Connecting Grassroots and Government for Disaster Response

by John Crowley

Wilson Center COMMONS LAB

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COMMONS LAB

The Commons Lab advances research and non-partisan policy analysis on emerging technologies that facilitate collaborative, science-based and citizen-driven decision-making. New tools like social media and crowdsourcing methods are empowering average people to monitor their environment, collectively generate actionable scientific data, and support disaster response.

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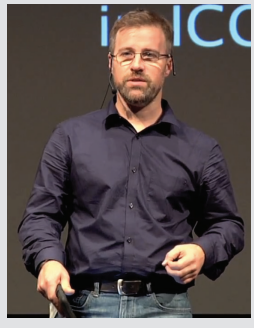

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Dedicated to the citizens of
Newtown, Connecticut:

my hometown
whose educators and first responders
taught us a love of community,
introduced us to the joys of public service, and
filled our hearts with the courage to
make great sacrifices to
protect that which is most dear.

And to the citizens of my adopted home,
Boston, Massachusetts:

who stand as one
in times of great need.

Contents

Preface

Connecting Grassroots and Government for Disaster Response is a testament to the vision of the staffs at the Woodrow Wilson International Center and the Alfred P. Sloan Foundation, who decided to study the best ways to address an emerging problem in disaster response. After Hurricane Katrina, it is no longer acceptable to think of response operations as the domain of governments alone. Communities have always performed most of the actions on the ground. However, these efforts are often poorly coordinated, both within community activities and with government-led operations. Communication technologies—from social media to crisis mapping—have improved coordination at the citizen-to-citizen level for several years. They are just beginning to affect the interface of grassroots efforts and government. This report examines the connections that forward-looking agencies are establishing, setting them out as exemplars of change.

The interface between the two communities—grassroots organizations, such as the Humanitarian OpenStreetMap Team (HOT) and the Standby Volunteer Task Force (SBTF), and U.S. federal agencies—is changing rapidly. Both the earthquake in Haiti and Hurricane Sandy catalyzed efforts by federal agencies to connect into the whole of community response. As a result, I am writing a dynamic document: a text meant to be edited like a wiki, rather than consulted as a static brick that one scholar has added to a growing wall of knowledge.

With the Wilson Center, I will build a wiki to edit the core toolkits and examine policy issues. I will also drive the development of a comprehensive map via workshops at the Wilson Center and other venues, such as the humanitarian experiments at Camp Roberts[1] under the Naval Postgraduate School and the National Defense University's Center for Technology and National Security Policy, the International Conference of Crisis Mappers (ICCM), and the Open Humanitarian Initiative under NetHope.

This report does not claim to be a new version of Disaster Relief 2.0 (the so-called 2.1 version), but rather a 0.1 version of an interface between the grassroots and the government around crises. Like most version 0.1 software, its aim is to provide a framework for

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further work by many others. I hope that experts can expand my thinking and correct my errors early in the process. With luck, this paper will outline a framework that can shape these efforts, without locking agencies into a single approach, especially amid rapidly evolving legal and policy opinions about engaging with the grassroots. It is my hope that technologists, legal advocates, and senior policy makers will create a partnership to explore what can be done when collective intelligence comes together for disaster response.

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Introduction

Leaders in disaster response are finding it necessary to adapt to a new reality. Although community actions have always been the core of the recovery process, collective action from the grassroots has changed response operations in ways that few would have predicted. Using new tools that interconnect over expanding mobile networks, citizens can exchange information via maps and social media, then mobilize thousands of people to collect, analyze, and act on that information. Sometimes, community-sourced intelligence may be fresher and more accurate than the information given to the responders who provide aid.

Federal agencies have noticed this newfound capacity. Over the past two years, a series of events caused several agencies to explore ways to engage citizen-driven efforts and fashion the citizens into new partners in agency response operations. This work began in Haiti, when—for the first time—crowdsourced datasets became the foundation on which the United Nations (U.N.) and U.S. federal agencies planned their response operations. Over the three weeks following the 2010 earthquake, 640 volunteer mappers from OpenStreetMap traced high-resolution satellite imagery released by Digital Globe and GeoEye (see figure 1) They made 1.2 million edits to the map in less time than it would have taken an agency to solicit bids from vendors. This effort built a free and open atlas of roads and critical infrastructure that is among the most detailed digital maps in the world. The U.N. used these data to build its maps, and the United States soon followed (albeit with some caveats). In addition, SMS-based initiatives[1] collected, translated, and mapped (geo-located) more than 90,000 text messages from Haitian citizens and made them available in various formats for responders and urban search and rescue teams. They also broadcast more than 600,000 messages back to the affected population.[2]

Figure 1: OpenStreetMap map of Port-au-Prince, Haiti. © 2012 OpenStreetMap contributors. Used under CC-BY-SA. Available at: http://www.openstreetmap.org/copyright.

After the Deepwater Horizon Oil Spill in May 2010, federal agencies missed an opportunity. Most imagery was available only at coarse resolutions (1m to 250m). The Public Laboratory for Open Technology and Science (PLOTS) organized volunteers to take 3cm resolution balloon images of beaches affected by the spill. In 36 sorties over 7 weeks, volunteers collected 11,000 photographs. By reference, experts can use 15cm imagery to identify individual species of plants and animals. To the knowledge of PLOTS, none of its data were integrated into the federal response operation.*

Figure 2: Balloon imagery from southern Chandeleur Islands, Louisiana, collected by the Public Laboratory for Open Technology and Science and LA Bucket Brigade after the Deepwater Horizon Oil Spill, on May 9, 2010. Used under CC-BY 3.0 license. Available at http://publiclab.org/notes/gonzoearth/5-23-2011/chandeleur-islands-louisiana.

* Jeffrey Yoo Warren, Grassroots Mapping: tools for participatory and activist cartography, MS Thesis (Massachusetts Institute of Technology, 2010): 69-74, available at http://unterbahn.com/thesis/. See also, Public Laboratory for Open Technology and Science archive page on the efforts during the Deepwater Horizon Oil Spill, http://publiclab.org/wiki/gulf-coast.

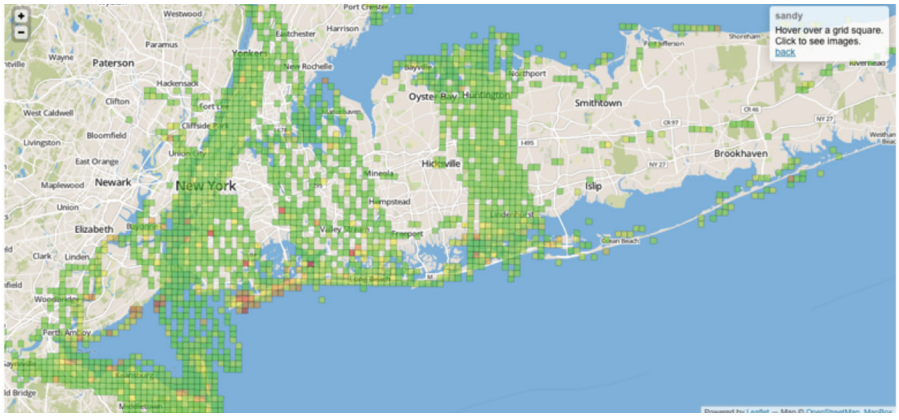

Figure 3: MapMill analysis of damaged areas around New York City after Superstorm Sandy 2012.

In 2012, when Superstorm Sandy hit the East Coast of the United States, 6,717 volunteers analyzed more than 35,535 photographs, completing more than half of that work in 48 hours (see figure 3). The analysis combined with several other geospatial advances, which together accelerated FEMA's response operation by several days over previous methods. In a time when budget cuts are accompanying increased expectations from American citizens around disaster response capabilities, this surge in capacity is difficult for federal agencies to ignore.

In reaction to the challenges of these operations, several grassroots technology initiatives transformed into stable organizations that now provide services to governments during crises. Some analyze imagery and build maps. Some develop modular structures to translate, categorize, and summarize social media and reports from the general populace over mobile phones. Others engage experts to develop and deploy tools from citizen scientists and technologists for difficult challenges in disaster response. Each type has shown great promise for augmenting the capacity of federal agencies.

For all the potential power that would flow from strengthening these new forms of mutual aid, creating an interface between grassroots and government has raised numerous challenges. After studying efforts to connect the grassroots and government at the Departments of State, Defense, Health and Human Services, Homeland Security, and Interior, the major issues can be distilled to two questions. First, under what authority can government personnel create workflows with grassroots communities that apply techniques like crowdsourcing, participatory mapping, and other approaches that build information resources from the bottom up (i.e., socially constructed

knowledge)? Second, what controls must be put in place within any such workflow to ensure that the process itself stays within the law and the resulting data can be reliably delivered and trusted?

Based on research funded by the Commons Lab at the Woodrow Wilson International Center for Scholars, the answer to the question on authority is straightforward. *No law prohibits government engagement with grassroots technology organizations during disasters.* Several policies encourage agencies to pursue community-based activities—termed "whole of community" engagements—that increase national resilience. For example, the U.S. Agency for International Development/ Office of Transition Initiatives actively fosters these activities, including participatory mapping. Similarly, FEMA catalyzes these approaches to major disasters under Presidential Policy Directive 8.

The laws and policies studied for this report (outlined below) govern only the second question: how government agencies engage with grassroots communities. The question breaks down into several practical areas:

- How should agencies establish workflows with volunteers that create no expectation of payment and no overlap with duties already performed by government personnel (Anti-Deficiency Act)?
- Do the terms of service of underlying technical platforms expose agencies to financial liabilities that could (potentially) exceed their appropriations? What happens when a federal employee has contracting authority and agrees to open-ended indemnification clauses that have become common within the terms of service for most social media (Anti-Deficiency Act)?
- How should these processes deal with personally identifiable information (Privacy Act) and prevent disclosure of private information (Nondisclosure Act)?
- How can government personnel avoid creating undue burdens on citizens (Paperwork Reduction Act)? Can they work with OMB to seek formal exceptions to the law to cope with the exigencies of disasters and national crises?
- How should agencies ensure that data integrated adhere to the standards for quality, objectivity, utility, and integrity that citizens expect from government (Information Quality Act)?

Research indicates that several U.S. federal agencies have found answers to most of these questions and developed pilot projects establishing experimental interfaces with grassroots technology organizations. Although each pilot responded to a unique problem and emerged in the context of the agency's interpretation of law and policy, a pattern is emerging. Although the development of this grassroots to government interface happened iteratively—without a master plan pursued via linear steps—agency efforts generally unfolded in four phases:

1. **Design:** *A process to scope the legal and policy questions, define tasks, and determine why, by whom, and how the tasks are to be done.* This established the goals of the pilot, clarified the roles of the agency and their partners, built a worknet, including legal and technical advisors, and created the holding environment for exploring legal, policy, and technology challenges.

2. **Experimentation:** *A process for the iterative exploration of options that inform the design, workflow, policy/legal framework, and choice of technologies.* Agencies created a shared laboratory space, which gave them and their partners a zone where they tried multiple approaches and failed—sometimes repeatedly—in a safe environment.

3. **Activation:** *The execution of an initial plan, including a plan for collecting metrics on system performance.* To learn how to apply experimental approaches in the real world (or simulation), the partners implemented their designs and gathered data about their performance. In this way, they were able to learn and measure their results without expectations of fully operational capability. Agencies were also able to refine (or reconceive) of their requirements in a pre-acquisition environment, before various obligations under the Federal Acquisition Regulations might have forced federal program managers to limit the amount of learning and alterations to the design that can happen.

4. **Learning/Evaluation:** A process for auditing the quality of data submitted from the crowd and integrating lessons learned. After activation, partners discovered that parts of their design needed alterations. They also found that they had the data to prove the merits of their approach to skeptical audiences and began advocating for the proposed design as a policy change.

The Design-Experiment-Activate-Learn (**DEAL**) framework is the lens through which this report will analyze three examples of crowdsourcing:

1. The U.S. Department of State Humanitarian Information Unit's pilot workflow with HOT and the National Geospatial-Intelligence Agency to catalyze remote mapping activities like those that took place during the first weeks of the Haiti earthquake operation[3]

2. An interface FEMA established with the Civil Air Patrol and HOT to provide damage assessment from photographs collected by aircraft after disasters[4]

3. The process that USAID created with the SBTF and GISCorps to 'munge'[5] geographic data on loan guarantees in developing nations.

Through this report, I aim to explore and provide approaches to the questions that commonly emerge when building an interface between grassroots to government. This report will also dive into the specific legal, policy, and technology questions that each team had to answer.

For all the potential power that would flow from strengthening these new forms of mutual aid, creating an interface between grassroots and government has raised numerous challenges...

Report Overview

Section 1 begins with context: what is crowdsourcing, and why is it useful? Why is it hard to mix crowdsourced data with authoritative government data? Section 2 explores how grassroots entities emerged and how they function. It also explores problems with engaging the crowd. Section 3 focuses on three short cases. Section 4 examines the DEAL framework by which agencies successfully established crowd engagement.

An online site will provide a space for a growing repository of case studies. It will be linkable from: http://CommonsLab.wilsoncenter.org.

Methodology

The research team used a mixed methods approach to this study. Based on requests from federal agencies and the Wilson Center's Commons Lab, we identified key stakeholders across a range of digital humanitarian organizations and federal agencies that work in disaster or crisis response and developed a set of questions to form the core points of discussion for qualitative research. Stakeholders were selected from three categories:

1. Digital humanitarian leaders

2. Federal agency experts in crowdsourcing and policy around their application to emergency operations.

3. Outside experts

Interviewers met with stakeholders in person or talked with them via Skype or telephone for 30 to 120 minutes. A set of eight research questions (see Appendix 1) formed the core of each interview. In some cases, researchers convened several stakeholders from a given agency or agency partnership for a larger group conversation. In cases where the interviewees agreed, interviews were recorded, and researchers then took notes from the audio. In all cases, the researchers took detailed notes.

Research on the grassroots to government interface also occurred through participatory observation at two venues. One such investigation took place

through an existing Joint Interagency Field Experimentation program, which is held each quarter by the Naval Postgraduate School and the National Defense University at Camp Roberts (Paso Robles, CA). This research focused on the intersection of policy, legal, and technical challenges around the collection, analysis, and application of information gathered from both unbounded and bounded crowds, where membership is limited to trained volunteers. The second occurred when the FEMA Innovation Team invited a small team of experts—including the author—to the response operation in New York to explore ways to connect federal agencies to grassroots operations, such as OccupySandy. In both cases, the author worked with the grassroots communities and the government to bring hidden issues to the surface and build frameworks to address them. The results of this research informed the research in this paper.

The research team developed this report over a period of eight months. In the process, federal agencies adapted their approaches to incorporate ever greater integration with digital humanitarian organizations, necessitating a round of edits and approvals of the final text with federal agencies so that this document (completed in July 2013) reflects current practice.

Defining the Context

1

The interconnectedness of societies is transforming disaster response. Billions of people have direct access to cellular phones and communications networks. Billions of networked devices participate in this ecosystem as automated intelligent agents. Via face-to-face relationships with other community members, millions have indirect access to messages. With this increase in scale, the cost of sending a message is approaching zero.[6]

During recent disasters, this social network has behaved like a central nervous system. Signals traversed wide areas, sometimes giving early warning to those beyond the immediate impact zone. This happened with the 2011 Virginia earthquake. Just as light from an exploding firework precedes the boom, a Twitter wave of memes[7] about the earthquake preceded the buckling of the earth's surface. Citizens in New York and Boston knew an earthquake was happening seconds before they felt any shaking, simply by glancing at the surge of messages (see figure 4).[8]

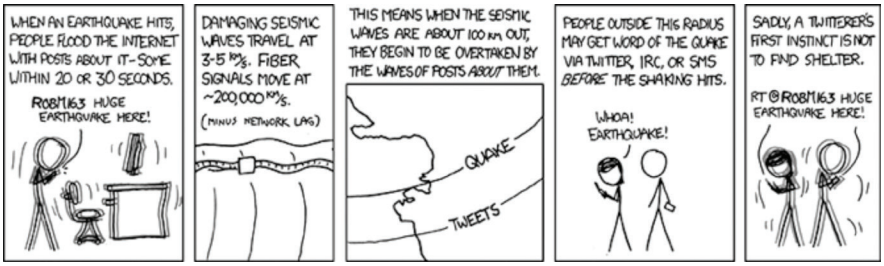

Figure 4. XKCD Seismic Waves. http://xkcd.com/723/. Used under the Creative Commons 2.5 Non-Commercial-Attribution License. See http://xkcd.com/license.html.

This phenomenon of citizens as sensors becomes more complicated once response operations begin. When organizations mobilize their personnel, all parties endeavor to make sense of the data available to determine *who needs what where and who is doing what where*. The grassroots and government efforts to make sense of Hurricane Sandy generated more than 20 million tweets, several terabytes of satellite and aircraft imagery, and an incalculable number of emails, SMS/text messages, and documents. For federal agencies, the task of aggregating, filtering, and interpreting such information streams is overwhelming. As communities participate more in response operations, the interpretation problem is going to get bigger. Much bigger.

Study after study shows that the stock of human information is expanding exponentially.[9] As Eric Schmidt of Google noted in 2010, we now produce as much data in 48 hours as did all of human civilization from the beginning of written history until 2003.[10] However fast this data creation may seem, this 'information velocity' is also accelerating. The doubling rate for today's level of data production is already less than three years, and that rate is increasing; in other words, the rate of information production in 2016 will be more than double what it is today, and the numbers in 2019 will be more than double those in 2016.[11] For disaster response agencies, these numbers should ring alarm bells. Disasters cause spikes of data production that may be orders of magnitude above baseline levels; the rate of information flow spikes as families track loved ones, coordinate household-level responses, and learn about the disaster. This phenomenon occurred at the time of the Japan earthquake, Hurricane Sandy, and (during editing of this paper) the Boston Marathon bombing.

Such spikes in information velocity are growing as the baseline rate of information flows also increases. Federal agencies already live in an information superstorm. If citizens' capacity to publish needs via multiple channels increases, the familiar approach of linearly scaling staff to process increase information flows will no longer be sufficient. Our capacity to process and contextualize information must scale[12] *exponentially*.

Federal agencies in the United States are not ready for the volume and increasing velocity of this flow, nor are international humanitarian institutions. Collecting, processing, and analyzing information requires staff to monitor hundreds of channels, many of which are compartmentalized by law, policy, or technology into silos that may not permit cross-correlation because of Privacy Act concerns or where the fusion[13] of information may cause political consequences. The management of such high information flows is beyond the capacity of federal agencies—even those with reserve staff, such as FEMA and the Department of State.

Setting aside traditional methods,[14] there have been two innovative approaches to addressing this challenge:

1. Teaching computers to make sense of the ways in which humans express ideas in crisis (augmenting

the capacity of humans to discern patterns)
2. Teaching humans how to work in new organizational designs that enable thousands of individuals to collaborate on aggregating, processing, and analyzing large streams of data[15]

The first approach—machine intelligence—uses technologies where algorithms help to discern signals from noise. Large U.S. agencies, including the Department of Defense and the intelligence community, as well as academic institutions, have used this "big data" strategy. Their projects ingest millions of messages from social media and text message services, and then extract memes, such as aid requests or changes to the perception of a situation (also called sentiment analysis).[16] This process often uses a "human in the loop" to correct and teach the machine how to discern patterns that are not semantically obvious. For example, several university teams collected social media during Hurricane Sandy and identified patterns of communication between federal agencies and the affected population; they then divided those dialogues into memes that summarized the general sentiment.

Unfortunately, humans make this approach complicated. Language is contextual. We are apt to retweet messages about people buried under rubble long after the building has been cleared. This causes a conflict between the big data analysts, who assert that the crowd is certain people are still buried there, and field personnel at the location, who know that all bodies have been recovered but lack the Internet communications or time to "close the loop" with the crowd via social media. The problem then gets pushed into a space where two or more bureaucratic hierachies must determine who is right. Such a conflict caused search and rescue teams in Haiti to clear the same building multiple times.

For federal agencies, another problem has emerged around big data: aggregating data about American citizens on a government-managed platform—one that correlates a citizen's personal expressions with other conversations—raises troubling privacy issues. Further, machine learning does not provide an opportunity to delegate the interpretation of data to citizens, nor does it allow citizens *in situ* a chance to offer mutual aid without the information flows first passing through many layers of government. As implemented by federal agencies, big data efforts tend to keep the information flow inside government and its contractors, inaccessible to citizens.[17] Thus, the second approach to information processing—collective intelligence—is taking on special currency.

A collective intelligence enables volunteers and paid crowds to work on open platforms to aggregate, process, and analyze large pools of information (e.g., Wikipedia). Their methods are divided primarily into two categories. They either separate a large stock of information into smaller pieces that individuals can analyze (the origin of "crowdsourcing"), or they aggregate a stream of data into larger stocks of information (sometimes into a market or a wiki). In some cases, they use a combination of both strategies.[18] The OpenStreetMap community's

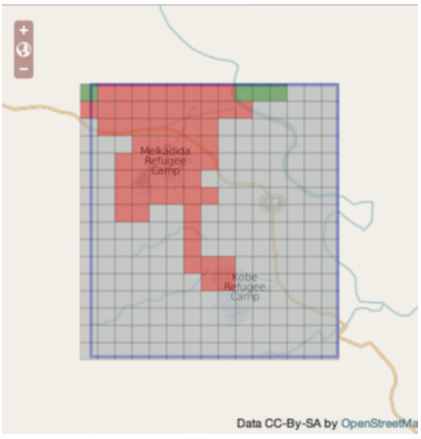

Figure 5: Humanitarian OpenStreetMap Team Tasking Server, showing division of an area into grid squares that can be checked out (red) and those that have been audited and cleared (green). © 2012 Humanitarian OpenStreetMap Team. Used under CC-BY-SA by OpenStreetMap. Source: task.hotosm.org. License is embedded in the image itself.

mapping of refugee camps in East Africa illustrates the fusion strategy. Approximately 40 individuals reviewed a grid of fresh satellite imagery, dividing the magnitude of the stock into smaller areas (see figure 5). Then, they used the OpenStreetMap software to add roads and structures to each grid square, creating a digital map of the camps around Somalia by adding a multitude of small edits together to create a whole picture.[19]

Collective intelligences do not emerge *ex nihilo*, without dependency on the existing resources; they require an organizational structure that provides coordination, determines methods and tools, and includes a mechanism for recruiting and mobilizing individuals. In crisis response, these structures take two forms: (1) communities of volunteers that associate and often incorporate for support and (2) corporate structures that mobilize large user bases to provide aid. Examples of the former include Crisis Commons, HOT, and the SBTF. Examples of the latter include Google MapMaker.

During recent disasters, these organizations have mobilized collective intelligences to coordinate and channel the energy of an interconnected society. They are providing 'information as aid' to responders and the affected population.[20] This new capacity—and the legal and policy challenges it raises—catalyzed this report.

Here is the rub: federal agencies have an easier time working with corporations that engage in collective intelligence than with communities that emerge from the grassroots. Like agencies, corporations have careful internal processes to vet data before publication. Agencies also have contracting mechanisms to ensure data quality and place liabilities onto the corporate contractor. However, corporations have weak incentives to work collaboratively; Google and Facebook compete both during an emergency and in between events.

During crises, grassroots organizations have significant advantages. They attract individuals with direct connections with the affected populations. Because grassroots organizations can mobilize and train eager volunteers, they can scale and process information at faster rates than most large corporations.[21] For those federal agencies, this speed is important. Agencies must quickly define the scope of their response to a sudden onset emergency and then decide how many zeroes will be assigned to

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their operations In this use case, rough answers on a fast timeline are often better than exact figures that are delivered after the crisis has moved into another stage. Federal agencies are not always optimized to provide rough estimates in hours or minutes. The rise of collective intelligences outside of government makes it possible to quickly process information and mobilize citizens to provide mutual aid (with caveats added about potential risks of verification of the data).

For all the power that grassroots organizations have demonstrated, their interface to U.S. federal agencies is still underdeveloped. These groups have experienced growing pains—some from lack of resources during the recent economic downturn, which occurred right at the time in their maturation when they were beginning to scale their operations.

Federal officials interviewed for this report raised many questions about how these groups work, what they do, and why they do it. The officials want to know how these groups make decisions and how a federal agency can invest in this capacity. They are curious about how these groups handle data aggregation within the federal bureaucracy.

The next two chapters provide an initial overview of the answers uncovered from a summer of research. They are inherently incomplete and therefore placed into the public discourse for editing and expansion by the community. The following report is intended to be placed into a wiki, so that practitioners can amend (and probably emend) the analysis and framework. We begin with a definition of the grassroots and how they work in Section 2, followed by an examination of three cases at the interface between these groups and federal agencies in Section 3.

Defining the Grassroots: Who They Are and What They Do

2

During our research, federal officials frequently asked, "Who are these volunteer technical communities, and why are they trying to provide services during disasters? Why should we trust the data?" This paper sketches out preliminary answers and offers basic frameworks on which these communities and future researchers can build.

The first step toward this end is to abandon two terms that have come into common use: "volunteer technical community" and its variant, "volunteer and technical community." Both have been used to describe the grassroots communities that emerged from crisis mapping activities. They appeared in 2010 after the Haiti crisis, when the movement was inchoate and appeared to be composed of volunteers using technologies inside online communities. It is now better understood that both terms have changed or were inaccurate to begin with.

Important leadership roles—"supernodes"[22] in a large network of contributors—are not always filled by volunteers, but instead are often filled by employees being paid by their respective employers to participate in a collective intelligence. Similar roles have long existed in the field of open-source software. These individuals take on leadership roles for a variety of reasons. Some test their tools and practices in crisis response, which is one of most unforgiving environments in the world for privacy, security, and austere communications (and therefore an ideal site for spurring innovation). Others engage to advance efforts at corporate social responsibility or other forms of giving. Many leaders of volunteer organizations have become paid professionals who earn part or all of their income running incorporated grassroots organizations.

The individual volunteers who participate in these efforts are not all technologists, nor are the grassroots organizations purely technical or limited to conducting their work via online/virtual communities. Most participants are, in fact, experts in other fields who happen to be adept at using crisis mapping tools, many of which are simple, familiar tools that are applied within a set of increasingly standardized practices (such as SMS/text messages and social media). These

grassroots organizations foster practical approaches that focus on relationship building, information analysis and fusion, rather than software development. Several organizations now send staff directly into affected communities to mentor members on collecting, analyzing, and curating community data.

Last, these groups may mobilize communities, but they are now generally incorporated entities with different expectations around their behavior, including governance and reporting requirements. They are more appropriately called organizations.

In late 2011, an association of these communities adopted the term d*igital humanitarians*, because their tools tend to be based on ideas that emerged during the digital revolution.[23] Today, most organizations work under this moniker and an umbrella called the *Digital Humanitarian* Network (DHN). However, the term digital humanitarian is also imperfect. Entities like HOT are not purely digital; they use a mix of handheld-and paper-based tools when they work from the field with affected communities. They are also not necessarily fully subscribed to humanitarian principles of impartiality, neutrality, and independence. These organizations are focused on working with collective intelligence to bring together affected communities, diasporas, and experts. However imperfect the term, digital humanitarian organizations (DHOs) is used here to reflect current practice.

Defining Digital Humanitarian Organizations

The DHOs studied harness collective intelligence to provide information as aid before, during, and after a crisis. Each DHO applies a mix of social technologies using an evolving set of practices shared by members. These practices often involve the use of open-source software, open data, and open interfaces. All the DHOs have adopted or are adopting ethical standards in codes of conduct. **Our working definition is:**

A DHO is a grassroots organization that mobilizes a large number of individuals that share a set of open tools, practices, and ethical standards to create a collective intelligence for providing information as aid.

An Abbreviated History of DHOs

Most DHOs evolved from networks of volunteers that collaborated to solve complex problems during previous emergencies. The first two—MapAction and GISCorps—mobilized seasoned geospatial professionals to provide mapping and analytical services to institutions learning how to leverage geographic information system (GIS) tools in the early 2000s. The evolution of these networks defined the organizational design of subsequent DHOs.

Based on the successes of these first DHOs and parallel work in disciplines such as crime mapping, Patrick Meier and Jen Ziemke convened a group of practitioners, academics, and corporate representatives to explore the

The Crisis Mappers network was the forum where international responders coordinated requirements with volunteer efforts of hundreds of organizations.

concept of crisis mapping. In October 2009, they hosted the first International Conference of Crisis Mappers, which brought together geospatial experts from the United Nations, the private sector, and the public sector, including multiple governments.[24] This meeting came at a pivotal moment. The relationships and ideas created a buzz throughout the late fall of 2009. When the Haiti earthquake hit on January 12, 2010, these relationships became a game-changing part of the response operation—a dynamic that is explored in the report, *Disaster Response 2.0*.

When dozens of international agencies were searching for images and maps of Haiti, the Crisis Mappers discussion list quickly catalyzed into a worknet—an organizational design that pools key experts across institutional boundaries. This network was the forum where international responders coordinated requirements with volunteer efforts of hundreds of organizations. These organizations included: companies like Digital Globe, GeoEye, Google, and ESRI; formal response organizations like the U.S. State Department, the U.S. Department of Defense's Joint Task Force for Haiti, UN OCHA; and a myriad of open-technology communities, including OpenStreetMap and Ushahidi.[25]

In the following months, Crisis Mappers responded to a string of major emergencies: Chile in February–March 2010, the Deepwater Horizon oil spill in April–May 2010, the Pakistan floods in July 2010, and the Haiti cholera outbreak in Oct 2010. As a result of the intensity and tempo of these activations, DHOs affiliated with Crisis Mappers found that they could not function solely as an informal worknet. Individuals had insufficient support from their organizations to keep self-activating. Some overstepped their mandates or job duties, and their ongoing, non-emergency projects suffered because of the time that they committed to disaster response. Others required a business model to continue work on crisis mapping. During this period, several DHOs began building formal organizational structures that could receive funding, sign contracts, and limit their members' liabilities.[26]

Today, the organizational structures of DHOs reflect this evolving dynamic. Some are communities that are co-

ordinated by corporations (Google MapMaker) or larger formal associations (e.g., GISCorps is under the Urban and Rural Information System Association). Others are fully incorporated independent nonprofit organizations (HOT, Humanity Road, Crisis Commons) or UK charitable organizations (MapAction). Some remain unincorporated voluntary associations (SBTFs). Groups in this last class of organization retain the strongest link to the idea from which they emerged: grassroots networks.[27] Although they retain a great deal of flexibility with as an informal association, they incur additional risks for volunteers. As Edward Robson noted in 2012, the actions of one 'bad apple' may expose volunteers to tort liabilities.[28]

Organizational Design

DHOs have four elements that enable them to perform their work:

1. **Communities.** They have the reputation and skills to mobilize individuals around an approach to building collective intelligence.

2. **Technologies.** They use a suite of hardware and software tools to facilitate their work.

3. **Practices.** They apply their tools within best practices that provide an organizational design for delivering information as aid.

4. **Ethics.** They ensure participants in collective intelligence work within shared values.

This paper examines each of these four elements so agency officials understand the basic structure of DHOs' work, their decision making processes, and their values. All are essential for building trust and creating an interface between DHOs and government.

Communities

Mobilizing collective intelligence requires an organizational design that harnesses low-cost communications to enable coordinated action.[30] Leaders must motivate experts to devote time (leadership), then mobilize them to use their skills appropriately and efficiently (management). When a federal agency interfaces with a DHO, DHO leadership and management need to be channeled to meet a given end, rather than treating it as a contracted service. As a result, interviewees emphasized the need for a statement of work to establish clear expectations between organizations and to give DHO leaders guidelines that they can provide their members.

A growing number of DHOs have come to occupy a special niche in an ecosystem. They each have a different design by which they coordinate their internal activities. The following short descriptions of the major players are derived from their own descriptions:

Humanity Road has a mission "to educate the public before, during and after disasters on how to survive, sustain and reunite with loved ones."[31] Humanity Road activates hours after a disaster, providing immediate information triage and categorization for later analysis. It has also deployed field teams to provide direct aid.

Box 1. Conflation of Technologies, Channels, and DHOs

Research revealed an important misunderstanding in many federal agencies: DHOs are often confused with the technologies that they deploy. Some DHOs are called by the name of the tools they use instead of by their organizational names. However, the Standby Volunteer Task Force is not Ushahidi. The Humanitarian OpenStreetMap Team is not OpenStreetMap. These are four separate organizations.[29] Large system integrators have perpetuated this confusion: it is far easier to sell a silver-bullet technology to the government than to build the combination of community, technology, and best practices that DHOs have created. However, without grassroots mobilization of collective intelligence, important elements are missing from the packages some companies are selling. Implementations of crowdsourcing *as a tool* will lack the best practices by which participants coordinate, build a shared understanding, and establish the ethical frameworks that keep the values of thousands of individuals aligned. Without these, technologies are only empty shells.

The **Standby Volunteer Task Force** (SBTF) endeavors "to provide live mapping support to humanitarian, human right, and media organizations."[32] It offers a range of services organized by specialty and managed by seasoned volunteer coordinators. It has an activation protocol that can deploy in the initial hours of a disaster and lasts up to 3 weeks into the response operation.

The **Humanitarian OpenStreetMap Team** (HOT) aims to coordinate the creation, production, and distribution of free mapping resources to support humanitarian relief efforts in many places around the world. It applies "the principles of open source and open data sharing towards humanitarian response and economic development.[33] HOT trains communities how to map (so-called community mapping) while also organizing a worldwide community of mappers to trace satellite imagery during emergencies (remote mapping).

GISCorps is one of the oldest DHOs, launched in 2003. It provides "short term volunteer GIS services to underserved communities worldwide both in post disaster, humanitarian relief, capacity building," and other services. It is an association of approximately 2,600 GIS professionals who donate their expertise to the betterment of underserved communities.

MapAction is another of the oldest DHOs in disaster response, with its first deployment in 2004. It is the only nongovernmental organization (NGO) that can deploy teams of GIS experts anywhere in the world in a matter of hours. MapAction is the official mapping support element of the United Nations OCHA. It is a U.K.-based charity.

Crisis Mappers is an "international community of experts, practitioners, policymakers, technologists, researchers, journalists, scholars, hackers, and skilled volunteers engaged at the intersection between humanitarian crises, technology, crowd-sourcing, and crisis mapping."[34] Crisis Mappers provided the forum by which many other DHOs, agencies, universities, NGOs, and corporations coordinated the exchange of imagery, maps, and operational data during recent emergencies. It is a network more than a DHO, but a critically important coordinating mechanism.

Several newer DHOs have emerged. The Public Laboratory for Open Technology and Science is developing remote sensing as a citizen science. DataKind provides experts in databases and data manipulation. Geeks without Bounds leverages experts in convening and incubating technology interventions. Translators without Borders mobilizes experts in translation. And Statisticians without Borders recruits experts in the application of statistical analysis to humanitarian problems. These organizations are worth further exploration by U.S. agencies. They are omitted from this report no for lack of merit, but only because there are no specific case studies around their work with U.S. federal agencies. This is an open opportunity for another researcher to dive more deeply into these communities.

Technologies

A growing number of platforms enable collective intelligences. Companies or nonprofit organizations generally support the development of the software, but it must be emphasized that these organizations support the underlying software—not deployments for disaster response operations. Although many such organizations have donated their time for special cases, large agencies assume that disaster response is their mission. It is not. Most exist to build the ecosystem around the software that drives social value, a revenue model (profit or nonprofit), or both. The platforms in common use are here divided into four categories: imagery, mapping, citizen reporting, and data aggregation and analysis.

Imagery. Many volunteer organizations have access to satellite and aerial imagery, and they have developed tools to collect imagery using various aerial and ground-based platforms. Given the challenge of making sense of so many pixels, groups have also developed tools to crowdsource analysis among thousands of volunteers. These include MapMill from the Public Laboratory for Open Technology and Science (PLOTS or Public Lab) and OpenAerialMap.

Mapping. The development of maps has traditionally been done by closed groups of surveyors and cartographers. With advancements in global positioning system (GPS) technologies, it is now

possible to use standard GPS units (and even some smart phones, albeit with less accuracy) to trace roads and map major points of interest. There are currently two platforms that dominate this market: OpenStreetMap and Google MapMaker.

Citizen Reporting. When citizens act as sensors, they generally submit text reports via text messages from their cellular phones or tweets via Twitter. Increasingly, they are using applications built for field data collection by open-source communities and corporations (both for-profit and nonprofit). There are a growing number of platforms in this area, but the most well-known are Ushahidi, FrontlineSMS, and Twitter, Fulcrum/PushPin, FormHub, Kobo Toolbox, and the Open Data Kit. These technologies are the ones most often conflated with the communities who deploy them. In specific, the Standby Task Force is not Ushahidi; they are two entirely different entities. However, the communities of technologists who build the software work in close collaboration with communities that mobilize a collective intelligence. DHOs are important users, though not the only users.

Data Aggregation and Analysis. Collating data from multiple sources into a common platform for analysis is fundamental to move sense making from a solitary activity on a desktop to a collective one on the Internet. Several applications facilitate this type of work, such as GeoIQ, ArcGIS Online, Google Crisis Map, Data.gov, Amazon Mechanical Turk, MapStory, Sahana, Crowdflower, and Idabon.

DHOs Are Not Social Media

It is critical to separate the *channels* of social media, the *techniques* of crowdsourcing, the *platforms* that enable those techniques, the *organizational structures* around DHOs, and the *actions* that they perform.

The term *social media* refers to several of the various *channels* through which citizens share reports from a crisis. These include short text messages (Twitter, Facebook), photos (Instagram/Facebook, Flickr), videos (YouTube, Vimeo), as well as fusions of all three (Facebook). Social media can be bounded or unbounded. Distribution can be limited to a social network that the user has defined, or distribution can be public. In the hands of a skilled organizer, social media can become a set of interlinked channels. A quote from an activist in Cairo from the Arab Spring provides insight: "We use Facebook to schedule the protests, Twitter to coordinate, and YouTube to tell the world."[35]

That said, social media represent only a subset of the total channels being used in collective intelligence. Others include wikis, which allow any authorized user to edit a common knowledgebase, as well as OpenStreetMap and Google MapMaker, which are essentially wikis for maps. In addition, traditional Web 2.0 interactive tools and the emerging set of Web 3.0 (Semantic Web) services like Web Mapping Service (WMS), Resource Description Framework (RDF), and other languages aim to create an ecosystem of humans and automata interacting on each other's behalf.

Practices

Separate from the channels over which information flows, *crowdsourcing* is the term more accurately used to describe a specific set of techniques within the realm of collective intelligence. Many of such techniques are detailed in the *Handbook of Collective Intelligence* from the MIT Center for Collective Intelligence.[36] The following are the most relevant to crisis mapping:

1. **Crowdsourcing:** Dividing larger tasks into smaller ones, each of which can be performed in a relatively short period of time.

2. **Wiki Development:** Building collective understanding through aggregation and collation of knowledge.

3. **Markets:** Aggregating information on complex problems (like pricing or logistics needs) through the exchange of data between many individuals. In this context, markets need not set pricing or lead to sales of items.

4. **Open Source:** Developing common understandings or code bases by the collective action of many, as with open-source software.

These techniques are then applied to *actions* performed by communities, which tend to fall into four areas:

1. **Data Collection** (markets and wikis): Citizens and their devices act as sensors, where submitted data may range from simple text reports to eye-level photos of a flood taken with a smartphone (and "geotagged" with the location). The U.S. Geological Survey (USGS) Did You Feel It? program, where citizens submit information about earthquakes is one example.[37] Another derives from the Louisiana Bucket Brigade, which partnered with the MIT-affiliated Public Laboratory for Open Technology and Science to take ultra-high resolution aerial photographs of the beaches around the Deepwater Horizon oil spill. They not only documented the initial damage, but also took periodic photographs to show the ongoing issues and absorption of oil into the ecosystem.

2. **Data Aggregation** (crowdsourcing, markets, wikis): In many cases, information about a disaster is spread across multiple data sources: Twitter, Facebook, Crowdmap, Google+, Flickr, YouTube, and (in several countries) proprietary or local websites. Of note to federal agencies, many local sites may perform their work in languages with non-Roman character sets or low-density languages. Mobilizing volunteers to aggregate and categorize these data is a time-consuming task that may require special language skills. For example, the SBTF aggregated and categorized social media reports from Libya on behalf of several U.N. agencies, allowing those agencies to see the emerging needs on the ground.

3. **Data Processing** (crowdsourcing): Once data have been aggregated, they often must be transformed into other formats or languages so that someone can make sense out of them. Sometimes this work is done through

traditional crowdsourcing. An organization breaks a large task into small tasks that can be done by individuals, and citizens perform those tasks, re-aggregating them into a processed dataset. The Mission 4636 Initiative, for example, translated Haitian Kreyol text messages into English. Also, HOT traced satellite imagery and turned those pixels into polygons on the map of Haiti.

4. **Analysis** (wikis, open source): Turning processed data into information that can be used to drive decision-making often requires analytical skills that extend far beyond those of the typical volunteer. These functions have included the fusion of datasets that map social media activity over both time and place, showing the progression of a fire line against movement of persons. This type of analysis may include quality assurance work on the processed data of other volunteers. For example, GISCorps deployed experienced GIS professionals (average 8+ years of experience) to analyze the accuracy of work performed by the SBTF in processing the geodata of a USAID dataset.[38]

Recruiting individuals to participate in a collective intelligence and channeling them to activities that are appropriate for their skills and interests are themselves competencies. Most DHOs have developed a set of recruiting processes and workflows around this challenge, usually in the form of an activation protocol. As federal agencies learn how to engage with DHOs, they have much to learn from these evolving protocols.

Ethics

DHOs exist as a form of mutual aid. Their assistance to affected communities often takes the form of assistance to the organizations with a formal mandate to respond to the emergency, from local fire departments to federal agencies and international organizations. This focus on using information to save and sustain lives has exposed both opportunities and risks.[39] For example, humanitarians have long known that family reunification is difficult. Although collecting information about refugees can enable them to locate separated family members, making that database fully open can expose the vulnerable to further risks.[40] This concern is especially acute in areas where genocide or blood feuds may have motivated a family to take the risk of migrating from one place to another. As DHOs enter this area, they bring more powerful tools than humanitarians have traditionally used. They also have mobilized a base of volunteers from many backgrounds, most of whom have never been in the field. DHO leaders have recruited humanitarians who provide an ethical mindset and build training programs that enable volunteers to understand how opening information may also open risks.

Most DHOs combine specific training with codes of conduct to ensure participants are working with common techniques and values. These programs vary widely in rigor, but ensure that anyone who helps build collective intelligence has basic knowledge of the technologies and practices. They also provide forums where mentors can correct issues and answer questions, both in real time via chat and asynchronously via discussion

In closed systems, such as government, the fear is *being in error*. Making a mistake can be costly, can generate penalties, and sometimes end a career—or a life. In an open, collective intelligence—where knowledge is a social construction—the fear is *burying error*.

forums.[41] These mentors sometimes form into teams to review participants' work. This review may take place either before data are released to partners or once the data are in a wiki-like forum, such as the OpenStreetMap database.

DATA QUALITY: WHY TRUST DHO-GENERATED DATA?

Federal agencies are legally obligated to provide data that are accurate, reliable, and useful. They must take steps to ensure the integrity of information. They must also prevent the release of data that breach the privacy or security of citizens or organizations, violate nondisclosure agreements, or endanger national security. When agencies consider the use of DHOs either to process existing data or to collect new data, they must ensure data quality throughout the process. They must release data to DHOs in a way that protects the privacy of citizens and prevents the disclosure of protected information. Likewise, federal agencies must know that the data received from DHOs are accurate, reliable, and useful both for government decision-making and release to the public.

It is far easier to mandate data quality controls for machine learning or big data initiatives than for collective intelligence projects. Agencies can issue legally binding contracts for the development of big data tools, which can be structured around intellectual property agreements that lock the methodologies, code, and often the data into tightly scoped work groups. Teams can be made responsible for harnessing various inputs, processing and analyzing the data, and delivering a complete product that answers either pre-established questions in a workflow or identifies emerging threats that need further analysis. As a result, the software and data often remain locked in the system; the method and questions being asked may be open (but are often closed).

In contrast, collective intelligence requires a far greater openness around software, data, and methodology. To harness the capacities of a network, large numbers of individuals must be trusted to view or edit subsets of the total dataset. In some cases, the release of the complete dataset is highly desirable or even mandatory. An initiative for collective intelligence works best when it has transparent processes enabled by open-source soft-

Box 2. **Three Definitions in Open Technology**

Open data are "a piece of data or content is open if anyone is free to use, reuse, and redistribute it — subject only, at most, to the requirement to attribute and/or share-alike."[43]

Open-source software is a piece of software whose "source code is available to the general public for use and/or modification from its original design. Open source code is typically created as a collaborative effort in which programmers improve upon the code and share the changes within the community. Open source sprouted in the technological community as a response to proprietary software owned by corporations."[44]

Open standards/formats for data provide a free and openly available specification for "storing digital data, usually maintained by a standards organization, which can therefore be used and implemented by anyone. For example, an open format can be implementable by both proprietary and free and open source software, using the typical software licenses used by each."[45]

ware to manipulate open data that are exchanged using open standards.[42]

Open systems establishes a very different view of the construction of knowledge than closed system. In closed systems, such as government, the fear is *being in error*. Making a mistake can be costly, can generate penalties, and sometimes end a career—or a life. In an open, collective intelligence—where knowledge is a social construction—the fear is *burying error*. There is a fear that errors will be hidden in secrecy and that collective efforts will perpetuate or even amplify those errors. This social approach to constructing knowledge is every bit as powerful as the authoritative method: it has generated Wikipedia as well as the major software that drives the Internet (including Linux and Apache).

Early academic studies of DHOs indicate a high degree of accuracy in the data that they have processed. OpenStreetMap data can be very close to professional cartography.[46] Crowdsourced geotagging of large datasets can be more accurate than automated processing of the same information.[47] The challenge of creating an interface between the grassroots and government is more than integrating new techniques into federal workflows. It is about building trust around new methods of generating knowledge in the open. This trust is one of the core challenges of developing open government.

Several federal agencies have been developing processes to build this trust. The next section explores the framework by which they have been performing this work.

Defining the Grassroots to Government Interface

3

The path can be unclear for federal agencies that wish to harness DHOs for disaster response. The first pilot projects have only begun to map the legal, policy, and technology issues involved with integrating crowdsourced information sources into official, authoritative datasets. That said, several U.S. federal agencies have been involved with collecting and verifying data collected from citizens in crisis for many years.

The best-known example may be the USGS *Did You Feel It*? service, which was established in 1999 to augment the USGS's understanding of the human impact of earthquakes. Over the past 14 years, more than two million citizens have submitted data about the effects of earthquakes in the United States, as well as in other countries (see figure, pg 15). In 2010, the Centers for Disease Control and Prevention (CDC) implemented BioSense to enable the community of local, state, and federal public health officials and practitioners to identify emerging disease outbreaks and health threats. The 2.0 version brings together a community of public health officials and other experts to analyze real-time health data, with some pulled from social media.

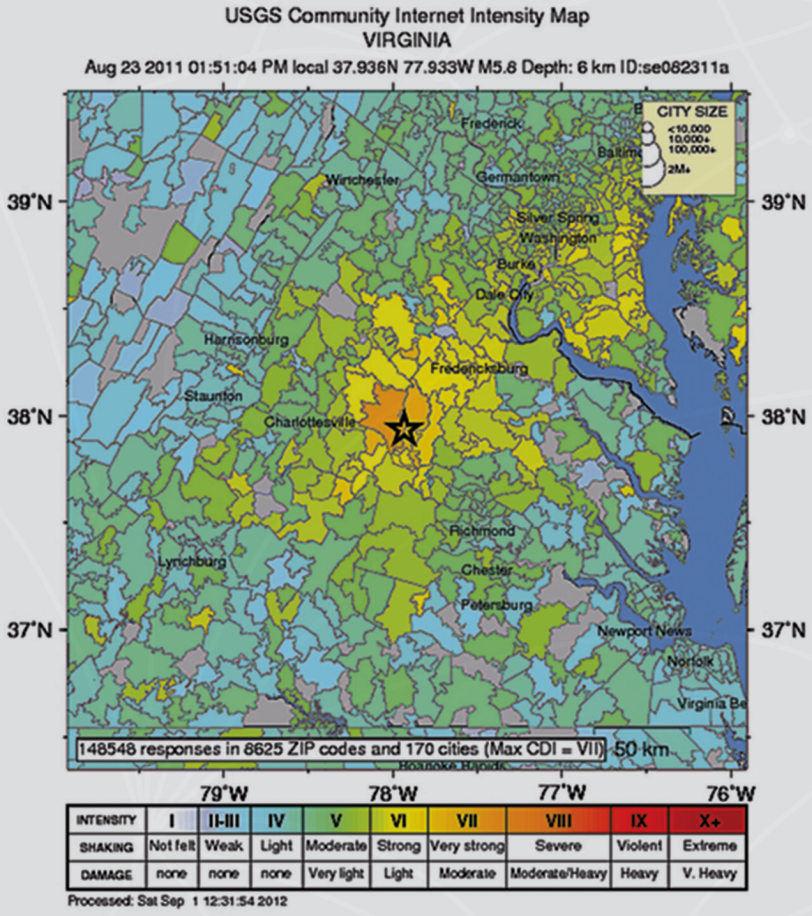
Although these tools do connect an agency to citizen sensors and convene a community of trusted experts around their data, creating an interface to DHOs requires a special level of policy review that neither a pure sensor network (e.g., USGS's *Did You Feel It*? See Box 3) nor an interagency community of practice (e.g., BioSense) has yet required. They are therefore the focus of the cases in this report.

There are three known cases in the U.S. government that established an interface to grassroots technology networks within the crisis mapping community: two specific to disaster and one with a development focus, but with obvious applications to crisis response:

1. The U.S. Department of State Humanitarian Information Unit's pilot workflow with HOT and the National

Box 3. Citizen Responses to Did You Feel It?

On August 23, 2011, approximately 148,000 individuals used DYFI? to describe their experience of a magnitude 5.8 earthquake affecting the Washington, D.C., area.[a] Additionally, because high-magnitude earthquakes are fairly rare along the East Coast, only a handful of nearby seismometers recorded the main shock of this earthquake. Thus, much of the preliminary data about the extent and level of shaking of this earthquake came from DYFI? Because similar sensor conditions exist in most of the country outside of California, DYFI? continues to offer invaluable benefits.



a. U.S. Geological Survey, "One Year Anniversary: Magnitude 5.8 Virginia Earthquake," USGS website, 2012, accessed September 4, 2012, http://www.usgs.gov/blogs/features/usgs_top_story/one-year-anniversary-magnitude-5-8-virginia-earthquake/.

Geospatial-Intelligence Agency to catalyze remote mapping activities like those that took place during the first weeks of the Haiti earthquake operation[48]

2. An interface FEMA established with the Civil Air Patrol and HOT to provide damage assessment from photographs collected by aircraft after disasters[49]

3. The process that USAID created with the SBTF and GISCorps to 'munge'[50] geographic data on loan guarantees in developing nations[51]

U.S. STATE DEPARTMENT/ NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY

In late 2010, the U.S. State Department Humanitarian Information Unit (HIU) and the National Geospatial-Intelligence Agency (NGA) explored ways in which the U.S. government could use the commercial satellite imagery that it purchases to catalyze remote mapping activities by entities like HOT. This initiative required finding solutions to several legal, policy, and technology challenges:

- Seeing if and how intellectual property licenses with government vendors could apply to the creation of derived works by DHOs.

- Developing a workflow for requests from DHOs so the HIU would not be overwhelmed and so NGA would not violate its status as a supporting federal agency.

- Developing software to ensure that those who participate in remote mapping can perform five linked tasks: (1) users can consent to the terms of the intellectual property agreement; (2) users can check out a small section of imagery for work; (3) users can check their completed work back into the system; (4) editors can check/correct initial work of remote mappers; and (5) the HIU can ingest the DHO data for inclusion in its analytical products.

The project iteratively uncovered issues through experiments held under a program called Research and Experimentation for Local and International First Responders (RELIEF) with the National Defense University and Naval Postgraduate School. This program provided the holding environment where lawyers, line managers, analysts, and DHOs co-designed solutions iteratively.

By using the quarterly field exploration cycle of RELIEF to gradually explore techonology and policy issues, agencies built trust with DHO leaders and created solutions to all three challenges. During its first activation for the famine in the Horn of Africa, 40 mappers traced imagery from 10 refugee camps in Kenya and Ethiopia, creating a dense map with three days of activation. The State Department officially released information on the process under the moniker *Imagery to the Crowd*.[52]

FEDERAL EMERGENCY MANAGEMENT AGENCY/CIVIL AIR PATROL

FEMA had a problem similar to that of the State Department, but could not use satellite imagery to solve it. Within the first few hours of a new emergency, FEMA's leadership must make rapid decisions about what federal resources should be deployed. In general, satellite imagery is not available fast enough, especially if there is cloud cover over the disaster area. In contrast, the Civil Air Patrol has 550 aircraft in all 50 states and has developed the ability to photograph crisis-affected areas quickly and to collect imagery from under the clouds. However, neither FEMA nor the Civil Air Patrol had a method to quickly analyze thousands of images and assess the level of damage over a wide area. So FEMA and the Civil Air Patrol partnered with HOT to build a method of crowdsourcing this analysis.

Working through the RELIEF experimentation process, Kate Chapman and Schuyler Erle from the Humanitarian OpenStreetMap Team developed a basic workflow and modified open-source software called MapMill. Originally developed by the Public Laboratory for Open Technology and Science to crowdsource analysis of imagery collected from low-cost balloons, this new fork of MapMill for the Civil Air Patrol provided a simple interface that FEMA, the Civil Air Patrol, and HOT could deploy in a disaster.

During its first activation in Hurricane Sandy, more than 6,717 volunteers processed 35,535 images in a few days; much of the work was completed in the first 48 hours. These initial damage assessments gave FEMA's leadership a rapid understanding of the areas most affected by the storm. They realized that this capability could accelerate the deployment of federal assets to those sites.[53]

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

The Development Credit Authority (DCA) of USAID provides more than $200 million loan guarantees to entrepreneurs. This program is a success, with only about $9 million in defaults paid by U.S. funds (more than offset by $10 million in income from bank fees). However, the program had only country-level geographic data on the 117,000 borrowers that benefitted from this source of capital; USAID could not tell where in a country these loans were flowing. As a result, the agency could not tell if guarantees were being concentrated in urban areas or if adjacent regions in different countries had aligned strategies across USAID missions. The DCA also wanted to release the data to show the impact of their work, which would require releasing data about each individual loan, including the geographic data that USAID missions had collected about these borrowers.

In the spring of 2012, the DCA worked with the USAID GeoCenter in an effort to determine how to make best use of this extant geographic data. An analysis of the database showed that about 40,000 of the records had only the country listed for the borrower's address and, thus,

borrowers could be mapped only at the country level. The remainder had additional data that might enable the DCA to map the borrowers at the subcountry (i.e., Admin1) level or below. Further analysis indicated that the process would take about 15 minutes per record to address—a time commitment of approximately 9 person-years. The process by which USAID addressed this challenge combined the big data approach with crowdsourcing.

USAID worked with the Department of Defense to develop a process to automate the extraction of geographic data from a single column of data into additional layers of specificity. The set of tools that they built used natural language processing to match geographic data with the National Geospatial-Intelligence Agency's GeoNames dataset. This technique enabled USAID to process an additional 66,917 records, leaving a sizable chunk of the data (about 9,600 records) to be processed by humans. Because the amount of time needed to process this many records was still not within any USAID budget of time or resources, the team turned to the SBTF and GISCorps to develop a crowdsourced process.

Over three months, a team of USAID geographers, lawyers, and managers worked with the SBTF and GISCorps to develop a workflow on data.gov—a process that required adding new data-editing tools to this government open-data platform with the vendor, Socrata. The plan was to divide about 300 volunteers into shifts over three days to process the remaining 9,600 records. In practice, 145 volunteers completed the entire queue in only 16 hours. A subsequent review found that the quality of the resulting dataset had 69,038 records at 64 percent accuracy. In comparison, the crowdsourced process refined an additional 9,616 records at 85 percent accuracy.[54] USAID showed that volunteers are willing to cleanse government records at low or no cost.

Grassroots to Government Framework

4

In each of these three cases, government staff engaged in informed risk taking, As a result, the pathway was built by walking it.[55] Analysis after their work indicates that the main areas of effort occurred in four stages: Design, Experimentation, Activation, Learning/Evaluation (DEAL).

- **Design:** A process to scope the legal and policy questions and defining tasks, why, by whom, and how.
- **Experimentation:** A process for the iterative exploration of options that inform the design, workflow, policy/legal framework, and choice of technologies.
- **Activation:** The execution of an initial plan with a plan for collecting metrics on system performance.
- **Learning/Evaluation:** A process for auditing the quality of data submitted from the crowd and integrating lessons learned.

During each stage, agencies had to determine answers to three groups of questions:

1. **People:** From the grassroots and the government, who should be part of the discussion to build a solution to the problem? After the solution is built, who needs to be authorized to work at the interface of grassroots and government, and what are they authorized to do? How does one establish a neutral space between the grassroots and the government that can act as an incubator? Who needs to be included in this worknet, and who can build the worknet between grassroots and government?

2. **Processes:** What processes are authorized for work at the intersection of grassroots and government? What laws and policies govern these processes? When is socially constructed knowledge admissible into authoritative datasets, and how should it be sourced and labeled? What policy issues emerge around key parts of the federal contracting interface and requirements of the U.S. government for the storage and release of data, including privacy and information quality?

3. **Protocols:** What standards and technologies are in use by the parties

Federal staff have to be empowered to go to the events where digital humanitarians develop their tools, practices, and ethics.

to the grassroots and government interface? What open standards are available? How can the platforms be altered so that that any agreed upon processes can be used by authorized persons? How does one bound the system, and when (and how) should it be opened?

A set of common issues and approaches is emerging from insights garnered in all cases that we researched. The DEAL framework aggregates the experiences of individuals who have worked across the cycle of designing a project, experimenting with one or more prototypes, deploying a pilot, and then evaluating the entire process. Instead of narrating a history, the framework outlines an approach that an agency might take based on the lessons learned.

DESIGN

In the design phase, the appropriate minds from the grassroots and the government need to be convened, often with a trusted facilitator. As in any project, the team needed to decide upon the goal for the project and establish the framework by which the team would work. In hindsight, several interviewees emphasized that the primary goal of this period was building trust between the agency and the participating DHOs. To this end, it was imperative to pursue two activities in parallel.

1. Federal staff had to be empowered to go to the events where DHOs develop their tools, practices, and ethics. This freedom helped federal staff connect with DHOs and enabled DHOs to build trust with U.S. agencies.[56]

2. Once the agency and the DHO had built sufficient trust to try working a problem together, the whole team needed to define who needed to be involved, what the interface between the grassroots and the government was supposed to do, how it would work, and when this interface would be needed (i.e., under what circumstances the DHO would be activated).

People

In each case studied, the first part of the design phase was to build the worknet that connected all participating

organizations. This group may become quite large, but not all those in the loop needed to be active in all aspects of the design. Interviewees emphasized that it was best to keep the team small so that work could be done efficiently, with experts consulted and informed periodically.

The roster generally included the following types of individuals:

- **Government Champion.** Typically, the team had a senior leader, such as an member of the Senior Executive Service (SES), with the authority and legitimacy to take informed risks. This person had the political clout to protect crowdsourcing initiatives from potential adversaries within the bureaucracy and the interagency process.

- **Project Manager(s).** One or two federal staff or contractors who were the action officers assigned to the crowdsourcing project, often directly reporting to the champion, were generally on the team. When there were no project managers, the process moved far more slowly; federal staff recommended that someone be named project manager in the future. On the fastest moving process—USAID's crowdsourcing work with the DCA—the project managers did the work on their personal time, which was not ideal either. The recommendation was to keep stable leadership so that the project managers would be the ones charged with developing the interface and running it through the Learning phase. It was desirable that they be the managers of the process in the long term.

- **Legal Advocate(s).** Both the champion and project managers encountered areas of policy and law that were never designed for government integration with grassroots technology communities. Interviewees emphasized that at many points in the process, they needed and found a legal advocate who helped them find a way to accomplish what needed to be done within the law. This legal advocate was critical to the success of the project. Some argued that, other than the champion, the legal advocate was the most important person on the team and remarked that is was especially helpful when the legal advocate and the champion worked closely together. One of the greatest fears during the project was that the opposite of a legal advocate might appear: a lawyer who creates delays and tells innovators what cannot be done.

- **Technology Advisor(s).** It was important to include individuals with knowledge of the data standards in use by the agency, along with the information quality criteria and platforms. These were not people whose jobs were to keep the servers running; they were instead information strategists who could contact specific experts for particular technical questions.

- **Subject Matter Experts (SMEs).** Each agency needed advice from the operational staff, their pool of vendors and contractors, and academics. Although some of these interactions

were brief, these individuals were brought into the worknet and kept abreast of progress. Examples included remote sensing experts, contracting officers who understood specific data licensing agreements around the data that the DHOs were handling, and vendors whose government platforms would be involved in the initiative. Vendors often viewed the project as a positive opportunity to explore the addition of new features to their products.

- **Facilitator(s).** Sometimes the nature of the agency (e.g., the National Geospatial-Intelligence Agency) or of the project itself required an intermediary to assist with parts of the process. This was the case with design and experimentation, when agencies needed an individual who understood how to apply crowdsourcing techniques and had personal relationships with DHOs. The facilitator advised the project managers on whom to include in the worknet while focusing the team on the need to preserve the inclusive values fostered within the DHO community. For experiments that required the coordination of federal assets and DHO personnel, the facilitator found it helpful to have an assistant who could plan events, schedule meetings, and coordinate logistics.

- **DHO Leadership.** Federal agencies should understand the formal and informal authority structures of DHOs sufficiently well to allow a given DHO to determine who should participate in the various phases of their engagement on the project. Some organizations are decentralized and cellular; they may also have roles that can be occupied by a rotating stock of individuals. It may, therefore, be important to know when one is inviting a role rather than an individual. The agencies should also ask that these DHO leaders remain stable throughout the project. In return, agencies should ensure stability in the agency staff assigned to the core team. In this case, trust building requires advice from those who work with such organizations (e.g., *Occupy*).

- **DHO Technical Advisor(s).** Technology platforms used by DHOs can be at the cutting edge of the field. In fact, some of the DHO experts are defining the cutting edge. Therefore, DHO experts should be included in the dialogue, both as architects and visionaries. A technologist of this caliber can make seemingly difficult problems disappear with a few hours of hacking (this has occurred at Camp Roberts numerous times). They are often called alphageeks.

- **DHO SMEs.** From volunteer coordinators to field staff, DHOs often have a depth of expertise that needs to be engaged in the design of a collaboration with a federal agency. Sometimes the issues are not known until they are explored as part of the design process.

Processes

Once the worknet was organized, the team answered four major groups of questions that laid the groundwork for

the legal, policy, and technology challenges that the team confronted later during the experimentation phase.

1. **What is the goal of the work?** Those interviewed emphasized that clarifying the goals helped them to define the legal and policy questions that needed to be explored and to design a project that would serve the use cases of a specific set of audiences. In two of the case studies, the goals iterated: they started in one place and evolved to another. This shift demonstrated the importance of being flexible when integrating lessons learned into the design process in real time. It also showed that some freedom is needed for federal agencies when exploring a new workflow.

2. **What tools exist to accomplish this task?** Agencies should conduct a review of alternatives to ensure that a crowdsourcing project is an appropriate approach for the intended goals. As was discovered with the USAID initiative, crowdsourcing efforts might best be done by modifying existing channels, like data.gov. In contrast, some federal platforms have limitations that make it far easier to extend the tools managed by DHOs. Instead of creating a special (expensive) federal GIS platform in the Department of State/Humanitarian Information Unit case, for example, the State Department asked HOT to make simple changes to the existing HOT Tasking Manager that would support an important federal requirement: that all volunteers agree (via click-through) to the NEXTVIEW license under which the federal government purchased the imagery from the private sector.

3. **What legal issues need to be overcome?** The legal issues addressed four laws, in addition to the intellectual property requirements of the process and agency specific concerns:

   Anti-Deficiency Act: At USAID, project managers needed to ensure that crowdsourcing work did not replace work already performed by federal staff. Volunteers had to agree that their work did not imply that they had any employment relationship with the U.S. government, that they would receive no compensation for their efforts, and that they waived any and all claims against the U.S. government around the services they were providing.[57] To do so, volunteers checked a box on a web form on data.gov.

   After the Office of Management and Budget (OMB) memo of April 4, 2013 on the potential Anti-Deficiency Act implications of certain social media applications, a new legal review is required.[58] The memo states that under a limited set of circumstances, the indemnification clause in the terms of service of social media platforms could lead an agency to incur a potential financial liability that could (theoretically) exceed the agency's appropriation. Thus, if a federal agency works with a DHO community (like the SBTF or HOT) to process either citizen-generated data or social media during disasters, as opposed to contracting

directly with the underlying software technology platform like Ushahidi or OpenStreetMap, a question arises: Would it be the DHO community that agrees to the terms of service of the underlying technology platform in the course of their work with a federal agency or the federal agency itself? Would this avenue or a structure like the Digital Humanitarian Network for the United Nations make it possible to avoid potential Anti-Deficiency Act liabilities for federal agencies?

Privacy/Nondisclosure. Data sources that might trigger the Privacy Act require special handling. Sometimes certain personally identifiable information must be removed before a grassroots organization can be allowed to handle the data. The legal advisor and project managers from the U.S. government must determine when removal of data is necessary, balancing privacy concerns with efficiency and effectiveness.

Paperwork Reduction Act. Although none of the three cases explored the obligations under the Paperwork Reduction Act to measure the information collection burden, there is a small chance that a disaster might trigger the Paperwork Reduction Act. During the Superstorm Sandy response, FEMA received orders to first cut red tape and then "take a blowtorch to the red tape."[59] The OMB Office for Information and Regulatory Affairs is the point of contact within the federal government for exemptions; it is the best place for agencies to contact to learn how disasters change the requirements under the Paperwork Reduction Act.

Information Quality Act. Agencies must ensure that information released from DHO projects adheres to the agency's standards under the Information Quality Act.[60] In the examples, the agency conducted an audit of the data before release or, initially, prioritized speed and utility over accuracy. Establishing basic metrics and data collection procedures, as well as a process for monitoring and evaluating the project, helped meet the requirements under this act.

Intellectual Property Licensing. The project managers had to ensure that data released or collected had appropriate intellectual property rights. To link the effort to open government, they focused on making the data as open as possible. This openness was a core value shared with DHOs and one of the motivating factors for DHOs to partner with federal agencies. It also gave agencies a success under the Open Government Initiative.

4. **What political concerns need to be addressed?** It is imperative to confront the internal politics at the participating agencies. Discussions with or about DHOs sometimes became quite heated and did not always yield clear answers. The champion, project managers, and facilitator must keep the group moving even in the face of uncertainty. Interviewees noted

This openness was a core value shared with DHOs and one of the motivating factors for DHOs to partner with federal agencies.

that it was better to enter experimentation with unanswered questions than to get stuck in a series of conference calls on hypothetical risks.

5. **How do DHOs develop trust with federal agencies, some of which operate in ways quite foreign to the volunteers?** In addition, an intangible, but important, process under any crowdsourcing initiative is convincing internal skeptics that this alternative model can create data that meet government standards for timeliness, quality, objectivity, utility, and integrity. Understanding their criticisms allowed supporters to plan data collections to mollify skeptics or convince them that the use of DHOs is a valid method of generating authoritative data. One important concern raised was the sustainability of DHOs. The plan for the pilot project must include instructions for handing off the work to the DHOs within a sustainable framework.

Protocols

The open technology used by DHOs tends to be very malleable: it can be shaped to conform to project goals, legal channels, and political realities. However, it was necessary to map out the way in which these tools integrated with federal enterprise systems. The real issues were often discovered only during the experimentation phase, but in each case, the process of mapping out how data would flow in and out of the agency started in the design process. This work incorporated two principles (open data and open-source technology) and an emerging method (open workflows).

Open Data Standards. Engagement with the grassroots usually generates an economic public good, where "individuals cannot be effectively excluded from use (non-exclusivity) and where use by one individual does not reduce availability to others (non-rivalry)."[61] A good example is Wikipedia itself, where an open license on the content ensures non-exclusive use and where global availability on the Web ensures non-rivalrous use. Because each individual contribution to a public good adds value to the good, each contribution can be used and augmented by many actors to bootstrap efforts at the community level.

In contrast, some government data standards are controlled by an ecosystem of vendors, whose platforms may not support open data standards (though the new U.S. Open Data Policy should change this situation). Establishing open data standards—especially by incorporating those from international standard bodies or associations—can create a forcing function to help establish data and transparency as a public good. Agencies should strongly consider using this lever as part of engagement with the grassroots; it may be a non-negotiable item with many DHOs. Given the new U,S. Open Data Policy, the development of criteria will take on additional importance and urgency.[62]

Open-Source Technology Platforms. Open-source software allows everyone to see the methods by which data are collected, analyzed, and visualized. Opening these methodologies to all is an important aspect not only of many DHO activities, but also of the interface between grassroots and government.[63]

Open Workflows. Designing workflows between multiple organizations requires transparency. In the process of tracing the data flows, the entire team—those who function in the legal, technical, policy, and operations areas—encounter issues about which others may have only tangential awareness. The more open the process of development, the more likely that design will raise issues that can be explored and solved during experimentation.

EXPERIMENTATION

Experimentation offers a way to iterate upoon explorations that are only begun in the design phase. One critical aspect of experimentation was to expose legal advocates, operational staff, and skeptics to the challenges inherent in the implementation of the idea. In this way, they were able to offer criticisms and insights that technologists and DHOs could address before the tools were deployed.

A key lesson learned from previous projects was that it is important to fail early and often (within an environment of shared good will). Failure in this context is an opportunity for both sides to discover stumbling blocks, misunderstandings, or incompatibility before an activation. This kind of space is rare in a federal bureaucracy, where failure is usually penalized. However, it is imperative for the champion to establish that the purpose of experimentation is to fail early and often, and requires making a series of "new mistakes." It is best to discover and fix these problems before an operation forces the activation of a DHO for an actual crisis. This is the time when the team discovers, in Edison's famous phrase, 9,000 ways to not make a lightbulb.[64] Experimentation was the key time to build trust between individuals, bridging the government and grassroots.

People

The experimentation phase involved a small group of innovators who can bridge the various challenges. These innovators included the facilitator, project manager(s), legal advocate, technology

advisors, SMEs, and DHO representatives. For two of the cases, the inclusion of lawyers in field experiments gave the DHOs and government technology advisors the opportunity to take questions out of the hypothetical and demonstrate the use of specific technologies to solve specific problems. This specificity enabled the legal advocates to use case law and policy against a particular set of problems. The author personally witnessed lawyers co-designing workflows with technologists from both DHOs and federal agencies, breaking through weeks of hypothetical questions in a matter of hours.

Processes

Experimentation is an iterative process, not a linear one. The worknet may enter this phase and find that multiple iterations are necessary to work through issues before the project is ready to be activated during an emergency. This learning loop is a feature, not a bug. It is an opportunity for all parties to explore new ways of working—the core of innovation. The results should be measured not only by the project's success, but also by the number of minds that were opened to new ways of approaching crisis information sharing challenges.

Minimal, Lightweight Workflows. DHOs are often intensely focused on keeping things simple. They must: they have to work with a wide range of volunteers, sometimes across languages. Simplicity is a design feature for government, as it forces a focus on the essential instead of on the creation of expensive tools to cover all possible scenarios. For disasters, simple is fast and resilient. Although it may not be the criterion for government applications in non-emergency contexts, amid the chaos of disasters, it is essential to have simple, lightweight, minimal processes.

Some experiments can be performed in an office or in virtual space. Interviewees, however, indicated that face-to-face interactions in a safe space—removed from the agency office—are an effective and worthwhile expense. One issue that emerged during the budget crises was a strong desire to measure the effectiveness of experimentation (managers asking, "What are we getting for our money?"). The tendency to impose formal structures on experimentation so that specific goals are achieved or the experiment "fails." While this approach is understandable, the experience of Camp Roberts/RELIEF experiments points to the effectiveness of semi-structured experimentation in a remote location—where the design of the work can be altered midstream to meet emerging understandings, and where failure is a significant finding that provides feedback and enables partners to seek new pathways.

Experimentation usually created reports about what each side learned during each event. That said, the most important deliverables tended to be the ideas that worked their way from bar napkins to formal documents and projects. One such sketch appears in figure 7 with digital annotations over the original markings.

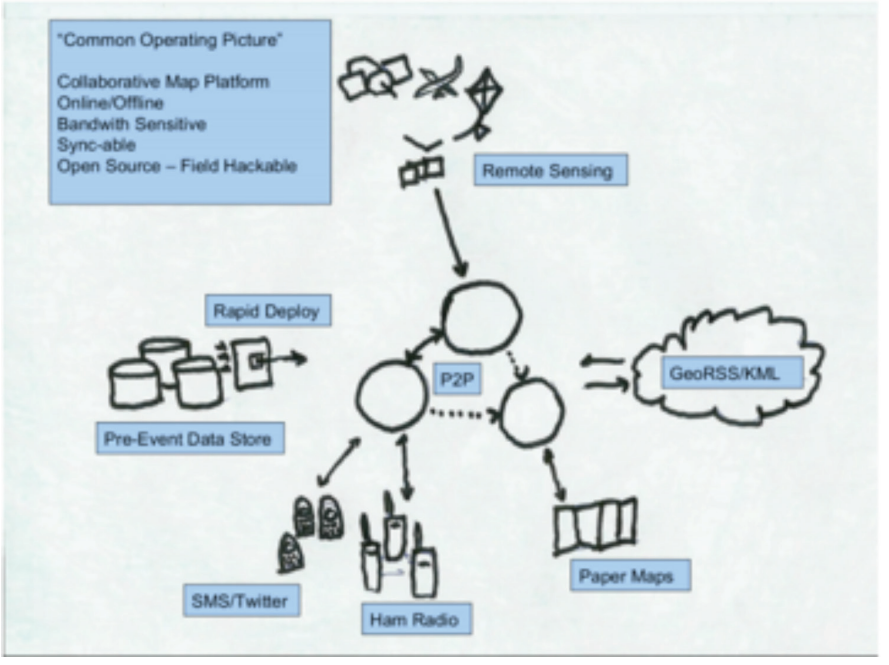


Figure 7: Bar Napkin diagram from Camp Roberts RELIEF experiments, August 2009. © 2009 Mikel Maron. Used with permission. Source: http://brainoff.com/weblog/2009/08/10/1444.

Statement of Work. Interviewees were clear: creating a clear statement of work is a necessity for success. They emphasized that the statement of work must be flexible. It cannot be a boilerplate document or inflexible contract. Rather, it must be a malleable, adaptable statement of expectations created collaboratively and iteratively. Its generation (and redefinition over time) allows agencies and DHOs to negotiate (and renegotiate) their approaches, make their technologies interoperable, establish data standards, and create evaluation metrics and processes.

Interviewees also recommended that projects should start small. By discussing how to build a minimally viable example of how a collective intelligence would use a specified set of tools to process data, project teams were able to move from general agreements into specific courses of action. Over time, the teams added more complexity. In turn, these iterative statements of work enabled the DHOs to build their tools to federal requirements.

Volunteer Management Plan. By co-designing the workflow, the DHOs and agency representatives were able to develop plans to mobilize, motivate, coordinate, and manage volunteers around the experimentation. The co-design process aided in the development of a plan to coordinate and manage the activation of volunteers during an emergency. The specificity of these plans enabled DHOs to recruit SMEs, who led teams around specific issues raised by the federal government, including data validation,

the handling of personally identifiable information, and the licensing of intellectual property. The process of keeping volunteers motivated under an increasing tempo and duration of deployments will require additional study.

Protocols

Experimentation will lead to exploration of the interaction of government and DHO technologies. This phase explores the quirks of making open-source software, open data, and open methods work together. This review of protocols should include:

- **Testing Open Data Standards.** The specification and testing of open data standards might expose differences in implementation or the need for adaptors between different open data standards. For example, the OpenStreetMap, Google, and ESRI data models are each compliant with open standards, but each has a slightly different way to draw a polygon. As a result, it is necessary to design adaptors to handle polygons as data move between OpenStreetMap, Google, and ESRI software.

- **Testing the Flow of Data across Technology Platforms.** The data flow is generally easy to describe on a whiteboard. It may all be structured using open standards, and pathways between government and grassroots systems may be clear. However, it is only by experimentation that the team will discover the file limit placed on a specific server by government information technology staff or discover the costs incurred by transferring data over a satellite terminal to a field team. Technical interoperability is often achieved only by failing repeatedly as teams discover that underlying assumptions about networks and other infrastructure are incorrect.

- **Testing User Experience (UX).** The human factors in crowdsourcing can make or break the initiative. The UX design expectations of volunteers is quite high. To keep volunteers engaged, each task should be simple and easy to perform, which requires good design. Interviewees pointed to a problem: the UX design of government web applications tends to be quite poor. As a result, work with DHOs creates a disruptive effect among federal vendors and staff, pushing them to think more deeply about the user experience. This effect can be used as a positive lever for change.

ACTIVATION

The activation phase gives agencies and DHOs an opportunity to show the results of all previous planning around legal, policy, and technical issues. In two of the cases, the projects were activated only after the teams had tested the tools repeatedly and resolved major issues. In the case of the use of MapMill during Superstorm Sandy, however, the code saw its first use during an actual emergency. Although the workflow around MapMill worked very well (and the code remained stable), this was a matter of luck and credit to the skill of the developers at the Public Laboratory for Open Technology and HOT, not prior plan-

ning. Managers at federal agencies will generally not allow such a leap of faith. Given the scale of Sandy, the dire need for imagery analysis, and the fact that internal independent analysis was going to occur in parallel, the cost–benefit ratio pointed strongly toward the deployment of the new tool. With MapMill, FEMA demonstrated that it is possible to manage the risks of using information processed from the crowd.

People

An activation generally includes the people who have been identified in the workflow designs that the team built in the previous two phases. Because an innovative deployment will attract attention when it works well, federal project managers need to ensure that they include those who are necessary without overburdening the worknet. It is prudent to keep the activation simple and minimal, confining the list of those in leadership posts to people who are essential to the activation. Crowds can be somewhat broader, but should adhere to the policies that the team designed, unless circumstances (e.g., Superstorm Sandy) call for wider participation.

Processes

For most federal agencies, the establishment of a standard operating procedure or new policy around crowdsourcing is a complicated process that engages a wide range of actors. Some of these participants may not yet be ready for a deep commitment to a new form of knowledge creation. As a result, most activations of DHOs are characterized as "pilots," which must meet lower standards for getting approval and sustainment. To our knowledge, no collective intelligence initiative has reached the level of becoming a standing policy. All are still "pilots."As a result, they are still free to innovate and adapt during the emergency—a privilege (and opportunity) rarely afforded to mature enterprise systems.

Choose *non-critical missions*. For many agencies, engaging in a new form of knowledge creation in a mission-critical activity is frightening. For the initial activation, it is often best to choose topics, regions, or datasets that allow the worknet to explore and learn without triggering anti-body reactions within the federal bureaucracy. This approach (often called a *shadow operation*) gives the pilot a chance to prove its worth in an environment that permits the team to take risks and make changes on the fly.

Protocols

The technologies and data standards should have been established in the design phase and then honed during the experimentation phase. They must remain malleable during the activation phase. Although science requires holding variables constant in order to learn, the mission during an emergency is not to remain loyal to the scientific process; it is to preserve lives, health, and property. The worknet must remain adaptable and may elect to adapt its protocols to meet unexpected situations or emerging needs. In field discourse, this is sometimes called "*semper Gumby*—always flexible." If the DHO pilot occurs during an emergency, in no case should the plan for collecting performance metrics

get in the way of operations or provision of aid to affected communities.

LEARNING

Qualitative and quantitative evaluation of the project is important for adapting the design to the actual requirements of activations.

People

The process of evaluating and learning from a pilot activation should include not only those in the worknet from the design, experimentation, and activation phases, but also SMEs who can assist in the evaluation of collective intelligences. Such SMEs are found within the DHO realm, as well as in academia and commercial crowdsourcing companies. Many people specialize in the analysis of DHO operations using a range of methodologies. Most experts mix qualitative research with quantitative analysis of the data that a project creates during an emergency (e.g., mixed methods approaches).

Processes

Open Evaluations. Evaluation and learning should be in an open forum, so government and grassroots can learn from each other. Internal government reviews are often marked with the caveats *For Official Use Only* (FOUO) or *Sensitive But Unclassified* (SBU). While it may be necessary to address some internal arguments over data quality and ensure that certain internal assessments remain confidential, this approach slows down collective learning. Openness should be written into the statement of work with the DHO so that there is a framework to draw specific individuals into official internal government reviews. If nondisclosure agreements are required, they should be in place before activation.

Protocols

Open data and open-source projects are just beginning to establish frameworks for monitoring and evaluation. To date, there are no off-the-shelf frameworks for evaluating the performance of DHOs. The DHO community expects that all learning will be published in an open forum, such as a wiki, where collective intelligence can add questions and layers of meaning to the findings. No government project has yet used this format. However, this resource should be a core principle of open government. Parties must share what partnerships learn, and future work should publish as much as is feasible. In this way, other agencies and DHOs will not need to rediscover lessons learned.

Conclusion

5

"When Thomas Kuhn defined paradigm change in *The Structure of Scientific Revolutions,* he described a state where a traditional framework and several experimental approaches existed in parallel—a period when the explanatory power of the old system wanes while some inchoate new system explores and codifies the methods that are strong enough to begin replacing the old ones." [65]

I wrote those words two years ago, for the conclusion of a World Bank report about the performance of volunteer technology communities in Haiti. Despite these technological determinism that can be found in the discourse of DHOs, DHOs will never fully replace traditional institutions for disaster response. That said, they are accelerating sense making during emergency operations—a role that will become ever more critical as information flows scale at an exponential rate. Building an interface between grassroots and government will be a challenge. However, agencies have already begun to confront the legal, policy, and technology issues that DHOs have raised. This report is only the first step in outlining a framework for this connection. The task is now on the community—the agency champions and DHO leaders—to fill out this initial skeleton.

The key to the successful use of a collective intelligence will be generating trust in the knowledge it creates—not just inside the government, but within the populations that may be affected by future disasters. When FEMA or USAID uses citizen-generated knowledge to make decisions around saving and sustaining life, citizens must trust that the data used to generate those decisions were the best available at the time. The process of deciding when to use collective intelligence to augment traditional mechanisms of sense making will mediate how this trust is built.

Collective intelligence is a form of leadership: it requires asking our citizens to participate in responses as a 'whole of nation' activity. Despite the many reports of apathy and disengagement with domestic and international operations, throughout my experiences. I have seen that this sense of service is alive and well. That said, we need leaders inside of government to harness collective action

to speed our ability to determine at least two questions: *who needs what where and who is doing what where*. Call it the 21st-century bucket brigade: the information brigade.

I wish to state—emphatically— that this document is only an initial version of an interface—in technical lingo, an 'alpha' version. I encourage those with expertise and experience to fill out the framework, emend its errors, and amend its scope. Like patches in an open- source software project, your edits will be merged into the main body of the work through an editing process. Not all will make the cut, but the objective is not to integrate every edit; rather, it is to create a cohesive, relevant, and accurate framework that others can use and build upon—and come to trust.

Appendix

Research Questions

The following 8 questions formed the core of research interviews:

1. How has your agency approached the issue of engaging citizens in the collection or analysis of US government data? Could you give some examples or case studies?

2. What policy or legal challenges emerged as your agency explored working with grassroots organizations like the Standby Volunteer Task Force, Humanitarian

3. What approaches did the agency choose towards those policy or legal challenges? How do these solutions work?

4. What decisions can be made using data quality?

5. What privacy issues have been raised by working with citizen-generated or citizen-analyzed data?

6. What procurement issues had to be overcome?

7. How is your agency working with the decision making processes of grassroots organizations? What challenges and lessons emerged?

8. How is your agency tracking or measuring progress on these early efforts?

Endnotes

1 Short message services (SMS) is also called text messaging or texting. SMS enables a mobile phone subscriber to send text messages approximately 140 characters in length, sometimes with attached photographs, video, or other media.

2 See Robert Munro, "Crowdsourcing and the Crisis-Affected Community: Lessons Learned and Looking forward from Mission 4636," *Journal of Information Retrieval* 16, no. 2 (2013):210–266. See also "InSTEDD's response in Haiti," ICT for Peacebuilding (ICT-4Peace), at http://ict4peace.wordpress.com/2010/05/11/instedds-response-in-haiti/ (last accessed June 1,2013).

3 K. Walker, "Disaster Response Efforts Highlight Value of Relationships, Non-traditional Partners," *Pathfinder* 10, no. 4 (2012):18–20. See also Humanitarian Information Unit, "Imagery to the Crowd," Department of State website, available at https://hiu.state.gov/ittc/ittc.aspx.

4 Jennifer Chan, "How to Make Crowdsourcing Disaster Relief Work Better," *U.S. News & World Report* (November 23, 2012), available at http://www.usnews.com/opinion/articles/2012/11/23/how-to-make-crowdsourcing-disaster-relief-work-better. See also Jennifer Chan, John Crowley, Shoreh Elhami, Schuyler Erle, Robert Munro, and Tyler Schnoebelen, *Aerial Damage Assessment Following Hurricane Sandy* (Idibon, GIS Corps, Harvard Humanitarian Initiative and Humanitarian OpenStreetMap, 2013), available at http://idibon.com/wp-content/uploads/2013/05/Sandy_After_Action_Report.pdf.

5 Data munging is "loosely the process of manually converting or mapping data from one 'raw' form into another format that allows for more convenient consumption of the data with the help of semi-automated tools." See "Data Wrangling," *Wikipedia*, available at http://en.wikipedia.org/wiki/Data_wrangling.

6 That said, the household costs of communication as a percentage of household budgets is a new load on the vulnerable.

7 A meme is an idea or concept that spreads from human to human using mechanisms analogous to the spread of information in genes. See Francis Heylighen, *Evolution of Memes on the Network: From Chain-Letters to the Global Brain*, available at http://pespmc1.vub.ac.be/Papers/Memesis.

html. See also, *Oxford English Dictionary*, meme, available at http://oxforddictionaries.com/us/definition/american_english/meme.

8 XKCD, http://xkcd.com/723/. Used with permission under the Creative Commons 2.5 Non-Commercial-Attribution License. See http://xkcd.com/license.html.

9 See *How Much Information? 2003.* Available at http://www2.sims.berkeley.edu/research/projects/how-much-info-2003/.

10 Eric Schmidt, Techonomy 2010 Conference remarks. See http://techcrunch.com/2010/08/04/schmidt-data/.

11 Ibid. See also *What's the Big Data?* at http://whatsthebigdata.com/2012/06/06/a-very-short-history-of-big-data/.

12 The verb scale here refers to the scalability of a system—its ability to grow to match the demands placed upon it without needing to change the underlying architecture. See *Wikipedia*, http://en.wikipedia.org/wiki/Scalability.

13 Information fusion is the "combination of information into a new set of information towards reducing uncertainty." Several federal agencies operate information fusion centers. See *Wikipedia*, http://en.wikipedia.org/wiki/Information_integration.

14 If a traditional approach (such as a SharePoint) portal can withstand exponential rates of increase to total information resources in a problem domain while scaling knowledge management staff linearly, it will need to show year over year exponential increases to productivity of its curators, who are often professional knowledge managers. That kind of performance metric appears to be absent in industry. There is too much to know.

15 A third approach—a hybrid of the two—is now in experimentation, but has never been applied to an emergency.

16 Good examples include the social media tools used in the American Red Cross Disaster Operation Center, as well as the Information Volume and Velocity joint capability technology demonstration from the Department of Defense.

17 There are other ways to run a big data project—ways in which citizens are integrated into the analysis. Patrick Meier is building such a system at the Qatar Computing Research Institute (personal email, May 23, 2013). The Edward Snowden National Security Agency scandal in May 2013 revealed additional complications around the use of big data without citizen voice in the oversight of a program apparently run by a private contractor (in this case, Booz Allen Hamilton).

18 See Boethius, *The Consolation of Philosophy*. This sixth-century text established the seven liberal arts, including arithmetic, which was then concerned with the aggregation of small multitudes into larger structures (induction), and geometry, which was then concerned with ratios and the division of larger concepts into small structures (deduction). This division is one of the earliest codifications of the pursuit of knowledge through the concept of magnitude and multitude—core concepts at the root of the development of natural science in the 12th century and, from there, of the Scientific Revolution.

19 For more information on OpenStreetMap and refugee camps, see Humanitarian Information Unit, "Imagery to the Crowd," Department of State website, https://hiu.state.gov/ittc/ittc.aspx.

20 One nongovernmental organization now has a campaign called "Information is Aid." See Internews' work with on Humanitarian Communications, available at http://www.internews.org/global-issues/humanitarian-information, as well as the now closed Information as Aid project, available at http://infoasaid.org.

21 Small crowdsourcing companies that fuse the two concepts, such as Idabon and Crowdflower, which have their own models for scaling quickly, are possible exceptions.

22 In social network theory, supernodes have an extraordinary number of connections within (and often between) networks of individuals. They function as influencers and amplifiers. In collective intelligences, their ability to be at the intersection of so many communication pathways enable them to have the best understanding of who is doing what and therefore they often become coordinators—and thereby leaders—in self-organizing networks. See Malcolm Gladwell, *The Tipping Point: How Little Things Can Make a Big Difference.* Little, Brown and Company (2000).

23 Andrej Verity, Office for the Coordination of Humanitarian Affairs, indicates that the term digital humanitarian dates from the November 2011 meeting of a Community of Interest around the application of the SBTF model to provide an interface between the United Nations and a growing number of volunteer technical communities (personal email, May 19, 2013).

24 See International Conference of Crisis Mappers, available at http://crisismappers.net/.

25 OpenStreetMap (http://openstreetmap.org) is a community of more than 1 million volunteers who are building a free and open map of the world, using a model analogous to Wikipedia. Ushahidi (http://ushahidi.org) is a platform for citizen reporting based primarily on messages submitted by SMS/text services via mobile/cellular phones.

26 See Edward S. Robson, *Responding to Liability: Evaluating and Reducing Tort Liability for Digital Volunteers* (Washington, DC: Commons Lab of the Woodrow Wilson International Center for Scholars, 2012), available at http://www.wilsoncenter.org/publication/responding-to-liability-evaluating-and-reducing-tort-liability-for-digital-volunteers. The surprising finding is that Good Samaritan laws in the United States do not protect volunteers engaged in crisis mapping activities within the United States; in fact, current law may open them to liabilities in multiple jurisdictions.

27 An emerging class of DHOs now requires study: the FlashNGO. First seen in Haiti with the Mission 4636 Initiative (discussed later in this report), a FlashNGO emerges to serve a specific purpose during a single response operation and then disbands. This structure was not specifically examined by Mr. Robson's report, but the liabilities an unincorporated association appear to hold true for it. The operation during Hurricane Sandy saw the rise of numerous FlashNGOs, so many that they are now

on FEMA's radar as an emerging policy issue. At the time of this report, creating a workflow with these FlashNGOs remains an ad hoc art form. Given the importance of these FlashNGOs to the delivery of aid during Hurricane Sandy, it may be necessary to perform additional study on this issue in a domestic legal context.

28 Robson, Responding to Liability.

29 Ushahidi is a U.S.-based 501(c)3 nonprofit organization that supports the development of a software platform for citizen reporting. The OpenStreetMap Foundation is a United Kingdom–based charity that supports the development of the software and community behind OpenStreetMap.org.

30 See Thomas Malone, *The Future of Work: How the New Order of Business Will Shape Your Organization, Your Management Style, and Your Life*. Harvard Business Press Books, 2004.

31 "Humanity Road's Page," Digital Humanitarian Network website at http://digitalhumanitarians.com/profile/HumanityRoad, last accessed January 8, 2012.

32 "Standby Task Force's Page," Digital Humanitarian Network website at http://digitalhumanitarians.com/profile/StandbyVolunteerTaskForce.

33 Humanitarian OpenStreetMap Team's Page," at http://hot.openstreetmap.org/.

34 "International Conference of Crisis Mappers's Page" at http://crisismappers.net/.

35 See Clay Shirky, 'The Political Power of Social Media,' *Foreign Affairs* (Jan/Feb 2011), at http://www.foreignaffairs.com/articles/67038/clay-shirky/the-political-power-of-social-media.

36 *Handbook of Collective Intelligence*, available at http://scripts.mit.edu/~cci/HCI/index.php?title=Main_Page. The version on SocialText from 2008 is the version referenced.

37 Jason C. Young, David J. Wald, Paul S. Earle, and Lea A. Shanley, Transforming *Earthquake Detection and Science Through Citizen Seismology* (Washington, DC: Commons Lab of the Woodrow Wilson International Center for Scholars, 2013), available at http://www.wilsoncenter.org/publication/transforming-earthquake-detection-and-science-through-citizen-seismology.

38 Shadrock Roberts, Stephanie Grosser, and D. Ben Swartley, *Crowdsourcing to Geocode Development Credit Authority Data: A Case Study* (Washington, DC: USAID, 2013), 17. Hereafter cited as USAID Crowdsourcing Study.

39 Louise Searle and Phoebe Wynn-Pope, Crisis Mapping, *Humanitarian Principles and the Application of Protection Standards: A Dialogue between Crisis Mappers and Operational Humanitarian Agencies*, available at https://docs.google.com/ument/d/1N25XfSXHcR5ZmkEegSW-1lao0i8r3GKyqpsgKCafU7A/edit. Cf. also Emmanuel Letouzé,; Patrick Meier, and Patrick Vinck, *New Oil & Old Fires: Reflections on Big Data for Conflict Prevention* (New York: International Peace Institute, 2013), available at http://irevolution.net/2013/04/10/big-data-conflict-prevention/, as well as George Chamales, *Towards Trustworthy Social Media and Crowdsourcing* (Washington, DC: Commons Lab of the

Woodrow Wilson International Center for Scholars, 2013), available at http://www.wilsoncenter.org/publication/towards-trustworthy-social-media-and-crowdsourcing.

40 Joel R. Reidenberg, Robert Gellman, Jamela Debelak, Adam Elewa, and Nancy Liu, *Privacy and Missing Persons after Natural Disasters* (Washington, DC, and New York: Commons Lab of the Woodrow Wilson International Center for Scholars and Fordham Law School, 2013), available at http://www.wilsoncenter.org/publication/privacy-and-missing-persons-after-natural-disasters.

41 Federal officials often lack access to these real-time exchanges because chat is blocked at the federal firewalls. This creates liabilities for crisis response operations, as federal officials face delays in correcting the actions of DHOs and federal staff need to go offsite to work with DHOs, separating them from internal resources.

42 The Whitehouse /Developers blog on open data and open source software, available at http://www.whitehouse.gov/developers.

43 *Open Definition*, available at http://opendefinition.org/.

44 *Open Source*, Wikipedia, available at http://en.wikipedia.org/wiki/Open_source.

45 *Open Format*, Wikipedia, available at http://en.wikipedia.org/wiki/Open_format and Open Standard, available at http://en.wikipedia.org/wiki/Open_standard.

46 Morechai Haklay, "How good is volunteered geographical information? A comparative study of OpenStreetMap and Ordnance Survey datasets," *Environment and Planning B: Planning and Design* 37, no.4 (2010):682–703, available at http:www.envplan.com/abstract.cgi?id=b35097. See also Trias Aditya, Nurrohmat Widjajanti, Dany Laksono, S.T., Rindi Kurniati, S.T., Maratun Solihah, S.T., Siti Purwanti, S.T., Burhan Sidqi, S.T. (Dompu), Adisty Paramitasari, S.T. (Yogyakarta), Mulya Sina Diputra (Yogyakarta), *Evaluation of OpenStreetMap Data in Indonesia, A Final Report* (2012).

47 Roberts, Grosser, Swartley, *USAID Crowdsourcing Case Study*.

48 K. Walker, "Disaster Response Efforts Highlight Value of Relationships, Non-traditional Partners," *Pathfinder* 10, no. 4 (2012):18–20. See also Humanitarian Information Unit, "Imagery to the Crowd," Department of State website, available at https://hiu.state.gov/ittc/ittc.aspx.

49 Jennifer Chan, "How to Make Crowdsourcing Disaster Relief Work Better," *U.S. News & World Report* (November 23, 2012), available at http://www.usnews.com/opinion/articles/2012/11/23/how-to-make-crowdsourcing-disaster-relief-work-better. See also Jennifer Chan, John Crowley, Shoreh Elhami, Schuyler Erle, Robert Munro, and Tyler Schnoebelen, *Aerial Damage Assessment Following Hurricane Sandy* (Idibon, GIS Corps, Harvard Humanitarian Initiative and Humanitarian OpenStreetMap, 2013), available at http://idibon.com/wp-content/uploads/2013/05/Sandy_After_Action_Report.pdf.

50 Data munging is "loosely the process of manually converting or mapping data from one 'raw' form into another format that allows for more convenient consumption of the data with the help of semi-automated tools." See "Data Wrangling," *Wikipedia*, available at http://en.wikipedia.org/wiki/Data_wrangling.

51 *USAID Crowdsourcing Case Study*, cited above.

52 A brief can be found at https://hiu.state.gov/ittc/ittc.aspx.

53 FEMA Deputy Administrator Richard Serino and Federal Coordinating Officer Mike Hall released these videos about the MapMill process: http://www.fema.gov/medialibrary/media_records/10370 and http://www.fema.gov/medialibrary/media_records/10369.

54 *USAID Crowdsourcing Study*, p. 23.

55 Antonio Machado, "Proverbios y cantares XXIX" [Proverbs and Songs 29], *Campos de Castilla* (1912); trans. Betty Jean Craige in *Selected Poems of Antonio Machado* (Louisiana State University Press, 1979).

56 Many individuals in DHOs are not U.S. nationals.

57 *USAID Crowdsourcing Study*, p. 8

58 OMB Memorandum, *Antideficiency Act Implications of Certain Online Terms of Service Agreements*, April 4, 2013,available at http://m.whitehouse.gov/sites/default/files/omb/memoranda/2013/m-13-10.pdf, last accessed June 1, 2013.

59 FEMA Deputy Administrator Richard Serino, speech at Harvard University, May 13, 2013.

60 The White House, *Agency Information Quality Guidelines*, available at http://www.whitehouse.gov/omb/inforeg_agency_info_quality_links.

61 Wikipedia, http://en.wikipedia.org/wiki/Public_good, last accessed June 23, 2013.

62 *Executive Order on the U.S. Open Data Policy,* available at http://www.whitehouse.gov/blog/2013/05/09/landmark-steps-liberate-open-data.

63 Larry Lessig, *Code: And Other Laws of Cyberspace*, Basic Books (2000).

64 Larry Page, CEO of Google, calls for such a safe space for experimentation in his speech at I/O 2013, available at http://techcrunch.com/2013/05/15/larry-page-wants-earth-to-have-a-mad-scientist-land/.

65 John Crowley, *Volunteer Technical Communities: Open Development*, World Bank and GFDRR (2010): 15.

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The Commons Lab of STIP advances research and policy analysis of emerging technologies and methods—such as social media, crowdsourcing, and volunteered geographic information—that empower individuals ("citizen sensors") to collectively generate actionable scientific data, to augment and support disaster response and recovery, and to provide input to government decision-making, among many other activities.

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