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CROWDSOURCED GEOGRAPHIC INFORMATION USE IN GOVERNMENT

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A report prepared for the World Bank
Global Facility for Disaster Reduction and Recovery

THE WORLD BANK GFDRR UCL

About GFDRR The Global Facility for Disaster Reduction and Recovery (GFDRR) helps high-risk, low-income developing countries better understand and reduce their vulnerabilities to natural hazards, and adapt to climate change. Working with over 300 national, community level, and international partners GFDRR provides grant financing, on-the-ground technical assistance helping mainstream disaster mitigation policies into country-level strategies, and thought leadership on disaster and climate resilience issues through a range of knowledge sharing activities. GFDRR is managed by the World Bank and funded by 21 donor partners.

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Participatory GIS training, Bhaktapur (see case study 5)

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A land management specialist, deployed to the Warrap state, South Sudan (see case study 7)

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Boston StreetBump application in use (see case study 17)

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CROWDSOURCED GEOGRAPHIC INFORMATION USE IN GOVERNMENT

This work is being supported as part of the World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR) project, the Open Data for Resilience Initiative (OpenDRI). Engaging the public in the process of collecting data on location and characteristics of basic infrastructure and critical facilities has become a key pillar of the OpenDRI project, which has engaged in activities that incorporate this approach in Colombia, Haiti, Malawi, Nepal, Sri Lanka, Bangladesh, Indonesia and the Philippines. Understanding how governments can better interact with volunteer communities will be critical to the future development of OpenDRI's work. The research is carried out at the Extreme Citizen Science group, University College London (UCL).

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EXECUTIVE SUMMARY

This report is based on a six-month study of the use of volunteered geographic information (VGI) by government. It focuses on government use of information relating to a location, which was produced through what is known as "crowdsourcing", the process of obtaining information from many contributors amongst the general public, regardless of their background and skill level. The aim of this report is to provide a guide for the successful implementation of VGI in government.

The findings are that:

- There are some established cases of close collaboration between government and the public, which range from land management and biodiversity monitoring to disaster response. These examples demonstrate that successful interaction is possible under certain conditions.
- Many of the lessons from the early implementation of Geographic Information Systems (GIS) in government hold for VGI projects and can be used to ensure their successful implementation.
- Where governmental data is lacking, the need for suitable data sets can lead to the initiation of VGI projects.
- Technical issues are not insurmountable so these are not the limiting factor in VGI adoption by government.
- Organizational practices, regulations and legal issues such as license conditions are much more likely to restrict VGI projects.
- The acceptance and use of VGI will be influenced by individual, organizational, business model, technical and conceptual factors.

Specifically, the most significant issues that need to be considered from the start of any VGI project are:

- How the data collected will contribute to government process and the organizational issues that this entails.
- The ways traditional GIS practices and concerns over organizational change might limit the adoption of VGI by government.
- Methods to overcome inherent coverage, temporal and participation biases, which influence data quality.
- Funding continuation and sustainability beyond often short-term initial projects.
- Maintaining user participation.
- Licensing and other Intellectual Property Rights (IPRs).
- Identifying clear responsibilities and lines of communication for stakeholders.
- Creating clear reporting channels for participants.

INTRODUCTION

The acceptance of volunteered geographic information (VGI) as a valued and useful source of information for governments is growing at all levels. Put simply, VGI is "crowdsourced" geographic information provided by a wide range of participants with varying levels of education, knowledge and skills (see Michael Goodchild's writing for the original definition of the term). While a growing body of research demonstrates the reliability and accuracy of VGI when compared to official or government produced data sets, the progression towards their adoption and wider use is slow. There are a range of mechanisms and methods available for ensuring that crowdsourced information is fit for purpose so concerns about data quality are not the major reason for the lack of adoption. Instead, organizational practices, regulations and legal issues limit the rate of change.

Open dialogue on people's priorities for their communities in Kigali, Rwanda

SOURCE: UNDP / CC BY-SA 3.0

As the World Bank's Open Data for Resilience Initiative (OpenDRI - see below) has recognized, to build resilient societies, policy makers and the public must have access to the right data and information to reach good decisions. Sharing data and creating open systems promotes transparency, accountability and ensures that a wide range of actors can participate in the challenge of building resilience. Within this context, VGI has a role to play and, arguably, it will be impossible to achieve the desired results without the active involvement of local communities in this kind of data collection and maintenance.

OpenDRI

Hosted by the World Bank's Global Facility for Disaster Reduction and Recovery, the Open Data for Resilience Initiative (OpenDRI) works to bring the philosophies and practices of the open data movement to bear on the challenges of building resilience to natural hazards and impacts of climate change. Partnering with governments, international organizations and civil society groups, this initiative develops open systems for creating, sharing, and using disaster risk and climate change information to ensure that a wide range of actors can participate in the challenge of building resilience. Since it was launched in 2011, OpenDRI has worked to implement these ideas in over 25 countries around the world.

The aim of this report is to review governmental projects that incorporate voluntary and crowdsourced data collection and to provide information that can be used to support the wider adoption of VGI (the terms crowdsourced information and VGI are used interchangeably). To this end, the report compiles and distributes lessons learned and successful models from existing efforts by governments at different sectors and scales. The research presented in this report was motivated by the following interrelated issues:

- Sources of VGI data such as OpenStreetMap (OSM) are increasingly important across a range of thematic areas and user communities.
- The quality, consistency and completeness of VGI data have been assessed by a range of studies and overall have been found to be suited to many tasks, and therefore concerns about these issues should not prevent the exploitation of VGI as a valuable source.
- Interacting with VGI communities is a different and potentially more complex relationship than governments have had with traditional sellers and resellers of geographical information systems (GIS) data.
- There are a number of ways in which governments have begun engaging with VGI communities and there is much to learn from early experiences.

VGI projects rely on different kinds of information flows, which are summarized below:

- **Public→Government**. VGI provided by the public to government authorities also has a long history pre-dating the web, e.g. calling to report a problem at a location. This report includes several examples of such cooperation to illuminate specific aspects of VGI practice.

- **Government→Public→Government** and **Public→Government→Public**. Examples of two-way cooperation between government and the public or civic society organizations form the core of this report. Again, collaboration with commercial entities has a long history. This report refers particularly to the use of publicly contributed information by a government authority to make decisions and actions (e.g. NGOs (non-governmental organizations) using OSM data for disaster preparedness) and the release of government information to the public for improvement and its subsequent use by government.

In addition, there is one flow of information that is not covered in this report but is important in the context of information flows in general in order to understand the full picture:

- **Government→Public**. The flow of information from government to the public is important, but is very rarely implemented to initiate VGI projects. The main focus of this report is not on the application of "open data", which is made available by governmental bodies without charge or restrictions to the public, as there are examples aplenty in commercial and civic society. This is also covered in the *OpenDRI Field Guide*.

This report explores different aspects of government use of VGI, including the maintenance of public space (streets, public buildings and parks), education, health, tourism and civil safety. It includes a set of case studies with a common structure, which are presented at the end of the report. The following sections provide background on the use of geographical information by government, which has a long history and should be taken into account. It then turns to the methodology of the research and explains how it developed. A detailed explanation for the case study structure and overview of the case studies is provided next. This is followed by analysis of the findings and recommendations for improving the use of VGI in government.

Boston StreetBump application in use (see case study 17)

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LEARNING FROM PAST IMPLEMENTATION OF GEOGRAPHIC INFORMATION IN GOVERNMENT

The history of digital geographical information is intertwined with government activities. The system commonly recognized as the first GIS was created by the Canadian government in the 1960s to map land use and agricultural productivity and suitability. Moreover, the use of geographical information by government bodies at all levels – from the local to the regional, national and intergovernmental – continues to be one of the most significant applications of GIS.

By the 1980s, with the introduction of customisable and off-the-shelf software packages, GIS implementation became more common in organizations. This led to research into the processes that assist organizations in implementing GIS and how to ensure that the use of digital geographical information is done in an effective way. Of particular importance and relevance to this report are the work of Stan Aronoff and his 1989 book, *Geographic Information Systems: a Management Perspective*, and William Huxhold's, *An Introduction to Urban GIS*. Both paid attention to the management of GIS projects, the importance of understanding the way organizations work and the effort required for successful GIS implementation.

The issue of data capture is particularly relevant to contemporary VGI projects. In the early days, a major part of any given GIS project was the conversion of paper maps to digital formats. The challenges of integrating varied data sources into a coherent database reflect many of the issues emerging from crowdsourced information. Since this early work, the implementation of GIS projects have received on-going attention, with Roger Tomlinson's 2007, *Thinking about GIS: Geographic information system planning for managers*, and significant portions of a leading GIS textbook such as Longley et al.'s 2010, *Geographic Information Systems and Science*, providing the latest summaries from nearly four decades of practice.

While VGI projects may seem fundamentally different from these projects, with their higher level of public engagement and informal participation scheme, there are a lot of parallels. This is because the governmental systems to which VGI is integrated are often "enterprise systems" set along the same lines. Moreover, many of the early lessons from when GIS was first introduced to governmental organizations are similar to the findings discussed below. For example, as with early GIS implementation, VGI use relies on specific individuals who act as "champions" inside the organization and spearhead the effort necessary to secure acceptance for this source of information. Another example is the opportunity that major events, such as disaster response, create in terms of rethinking current procedures and practices. Evaluations of organizational responses provide opportunities to reflect on the way current systems are utilized and develop new procedures for data capture and use. They also open up the policy opportunity to recognize the use of VGI, just as for GIS.

Brabham (2013) Best practices for crowdsourcing in government	
One	Clearly define the problem and solution parameters
Two	Determine the level of commitment to the outcomes, commit to communicate to the online community exactly how much impact user-submitted ideas and labor will have on the organization
Three	Know the online community and their motivations. It is important to know whether a given crowdsourcing application will appeal to participants
Four	Invest in usable, stimulating, well-designed tools
Five	Craft policies that consider the legal needs of the organization and the online community
Six	Launch a promotional plan and a plan to grow and sustain the community
Seven	Be honest, transparent and responsive
Eight	Be involved, but share control
Nine	Acknowledge users and follow through on obligations
Ten	Assess the project from many angles

As a consequence, working with people who are experienced in implementing GIS in government, and encouraging them to adopt VGI as a usable source of information, makes it possible to use past lessons from other projects and adapt them to VGI. In other words, while accepting the specific characteristics of VGI, it should not be seen as an unprecedented data source.

To the best of our knowledge, though, this is the first study and report of its kind to deal directly with VGI use in government. Brabham (2013) produced a report called "Using Crowdsourcing in Government", which outlines a more general overview of the potential for crowdsourcing in government (see box). Brabham also attempts to classify crowdsourcing and understand when and how to deploy crowdsourcing in government. His analysis includes a small number of case studies and the report concludes with ten best practices and considerations for crowdsourcing. This summary is a helpful starting point on which this report builds.

CRAIG CHEW-MOULDING / CC BY-SA 2.0

Ordnance Survey map of the coast (see case study 12)

RESEARCH METHODOLOGY

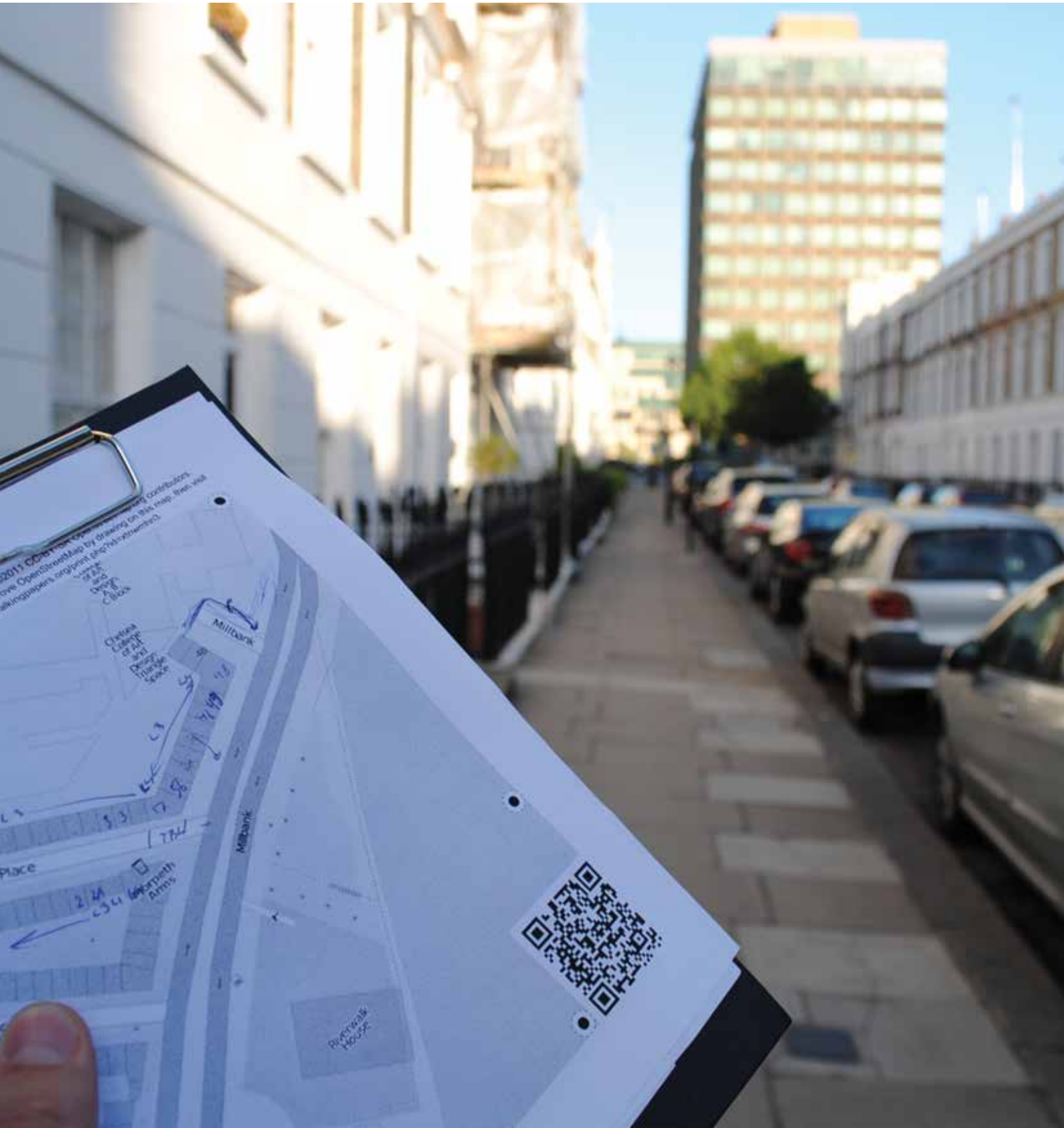
The overall structure of the research process was as follows. First, seven cases known to the research team were developed collaboratively to establish the relevant information required for each case study and develop a questionnaire with appropriate fields to capture this. Once the pilot case studies had been developed in January 2014, they were transferred to a website. The case studies, together with introductory material and details about the report, provided the context for the questionnaire, which was integrated on the site.

The website and questionnaire were tested with five experts active in the area of VGI and government, and their feedback was used to improve it before promoting the website in email lists and other social media outlets between late February and early May 2014. The website offered an incentive scheme, in which contributors chose between donating to OSM, another organization or receiving Amazon vouchers. This aimed to encourage a variety of contributors to provide the research team with concrete case studies. The website received 3500 page views over the period, from about 1100 visitors. However, only five responses were provided through the open questionnaire. Therefore, in parallel to the questionnaire, the research team continued to search for, identify and compile further case studies, bringing the total to 29. The details of the case studies are summarized below and then provided in full in a later section (five are shorter due to the limited information available).

Following the data collection exercise, the case studies were reviewed, analyzed, further documented and classified according to themes. This provided the outline of the Analysis section. The final report was then opened for comments from the Global Facility for Disaster Reduction and Recovery (GFDRR) and the wider community before it was concluded.

OpenStreetMap mapping in London

ALEXANDER KACHKAEV / CC BY-SA 2.0



CASE STUDIES: STRUCTURE AND OVERVIEW

Each case study is intended to provide an example of the use of VGI by government or by the public, and summarizes the context, positive and negative outcomes and main lessons. The case studies are presented in full in a later section and are all deliberately short, with the same structure.

First, a summary table provides general information about the case study in the format below:

Interaction type	The flow of the data (either crowdsourced or authoritative), in one of the categories introduced earlier: **Public→Government, Government→Public→Government** or **Public→Government→Public**.
Trigger event	A specific event that might have triggered the data sharing (e.g. change in data license, natural disaster, etc.), where relevant.
Domain	The area in which the data sets have been used. This may include both an abstract characterisation of the general area (e.g. generic mapping) as well as information about the specific field (e.g. update of national topographic database).
Organization	The organization(s) that initiated the data sharing process and those that have been actively involved in the whole project.
Actors	Interested parties/stakeholders that have contributed to, or benefited from, the data sharing process in any way.
Data sets	The data sets that have been shared and used by the public or the authorities (including new data sets generated).
Process	The process followed to implement the data sharing, data integration and cooperation.
Feedback	The immediate result returned to the initiator of, and/or participants in, the data sharing process, if any.
Goal	The original goal of the project and reason for exploring crowdsourced geographic information.
Side effects	Any other issues or outcomes.
Contact point	The person who has either provided details about, or been significantly involved in, the case study, when available.

Next, each case study includes the context, a description of the project and a discussion of the positive and negative aspects of the collaboration. They each close with bullet points indicating the most important lessons to be learnt. Below are short descriptions of the case studies that provide the basis for this report:

1. Participatory mapping and decision support tools for disaster risk reduction, the Philippines

This project provided training and technical assistance to local government units to create basemap information and then perform impact analysis using InaSAFE impact modeling software. This allows analysis of the effect of a disaster on an area, using scientific models as well as population/infrastructure data.

2. Community Mapping for Exposure in Indonesia

The goal of this project is to reduce vulnerability to natural disasters. Young people have successfully collected spatial and attribute data, and traced them in the OSM platform so that thematic maps can be created to show potential damage in case of physical disasters.

3. Flood preparedness through OpenStreetMap, Jakarta, Indonesia

A sub-category of Community Mapping for Exposure, in this project the heads of villages in the area of interest were asked to identify their critical infrastructure by using paper maps and university students entered the information into OSM. The data can produce maps for disaster risk planning.

4. Humanitarian OpenStreetMap Team mapping in Ulaanbaatar, Mongolia

A greater vision for creating a "Smart City" in Ulaanbaatar, Mongolia, motivated local stakeholders and volunteers to participate in a project to create an updated topographic map. The World Bank/ICT and the Humanitarian OpenStreetMap Team (HOT) worked with local officials (universities, city officials and government) to establish an OSM community in the city to support this project.

TriMet: MAX and bus on Portland Mall (see case study 29)

TRIMET / CC BY-NC-SA 2.0

5. Mapping schools and health facilities in Kathmandu Valley, Nepal

This is a proactive crowdsourced mapping project to minimize the consequences of a possible future natural disaster in an area at high risk of a high-magnitude earthquake. Learning from the difficulties in Haiti, Kathmandu officials have worked with NGOs to map the basic education and health infrastructure. These data sets will facilitate the delivery of humanitarian efforts if needed.

6. Informal settlement mapping, Map Kibera, Nairobi, Kenya

Map Kibera was carried out in the most crowded slum in Nairobi, Kenya, in an effort to improve its reputation and offer an accurate picture of the area, which is quite dynamic due to the movement of the population. Local people collected and edited GPS tracks. Innovative techniques such as SMS, video and voice reporting were also launched and a small amount of compensation offered to participants.

7. Mapping of South Sudan

This was launched because of the need for a temporal and up-to-date map when the new nation was created. Google Map Maker, the Sudanese diaspora and various organizations carried out workshops to train people to work separately on the digitization of aerial imagery. A significant amount of work was completed in a short time by adopting local knowledge and providing technical tools. Those who experienced the training sessions were inspired to recruit new volunteers.

8. iCitizen, mapping service delivery, South Africa

This project is at the design phase and aims to involve the public at a local level to collect data points via mobile phones and adopt different ways of geotagging photos in real time or via SMS and email. The purpose is to report infrastructure problems.

9. Skandobs, Scandinavian predator tracking system, Norway and Sweden

This is a cross-country project developed to collect observations for lynx, wolverine, brown bear and wolf populations, driven by new legislation requirements. Reliable observations help to inform management objectives including long-term conservation and population-level management. Monitoring is complicated and expensive for many reasons, including the geographical size of the area under observation but involving the public has been very successful.

10. Corine Land Cover 2006 in OpenStreetMap, France

The change in the data release policy of CLC2006 enabled the French OSM community to integrate it into OSM and engage the public to add updates. The methodology and best practices were adopted by a large number of national OSM communities. The updated OSM data can be used by the public and governmental agencies.

11. FixMyStreet for municipality maintenance information, UK

Led by a third sector organization (mySociety) this project is based on a web platform that engages the public to provide data about problems in the local area. The data collected is propagated to the local authority responsible for maintenance, which can then feedback any action taken to remedy the problem.

12. FINTAN vernacular placenames project, Ordnance Survey and Maritime and Coastguard Agency, UK

This project leverages “professional” crowdsourcing to facilitate the response to distress calls by centrally recording and managing vernacular placenames. In order to achieve this HM Coastguard personnel and other professionals submit their local knowledge on placenames to a central platform.

13. Towns Conquer, gamification and Instituto Geográfico Nacional toponyms database, Spain

Developed when a university research team were awarded a small funding prize, an Android-based game was created and linked to a web-based map service at Spain's national mapping agency (NMA). Volunteers were able to submit their suggestions for corrections and updates within a competition format.

14. National Biodiversity Data Centre, Ireland

This project was initiated to leverage the potential of outreach groups and the general public for data survey and observation. This widens the base from which observational biodiversity data may be obtained in Ireland. Another aim was to initiate a stronger engagement of non-professional scientists and heighten the understanding of biodiversity related matters amongst the general population.

15. Haiti disaster response

One of the most well-known crowdsourcing applications, this was developed after the earthquake hit Haiti in 2010. Within 48 hours, the capital had been mapped by volunteers who contributed from every part of the world to create a temporal topographic map to fill the gap left by the official mapping agency. The maps were used by various organizations to allocate supplies and medicine.

16. Mapping for Natural Resources Canada

The Mapping Information Branch of Natural Resources Canada (NRCan) is releasing its data sets into OSM format in an effort to engage the local OSM community. The aim is to update the national database to supplement the agency's limited resources and correct outdated topographic maps.

17. Boston StreetBump, US

This is part of an initiative by the Boston Mayor's Office of New Urban Mechanics (MONUM) to pilot experiments that offer the potential to radically improve the quality of city services. The idea was to capture new technology – from smartphones to GPS – and a resurgent spirit of civic engagement. In this example, the public use their smartphones to help detect bumps or potholes on Boston's streets.

18. Open data initiative, New York City, US

Part of a broader open data initiative, the City of New York has released building footprint and address location data. MapBox, a private company, in partnership with the US OSM community, has begun importing these data sets into OSM. The city administration receives email updates when changes are made. This helps them to prioritize surveying efforts and keep government data up to date.

19. Imagery to the Crowd, State Department Humanitarian Information Unit, US

A program whereby high-resolution satellite imagery is made available to the OSM community to facilitate the digitization of ground features. The resulting data has been used to support a number of humanitarian operations.

20. OpenStreetMap Community of Practice, US Census Bureau

Several US Census Bureau employees have worked to build an active volunteer group of OSM contributors within the Bureau. This group is now advocating for the incorporation of VGI practices into Census operations.

21. Crowdsourcing The National Map, National Map Corps, US

The National Map Corps has given volunteers the chance to collect and edit data about ten different human-made structures in 50 states in an effort to provide accurate and authoritative spatial data. The methodology includes various steps such as

adding new features, removing obsolete points and correcting existing data. A pilot test in Colorado showed that the VGI was satisfactory in its accuracy.

22. US Geological Survey "Did you feel it?"

A website that automatically maps reports from the public about their perception of recent seismic activity in their areas. It also collects quantitative data from citizen reports. The project was driven by a lack of instrumental ground-motion data in regions of low seismicity and the vast amount of new data being collected offers a valuable resource and has the potential to address some long-standing controversies in earthquake science.

23. Places of Interest project, National Park Service, US

The US National Park service is seeking to incorporate VGI principles into their strategy for keeping park maps up to date and accurate. Using tools developed by the OSM community, park visitors and staff can now contribute to mapping trails, tourist sites and other park infrastructure.

24. California Roadkill Observation System (CROS), US

This project was developed by a university-based research organization to understand the relationship between ecology, wildlife behavior and transportation. It includes the use of GIS and statistical modeling to predict roadkill hotspots, measure contributing factors, quantify impacts and estimate benefits of different remedial actions. CROS can be used to record observations from reporters out in the field who come across identifiable road-killed wildlife. The goal is to provide a safer environment for wildlife in relation to California's motorways.

25. Shelter Associates, slum mapping in India

Shelter Associates is an NGO focused on housing projects, sanitation, health and education initiatives in India. It uses slum mapping to promote good governance and decision making policies. It is a hybrid model with expert and local volunteer contributors and has used GIS since the late 1990s, recently introducing Google Earth as an easy-to-use tool for informal settlement mapping.

26. Crowdsourcing satellite imagery in Somalia

This project was launched in an effort to map all shelters located in the Afgooye corridor, Somalia, to identify the number and location of refugees. Satellite imagery was used to map the information in order to facilitate decision making policies.

27. Agricultural data collection and sharing by Community Knowledge Workers, Uganda

A Community Knowledge Workers network in Uganda facilitates grassroots data collection and sharing by farmers for other farmers and policy makers. The network has overcome the lack of electric power and mobile network infrastructures to provide data and services such as weather forecasts, crop market prices, livestock disease outbreaks and focused policy implementation for improved farming practices.

28. Twitter use in Italian municipalities

A research project into the profile, activity and use of Twitter accounts of Italian municipalities, the study focused on the types of messages sent, revealing that culture and tourism are the most common topics. Twitter also provides opportunities for members of the public to communicate with municipalities.

29. Portland TriMet, transportation planner, Oregon, US

TriMet, the public agency that provides bus, light rail and commuter rail transit services in the Portland, Oregon, metropolitan area turned to the use of OSM data to improve its services by including multimodal transportation plans. The TriMet officials committed to support the OSM community and realized that releasing governmental data to the public led to improved public services.

Participants of the Map Kibera project (see case study 6)

MAP KIBERA / CC BY-NC-SA 2.0

ANALYSIS

The overall analysis of the collected case studies delineates seven main components of VGI projects for government use.

1. Incentives/drivers to start a project, mostly from the government perspective
2. Scope and aims
3. Participants, stakeholders and relationships, identifying the roles that different participants play
4. Modes of engagement
5. Technical aspects
6. Success factors
7. Problems encountered

1

INCENTIVES/DRIVERS

There are many different factors that encourage organizations to search for an alternative to institutional data solutions and start VGI projects.

Lack of institutional data in time sensitive situations

This is one of the most common drivers and its importance was shown particularly by the aftermath of the Haiti earthquake, where there was an urgent need to provide mapping to facilitate humanitarian and first aid efforts. The Kathmandu case study is a proactive example of local and international stakeholders teaming up to provide basic mapping of schools and health facilities in case of earthquake.

Policy change around governmental data

For example, the adoption of an open data policy in New York City; the use of the released CLC2006 data by the French OSM community; and the US State Department Humanitarian Information Unit (HIU) sharing high-resolution imagery with humanitarian organizations and volunteer communities.

Low resources and need for infrastructure support

Interestingly, this situation can be a driver for both well-established NMAs, such as the one in Canada where updates are needed to mapping covering 10 million km^2, and newly established ones, such as in South Sudan where basic topographic features are needed to build the first data infrastructure of the new state. Similarly, the implementation of ambitious efforts like the "Smart City" project in Ulaanbaatar, Mongolia, need support from VGI.

Research and development efforts

This includes exploring new products or new directions of research. Examples are CROS, a university-led initiative about wildlife roadkills, and Towns Conquer, which explores gamification techniques and strategies to enhance VGI. A slightly different approach is taken by FINTAN in the UK, which uses "professional" VGI to collect and preserve expert local knowledge.

Environmental monitoring through citizen science

Public participation in scientific data collection is frequently related to monitoring the state of the environment rather than the creation of new products/research trajectories (as in research and development, above). Examples include the USGS's "Did you feel it?" public participation in seismic monitoring; Ireland's National Biodiversity Data Centre submission of biodiversity records by the general public; and Skandobs wildlife observations crowdsourcing.

California Roadkill Observation System (see case study 24)

2

SCOPE AND AIMS

Basic mapping coverage

In many cases the aim is as basic as the creation of a cartographic background for an area of interest or entire country. In many developing countries there is no spatial data infrastructure to support efforts such as humanitarian support, disaster prevention and general planning. Examples include South Sudan, where the new nation was in urgent need of basic cartographic coverage, and Map Kibera, where the aim is to create a topographic backdrop of Nairobi's biggest informal urban settlement.

Update authoritative spatial data sets

A step further is the aim to support established spatial infrastructures. Keeping data sets up to date (mainly through change detection projects) is a crucial task, especially for NMAs as this guarantees the quality of their services. Examples include NRCan, Towns Conquer, New York City's open data initiative, Ulaanbaatar's "Smart City" and the US Census Bureau.

Upgrade public sector services

Related to the above is the effort to collect new and unrecorded spatial data sets to upgrade the quality of the services provided by a public sector organization. Examples include the FINTAN project in the UK, which will improve HM Coastguard services in terms of time response to distress calls, Portland TriMet, iCitizen in South Africa, Boston StreetBump and FixMyStreet.

Policy development or reporting

Local knowledge and the timely nature of participants' observations are two of the most important VGI characteristics that stakeholders are trying to tap into. Examples that combine observation gathering and policy planning are CROS, where observations about roadkills help stakeholders understand the phenomenon and the best remedial actions, and Skandobs, where wildlife observations inform actions and policies in accordance with new legislation. Ireland's NBDC and USGS's "Did you feel it?" are more report oriented and use the observations to stimulate public engagement and analysis respectively.

KIRU PILLAY, UNIVERSITY OF THE WITWATERSRAND

iCitizen interface (case study 8)

Natural disaster preparedness (proactive) and crisis management (reactive)

As well as being a driver, one of the most important aims of existing projects is to build spatial data sets for humanitarian purposes. This covers both the action of crisis management after a natural disaster as in Haiti and the proactive actions of creating the necessary infrastructure in an effort to minimize the consequences of a future disaster, as in the cases of Kathmandu, Indonesia and the Imagery to the Crowd project.

3

PARTICIPANTS, STAKEHOLDERS AND RELATIONSHIPS

Public sector and NGOs/international organizations

This type of cooperation is relevant to various contexts, including crisis management, where the active participation of all stakeholders is needed to address often difficult and complicated tasks. Those involved in such partnerships include the United Nations, World Bank, HOT, NMAs, state mapping departments and local universities. The following examples indicate the breadth of such cooperative efforts: Haiti disaster response, Imagery to the Crowd, Ulaanbaatar's "Smart City", Kathmandu and Map Kibera (the latter involving thirteen national and international bodies).

Public sector, private sector and NGO cooperation

An even more inclusive type of cooperation is the additional participation of the private sector. For example, MapBox joined forces with the OSM community and the New York City government to support data migration and software provision, in turn gaining valuable insight into the data released. In another case, a number of international organizations had the active support of Google in terms of software and user motivation to help the local government begin the mapping of South Sudan.

Universities and research institutions

As VGI is a relatively new and dynamic phenomenon, there is much active research undertaken by universities and research institutions on its evolution (e.g. Towns Conquer) and on possible real-life applications (e.g. Skandobs, USGS's "Did you feel it?", Ireland's National Biodiversity Data Centre and CROS, California).

Private and public sector initiatives

The private, rather than public, sector can also lead on projects for VGI use in government. One such example is FixMyStreet, run by social enterprise mySociety; another is the involvement of the UK's Ordnance Survey (which functions with market criteria, despite being an NMA) in the development of an application that supports "professional" crowdsourcing for vernacular placenames for use by HM Coastguard.

Skandobs observation of a lynx (see case study 9)

4

MODES OF ENGAGEMENT

Reaching out for public support

One of most common types of engagement is for the stakeholders to directly reach out for public support and in parallel engage with pre-existing local communities of volunteers (e.g. Kathmandu) or create such communities (e.g. Ulaanbaatar) as part of the effort to produce geospatial data sets. Another example is the engagement of the diaspora of South Sudan to provide a solid topographic map of the new state. The Haiti disaster response is an interesting example because there was strong hesitation on behalf of the local NMA regarding the support that non-experts could provide. However, due to the initiatives of other participants (i.e. OSM, UN) the results of the public engagement proved to be a valuable tool for delivering relief on the ground.

Releasing existing resources

This can include the release of data sets (including visual databases) or license changes enabling greater use for public users, including the OSM community, and private entrepreneurs. The most characteristic cases of this type of engagement are the Imagery to the Crowd project, New York City open data initiative and use of Corine Land Cover 2006 in France. Both the general public and active volunteers seem to be in quest of data sets that will facilitate their efforts and thus welcome such initiatives.

Direct investment

Directly employing contributors can help government agencies to ensure that the data collected meets their immediate needs, while still benefiting from participation in the broader ecosystem.
In both the Portland TriMet and Community Mapping for Exposure in Indonesia case studies, government resources were used to hire in-house mappers to contribute to OSM. Community-based projects in areas of very low income can also benefit from providing financial compensation to public participants to replace earning potential, as Map Kibera did in Kenya.

Research and citizen science initiatives

Although giving the public the opportunity to participate in monitoring and research projects has a very long and successful history, technological advances, especially in the mobile domain, offer a different level of dynamic engagement. The case studies of Towns Conquer, CROS, USGS, Skandobs and Ireland's National Biodiversity Data Centre all demonstrate this type of engagement.

JENNIFER JEWETT/USFWS / CC BY 2.0

Christmas Bird Count is an example for citizen science projects

Role of champions within a specific community of practice

This type of engagement stems from individuals' prior knowledge about the nature and use of VGI and, often, from their cooperation with local communities such as OSM volunteers. Their personal effort pushes their organizations to engage more actively in VGI and develop methodologies and best practices that would be beneficial for all stakeholders, including governmental organizations, the OSM community and the public. This particular mode of engagement can be observed in the case studies of the US Census Bureau and Natural Resources Canada.

5

TECHNICAL ASPECTS

Of specific relevance here is the need to formalize and standardize VGI before it can be used in government systems. This influences the following aspects:

Combination of conventional and open source data

Many crowdsourcing projects use a wide range of software applications, both closed and open source. The Corine Land Cover in France and Natural Resources Canada case studies prove that combining various tools in different applications can widen the technical horizons of an application and create new opportunities. However, access to the knowledge and experience of using these software tools is not available to everyone and requires high technical abilities.

Data sets

Another issue with VGI data sets is the need for synchronisation and coordination. During update operations, data sets often diverge but the users and recipients of a project should know which version is the correct one and how to maintain a definitive copy. In some cases, and especially where open source software is used, the format of data is not convenient for further use in proprietary software packages, making it difficult to reintegrate the data. Therefore, the interoperability of data formats is a significant issue.

Accuracy and quality

The accuracy of the information continues to play a key role in VGI projects. Community Mapping for Exposure in Indonesia indicated that accuracy varies among the different data sets, which is an issue of concern. Elsewhere, the Colorado pilot project for the National Map Corps showed that accuracy significantly improved when volunteer participation increased. A related concern includes the accuracy of data collected by mobile phones, as in the iCitizen project where this is the main issue. However, there are many methods for quality assurance in VGI and these can be used to ensure the accuracy and quality of the information.

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OpenStreetMap buildings

Authority

The authority given to VGI data is one of the most challenging issues for its use in government. In a departure from an era in which information is considered authoritative simply because it originates from a government organization, recognition of the inherent heterogeneity in geographical information and the need to keep it up to date permeate many of the case studies. However, because government bodies have both the authority and the responsibility to provide accurate and comprehensive information, this requires more control over the data and its quality. Many of the case studies, such as USGS or NRCan, show that governmental organizations need to put appropriate procedures in place to ensure that, regardless of the source, the information released is accepted as trustworthy and valuable.

6

SUCCESS FACTORS

Elements that contribute to the success of VGI projects should be considered from the outset and are often linked to the original drivers.

Identification of appropriate cooperation between the public and government

Approval and acceptance by the government is central to VGI success in this context, regardless of the stage of the project. Approval means not only the adoption of crowdsourcing techniques but also the cooperation between the public and government in a continuous effort to produce the desired result. Governmental experimentation plays a crucial role in identifying how to incorporate crowdsourcing techniques into official activities and projects. VGI support is divided into two main categories, that offered during the evolution of the project (e.g. NRCan-OSM on-going collaboration) and that offered in its aftermath (e.g. South Sudan government evaluation of the project by Google Map Maker and the Sudanese diaspora). In contrast, it is notable that the outcomes of the Haiti disaster response were not subsequently used by the local official mapping agency, though they were used by other humanitarian actors operating in the country at the time. This represents a missed opportunity to establish a richer connection between the Haitian government and the OSM community, and is linked to issues of IPR, covered below.

Partnership of scientific organizations

Strong collaboration between different organizations, which are experts in different parts of a project, is key to success. Although in a few cases this has led to a lack of coordination and duplication of data (e.g. the Haiti disaster response), in others duties are separated into technical, economic and human resources (e.g. the National Map Corps project). Research organizations and universities can play a positive role in this as centers of innovative ideas and techniques as well as participants and volunteers.

Workshops

A series of workshops carried out in the preliminary stages of projects encourages the training of volunteers and defines the pattern for participant coordination. It is noticeable that among the most successful stories (e.g. Community Mapping for Exposure in Indonesia, Map Kibera in Kenya and South Sudan mapping) the workshops indicated the value of partnering with scientific organizations such as local universities to train volunteers and conduct quality assessment to ensure government acceptance of the data.

Recruitment of volunteers

Although the common view is that the public can participate in all crowdsourcing applications without restriction, the reality is quite different. Most projects are oriented to specific tasks and recruit the public according to their age, background or technical skills. One example is Community Mapping for Exposure in Indonesia, where young undergraduate students were recruited and scholarships offered in exchange for participation. As crowdsourcing reaches new locations, compensations and awards to participants may also become more important, as in the case of Map Kibera.

Innovative techniques

In an effort to keep the interest of the public and adopt new technologies and platforms, different organizations have promoted new crowdsourcing techniques, such as gamification (e.g. Towns Conquer) and reporting with the aid of photographs, video and SMS (e.g. Map Kibera) or use of social media (e.g. by Italian municipalities).

7

PROBLEMS ENCOUNTERED

One-off event versus on-going initiative

While many VGI activities are conceived as a single event, the longevity of updates and maintenance needs careful consideration. Projects vary significantly in this respect. For example, the use of CLC2006 in OSM in France lasted many months and resulted in an outcome which remained unexploited; while others lasting only a few days, such as the mapping of South Sudan and the Haitian disaster response, provided a clear solution to a significant problem relatively quickly. The main differentiation concerns the strategy behind each VGI project and how it is recognized by local authorities and the public, whether as a one-off crowdsourcing event or as an on-going initiative. The response is directly linked to the perspectives that have been cultivated, the trust that is given and the aims of the project.

Accuracy and reliability

The quality of the VGI and its application are among the main questions that must be answered at the beginning of, and during, a project. A challenge in projects launched or supported by governmental bodies is that they are responsible for providing authoritative data, while also integrating input from the public, making accuracy and reliability key issues. The case studies demonstrate different levels of accuracy and ways of assessing this (e.g. Community Mapping for Exposure in Indonesia, National Map Corps in the US). Accuracy varies depending on the new data's purpose and the existing data available as a reference. This is also relevant to hardware issues in passive VGI, in which data from sensors that are carried by members of the public is shared with government bodies. For example, in the Boston StreetBump case study, the use of smartphone-based sensor technology produced many "false-positives" due to erroneous movement detection. As noted, there are multiple methodologies for quality assurance of VGI, and these should be explored and integrated according to the specific context and aims.

Maintaining public interest

Public interest and participation need to be maintained through the life of a VGI project. For example, researchers involved in iCitizen are concerned about how to convince the public to use mobile phones and applications. The experiences of other projects indicate that solutions are divided between less and more economically developed contexts. In the former, attracting volunteers means offering a small amount of compensation to replace time that could otherwise be used to generate income. In the latter, innovative techniques such as gamification and clear targets can be helpful. Maintaining the data and the relevant software is also an issue of concern. Financial resources should therefore be split across the whole life of a project rather than allocated only to the beginning stages.

KATHMANDU LIVING LABS www.kathmandulivinglabs.org / CC BY-SA 3.0

Five-day OpenStreetMap training to Nepal Red Cross Society for community based disaster risk reduction (Koshi Basin) program

ADOPTING CROWDSOURCED GEOGRAPHIC INFORMATION IN GOVERNMENT

The clear message in this report is that there is no "magic bullet" or perfect methodology for a VGI project. However, it does reveal that there are a series of issues which need to be addressed when considering a crowdsourcing project. Attention to these issues can increase the likelihood of successful adoption by government and acceptance by the public.

Separation between data collection and use for policy analysis

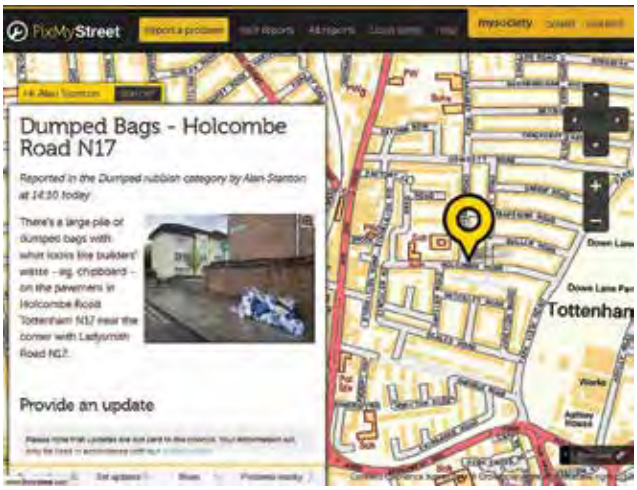
One of the key concerns for the public involved in VGI is how and where their data and contributions are put to use. Very often it is unclear if their information has been used at all. In this report we have emphasized where VGI has been used to directly influence policy. It is very important when adopting crowdsourcing that the connection between data collection and eventual use by the government is made clear.

Traditional GIS practices and concern over organizational change

It is important to highlight that VGI should not be seen as an activity that replaces the work of professionals, but as one that enhances it. In some cases, such as Haiti, the use of VGI was seen as a direct threat to the business model of the NMA and the OSM data could not be adopted without consideration of how this could be protected (see also Intellectual Property Rights issues). In other cases, VGI is perceived as a challenge to existing procedures, funding and professional standing, which leads to a negative response. There is also a need to integrate VGI processes, including issues of engagement and feedback to contributors, into established systems, practices and procedures. In some cases, current practice does not require such high levels of engagement so organizational transition is required. This is particularly important in emergency situations, where entrenched procedures are necessary to ensure an appropriate response and capacity to deal with uncertainty and complexity is reduced. If VGI is considered for use in crisis response it should be evaluated and tried in preparation exercises to ensure that it is fit for purpose.

Inherent coverage, temporal and participation biases

The growing body of research into VGI demonstrates that they can exhibit certain biases in the level of participation, as well as when and where the activities take place. For example, there is a problem of coverage bias towards populated and popular places (such as large urban centers) and crowdsourcing rarely includes a representative sample of the general population. An example of a case study limited by such inherent biases is the Skandobs project, where the real areas of interest are geographically remote and present physically challenging terrain. Special incentives may be needed to encourage public involvement from specific regions and known biases of this kind should be considered during the design and implementation of such projects.



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Reporting with FixMyStreet (see case study 11)

Project continuation and sustainability

In many of the case studies examined there is no specific plan for longer term adoption of VGI by the governments involved. Adoption of crowdsourcing by government is a process, which must be subject to resource management and organizational change. Adopting crowdsourcing is likely to require additional resources in terms of managing the crowdsourcing processes, the data collected and engaging with the communities involved. Interaction with crowdsourcing projects may be terminated by governments for a number of reasons: the VGI champion may be redeployed, there may be a change in policy or resources may not be available to continue the engagement. Governments must consider long-term plans and assess the sustainability of their adoption of crowdsourcing.

Licensing and other Intellectual Property Rights (IPR)

Concerns over data ownership and specific licensing agreements are another obstacle to the adoption of VGI in government. Incompatibility in licensing should be considered at the outset of the project. For example, the OSM license requires data to be shared-alike and Google owns all data in Google Map Maker. IPR is especially important in geographical data sets because most of the value will not come from a single data set but from linking and matching it with other data sets. This means that problems with derivation (e.g. the source that dictates the coordinates used to locate an object on the map) can emerge and create uncertainty about how the data can be used and under which conditions.

Contact points

When governments engage with established crowdsourcing communities it is very important that there are open and clear lines of communication between both parties. Some of the skepticism around VGI stems from the fact that it can be difficult to contact those involved. This is very different from when governments enter into a contract with a third party company or organization. When governments provide a general call for contributions from the public, there is often no way of contacting the leader or director of the crowdsourcing community and indeed such a person may not exist. HOT provides an example as to how this can be resolved, as an established organization dedicated to providing VGI services in crisis situations. More generally, there is a need to define clear ownership of the process and responsibility over its management. The information should be clear so volunteers can easily identify and contact the responsible individual, especially in case of emergency.

Conflict between channels of reporting

In some projects, channels of reporting can be confusing and conflicting for participants. An example is the relationship between FixMyStreet, which is run by an independent body, and the helpline of the local authority. In other cases, there are multiple channels, which can be important in crisis situations but require management. At the same time, it is clear that different participants will prefer different channels so enforcing the use of a single channel can be counterproductive.

Citizen science participant during a Bioblitz

JO SUMMERFIELD / CC BY-ND 2.0

SUMMARY AND WAY FORWARD

This report has reviewed VGI use in government and identified success factors and challenges. While suggestions of crowdsourcing best practices that were identified by Brabham (2013) are relevant here, such as the need to define the problem clearly, ensuring commitment from the organization and knowing the online community, this report identifies several factors specific to VGI projects. To summarize, the factors likely to influence the use of VGI relate to the following:

- individuals
- organizations
- business models
- technical problems and
- conceptual issues

At the **individual** level, champions and change leaders within public sector organizations can be critical. In both the UK and France, there are examples of open data enthusiasts at local government level, who have led to significant changes in the way organizations use VGI. Such champions were always critical in the adoption of geographic information technologies in government and will continue to be so. On the other hand, specific individuals with worldviews that oppose public participation in data collection and analysis can block or hinder the integration of VGI into government.

The **organizational level** is also important. In organizations mostly using information provided by external sources (e.g. private sector) there is a higher potential for replacing this information with VGI than if information is maintained internally and the use of VGI might be seen as a threat. This is despite evidence demonstrating that successful VGI augments rather than replaces organizational activities. Further organizational issues can be procedural, such as existing legislations and obligations to service delivery, or structural, such as the responsibilities for data collection and use.

Next are issues that relate to **business models**. Organizations responsible for data collection, maintenance and dissemination have an incentive to use VGI to reduce costs, although additional costs might be involved in communicating with the public and maintaining their interest. On the other hand, for organizations responsible for selling data to maintain their operations the use of open data and release of highly valuable geographic information is a threat to their financial viability. Private sector organizations are also affected when they have committed to deliver public services based on assumptions that emerging data can be used for profit.

Technical problems should be also noted, which include the ability to merge data sets that have been changed by the public into an existing system. This requires various abilities, from version management to object level metadata. In some cases, differences in formatting and fundamental data structure, as well as semantic ambiguity, add to the challenges of using VGI fully. In addition, the plurality of tools and channels through which information can reach an organization are significant challenges.

Finally, **conceptual or "worldview"** issues need to be recognized and may well be presented as one of

the above categories. VGI use requires accepting a higher level of uncertainty, attention to heterogeneity and the need to work closely with diverse groups and communicate with the public. This can be challenging to people who are used to working in an isolated and top-down manner. In addition, perceptions of VGI as professionally threatening should be accepted as genuine and reasonable, and need to be addressed.

To conclude, this report has documented only the early stages of VGI use in government. There is a need for further research to explore the factors influencing the success and failure of VGI projects for government use. Some of the problems, such as licensing terms, will require specific effort from both governmental organizations and crowdsourcing communities. At this point in time, there is much misunderstanding between the two groups in terms of time frames, work practices and problem solving approaches.

At the same time, this report has demonstrated that collaboration between government organizations and the public is possible and beneficial to both parties. Technological and societal changes over the past decades mean that opportunities for such collaboration are increasing. However, like any cooperation between established institutions and external groups or individuals, VGI projects require attention and planning. The successful cases are no longer "happy accidents" but evidence of commitment and investment at individual and organizational levels, which provide a return in the form of information that would otherwise be difficult to obtain. Practitioners can use the lessons identified from case studies across the world in order to further develop this field.

Participatory GIS training (see case study 5)

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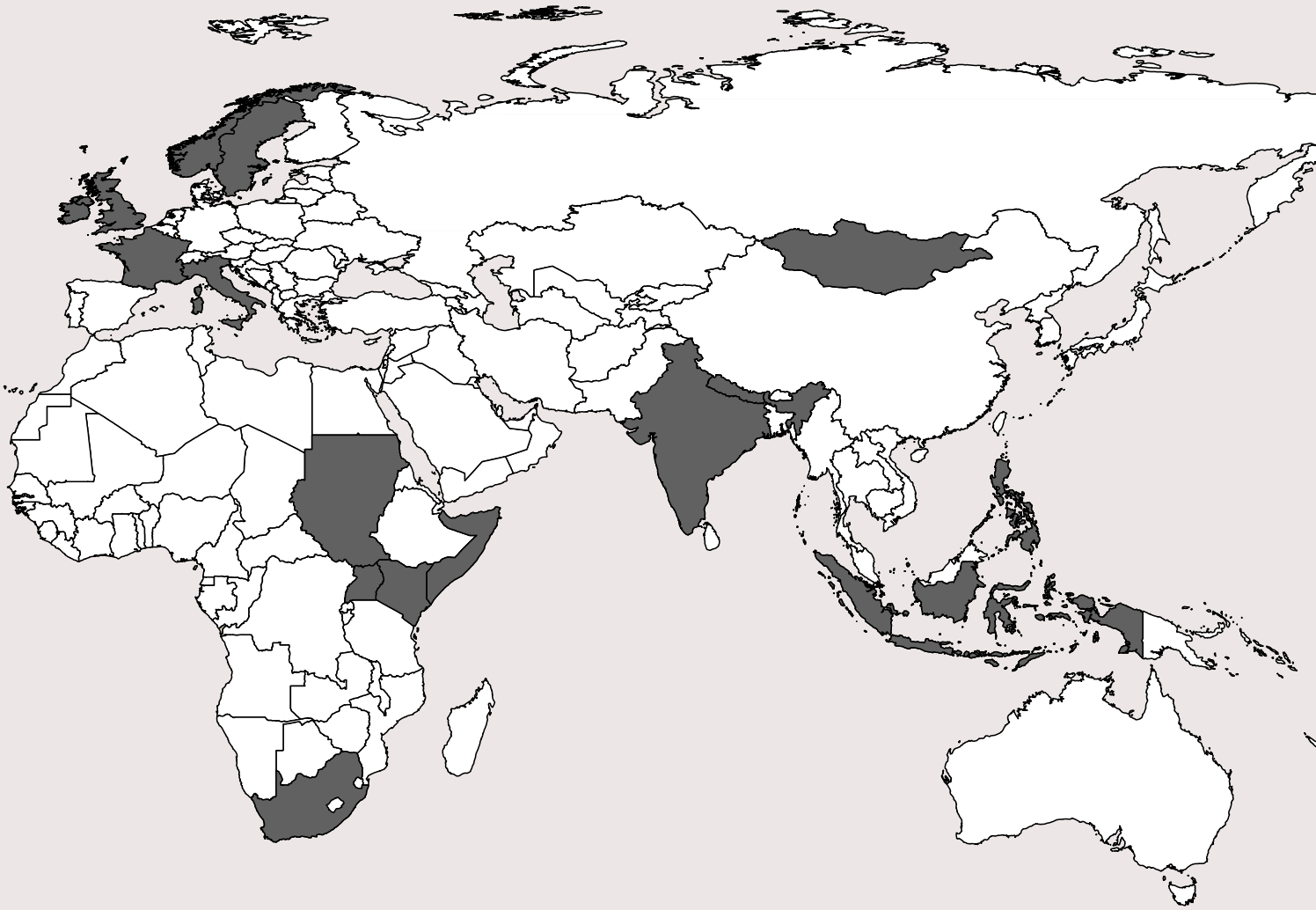
CASE STUDIES



Quick reference

No	Case study	Disaster/ risk	New data sets	Maintain data sets	Public services	Specialist knowledge
1	Participatory mapping and decision support tools for disaster risk reduction, the Philippines	Yes				
2	Community Mapping for Exposure in Indonesia	Yes				
3	Flood preparedness through OpenStreetMap, Jakarta, Indonesia	Yes				
4	Humanitarian OpenStreetMap Team Mapping in Ulaanbaatar, Mongolia	Yes				
5	Mapping schools and health facilities in Kathmandu Valley, Nepal	Yes	Yes			
6	Informal settlement mapping, Map Kibera, Nairobi, Kenya		Yes		Yes	
7	Mapping of South Sudan		Yes			
8	iCitizen, mapping service delivery, South Africa				Yes	
9	Skandobs, Scandinavian predator tracking system, Norway and Sweden					Yes
10	Corine Land Cover 2006 in OpenStreetMap, France			Yes		
11	FixMyStreet for municipality maintenance information, UK				Yes	
12	FINTAN vernacular placenames project, Ordnance Survey and Maritime and Coastguard Agency, UK					Yes
13	Towns Conquer, gamification and Instituto Geográfico Nacional toponyms database, Spain			Yes		
14	National Biodiversity Data Centre, Ireland					Yes

No	Case study	Disaster/ risk	New data sets	Maintain data sets	Public services	Specialist knowledge
15	Haiti disaster response	Yes	Yes			
16	Mapping for Natural Resources Canada			Yes		
17	Boston StreetBump, US				Yes	
18	Open data initiative, New York City, US			Yes		
19	Imagery to the Crowd, State Department Humanitarian Information Unit, US	Yes				
20	OpenStreetMap community of practice, US Census Bureau			Yes		
21	Crowdsourcing The National Map, National Map Corps, US			Yes		
22	US Geological Survey "Did you feel it?"					Yes
23	Places of Interest project, National Park Service, US			Yes		
24	California Roadkill Observation System (CROS), US					Yes
25	Shelter Associates, slum mapping in India		Yes		Yes	
26	Crowdsourcing satellite imagery in Somalia	Yes	Yes			
27	Agricultural data collection and sharing by Community Knowledge Workers, Uganda					Yes
28	Twitter use in Italian municipalities				Yes	
29	Portland TriMet, transportation planner, Oregon, US				Yes	

1. Participatory mapping and decision support tools for disaster risk reduction, the Philippines

Interaction type	Government→ Public→ Government
Trigger event	The Department of Interior and Local Government (DILG) of the Philippines wanted to better support local government units (LGUs) to prepare risk-sensitive land-use plans, structural audits of public infrastructure and disaster contingency plans. Detailed data to be used for planning was not available.
Domain	Generic mapping by local government.
Organization	DILG.
Actors	World Bank - East Asia Pacific (EAP), Environment Science for Social Change (ESSC), DILG, LGUs of Pampanga, Project NOAH, OSM Philippines Community, GeoRepublic Japan, HOT.
Data sets	OSM data describing standard features, land use and administrative boundaries.
Process	New training materials were created specifically aimed at LGUs in the Philippines. Next training and mapping activities were conducted in the selected LGUs. Further community building activities to support the growth of the OSM community in the Philippines were also conducted. Key to this was inviting community members to all the trainings either to learn or assist in delivering the training.
Feedback	Success in the data collection in OSM varied by participating municipality. For two very little data collection occurred after the initial training and mapping phase, but one continued to map afterwards.
Goal	Collect detailed data to better support LGUs in developing disaster plans.
Side effects	-
Contact point	Kate Chapman, HOT, kate.chapman@hotosm.org

The goal of this project was to use participatory mapping and InaSAFE impact modeling software to support Philippines LGUs in disaster risk reduction activities. DILG had a need to better support such activities and determined that participatory mapping and use of InaSAFE was the best way to accomplish this.

The project provided training and technical assistance to LGUs to create basemap information and then perform impact analysis using InaSAFE. Three LGUs participated in the program from the province of Pampanga (Candaba, Lubao, Guagua). A total of 85 people participated in the process from these areas and six OSM volunteers additionally participated and assisted the training team during the activities. The first portion of the training was about the collection of infrastructure data using OSM. Later InaSAFE workshops were held to show how the collected data could be analyzed.

The intent was that the LGUs could continue mapping in OSM to improve the analysis in InaSAFE and create a more detailed basemap for other uses. Freely available data of the areas are now available in OSM. During the training the OSM Philippines community assisted with the goal of further strengthening and supporting the OSM community as a whole.

Teaching LGUs how to map in OSM and then analyze the data in InaSAFE was of benefit, though it was difficult for LGUs to continue mapping after their initial workshops. Little mapping occurred outside of the scheduled mapping activities during the training. Only one LGU continued to map any amount of substance afterwards. New methods for better supporting mapping are being explored, including creating a Training of Trainers (ToT) program to expand the community within the Philippines able to provide support in OSM. Creating and discovering local champions within LGUs will help to ensure greater support for mapping after training. Using these methodologies in other places is certainly possible, but it would be important to take into account the context and government structure to ensure support for mapping outside of initial training.

Main lessons

- It is important to highlight the benefit of mapping outside of the immediate usage, to encourage continued work and data collection after the project period concludes.
- Efforts to build broader VGI communities as part of focused data collection activities can be valuable and should be encouraged.
- With care, VGI data can be an important complement to official data sources and used for scientific modeling purposes.

2. Community Mapping for Exposure in Indonesia

Interaction type	Government→Public→Government
Trigger event	-
Domain	A priori disaster response.
Organization	Community Mapping for Exposure in Indonesia.
Actors	Indonesian Disaster Management Agency (BNBP), Australian Agency for International Development (AusAID), HOT, Civil Society Strengthening Scheme (ACCESS), GFDRR.
Data sets	Satellite imagery, GPS tracks and attribute data.
Process	Collecting spatial and attribute data and tracing in OSM platform.
Feedback	Thematic maps showing damage in case of various physical disasters.
Goal	Reduction of vulnerability to natural disasters.
Side effects	Deemed a successful example of disaster relief preparedness that could be applied in other developing countries.
Contact point	Kate Chapman, HOT, kate.chapman@hotosm.org

An example of an a priori disaster response, the Indonesian mapping project began in early 2011 and at the time of writing is still active. The main idea behind the project was to use OSM to collect previously unavailable data about buildings and their structure in both urban and agricultural environments and to use appropriate models to calculate likely damage in case of physical disaster. The combination of the impact models and the use of realistic data led to the development of an open source risk modeling software (InaSAFE) showing the affected people, infrastructure and damage if disaster were to hit a specific area. This offers a practical tool for governments to develop actionable contingency plans and fills the need for risk assessments identified by the World Bank.

The pilot phase consisted of workshops offering training on the project and building construction as well as data collection in urban and rural areas. The approach between rural and urban areas was slightly different, although the result was similar. The original data were derived from paper maps, which were edited by local people; satellite imagery, depending on availability; and GPS tracks. Data were edited using JOSM and Potlach2 web editor and then used in QGIS. Urban areas were mapped by students who took part in a mapping competition. Rural areas were mapped with ACCESS contributors and local people. The second phase lasted from July 2012 to March 2013 and focused on collecting exposure information essential for impact modeling software. In total, 163,912 buildings were mapped during the pilot, 29,230 of them in urban areas; and 16 workshops were held with 124 people participating in rural areas and 5 universities in urban areas.

To encourage participation, Community Mapping for Exposure has a pyramid format based on leadership, with specific guidelines in data manipulation and great coordination between different contributors. The whole process is focused on workshops, participants were supervised at many stages and the procedure of data collection and manipulation was firmly defined. Motivations for participation varied, with incentives covering a spectrum from disaster protection to a mapping competition. In terms of technical support, the project was not only supported by HOT and OSM but also by open source software such as QGIS. The main innovation in data collection was the private datastore, which offered a unique ID for each object. The final output has also been a success in enabling local government to visualize where people are most in danger by combining local wisdom with scientific knowledge to produce realistic scenarios for numerous different physical disasters.

The main aspect of concern is the quality of the results, which showed great variation. According to the final report, the quality was either very bad or very good in different areas, although it was found to be acceptable generally. The attribute quality, which has a principal role in the success of the project, indicated a great number of empty or incorrect records concerning the structure of buildings. Other minor deficiencies were also noticed, such as failing to create constant mapping volunteers and the use of time-consuming technical methods in a few cases (e.g. Excel spreadsheets in data collection or manual methods of data manipulation).

Main lessons

- An a priori disaster response can be focused on appropriate models and parameters and can calculate damage in case of a physical disaster by using VGI.
- Interaction between official providers and VGI is a parameter of success not only for the beginning of the project but also for its continuity.
- Open source data can be reliable for scenario building but its quality can vary, especially in terms of attribute data.
- Risk managers, local communities and the public can combine local wisdom with scientific knowledge to produce realistic scenarios for numerous different physical disasters that may occur in an area of interest.
- The coordination of participating organizations and volunteers is important to take full advantage of human resources and technical innovations.

3. Flood preparedness through OpenStreetMap, Jakarta, Indonesia

Interaction type	Public→ Government → Public
Trigger event	Disaster management agency of Jakarta wanted to have better data for flood planning and reporting.
Domain	Mapping for disaster preparedness.
Organization	Jakarta Disaster Management Agency (BPBD DKI Jakarta).
Actors	Australia-Indonesia Facility for Disaster Reduction (AIFDR), United Nations Office for Coordination of Humanitarian Affairs (UNOCHA), HOT, University of Indonesia.
Data sets	OSM data of neighborhood boundaries (Rukun Warga), religious, health, sports and government facilities, schools and roads.
Process	The heads of Jakarta's 267 urban villages were asked the locations of their critical infrastructure, which was then mapped by university students and entered into OSM.
Feedback	Urban village leaders received paper poster maps of their villages.
Goal	Improve geographic information available for flood planning.
Side effects	Having a detailed basemap of Jakarta has made others interested in the idea of crowdsourcing and using community mapping to collect base data and record event data at a relevant scale.
Contact point	Kate Chapman, HOT, kate.chapman@hotosm.org

Jakarta, Indonesia, is a large megacity that has frequent seasonal flooding issues. Jakarta's disaster management agency (BPBD DKI Jakarta) needed better data to prepare for the flood season. AIFDR, UNOCHA, HOT and University of Indonesia assisted in the process.

The original idea was to ask the heads of the 267 urban villages the location of their critical infrastructure, then ask university students to help with technical mapping. Impact analysis using InaSAFE open source impact modeling software was then performed as part of a contingency planning process, and the data has been used to create government maps to report flood conditions

and village heads have used poster maps to plan logistics when responding to flooding.

The project also created an open data set that can be used for a variety of analyses at the village, district and provincial levels. Using an open platform means that anyone can use the data and it can be updated easily as the information becomes outdated. The data collected was useful in both the 2013 and 2014 floods, allowing the government of Jakarta to show more detailed maps than previously available and increasing demand for additional mapping at a higher resolution.

One negative aspect of the methodology used is that while it did collect the data very quickly, the urban village officials do not have an easy way to update their area as the data changes.

Main lessons

- Collaboration between different teams of local people, depending on their knowledge, means participants can contribute to specific tasks and stages of the project.
- Open data can be used at different levels of decision making policies such as village, district and provincial levels.
- Difficulties in keeping data up to date is one of the most important concerns in terms of viability.
- Data can be used in a variety of ways, including by governmental bodies for the creation of maps.

4. Humanitarian OpenStreetMap Team mapping in Ulaanbaatar, Mongolia

Interaction type	Public→ Government → Public
Trigger event	A greater vision to create a "Smart City".
Domain	Topographic mapping.
Organization	Ulaanbaatar City Governor's Office.
Actors	World Bank/ICT, HOT, Mongolian University of Science and Technology, city officials, Mongolian Land Management, Geodesy, and Cartography Department.
Data sets	Aerial and satellite imagery (Bing Maps), field survey.
Process	Training core group of people in field data collection, mapping a part of the city, creating conditions for the project to continue by setting up an OSM community.
Feedback	Topographic maps of the city.
Goal	Map a part of the city, create an OSM community and train locals to continue the mapping effort in order to support the vision to transform Ulaanbaatar into a "Smart City".
Side effects	-
Contact point	-

At the beginning of March 2013, the local authorities of Ulaanbaatar in Mongolia announced their vision to turn their city into a "Smart City" by 2020. The aim is to enable city residents to access information regarding public services, provide a consolidated list of public service assets and allow citizens to send comments, reports and requests to relevant officials via the Internet. This effort is expected to promote transparency and fair public service while cutting down on bureaucracy.

Such an effort could only be successful if it could rely on a comprehensive and detailed cartographic background of the city, which did not exist at the time. To support this effort a project to map the city was funded by World Bank/ICT. The aims of this project were to map a part of the city under OSM guidance and simultaneously train a core community to continue the task of mapping the entire city.

The process started with basic training on tracing features from imagery and moved to the handling

of GPS devices in data collection. The data sets were documented by field papers and ground photos which facilitated data management before the final uploading. An OSM wiki page was also created with useful information and a catalog of resources for trainees and the newly built OSM community, including training videos translated in Mongolian, OSM data collection best practices and local tagging rules. A consensus on the best tagging practice had to be achieved in order to describe geographic features that do not exist in other areas of the world and are therefore not documented elsewhere.

An important challenge was that the city of Ulaanbaatar was undergoing a great reconstruction phase and thus the available imagery data sets might not provide up-to-date information. Additionally, due to weather conditions, the data collection process was taking place during mild days while data management and upload was taking place days later, possibly by volunteers who did not collect the data themselves. These two factors raise some issues regarding data quality. Another factor that might influence the overall data quality was the fact that the contributors had no previous OSM experience, such as an active OSM community or available OSM wiki pages, while the contributors also had little knowledge of the English language to assist them in steepening the learning curve. On the positive side, after five weeks, the project had: created an OSM community to continue the mapping project, improved the awareness of local officials of the use of VGI and open data and also caught the attention of the private sector, which can enhance OSM community efforts by providing resources while at the same time drawing more official attention to them.

Main lessons

- Building an OSM community from scratch might be intensive and slow to begin with.
- Spatial data sets and mapping products might suffer in quality, at least until a populous and active OSM community forms.
- Local tagging requirements might be missing from the overall OSM project or might be considered as outliers when it comes to normalizing the data set into a spatial product (e.g shapefile, import into a database schema, etc.).
- Both governmental officials and private sector organizations recognize the value and potential of VGI and open data.

5. Mapping schools and health facilities in Kathmandu Valley, Nepal

Interaction type	Public→ Government→ Public
Trigger event	No single event but increasing disasters around the world, including the earthquake in Haiti, inspired discussion about the safety of school and hospital buildings in Nepal.
Domain	Generic mapping of major points of interest and critical infrastructure as well as schools and health facilities.
Organization	Department of Education and Kathmandu Living Labs with support from World Bank/GFDRR.
Actors	Department of Education, Kathmandu Living Labs, World Bank/GFDRR, Nepal Risk Reduction Consortium (NRRC), NSET.
Data sets	Aerial imagery from Bing and HIU, lists of schools from government and health facilities from other sources. Data sets on the road network and other points of interest with a focus on school and health facilities have been generated.
Process	Initial data about schools and hospitals were mapped using a variety of techniques and the results were presented to authorities and discussed.
Feedback	Interactive thematic map (for schools and hospitals) showing structural and non-structural attributes; more detailed online map of Kathmandu Valley.
Goal	Collect and map exposure data for schools/colleges and hospitals, digitize building footprints, build a robust OSM community.
Side effects	None so far.
Contact point	Nama Budhathoki, namabudhathoki@gmail.com

Nepal is considered one of the countries most exposed to natural hazards and especially earthquakes. The capital city of Kathmandu has experienced rapid urbanization in the last decades and is considered to be vulnerable to earthquakes as the majority of the houses do not meet earthquake safety requirements. In Kathmandu, local stakeholders have recognized the danger and have tried to be proactive by initiating an effort to create an OSM map of the city. The aim is to provide a

critical resource for disaster risk mitigation and emergency planning.

In 2012, the World Bank's South Asia Region launched the Open Cities Project to create an asset and exposure database for urban areas and facilitate its use for urban planning and disaster resilience. As part of this project, Open Cities Kathmandu was started in November 2012 as a pilot initiative.

The process was to first divide the Kathmandu Valley into zones, each one consisting of several wards and assigned an OSM champion. Using GPS, paper field maps, satellite imagery, web and mobile technology, exposure data of schools/colleges and health facilities was then collected in the field. These data were uploaded onto OSM using an in-house web application called WebDRI, developed by Kathmandu Living Labs. This was followed by a rigorous data validation process, which ensured that data were accurate.

The champions worked simultaneously towards building an OSM community in Nepal by delivering sensitization presentations and training other people at mapping parties. This effectively took the project back to its direct recipients, the community. It also multiplied the number of "surveyors" in the project because it produced new mappers and data providers, whose contributions enriched map data and brought local knowledge of the exact locations of schools/hospitals in field.

Mapping was done in multiple stages, focusing on different geographical features at different times, and regular validation was a part of the mapping process itself. In November 2013 the GeoCenter of USAID organized a distant mapping party with the collaboration of George Washington University and in one evening, 90 students digitized more than 15,000 buildings in Kathmandu. Open Cities Kathmandu has to date mapped over 130,000 buildings and collected exposure data for 2256 educational and 350 health facilities.

The outcome of the project has sparked a policy-level discussion about ensuring the safety of schools and health facilities in emergency situations. This has also expanded to private schools while previous discussions were limited to government schools. Following the outcome of the project, the Department of Survey, Nepal's authoritative mapping agency, is now exploring ways to integrate VGI in their workflows. Additionally, the National Society for Earthquake Technology in Nepal has decided to share its own data sets with the public. As part of the Open Cities program, more than 1500 people received training on OSM procedures and a large number of presentations were delivered to universities in an effort to build a robust OSM community. At the same time, Kathmandu Living Labs is continuing the effort to expand the coverage of the map both within and beyond Kathmandu Valley, as well as enhance the quality of the data.

Main lessons

- Being proactive is key to ensure that an area is prepared for future natural disasters.
- A solid mapping background is needed for relief efforts following disaster. Creating or updating an existing map is of great importance.
- A well-managed and coordinated effort to drum up public support can provide valuable input from both local and international contributors.
- As well as a short, intensive mapping effort, it is also vital to create a community that will continue the task to complete or update the maps.

6. Informal settlement mapping, Map Kibera, Nairobi, Kenya

Interaction type	Public→ Government→ Public
Trigger event	-
Domain	Generic mapping of the biggest informal urban settlement area and thematic mapping of security, water sanitation, health and education.
Organization	Map Kibera.
Actors	Map Kibera team, CfK (Carolina for Kibera), GOAL, USIP, Indigo trust, ATTI, Habitat, Global Giving, Plan Kenya, Hivos, Unicef, JumpStart International, Ushahidi, SODNET (Social Development Network), KCODA (Kibera Community Development Agenda).
Data sets	GPS tracks, open source and conventional software.
Process	Collecting GPS tracks and tracing them in the OSM platform after training workshops.
Feedback	Topographic and purpose-built maps for the management of supplies in health, education, security and water sanitation.
Goal	Map the unmapped Kibera and actively involve local people.
Side effects	-
Contact point	Mikel Maron, HOT, mikel_maron@yahoo.com

The homepage of the project welcomes the visitors by stating that, "Kibera in Nairobi, Kenya, was a blank spot on the map until November 2009, when young Kiberans created the first free and open digital map of their own community". The welcome message summarizes the main idea behind the project, which is to map one of the biggest informal settlements of the world by putting marginalized communities on the map.

Map Kibera was launched in 2009 by Mikel Maron and Erica Hagen with initial funding by Jumpstart International, an NGO specializing in community-based mapping. The first phase, which lasted three weeks from October to December 2009, involved 13 young people who were trained to collect and edit GPS tracks. OSM was used to create a dynamic and easily edited map and QGIS software was adopted to do further analysis and create specialty maps. ARCGIS, a non-open source software, and Tile Mill and other MapBox products were also used.

The second phase of the project (February to August 2010) offered the opportunity for mappers to enhance points of interest such as water, public toilets, schools, police stations and clinics. It also included two other mini projects: the Voice of Kibera and the Kibera News Network. The first offered the opportunity to submit reports, write articles and add breaking news with the aid of Wordpress blogging and Ushahidi software. Work could be sent by SMS and published after approval by an editorial team. The second is a video journalism initiative offering more locals the opportunity to participate, ensuring the wider acceptance of the project and hence its longevity.

Among the main successes is the project's acceptance by local government, which embraced it from the beginning. At the end of the project, Map Kibera representatives presented the analysis to government officials. The negotiation between the two sides had a positive impact for the community, which became recognized as a real neighborhood, and residents gained new technological knowledge.

The project faced various challenges, the primary being to educate residents in new technologies. The voluntary participation model was unrealistic in Kibera. Locals suffer great survival issues so a small daily compensation was given for their participation. Residents also found it hard to understand the benefits they could gain through participation and the general potential impact of the project. Finally, NGOs found it difficult to cooperate and share information. They had learned to work separately and competitively for a long time, which meant that voluntary work was splintered off into small pieces, for different purposes.

Main lessons

- Slum mapping can be achieved by young local people relatively quickly.
- Basic topographic maps can be enhanced with essential thematic layers.
- A combination of open source and conventional software can facilitate VGI projects.
- Compensation may be needed to improve participation in locations where participants suffer great survival issues.
- Innovative methods such as SMS, voice and video reporting can support the appeal of mapping projects.

7. Mapping of South Sudan

Interaction type	Public→ Government→ Public
Trigger event	On 9 July 2011 South Sudan became Africa's 54th nation after its official independence. Although it is the newest nation, it is poorly mapped.
Domain	Generic mapping of a poorly mapped area and thematic maps of essential features like roads, hospitals and schools.
Organization	Google, NGOs along with the World Bank, United Nations Institute for Training and Research (UNITAR) Operational Satellite Applications Programme (UNOSAT) and Regional Center for Mapping of Resources for Development (RCMRD).
Actors	The Sudanese diaspora, Google, the World Bank, UNOSAT and RCMRD.
Data sets	Updated satellite imagery covering 125,000 km² (40 percent of the UN's priority areas) uploaded to Google Earth and Maps.
Process	Workshops and editing on Google Maps via Google Map Maker.
Feedback	Generic and thematic maps covering important points of interest such as schools, hospitals and roads.
Goal	To engage and train the Sudanese diaspora and other volunteers worldwide to participate in Google Map Maker.
Side effects	Mapping the poorly mapped South Sudan so that the infrastructure and economy of the country could be developed and humanitarian aid provided to the local population.
Contact point	-

After years of political instability, South Sudan became a new nation on 9 July 2011 after its official independence. Although South Sudan is expansive and the newest nation, it is poorly mapped. Maps are particularly important for the development of the infrastructure and economy of the country and the distribution of humanitarian aid.

Google, with the aid of World Bank, UNOSAT and RCMRD, recognized this need and started the project for the creation of better maps of South Sudan by supporting communities to map schools, hospitals, roads and more with Google Map Maker. The project was launched with a series of events to disseminate the purpose of the mapping and inspire and train participants. The first event was in April 2011 at the World Bank headquarters in Washington, DC, with a satellite event in Nairobi at the same time. The next event was in September 2011, held by the South Sudan National Bureau of Statistics in Juba.

To aid their work, updated satellite imagery of the region, covering 125,000 km² (40 percent of the UN's priority areas), was uploaded to Google Earth and Maps. In the last event volunteers worked together and made hundreds of edits in less than four hours. The process is simple: citizens edit using available web tools and their local knowledge and, after approval, edits become visible to all Google users worldwide. The mapping was used by the Satellite Sentinel Project, a collaborative project focused on human rights violations and human security concerns in Sudan and involving Google, the Enough Project, Not On Our Watch, UNITAR, UNOSAT, DigitalGlobe, the Harvard Humanitarian Initiative and Trellon.

Among the main factors for the project's success is not only the enthusiasm and inspiration of the Sudanese diaspora, which encouraged them to convey the experience and knowledge to other people, but also the interest that the local government showed in the project. The project's approval by local government and its impact in decision making policies is noticeable. Another innovation of the project is the principal role and contribution played by the Sudanese diaspora. Through VGI projects, local knowledge can be shared worldwide and from different parts of the world, not only from the area of interest. At the same time, among the main weaknesses of the mapping is that local people were not actively involved. The project lacked research in the field, and did not use GPS or open source software, although Google's involvement guaranteed great participation levels.

Main lessons

- Crowdsourcing projects can be coordinated and implemented from a distance.
- Great participation of volunteers and transmission of motivation to others are key factors in terms of participation in crowdsourcing applications.
- Inspiration for other projects and improved applications can be beneficial to areas of interest.
- Acceptance by local government as an opportunity for decision making policies and humanitarian aid can escalate the impacts of a VGI project.

8. iCitizen, mapping service delivery, South Africa

Interaction type	Public→ Government
Trigger event	-
Domain	Generic mapping with focus on local infrastructure issues.
Organization	University of Witwatersrand, LINK Centre.
Actors	LINK Centre.
Data sets	Multiple data sets per service delivery issue to be tracked.
Process	Collection of data points via mobile phones. Adoption of different ways of geotagging photos in real time or via SMS or/and email.
Feedback	Generic and purpose-built maps for disaster preparedness.
Goal	Reporting and solving fundamental problems with basic infrastructure and services.
Side effects	-
Contact point	Dr Kiru Pillay, University of the Witwatersrand, kiru2010@gmail.com

In recent years, South Africa has seen a surge in political protest against slow service delivery. While the United Nations Human Development Index considers South Africa to be a middle-income country, there is a large disparity in income distribution across the population. Social unrest is an obvious consequence of poverty, high levels of unemployment and service delivery backlogs.

Within the context of these issues a new initiative has been launched, which intends to improve the daily life of citizens by collecting crowdsourced reports of service issues and passing them to the relevant authorities for resolution. The iCitizen project will give members of the public the ability to report on fundamental problems with basic infrastructure and services. The researchers involved in the project intend to contact local municipalities to discuss the extent to which this project can be embedded within current initiatives around citizen monitoring and evaluation. The main aim of the project is to give citizens an active voice. A secondary research objective is to understand and identify the role of mobile phones in citizen-led monitoring and evaluation.

Members of the public will be able to report issues by forwarding geotagged photographs, sending in locations via SMS or reporting issues via email. The first iteration of iCitizen was built upon the Drupal open source content management system (CMS). As an enterprise CMS, it provided a lot of services out of the box, including membership management, image upload, taxonomy (category) management, user commenting, thorough user permissions, field APIs (application programing interfaces), views templating and reporting and HTML5 theming capability. Researchers were able to extend the core functionality to include mapping enabled through geolocation, leaflet maps (using OpenStreetMap as the Map Tile server) and a voting API allowing users to verify incidents.

The designers of the application will be extracting boundary data for South African provinces, districts and local municipalities and exposing these on the online map using GeoJSON data. This will automate the process of calculating the jurisdiction of any reported incidents. A live reporting engine and online social tool will also allow for two-way communication between the web server (and its user base) and local municipalities and civil societies.

The main difficulty relates to the acceptance of the project. One university found validity in the concept but was unable to commit resources for the development of the application. Going forward, two difficulties are envisaged. The first is acceptance of the validity of the generated data sets by local municipalities. The second is acceptance of the use of mobile phone and applications by the public as an effective tool for voicing service delivery concerns. Even though the penetration rate of mobile phones is fast approaching 100 percent of the adult population in South Africa, the use of mobile applications and GIS-mapping tools of this nature is largely untested.

Main lessons

- Projects can be used for a variety of tasks at local level, not just that for which they were designed.
- Using a range of software, programing languages and platforms can broaden a project's horizons.
- VGI applications face financial issues due to their technological nature and the resources of the organizations involved.
- Concerns from agencies about the quality of generated data sets and improving public adoption of mobile applications are common challenges.

9. Skandobs, Scandinavian predator tracking system, Norway and Sweden

Interaction type	Public→ Government
Trigger event	Policy requirements for wildlife monitoring in Scandinavia.
Domain	Species population observation and tracking.
Organization	Rovdata (an independent part of the Norwegian Institute for Nature Research (NINA)) and the Swedish Environmental Protection Agency (EPA).
Actors	Rovdata, EPA.
Data sets	-
Process	Using either smartphone applications or the Skandobs website contributors can submit their observations. Geographical data are required with each observation and anonymous submissions are not allowed. All contributors who wish to see their contributions listed on the website and stored in the Skandobs database must register on the website. Quality checks are performed by Skandobs staff.
Feedback	The number of observations in the database is updated on the website every 15 minutes. A table provides summary information of the total number of observations for the current year and month. League tables also show top contributors by individual and municipality.
Goal	To collect observations for lynx, wolverine, brown bear and wolf to increase knowledge about species populations in Scandinavia.
Side effects	Increasing expectations from NGOs, the media and the public who want information on numbers and distribution of carnivore populations in their countries.
Contact point	-

Skandobs was developed to to collect observations for lynx, wolverine, brown bear and wolf locations and population sizes, driven by new legislation, international conventions and directives. Reliable observations help to inform management objectives including long-term conservation and population-level management. Monitoring is complicated and expensive for many reasons, including the geographical size of the area under observation but involving the public has been very successful.

The Skandobs database is jointly maintained by two national agencies, Norway's Rovdata and Sweden's EPA. Citizens can submit their observations at any time, using iPhone or Android smartphone applications or through the website. The addition of photographs and other information is encouraged. The Skandobs database is made available for download via a search interface on the website. A Google Maps-based visualisation tool is also available to allow map-based visualisation of the Skandobs database.

User observations are subjected to internal validation and when this is completed they are assigned a validation status, which appears in the list of observations. Only rated observations are also added to Rovbase, the primary database for national population monitoring data in Norway and Sweden. The number of observations in the database is updated on the website every 15 minutes with tables summarizing the total number of observations plus totals for the year and month. Observation totals are also provided for key species.

There are concerns about the potential bias in the observational data. For example because there is greater population density in southern Sweden, there will be more observations than in northern Sweden. This problem of the distribution of observations/observers is a problem in citizen science and VGI more generally.

Main lessons

- Feedback can be provided to participants through real-time updating summaries of the types and quantities of contributions.
- Nations can work together on VGI initiatives to meet policy requirements and reduce costs.
- VGI initiatives can work well in transboundary situations.
- Observational bias due to population distribution remains an inherent challenge in VGI.

10. Corine Land Cover 2006 in OpenStreetMap, France

Interaction type	Government→ Public→ Government
Trigger event	Change in the license policy of the Corine Land Cover 2006 data set.
Domain	Generic mapping (update of land cover/ environmental data sets).
Organization	European Environment Agency (EEA).
Actors	French OSM Community, EEA.
Data sets	44 land cover classes for France.
Process	CLC2006 data not overlapping existing OSM data have been imported (accounting for ~60 percent of the land). The CLC2006 typology has been adjusted to match OSM.
Feedback	-
Goal	Update the OSM database with land cover information, mainly in rural areas, as the contribution in such areas is limited.
Side effects	A number of national OSM communities have followed the example and integrated CLC2006. Inconsistencies in levels of detail, semantics and metadata between VGI and authoritative data sets have been revealed.
Contact point	pieren3@gmail.com (OSM community member)

COoRdinate INformation on the Environment (Corine) is a European Commission supported program that aims to provide a land cover data set (known as CLC; Corine Land Cover) for 39 European countries. The CLC2006 project was coordinated by the European Environment Agency. The image production for the land cover digitization was centrally coordinated by the EEA and the actual data production was undertaken by EEA member states to "benefit from local knowledge". The data integration of the national contributions was managed by the EEA and the European Topic Centre on Land Use and Spatial Information (ETC LUSI). As in previous CLC projects, CLC2006 includes 44 land cover classes.

As permitted under the release terms of CLC2006, the French OSM community imported the CLC2006 data set into the OSM database. However, only ~60 percent of the original data set was automatically imported, which was for those areas where there was no OSM data. The rest was not imported because it was in conflict with existing land cover polygons created manually by the OSM contributors. This was deemed more efficient as the OSM community realized that land cover polygons created by OSM contributors were more accurate than the CLC2006 data set. Moreover, as OSM contributors now have access to high-resolution Bing aerial imagery, their data should be even more accurate than the CLC, which is based on IMAGE2006.

The integration of CLC2006 to the OSM data sets has instantly enriched the latter with data regarding ~60 percent of the French territory. Land cover classification based on imagery interpretation needs considerably more expertise than road classification and in general attracts fewer contributors that the "high-profile" urban fabrics. However, in this case, the land cover parcels imported serve as first-class photo interpretation keys to aid the OSM community. The French example has paved the way and built the expertise for more countries to follow this practice successfully (nine more countries have imported their national CLC2006 data).

The integration of the French CLC2006 and OSM data sets has brought to light a number of issues characteristic of the co-existence of VGI and authoritative data. First, importing authoritative data into a VGI database injects both the positive and negative endogenous issues, such as the failure to keep the data up to date. For example, CLC2006 data set was imported in 2009, which means the data were already two years old (the project for France finished in 2007). However, the authoritative nature of CLC2006 might give OSM users the false impression that such data sets are more accurate or more recent than they actually are, diverting their attention to other as yet uncovered areas. Second, it should be expected that there will be semantic inconsistencies. For example, the CLC2006 has fewer land cover classes than those used in OSM, while some CLC2006 classes are too vague for OSM and have not therefore been converted and imported to OSM. Third, it must also be expected that there will be inconsistencies regarding the level of detail. In the case of CLC2006, the features captured were at 1:100,000 (country-level) while OSM is a street-level data set.

Main lessons

- The existence of active public communities facilitates the take up of opportunities to work on open source data.
- Data integration should not be considered easy or straightforward. This should also be made clear to volunteers as any integration initiative might mean large workloads with moderate results. Considerable expertise among volunteers is required for success.
- Successful, community-led efforts can be replicated by others now experience in solving problems has been built and often shared.
- Multiple data sets often have semantic inconsistencies and temporal accuracy should be addressed during integration.

11. FixMyStreet for municipality maintenance information, UK

Interaction type	Public→ Government
Trigger event	-
Domain	Local authority/municipality maintenance.
Organization	mySociety (originally developed with central government funding).
Data sets	Government data sets of postcodes, basemap, local authority boundaries, contact details and email addresses of relevant personnel in local authorities.
Process	A problem is indicated on a website using its location postcode and an email alerts the local authority. The authority can respond to the complaint on the website.
Feedback	Update to participants provided through the website and in email that can be triggered when a person registers.
Goal	Provide online tool for residents to report problems to their local authority and follow up the exchange with the public body in an open way.
Side effects	Application source code released under the GNU Affero GPL software license and has been used in other countries.
Contact point	-

FixMyStreet is a web-based application, launched in February 2007, which enables the public to report local problems (e.g. abandoned vehicles, graffiti, unlit lampposts, potholes, litter). Reporting is facilitated by the use of Ordnance Survey maps as a backdrop for users to mark the exact location of the problem. Issues reported by users are propagated to the relevant local authorities by email. Users reporting a problem are contacted by FixMyStreet after four weeks to check if the issue has been resolved.

FixMyStreet was built and administered by mySociety, a social enterprise (business with social aims), and is free to the public. However, there is also a FixMyStreet for Councils application, which is a paid version adapted to local authority needs for handling the problem reports.

FixMyStreet has been one of the most popular web applications that enable the public to voice their

concerns regarding local issues. Through a simple process, the website has succeeded in engaging people and opened a channel for public input into problem solving. Moreover, it has resulted in public value creation both direct (i.e. social gain that has immediate relationship with the user that reports the problem and his/her neighbors) and indirect (i.e. social gain that is dispersed to the entire community). The difference between FixMyStreet and previous mechanisms for reporting local problems is the public aspect: instead of the report being recorded on a local authority system, it is done in the open and other residents can see the issues reported and how the local authority dealt with them.

However, there are some issues of concern especially when it comes to the data created: the cycle of public data creation, propagation, consumption and diffusion back to the public creates inconsistencies. More specifically, councils themselves have an independent channel for local problem reporting and thus the launch of FixMyStreet created a parallel channel that often simply duplicates problems already known to the council or, in the worst case, confuses the authorities as descriptions of the same problem appear slightly different. Additionally, when the council fixes the problem (which might take more than four weeks), it is not able to report progress on the issue within the application. This is the driving force behind FixMyStreet for Councils but as this is a paid version, few local authorities have adopted it so far.

In analyzing the success of FixMyStreet it is also important to note the overall context: first, in UK there are digital savvy members of the public, which makes it easy for users to participate; and second, in most Western societies, the core social principles on which FixMyStreet is based are shared and voicing criticism of the government is accepted practice, which may not be the case in other countries (see case study 8).

Main lessons

- Given technological advances it should be expected that the public will find their way to web applications of this kind.
- Authorities should develop processes and methods to integrate data from the public in order to avoid issues of data duplication, confusion and misunderstandings.
- Public VGI initiatives that address community problems might overshadow existing authoritative structures. Flexibility in embracing such initiatives might minimize future problems for local authorities and maximize impact on society.
- Successful examples of public participation can increase pressure on authorities for data sharing under flexible license schemes.

FixMyStreet (UK) is an example of participation in municipal maintenance

12. FINTAN vernacular placenames project, Ordnance Survey and Maritime and Coastguard Agency, UK

Interaction type	Government→Public→Government
Trigger event	Increasing recognition of the use of vernacular placenames and their importance to emergency services.
Domain	Emergency operations such as search and rescue.
Organization	Ordnance Survey (OS) and Maritime and Coastguard Agency (MCA).
Actors	OS (research staff, data capture staff), MCA (coastguards), volunteer coastguards.
Data sets	OS topographic maps; address and placename gazetteers containing current known placenames.
Process	FINTAN application developed by OS to enable MCA and their volunteers to enter, locate and classify vernacular placenames; OS then assessed the quality of the data.
Feedback	Many new vernacular placenames that are assessed and quality controlled by OS.
Goal	Improve ability of the Coastguard to locate people when contacted in emergency situations; improve OS database of placenames for use in new and existing products.
Side effects	Tensions in areas where English is not the first language - some groups unwilling to report English names even when in common usage even by locals.
Contact point	Glen Hart, Ordnance Survey, glen.hart@ordnancesurvey.co.uk

Two of the most prominent UK governmental agencies, the HM Coastguard of the Maritime and Coastguard Agency, responsible for the initiation and coordination of all civilian maritime search and rescue operations, and Ordnance Survey, the UK's national mapping agency, have joined forces to create an up-to-date data set of vernacular placenames. Vernacular placenames are those in common usage irrespective of whether they are official names or not.

There has been an increasing recognition by the OS of the need to capture richer and more detailed vernacular placenames. At the same time, the UK Coastguard were in the process of closing approximately half of their Coastguard centers and recognized that a lot of local knowledge could be lost. In that context, both sides recognized the mutual benefit of capturing vernacular coastal placenames using the knowledge of the coastguards (professional crowdsourcing) and local coastguard volunteers (local people who assist in coastguard operations).

An updated database of vernacular placenames is a priceless tool when it comes to providing swift response to life-threatening situations. One of the most important parts of the response process is to understand the position of the person in difficulty and often official mapping products might not provide all the necessary information. It is very common for people in need to use local names that do not exist in official gazetteers.

FINTAN is an OS application that enables the crowdsourcing of vernacular local names of coastal areas. FINTAN includes topographic mapping on a wide range of scales provided to the Coastguard to enable the recording of placenames. Additionally, address and placename gazetteers containing current known placenames have been used. Special care has been taken to allow other emergency services that use different reference systems to work to a common geography and terminology.

Through FINTAN, HM Coastguard and their volunteers can enter, locate and classify vernacular placenames of features such as beaches or rocks to update the existing database. Personal connection with participants has been helpful in encouraging participation, facilitated by coastguards inputting data from their local volunteers, and the specialist application has been targeted at their specific interest (as opposed to more generic approaches like OSM). The future of FINTAN is promising as there are plans to open the application to other stakeholders, such as sailing clubs, and thus harvest more local knowledge.

On the negative side, tensions in areas where English is not the first language have been observed as some groups are unwilling to report English names even when these are in common usage even by locals.

Main lessons

- Crowdsourcing can be a valuable tool when it comes to existing knowledge preservation.
- Professional crowdsourcing might be equally or even more productive compared to general crowdsourcing practices when collecting data for specific areas or subjects.
- Local and regional interests and perceptions might introduce biases to the data collected.
- Two-way data flow can be a win-win situation for all involved parties as well as the general public, and is facilitated by shared interests and benefits.

13. Towns Conquer, gamification and Instituto Geográfico Nacional toponyms database, Spain

Interaction type	Public→Government
Trigger event	Funding opportunity from AGILE and EuroSDR project on Crowdsourcing in National Mapping 2013.
Domain	Validation of a national toponyms database.
Organization	Universities (University of Nottingham UK and Universitat Jaume I of Castellón, Spain), ESRI Europe (sponsor), Instituto Geográfico Nacional (IGN) Spain.
Actors	IGN, University of Nottingham UK and Universitat Jaume I of Castellón, Spain.
Data sets	IGN national toponyms database of Spain.
Process	Users provide updates to the database while playing a game for rewards, contributions are checked by the national mapping agency before being incorporated into the national database.
Feedback	Users played the game to gain points. Points were maintained in a league table format and when a user gained enough points they became the mayor of that particular region. The more validations the user provided, the more points they gained.
Goal	Volunteer validation of a national toponyms database. In Spain it has taken over ten years to implement a model to standardize the nomenclature of municipalities, yet today there are still conflicts with the names of some places, especially in regions with two languages.
Side effects	Validated gamification techniques for public update and management of important national databases.
Contact point	Dr. Joaquín Huerta, Universidad Jaume I, Castellón, Spain, huerta@uji.es

The Towns Conquer application was developed when the research team were awarded a small funding prize from a joint funding venture between AGILE and EuroSDR. This funding allowed the support of one person to work in the university, in collaboration with a nominated national mapping agency. The aim of this project was the validation of a toponyms database provided by the Spanish Instituto

Geográfico Nacional, with 136,454 entities requiring validation. The public is involved through mobile and web-based gamification techniques, which are used to persuade users to contribute their amendments to the given toponyms database. The goal is for citizens to amend well-known placenames while playing a game and using their knowledge of their local area or other areas/regions in Spain.

An Android-based game was developed which was linked to a web-map service at IGN. This allowed IGN Spain to deliver the toponyms database on suitable basemaps for the mobile application. Users signed up for free. There were some prizes at the end of the game (with a time limit on the number of months) for the citizens who had gained the most points (conquered the most placenames) during this time. Placenames submitted to IGN via the gamification software were checked by an IGN official before being submitted and updated in the database.

This funding allowed the NMA to test out crowdsourcing and gamification as a means of updating a national database. In Spain it has taken over 10 years to implement a model to standardize the nomenclature of municipalities, yet today there are still conflicts with the names of some places, especially in regions with two languages.

This project did highlight that gamification techniques (when properly designed and thought out) could provide a very good platform from which bodies like IGN could involve the public in updating and managing important national databases. The game also provided the mechanism to motivate users to participate.

Main lessons

- Funding can drive innovative VGI projects and instigate new modes of engagement.
- Links between government agencies and research centers can generate the resources required for VGI projects.
- Gamification can be a successful way of engaging the public in VGI projects.
- Data quality issues can be addressed through checking processes done by the official organization.

14. National Biodiversity Data Centre, Ireland

Interaction type	Public→ Government→ Public
Trigger event	-
Domain	Update of national biodiversity database.
Organization	National Biodiversity Data Centre (NBDC), Ireland.
Actors	NBDC and the Irish biodiversity community (in particular university researchers).
Data sets	Existing NBDC database.
Process	Users enter their observations through the appropriate HTML forms on the NBDC website. Observational data is checked internally at NBDC then made available for access and visualisation on the online maps and charts. Data is submitted by email for large and possibly incorrectly formatted observations.
Feedback	Data is quickly checked and made available for access and visualisation on an online map. Those who submit their data to the system can access this data in the future.
Goal	Heighten the understanding of biodiversity in Ireland and widen the base from which observational data may be obtained.
Side effects	-
Contact point	Dr. Liam Lysaght, National Biodiversity Data Centre, llysaght@biodiversityireland.ie

The National Biodiversity Data Centre initiated this project to leverage the potential of outreach groups and the general public for data survey and observation. This widens the base from which observational biodiversity data may be obtained in Ireland. The NBDC also launched this project with an aim to initiate a stronger engagement of non-professional scientists and heighten the understanding of biodiversity related matters in the general population in Ireland. There is a good tradition of observational work being performed by volunteer community groups in Ireland.

All of the systems and software are housed at NBDC. Contributors are also given assistance in working out grid references for their records, observations

and sightings. The system provides online forms for recording observations but these can also be submitted in bulk via email if the contributor has collected a lot of data.

Since June 2012 there have been over 61,000 records submitted, validated and stored in the NBDC databases. Approximately 1600 records are submitted per month. NBDC also makes these data available to the Global Biodiversity Information Facility (GBIF), a network of 80 participants worldwide working on an open biodiversity data infrastructure, funded by governments. It allows anyone, anywhere, to access data about all types of life on earth, shared across national boundaries via the Internet. The NBDC is Ireland's GBIF node and contributes Irish data to the more than 400 million biodiversity records mobilized through the GBIF data portal.

For the submission of observational data there are species and site forms, with the latter allowing a more detailed recording of biodiversity information. The data from these forms and collections are extracted and merged with other data sets in the NBDC for insertion into their spatial databases. Data is quickly checked and made available for access and visualisation on an online map. Those who submit their data to the system can access this data in the future.

When there is particular need for observation or data collection for a specific species there is a call for "species in focus" where the importance, reasoning and biodiversity importance of a specific species is outlined. The NBDC ensures that the contributors have their efforts well recognized and advertised online. For example there is an annual distinguished recorder award presented to the person who has made an outstanding contribution. This is very important in recognizing the work of the volunteers who submit data to initiatives like this. Workshops are also held on a frequent basis which report on the progress of this project, the types of uses that this data is being put to, and how the project can be sustained and improved. Events such as Bioblitz (held annually) involve the general public in biodiversity data collection events which have an aspect of fun and competition.

Main lessons

- Feedback for contributors is very important and can be established in many forms. For example personal contact with contributors, publishing information on the website ("we have x records this month"), awards for distinguished contributors.
- Providing several options for users to contribute their biodiversity observations improves accessibility for different users.
- Allowing contributors to provide as much (or as little) information as they have available means there can be great diversity in the resolution of data provided, requiring manual and automated checking controls.

15. Haiti disaster response

Interaction type	Public→ Government→ Public
Trigger event	A natural disaster (earthquake) and humanitarian crisis.
Domain	Generic mapping (topographic maps of the area) and purpose-built maps (disaster relief management).
Organization	HOT.
Actors	United Nations, NGOs, National Haitian Mapping Agency, National Center of Spatial Information, Haitian civil society.
Data sets	Historic maps, CIA maps, high-resolution imagery from Yahoo, paper maps and GPS tracks.
Process	Tracing in OSM platform from different data sources and collecting GPS tracks.
Feedback	Topographic and purpose-built maps for the management of supplies of medicine and food, and location of settlements.
Goal	Facilitate disaster response management.
Side effects	The data sets created have not been used by the national mapping agency but by international aid organizations (UN, USAID).
Contact point	Mikel Maron, HOT, mikel_maron@yahoo.com

Haiti was dramatically affected after a 7.0 magnitude earthquake hit the capital city of Port-au-Prince on 12 January 2010. Death toll estimates range from 100,000 to 200,000. More than 250,000 residents were injured and more than 30,000 buildings collapsed or were severely damaged. When the magnitude of the disaster became clear, the main issue for those responding to the disaster was that the only available spatial data were poor and last updated in 1960s. The local mapping agency collapsed in the earthquake, with the loss of most of the skilled employees. An updated map was urgently needed for the distribution of supplies, identification of collapsed buildings, damaged infrastructure and medical stations.

The Haiti disaster response is one of the successful examples of geographic information being made open by official partners, enhanced by public volunteers and returned to government for action (although the government was reluctant about the involvement of volunteers). The first imagery was loaded on the OSM platform in 48 hours. Sixty people were trained and more that 700 contributed to the mapping, among them people from UN agencies, NGOs, National Haitian Mapping Agency, National Center of Spatial Information (CNIGS) and Haitian civil society. Historic maps, CIA maps and high-resolution imagery from Yahoo were first used for tracing in OSM to improve the basic maps. Volunteers with paper maps and GPS completed the second phase of tracing. The effort led to the PDNA (Post Disaster Needs Assessment), the result of the analysis of satellite and aerial imagery by multiple sources, in which more than 30,000 damaged infrastructures were identified and classified. According to HOT, 600 volunteers added spatial information to OSM in a month and the result was used as a default basemap for responding organizations and the Haitian government.

The main reasons for its success can be focused on four main factors; time, cost, great participation of volunteers and official trust. The sensitization of the public to the Haitian crisis led to a great participation of volunteers and immediate mobilization worldwide. The contribution of NGOs and other official partners and the release of conventional data sets as reference maps for tracing without license restrictions were vital to success. Government support was inevitable due to the critical circumstances and limited resources.

Although, the project is characterized as successful, there were a few weaknesses. On the one hand, all the responding organizations lacked experience and awareness of the operational norms in humanitarian response, which constitute an operational framework for the accountability of different sources. Deficiency of coordination led to the duplication of data. The national mapping agency, CNIGS, also never really engaged with OSM, although official data were given supportively at the beginning of the project.

Main lessons

- This was the first crowdsourced mapping exercise for humanitarian reasons and shows its successful use in reacting to disaster.
- An integrated methodology of this kind follows four steps: spatial data contributed by official providers, supplemented with GPS tracks,

integrated into OSM and updated by a great number of volunteers from each part of the world.

- Time, cost and official trust of data by NGOs and other official partners are key to success.
- Lack of coordination and experience between different actors can lead to duplication of data and waste of resources.
- Differentiation between conventional and governmental data in terms of engagement to the project did not prevent success.

16. Mapping for Natural Resources Canada

Interaction type	Government→ Public→ Government
Trigger event	The proven inability of the NMA to keep data sets up to date along with the familiarisation of its personnel with OSM data, quality and processes.
Domain	Generic mapping (update of national topographic database).
Organization	Mapping Information Branch (MIB) at Natural Resources Canada (NRCan).
Actors	OSM community, MIB, NRCan.
Data sets	Canvec (mainly the road network).
Process	NRCan releases its database into .osm format. The data is imported into OSM and updated/modified by the OSM community. NRCan regularly compares OSM data sets with its own as a change detection mechanism to keep its database up to date.
Feedback	Change detection data sets that have been verified by NMA employees.
Goal	Keep national databases up to date.
Side effects	OSM data cannot directly be used by the authorities due to IPR and licensing issues.
Contact point	-

National mapping agencies are responsible for providing up-to-date topographic maps and a range of spatial products to the public and private sector. The role of the Mapping Information Branch at Natural Resources Canada is to provide accurate geographic information of the landmass at the scale of 1:50,000. However, this translates to regularly covering an area of 10 million km^2 divided into 13,200 map sheets so keeping geographic information up to date is a challenge.

The collaboration with the OSM community is based mainly on two factors: i) a proven inability to keep national data up to date, and ii) a willingness to trust OSM VGI data. The Canadian authorities are also well organized and equipped to implement standard processes of data collection, change detection, quality control and assurance. This facilitates the integration of the two different data sets.

The process was enabled the Centre for Topographic Information in Sherbrooke (CTIS) release of Canvec (the digital topographic map of Canada) in .osm format (the native OSM format). This allowed the Canadian authoritative data to be integrated into OSM and gave the OSM community the opportunity to interact with it (i.e. by completing, correcting or updating). The OSM database is regularly compared with the Canvec data to pinpoint the differences. Any differences are treated as potential changes and are verified using the authoritative channel in the field. Verified changes are propagated to the Canvec database.

Leveraging the OSM crowdsourcing mechanism means the Canadian authorities have developed a much needed change detection process, which helps them concentrate resources on potential changes. Challenges include: the compatibility of the two data sets (in terms of semantic and attribution differences), the lack of metadata for OSM data and the differences in coverage (OSM contributions are concentrated mainly in urban areas). These challenges stem from the differences in the two data generating processes (i.e. the bottom-up, informal OSM process compared to the top-down, authoritative NMA procedures) and still need to be addressed. Moreover, there is a conflict between the license and use terms of OSM data and the IPR of Canadian authorities that needs to be resolved.

Main lessons

- The need for other sources of geographic data sets, such as VGI, can be generated when authorities are falling short of their targets.
- VGI data sets can be used by authoritative and governmental bodies to supplement or facilitate their standard operational procedures.
- Differences in structure and operation mean that updates to geographic information do not move freely between the two systems.
- Connectivity between the two different data sets is limited by different terms of use and licenses.

17. Boston StreetBump, US

Interaction type	Public→Government
Trigger event	Smartphone technologies and resurgent civic engagement.
Domain	Public contribution to urban services reports database.
Organization	Mayor's office, City of Boston.
Actors	The City of Boston Roads and Public Infrastructure Division.
Data sets	-
Process	Using the accelerometer and GPS devices on smartphones users with the StreetBump application automatically report "bump" or pothole information to the City of Boston. These reports are collected in a database. The Roads and Public Infrastructure Division carefully monitor these reports. If a specific area receives many reports, an engineer will physically examine that location.
Feedback	Users gain points ("street cred") for each pothole they assist in reporting which is subsequently fixed or repaired by the city engineers.
Goal	Overcome the manual, antiquated method of reporting potholes from public complaints or manual survey by city inspectors.
Side effects	The City of Boston uses this information to plan long-term investments in road and street infrastructure repair, upgrade and construction.
Contact point	-

Boston's Mayor's Office of New Urban Mechanics (MONUM) pilots experiments that offer the potential to improve the quality of city services. New technology – from smartphones to GPS – and a resurgent spirit of civic engagement have created increased opportunities for closer connection and communication between the city government and its citizens. Partnering frequently with the Mayor's Constituent Service Office, MONUM is piloting projects that leverage this new technology and civic spirit to deliver services that are more personal and citizen driven.

Using the motion-sensing capabilities of smartphones, volunteers who download Boston's StreetBump application automatically send

information to the city about the condition of the streets they are driving on. When their cars hit a pothole—or a pothole-to-be—their phone sends the accelerometer data to a server application, which combines the information from many other phones to pinpoint problem areas on the streets. If three or more bumps occur at the same location, the City of Boston will physically inspect this obstacle and assign it to a queue for short-term repair or record its location to assist with longer-term repair planning.

There are some problems around the reporting of "false positives". The use of phone accelerometers means that other vibrations felt/absorbed by the phone can be incorrectly calculated as a pothole or bump in the road surface. Users are encouraged to ensure that the phone is stationary inside the vehicle with horizontal positioning of the device likely to offer more accurate observations according to the help documentation. However these "false positives" are reviewed manually internally. Unless there are multiple reports of a bump or pothole problem in the vicinity of a specific location it will not be physically investigated by city engineers. Users can contact a specific hotline number to manually report a problem. In addition to the passive reporting of the accelerometer, GPS data users can also submit geolocated photographs of the problematic street segment.

Main lessons

- VGI can be used to address urban service issues such as problems with roads and street infrastructure.
- "False positives" in reports can be effectively handled by applying a limit to the number of reports which are required before action is taken by the government agency.
- The types of devices and their hardware capabilities must be considered in the planning in using VGI. Some technologies can be unreliable, over-sensitive or unsuited to particular applications.

18. Open data initiative, New York City, US

Interaction type	Government→ Public→ Government
Trigger event	Adoption of open data policy.
Domain	Local authority.
Organization	NYC GIS Department and Department of Information Technology and Telecommunications (DoITT).
Actors	NYC OSM community, NYC government, private sector.
Data sets	Building footprint, addresses.
Process	Data import into OSM and public maintenance in OSM platform.
Feedback	Daily changes.
Goal	Leverage volunteers to help keep authoritative data current.
Contact point	Alex Barth, MapBox, alex@mapbox.com

In September 2013, New York City released over 200 government data sets to the public as part of a broad open data initiative to "improve the accessibility, transparency, and accountability of City government." Using the web-platform Socrata, the data is made available for download or through APIs (application programing interfaces) that allow software developers to construct mobile and web-based applications that incorporate this information. This data release continues an aggressive open data push by the city government that began in 2011. New York City's open data law, signed by Mayor Bloomberg in March 2012, mandates that all city agencies "systematically categorize and make accessible in "open" formats all public data sets at no charge" before 2018. To date, over 1100 data sets have been made available on the city's open data portal and numerous applications have been built that address issues ranging from transportation to food safety and the environment.

In partnership with the Department of Information Technology and Telecommunications, the members of the local OSM community have begun to import city building footprint and address point data sets into the OSM database. These critical data sets, which are necessary to support a wide variety of data analysis and visualization projects, can be difficult and expensive to keep up to date in a city as large and dynamic as New York. Thanks to software developed

by the company Mapbox, the New York City GIS department now receives daily emails detailing changes to OSM building or address information. These emails allow the GIS team to quickly assess updates in OSM to identify where new construction or other changes in the city may necessitate updates to the authoritative city data set.

Upon completion of the import of the city data into OSM, a feedback loop between the city and the volunteer OSM community allows both the government and the public to work together to create and make use of up-to-date and high-quality spatial data. Importing large and detailed data sets like addresses and buildings is a complex process that requires technical resources, significant labor and solid coordination between the OSM community and others involved. In this case the information released by DoITT was up to date and of high quality, but the same cannot be said of all municipal data sets. It should also be noted that DoITT has expressed interest in incorporating OSM into other parts of their data management practices but have so far been unable to due to the conflict between OSM's share-alike license and the public domain license required by NYC open data mandates. There has also been a great deal of communication between the city government, the OSM community and the people working on the import, which is critical to the success of these kinds of efforts. It will be important and useful to revisit this project in the future in order to learn more but so far it provides an excellent example of cooperation between local government and the volunteer OSM community around open data.

Main lessons

- Releasing government data sets freely into the public domains means citizens can download and create their own applications.
- VGI communities like those of OSM can keep government data sets up to date even in large, dynamic cities.
- Cooperation between VGI communities and relevant government departments allows them to work together to create and make use of up-to-date and high-quality spatial data.
- VGI communities and government departments can bring technical resources, significant labor and solid coordination.
- Municipal data sets, even when of high quality, need to be maintained in order to stay accurate. This can be achieved effectively and at lower cost than via traditional practices through the cooperation of VGI communities and government departments.

19. Imagery to the Crowd, State Department Humanitarian Information Unit, US

Interaction type	Government→ Public→ Government
Trigger event	Adoption of new policy (the "Imagery to the Crowd" program).
Domain	Generic mapping and purpose-built maps for humanitarian relief programs.
Organization	HIU State Department's Imagery to the Crowd program.
Actors	HIU, HOT.
Data sets	Satellite imagery.
Process	Manual digitization of roads, buildings and other features.
Feedback	Access to vector OSM data for local and international humanitarian organizations.
Goal	Leverage volunteers to create OSM data to support efficient management of disaster relief efforts.
Contact point	Josh Campbell, State Department HIU, CampbellJS3@state.gov

As shown in Haiti (see case study 15), facilitating the access of volunteer communities to high-quality aerial and satellite imagery can have dramatic results. However, such imagery is often prohibitively expensive or only available under licenses that would prevent digitization by the public. With this in mind, the US State Department's Humanitarian Information Unit launched a new initiative in 2012 called "Imagery to the Crowd". This program makes high-resolution imagery, purchased by the US Government from providers like Digital Globe, accessible to humanitarian organizations and the volunteer communities that support them. Since its inception, Imagery to the Crowd has facilitated the digitization of basic infrastructure data into OSM in eight countries to support humanitarian response or disaster risk reduction.

In the recent 2013 Typhoon Haiyan disaster in the Philippines, Imagery to the Crowd published images for Tacloban, Ormoc, Northern Cebu and Carles. This imagery supported a massive volunteer effort of over 1600 mappers from the OSM community, coordinated by the HOT, who contributed nearly five million changes to the map. These changes provided detailed information on the location and extents of pre-event infrastructure as well as preliminary damage assessment. The OSM data created through these efforts was in turn used by a number of actors in the response, including UNOCHA, MapAction, the World Bank and the American Red Cross.

Another recent Imagery to the Crowd project, implemented in partnership with the Global Facility for Disaster Reduction and Recovery and USAID, recently organized volunteers in Nepal, the United States, Germany and the United Kingdom to digitize roads and building footprints in the Kathmandu Valley of Nepal. Kathmandu is one of the most seismically at-risk cities in the world and the data created through this program will help inform an earthquake retrofitting program led by the government of Nepal and disaster response planning by USAID (see also case study 5).

These examples from the Imagery to the Crowd project demonstrate that the release of US government owned imagery to volunteer communities has resulted in the creation of valuable spatial data, which is in turn accessible to governments and international agencies. Technical and policy efforts are underway to increase the speed at which imagery can be released and to standardize and improve the process but this new initiative has already achieved demonstrable results. In cases like USAID's work in Nepal, this becomes a full-loop example where a US government agency makes direct use of the data created as a result of the imagery release. In other instances the users are UN agencies or not-for-profit organizations working towards humanitarian ends.

Main lessons

- Making government-owned high-resolution imagery accessible to humanitarian organizations and the volunteer communities can support them in their work worldwide.
- Technical and policy efforts are required to increase the speed at which imagery can be released and to standardize and improve the process.
- Such projects demonstrate successful full-loop and half-loop feedback projects.

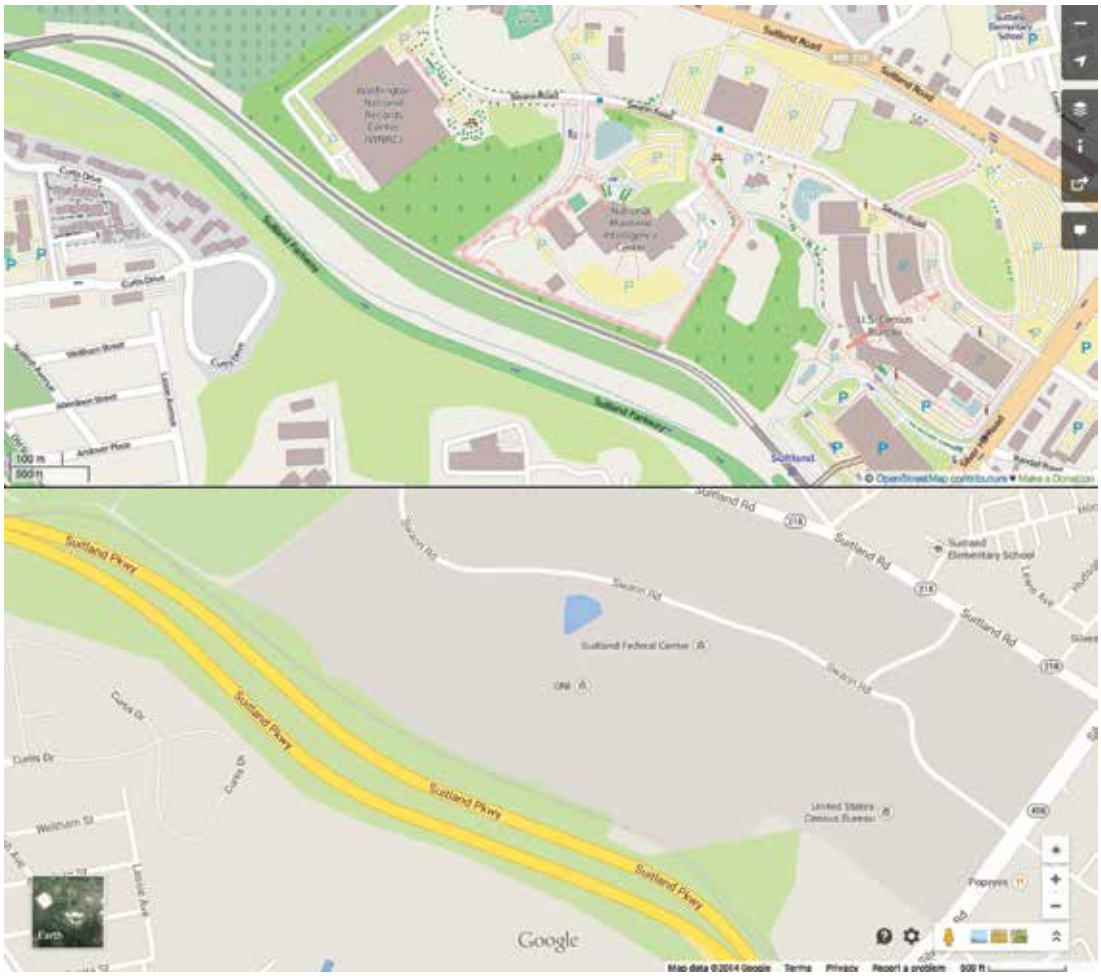
20. OpenStreetMap community of practice, US Census Bureau

Interaction type	Public→ Government→ Public
Trigger event	Internal champion.
Domain	Generic mapping.
Organization	United States Census Bureau.
Actors	United States Census Bureau.
Data sets	OSM.
Process	Mapping events and outreach within the Bureau.
Feedback	-
Goal	To build a group of mappers and supporters of OSM within the US Census Bureau.
Side effects	-
Contact point	Steven Johnson, OSM, US

At the moment, the US Census Bureau has no formal interaction with OSM. However, a small number of internal champions have been working to build a community of mapping enthusiasts to create support for the incorporation of OSM into the Bureau's work.

One of the leading advocates for the use of volunteered geographic information within the US Census Bureau's programs says that there a number of ways in which the platform could be useful. Data collection is expensive and OSM could offer a way for the Census to partner with citizens to help identify areas where change has occurred and, perhaps, collect basic location data about the neighborhoods where they live. OSM could also be used as a tool for helping Census professionals better understand issues that Census field representatives encounter in their work. For example, by participating in OSM, they would have to engage with ambiguity in tagging systems as well as better understand the geography of the areas to which they are assigned.

In order to help grow the OSM community within the Census Bureau, advocates held mapping



Suitland Federal Center - Google Maps and OpenStreetMap comparison

GOOGLE, OPENSTREETMAP CONTRIBUTORS

events during lunch hours every other week during June and July of 2013. Participants were given basic information about the OSM platform and community, taught how to map using OSM tools, and sent out in small teams to survey the area around the Suitland Federal Center, where the Census Bureau offices are located. In addition, advocates have given a number of internal presentations about OSM and its applicability to the Census's mission and brought their colleagues to OSM conferences and meetups.

OSM champions face a number of challenges in promoting adoption of OSM within the Census Bureau. Many who have traditional GIS backgrounds have difficulty accepting OSM's open source model of data production. In government data sets, there is a notion that databases are authoritative. OSM offers no such assurances. The OSM community has no central point of contact to provide support. Thus, learning how to engage with the distributed OSM community would be an important part of any adoption. Finally, the census could potentially use OSM as a data source for TIGER/Line products, which describe fundamental features such as transportation networks, natural features and geographic boundaries, but are unable to do so because the Census would need to release this into the public domain, which is disallowed by the current license.

Main lessons

- Building support within government organizations for VGI requires time and willingness to learn different models of creating, validating and using data.
- Hands-on exposure to OSM tools is a useful way of helping individuals understand the platform and its potential value.

21. Crowdsourcing The National Map, National Map Corps, US

Interaction type	Public→ Government→ Public
Trigger event	The need to update the national map and other national map databases.
Domain	Generic mapping.
Organization	US Geological Survey (USGS), National Geospatial Program.
Actors	Local, state and federal agencies including the USGS.
Data sets	USDA National Aerial Imagery Program (NAIP) imagery, National Map base layers, ESRI world imagery, Alaska community photos, the national structures database and USTopo.
Process	Using crowdsourcing techniques, the USGS's National Map Corps encourages public volunteers to collect and edit data about human-made structures to provide accurate and authoritative spatial map data for the USGS National Geospatial Program's web-based The National Map.
Feedback	Updated structures are contributed in real-time. Databases are downloaded on a nightly basis. Data collected is in the public domain and freely downloadable.
Goal	Maximize limited resources while continuing to support the National Geospatial Program by leveraging volunteers with local knowledge to update The National Map and USTopo.
Side effects	-
Contact point	Elizabeth McCartney, emccartney@usgs.gov or nationalmapcorps@usgs.gov

VGI is not new to the USGS, but past efforts have been hampered by available technologies. Over the last two decades, the USGS has sponsored various forms of volunteer map data collection projects, including the Earth Science Corps where volunteers annotated topographic paper maps, the collection of GPS points using handheld GPS devices and, finally, web-based technology to input data in 2006. In spite of these efforts, and as valuable as the updates were, technology could not keep pace with decreasing USGS resources, and the VGI effort was suspended in 2008. Today, improved technology, social media and ever decreasing resources have once again made crowdsourcing an attractive option.

After several pilot projects to determine the viability of bringing back the volunteer mapping program, The National Map Corps volunteers are successfully editing ten different structure types in all 50 states, including schools, hospitals, post offices, police stations and other important public buildings. Using National Agricultural Imagery Program imagery as the primary base layer, volunteers collect and improve data by adding new features, removing obsolete points and correcting existing data. Edits are contributed through a web-based mapping platform built using open source technology developed by OpenStreetMap. Points edited are incorporated into The National Map and ultimately become part of USTopo.

In order to address quality concerns, an analysis of a pilot project was conducted over the state of Colorado. For all structure feature types, volunteer involvement was found to improve positional accuracy, attribute accuracy and reduce errors of omission. The Colorado pilot demonstrated that volunteer edits improve baseline structures data; that further review by advanced volunteers willing to provide peer review improves the data further; and that sample-based inspection by USGS personnel can monitor these processes.

Successful crowdsourcing is not without challenges, some of which include volunteer recruitment, volunteer engagement and participant motivation. The National Map Corps endeavors to meet these challenges using gamification techniques and a mixture of traditional and social media. Gamification includes easy on-ramping, virtual recognition badges, friending, map challenges, social media interaction and a tiered editing approach. Using these techniques has been successful. The National Map Corps continues to see substantial increases in the number of volunteers and volunteer contributions to The National Map.

Other challenges continue to exist and include: organizational resistance to accepting data from volunteers as being "good enough" to populate national databases; and working through issues for which there is no well-established policy regarding government accepting data from citizens. One example is the requirement to obtain approval for conducting a "survey" from the Office of Management and Budget as part of the Paperwork Reduction Act even though the project is not really conducting a "survey".

Main lessons

- Adoption of challenging techniques such as gamification has been successful and attracts volunteer interest.
- Evaluation of the quality indicated that the participation improves accuracy and reduces errors.
- Organizational resistance to accepting data from volunteers is one of the major challenges for VGI projects of this kind.
- Key factors to successful crowdsourcing include building on past experience, leveraging existing technology and having the support of key individuals within the organization.

ELIZABETH MCCARTNEY, USGS

US National Map Corps editor

22. US Geological Survey "Did you feel it?"

Interaction type	Public→ Government
Trigger event	Paucity of instrumental ground-motion data in regions of low seismicity.
Domain	Collection of ground-motion seismic data from the public.
Organization	United States Geological Survey (USGS) Community Internet Intensity Map ("Did you feel it?", DYFI).
Actors	USGS Earthquake Hazards Program.
Data sets	-
Process	On feeling earthquake activity, users log-on to the DYFI website and submit their observation. The intensity of the earthquake they have just felt is quantified using the Modified Mercalli Intensity (MMI) scale. There is no need for users to have experience in seismology.
Feedback	Maps and graphics are generated automatically by the DYFI system and made available to the public. There is no specific personalized feedback to the contributor.
Goal	To integrate the public into the seismic monitoring network and allow USGS to continue to learn and understand more about earthquake activity.
Side effects	The data collected from DYFI is made compatible with ShakeMap, a product of the USGS Earthquake Hazards Program in conjunction with regional seismic network operators.
Contact point	-

The USGS's Community Internet Intensity Map (more commonly referred to as "Did you feel it?") is a website that automatically maps reports from citizens about their perception of recent seismic activity in their area. If a member of the public feels a tremor they can visit the DYFI website and report their location and their estimate of the intensity of the tremors they have just felt. In combination with a large network of sensors, which are placed all over the world, these additional citizen reports allow USGS to develop a more detailed map of the intensity of an earthquake's activity. Over 360,000 earthquake events have been submitted to DYFI and are available to browse online on the archive section of the website. There is an option for users to give first-person descriptions of how the earthquake affected them. However it is made clear on the form that if the USGS uses this qualitative information the user will only be referred to as "the observer". Contributors can watch the DYFI webpage for the display of their report. Maps and graphics are generated automatically by the DYFI system and made available to the public.

The "Did you feel it?" form interface is easy to use. Ideally those reporting earthquake events in the United States will know their ZIP code but citizens from outside the US can submit observations with their coordinates in longitude and latitude. The form is mostly comprised of drop-down lists asking for feedback on: your situation when the earthquake occurred, your experience of the earthquake (shaking strength, duration, reaction), earthquake effects (sounds, damage to free standing objects, etc.), damage to buildings, etc.

DYFI's appeal to users means the data makes up in quantity what it may lack in scientific quality and offers the potential to resolve long-standing issues in earthquake ground-motion science. Such issues have been difficult to address due to the paucity of instrumental ground-motion data in regions of low seismicity. Prior to this system, intensity maps were rarely made for US earthquakes of a magnitude of less than about 5.5; now intensities as low as magnitude 2.0 are routinely reported for the smallest felt earthquakes nationwide. The intensity of earthquakes reported by users is quantified using the Modified Mercalli Intensity (MMI) scale. MMI measures the intensity of ground motions from the perspective of human and structural response on a qualitative scale from 1 (not felt) to 10 (very heavy damage) or sometimes 12 (total destruction), based on descriptions such as "felt indoors" (MMI = 3) to "felt by all, windows, dishes, glassware broken, weak plaster cracked" (MMI = 6) to "some structures with complete collapse" (MMI = 9). The MMI allows anyone to report activity. There is no need for the contributor to have experience in seismology. This public reporting allows the USGS to continue to learn and understand more about earthquake activity. In addition the USGS can then use this knowledge to inform emergency response planning efforts and budgets for modeling disaster relief.

There are some negative aspects to "Did you feel it?". Despite their significant value to emergency responders, the subjective observations of untrained users are only a qualitative indicator of the effects of an earthquake. Moreover, the effectiveness of DYFI-based maps may be greatly hampered by the speed at which people report critical information during crises.

Main lessons

- Quality control can be achieved by securing a large response rate from contributors.
- The requirement for non-technical jargon free locational data allows greater levels of public participation.
- Accessible and easy to understand input forms which avoid using specialist terminology helps to engage non-specialist users.
- VGI can be used to fill gaps in official data sets and supplement official government monitoring programs.

23. Places of Interest project, National Park Service, US

Interaction type	Public→ Government→ Public
Trigger event	Licensing and data validation concerns.
Domain	Mapping of tourist infrastructure and natural features.
Organization	National Park Service (NPS), US.
Actors	NPS.
Data sets	OSM.
Process	Edits to NPS data are made by Park Service employees. There is no validation in effect but this may change in future.
Feedback	Internal park data sets that have been digitized from park maps.
Goal	To create an up-to-date map of all the parks for viewing and use by the public on the parks' websites.
Side effects	None yet, but data quality issues are anticipated.
Contact point	Jim McAndrew, US National Park Service

The National Park Service does not have a comprehensive data set of geographic information describing tourist infrastructure and natural features for all of the 400 or so individual territories managed by NPS. Some parks have their own GIS departments and produce excellent data, while other parks are small and do not have these resources. The aim of the NPS Places of Interest project is to allow non-technical users to add and modify important landmarks in the parks in a single map. This map can then be used as a basemap for all NPS web maps. When users see the crowdsourced map in parks and notice errors, they will be able to make changes to the maps immediately.

The NPS Places project uses the OSM platform because of the robust open source tools that are available. This includes the backend API and rendering formats as well as the easy-to-use iD editor. It does not use the OSM database itself. Due to licensing restrictions on OSM data, the NPS maintains its data separately.

The project is designed to collect point data from NPS employees that will be displayed on most of the web maps on the NPS website. There are future plans to expand this project further to the public and

use Park employees to verify information before it is published on the map.

There is currently no easy way to extract information from the NPS Places project although its API is open and fully documented. It is possible for motivated users to extract the information they want from this API.

The biggest success of this project is collecting contributions from non-technical Park staff. This includes people with extensive knowledge about the parks, such as rangers and maintenance managers. These people know the parks better than anyone, but they have not been able to get their data into traditional GIS at parks without a dedicated GIS staff. Few non-technical users are involved yet but the project is planning to visit the parks and train users so they know what they can add. Some parks with GIS departments have already started synchronizing their own information with the system and have been making a big push to use the system for all of their web pages.

The biggest challenge is that OSM does not deal with traditional GIS very well. This means building tools to synchronize ESRI databases with the NPS database using the ESRI REST API. NPS would like to make contributing to the system as easy as possible for the existing GIS departments that do the bulk of the GIS work in the parks. While the goal is to get non-technical people involved, the core of the project will still be the GIS departments the exist in the parks and the regional offices.

Main lessons

- It is possible and sometimes desirable to use the OSM toolset to facilitate voluntary mapping activities without using the data set itself.
- The OSM platform can be used as a great platform for empowering non-technical users to start modifying maps. The iD editor is extremely easy to use and rendering tools, such as Tile Mill and Mapnik, allow the data to be updated in real time.
- The success of the system relies on working with existing GIS managers on site and regional offices.
- Non-specialists are an important part of this process but require more training to get their contributions into the system.
- Live feedback is an important feature to encourage contributions.

24. California Roadkill Observation System (CROS), US

Interaction type	Public→ Government
Trigger event	A university-based research project.
Domain	Development of a database of user-contributed observations of roadkill incidents.
Organization	ICE (an environmental information brokerage and research laboratory in the Department of Environmental Science and Policy at the University of California, Davis) and Caltrans (California Department of Transportation).
Actors	ICE, Caltrans.
Data sets	GIS data sets such as Californian roads infrastructure.
Process	A user can contribute details of incidents of roadkill in California (location, type of roadkill, photographs, etc). Contributions are uploaded on the CROS website then submitted to the CROS database and displayed on the public web map interface.
Feedback	The contributor of roadkill information is provided with feedback to state that the contribution has been successfully submitted to the CROS system. If contributors register on the website their name is placed beside any contribution they make. All contributions are made publicly available. The top 20 species observed and top 20 observers are listed on the website.
Goal	To understand the ecology, wildlife behavior and how transportation contributes to this problem. This includes the application of GIS and statistical modeling to predict roadkill hotspots, to measure the contributing factors to roadkill, to quantify impacts, and to estimate benefits of different remedial actions.
Side effects	Caltrans have used the data from CROS and the expertise at ICE to develop a guidance manual for effective strategies to address road/wildlife conflicts in California.
Contact point	-

The California Roadkill Observation System can be used to record observations from reporters out in the field who come across identifiable road-killed wildlife. This includes the type of animal and/

or species found, its location, when it was found, how long it might have been dead, pictures of the roadkill and any additional details about road or traffic conditions. CROS displays a summary of this information for different wildlife groups across the state. Information about where wildlife vehicle collisions occur, what animals are involved, on what kinds of roads and other data can help inform policy, management and financial investment to reduce roadkill. The mission is to provide a safer environment for wildlife in relation to California motorways.

The collectors of the roadkill data are a university-based research organization. The CROS project includes past and current participation by over 900 volunteer scientists, including several hundred academics as well as agency and NGO biologists and natural historians. More than 25,000 observations have been logged on the website since August 2009. An Android application is available but the website is the most stable and robust means of submitting contributions.

The observations are used in a geographic information system to find wildlife-vehicle collision hotspots. By contributing wildlife observation data, users help researchers understand where wildlife live and the threats they face from human activities. The research organization hope to use this data and their GIS analysis to inform transportation planning in the state of California. Caltrans and ICE teamed up to create a guidance manual for California.

Main lessons

- Internet-based training materials can be provided to allow some contributors to undertake training in scientific methods of surveying.
- The user interface for contribution should be easy to use and should include widgets such as pre-defined lists and clickable maps to decrease the opportunities for erroneous data submission.
- Photographs submitted in addition to basic geographical data can provide very useful visual context information.

25. Shelter Associates, slum mapping in India

In urban areas of India the percentage of citizens who live in slums fluctuates from 10-50 percent, which means that a great number of people lack basic infrastructure and housing. Housing, health, sanitation, education and livelihood are among the main issues that NGO Shelter Associates tries to address in specific areas of India through a variety of projects intended to improve the living conditions of slum dwellers. Shelter Associates was established in 1993 by architects and planners and works in direct collaboration with the local government for the improvement of citizens' lives. It has adopted a hybrid model of experts in various academic fields, such as GIS analysts, sociologists, planners and architects, who work with the aid of local volunteers. The volunteers contribute to slum mapping by maintaining up-to-date data for informal settlements and supporting community participation in other projects carried out by Shelter Associates.

According to Shelter Associates, the main issue that local government faces is the lack of local knowledge about the spatial infrastructure of slums, which results in the exclusion of informal settlements from city planning and urban development. The local people consider mapping as an opportunity to move to other areas where schools are located or to save money by adopting better transportation routes.

Shelter Associates pioneered the use of GIS for poverty mapping in the late 1990s. However, in recent years, the need to connect the data collected for the various projects, and stored in different layers alongside spatial information, became crucial. The team adopted Google Earth as a basemap for the slum mapping and among other benefits, Google Earth is easy to use, easy to understand because it includes aerial images and offers a clear picture of development within the city. The spatial data was introduced into a variety of projects to support good governance and decision making policies.

26. Crowdsourcing satellite imagery in Somalia

This is a humanitarian project to geo-locate all shelters in Somalia's Afgooye corridor with the aid of satellite imagery provided by the Standby Volunteer Task Force. UNHCR, DigitalGlobe, Tomnod, SBTF and Ushahidi are the main organizational bodies cooperating so that crowdsourcing can take place with the aid of volunteers. The aim of the project behind this collaboration is to map all shelters by dividing them into three main categories: large permanent structures, temporary structures with a metal roof and temporary shelters without a metal roof. The rule set describes the shape, color, tone and clustering of the different shelter types. The project was divided into two phases: a trial and an official launch where specific instructions were given to participants. The goal of the project is to test the feasibility of crowdsourcing rapid shelter enumerations of internally displaced persons to support population estimates. The process cannot be replaced by an automated system because this could not identify the type of shelter.

The satellite imagery methodology was adopted because access to the area of interest is limited. The main question was how many people are in the shelters and need humanitarian aid in order to inform decision making around logistics and planning policies. During the project, 253,711 tags were created and more than 9400 shelters visually identified after processing 3909 satellite images.

27. Agricultural data collection and sharing by Community Knowledge Workers, Uganda

The digital divide is an urgent social and technical issue in Uganda, especially for small farmers who have low literacy rates and limited access to the power grid to support the use of technical equipment. The lack of technology savvy people also results in the exclusion of local people from data collection, which could help them to reach informed decisions and improve their farming efficiency and consequently their everyday lives.

Community Knowledge Workers (CKW) is an initiative of the Grameen Foundation that aims to train locals in the use of technology, overcoming power infrastructure issues, for data collection and sharing to enable their communities to make informed decisions based on actionable and up-to-date farming knowledge.

After registering, participants of the CKW network can use mobile phones to collect a range of information regarding livestock and farming. The mobile phones can be recharged by solar power or manually (e.g. using bicycles). As most areas are not covered by the mobile network, data collection takes place offline simply using the GPS sensor of the device and properly designed forms. Once the phones are inside a wireless or mobile network area, the data is uploaded to a central server and becomes available to other farmers or stakeholders. The information shared is helping farmers and policy makers to evaluate the needs of farmers, assess potential disease outbreaks, provide market price updates, receive weather forecasts and even provide income to the farmers as the surveyed data is used by agricultural organizations. All the data have feedbacks to the farmers in terms of improved policies and prompt government action. Thus, CKW has established an efficient grassroots network of data and services that has fundamentally changed agricultural knowledge sharing in Uganda.

28. Twitter use in Italian municipalities

Research investigating the Twitter profiles of Italian municipalities identified that, at the time of the survey (November 2013), only 461 of more than 8000 Italian municipalities had Twitter profiles, approximately 6 percent. After a few months, this increased to about 25 percent while six months before, only 368 municipalities had a Twitter account. The geography of municipal Twitter profiles in Italy seems to reflect the urban structure of the country, which is mostly made up of many small and medium sized cities. At the time of the survey, only 1 percent of the 461 profiles had been activated by large municipalities, 4 percent by medium municipalities, 44 percent by small to medium municipalities, while 51 percent had been activated by municipalities with less than 10,000 inhabitants.

This demonstrates that reduced population size is not a barrier to the spread of social applications but may in fact be an advantage or a driver. The first and most active (in terms of tweets sent and followers) municipalities on Twitter are those which started with the activation of "civic networks" (municipality websites) in the late 1990s, showing the relationship between the adoption of these kinds of technologies.

The survey analyzed the types of messages sent, since the activity profiles must be assessed not only in relation to the amount of tweets and followers but also with respect to the quality and type of information sent. The latter relate to different fields, which include simple messages for informational purposes up to more complex messages addressing planning and territorial management. The research team classified the hashtags used by most municipal profiles into several categories and the most widely represented information related to culture and tourism, followed by geographical information, utilities and weather forecasts. Messages about governance are still quite limited except in some cases, demonstrating that the potential of Twitter as a collector and distributor of information on complex issues around which to initiate debates and discussions has not been realized. Only a few municipalities have used Twitter for emergency and risk management, such as Castelnuovo Garfagnana (earthquake) and some municipalities in Sardinia (flooding). Nevertheless it is worth noting that the news about L'Aquila's severe earthquake of 2009 was first announced through Twitter before other media.

29. Portland TriMet, transportation planner, Oregon, US

TriMet is a public agency that provides bus, light rail and commuter rail transit services in the Portland, Oregon, metropolitan area. In an effort to keep the services provided to the public at the highest possible level, TriMet is incorporating a range of services such as multimodal trip planning and service change analysis. TriMet needs a new generation of data that traditional proprietary data sets cannot provide. To solve this problem, TriMet turned to the use of OSM. As well as traditional road network data sets, OSM also provides data about pedestrian paths and bicycle routes that can enable TriMet to provide multimodal services to the citizens of Portland. Moreover, proprietary routing data sets are costly and do not come with near real-time updates.

In this context, OSM data sets are now used by all internal systems and applications that need routing data. Also, TriMet officials have realized the value of OSM data and have committed to contribute to OSM with a full-time employee. Moreover, city officials realized that by releasing governmental data to the public, the OSM community will contribute to data improvement and will enable TriMet to provide better services to the public.

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