitoring/</a></td>
</tr>
<tr>
<td>Did You Feel It?</td>
<td>Contributory</td>
<td>Earthquakes</td>
<td>12, 16</td>
<td>The U.S. Geological Survey’s program collects reports on earthquake location, perceived intensity, and damage from people around the world, which are used to create maps of earthquake intensity and support research. <a href="https://earthquake.usgs.gov/data/dyfi/">https://earthquake.usgs.gov/data/dyfi/</a></td>
</tr>
<tr>
<td>MyShake</td>
<td>Contributory</td>
<td>Earthquakes</td>
<td>39</td>
<td>A project that aims to build a worldwide early-warning network for earthquakes by having volunteers download an app to their smartphones that uses the phones’ sensors to detect earthquake shaking. Volunteers can also submit damage and shaking reports and view other people’s reports. <a href="https://myshake.berkeley.edu/">https://myshake.berkeley.edu/</a></td>
</tr>
<tr>
<td>Planetary Response Network</td>
<td>Contributory</td>
<td>Earthquakes, hurricanes</td>
<td>50</td>
<td>An app that deploys a network of volunteers to analyze satellite imagery of areas affected by disasters, such as earthquakes or hurricanes, and perform damage assessments. <a href="https://www.zooniverse.org/projects/vrooj/planetary-response-network-and-rescue-global-caribbean-storms-2017">https://www.zooniverse.org/projects/vrooj/planetary-response-network-and-rescue-global-caribbean-storms-2017</a></td>
</tr>
<tr>
<td>Name</td>
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<tr>
<td>Landslide Reporter</td>
<td>Contributory</td>
<td>Landslides</td>
<td>16</td>
<td>A NASA project that invites the public to provide reports of landslides that are reviewed and approved by NASA scientists before being posted online <a href="https://gpm.nasa.gov/landslides/report.html">https://gpm.nasa.gov/landslides/report.html</a></td>
</tr>
</tbody>
</table>
| Participatory action research with Indigenous communities to reduce pandemic influenza risk | Collaborative  | Infectious disease  | 12   | A project using a participatory action research approach to investigate the impact of pandemic influenza (H1N109) in rural and remote Indigenous communities in Australia and develop culturally appropriate and effective strategies to reduce influenza risk.  


| Patients Like Me                                                      | Collaborative  | Infectious disease  | 17   | A health network that helps connect individuals suffering from the same ailments. The also site created a community for patients that have recovered from COVID-19. Patients generate data by sharing information about symptoms, treatments taken, perceived effectiveness, side effects, and other experiences.  

| OpenCovid19                                                           | Collaborative  | Infectious disease  | 17   | A decentralized science and engineering collaborative seeking open-source and low-cost tools, methods, and projects to address diagnostic, prevention, and treatment challenges related to COVID-19  

https://app.jogl.io/program/opencovid19 |
| Codevid-19                                                            | Collaborative  | Infectious disease  | 17   | A hackathon for developers, designers, and content experts interested in developing solutions to support crisis response, pandemic dynamics, physical-distancing practices, and scarcity and economic issues  

https://codevid19.com/ |
| Foldit                                                               | Collaborative  | Infectious disease  | 17   | An online citizen science gaming app developed by the University of Washington that challenges users to design virtual proteins that could disrupt the infective ability of the COVID-19 virus or be used in antiviral treatments  

https://fold.it/ |
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<tr>
<th>Name</th>
<th>Model</th>
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<tbody>
<tr>
<td><strong>The Workers and Community Relief and Aid Project (RAP)</strong></td>
<td>Collaborative</td>
<td>Hurricanes</td>
<td>14</td>
<td>A community-based participatory research project with rural populations in North Carolina displaced by Hurricane Floyd. The project documented displaced survivor experiences in terms of relocation, living conditions, and potential threats to health and loss of community as a result of storm-related flooding. Stephanie Farquhar and Noelle Dobson, “Community and University Participation in Disaster-Relief Recovery,” <em>Journal of Community Practice</em>, Vol. 12, Nos. 3–4, 2004, pp. 203–217.</td>
</tr>
<tr>
<td>Name</td>
<td>Model</td>
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</tbody>
</table>
| Environmental exposure survey in Atlanta                | Collaborative    | Flooding                  | 40   | A project in Atlanta in which teams of students and community members carried out neighborhood surveys to document the prevalence of asthma and associated environmental exposures in two flood-prone communities  
| Local Environmental Observer (LEO) Network             | Collaborative    | Climate change and related impacts | 74   | A web-based platform, established in 2012 by the Alaska Native Tribal Health Consortium, that allows members to report observations of unusual phenomena in the environment. The network connects Indigenous people and their local knowledge with professional scientists to share insights about observations.  
  https://www.leonetwork.org/en/  
| AIDS activism and citizen science                      | Collegial        | Infectious disease        | 15   | A movement during the early years of the AIDS epidemic, in which activists fought for better health care research and treatment by engaging with scientists  
| iWitness Pollution Map                                  | Collegial        | Toxic release/contamination | 12   | A crowdsourcing tool from the Louisiana Bucket Brigade that displays public and official reports of oil and chemical accidents and their impacts, submitted via text message, voicemail, email, and the web  
  http://map.labucketbrigade.org/ |
| Clean Air Coalition Tonawanda air study                | Collegial        | Toxic release/contamination | 13   | A project in Tonawanda, New York, in which community members organized to collect air samples that demonstrated harmful pollution levels from a nearby factory  
  https://csresources.org/  
  https://www.cacwny.org/ |
| Surfrider Foundation’s Blue Water Task Force           | Collegial        | Toxic release/contamination | 14   | A national network of volunteers who perform water-quality testing of recreational waters in communities across the United States  
  https://www.surfrider.org/programs/blue-water-task-force |
| Safecast                                               | Collegial        | Toxic release/contamination | 14   | An initiative started after the Fukushima Daiichi nuclear disaster that collects radiation measurements from volunteers worldwide and makes open data sets  
  https://safecast.org/ |
| Public Lab and community-based environmental monitoring | Collegial        | Toxic release/contamination | 14   | An initiative during the Deepwater Horizon oil spill in which community members captured visual data about the spill with homemade satellites. The effort led to the founding of Public Lab, a space for ideas and knowledge exchange around low-cost and practical applications for community-based environmental monitoring.  
  https://publiclab.org/ |
<table>
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<th>Name</th>
<th>Model</th>
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<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Bayou Interfaith Shared Community Organizing (BISCO) and environmental monitoring for oil spill contaminants</td>
<td>Collegial</td>
<td>Toxic release/contamination</td>
<td>38</td>
<td>A project by BISCO in which residents from coastal Louisiana were trained on soil, water, and air sampling to monitor the environment for oil-related contaminants.</td>
</tr>
<tr>
<td>SkyTruth pollution trackers</td>
<td>Collegial</td>
<td>Hurricanes, toxic release/</td>
<td>50, 72</td>
<td>A project by SkyTruth that launched map-based crowdsourcing tools during the Deepwater Horizon oil spill and hurricanes in 2017 that allowed people in the Gulf Coast states and the Caribbean to report oil and hazardous waste spills and other pollution incidents resulting from the disasters.</td>
</tr>
<tr>
<td>Surfrider Rincón and water quality testing after Hurricane Maria</td>
<td>Collegial</td>
<td>Hurricanes, toxic release/</td>
<td>50, 80</td>
<td>An effort in Puerto Rico in which the Rincón chapter of the Surfrider Foundation organized volunteers to restart a water-testing program, enabling the local community to generate its own information on the safety of recreational waters and sources of drinking water post-hurricane.</td>
</tr>
<tr>
<td>Community mapping to support rebuilding after Hurricane Katrina</td>
<td>Collegial</td>
<td>Hurricanes</td>
<td>41</td>
<td>A project, led by Churches Supporting Churches in New Orleans, combined community mapping, enhanced GIS methods, and public policy advocacy to help pastors display uneven redevelopment patterns of neighborhoods following Hurricane Katrina and build capacity to effect change.</td>
</tr>
<tr>
<td>Beacon of Hope M.O.D.E.L. for disaster recovery</td>
<td>Collegial</td>
<td>Hurricanes</td>
<td>75</td>
<td>A model for disaster recovery that was developed in New Orleans after Hurricanes Katrina and Rita. Research activities included resident-led neighborhood mapping, as well as community analysis, interpretation, and use of data.</td>
</tr>
</tbody>
</table>
Volunteered geographic information and the Santa Barbara wildfires

Project involving public use of social media and mapping technologies to share, document, and interpret data, observations, and other materials related to the 2007–2009 wildfires in Santa Barbara, California.

All disasters are local, and health departments form the backbone of response. Scientific research is critical for understanding the characteristics of a disaster, documenting adverse outcomes, and testing strategies for preventing disasters and reducing their harms. Disaster science has typically been performed by professional researchers. But, today, the public has a much bigger role to play. The field of citizen science may hold the key to performing better research and delivering better results for communities everywhere. Citizen science, also sometimes called community science or street science, is public engagement in scientific research as scientists rather than study subjects. When applied to disasters, the field is called disaster citizen science. With the invention of new technologies, scientific knowledge, tools, and methods have become accessible to everyone in ways that did not exist before. By harnessing these advancements, health departments could obtain data that address critical needs to improve preparedness planning, while using an approach that is inherently designed to promote public participation, education, and understanding of science. Everyone benefits.

The authors designed this toolkit to provide guidance to a broad range of community groups (e.g., volunteer or faith-based institutions, social service organizations, private or other nonprofit organizations) on designing and implementing disaster citizen science projects. It is primarily directed toward groups that are interested in creating and leading their own projects, small or large, rather than supporting projects carried out by others.