Citizen Science for Disasters
A Guide for Local Health Departments

Ramy Chari
Sameer M. Siddiqi
Vishnupriya Kareddy
Elizabeth L. Petrun Sayers
Jaime Madrigano
Lori Uscher-Pines
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—when 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, local health departments and community groups alike 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 health departments about engaging with disaster citizen science. Health departments are on the front lines of disaster preparedness, and community engagement is critical to the relevance and success of their actions. The potential for communities to engage in data collection and research to support preparedness, supplement or augment certain health department functions, and increase their own knowledge and understanding of risks holds much promise for helping health departments fulfill their missions. The toolkit can help health departments understand whether citizen science can be a resource in their communities and, if so, how to get involved in the field. 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. Health departments are the intended audience for this toolkit, but it may also be relevant to other local and state-level agencies involved in preparedness and community-facing functions or missions.

RAND Community Health and Environmental Policy Program

This toolkit was developed by the RAND Corporation under contract with the Centers for Disease Control and Prevention. RAND Social and Economic Well-Being is a division of the RAND Corporation that seeks to actively improve the health and social and economic well-being of populations and communities throughout the world. This research was conducted in the Community Health and Environmental Policy Program within RAND Social and Economic Well-Being. The program focuses on such topics as infrastructure, science and technology, community design, community health promotion, migration and population dynamics, transportation, energy, and climate and the environment, as well as other policy concerns that are influenced by the natural and built environment, technology, and community organizations and institutions that affect well-being. For more information, email chep@rand.org.

Acknowledgments

In developing this toolkit, we owe much gratitude to the health departments, citizen scientists, community groups, project leaders, researchers, practitioners, and policymakers who generously gave their time to speak with us about their experiences and offer advice and lessons learned. We thank our advisory board, composed of representatives from local health departments and community organizations, for feedback and commitment to the project. We thank the many evaluators and reviewers of the toolkit whose insights and edits have served to only strengthen the product. Finally, we thank our funder, the Centers for Disease Control and Prevention, which supported the project in countless ways.
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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 can have profound effects at the local level, and health departments form the backbone of a community’s response. 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 a disaster recedes, 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 best to help communities prepare for, respond to, and recover from disasters. Research is needed to understand and characterize disasters—how they arise, how they
move, 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. Findings from research feed into decisions about resources and services needed to serve 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 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 involvement 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, health departments can obtain important data, answer critical questions, and improve preparedness planning, 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 health departments on engaging with disaster citizen science to support public health preparedness, response, and recovery. Because of the unique needs and constraints of health departments, this toolkit is designed to

- raise awareness of the types of disaster citizen science activities that health departments have leveraged for disaster preparedness, response, and recovery
- provide guidance on how to design a disaster citizen science project and identify resources to support activities
- facilitate partnerships between health departments and other entities, such as community groups or research institutions, to carry out disaster citizen science activities
- raise awareness of health department attitudes about and challenges to the implementation of disaster citizen science

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**BOX I.1 Definition of disaster citizen science**

Disaster citizen science is the involvement of members of the public in scientific activities relating to disaster preparedness, response, or recovery (e.g., study design or collection or analysis of data). Individuals can pursue citizen science in collaboration with professional scientists or independently.

*Although the term includes the word citizen, disaster citizen science includes everyone who lives in or serves a community.* In this toolkit, we adopt this terminology, which is currently used by the field of citizen science, but recognize that the use of this term may be sensitive or easily misinterpreted. When applying or using the toolkit, there is no requirement to use the term citizen science, and substitute terms, such as community science, are perfectly acceptable.
• provide guidance for health departments on responding to and coordinating with disaster citizen science projects that are either led or supported by community groups.

Health departments are the intended audience for this toolkit, but this guidance may also be relevant to other local and state-level agencies involved in preparedness and community-facing functions or missions. 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 that have been carried out and explaining their relevance for health departments.

• The second chapter, **Act**, describes a five-step approach for planning and designing disaster citizen science projects and for addressing common challenges that may arise. The chapter also discusses how health departments can respond to citizen science projects led by community groups or others working outside regulated research institutions.
How to Use the Toolkit

This toolkit will walk health department staff 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 as a group. The toolkit contains many interactive elements, including exercises, that can help you and 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/TLA175-1). The appendix also includes a compilation of all the disaster citizen science project examples described in the toolkit and a pullout sheet listing ten benefits of disaster citizen science for health departments for easy reference.

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**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., raise public awareness, build community capacity, 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 your health department 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 expand your capabilities and communicate with a wider variety of stakeholders.

**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 communities 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 communities to identify recovery needs (e.g., participatory research studies with small, vulnerable groups).
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 health department representatives; 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 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 health department representatives and community organization leaders to provide guidance on toolkit development.
CHAPTER 1. LEARN

A Primer on Disaster Citizen Science

Why Use 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.

Local groups can also draw on their knowledge of local neighborhoods and their credibility with residents. Local groups have firsthand knowledge about their own neighborhoods that response professionals and outside scientists may lack. In addition, community groups are better 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. The last option could be especially useful for health departments when engaging in data collection efforts, such as Community Assessment for Public Health Emergency Response (CASPER) surveys (Centers for Disease Control and Prevention, 2020a). Such information may help 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. Finally, community members can also participate in public health surveillance activities. The public can be enlisted to provide data on many issues of public health concern to help
identify and mitigate or prevent potentially dangerous situations before they escalate (e.g., observations of disease vectors, disease symptom reporting).

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.

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="image" alt="Education and scientific literacy" /></td>
<td><img src="image" alt="Social capital" /></td>
<td><img src="image" alt="Knowledge resources" /></td>
<td><img src="image" alt="Future leaders" /></td>
<td><img src="image" alt="Democratic decisionmaking" /></td>
</tr>
</tbody>
</table>

Community health and well-being
As noted by a health department emergency manager we interviewed:

Trying to build resiliency is always, especially postdisaster, what we’re really trying to do. And if we can actually do it through people’s efforts rather than just by telling people stuff, I think that’s always a great way to go. It’s partly why I was excited about hearing more about this whole concept of citizen science because—especially when there are disasters going on—it’s very overwhelming… incredibly overwhelming, to be in the lead position of, “How do we tackle this?” And then the public is staring at you like, “What should we do?” And the minute that you give people something to do, it just gets better.

The potential of citizen science has been recognized at the federal level. Since 2012, the Federal Community of Practice for Crowdsourcing and Citizen Science has met regularly, growing from five people at the start to more than 400 members today (General Services Administration, 2020). A federal crowdsourcing and citizen science toolkit was released in 2015, offering general guidance for designing and carrying out citizen science projects (CitizenScience.gov, 2015a). In January 2017, the American Innovation and Competitiveness Act (Public Law 114-329) was signed into law. Section 402, the Crowdsourcing and Citizen Science Act, encourages federal agencies with scientific missions to use crowdsourcing and citizen science to advance those missions:

Crowdsourcing and citizen science projects have a number of additional unique benefits, including accelerating scientific research, increasing cost effectiveness to maximize the return on taxpayer dollars, addressing societal needs, providing hands-on learning in STEM [science, technology, engineering, and mathematics], and connecting members of the public directly to Federal science agency missions and to each other.

The same benefits proposed for federal agencies would hold true for state and local agencies. If pursued properly, disaster citizen science could be a force multiplier for health departments, helping to achieve preparedness goals while also benefiting community health. By directly integrating the public in research and practice applications, citizen science projects would not result only in actionable data but could also be used to educate communities and mobilize partnerships. Disaster citizen science is therefore uniquely positioned to help health departments carry out essential public health services, listed in Figure 1.2.
Later in this chapter, we present examples of projects that provided these services.
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>
<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. Sometimes groups, such as local government, may have scientific resources in-house but partner with other entities to meet an objective (e.g., dissemination of findings). Groups that lack extensive research capacities may partner with academic institutions or individual scientists. Mutual benefits arise when groups work together to fill those gaps. 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, 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
Learn

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 health departments may pose.

### TABLE 1.2

Models of citizen science

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contributory: Science that leverages the people</td>
<td>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).</td>
</tr>
<tr>
<td>Collaborative: Science done with the people</td>
<td>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).</td>
</tr>
<tr>
<td>Collegial: Science done by the people</td>
<td>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).</td>
</tr>
</tbody>
</table>

**SURVEY RESULTS**

62% of local health departments surveyed have engaged with at least one citizen science project (any model), with disaster preparedness being one of the most common applications.

**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
- 24% Technology groups
- 11% Advocacy organizations
- 26% Government agencies

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.

**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.
Disaster Citizen Science in Action

Our research has found many examples of disaster-related citizen science projects, run either by health departments or with health department involvement, that were instrumental in addressing key public health services. Such projects have led to many reported impacts. For example, health departments have reported that citizen science activities have

- enhanced the strength and quality of agency partnerships
- enhanced agency communication efforts
- increased awareness or knowledge among the public
- prevented or mitigated adverse events
- directed interventions by the health department.

Below, we present four examples of health department engagement in disaster citizen science projects. For each example, we describe the type of disaster citizen science model used and the essential public health services that were met through the projects.
The Houston Department of Health and Human Services performed a needs assessment using a community-based participatory research approach, working with community partners to understand the disaster preparedness needs of linguistically isolated population groups. To effectively engage a hard-to-reach population, the health department recruited and trained community researchers, trusted members of the communities of interest, to perform focus groups. The assessment provided important insights about how linguistically isolated groups perceived preparedness and how to improve communication strategies.

**Model:** Collaborative  
**Public health services:** Monitor health; diagnose and investigate; inform, educate, and empower; mobilize partnerships; research  
(Nepal et al., 2010)

In Arizona, state and local health departments partnered with academic institutions to enlist schools and community members in mosquito surveillance efforts. Health department epidemiologists worked with high school students and retired adults to collect mosquito eggs, which were then used to identify and map mosquitoes that were carrying dengue, Zika, and chikungunya. Public education was also part of the initiative.

**Model:** Contributory  
**Public health services:** Monitor health; diagnose and investigate; inform, educate, and empower; mobilize partnerships; research  
(Torter et al., 2019)

The Texas Department of State Health Services, in collaboration with academic partners, created a program for the public to submit photos and specimens of kissing bugs to understand vector distribution and prevalence of Chagas disease in Texas. The collaboration resulted in submission of 1,980 kissing bugs and provided new information about geographic regions harboring the bugs and other important insights into kissing bug activity and infection prevalence. Educational campaigns were also used to increase public understanding of Chagas disease and how to reduce health risks.

**Model:** Contributory  
**Public health services:** Monitor health; diagnose and investigate; inform, educate, and empower; mobilize partnerships; research  
(Curtis-Robles et al., 2015)

Following a train crash in Graniteville, South Carolina, that resulted in chlorine gas exposure, the South Carolina Department of Health and Environmental Control used a community-based participatory service approach to partner with community groups to track recovery efforts. The health department and community partners 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. See Box 1.1 for more information about the project.

**Model:** Collaborative  
**Public health services:** Monitor health; diagnose and investigate; inform, educate, and empower; mobilize partnerships; develop policies; link to care; research  
(Svendsen et al., 2010)
There are numerous other examples of disaster citizen science projects that might not have had direct health department participation but nonetheless resulted in research relevant to health department functions. Health departments can be on the receiving end of data or results that helps to inform public health services needed in a community. Examples of other projects and their relevance for health departments are shown below.

**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

**Health department relevance:** Data useful for identifying populations in need for testing of blood lead levels, follow-up, and education.

(Ruckart et al., 2019)

**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

**Health department relevance:** Data useful for monitoring water safety and identifying potential harms to human health.

(Surfrider Foundation, undated)

**In Fukushima, Japan, 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

**Health department relevance:** Data useful for identifying populations that may require health services or follow-up monitoring for health effects.

(Safecast, undated)

**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

**Health department relevance:** Data useful for identifying populations that may require health services or follow-up monitoring for health effects.

(Citizen Science Community Resources, undated)

**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

**Health department relevance:** Data useful for identifying populations that may require health services or follow-up monitoring for health effects.

(Citizen Science Community Resources, undated)
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

**Health department relevance:** Direct engagement with activists could result in changes to departmental policies or procedures that benefit communities

(Epstein, 1995)

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

**Health department relevance:** Data useful for identifying areas in need of health services and monitoring postdisaster

(Farquhar and Dobson, 2004)

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

**Health department relevance:** Data useful for monitoring community health reports and identifying signals that may indicate that a health problem requires further investigation

(Public Lab, undated)
These examples span **contributory**, **collaborative**, and **collegial** models of disaster citizen science. Health departments may find themselves involved in all model types, whether leading a **contributory** project, leading or partnering with research institutions or community groups on **collaborative** models, or supporting **collegial** models.

We make a special note about contributory projects because they are currently the most common disaster citizen science activity. 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, severe weather, landslides, earthquakes, volcanic eruptions, vector-borne disease, 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. Ongoing contributory projects with open data sets can simply be used by health departments for situational awareness of an issue. Health departments can also take action to advertise and encourage members of their communities to use certain apps to increase the geographic relevance of the data. Table 1.3 provides
an example list of disaster citizen science apps that are already built to receive data from the public. Health departments can use these apps for their own purposes. We note that the website SciStarter (https://scistarter.org/) provides an inventory of many citizen science projects, including disaster-relevant ones, for anyone to join. It is an especially great resource for finding contributory citizen science projects.

**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 engages 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/">https://earthquake.usgs.gov/data/</a>).</td>
</tr>
</tbody>
</table>
As of this writing, many of the citizen science projects focusing on COVID-19 use 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 crowdsourcing-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 agreed to, 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 who have 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 datasets 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 health departments and other groups 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 preparedness and health department functions?

• What are the three models of citizen science? Provide examples of projects for each model.

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

• What are the ways health departments have engaged in disaster citizen science?
Implementing Disaster Citizen Science Activities

Now that you know what disaster citizen science is and how it can benefit health departments, the next step is to design and implement a project. You or others in your health department 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 prepare your health department to participate in disaster citizen science (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 that 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 your organization is not ready to lead a disaster citizen science project. Resources may be tight, or staffing may be an issue. Departmental leadership might not yet be convinced that citizen science is worth pursuing. Regardless of the reason, in Chapter 1 we showed you numerous examples of health department involvement in citizen science. There are different roles your organization could play:

**Define problems and champion others:** The health department could define a problem, indicate the need for a citizen science solution, and facilitate activities, but the department would not be directly involved with implementing a project itself. The health department could fund other entities to carry out citizen science activities or could engage in meetings or other discussion avenues with such entities.

**Be a supporting partner.** The health department could engage as a supporting partner with a smaller, narrower role in other entities’ projects. The health department could approach research institutions to discuss needs in disaster citizen science or could express interest in partnering on funding opportunities led by the institution—or could approach entities with ongoing projects to determine ways to engage.

**Be an end user.** The health department could be a recipient of research results. The health department could express interest to academic, community, and other groups about receiving citizen science–generated data and working with such groups to determine data needs and inform them of constraints and limitations. The health department could also use existing apps of interest (see, for example, Tables 1.3 and 1.4) and encourage members of the community to contribute data for health department use.

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 are engaging with disaster citizen science in other roles, understanding the process of thinking through a research project will better prepare you to serve as a partner or will help you know what to look for in research data if you are an end user. In addition, 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 could join. This could be an accessible way to learn more about citizen science projects before diving into one of your own.
**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 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 health department and 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?

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 logic model, you can think about what you want to achieve in both the short term and 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

We developed 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 health department is concerned about community spread of mosquito-borne disease. The toolkit presents several 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 mosquitoes and their potential harms.
- More people take protective actions against mosquitoes (e.g., reducing habitats, implementing structural barriers, using personal protection, applying pesticide treatments).
- Health department increases mosquito surveillance.
- Mosquito populations are reduced.
- The incidence of mosquito bites is reduced.
- Mosquito-borne disease is reduced.

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 these example outcomes 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 mosquito-borne disease reduction. 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 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.)

Community spread of mosquito-borne disease

<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 mosquitoes and their harms</td>
<td>Mosquito habitats are reduced</td>
<td>More people implement structural barriers for indoor areas</td>
<td>Mosquito population is reduced</td>
<td>Incidence of mosquito-borne disease is reduced</td>
<td></td>
</tr>
<tr>
<td>Mosquito habitats are reduced</td>
<td>More people carry out personal protective behaviors (e.g., repellent use) during mosquito season</td>
<td>Incidence of mosquito bites is reduced</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More people carry out personal protective behaviors (e.g., repellent use) during mosquito season</td>
<td>Larvicide treatments are increased</td>
<td>The health department increases surveillance of mosquito populations</td>
<td></td>
<td></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 mosquitoes and their harms</td>
<td>Within two years, surveyed community members will self-report greater levels of understanding about mosquito species and their harms, compared with baseline.</td>
</tr>
<tr>
<td>Mosquito habitats are reduced</td>
<td>Within two years, actions taken by individuals, businesses, and government to remove standing water sources will reduce mosquito habitats by 75 percent, compared with baseline.</td>
</tr>
<tr>
<td>More people implement structural barriers for indoor areas</td>
<td>Within two years, the number of community members implementing structural barriers in their homes (e.g., installing screens, filling holes in walls) will increase by 50 percent, compared with baseline.</td>
</tr>
<tr>
<td>More people carry out personal protective behaviors during mosquito season</td>
<td>Within two years, the number of community members carrying out protective behaviors during mosquito season will increase by 50 percent, compared with baseline.</td>
</tr>
<tr>
<td>Larvicide treatments are increased</td>
<td>Within two years, larvicide treatment around residential properties will increase by 25 percent, compared with baseline.</td>
</tr>
<tr>
<td>Pesticide control of adult mosquitoes is increased</td>
<td>Within two years, pesticide control of adult mosquitoes around residential properties will increase by 25 percent, compared with baseline.</td>
</tr>
<tr>
<td>The health department increases surveillance of mosquito populations</td>
<td>Within three years, the health department will increase the duration, frequency, and geographic range of its surveillance efforts.</td>
</tr>
<tr>
<td>Mosquito population is reduced</td>
<td>Within five years, the mosquito population in the community will be reduced by 75 percent, compared with baseline.</td>
</tr>
<tr>
<td>Incidence of mosquito bites is reduced</td>
<td>Within five years, the incidence of mosquito bites in the community will be reduced by 75 percent, compared with baseline.</td>
</tr>
<tr>
<td>Incidence of mosquito-borne disease is reduced</td>
<td>Within ten years, the incidence of mosquito-borne disease will be reduced by 75 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 or what others in your health department have done in the past. You will want to explore what has happened not only locally in your own organization and community but also elsewhere. Your background research may include online searches, library research, interviews with people you know, and informal surveys. 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 need 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>
</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 mosquito-borne disease scenario discussed previously. The answers are provided as examples of how you might respond to each worksheet item according to 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>Federal government agency (name)</td>
<td>Built an app for crowdsourcing data about mosquito habitats</td>
<td>App has effectively transmitted photos and text observations to a central site for analysis</td>
<td>Public communications about app were not great; directions were hard to follow</td>
</tr>
<tr>
<td>Local high school (name)</td>
<td>Had field trips in science class to show students how to identify mosquito breeding sites</td>
<td>Students reported that they enjoyed the field trips</td>
<td>Learning outcomes were not tracked; field trips are not consistently planned</td>
</tr>
<tr>
<td>Local university (name)</td>
<td>Did a study evaluating the effectiveness of different larvicides</td>
<td>Study found strong effectiveness for ecofriendly larvicides</td>
<td>Did not engage with health department to communicate relevant findings</td>
</tr>
<tr>
<td>Other university (nonlocal) (name)</td>
<td>Did a community study evaluating different behavioral strategies for mosquito bite prevention</td>
<td>Held focus groups with residents; interviewed the local health department to get perspectives</td>
<td>Never published results; never let health department or community know what happened with findings</td>
</tr>
<tr>
<td>Local pest control service (name)</td>
<td>Offered education to the public on mosquito risks and control strategies</td>
<td>Outreach events were seen as informative by attendees</td>
<td>Outreach events limited by staff size of the company; did not cover many topics</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 engage the public or students in mosquito-related education, which has been well received. However, overall, efforts have been limited in number, in scope, or by poor communication. 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 increasing community involvement in mosquito activities, working with local schools and businesses on education efforts, developing deeper partnerships with universities, or leveraging and improving existing apps for data gathering.
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 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, undated). 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) using the mosquito-borne disease scenario.

Short-term outcomes:
- The community learns more about mosquitoes and their harms.
- Mosquito habitats are reduced.
- More people implement structural barriers for indoor areas.
- More people carry out personal protective behaviors (e.g., repellent use) during mosquito season.
- Larvicide treatments are increased.
- Pesticide control of adult mosquitoes is increased.
- The health department increased surveillance of mosquito populations.

Medium-term outcomes:
- Mosquito population is reduced.
- Incidence of mosquito bites is reduced.

Long-term outcomes:
- Incidence of mosquito-borne disease is reduced.

In our Example Worksheet 1b, we listed the one long-term outcome specified: incidence of mosquito-borne disease is reduced. 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 incidence of mosquito-borne disease is reduced. 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.
FIGURE 2.2
Developing a theory-of-change story

In Example Worksheet 1b, we listed two medium-term outcomes as a precursor to reduced disease incidence. We will choose one of these outcomes for this example (the box in red in Figure 2.2). We can now ask the question: What caused the mosquito population to go down? The next story block (row) in the figure provides a possible answer.

Example Worksheet 1b listed several short-term outcomes. Some of the outcomes would logically lead to a reduction in the mosquito population (habitat destruction, larvicide, and pesticide use). For illustration purposes, we choose just one of these outcomes (the box in red). So, now we ask: Why were mosquito habitats reduced? See the next block in the figure.

We can come up with a theory that mosquito habitats were reduced because they were found and destroyed (box in red), which leads to the next question: Why might this be happening? See the next block in the figure.

We again raise a theory that mosquito habitats were found through data collection efforts. Why did these efforts occur?

By working backward, our theory of change has led to an outcome based on data collection and analysis. We now can ask a possible research question that could eventually lead to a reduction of mosquito-borne disease: What is the distribution and extent of mosquito infestation in the community? In addition, by continuing to move backward in our story, we have identified a possible method for answering the question: surveillance of mosquito populations. We can continue with the theory-of-change story to next ask: How did the health department increase surveillance? The answers could include different methodological options for surveillance, one of which could be a citizen science approach—enlisting community members to help detect and destroy mosquito habitats.
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—determining the distribution and extent of mosquito infestation in a community—appears to be a health or environment monitoring study. Identifying what type of study you want to conduct will influence the methods you choose and the activities you perform. Sometimes the same research questions can be pursued as different study types. For example, determining whether air pollution is dangerous to community health could be conceived as a monitoring study or an epidemiological investigation. 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.

Creating theory-of-change stories will take practice, but 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 its 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 data collection methods that citizen science projects can use to address public health 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 (Eiffert 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, photo, video, 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 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?

- Yes
- No

Does the study need data collected from the environment?

- Yes
- No

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

- Observations
- Sensor
- Physical collection

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

- Yes
- No

Methods: observation, sensor, and/or physical collection design

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

- Yes
- No

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 to dive deeply into topics?

- Yes
- No

Methods: observation, sensor, and/or physical collection design

Does the study need to dive deeply into topics?

- Yes
- No

Methods: observation, sensor, and/or physical collection design
In the example mosquito-borne disease scenario, the theory-of-change story led to a decision to conduct a surveillance study in which we would collect data on mosquito habitats using a citizen science approach. Using the flowchart, we ignore questions that ask about data collection from people and focus on questions about data collection in the environment. There is one further question about whether hazards 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.

Foundational resources

- **Funding**: 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.

- **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, or expertise not already contained in the organization conducting the 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 individuals or community organizations, research institutes, other government agencies, 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. Staff 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. Health departments 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 department funds and in-kind goods or services provided by partners.

We note that, regardless of resources available, the 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 feel 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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</tr>
</tbody>
</table>

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

In Example Worksheet 2c, we provide guidance on how to fill out Worksheet 2c using the mosquito-borne disease scenario. The 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>Some</td>
<td>Partnerships may help with resources</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 mosquito risk awareness 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 testing this project</td>
</tr>
<tr>
<td>Labor</td>
<td>Yes</td>
<td>Yes</td>
<td>Our organization is fully staffed to support this project</td>
</tr>
<tr>
<td>Volunteers</td>
<td>Yes</td>
<td>No</td>
<td>Recruit from area schools</td>
</tr>
<tr>
<td>Partnerships</td>
<td>Yes</td>
<td>No</td>
<td>Reach out to potential partners, such as area schools, pest control companies, and universities</td>
</tr>
<tr>
<td>Technical skill: data management</td>
<td>Yes</td>
<td>No</td>
<td>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>
<tr>
<td>Equipment: app for public reporting</td>
<td>Yes</td>
<td>No</td>
<td>Conduct online research to see if there are free or paid apps that can be used for the project</td>
</tr>
</tbody>
</table>

You can add notes in the space below.
Act 2d. 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 the 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) may 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.

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.
**BOX 2.5**

**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 (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 effective 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

 Depending on who leads a citizen science project, the ethical and legal standards that apply will vary. For example, there are unique legal issues faced by federal agencies that pursue citizen science (Gellman, 2015). Professional 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. Approval from an IRB is required for federally funded and many privately funded research projects that involve humans.

 Citizen science research led by academic or government institutions is governed by the same ethical and legal rules applicable to traditional human subjects research. In certain cases, citizen science activities that a health department is involved in may count as essential public health services (e.g., conducting a needs assessment) and therefore would be exempt from IRB review. Nonetheless, health departments are still expected to follow research ethics standards even if there is no formal review. When in doubt, health departments should consult an IRB to determine whether a full application is required, given the scope and activities of the proposed project. IRBs can be affiliated with local universities or academic institutions. Many are independent entities as well. 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.gov/search/irbsearch.aspx).

 We note a case specific to citizen science that raises the importance of being attuned to ethical issues. 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 community groups or individuals to understand and monitor these issues on their own (Stone, 2013). Health departments should be aware of this when dealing with collegial models of citizen science or if asked to examine and use data collected by researchers working outside regulated scientific institutions. Health departments should especially be careful if disaster citizen science projects, regardless of who is leading, deal with protected health information (PHI). Under the Health Insurance Portability and Accountability Act (HIPAA), passed by Congress in 1996 (Public Law 104-191), PHI should be protected and made confidential. PHI refers to information about health status, care received, or payment for health care that can be linked to a specific individual. HIPAA will apply to projects that collect, receive, handle, or share PHI, including PHI about the volunteers involved (U.S. Department of Health and Human Services, 2013). Projects led by a health department will need to ensure compliance with HIPAA and develop and follow procedures that ensure the confidentiality and security...
of PHI. There may also be policies governing the use of PHI that may be brought to the health department from outside sources. Health departments should let citizen scientist groups interested in working with them know exactly what constraints the department might face in using sensitive health data.

Ethical and legal considerations in research 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 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.

Below, we first discuss an issue relevant to both volunteers and 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 that data, if released publicly, might cause harm or embarrassment to a person. 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.
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 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.

Some health departments face limitations on whether and how they can engage volunteers. Prior to setting up a citizen science project, health departments should ensure compliance with laws and regulations on volunteer use and engagement. In some cases, it may be preferable to leverage existing volunteers (e.g., Medical Reserve Corps members) rather than recruit new ones.

Other issues with an ethical dimension 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 or are planning a particularly risky project, consider partnering in some form with another institution with the capacity to safeguard data.

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>Ethical and legal issues in research</td>
<td>European Citizen Science Association, 2015</td>
<td>“The Ten Principles of Citizen Science”</td>
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<td>International Federation of Red Cross and Red Crescent Societies, 2020</td>
<td>The Fundamental Principles of the International Red Cross and Red Crescent Movement: Ethics and Tools for Humanitarian Action</td>
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<td>Clinical and Translational Science Institute, University of Pittsburgh, undated</td>
<td>“Community Partners Research Ethics Training”</td>
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<td>Hoffman, 2015</td>
<td>“Citizen Science: The Law and Ethics of Public Access to Medical Big Data”</td>
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<td>Community Tool Box, undated-c</td>
<td>“Increasing Participation and Membership”</td>
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<td>Clinical and Translational Science Institute, University of California, San Francisco, 2013</td>
<td>Community-Engaged Research: A Quick-Start Guide for Community-Based Organizations</td>
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<td>Division of Prevention Science, University of San Francisco, undated</td>
<td>“Community Based Participatory Research Toolbox”</td>
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<td>Scientist-Community Partnerships: A Scientist’s Guide to Successful Collaboration</td>
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<td>Center for Science and Democracy, Union of Concerned Scientists, 2014</td>
<td>Citizen Science Toolkit: Build a Community</td>
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<td></td>
<td>Collective Impact Forum, 2017</td>
<td>Community Engagement Toolkit</td>
</tr>
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<td>Volunteer management</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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<td>Kragh, 2016</td>
<td>“Motivations of Volunteers in Citizen Science”</td>
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<td>Texas Health and Human Services, undated</td>
<td>“The 4 R’s of Volunteer Management Toolkit”</td>
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<td>Data quality, management, and safety</td>
<td>Environmental Protection Agency, 2019</td>
<td>Quality Assurance Handbook and Guidance Documents for Citizen Science Projects</td>
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<td></td>
<td>CitizenScience.gov, 2015c</td>
<td>“Step 4—Manage Your Data”</td>
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<td>Wiggins et al., 2013</td>
<td>Data Management Guide for Public Participation in Scientific Research</td>
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<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>
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<td></td>
<td>Bowser, Wiggins, and Stevenson, 2016</td>
<td>Data Policies for Public Participation in Scientific Research: A Primer</td>
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<td>National Institute of Environmental Health Sciences, 2018</td>
<td>“Evaluation Metrics: Partnerships for Environmental Public Health”</td>
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<td>Community Tool Box, undated-b</td>
<td>“Evaluating the Initiative”</td>
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<td></td>
<td>Centers for Disease Control and Prevention, 2016</td>
<td>“CDC Evaluation Resources”</td>
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</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. Step 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: (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 mosquito-borne disease scenario we provided, our theory of change was that health department surveillance of mosquito populations, using a citizen science approach, would reveal the extent and geographic distribution of mosquito habitats, allowing individuals to target habitat destruction activities. These activities would result in a reduced number of mosquito species and, subsequently, mosquito-borne disease in the community. To fill in the inputs column, we simply referred to the resources listed in step 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., apply for grants) or technical expertise (e.g., find an academic partner). We knew from our theory-of-change story that surveillance, using a citizen science approach, was the method of choice. Thus, for activities associated with project methods, we included the need for volunteers who are trained in identifying mosquito habitats and other activities associated with data collection and analysis. Finally, to get to the outcomes, we needed activities that reflect what we would do with the data (e.g., outreach to the public).

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 take place and to train a specified number of people. Other desired outputs might be to ensure that the trainings are well received by volunteers and that they are effective in teaching volunteers the skills they need. In the fully filled-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.)

**Community spread of mosquito-borne disease.**

<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>Apply for grant</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 long term (e.g., 10+ years) if project activities are carried out as intended?</td>
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<tr>
<td></td>
<td>Partner with local university for any technical expertise</td>
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<td></td>
<td>Research equipment or apps for data collection or analysis</td>
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<td></td>
<td>Recruit volunteers</td>
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<td></td>
<td>Develop training protocol and materials</td>
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<td>Hold training sessions</td>
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<td></td>
<td>Collect data identifying mosquito species and habitat locations</td>
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<td></td>
<td>Destroy habitats</td>
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<td></td>
<td>Analyze data</td>
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<td></td>
<td>Hold briefings with health department leaders</td>
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<td>Hold outreach and public meetings on the project</td>
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<tr>
<td></td>
<td>Labor</td>
<td>1 grant application completed</td>
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<tr>
<td></td>
<td>Technical expertise</td>
<td>100 percent of project funds raised</td>
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<tr>
<td></td>
<td>partners</td>
<td>1 university partnership developed</td>
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<td></td>
<td>Equipment</td>
<td>Partner shows high satisfaction with roles and communications</td>
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<td></td>
<td>Volunteers</td>
<td>1 free mobile app selected for data collection activities</td>
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<tr>
<td></td>
<td>Training and educational materials</td>
<td>30 volunteers from area schools recruited</td>
<td></td>
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<tr>
<td></td>
<td>Supportive organization and strong leadership</td>
<td>Volunteer groups show high satisfaction with recruitment process</td>
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<td></td>
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<td>Training materials developed</td>
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<td></td>
<td>Volunteers show high satisfaction with training materials</td>
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<td>4 training sessions held</td>
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<td></td>
<td>30 volunteers trained</td>
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<tr>
<td></td>
<td></td>
<td>Volunteers show high satisfaction with trainings</td>
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<tr>
<td></td>
<td></td>
<td>120 habitats and species identified correctly</td>
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<tr>
<td></td>
<td></td>
<td>120 habitats correctly destroyed</td>
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<td></td>
<td></td>
<td>2 briefings held with health department leaders</td>
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<td>Health department leaders show more-positive attitudes toward citizen science than before</td>
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<tr>
<td></td>
<td></td>
<td>4 public meetings held</td>
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</tbody>
</table>

Funding

- Apply for grant
- Partner with local university for any technical expertise
- Research equipment or apps for data collection or analysis
- Recruit volunteers
- Develop training protocol and materials
- Hold training sessions
- Collect data identifying mosquito species and habitat locations
- Destroy habitats
- Analyze data
- Hold briefings with health department leaders
- Hold outreach and public meetings on the project

Labor

- 1 grant application completed
- 100 percent of project funds raised
- 1 university partnership developed
- Partner shows high satisfaction with roles and communications
- 1 free mobile app selected for data collection activities
- 30 volunteers from area schools recruited
- Volunteer groups show high satisfaction with recruitment process
- Training materials developed
- Volunteers show high satisfaction with training materials
- 4 training sessions held
- 30 volunteers trained
- Volunteers show high satisfaction with trainings
- 120 habitats and species identified correctly
- 120 habitats correctly destroyed
- 2 briefings held with health department leaders
- Health department leaders show more-positive attitudes toward citizen science than before
- 4 public meetings held

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, though, 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 for 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).
FIGURE 2.3
Levels of partnership engagement in a research project

SOURCES: Adapted from Environmental Protection Agency, Strengthening EPA Citizen Science Partnerships for Environmental Protection, Washington, D.C., 2018, Figure 5; also see International Association for Public Participation, “Public Participation Pillars,” undated.

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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<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 3

**Example Worksheet 3** provides guidance on filling out this worksheet using the mosquito-borne disease scenario. We first populated the table with stakeholders listed in Example Worksheets 1c and 2c. We then used the two stakeholder criteria to identify additional groups with interests in the research. The sample answers are provided as examples of how you might respond to each worksheet item. Red boxes indicate the groups that should be further explored as partners in your research effort.

### 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>
</tr>
</thead>
<tbody>
<tr>
<td>Federal agency</td>
<td>Built a relevant mobile app</td>
<td>Reduce disease</td>
<td>Help in using app; project advice</td>
<td>Time</td>
<td>Yes; perhaps in advisory role</td>
</tr>
<tr>
<td>Local high school</td>
<td>Mosquito identification is part of schoolwork</td>
<td>Increase education; reduce disease</td>
<td>Help recruit volunteers</td>
<td>Time; labor; funding</td>
<td>Yes; good source of knowledgeable volunteers</td>
</tr>
<tr>
<td>Other area schools</td>
<td>Mosquitoes are part of science curriculum</td>
<td>Increase education; reduce disease</td>
<td>Help recruit volunteers</td>
<td>Time; labor; funding</td>
<td>Yes; volunteers would need training</td>
</tr>
<tr>
<td>Local university</td>
<td>Did larvicide study</td>
<td>Reduce disease; more research 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>Did community study on mosquito protection strategies</td>
<td>Reduce disease; more research needed</td>
<td>Provide expertise</td>
<td>Funding; time</td>
<td>No; based on past experience</td>
</tr>
<tr>
<td>Local pest control service 1</td>
<td>Is a service provider; provides free education</td>
<td>Increase education; reduce disease; enhance business</td>
<td>Provide training, education</td>
<td>Funding; time</td>
<td>Maybe; small staff size may be a big constraint</td>
</tr>
<tr>
<td>Local pest control service 2</td>
<td>Is a service provider</td>
<td>Reduce disease; enhance business; nonprofessionals shouldn’t be involved</td>
<td>Provide training, education</td>
<td>Funding; time; labor</td>
<td>Maybe; should be consulted to ensure viewpoint is represented</td>
</tr>
<tr>
<td>Health care providers</td>
<td>Treat mosquito-borne diseases</td>
<td>Reduce disease; increase education</td>
<td>Provide education on health effects</td>
<td>Funding; time</td>
<td>No; already have these resources</td>
</tr>
<tr>
<td>Community members</td>
<td>Have been exposed to mosquito-borne disease</td>
<td>Reduce disease</td>
<td>Volunteer for project</td>
<td>Time; interests</td>
<td>Not applicable; will be source of volunteers</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 education is listed as an outcome and involving community members as volunteers is listed as an output, it is clear that educating the community is an important value for you. Therefore, you should ideally look for partners who would 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 (about project aims, design, methods, use of results, etc.). 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 2.6 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; cyano-Scope, 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 organization’s readiness is lacking will help you understand where to focus your energies.

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 or partners).

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>Item</th>
<th>Y</th>
<th>N</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>Item</th>
<th>Y</th>
<th>N</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>Item</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>
<td></td>
</tr>
</tbody>
</table>

#### Partnerships*

<table>
<thead>
<tr>
<th>Item</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>
<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>Item</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>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Volunteer management**

<table>
<thead>
<tr>
<th>Item</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>
</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>
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<td></td>
</tr>
</tbody>
</table>

#### Organizational support

<table>
<thead>
<tr>
<th>Item</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>
</tr>
<tr>
<td>Our organization will give us time to prepare and work on the project.</td>
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<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>
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</tbody>
</table>

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* Only relevant if your project requires outside partners.

** Only relevant if your project plans to use volunteers.
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, you are also building your organization’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 the health department has access to that you did not know about before, and you will become familiar with federal, state, and local legal and regulatory constraints surrounding budgets and use of volunteers.

In addition to knowledge about your health department, you may learn more about resources available in the community and good partnerships to pursue. Many health departments told us that they built networks with local universities, which became an established source of volunteers, or such volunteer organizations as the Red Cross and Team Rubicon. Other volunteer networks that health departments pursued or used for disasters were virtual operations support teams, amateur radio teams in the area, community emergency response teams (CERTs), and the Medical Reserve Corps. The Emergency System for Advance Registration of Volunteer Health Professionals also served as a resource for calling on health professional volunteers. Health departments reported using these volunteer networks for not just response operations but also data collection activities, such as CASPER surveys, damage assessments, and community health assessments. Even spontaneous volunteers, who typically show up during a disaster event, can be engaged in data collection activities, such as damage assessments, if health departments have just-in-time trainings already prepared.

In the end, disaster citizen science can be a force multiplier for health department activities around preparedness, response, and recovery. Putting the pieces in place for an individual project is the first step to identifying all the opportunities in your own department where a disaster citizen science element makes sense—and then to building greater capacity to pursue those opportunities as well. According to a health department disaster coordinator we interviewed,

> The beauty of citizen science is of course, numbers, we are limited in FTEs [full-time equivalents], so we’re able to get volunteer help to collect a lot more information. If I can train, I’m looking at it from a standpoint that it’s not just the citizen science project but the system that’s responding. We can train them and utilize them to do damage assessment or surveys. We can pair them with a county or a city worker and it just increases the availability and number and the geographical area we can cover. If we can get individuals that are GIS knowledgeable, again that helps us because they can take over some of the mapping and some of the electronic information that we give them. To me, citizen science would be adding extra hands and feet to a job that needs to be done.
**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 detailed action steps that clarify otherwise complex tasks, milestones, and goals. The plan helps ensure 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>
<td></td>
<td></td>
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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.

Building the pieces to your disaster citizen science project has benefits beyond just the individual project. By developing or tapping into resources; strengthening partnerships, networks, and a volunteer base; and enhancing skill sets prior to a disaster, you are building the capacity and capability to operate quickly when a disaster hits. For example, we previously described the Planetary Response Network and its army of digital volunteers who provide damage assessments in the immediate aftermath of an event (Zastrow, 2016). The Planetary Response Network now has the infrastructure, partnerships, and volunteer base in place so that, in the event of a future disaster, they can quickly gain access to satellite images, put a call out to volunteers, and share the images on the Zooniverse platform (https://www.zooniverse.org/). When planning disaster citizen science projects, in addition to contingency plans, health departments should similarly consider what elements of their projects could be leveraged for response activities in the event a disaster arises.

Health departments should consider, in particular, how to leverage existing volunteer networks, such as the Medical Reserve Corps, for both disaster citizen science projects and response operations. For example, the Lake County General Health District in Lake County, Ohio, engages its Medical Reserve Corps to assist with a range of environmental data collection activities in routine times. The Medical Reserve Corps, which is composed of medical and nonmedical volunteers, has collected data on tobacco use in college and outdoor environments, as well as pre- and postintervention data following a fall prevention program. One advantage to keeping volunteers active throughout the year on data collection tasks is that the network will be better able to ramp up or shift gears in the event of a disaster, since the volunteers are already active. This can be very beneficial for response, as described by a health department director we interviewed:
Those first couple hours of a disaster response are pretty chaotic, but I would say, when it’s all said and done, we gained a lot of information. I mean a ton of information out of utilizing that type of information-sharing system, so it was very beneficial. [If we didn’t have the volunteers,] we wouldn’t have been able to identify the scope of the disaster area, the amount of resources that were needed. We would have just been making resource decisions in the dark.

Box 2.7 provides another example of how having an infrastructure, partnerships, and an existing volunteer network in place can be used in important ways for disaster response.

**Developing a communication and dissemination strategy**

A state health department fellow we interviewed noted,

> Citizen science is about data collection, but actually I thought the biggest or equally important part of the project we did was that we spread awareness. . . . So, I think that would be really important to share with other health departments. . . . Use [citizen science] as a data collection tool, but also use it as a way to grow your relationships and to spread outreach.

To perform outreach and 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, should include details on data collection and analysis methods. Materials prepared for community groups or the general public might have a stronger emphasis on the benefits of the disaster citizen science project, including educational impacts, effects on community disaster preparedness, or the 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.

**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.

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**BOX 2.8**

**CASE STUDY IN DISSEMINATION**

How the LEO Network shares its observations

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 the 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 five especially common challenges that can pose a threat to project success and describe options for overcoming them.

**Challenge 1: Lack of support from health department 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 familiar with the concept of health department engagement in 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. They could worry that, if a citizen science project reveals a problem, it will be the health department’s responsibility to fix it.
- 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. Box 2.9 lists ten benefits of disaster citizen science that could serve as quick talking points to counter potential objections. The talking points are also available as a pullout in the appendix.
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 health departments. Use examples from this toolkit (see the appendix for a compiled list) or find others by networking with other health departments.

4. Find a way to incorporate citizen science into one of your organization’s existing activities. Explain why using a citizen science approach would be more efficient or 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 health departments engaged in citizen science activities. For late adopters, consider framing your citizen science activities as concrete solutions to distinct problems.
Ten benefits of disaster citizen science: A list of talking points

1. **Disaster citizen science can help us fulfill our mission.** By directly incorporating communities in research or data collection, disaster citizen science will help our health department fulfill many essential public health services.

2. **Disaster citizen science is flexible.** There are many different models of disaster citizen science—we can do crowdsourcing, conduct collaborative studies, or work with community members to receive their research. Therefore, we can find the model that works best for our health department.

3. **Disaster citizen science can increase efficiencies.** By directly incorporating a “wisdom of the crowd” approach, we can use disaster citizen science as a force multiplier for our department, allowing us to get more done with less.

4. **Disaster citizen science is feasible.** Disaster citizen science does not have to be a completely new activity—we could incorporate community groups in data collection efforts or services that we already provide as part of our mission. This includes community health assessments, CASPER surveys, or public health surveillance activities.

5. **Disaster citizen science can improve communications.** The right partnerships with the right community groups can help us in health department messaging. By engaging in disaster citizen science, whether for research or educational purposes, we create a volunteer **public health workforce** that can bring important messages back to the community and amplify our communications.

6. **Disaster citizen science can improve disaster response.** Investing in disaster citizen science may help augment our response capabilities during a disaster. Through trained community help, we could collect the types of urgently needed data that we can’t typically get in real time to help us understand community needs and impacts.

7. **Disaster citizen science can improve preparedness.** Investing in disaster citizen science may help augment our preparedness and surveillance capabilities ahead of disasters. As volunteers, community members would be part of the “public health workforce” and could expand the geographic scope of surveillance operations or depth of information we could collect on issues of public health importance. We could collect more data than we can today and be better prepared for future threats.

8. **Disaster citizen science is community engagement.** Disaster citizen science isn’t just about research; it’s also about community engagement and education. If leading or running robust, high-quality research is too big of a lift for us at this time, we could pursue citizen science activities as a creative, and potentially more effective, way to do public education on topics.

9. **Disaster citizen science may be unavoidable.** Even if we do nothing, disaster citizen science will be coming. Communities may take on more research and data collection efforts because they have access to technology and knowledge that make it possible. If we are not prepared to engage with them on their findings, we will lose community trust, as well as our reputation in the community.

10. **There is a growing community of health departments engaging in disaster citizen science.** There are many health departments across the United States currently engaging in disaster citizen science. We don’t have to reinvent the wheel. There are resources we can tap into through networking and approaches that we can adapt for our health department.
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.

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<th>How will the group respond?</th>
<th>What critiques might the group have?</th>
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You can add notes or your conclusions in the space below.
Challenge 2: Insufficient resources

Health departments are accustomed to operating with budget constraints and limited resources. It is not uncommon for health departments 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 health department 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, another 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, health departments can reduce the amount of time their 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.

In addition, health departments can consider partnering with private-sector or academic entities. Private-sector organizations can encourage their employees to volunteer, donate equipment, and provide resources, such as cloud services for data sharing and facilities for meetings. Academic organizations (including K–12 and all postsecondary institutions) can provide technical and other expertise (e.g., cultural competence, research translation) and can also be a source for volunteers.

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

BOX 2.10 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: Legal and regulatory barriers

As described earlier, in the section on addressing ethical and legal considerations, your health department might have difficulties ensuring compliance with HIPAA or could face limitations on how and whether you can use volunteers. You might also have difficulty obtaining IRB approval in a timely fashion or in ensuring that your health department is prepared if a volunteer is injured while conducting citizen science. Who owns citizen science data and who can access the data are also key issues.

So, what should you do?

It is very important to consult with your legal team prior to starting a disaster citizen science effort to ensure that you are complying with all applicable laws and regulations. Although you may get a list of restrictions on your activities, advanced planning can overcome many of these challenges. Health departments that are not permitted to engage community volunteers have sometimes managed to conduct disaster citizen science by using local government staff in other departments as “volunteer data collectors” or college students who receive course credit to support data collection.

As stated earlier, data policies (e.g., who owns the data, whether data can be reused, whether data will be made public) should be clarified in advance and described in a terms of agreement with volunteers. Health departments should also discuss and communicate how volunteers will be acknowledged for their work in research products that come out of the project.
**Challenge 4: Conflicts with partners**

In some cases, your health department might encounter difficulties in initiating or sustaining engagement with community-based organizations 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 prior history of engagement, cultural beliefs regarding certain practices or industries, or political conflicts between local, state, or national government agencies
- perceptions that health departments or other potential partners do not value community input or community-generated data
- perceptions that health departments or other potential partners have distinct incentives or are not accountable to community stakeholders
- concerns regarding the 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 community members and other partners to better understand current sentiments about participating in disaster citizen science projects. A similar approach might be used to address perceptions that the health department or others in a partnership do not value community input or community-generated data. To address perceptions regarding misaligned incentives, accountability, or data ownership and reporting, your health department should clearly articulate its motivation for engaging in citizen science, demonstrate areas of overlap between your mission and those of potential partners, and explain how data collected from volunteers will be used. But make sure that such efforts involve two-way communication with partners. The health department needs to understand their motivations and concerns and to seek opportunities for common solutions.

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 5: 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 they would trust 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. However, there are many examples of scientifically rigorous and robust citizen science projects that belie these claims. To address these negative perceptions, health departments 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 health departments developing a new project, it may be helpful to reach out to other 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, a variety of strategies 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.

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

**BOX 2.11**
**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: health department representatives, community organization leaders, citizen scientists, academic researchers, technology developers, other 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 health department 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 your resources on technology, equipment, and training. 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 toward the management of volunteers, and we had 500 of them!

- **Be honest about the limitations of your data, and consider alternative explanations for findings.** To increase the likelihood that decisionmakers within or outside the health department 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?

Responding to collegial citizen science projects

So far, this toolkit has focused on how health departments can design and lead disaster citizen science projects. We have discussed how to engage and sustain interest among community volunteers, what roles they might play in data collection and other aspects of the research, and how you can address challenges that might arise along the way. In these discussions, we have assumed that the health department is playing an active role in setting up and implementing the disaster citizen science project. But what if your health department learns about or is asked to respond to a disaster citizen science project led by members of the public, either individually or as a group? Recall that in Chapter 1 we discussed how collegial citizen science activities are controlled and led by community groups or members, either wholly independently or in partnership with others (e.g., government agencies, research institutions).

You might hear about data generated by such an activity or be asked to comment on the validity or the data collected. Your health department might be the direct recipient of the data and asked, “What are you going to do about it?” In many cases, your health department might not have any prior knowledge that a community group is conducting research until the data arrive at your health department or are reported by the media, another citizen, or some other entity.

Many health departments across the United States already have experience with concerned individuals presenting data on such issues as potential cancer clusters. Often, members of the public believe that cancer cases they have observed are associated with some environmental exposure (e.g., proximity to a nuclear power plant or oil spill). Individuals might approach the health department with their own data on cancer rates, requesting that some action be taken. They might ask the health department to launch its own investigation, partner on additional data collection activities, or reduce certain environmental exposures. Box 2.12 presents an example of local government responding to community-generated data. Is your health department prepared to answer such requests? And as citizen science grows in sophistication, is your health department prepared to not just respond to collegial citizen science activities but also engage and move it forward? As a senior analyst at a local health department remarked:

I’m thinking of citizen science as a way to identify new research questions. That’s something that I would really be excited to see come out... As these outside groups mature in their data understanding, I really want [these groups] to force us to think about things in a new way... And frankly to push us into a new paradigm.
This section aims to help you become better prepared for collegial citizen science, whatever your health department’s current level of readiness.

**BOX 2.12**

**CASE STUDY IN RESPONDING TO COLLEGIAL CITIZEN SCIENCE**

Community-generated data and government action in the wake of the Aliso Canyon gas leak

In October 2015, a leak in the Southern California Gas Company’s underground natural gas storage led residents of Porter Ranch—a neighborhood in Los Angeles—to issue complaints about odor and health problems, such as headaches, nosebleeds, and respiratory issues. Residents were assured by representatives of the gas company, who were conducting the air sampling, and initially by some government officials that the leak was not resulting in contamination of the air in amounts sufficient to cause residents any serious harm. However, residents were not convinced and set out to develop an evidence base through environmental monitoring and medical data. One influential source of information was an infrared video shot by a team of Environmental Defense Fund members that depicted the movement of the gas toward the Porter Ranch community. Soon after the video went public, the various government agencies with jurisdiction collaborated on implementation of the Expanded Air Monitoring Plan, which significantly increased the extent of air monitoring. In 2018, the Southern California Gas Company settled with the state and local government for $119.5 million—$25 million of which were allocated for a longitudinal study on the health impacts of the leak. The study was supported by a community advisory group.

For more information, see Michanowicz, 2018.

**Health departments should have a plan for responding to collegial citizen science projects**

Health departments have many options for how to respond if approached by citizen scientists about the results of a project they are engaging in. In some cases, your department might simply acknowledge any information or data presented and thank individuals for their efforts. Alternatively, you could leverage the health department’s own internal data sources to further investigate the issue of concern to the citizen scientists, launch an independent data collection effort to triangulate findings, or partner with the public to collect additional data. Given the range of possible responses, having plans and procedures for responding to collegial projects—whether on cancer, health symptoms, water testing, air-quality testing, or some other issue—is critical.

There are also many potential benefits of having a plan in place.

- **Preparation now will save time and effort later.** Given already high rates of smartphone ownership and growing familiarity
with data collection tools, community-led data collection will become increasingly common. More than 80 percent of all U.S. adults already own a smartphone (Pew Research Center, 2019). People are becoming more familiar with collegial citizen science data collection efforts. The issue, then, is not so much whether your health department will be asked to comment on or respond to a collegial project but when that will happen. Preparation allows you to understand your options in advance so that you can respond thoughtfully but also in a timely fashion.

- **Planning supports the health department’s relationship with the public.** A lack of planning can result in a poor or insufficient response to individuals’ health and environmental concerns, with potentially serious consequences for the health department. Individuals who report their self-collected data to the health department typically feel that there is an issue that needs to be addressed, which is why they collected the data in the first place. Furthermore, some collegial citizen science efforts begin because individuals do not trust that anyone else is willing or able to collect the data. If a health department responds to information about a collegial project in a way that is perceived to be inadequate, the public might feel that the health department does not care, damaging the department’s reputation and undermining trust in the government. Community groups that are not satisfied or do not feel heard may alert the media to draw additional attention to their cause. On the other hand, careful planning can help the health department build trust with the community and allows the best approach for responding to be chosen.

- **Community-generated data can be extremely useful.** If managed correctly through planning, the data generated from collegial citizen science projects can be helpful to your health department. The data can help to validate other data sources, alert the health department to community priorities and needs, and inform decisionmaking. Collegial projects can have all the same benefits we described earlier for health department–led projects.

Key questions that health departments should consider in planning include the following:

- What types of data are members of the public likely to present to you?
- Who has the jurisdiction over these issues of concern to the citizen scientists? Is it the health department or some other entity?
- What is the process of opening up an investigation? Who is responsible for making the decision to investigate? If you don’t choose to investigate a matter further, how do you communicate that to the public?
- What resources would you bring to an investigation?
Anticipating challenges with collegial citizen science

Health departments can confront multiple challenges in working with members of the public who have generated their own data and then approach the health department for help. Some of these challenges are similar to ones you might encounter in relation to a health department-led project. Planning should acknowledge and address these and other relevant challenges.

Partnership development

Although there are many unique challenges in working with citizen scientists in the context of disaster, there are also some standard challenges associated with community engagement and partnership development more broadly, regardless of the application. For example, deciding how and when to work together, establishing trust, and maintaining relationships are time-consuming and labor-intensive. These challenges can be intensified if a community group appears suddenly and the health department has not previously cultivated a relationship with that group. Resources and guidance are available to health departments on how to assess readiness to partner and on how to foster partnerships. We showed several resources in Table 2.2 in step 3.

Conflict management

Members of the public may present data to advocate for a specific policy change or action. The health department and the public might not agree on the process for investigating the issue or the appropriate response. Planning should acknowledge that such differences can occur and should identify options for mitigating conflict. Some effective strategies are asking for input early on and communicating frequently and in different formats (e.g., via townhall meetings, webinars, in-person meetings).

Misalignment of scientific literacy

Members of the public might not approach science and data collection the same way as health department staff and might not share a common understanding of statistics (e.g., understanding that cancer cases can sometimes be elevated in a particular community by chance) or of the need for robust documentation of data collection practices. Health department staff can prepare resources that community groups can use to learn about these key scientific concepts. It is also important for health departments to set expectations for how they will work with and interpret data generated by collegial citizen science projects, especially those working without input from scientifically rigorous institutions.

SURVEY FINDINGS

According to our survey responses, there were three main reasons for health department involvement with collegial citizen science projects:

- **65%**
  - Collegial citizen science efforts required the agency to respond.
- **39%**
  - The problem(s) had high visibility in the media.
- **32%**
  - Collegial citizen science was the best way to achieve trust and buy-in of the results.

Health departments reported using information resulting from collegial citizen science efforts in a variety of ways, including:

- **55%**
  - Informing the public
- **52%**
  - Providing education or educational materials
- **42%**
  - Supporting community needs assessments
- **42%**
  - Building or strengthening partnerships
- **42%**
  - Setting organizational priorities

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- **42%**
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- **42%**
  - Setting organizational priorities
Legal and ethical issues

Members of the public might not understand the legal and regulatory environment in which health departments must operate. They might not be aware of rules and protocols health departments are required to follow to safeguard the privacy and confidentiality of research subjects and the safety of volunteers. Health department staff can prepare resources to educate community groups about these and other legal and ethical issues, which can limit the health department’s ability to quickly integrate and respond to collegial citizen science data collection efforts.
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 ten 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 five common challenges faced by disaster citizen science projects?

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

• Why should health departments plan for collegial citizen science efforts?

• What challenges do health departments face in responding to collegial citizen science projects?

• How should health departments prepare for citizen science efforts led by members of the public?
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 health departments, there are now opportunities to augment data collection efforts through community participation, pursue more-collaborative types of research projects, and work together with communities on reviewing, interpreting, and responding to needs. Contributory, collaborative, and collegial citizen science models of research all have their strengths and together present numerous ways health departments and their communities can approach scientific research for disasters.

This toolkit aimed to provide an overview of disaster citizen science, as well as guidance for health departments 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 and working with collegial citizen science projects in particular.

We hope that the information in the toolkit will help you determine the role your health department might play in the world of disaster research. When it comes to making decisions that prepare and protect communities from harm, the voices of health departments and others on the front lines are needed most. 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

**amateur radio teams**: groups that use designated radio frequencies for noncommercial communication purposes. During disasters, amateur radio can still be used for emergency communications when conventional systems (e.g., landlines, smartphones) fail. Amateur radio operators can volunteer to help with the coordination and communication of messages.

**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.

**Community Assessment for Public Health Emergency Response (CASPER)**: a quick method for collecting household-level data to help public health authorities take action, such as addressing disasters

**community emergency response team (CERT)**: a program in which volunteers are educated about disaster preparedness and trained in basic skills (e.g., search and rescue, medical operations, fire safety)

**community health assessment**: an examination of key health needs for a population and problems undertaken at the state, tribal, local, or territorial levels. The assessment is conducted through comprehensive data collection and analysis.

**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

**Emergency System for Advance Registration of Volunteer Health Professionals (ESAR-VHP)**: a federally supported network of state-based registries for health professionals interested in volunteering during disasters and public health emergencies. The program verifies health professionals’ licenses and credentials ahead of disaster events.

**fitness-for-use**: the degree to which data are suitable for a particular purpose. Data should have the appropriate level of quality for their 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.
**just-in-time trainings:** trainings that are conducted to impart knowledge and skills to volunteers only when needed (at the time of the disaster event) and not ahead of time

**local health department:** municipal government agencies responsible for administering public health services

**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.

**Medical Reserve Corps:** a national network of volunteers, consisting of medical and health professionals and individuals without health care backgrounds

**National Association of County and City Health Officials (NACCHO):** an organization representing officials from nearly 3,000 local health departments in the United States

**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

**Virtual Operations Support Teams (VOST):** a network of emergency managers and volunteers who provide virtual support by helping process the large volumes of data generated by a disaster that may be overwhelming to disaster response teams
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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.

<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>
</table>

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?  Yes  No

Does the study need data collected from the environment?  Yes  No

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

- Observations
- Sensor
- Physical collection

Methods: observation, sensor, and/or physical collection design

Does the study need control over participants (e.g., careful selection, defined population)?  Yes  No

Does the study need a large number of participants or data points (>100)?  Yes  No

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 to dive deeply into topics?  Yes  No

Methods: survey or mapping designs; collects visual, text, and/or geographic data
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>
</tr>
</thead>
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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>Criteria</th>
<th>Y</th>
<th>N</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>
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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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</tbody>
</table>

### Project leadership

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Y</th>
<th>N</th>
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</thead>
<tbody>
<tr>
<td>We have identified project leaders who will take ownership of the effort.</td>
<td></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>
<td>Project leaders are, or will be, involved in all planning steps.</td>
<td></td>
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</tr>
</tbody>
</table>

### Resources and administration

<table>
<thead>
<tr>
<th>Criteria</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>
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<tr>
<td>Plans are in place to obtain all resources necessary for the project.</td>
<td></td>
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<tr>
<td>We have obtained all resources necessary for the project.</td>
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<tr>
<td>We have the capacity to obtain materials, labor, and other resources quickly if needed.</td>
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### Partnerships*

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Y</th>
<th>N</th>
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<tbody>
<tr>
<td>We have a thorough understanding of important challenges we might face in developing and maintaining partnerships for the project.</td>
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<tr>
<td>Plans are in place to establish all partnerships necessary for the project.</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>Criteria</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>
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</tr>
<tr>
<td>We have a thorough understanding of the ethical and legal issues facing our project.</td>
<td></td>
<td></td>
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<tr>
<td>We have plans in place to deal with ethical and legal issues facing our project.</td>
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</table>

### Volunteer management**

<table>
<thead>
<tr>
<th>Criteria</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>
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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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</table>

### Organizational support

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

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* Only relevant if your project requires outside partners.
** Only relevant if your project plans to use volunteers.
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>
<tr>
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</tbody>
</table>

You can add notes or your conclusions in the space below.
Ten Benefits of Disaster Citizen Science

Talking Points

1. **Disaster citizen science can help us fulfill our mission.** By directly incorporating communities in research or data collection, disaster citizen science will help our health department fulfill many essential public health services.

2. **Disaster citizen science is flexible.** There are many different models of disaster citizen science—we can do crowdsourcing, conduct collaborative studies, or work with community members to receive their research. Therefore, we can find the model that works best for our health department.

3. **Disaster citizen science can increase efficiencies.** By directly incorporating a “wisdom of the crowd” approach, we can use disaster citizen science as a force multiplier for our department, allowing us to get more done with less.

4. **Disaster citizen science is feasible.** Disaster citizen science does not have to be a completely new activity—we could incorporate community groups in data collection efforts or services that we already provide as part of our mission. This includes community health assessments, CASPER surveys, or public health surveillance activities.

5. **Disaster citizen science can improve communications.** The right partnerships with the right community groups can help us in health department messaging. By engaging in disaster citizen science, whether for research or educational purposes, we create a volunteer “public health workforce” that can bring important messages back to the community and amplify our communications.

6. **Disaster citizen science can improve disaster response.** Investing in disaster citizen science may help augment our response capabilities during a disaster. Through trained community help, we could collect the types of urgently needed data that we can’t typically get in real time to help us understand community needs and impacts.

7. **Disaster citizen science can improve preparedness.** Investing in disaster citizen science may help augment our preparedness and surveillance capabilities ahead of disasters. As volunteers, community members would be part of the “public health workforce” and could expand the geographic scope of surveillance operations or depth of information we could collect on issues of public health importance. We could collect more data than we can today and be better prepared for future threats.

8. **Disaster citizen science is community engagement.** Disaster citizen science isn’t just about research; it’s also about community engagement and education. If leading or running robust, high-quality research is too big of a lift for us at this time, we could pursue citizen
science activities as a creative, and potentially more effective, way to do public education on topics.

9. **Disaster citizen science may be unavoidable.** Even if we do nothing, disaster citizen science will be coming. Communities may take on more research and data collection efforts because they have access to technology and knowledge that make those efforts possible. If we are not prepared to engage with communities on their findings, we will lose community trust, as well as our reputation in the community.

10. **There is a growing community of health departments engaging in disaster citizen science.** There are many health departments across the United States currently engaging in disaster citizen science. We don’t have to reinvent the wheel. There are resources we can tap into through networking and approaches that we can adapt for our health department.
Compilation of Disaster Citizen Science Projects Described in the Toolkit

Altogether, there are 48 disaster citizen science projects mentioned in the toolkit (contributory projects = 21; collaborative projects = 14; collegial projects = 13). In Table A.1, we organize the projects by model and disaster and provide the page numbers where the project is referenced. Note that this list does not include examples provided to us by the health department survey.

**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>19</td>
<td>A crowdsourced 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 <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>19</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 <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>20</td>
<td>A crowdsourced 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 <a href="https://www.covidnearyou.org/#/">https://www.covidnearyou.org/#/</a></td>
</tr>
<tr>
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<tr>
<td>CoronaReport</td>
<td>Contributory</td>
<td>Infectious disease</td>
<td>20</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. <a href="https://www.coronareport.global">https://www.coronareport.global</a></td>
</tr>
<tr>
<td>COVID-19 Citizen Science</td>
<td>Contributory</td>
<td>Infectious disease</td>
<td>20</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 agreed to, provide location data to assist in analyzing disease spread. <a href="https://covid19.eurekaplatform.org/">https://covid19.eurekaplatform.org/</a></td>
</tr>
<tr>
<td>Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS)</td>
<td>Contributory</td>
<td>Severe weather</td>
<td>19</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>19</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>66</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>87</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>
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<tr>
<td>bloomWatch</td>
<td>Contributory</td>
<td>Algal blooms</td>
<td>19, 66</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.</td>
</tr>
<tr>
<td>bloomWatch</td>
<td></td>
<td></td>
<td></td>
<td><a href="https://cyanos.org/bloomwatch/">https://cyanos.org/bloomwatch/</a></td>
</tr>
<tr>
<td>Measure the Muck</td>
<td>Contributory</td>
<td>Algal blooms</td>
<td>42</td>
<td>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.</td>
</tr>
<tr>
<td>Measure the Muck</td>
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<td></td>
<td></td>
<td>Old Dominion University, “Measure the Muck with Mulholland,” December 2018 (<a href="https://www.odu.edu/oeas/news/2018/12/measure_the_muck_wit">https://www.odu.edu/oeas/news/2018/12/measure_the_muck_wit</a>).</td>
</tr>
<tr>
<td>cyanoScope</td>
<td>Contributory</td>
<td>Algal blooms</td>
<td>66</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.</td>
</tr>
<tr>
<td>cyanoScope</td>
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<td><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>66</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.</td>
</tr>
<tr>
<td>cyanoMonitoring</td>
<td></td>
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<td></td>
<td><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>13, 19</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</td>
</tr>
<tr>
<td>Did You Feel It?</td>
<td></td>
<td></td>
<td></td>
<td><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>42</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.</td>
</tr>
<tr>
<td>MyShake</td>
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<td><a href="https://myshake.berkeley.edu/">https://myshake.berkeley.edu/</a></td>
</tr>
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<tr>
<td>Landslide Reporter</td>
<td>Contributory</td>
<td>Landslides</td>
<td>19</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>
<tr>
<td>Patients Like Me</td>
<td>Collaborative</td>
<td>Infectious disease</td>
<td>20</td>
<td>A health network that helps connect individuals suffering from the same ailments. The site also 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. Patients Like Me, “COVID-19,” webpage, last updated May 30, 2020 (<a href="https://www.patientslikeme.com/conditions/COVID-19">https://www.patientslikeme.com/conditions/COVID-19</a>).</td>
</tr>
<tr>
<td>Codevid-19</td>
<td>Collaborative</td>
<td>Infectious disease</td>
<td>20</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>
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<tr>
<td>Foldit</td>
<td>Collaborative</td>
<td>Infectious disease</td>
<td>20</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>The Workers and Community Relief and Aid Project (RAP)</td>
<td>Collaborative</td>
<td>Hurricanes</td>
<td>17</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>
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<tr>
<td>iWitness Pollution Map</td>
<td>Collegial</td>
<td>Toxic release/contamination</td>
<td>13</td>
<td>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. <a href="http://map.labucketbrigade.org/">http://map.labucketbrigade.org/</a></td>
</tr>
<tr>
<td>Clean Air Coalition Tonawanda air study</td>
<td>Collegial</td>
<td>Toxic release/contamination</td>
<td>16</td>
<td>A project in Tonawanda, New York, in which community members organized to collect air samples that demonstrated harmful pollution levels from a nearby factory. <a href="https://csresources.org/">https://csresources.org/</a> <a href="https://www.cacwny.org/">https://www.cacwny.org/</a></td>
</tr>
<tr>
<td>Surfrider Foundation's Blue Water Task Force</td>
<td>Collegial</td>
<td>Toxic release/contamination</td>
<td>16</td>
<td>A national network of volunteers who perform water-quality testing of recreational waters in communities across the United States. <a href="https://www.surfrider.org/programs/blue-water-task-force">https://www.surfrider.org/programs/blue-water-task-force</a></td>
</tr>
<tr>
<td>Safecast</td>
<td>Collegial</td>
<td>Toxic release/contamination</td>
<td>16</td>
<td>An initiative started after the Fukushima Daiichi nuclear disaster that collects radiation measurements from volunteers worldwide and makes open data sets available. <a href="https://safecast.org/">https://safecast.org/</a></td>
</tr>
<tr>
<td>Public Lab and community-based environmental monitoring</td>
<td>Collegial</td>
<td>Toxic release/contamination</td>
<td>17</td>
<td>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. <a href="https://publiclab.org/">https://publiclab.org/</a></td>
</tr>
<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>41</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. Dan Copp, “Citizen Scientists Monitor Soil Conditions,” <em>Houma Today</em>, October 6, 2016 (<a href="https://www.houmatoday.com/news/20181006/citizen-scientists-monitor-soil-conditions">https://www.houmatoday.com/news/20181006/citizen-scientists-monitor-soil-conditions</a>).</td>
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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 health departments on engaging with disaster citizen science to support public health preparedness. Regardless of the specific disaster problem, or the size or scope of the intended project, the toolkit explains how to carry out a study that results in quality data. Ultimately, this toolkit should help health departments design and implement disaster citizen science projects and identify resources to support activities.