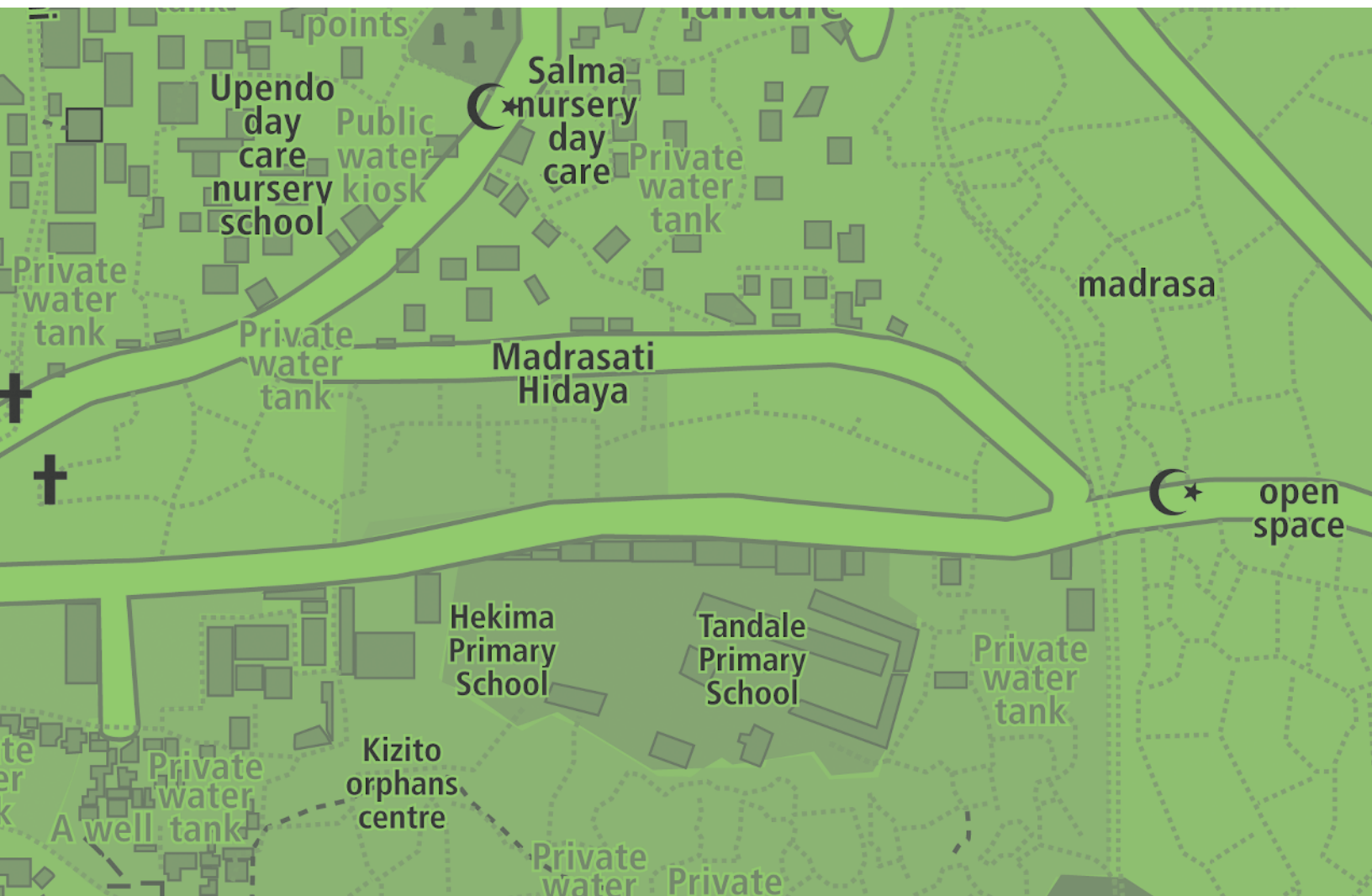


## Interactive Community Mapping

Between Empowerment and Effectiveness

*Jennifer Shkabatur*



# **Interactive Community Mapping: Between Empowerment and Effectiveness**

*Jennifer Shkabatur*

© 2014 International Bank for Reconstruction and Development / The World Bank  
1818 H Street NW  
Washington DC 20433  
Telephone: 202-473-1000  
Internet: [www.worldbank.org](http://www.worldbank.org)

This work is a product of the staff of the World Bank with external contributions. The findings, interpretations, and conclusions expressed in this work do not necessarily reflect the views of The World Bank, its Board of Executive Directors, or the governments they represent.

The World Bank does not guarantee the accuracy of the data included in this work. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of The World Bank concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

#### *Rights and Permissions*

The material in this work is subject to copyright. Because The World Bank encourages dissemination of its knowledge, this work may be reproduced, in whole or in part, for noncommercial purposes as long as full attribution to this work is given.

Any queries on rights and licenses, including subsidiary rights, should be addressed to the Office of the Publisher, The World Bank, 1818 H Street NW, Washington, DC 20433, USA; fax: 202-522-2422; e-mail: [pubrights@worldbank.org](mailto:pubrights@worldbank.org).

Cover design: James E. Quigley, World Bank

# Contents

<b>Acknowledgments</b> .....	<b>v</b>
<b>Note</b> .....	<b>vii</b>
<b>From Mapping to Interactive Community Mapping</b> .....	<b>2</b>
<b>The Elements of Interactive Community Mapping</b> .....	<b>4</b>
Stakeholders.....	4
External ICM Experts .....	4
Technology .....	8
<b>A Framework for Effective Interactive Community Mapping</b> .....	<b>10</b>
Process vs. Results in ICM Endeavors .....	10
Enabling Factors .....	12
General ICM for Social Development .....	16
ICM for Disaster Mitigation .....	22
Trade-offs .....	27
<b>Conclusion</b> .....	<b>31</b>
<b>References</b> .....	<b>32</b>
<b>Figures</b>	
Figure 1 Continuum of Trade-offs for ICM Projects.....	11
Figure 2 Framework for Successful ICM Interventions.....	13

Figure 3 Continuum of Trade-Offs for the Four Projects .....30

**Maps**

Map 1 Geo-Spatial Map of Kibera, Kenya..... 17  
Map 2 Information Layers on Map Kibera ..... 18  
Map 3 Voice of Kibera ..... 18  
Map 4 Map of Tandale, Tanzania .....20

**Photos**

Photo 1 Aerial Image Produced as Part of the Gulf of Mexico ICM .....24

**Tables**

Table 1. Enabling Factors .....28

## Acknowledgments

This chapter greatly benefited from interviews and conversations with Charles Brigham, World Bank (March 2012); Kate Chapman, director, HOT (September 2012); Schuyler Erle, OpenStreetMap (December 2011); Joshua Goldstein, World Bank (April 2012); Erica Hagen, GroundTruth (October 2012); Mikel Maron, GroundTruth and OpenStreetMap (December 2011, April 2012); Severin Menard, HOT (September 2012); Douglas Namale, KCODA (August 2010); Anne Rolfes, founding director, Louisiana Bucket Brigade (March 2011); and Philip Thigo, SODNET (August 2010). The author is also grateful to Savita Bailur from the London School of Economics for her suggestions and comments. A special thanks to Elizabeth Forsyth, the senior editor of the case study.



## Note

This case study was carried out under the umbrella of the Open Development Technology Alliance—the World Bank Group’s ICT Knowledge platform that aims to enhance the accountability and improve the delivery and quality of public services through technology-enabled citizen engagement.

The study was authored under the guidance of Björn-Sören Gigler, Team Leader, Innovations in Governance, at the World Bank Institute. He can be reached at [bgigler@worldbank.org](mailto:bgigler@worldbank.org)





# Interactive Community Mapping: Between Empowerment and Effectiveness

*Jennifer Shkabatur*

The area of Kibera—located in Nairobi, Kenya—is one of the largest slums in Africa. Although multiple civil society and development organizations have been present and active in Kibera for many years, this poor community has often remained a blank spot on public maps. On some, it has even been marked as a forest (Hagen 2011). In October 2009, this dearth of geo-spatial information about the slum led a group of social activists to create Map Kibera—an interactive community map of the area. The development of this map paved the way for many other interactive community-mapping endeavors around the world and created new opportunities for participatory development.

Interactive community mapping (ICM) is a process that engages individuals in creating a map of their community.<sup>1</sup> By developing improved maps of roads, settlements, buildings, local businesses, and other services, the ICM process aims to help community members, governments, civil society organizations (CSOs), and development partners to harness the collective wisdom and knowledge of these communities and to become drivers of development. ICM is used to assess the needs and concerns of the mapped communities and to tailor development activities accordingly.

This chapter explores the moving parts of the ICM phenomenon and offers a framework for effective ICM endeavors. It argues that ICM endeavors aim to achieve both process- and results-oriented goals: (a) empower and build the capacity of marginalized groups and (b) generate a map that will be used by political and civil society actors to improve service delivery for the benefit of the community. However, this scenario rarely materializes. More often, ICM initiatives are forced to prioritize and accept trade-offs between these two objectives, prioritizing community empowerment and capacity building over effectiveness or vice versa. In this context, the chapter offers a set of enabling factors that create the conditions for process- or results-oriented interactive community maps: (1) supporting information infrastructure, (2) need for information, (3) civil society capacity; (4) government cooperation; (5) incentives to cooperate; and (6) data quality. The chapter then examines the application of this framework

---

1. In the context of community mapping, the term “community” describes individuals who share a geographic area, such as a neighborhood, village, or town. The term does not presume solidarity or shared values among community members.

to four innovative case studies of ICM: two general maps to support social development (Map Kibera, Kenya, and Map Tandale, Tanzania) and two maps to mitigate the effects of natural disasters (mapping the oil spill in the Gulf of Mexico, United States, and improving disaster preparedness in Indonesia). The chapter concludes by discussing the opportunities that ICM presents for participatory development.

## From Mapping to Interactive Community Mapping

Throughout the history of cartography, professional cartographers have created maps to administer territories, establish boundaries, determine and enforce property rights, or support colonial, military, and other government projects (Pickles 2004).<sup>2</sup> Until recently, lay persons rarely took an active part in the mapping process (Perkins 2007).

Cartography, however, has been increasingly democratized since the 1980s as a result of both technological progress and the emergence of critical approaches to mapping (Crampton and Krygier 2005; Perkins 2007). J. B. Harley (1988, 1989), one of the most influential critical cartographers, emphasizes the relationship between maps and power and argues that cartography wears the “mask of a seemingly neutral science” (Harley 1989, 5). He regards maps as “authoritarian images,” stating, “Without our being aware of it, maps can reinforce and legitimate the status quo” (Harley 1989, 14). The technological advances of the past two decades helped to put this vision into practice and led to the introduction of an alternative cartographic vision.

Community mapping has emerged “as a response to conventional, elitist cartography, comprising an alternative, egalitarian counter-culture” (Parker 2006, 471). Unlike traditional maps, community mapping is a deeply inclusive and participatory process, which encourages marginalized and disempowered individuals to share their experience, values, and tacit knowledge (Parker 2006; Lydon 2003; Chapin, Lamb, and Threlkeld 2005). Such “democratized” mapping offers marginalized communities new possibilities for articulating their social, economic, political, and legal claims. It also allows CSOs, researchers, and other development partners to work closely with community members and to embrace “the multiplicity of geographical realities rather than the disembodied, objective, and technical ‘solutions’ which have tended to characterize many conventional GIS applications” (Dunn 2007, 616).

By positioning local residents at the core of the mapping process, community mapping provides unique opportunities for community empowerment and engagement (Parker 2006; Aberley 1993; Lydon 2003). First, the mapping process is perceived to be valuable for building local capacity. Community mapping enables marginalized communities to highlight local resources and assets rather than succumb to “official” maps that may present the community in an unfavorable light: “By making maps, neighborhoods understand and display their own conceptions and repudiate other representations of their community” (Parker 2006, 478). It may also be instrumentally valuable for poor communities, enabling local residents to acquire cartographic knowledge and skills (Elwood 2000; Kyem 2004). Second, community mapping strengthens self-representation: “Making a parish map is about creating a community expression of values

---

2. Maps can be defined as “graphic representations that facilitate a spatial understanding of things, concepts, conditions, processes, or events in the human world” (Harley and Woodward 1987, xvi).

and about beginning to assert ideas for involvement. It is about taking the place in your own hands” (Clifford 1996, 4).

Aside from its value for building capacity and strengthening self-expression, community maps have also helped to accomplish a wide variety of concrete development objectives. Development organizations, CSOs, researchers, and local communities have relied on community mapping to reassert indigenous people’s rights, advance local claims to land title, protect local flora and fauna, support legal claims over natural resources, plan local land use, reinstate lost place names, record cultural and historical information, build community awareness, and resolve conflicts (see Chapin and Threlkeld 2001; Cronkleton et al. 2010; Elwood 2000; Fox et al. 2005; Herlihy and Knapp 2003; Kyem 2004; Mohamed and Ventura 2000; Peluso 1995; Perkins 2007; Rambaldi et al. 2006). In Thailand, for example, a local map developed by villagers led to new forest conservation and development activities (Fox 1998). In Honduras, the creation of a community map helped local communities in La Mosquitia to organize themselves against loggers. In Victoria, Canada, a children’s mapping initiative of an abandoned park led the town council to introduce a restoration project (Lydon 2003).

The significance and potential of community mapping have grown considerably in the information and communication technology (ICT) era. Geo-spatial data have become increasingly available and accessible; inexpensive and simple technologies have allowed local residents to produce accurate and comprehensive maps with relative ease. Furthermore, the structure of the Internet itself has encouraged collaborative production and cost-effective dissemination of geo-spatial data and maps (Benkler 2006). As a result of this new reality, many experiments with *interactive* community mapping have emerged in the past decade. This new approach to community mapping has several advantages over the traditional process:

- *Speed.* Developing maps using traditional cartographic methods requires several months or even years. Benefiting from innovations in geo-spatial technology and access to local knowledge, the ICM process occurs substantially faster. As examples discussed in this chapter show, interactive community maps covering large urban areas can be generated within weeks.
- *Dynamism.* While traditional maps remain static and considerable effort is required to update them, interactive community maps can be easily edited, changed, and updated at any time. Thus the initial identification of the information that will be included in the map should not be regarded as conclusive. Additional data can be collected and imported to the map at any time.
- *Costs.* The ICM process typically relies on relatively cheap and basic technological devices and employs free and open-source software. Mappers belong to the mapped community and bring to the project unique tacit knowledge of their living environment. By and large, they volunteer to participate in the process after completing basic technological training (offered by ICM experts). The costs to produce an interactive community map are therefore substantially lower than the costs to fund traditional map making.
- *Granularity.* Most traditional mapping efforts focus on large-scale geo-spatial data and lack local context. The ICM process aims to provide granular information, tapping the local knowledge of community members. The dynamic nature of the ICM process allows the map maker to “zoom in” and “zoom out” according to the specific need for information of the community

and its stakeholders—the information provided on the map may be as detailed, localized, and contextualized as the map designers wish.

Naturally, the benefits of community maps are offset, at times, by unintended negative effects. Similar to traditional mapping, community mapping risks becoming an elitist initiative that only empowers the better-off members of a community and does not spill over to its worse-off members (Chapin, Lamb, and Threlkeld 2005; Elwood 2000). This concern becomes even more pertinent in the context of interactive community maps, since individuals with prior technological knowledge may find it easier to master geo-spatial tools than individuals without such knowledge. Moreover, the empowerment logic of interactive community mapping is often difficult to implement, as the production of a community map does not necessarily lead to genuine empowerment in itself. Rather, translating a community map into tangible development outcomes requires a deep shift in power relations, favorable institutional frameworks, and an array of social, economic, political, and legal factors. The rest of this chapter delves deeper into these considerations.

## **The Elements of Interactive Community Mapping**

The distinctive feature of ICM, compared to traditional forms of community mapping, is its reliance on information and communication technologies. However, the technological aspects of generating an ICM are often the easiest to implement. It is considerably more challenging to attain the objectives of satisfying community needs, empowering local residents, and ensuring that relevant stakeholders will use the map for the benefit of the community. However, before examining the conditions and choices necessary for designing a successful ICM initiative, it is important to understand the typical form and shape that ICM endeavors take.

This section describes the primary elements that are typically required for ICM initiatives as they are currently implemented around the world. It discusses the major stakeholders needed for an ICM project, the ICT tools that are employed as part of it, and their typical users and audience.

### *Stakeholders*

Four types of stakeholders typically take part in the development of an interactive community map: external ICM experts, local CSOs, local community members, and local public officials. The degree of involvement of each of these stakeholders varies from one ICM project to another.

### *External ICM Experts*

The production of interactive community maps is typically facilitated by international civil society groups and ICT experts. These specialists often have considerable experience in the design and implementation of

interactive community maps, but they are not rooted in the community being mapped. While the ICM technologies employed by these groups differ, the role they play in local communities is fairly similar. ICM experts often initiate the ICM process, attempting to implement their skills and expertise in new localities. They typically reach out to local civil society partners to learn the needs and capabilities of local communities and then collaborate with them on the design and implementation of the ICM process. These experts then lead the ICM process, training community mappers to use mapping technologies, helping them to collect and edit geo-spatial data, and producing coherent maps or aerial imagery on the basis of the data collected.

One of the most notable ICM expert groups is GroundTruth, an organization established by Erica Hagen and Mikel Maron—the team that led the creation of Map Kibera—in early 2010. Their goal has been “to build off of the work of Map Kibera and bring the tools to a wider audience by offering consulting services, trainings, and strategic advising internationally” (GroundTruth 2012).<sup>3</sup> Since their pioneering work in Kibera, the team has expanded their ICM activities in Kenya and also worked on ICM projects in Haiti, Indonesia, Palestine, Tanzania, and Uganda, among other places. The core of GroundTruth’s approach to ICM is intuitively simple. The group trains local residents to use inexpensive global positioning system (GPS) devices to collect geo-spatial data in their community. Local mappers collect geo-spatial data in their own village or neighborhood and feed it into OpenStreetMap (OSM)—an open-source software that contains a free editable map of the world. The resulting map is often complemented by a “storytelling” platform—a Web platform where community members use social media to share news, stories, and events in the community. Two major examples of GroundTruth’s approach—Map Kibera (Kenya) and Map Tandale (Tanzania)—are discussed later in this chapter.

The Humanitarian OpenStreetMap Team (HOT) is another ICM expert that works with OSM tools. HOT specializes in humanitarian situations, facilitating “the creation, production, and distribution of free mapping resources to support humanitarian relief efforts in many places around the world.”<sup>4</sup> HOT employs a two-prong strategy: *ex ante* disaster preparedness and *ex post* disaster response. As part of the former, HOT conducts extensive training for local CSOs and community members in areas prone to disasters, teaching them to use OSM tools and to collect vital data that can help to prepare for a disaster (for example, information on potentially vulnerable infrastructure). The most prominent example of this activity is HOT’s work in Indonesia, which is discussed later in this chapter. As part of its disaster response approach, HOT works with local civil society groups, relief organizations, and volunteers all over the world to collect geo-spatial data to support relief efforts on the ground. HOT’s operation in Haiti after the 2010 earthquake is an example of this approach.

The Public Laboratory for Open Technology and Science (PLOTS) takes a different, low-technology ICM approach. Founded in 2010 as an open-source, grassroots data-gathering and research initiative, PLOTS grew out of Grassroots Mapping—a project initiated by Jeffrey Warren while he was a graduate student at the Massachusetts Institute of Technology. According to its own definition, PLOTS is a “community which develops and applies open-source tools to environmental exploration and investigation. By democratizing inexpensive and accessible ‘Do-It-Yourself’ techniques, Public Laboratory creates a collaborative network of practitioners who actively re-imagine the human relationship with the

---

3. See <http://groundtruth.in/about/>.

4. See [http://wiki.openstreetmap.org/wiki/Humanitarian\\_OSM\\_Team](http://wiki.openstreetmap.org/wiki/Humanitarian_OSM_Team).

environment.”<sup>5</sup> PLOTS’s experts train local community members to use simple kites and balloons to capture aerial imagery and produce maps based on the images collected. Similar to GroundTruth and HOT, PLOTS has implemented its approach under a variety of circumstances. The ICM project in Lima, Peru, for instance, trained children who live in poor informal settlements to create an aerial map of their community. The interactive community-mapping endeavor in the Gulf of Mexico engaged more professional mappers and captured the effects of the Deepwater Horizon oil spill on the local environment. Both examples are discussed in more detail later in this chapter.

### Local Partners

Typically, external ICM experts work with local communities on a temporary basis, helping them to create an interactive community map and leaving shortly thereafter. As these experts are not personally embedded in the life of the community being mapped, they need to collaborate closely with local partners. These local partners—typically, civil society groups and social activists who live and work in the community—serve as the entry point for ICM experts into the community.

Robust partnerships between ICM experts and local CSOs are important in all stages of the ICM process. In the beginning, local CSOs, public officials, or civil society activists can help to identify the information needs and demands of the community and offer guidance with regard to implementation within the particular local context. Then, local partners can help by engaging and mobilizing the community to take part in the ICM process, organizing community forums, triggering public interest in the platform, recruiting community mappers, and supporting them throughout the mapping process. After completion of the map, local partners can serve as its “hosts,” ensuring the use and further development of the map.

While these collaborations are important for the success of ICM endeavors, they are often challenging to implement—even if the general capacity of civil society is high. In order to secure a high level of engagement, ICM projects have to be aligned with the interests, strategies, and activities of local partners. For instance, a CSO that works with poor communities on issues of water and sanitation would have direct incentives to collaborate with an initiative that aims to map sanitation services in the community. However, it would be less interested in a community-mapping initiative that aims to map education or crime. The examples discussed below show the importance of this alignment of interests and the limitations of ICM projects that do not take it into account.

### Local Community Mappers

Similar to traditional community mapping, the core of the interactive community-mapping process is the engagement of local residents. The ICM process is supposed to provide local residents with valuable technical skills, help them to represent their communities to the outside world, and generally amplify their

---

5. See <http://publiclaboratory.org/about>.

voice in areas that matter to them. However, local residents rarely initiate the mapping process. More often, interactive community mapping is a supply-driven process, introduced and championed by international ICM experts and local CSOs. As discussed below, creating the right incentives is a challenging task, as poor community members often do not immediately apprehend the value of creating an interactive community map and cannot afford to volunteer for the task without getting paid. The examples of Kibera, Tandale, and Indonesia illuminate the intricate trade-offs that this process entails.

### Local Public Officials

Government endorsement of the ICM process and the collaboration of local public officials with ICM experts, CSOs, and community mappers are key to securing the lasting success and impact of ICM initiatives. Active government engagement improves the odds that the resulting map will be continuously used to improve service provision and other government activities in the community. Government ownership of the map may also ensure the sustainability of the mapping process, enhance the incentives of local residents to engage in it, and improve the financing of it.

However, while the three other stakeholders—ICM experts, local CSOs, and local community mappers—are constant variables in all ICM initiatives, the role of local public officials and politicians varies considerably from one ICM endeavor to another. Social and political context plays a major role in this respect. In some cases (for example, Map Kibera in Kenya or PLOTS in the Gulf of Mexico), ICM experts and CSOs are the only leaders of the ICM process, and the map is generated without any political engagement or endorsement. In other cases (for example, Map Tandale in Tanzania or HOT in Indonesia), public officials take a relatively active role in the mapping process, collaborate with the mappers, and use the resulting map to improve their activities in the community.

### International Donors

International donors rarely play a central role in ICM initiatives, and their primary contribution to the process is their convening power. In the examples of Map Tandale in Dar es Salaam, Tanzania, and HOT in Indonesia, the World Bank played an important role in bringing public officials on board, ensuring their active support of the project, and helping to coordinate and leverage the activities of all the engaged stakeholders. As the active engagement of government officials supports the long-term use of the map, it is important to ensure their collaboration from the outset of the ICM project. This task is often best accomplished by international donors and development partners.



## Technology

There is no single technological approach to the production of interactive community maps. Both high-tech and low-tech tools have proved valuable for the process. Three prevalent techniques include OpenStreetMap, Google Map Maker, and the Grassroots Mapping Kit.

### OpenStreetMap

OpenStreetMap is the most common platform employed for ICM purposes. OSM is best understood as the Wikipedia of global maps: a collaborative Web-based project that aims to create a free and editable map of the world, built entirely by volunteers. It was founded in July 2004 with the aim of “encouraging the growth, development, and distribution of free geo-spatial data and of providing geo-spatial data for anybody to use and share.”<sup>6</sup> The major forces driving OSM have been the protest against licensing requirements restricting access to and use of geo-spatial information, along with the growing availability of inexpensive GPS devices. The OSM platform contains data collected from a variety of sources. First, volunteers around the world gather geo-spatial data on roads, paths, and various types of infrastructure using handheld GPS devices. OSM open-software editing tools convert GPS tracks and incorporate them in the map. The platform also contains aerial photography, satellite imagery, and other geo-spatial data collected from publicly open sources. In the past years, several commercial companies have released their data to OSM and enhanced the coverage of the map.<sup>7</sup> All OSM data are available for public use under an open-database license, which allows individuals to share, modify, and use the data for any purpose, while maintaining this freedom for others.

The OSM process is decentralized and collaborative—any user can edit any part of the map (subject to approval by experienced, long-term members of the community), similar to the editing policy of Wikipedia. The communal identity of the mappers is reinforced through a variety of online tools (for example, mailing lists, wiki discussions) and “offline” social events, such as “map parties.” As of November 2012, the OSM platform has had more than 920,000 registered users (individuals who contributed at least one edit to the system), and more than 3 billion GPS points have been uploaded by volunteers. OSM’s platform covers all parts of the world with varying degrees of detail. It has proven particularly effective in regions of the developing world where accurate geo-spatial data have not been available and in areas where highly detailed, flexible, and editable maps are needed for natural disaster response efforts (this type of a map was particularly useful following the earthquake in Haiti). The open-licensing approach of OSM is particularly compatible with the idea of interactive community maps, as community mappers retain all the rights to the data they collect.

---

6. See [www.openstreetmap.org](http://www.openstreetmap.org).

7. See <http://en.wikipedia.org/wiki/OpenStreetMap>.

## Google Map Maker

Google Map Maker (GMM) is another prominent tool that allows individuals to create and edit maps. Contrary to OSM, GMM does not follow the open-source approach. Instead, it encourages individuals to review and edit the satellite imagery that is available on Google Maps. GMM allows users to make three types of contributions to Google Maps: *placemarks* (points of interest, such as schools, local businesses, or hospitals), *lines* (roads, railways, and rivers), and *polygons* (boundaries and borders, parks, and lakes). Similar to OSM, the contributions of new users are reviewed and monitored by more experienced users in order to ensure accuracy. However, the data submitted to GMM are not available under open licenses for public reuse and become the property of Google. Despite the wide coverage of Google Maps, this restrictive licensing approach has made it unappealing to ICM specialists around the world. GMM has therefore been absent from major ICM projects.

## Grassroots Mapping Kit

Interactive community maps can also be produced using low-tech tools. PLOTS and the Grassroots Mapping project rely on low-cost balloons and kites to collect aerial images. The Grassroots Mapping Kit provides tools to capture original aerial imagery, process the data, and create digital and printed maps. As part of the Grassroots Mapping project, mappers arrive at the location they intend to map with a kite, balloon, helium tank, digital camera with automatic shooting, and a minimum of 200 meters of string (Warren 2011). They attach the camera to the bottom of the balloon or the kite, set it up to take pictures on a 1–10-second cycle, and raise the camera to an altitude of 200–2,000 meters. After capturing the imagery, the mappers reel in the tether to retrieve the camera and upload the best resulting imagery to the Cartagen Knitter software. The software then provides tools to create a map based on the collected imagery.

## Users and Audience

It may be tempting to believe that, if previously unavailable geo-spatial information reaches the public sphere, someone will make good use of it. However, this is rarely the case. More often, a map designed for general use does not satisfy the concrete needs and demands of the community and relevant stakeholders and is underutilized. An effective ICM process therefore begins by identifying the prospective users and targeted audience of the map. Typically, such users include the following:

- *Community members.* Although the interactive community map represents their living environment, members of poor and marginalized communities may have difficulty accessing (let alone using) the map in its online format. Targeting this audience therefore requires a series of offline activities that make the map more accessible and understandable to the community (printing out the map and distributing it in public places or holding community forums).

- *Civil society organizations.* CSOs are often the most likely users of the map, and they may be interested in using it as part of their own activities in the community. An ICM process that targets this audience should be structured around the information needs of CSOs and present the resulting map to them in a way that is aligned with their interests and activities.
- *Government.* Local government representatives may be the most effective users of an interactive community map, as they typically are responsible for providing public services in the community. Maps that target governments as their audience require the understanding of government needs and priorities, along with close collaboration with public officials throughout the ICM process.

Other users of ICM may include *private parties* (for example, private service providers that operate, or intend to operate, in the community and aim to improve their effectiveness or enhance the scope of their services), *international organizations*, *donors*, and *researchers*. Similar to the other audiences, an ICM that targets these users should engage them as early as possible in the design process and be structured around their information needs and demands.

## A Framework for Effective Interactive Community Mapping

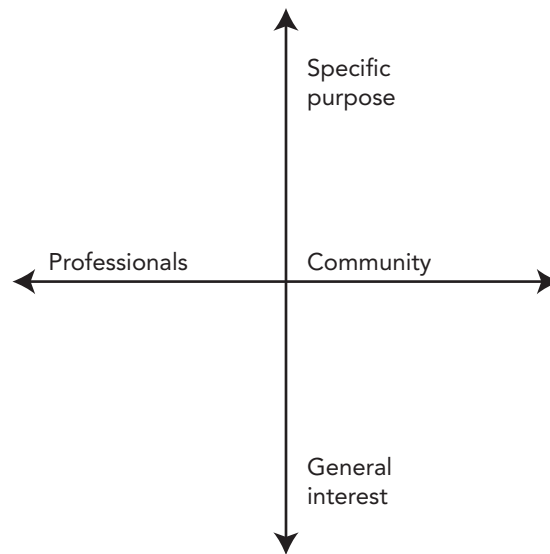
What counts as success for an interactive community map? What is the purpose of engaging stakeholders, experimenting with ICT tools, and targeting the needs of potential users? And what is the best way to generate an effective interactive community map? This section outlines the two primary objectives of ICM endeavors and offers a framework suggesting which factors are necessary to attain these objectives and which trade-offs are often embedded in ICM initiatives.

### *Process vs. Results in ICM Endeavors*

Similar to traditional community maps, ICM pursues two major objectives: process oriented and results oriented. The *process* of creating an interactive community map can be inherently valuable for local communities. It typically starts with extensive training that provides community mappers with new technological skills and knowledge (learning to use GPS devices or getting familiar with software editing programs and social media) that can open up potential employment opportunities. In some cases, the mapping process is embedded in educational curricula in schools, aiming to provide geo-spatial skills to children as well as adults. The ICM process is also an empowering experience, providing local residents from marginalized and poor communities with the opportunity to determine how their communities are portrayed to the outside world. In some cases, this goal of “self-representation” is amplified by including a “storytelling” aspect and providing local residents with tools to share news and stories about their community on a Web platform (for example, Map Kibera).

In addition to these process-oriented objectives, interactive community maps may also be results driven and pursue concrete developmental goals and objectives. Such goals may include, for example, mitigating the effects of a disaster by providing accurate geo-spatial information to rescue workers, generating accurate

**Figure 1 Continuum of Trade-offs for ICM Projects**



geo-spatial information about the resilience of local infrastructure to potential disasters, identifying problems with and improving the provision of public services in the community, and more.

To illustrate this, ICM initiatives can be placed along a continuum with two axes (figure 1). The location of an ICM initiative on these axes reflects the explicit and implicit choices made by its initiators. The horizontal axis refers to the primary identity of the mappers, ranging from professionals (international or local CSOs specializing in mapping, ICT specialists, researchers) to community members. The vertical axis refers to the goal of the ICM endeavor, ranging from specific-purpose maps created to fill a concrete information gap to general-interest maps created to provide general geo-spatial information.

#### Professionals vs. Community

Maps that are located on the far left end of the axis are created by professional mappers, who only visit the relevant community for mapping purposes and do not possess additional ties to it. These mappers may work with the community to gather information, but community members do not play a core role in producing the map. Such maps are relatively weaker on the participatory process of ICM, undermining the values of community participation, inclusiveness, or local capacity building. However, they may be advantageous in other ways.

A mapping process that relies on professionals is likely to be more efficient and results oriented than a mapping initiative that relies on community members. While outreach and mobilization efforts are often needed to attract community members and engage them in the ICM process, CSO representatives or researchers are often self-motivated, are familiar with the process, and require less preparation and training than community members. In some cases (for example, HOT in Indonesia), the engagement of professionals may also speed or scale up the creation of the map. The engagement of professionals is also

likely to improve the sustainability and effectiveness of the map. The ICM project in Indonesia, which relied almost exclusively on professionals, reflects these advantages.

As the location of a map moves farther to the right on the horizontal axis, the role of community mappers grows. Maps that are created by community volunteers prioritize the objectives of community participation, inclusiveness, and capacity building over efficiency, speed, or breadth of coverage. These maps are more likely to create empowerment, as envisioned by the advocates of community mapping. They can provide local mappers with mapping skills and offer tools for representing and amplifying the voice of their community in a process that has traditionally been confined to professionals. However, their efficiency and sustainability are likely to be weaker, as constant outreach and mobilization activities may be required to sustain the community's incentives for engagement.

### General Interest vs. Specific Purpose

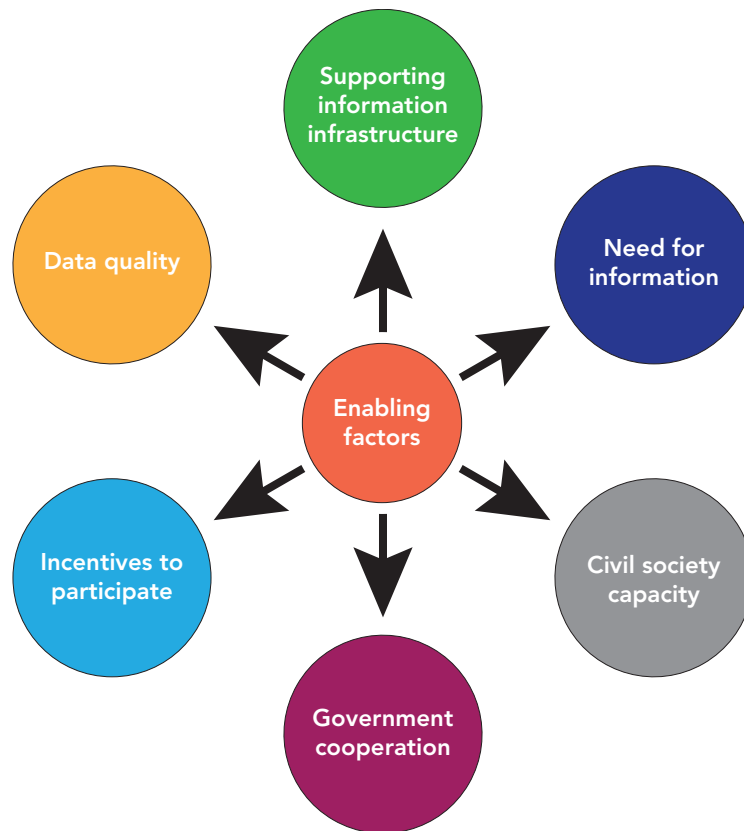
While the horizontal axis represents a trade-off between results (efficiency) and process (community inclusiveness), the vertical axis reflects a trade-off between a map that is general interest and a map that is narrowly tailored in its shape and scope to serve the needs of specific stakeholders or fill in a well-defined information gap. Most interactive community maps are located in between these poles, and the primary distinction between them is the immediate impact, relevance, and audience of the map. General-interest mapping endeavors put marginalized communities on the map, educate them about cartography, represent their geo-spatial realities, and give voice to their members. Specific-purpose maps fill a concrete information gap and respond to the need for specific information. These maps are usually tailored to the particular demands of CSOs, private service providers, or donors working in the community. They are more likely to be used than general-interest maps, but their intrinsic long-term value for the community is uncertain.

### *Enabling Factors*

Designing ICM interventions that produce successful processes and results is often a considerable challenge, and it inevitably requires trade-offs. This section presents six factors that are needed for an ICM initiative to create a valuable participatory process and produce tangible outcomes. The first factor—information infrastructure—is usually the only one that is beyond the control of ICM leaders. The other five—identified need for information, civil society capacity, government cooperation, community's incentives to participate, and data quality—are mostly within the control of the ICM initiative and should be taken carefully into account when designing an ICM process.

The goal of the framework is therefore both descriptive and prescriptive. Descriptively, it sheds light on the major enabling factors required for the success of an ICM on both the process and results fronts. Prescriptively, it illuminates common challenges that interactive community maps encounter and suggests how to alleviate these challenges and improve performance. The framework consists of the six factors diagrammed in figure 2.

Figure 2 Framework for Successful ICM Interventions



### Supporting Information Infrastructure

The distinctive feature of interactive community maps is their reliance on ICT tools. Naturally, this implies that supporting information infrastructure is an important factor in the ICM process. One major component of this infrastructure is Internet penetration and digital literacy. The availability of Internet access facilitates the creation of interactive community maps, and widespread computer literacy enhances the pool of potential community mappers and the ease of training mappers in ICM tools. Internet access also enhances the usefulness of the resulting map for members of the community, as it enables them to access and work with the map on a daily basis.

However, while Internet access and literacy naturally facilitate the ICM process, the absence of these conditions should not dissuade ICM efforts. On the contrary, interactive community maps may be particularly important in the poorest communities, as part of an effort to prevent their further marginalization, put their problems and concerns on a map, and help them to build capacity to use technology. Even if the community will not be able to access the digitized version, such a map can be helpful for CSOs, local officials, and development organizations active in the community, while the community would use a hard copy of the map. In sum, although supporting information infrastructure naturally enhances the immediate impact of an interactive community map, the ICM process may be important even in its absence.

### Need for Information

Intuitively, interactive community mapping should be most helpful in places that have not been mapped before. However, the dearth of information about a certain place does not mean that such information is needed or will be used. Effective ICM endeavors not only target blank spots on the world map but also identify specific needs and demands for information as well as concrete ways in which an interactive community map would benefit prospective users—community members, civil society organizations, public officials, development partners, and others.

Thus, although the lack of previously available geo-spatial information suggests that an ICM could be valuable, a more nuanced assessment of conditions on the ground is necessary for an impactful ICM process. Naturally, different users will need different types of data. A local CSO addressing water and sanitation needs, a public official working on security issues, and a group of community volunteers collecting trash all need different types of mapping data. The ICM process should be designed to satisfy the needs of all these potential stakeholders.

### Civil Society Capacity

The technical creation of an interactive community map is typically the easiest part of ICM. In order to ensure that the project will benefit local residents and that the map will be used meaningfully, local civil society should play a key role in the process. In fact, local CSOs and social activists are the main stakeholders of any effective ICM endeavor, taking responsibility for community outreach and engagement efforts, helping to recruit and engage community mappers, arranging the logistics for the ICM process, publicizing and distributing the map once it is complete, and using it for their own activities. The design of an ICM process should therefore be closely aligned with the interests, incentives, and activities of CSOs that are already active in the community.

### Government Cooperation

Since local government typically has ultimate responsibility for the provision of public services, government cooperation with the ICM process is pivotal for the impact and sustainability of the map. Based on mapped information, public officials may allocate additional resources to particular concerns or reallocate funds that have already been assigned in order to cope better with community problems. Public officials' endorsement of the ICM process can also bring on board other stakeholders who can help to distribute and use the map when it is complete. Further, the ICM process can benefit public officials themselves, as they may gain new information about the conditions and concerns of communities under their jurisdiction. Public officials do not always recognize these benefits. Convincing them to engage with the process and aligning the ICM with government's interests and priorities are therefore important tasks that are likely to yield positive results.

## Incentives to Participate

By definition, community mapping requires the engagement of the local community. However, the incentives of community members to participate in interactive community mapping are tricky. First, communicating the benefits of ICM to communities with low technological capabilities can be challenging. Since the resulting maps are largely available online and most residents of poor communities do not have stable access to the Internet, they do not necessarily see the value of the map. Moreover, local residents are intimately familiar with the geography of their community and thus may not apprehend the benefits of representing it on a map. Hence, ICM experts and local CSOs often have to engage in outreach activities and explain the benefits of interactive community maps to the community.

Second, remuneration presents a typical challenge (Berdou 2010; Hagen 2011). Most ICM initiatives are based on the idea that money should not play a role in the mapping process: ICM experts and CSOs provide local residents with complementary training and capacity-building activities; in return, local residents volunteer their time and generate a map that benefits their community. This approach is, however, difficult to implement. Engaging committed volunteers may simply be impractical in poor communities, and volunteering for a common cause (let alone a cause supported by wealthy development partners) is not a natural decision for young people, many of whom are unemployed and in urgent need of income (Berdou 2010).

This lack of appropriate incentives on the part of community members can therefore undermine and derail the ICM process. In some cases, the technological training that community mappers receive for free as part of the ICM process may suffice to keep them engaged with mapping activities. More frequently, however, some payment or reimbursement may be required to encourage the ongoing commitment of community mappers and to sustain the project. The incentives of community members to take part in ICM should therefore be considered carefully.

## Data Quality

The last enabling factor for effective ICM endeavors is the most intuitive. Interactive community maps are not likely to be useful or impactful unless they present high-quality data. The interpretation of what quality means is likely to differ from one ICM project to another. In some cases, quality simply means accuracy. The collection of accurate and up-to-date data is naturally a major component for any impactful ICM endeavor. In other cases, however, quality may also be interpreted as the scope of the data collected and the breadth of its coverage.

## Applying the Framework

This section applies the above framework to two types of interactive community maps: maps created to support general social development and maps created to mitigate the effects of disasters, providing two case studies for each category. It illuminates the practical considerations that are involved in the



implementation of an ICM and sheds lights on the trade-offs between process and results that are part of the ICM endeavor.

### *General ICM for Social Development*

A key objective of applying the ICM process to social development is to improve the provision of public services in a community. By drawing a clear picture of the social and economic conditions in an area, interactive community mapping helps government to decide what types of service provision interventions are required and how and where they should be implemented. Since community members are engaged throughout, the ICM process also encourages them to identify local solutions to the challenges facing their community. GroundTruth—the organization leading the creation of interactive community maps in Kenya, Tanzania, and other countries—is the primary representative of the social development approach to ICM.

#### Map Kibera

Map Kibera, a prototype for many other ICMs, is an interactive community map of Kibera, Nairobi—one of the largest slums in Africa. Although many CSOs and development organizations have been present and active in Kibera, it has largely remained a blank spot on the map. In October 2009, Mikel Maron and Erica Hagen of GroundTruth started collaborating with local partners and organizations in order to put Kibera on the map.

The underlying idea of Map Kibera is that basic geo-spatial knowledge is needed to support informed discussion on how life conditions can be improved in an area. The Map Kibera team therefore sought to cure “the glaring omission of roughly a quarter million of Nairobi’s inhabitants from mass communications and from city representation and policy decisions,” bypassing traditional information gatekeepers (Hagen 2011, 70). They expected that the provision of geo-spatial information would facilitate better coordination, planning, and advocacy efforts within the community and between the community and the government. As such, Map Kibera did not pursue a concrete, well-defined purpose. Rather, it sought to achieve two loosely defined objectives. First, it aimed to create an accurate geo-spatial representation of Kibera and its life conditions, assuming that interested parties would use this information for a variety of purposes (Hagen 2011). Second, it tried to build the capacity of local community members to use ICT tools to share information about local news, stories, and events among themselves and with the rest of the world. An online platform enabling locals to express themselves was created to balance the unfavorable bias in mainstream news coverage of the area and to allow the community to share positive information about itself (Hagen 2011).

The mapping process relied exclusively on local residents, who were recruited and trained by the Map Kibera team. The team also invested considerable efforts in the “digital storytelling” layer of the map, providing local residents with social media tools to capture daily life (Hagen 2011). In the first stage of its operation, the team partnered with local CSOs and, with their help, recruited 13 volunteer community mappers residing in Kibera. It also trained participants to use GPS devices, collect and edit geo-spatial data,

## Map 1 Geo-Spatial Map of Kibera, Kenya



Source: OpenStreetMap (<http://www.wired.co.uk/news/archive/2013-08/05/slum-mapping-google-maps-cartography/viewgallery/306827>).

use video equipment, work with the OSM platform and other relevant software, and use social media and blogging platforms (such as WordPress).

After completing a brief training, community mappers started collecting data using simple GPS devices. The team guided the mappers to include “points of interest,” thus granting them discretion to decide what pieces of information should be part of the map. After one week of mapping, community mappers compared the collected data and decided that points of interest would include data about the location of clinics, toilets, water points, places of worship, and more. The whole process of data collection lasted three weeks, after which mappers imported the information into the OSM software and generated the first detailed map of Kibera (map 1).

The second phase of the Map Kibera project took a more contextualized approach and deepened the map’s coverage of life conditions in the community. In response to demands voiced by local CSOs, the team collected detailed information on issues of health, security, education, and water and sanitation. In the area of health, for instance, they collected information about the working hours of clinics operating in Kibera as well as the services provided by them. As map 2 shows, this information was added on top of the original ICM layer, which only showed the location of a clinic.

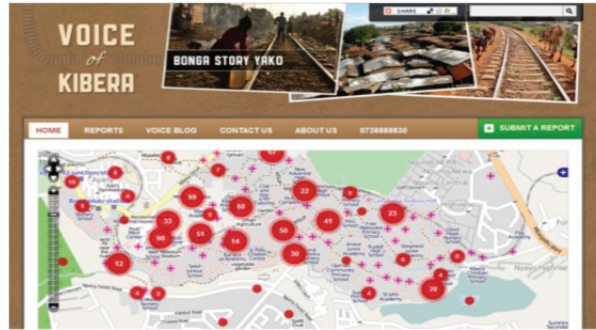
At this stage, the team also introduced the Voice of Kibera initiative—an online news and information-sharing platform for the Kibera community (map 3). The website relies on geo-located citizen reporting and contains news stories, photos, videos, and messages shared by residents. It allows local residents to speak for themselves on current events and issues and creates a digital community around local

## Map 2 Information Layers on Map Kibera



Source: Map Kibera blog (<http://www.mapkibera.org/blog/2011/09/10/engaging-community-stakeholders/>).

### Map 3 Voice of Kibera



Source: See <http://voiceofkibera.org>.

information. The website is constantly updated by the Map Kibera team with videos, photos, and stories on daily life in Kibera.

While some local CSOs reportedly have used Map Kibera<sup>8</sup>, there is no formal evidence of changes or improvements in service provision or other developmental policies in the slum. Map Kibera therefore scored high on the process-oriented dimension, but has been less successful on the results front. The interplay of the enabling ICM factors may be responsible for this outcome.

The initiative benefited from a moderate information infrastructure—local mappers were able to use the offices of KCODA, a local CSO, to access the Internet and use OSM software. Technical training went relatively smoothly, and local geographic information system (GIS) specialists were available to assist community mappers in performing their tasks. Other enabling conditions were less favorable.

The initial idea of Map Kibera was to focus on the supply side of ICM—create an accurate map of Kibera and assume that interested parties would use it for a variety of purposes. However, the data remained largely untouched (Hagen 2011) because too little attention was paid to the *need for information*. This situation began to change when the team began collaborating with local CSOs and mapping information that responded to their concrete needs. In retrospect, however, the generalist nature of the map and lack of attention to the need for specific information on the part of local CSOs

8. Interview with Erica Hagen, GroundTruth, October 2012.

and other potential users limited the immediate usability and relevance of the map for organizations working on the ground in Kibera.

As a result, the *capacity* exhibited by CSOs active in Kibera did not fully translate into concrete use or impact—while CSOs helped to generate the map, they did not use it to inform their own strategies and activities.

*Government participation* was another challenge. Government representatives were not part of the mapping process, did not endorse the map, and apparently did not use it, which limited its usability and impact.

As in many other community-mapping endeavors, *incentivizing participants* proved difficult. Map Kibera was initially designed as a volunteer project, but attracting individuals with a genuine interest in ICT, geo-spatial mapping, and community development was difficult. Local mappers expected to receive compensation for attending a workshop as well as money for lunch and transportation (Berdou 2010). While this aspect created some tensions in the initial mapping activities, it did not affect the ability of participants to perform the required tasks. However, lack of strong incentives to participate made it difficult to sustain the project. GroundTruth addressed this challenge by abandoning the purely volunteer approach and creating the Map Kibera Trust—an organization that now leads all Map Kibera activities and formally employs several community mappers.

Lastly, the Map Kibera team took the issue of data quality very seriously and conducted a series of verification activities to ensure the accuracy of the data collected. In the second stage of the project, more contextualized information was collected—for example, on crime and health—in an attempt to improve the usability of the data collected.

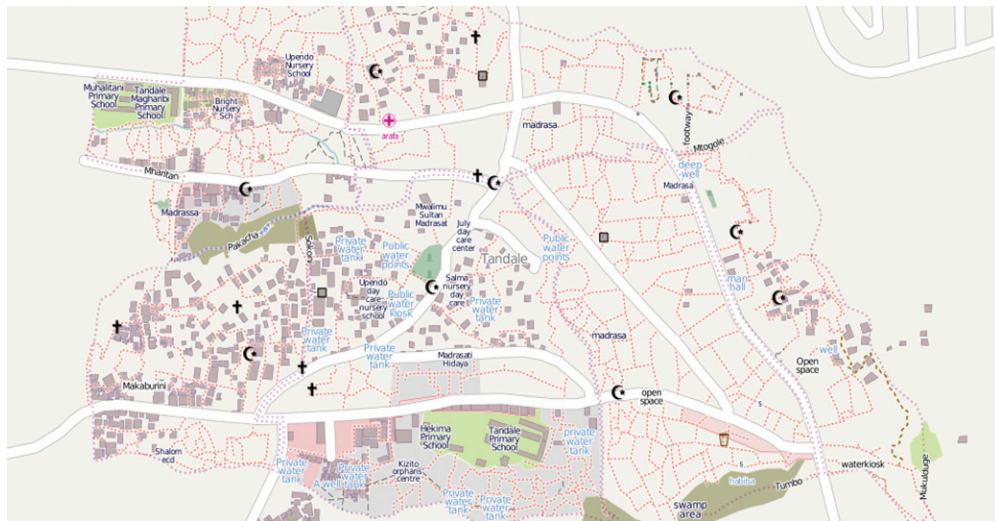
In sum, the interplay of the various enabling factors may explain the performance of Map Kibera: the favorable information infrastructure in Kibera, strong CSO presence, and Ground Truth's attention to the question of incentives contributed to the process-oriented objectives of the initiative. However, the lack of a concrete, identified need for information, limited use of the information by local stakeholders, as well as lack of government cooperation hindered the effective use and dissemination of the map and weakened its results.

## Map Tandale

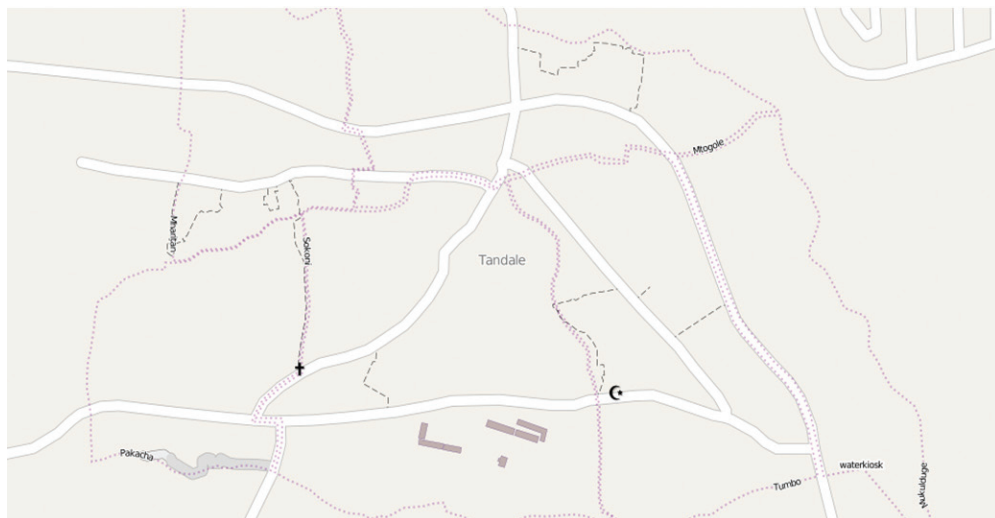
The interactive community mapping of Tandale—an informal settlement of 50,000 residents in Dar es Salaam, Tanzania—aimed to achieve goals similar to those of Map Kibera: improve the delivery of public services in the community and amplify the voices of community members. While Tandale's population has been growing rapidly, the unplanned settlement has suffered from insufficient basic services, such as water supply, drainage system, schools, and roads. Similar to Map Kibera, the underlying idea of Map Tandale is that it is important to understand the needs and concerns of the community from its own perspective before resources are allocated to improving service delivery. Contrary to Map Kibera, however, the Map Tandale project engaged a variety of stakeholders from the outset. In August 2011, the process was initiated by an array of civil society actors, local policy makers, urban planners from the local Ardhi University, community members, and development partners with support of the World Bank (GroundTruth 2012).

The Tandale ICM process consisted of 25 community mappers and 25 students from Ardhi University specializing in urban planning (the university recognized participation in the project as an internship). Students then worked alongside community members to generate a map of Tandale, including points of interest, roads, and some buildings. Students and community members were divided into six groups, with six to eight people per group, one group for each sub-ward. Each team member specialized in one of the following areas: GPS surveying, editing, satellite image tracing, and storytelling. At the end, the group imported the data into the OSM platform and also created a collaborative platform that contains reports on issues faced by the Tandale community (GroundTruth 2012).

#### Map 4 Map of Tandale, Tanzania



a. First day of ICM



b. After four weeks of ICM

Source: GroundTruth Initiative (<http://groundtruth.in/2011/08/22/ramani-tandale-work-in-progress/>).

Local CSOs and local government officials actively supported the project and cooperated with GroundTruth and the mappers. Map 4 portrays the amount of information collected for the map in only four weeks.

Similar to Map Kibera, Map Tandale had to cope with the *information infrastructure* available in Tandale. Internet access was relatively stable, but the organizers had difficulty storing, using, and accessing the equipment (GroundTruth 2012). On the positive side, the project was able to tap the technological capabilities of urban planning students at the Ardhi University.

Learning from the Map Kibera experience, the Map Tandale project was tailored to match existing *information needs* in the community. In preparing for the project, GroundTruth partnered with the Centre for Community Initiatives—a local savings group that had already begun mapping and collecting household data in Tandale. The group relied on a paper-based system to generate its maps and found the opportunity to create a digitized version appealing and well aligned with its own interests. This alignment of interests yielded considerable benefits. As GroundTruth notes in a recent report, “This partner was absolutely key to the level of interest in mapping and in sustained reporting that we found in Tandale, nearly one year later” (GroundTruth 2012, 2). The group not only supported the activities of GroundTruth, but also implemented its method in another informal settlement in Dar es Salaam, contributing considerably to sustainability of the project. In order to capture the information needs and demands of the community itself, GroundTruth also held an open community forum at the beginning of the ICM process. The forum revealed that community members were particularly interested in detailed information on water, health, education, accessibility, and security. The ICM process incorporated these demands, asking community mappers to collect detailed information about these topics.

The *civil society capacity* of both Ardhi University and CSOs working with GroundTruth were a preeminent component of the ICM process. The collaboration of these partners smoothed the introduction of interactive community mapping in Tandale, facilitated the mapping activities, and contributed to sustainability of the map.

*Government cooperation* was another key aspect in the production of Map Tandale. Some of the training and mapping activities were conducted in the Ward Office at Tandale, and the ward officer became a supporter of the process (GroundTruth 2012). He participated in some of the mapping activities and helped to generate community interest and involvement in the ICM effort. Such government engagement was made possible by the involvement of the World Bank, which acted as a “matchmaker” and networker, introducing city officials of Dar es Salaam to the ICM concept and helping to generate and sustain government buy-in to the ICM process.

Although Map Tandale engaged community members, university students took the lead in mapping activities (GroundTruth 2012). The involvement of these students was important for two reasons. First, it solved the challenge of providing the right *incentives to participants*, as students received university credit for participating in the project. Second, the educational background of the students (urban planning) considerably facilitated training and mapping activities and made the students inherently interested in the process. While the decision to rely primarily on university students limited the participatory and inclusive value of the process, it considerably improved the effectiveness and sustainability of the project (GroundTruth 2012). The reliance on university students and close cooperation with CSOs also improved the *quality of data* collected.

In sum, Map Tandale scored lower than Map Kibera on the process-oriented dimension. The reliance on students undermined the inclusiveness of the project (although, because community members were still involved, process values were achieved, albeit to a lesser degree). However, Map Tandale performed better on the dimension of results. The engagement of students and other dedicated stakeholders improved the relevance and usability of the map, as the mapping activities were better aligned with the interests and needs of civil society and government stakeholders. The design also improved the sustainability of the mapping activities, as students had incentives to take part in them. It remains to be seen whether this ICM initiative will result in tangible changes and improvements in life conditions in Tandale, but its performance has been positive so far.<sup>9</sup>

### *ICM for Disaster Mitigation*

In the past decade, ICT tools have been used increasingly to respond to humanitarian emergencies and to mitigate the effects of natural disasters. Mobile devices, for instance, have been used to enable individuals trapped in disaster areas to send requests for help, to facilitate the organization and coordination of volunteers and organizations seeking to provide help, and more (Harvard Humanitarian Initiative 2011; Norheim-Hagtun and Meier 2010; Shkabatur 2011). Interactive community mapping has come to play an important role in supporting these efforts as well.

The use of ICM for mitigating disasters is twofold. First, the creation of an interactive community map can be helpful for disaster response and monitoring purposes. Free and collaborative maps may be particularly valuable to humanitarian work, especially when disasters occur in poor, remote areas and when geo-spatial data are scarce, out of date, or changing rapidly. Second, interactive community maps can improve the disaster preparedness of regions. The discussion in this section illuminates the role of ICM in disaster mitigation and examines the application of the proposed ICM framework to these cases. The ICM in the Gulf of Mexico reveals the advantages and limitations of ICM in postdisaster situations. The ICM in Indonesia shows how interactive community mapping can enhance preparedness for natural disasters.

#### Disaster Monitoring: ICM in the Gulf of Mexico

On April 20, 2010, a large explosion tore through the Deepwater Horizon drilling rig, owned by British Petroleum (BP). The explosion caused the rig to burn and sink, killed 11 crew members, and started a massive offshore oil spill in the Gulf of Mexico.<sup>10</sup> The *Daily Telegraph* reported that the “BP spill spewed 4.1m barrels of oil into the Gulf of Mexico over 87 days, making it the biggest unintentional offshore oil spill in the history of the petroleum industry.”<sup>11</sup> President Obama dubbed it the “worst environmental disaster America has ever faced” (National Commission on BP Oil Spill 2011, 173).

9. According to an interview with Erica Hagen of GroundTruth in October 2012, the impact of the map is still uncertain, as it is currently being examined at the city council.

10. See the full report of the National Commission on the BP Deepwater Horizon Oil Spill (2011).

11. “BP Leak the World’s Worst Accidental Oil Spill,” *Daily Telegraph*, August 3, 2010 (<http://www.telegraph.co.uk/finance/newsbysector/energy/oilandgas/7924009/BP-leak-the-worlds-worst-accidental-oil-spill.html>).

The explosion and subsequent oil spill caused tremendous damage to the flora and fauna of the Gulf of Mexico. However, there was no publicly available, high-resolution, and accurate imagery of the affected area in the first weeks after the spill. While the National Aeronautics and Space Agency made some satellite imagery available, it was not sufficiently detailed to expose any specific damage caused by the spill to the marine ecosystem (Warren 2011, 70). Moreover, local authorities restricted all public access to affected areas, preventing citizens (and even journalists) from directly monitoring the effects of the spill (Peters 2010).

In light of this reality, the Public Laboratory for Open Technology and Science paired with the Louisiana Bucket Brigade (LABB, a New Orleans-based environmental activist group) and other local CSOs to create a community-led effort to track the environmental effects of the oil spill. Relying on LABB's outreach capacity, PLOTS recruited community mappers who were willing to volunteer their time to track the environmental effects of the oil spill using kites and balloons. As part of this method, mastered by PLOTS in previous initiatives, mappers attached a digital camera with a string to a balloon or a kite and put the camera on automated mode to capture images every 1–10 seconds. The images were then aggregated into a single coherent map using open-source software.

In order to prepare community volunteers for the mapping activities, LABB and PLOTS organized training workshops teaching participants how to fly balloons and kites in order to capture sample data sets (Warren 2011). The PLOTS mailing list and wiki page were also helpful in facilitating the mapping effort, as permanent members of the PLOTS community helped to coordinate volunteers. After completing training, PLOTS and LABB organized daily mapping missions to coastal areas.

This method allowed mappers to acquire high-resolution imagery of specific sites, showing the ongoing effects of the oil spill in the same area. The information was detailed enough to identify individual bird species, observe corals, and track oil smears, as well as obtain “before” and “after” images, revisiting the same sites and capturing images of the same areas. As Warren notes, “The potential for a set of maps of the same site, taken at intervals, to depict progressive damage to ecosystems and economies was a powerful new dimension to the project” (Warren 2011, 71).

As the crisis evolved, BP and local authorities attempted to restrict access to the affected areas by closing public beaches, preventing boats from entering some areas, and restricting flights to a minimum of 4,000 feet, making it difficult to capture images of the spill (Peters 2010). In order to gain access to some of the restricted areas, community mappers collaborated with local fishermen: since fishing was restricted in increasingly large areas of the gulf, fishermen were eager to document the effects of the spill and provided transportation and advice to the mappers. ICM efforts grew in importance, as the images that community mappers captured were among the best available for some of the areas (Warren 2011, 71).

Between May 7, 2010, and July 22, 2010, more than 47 participants made 36 trips to capture coastal imagery and took more than 11,000 images. According to Warren, “64% of trips returned with ‘excellent’ or ‘usable’ data” (Warren 2011, 71). A single set of photos from one kite or balloon typically included hundreds of images, and PLOTS used an online crowdsourcing tool to determine which images were of good quality and could be used. The images collected as part of the project were processed on Adobe Photoshop and uploaded to Flickr for public viewing. The imagery was also integrated into an Ushahidi-based website that was launched by LABB to collect oil spill-related reports from citizens.



## Photo 1 Aerial Image Produced as Part of the Gulf of Mexico ICM

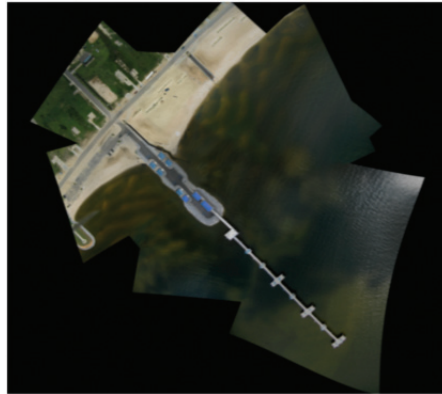


Photo credit: ©Warren 2011.

While the circumstances and purpose of the ICM initiative in the Gulf of Mexico differ considerably from those of Map Kibera and Map Tandale, the ICM framework still applies. The Gulf of Mexico ICM project benefited from the highly advanced *information infrastructure* in the United States. Open-source tools were readily available to process the images and upload them to a publicly available database. No challenges were related to technological capacity—both because the mapping method is easy to master and because technological literacy is high in the United States.

*Civil society capacity* was also strong. Local groups and communities (primarily LABB and the University of Tulane’s School of Public Health and Tropical Medicine) were instrumental in reaching out to potential volunteers and coordinating their participation in ICM activities. The project was also funded by relatively small donations from civil society groups, including the Center for Future Civic Media, the Lafourche Port Commission, the *Washington Post*, Development Seed, and others. As Warren (2011, 75) notes, “This dense web of collaborations has formed a backbone of support for the effort and ensured its regularity and sustainability.”

The tragic circumstances that gave rise to this ICM initiative were supposed to provide natural *incentives* for local community members, such as fishermen, to contribute to the mapping effort. However, as PLOTS and LABB did not provide community mappers with concrete incentives to participate, the scale and coverage of the activities remained relatively modest. Most of the participants only made one trip to the coast, and the ICM operation depended largely on the efforts of just six dedicated community mappers.

The performance of the initiative under the *need for information* criterion was mixed as well. On the one hand, the Gulf of Mexico initiative was driven by the need for specific information about the environmental effects of the oil spill. All mapping activities were targeted to achieve this purpose. LABB was also interested in obtaining information about the crisis and used it for its internal needs.<sup>12</sup> However,

---

12. Interview with Anne Rolfes, founding director, LABB, March 2011.

the lack of wide-scale public interest and little subsequent use of the data collected may indicate that the ICM process was not fully aligned with the information needs of other actors.

Lack of *government cooperation* also presented a challenge for the sustained impact of the project. According to Anne Rolfes, director of LABB, both local and federal authorities were reluctant to collaborate with civil society efforts to track the effects of the oil spill and to use the collected data. Similar to the case of Map Kibera, the dearth of government buy-in considerably limited the use and impact of the collected imagery. Further, while the PLOTS methods enabled the collection of high-quality, high-resolution imagery, the methods employed by the project and the small number of community mappers resulted in relatively limited coverage—the images only captured small and fragmented parts of the coast.

In sum, the project scored well on the process dimension. Most mappers were local community members who volunteered to participate in response to a disaster in their community. However, the extent to which this experience was empowering is unclear. The skills provided by PLOTS were highly specific and not necessarily applicable to other purposes. Further, lack of government interest in the data collected and their limited use undermined the effectiveness of the exercise and reduced its empowering potential. While some of the images were reprinted in the media, on-the-ground impacts were relatively modest (Warren 2011). Although the ICM process fulfilled a specific need for information, it did not change either behavior or policy.

#### Disaster Preparedness: ICM in Indonesia

In 2010 the National Disaster Management Agency (BNPB) in Indonesia and the Australian Agency for International Development (AusAID) decided to develop software that produces realistic scenarios of the impacts of natural hazards in order to improve planning, preparedness, and response to disasters.<sup>13</sup> Relying on the Australia-Indonesia Facility for Disaster Reduction and the World Bank's Global Facility for Disaster Reduction and Recovery, BNPB and AusAID developed the software, dubbed Indonesia Scenario Assessment for Emergencies (InaSAFE).<sup>14</sup> To produce reliable disaster scenarios, InaSAFE requires accurate data on exposure—information about the places where people work and live and data on the construction of these structures. Lacking such information, the government of Indonesia approached HOT with a request to use the OSM technology to collect the disaster preparedness data needed for InaSAFE.

HOT's initial pilot started in March 2011 and lasted until March 2012. It consisted of providing training, developing new software, translating various OSM materials into Indonesian, and collecting extensive data. As the Indonesian terrain consists of both sprawling cities and spread-out rural villages, HOT implemented different methods for collecting data in rural and urban areas.

In rural areas, HOT started collecting data by partnering with ACCESS—an Indonesian CSO that specializes in creating “poverty maps” in villages and helping local residents to understand problems in their area and explore possible solutions. The paper maps of poverty created by ACCESS in the past had not been accessible outside of the local community and could not be used to compare and visualize poverty information. HOT began its work with ACCESS by conducting “Introduction to OpenStreetMap”

13. This section is based largely on an interview and discussions with Kate Chapman, director, HOT, September 2012.

14. See <http://www.inasafe.org>.

training workshops in villages where ACCESS had already been working. HOT designated two training teams for the task, each consisting of one international expert and one GIS student from the University of Indonesia, and trained 126 ACCESS staff on using OSM tools to collect data. The collaboration with HOT was mutually beneficial. ACCESS took advantage of the training to improve and digitalize its own poverty maps; in turn, ACCESS staff collected disaster preparedness data that were of interest to HOT.

As HOT initially lacked partners in urban areas, its strategy for collecting data in cities differed from its strategy in rural areas. In cities, HOT decided to engage university students specializing in GIS. The idea was to train students in OSM methodologies and then hold a contest to incentivize them to map as many buildings as possible. The prize for the most prolific and accurate mapper from each university was a trip to the United States to attend the State of the Map and Free and Open-Source Software for Geo-Spatial (FOSS4G) conference to be held in Denver, Colorado.

HOT conducted one-day training workshops in partner universities in five Indonesian cities—Bandung, Jakarta, Padang, Surabaya, and Yogyakarta. These workshops, attended by 150 students overall, aimed to provide participants with OSM skills and techniques. After completing the workshop, students were requested to map as many buildings in their city as they could within six weeks. As part of the exercise, they were asked to indicate the location of buildings on the map and to collect information on building construction—type of structure, walls, and roof and number of floors. The HOT team monitored the data collected during the course of the competition and, in some cases, provided feedback and corrections via a website set up for the competition, KometisiOSM.<sup>15</sup> Overall, 44 students took part in the competition and mapped at least one building. The winners mapped between 1,000 and 12,000 each. Overall, students in the competition mapped 29,230 buildings in five major cities.

HOT employed an additional methodology to map large-scale urban areas: creating partnerships with local government authorities. The province of Jakarta, for instance, has been experimenting with different approaches to assessing the potential impacts of floods on Jakarta's residents and infrastructure. As part of this effort, Jakarta's Disaster Management Agency and the Indonesian National Disaster Management Agency have been developing detailed scenarios that estimate the impact of future floods in order to improve contingency planning. To support these activities, HOT helped to conduct workshops in each of Jakarta's six districts and trained district representatives on how to map boundaries and major infrastructure in their district. More than 500 representatives from Jakarta's 267 villages took part in the workshops. They subsequently mapped more than 6,000 buildings (government offices, health facilities, schools, places of worship, sports facilities, fire stations, police stations, and major roads) and nearly 2,700 neighborhood boundaries.

One of the desired outputs of HOT's project in Indonesia was to integrate the OSM data sets into InaSAFE. The newly created OSM data sets fulfilled this objective. The mapping of Jakarta facilitated by BPBD enabled InaSAFE to determine how many schools, hospitals, and government buildings would be affected by a flood.

HOT's performance is promising. First, the initiative coped well with the local *information infrastructure* in Indonesia. It assisted local organizations with training, equipment, and translations and took advantage of the technological capabilities of local CSOs and university students. Further, it fulfilled

---

15. See <http://kompetisiosm.org>.

the *information needs* of several key actors. HOT launched the ICM initiative following a direct request from local authorities and based on an identified demand—the operating needs of the InaSAFE program. The initiative was well aligned with the existing needs and priorities of civil society partners, primarily ACCESS. This alignment secured the close collaboration between HOT and ACCESS and enhanced the sustainability of the ICM project: ACCESS and other partners plan to use HOT’s methodology to map additional locations independently. As civil society partners not only needed the information provided by HOT but also had the capacity to lead mapping activities, *civil society capacity* was also positive.

*Government buy-in and cooperation* was another central component. As HOT collected information as part of a government program, in response to concrete needs and in a specific format, it maximized the chances that the relevant agencies will use the collected data in meaningful and socially helpful ways. HOT’s attempts to ensure the *quality and accuracy of the data* collected also played an important role in government endorsement of the project. The accuracy of the data, compared to official government data sets, was a prominent concern during pilot implementation. HOT monitored the quality of the data collected, comparing newly created OSM data sets with reference data sets (field surveys or others).

The last enabling factor—the *incentives of community mappers*—illuminates several aspects of ICM. As HOT worked with civil society representatives and public officials who were interested in acquiring geospatial data as part of their own activities and strategies, additional incentives were not needed. The case of student mappers was different. Although many students took part in the university competition and mapped urban infrastructure, the competition did not create permanent mappers. After its completion, only one student continued to be involved in mapping activities. As a result of this lack of sustained engagement, HOT decided not to hold additional university competitions and to focus instead on engaging and training local CSOs and public officials.

In sum, contrary to the other examples, community members did not play a central role in HOT’s ICM strategy. In its first year of operation, HOT did engage members of the community (CSO workers, planning students, and public officials), but these individuals represented the more educated and better-off segments of Indonesia’s urban population. Thus the traditional, process-oriented goals of ICM as a mechanism of empowerment and capacity building for disadvantaged and marginalized groups were compromised in favor of more efficient mapping operations, larger coverage, and sustained use. This was a deliberate choice. As results-oriented objectives—effective and wide-scale mapping of urban and village infrastructure—were the primary focus of the ICM initiative, process-oriented goals had to be compromised. Indeed, HOT’s decision to focus in its second year of operation on CSOs and public officials who were interested in disaster-related data and to discontinue university competitions was well aligned with this strategy.

### *Trade-offs*

The application of the proposed ICM framework to Map Kibera, Map Tandale, ICM in the Gulf of Mexico, and HOT in Indonesia reveals several illuminating patterns. Table 1 summarizes the interplay among the enabling factors for these four initiatives, scaling them as weak, moderate, or strong.

**Table 1. Enabling Factors**

<i>Indicator</i>	<i>Map Kibera, Kenya</i>	<i>Map Tandale, Tanzania</i>	<i>LABB and PLOTS, Deepwater Horizon, Gulf of Mexico, United States</i>	<i>HOT, Indonesia</i>
Supporting information infrastructure	Moderate. GroundTruth put infrastructure in place to create the map, but it was not available for potential users of the map.	Moderate. Internet was relatively stable, but storing, using, and accessing equipment were difficult. Resources of Ardhi University and technological capabilities of urban planning students were maximized.	Strong. Information infrastructure was highly advanced in the United States.	Moderate. Although not high-tech, project infrastructure was aligned with local infrastructure.
Need for information	Weak. Need for information was not explicit (aim was to create accurate geo-spatial representation). More specific needs-based crime and health-related information was collected in the second stage.	Moderate. The GroundTruth partnership with Centre for Community Initiatives resulted in mutual alignment, as the CSO was particularly interested in data on water, health, education accessibility, and security.	Strong. Information specifically related to the environmental disaster was needed, but wide-scale public interest was lacking.	Strong. Local authorities in Indonesia and the InaSAFE program both requested the information.
Civil society capacity	Moderate. Although there was a strong CSO presence in Kibera, the project did not benefit fully from it in the first stage of implementation. The map was not sufficiently used by CSOs to inform their strategies and activities in Kibera. This partially changed in the second stage of the initiative, when data were collected based on identified needs.	Strong. Both Ardhi University and the CSO had strong capacity.	Strong. Civil society capacity was instrumental in reaching out to potential volunteers.	Strong. The project served the goals of an already active organization.
Government cooperation	Weak. Government did not endorse the map and did not use it.	Moderate. Some training in mapping activities was conducted in the Ward Office, and the ward officer became a supporter of process. The World Bank helped to generate and sustain government buy-in.	Weak. Government cooperation was lacking.	Strong. Information was collected as part of a government program.
Community mappers' incentives	Moderate. Initially, mappers were volunteers, who lacked financial motivation. The lack of strong incentives was addressed by providing mappers with some reimbursement and creating Map Kibera Trust, which formally employed community mappers.	Strong. Students received university credit for participating in the project, and educational background facilitated training in mapping activities.	Weak to moderate. Natural incentives (for example, for fisherman) were insufficient, and the process was conducted primarily by just six community mappers.	Strong. Each of the actors was interested in the geo-spatial data as aligned with its own activities and strategies, although student incentives were weak.
Quality of collected data	Moderate. Verification activities were undertaken to ensure accuracy of the data collected.	Moderate. Quality of data was improved by training students.	Weak. The amount of data collected was small and fragmented.	Moderate. Quality and accuracy were a key concern.

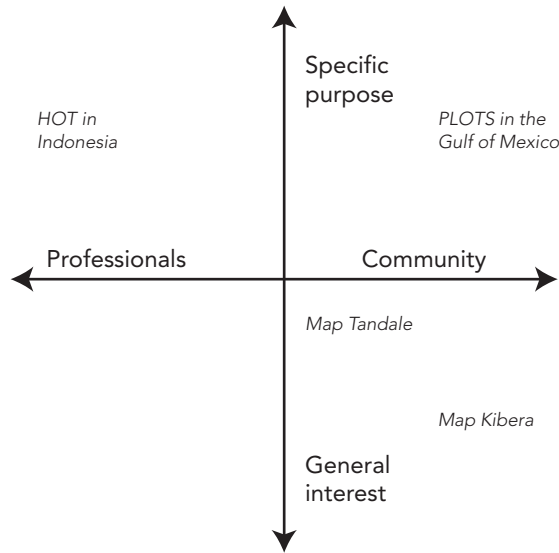
What is the meaning of a weak, moderate, or strong performance under each of the enabling factors? In other words, what constitutes a “success” in the context of an interactive community map? As suggested above, the response to this question depends on the process- or results-oriented goals that the ICM aims to achieve and often requires finding a proper balance between them.

*Map Kibera*, for instance, was envisioned as a general-interest project to capture the living conditions of a poor community on a map and actively engage local residents in this endeavor. As such, this ICM initiative was primarily *process* oriented. Within a year, the team created a digital and multilayered public map of Kibera, introduced online platforms that enable community members to share information and communicate online, and extensively trained local youth to use an array of ICT tools and platforms. As a result, participating community members gained “valuable technical skills, a greater confidence in their ability to change things for the better, and pride in their community” (Berdou 2010, 18). These achievements were made possible by the early choices that GroundTruth made—to rely only on community mappers and to create a general-interest map. Accordingly, Map Kibera scored “moderate” on the factors of information infrastructure, civil society capacity, incentives to participate, and data quality. However, these same choices inhibited the achievement of other objectives. Lack of attention to specific information needs (at least in the first stage) and absence of government cooperation led to a relatively limited impact on local service provision and weak *results*.

Some of the priorities of *Map Tandale* were fairly similar to those of Map Kibera. GroundTruth and its partners sought to create a detailed map of the settlement and to build the capacity of community members to take an active part in the endeavor. However, in order to improve the *results* of the initiative, and not focus only on the process, GroundTruth learned from Map Kibera’s experience and designed the Map Tandale project to identify and respond to the specific information needs of local CSOs, public officials, and community members, shifting it from a purely general-interest map toward a specific-purpose map (figure 3). Further, university students became the focal point of the mapping activities. While the students cannot be considered as pure “professionals,” they are not necessarily part of the Tandale community. These design choices directly affected the resulting map. Similar to Map Kibera, the project produced a detailed map of the Tandale settlement. It also provided valuable technical skills and encouraged knowledge sharing between university students, community members, and some Kibera mappers who joined the effort. The engagement of university students helped to solve the incentives challenges of Map Kibera, and the close partnership with local CSOs contributed to the sustained use of the map. Government buy-in was critical for raising interest in the project and sustaining its effects. However, less reliance on community members meant that the project was less inclusive or participatory. In sum, moderate or strong scores on the indicators of information infrastructure, civil society capacity, and mappers’ incentives contributed to the *process* value of the initiative, but the process was not as participatory as in the case of Map Kibera due to the reliance on professional mappers, rather than ordinary community members. Moderate or strong performance on the indicators of need for information and government cooperation made the initiative more *results* oriented.

Despite the difference in circumstances and objectives, the cases of ICM for disaster mitigation reveal a similar picture. The ICM in the *Gulf of Mexico* responded to a concrete need for information expressed by a local CSO and aimed to achieve a concrete goal—track the environmental damage of the BP oil spill. The project achieved this goal, but its overall scale and impact were modest. As the project

**Figure 3 Continuum of Trade-Offs for the Four Projects**



relied on community members, the absence of proper incentives limited the coverage and scope of the mapping activities. Further, due to the lack of government buy-in, the aerial imagery was underused. As a result, the ICM partially achieved the *process*-oriented objectives, but it performed weakly on the *results*-oriented dimension.

The case of *HOT in Indonesia* followed a different path. Targeted collection of disaster-related data, coupled with reliance on skilled, semi-professional mappers (CSO workers, urban planning students, and public officials) produced several results. First, the scope and coverage of the ICM project were considerably larger, as the project took full advantage of the CSO’s capacity and incentives to engage in the mapping activities. Second, its usability and sustainability were relatively high—data collected by HOT responded to concrete, well-defined information needs, and civil society and government stakeholders endorsed and supported the project. However, while it performed strongly on the *results* axis, HOT had to make trade-offs with regard to community engagement. By definition, its ICM process was less inclusive and participatory than the ICM in Kibera, for instance. Further, it did not necessarily empower the most marginalized or vulnerable groups in the community, thus abandoning a common *raison d’être* for many ICM endeavors.

These trade-offs point to the challenge of attaining both process-oriented and results-oriented objectives as part of an ICM initiative. As figure 4.3 shows, initiatives that pursue “general-interest” objectives, manage to mobilize community members effectively, and take advantage of the existing civil society capacity score well on the *process* dimension. However, as they do not rely on predetermined information needs and only loosely engage the government, the resulting interactive community maps may often be underused. Initiatives that pursue specific goals, respond to predetermined information needs, rely on professional mappers, and establish cooperation with government officials are more likely to score well on the results axis. However, as in the case of HOT, they may be weaker on the *participatory process* dimension.

## Conclusion

The ICM process entails a range of trade-offs and challenges. One of the most difficult trade-offs is the need to choose between community empowerment and capacity building, on the one hand, and effective delivery and use of the map, on the other hand. As the objectives of ICM projects become defined, special attention should be placed on the enabling factors. The framework introduced in this chapter of factors for the success and sustainability of interactive community mapping outlined six broad enabling factors: a supporting information infrastructure, need for information, civil society capacity, government cooperation, community mapper incentives, and the quality of collected data.

In chapter 1 of this volume, a broad framework of political, economic, sociocultural, and technological factors for empowerment through ICTs was introduced. These more detailed enabling factors for ICM complement the PEST framework. In terms of the political factors, all of the case studies described here illustrate the importance of key stakeholders such as public officials, CSOs, and the broader political environment. Economically, incentives both for mappers and for CSOs to commit expenditure to these projects were a concern. Socioculturally, these projects could only be successful if interests were aligned with the CSOs, government officials, and mappers, depending on which resources were the most necessary (and the trade-offs between process and results). Finally, the technology, in many ways, was the least important factor. Although the technological infrastructure was perhaps the most sophisticated in the United States, the Deepwater Horizon project gained the least impetus given the capacity in place. The implication, then, is that the ICT element is the least critical; the overall purpose, incentives, and cooperation of interactive community mapping are more important and interdependent.

Finally, along with the trade-offs and challenges embedded in ICM initiatives, it is important to remember the powerful opportunities that interactive community maps offer to put a community on a map, provide poor and marginalized communities with valuable skills and improve their living conditions, help to mitigate the effects of a disaster, or help communities to prepare for future disasters. Even if the achievement of these objectives is difficult and uncertain at times, the ICM process is still more inclusive and empowering than traditional mapping. It is also more dynamic, less time-consuming, and less costly.

The creation of interactive community maps can therefore be viewed as a shortcut on an otherwise long path toward improved service provision and community empowerment. A thoughtful design of interactive community mapping optimizes the chances of reaching the end of this path. The next chapter addresses the paradox of how ICM is potentially both the most beneficial and yet the most challenging path in fragile and autocratic states.



## References

- Aberley, D. 1993. *Boundaries of Home: Mapping for Local Empowerment*. Gabriola Island, BC: New Society.
- Benkler, Y. 2006. *The Wealth of Networks: How Social Production Transforms Markets and Freedom*. New Haven, CT: Yale University Press.
- Berdou, E. 2010. "Mediating Voices and Communicating Realities." IDS Working Paper, Institute of Development Studies, University of Sussex, Brighton, U.K.
- Chapin, M., Z. Lamb, and B. Threlkeld. 2005. "Mapping Indigenous Lands." *Annual Review of Anthropology* 34 (1): 619–38.
- Chapin, M., and B. Threlkeld. 2001. "Indigenous Landscapes." In *A Study in Ethnocartography*. Arlington, VA: Center for the Support of Native Lands.
- Clifford, S. 1996. "Places, People, and Parish Maps." In *From Place to Place: Maps and Parish Maps*, edited by S. Clifford and A. King, 3–7. London: Common Ground.
- Crampton, J. W., and J. Krygier. 2005. "An Introduction to Critical Cartography." *ACME: An International E-Journal for Critical Geographies* 4 (1): 11–33.
- Cronkleton, P., et al. 2010. "Social-Geomatics: Participatory Forest Mapping to Mediate Resource Conflict in the Bolivian Amazon." *Human Ecology* 38 (1): 65–76.
- Dunn, C. E. 2007. "Participatory GIS: A People's GIS?" *Progress in Human Geography* 31 (5): 616–37.
- Elwood, S. 2000. "Critical Issues in Participatory GIS: Deconstructions, Reconstructions, and New Research Directions." *Transactions in GIS* 10 (5): 693–708.
- Fox, J. 1998. "Mapping the Commons: The Social Context of Spatial Information Technologies." *Common Property Resource Digest* 45 (May): 1–4.
- Fox, J., K. Suryanata, P. Hershock, and A. Pramono. 2005. "Mapping Power: Ironic Effects of Spatial Information Technology." In *Mapping Communities: Ethics, Values, Practice*, edited by J. Fox, K. Suryanata, and P. Hershock, 1–10. Honolulu: East-West Center.
- GroundTruth. 2012. "Recommendations: Community Mapping." Working Paper, GroundTruth Initiative.
- Hagen, E. 2011. "Mapping Change: Community Information Empowerment in Kibera." *Innovations* 6 (1): 69–94.
- Harley, J. B. 1988. "Maps, Knowledge, and Power." In *The Iconography of Landscape*, edited by D. E. Cosgrove and S. Daniels, 277–312. Chicago: University of Chicago Press.
- . 1989. "Deconstructing the Map." *Cartographica* 26 (2): 1–20.
- Harley, J. B., and D. Woodward, eds. 1987. *History of Cartography, Vol. 1: Cartography in Prehistoric, Ancient, and Medieval Europe and the Mediterranean*. Chicago: University of Chicago Press.
- Harvard Humanitarian Initiative. 2011. *Disaster Relief 2.0: The Future of Information Sharing in Humanitarian Emergencies*. Washington, DC, and Berkshire, U.K.: UN Foundation and Vodafone Foundation Technology Partnership. <http://www.hhi.harvard.edu/sites/default/files/publications/publications%20-%20crisis%20mapping%20-%20disaster%202.0.pdf>.
- Herlihy, P. H., and G. Knapp. 2003. "Maps of, by, and for the Peoples of Latin America." *Human Organization* 62 (4): 303–14.
- Kyem, P. 2004. "Power, Participation, and Inflexible Institutions: An Examination of the Challenges to Community Empowerment in Participatory GIS Applications." *Cartographica* 38 (3-4): 5–17.

- Lydon, M. 2003. "Community Mapping: The Recovery (and Discovery) of Our Common Ground." *Geomatica* 57 (2): 131–43.
- Mohamed, M. A., and S. J. Ventura. 2000. "Use of Geomatics for Mapping and Documenting Indigenous Tenure Systems." *Society and Natural Resources* 13 (3): 223–36.
- National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. 2011. *Deepwater: The Gulf Oil Disaster and the Future of Offshore Drilling: Report to the President*. Washington, DC: National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, January. <http://www.oilspillcommission.gov/final-report>.
- Norheim-Hagton, I., and P. Meier. 2010. "Crowdsourcing for Crisis Mapping in Haiti." *Innovations* 5 (4): 81–89.
- Parker, B. 2006. "Constructing Community through Maps? Power and Praxis in Community Mapping." *Professional Geographer* 58 (4): 470–84.
- Peluso, N. 1995. "Whose Woods Are These? Counter-Mapping Forest Territories in Kalimantan, Indonesia." *Antipode* 27 (4): 383–406.
- Perkins, C. 2007. "Community Mapping." *Cartographic Journal* 44 (2): 127–37.
- Peters, J. W. 2010. "Efforts to Limit the Flow of Spill News." *New York Times*, June 9. <http://www.nytimes.com/2010/06/10/us/10access.html>.
- Pickles, J. 2004. *A History of Spaces: Cartographic Reason, Mapping, and the Geo-Coded World*. London: Routledge.
- Rambaldi, G., P. A. K. Kyem, M. McCall, and D. Weiner. 2006. "Participatory Spatial Information Management and Communication in Developing Countries." *EJISDC: The Electronic Journal on Information Systems in Developing Countries* 25 (1): 1.
- Shkabatur, J. 2011. "Cities @ Crossroads: Digital Technology and Local Democracy in America." *Brooklyn Law Review* 76 (4): 1413–69.
- Warren, J. 2011. "Grassroots Mapping: Tools for Participatory and Activist Cartography." Master's thesis, Massachusetts Institute of Technology.

*Jennifer Shkabatur*

Jennifer Shkabatur is a consultant for Social Development, at World Bank Group and a Democracy Fellow at the Ash Center for Democratic Governance and Innovation at the Harvard Kennedy School of Government. She holds a doctorate in law (SJD) and an LLM from Harvard Law School, and an MA in political science and an LLB from Tel Aviv University.