From Crowdsourced Mapping to Community Mapping: The Post-earthquake Work of OpenStreetMap Haiti

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Abstract The earthquake that struck Haiti on January 12, 2010 catalyzed a nascent set of efforts in then-emergent "volunteer technology communities." Among these was the response from OpenStreetMap, a volunteer-driven project that makes geospatial data free and openly available. Following the earthquake, remotely located volunteers rapidly mapped the affected areas to support the aid effort in a remarkable display of crowdsourced work. However, some within that effort believed that the impact and import of open and collaborative mapping techniques could provide much richer value to humanitarian aid work and the long-term development needs of the country. They launched an ambitious project that trialed methods for how to create sustainable and locally-owned community-mapping ecosystems in at-risk regions of the world. This paper describes how an organization that emerged out of the response—the Humanitarian OpenStreetMap Team—formalized their practices in relation to many different stakeholder needs with the aim for setting a model for how the potential of participatory, community mapping could be realized in Haiti and beyond.

1 Introduction

The paper describes events following the initial mapping response by the OpenStreetMap community to the January 12, 2010 Haiti earthquake. Over a 3-week period, 600 remotely located volunteer mappers built a base layer map for Haiti nearly from scratch. Though the initial crisis mapping activity by volunteer

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mappers was remarkable and garnered a great deal of attention, the critical work of situating the map in Haiti, and of making the map useful and meaningful to humanitarian aid efforts, as well as to the people of Haiti themselves had just begun.

This paper places the map's creation by OpenStreetMap's large, distributed community in a larger context of humanitarian efforts that continued on the ground long after the earthquake struck. It reports on a project born out of the obligations its participants felt to maintain and localize the map in a country with highly limited resources—and whose mappable socio-physical features were undergoing rapid change due to infrastructure damage, movement of displaced persons, reconstruction efforts, and public health crises.

Specifically, we describe how an offshoot of the OpenStreetMap community, the Humanitarian OpenStreetMap Team (HOT), worked for 1.5 years after the earthquake to make the map useful to the international effort and the local Haitian community. This effort attempted to materialize a set of values, which included the idea that local ownership of the map's production was not only ethically appropriate, but also the best way to sustain local value and to maintain the map as a dynamic product with local knowledge. Before achieving that localization goal, however, the early international humanitarian response was challenged by heterogeneous, redundant mapping efforts that the fledgling HOT thought it could resolve. The concerted early attempt by HOT to resolve those problems was used to then mobilize their ultimate goal that the map be a locally owned and maintained resource, that could make the country more resilient in the face of future threats that would inevitably come its way.

Others have examined at a high level OSM's role in the immediate wave of the Haiti disaster response, describing the OSM map as an organizational-level boundary object [20] that served multiple social worlds. In this paper, we extend that depiction to describe in detail how OSM came to play such a role through a progression of sometimes contentious and always challenging work. We provide detailed narrative of how HOT actively sought to bring groups to OSM, and how they helped them articulate their relationship to a complex socio-technical artifact. We also investigate the creation of HOT, and how they combined ideals of participation [11] and open data with the opportunities of the social computing platform of OSM to yield an important form of social entrepreneurial work.

2 Method and Style of Reporting

We offer a synthesized interpretation of a sequence of events reported by people immersed in the Humanitarian OpenStreetMap Team organization (HOT). The first author is himself a former HOT board member and participated in some of the events described. The account therefore comes from direct participation with the OSM Haiti effort coupled with interviews and reviews of the account by the others who were involved in the Haiti response. This follows a similar style of auto-ethnographic reporting as conducted in Aoki's research of highly restricted combat

information centers [1], where access would otherwise be difficult and/or brief. Our reporting has been supplemented with additional material, including academic publication, internal reports, white papers, and blogs generated during that time period.

3 Origins: The Rise of Crisis Mapping

The Haiti earthquake was a catalyzing event for many "volunteer technology communities" that provide humanitarian aid in emergency response. The year or so predating the earthquake—the 2008 and 2009 timeframe—was a period of great innovation and imagination around technology-abetted activism with respect to humanitarian work. Mobile computing and social media were becoming common, and activists and potential activists were beginning to envision what new possibilities existed for digital volunteerism focused on ideas of open data, open source software, and volunteered geographic information [15, 23, 27]—or what has become known as "crisis mapping."

Groups gathered in a variety of venues to brainstorm and commence work on their ideas. The earliest Crisis Camp events—whose concept was an elaboration of the "bar camp" idea—were held in May 2009 in Washington, DC, gathering many people from different backgrounds interested in "civic hacking" [47], joining together expertise in high tech and humanitarian work, and garnering the attention and support of the World Bank and civic action groups. The first International Crisis Mapper Conference took place in October 2009 from which an active community was launched. The Random Hacks of Kindness group sponsored by Google, Yahoo, and Microsoft hosted their first event in the San Francisco Bay Area in November 2009. The ideas and connections created during these events were supplemented by gathering interest from humanitarian GIS communities. In particular, a subset of the OpenStreetMap community was investigating ways in which open geospatial data created through crowdsourcing and other participatory methods could provide value to crisis response. OpenStreetMap, founded in 2004, was already well-established, but had not yet been applied in an organized fashion to large-scale humanitarian aid effort.

The January 12, 2010 Haiti earthquake, astonishing in the extent of its damage, came just as the early groundwork by these techno-humanitarian groups was being laid. People who connected through the events of 2009 drew in others alarmed by Haitian suffering, and mobilized—or converged [8, 10, 19]—as "technology volunteers," "digital volunteers" and "volunteer technologists." Crisis Camps proliferated throughout the US and Europe; Ushahidi responded to its first disaster arising from a natural hazard and conceptualized a reliable volunteer staff that eventually came to be known as the Standby Task Force; Humanity Road grew out of early "crisis tweeting" work; and the People Finder standard launched [4, 15, 16, 28, 35, 40, 41].

In what became one of the more immediately applicable solutions arising out of these efforts, the OpenStreetMap community mobilized around the extensive mapping needs of the response efforts in Haiti, giving impetus to the formalization of the Humanitarian OpenStreetMap Team.

4 OpenStreetMap

OpenStreetMap (OSM) was founded in 2004 at the University College London by Steve Coast, a computer science graduate student [6]. Coast and others were frustrated with the Ordnance Survey's restrictions on use of government-collected map data. They developed a simple database and web application and, using commercial GPS devices, began to map areas around London. The focus was on developing simple tools and ensuring the data were released under a license that would facilitate wide and varied use. Within 5 years, OSM had over 100,000 users and the project had spread to a number of countries [6]. Today it is a global project, with over 1.3 million registered users and active groups in at least 80 countries [31, 32] working towards a free and open map of the world.

OSM, which is sometimes called "the Wikipedia of maps," is a multi-faceted project that enables distributed work around a common product. It is a database that contains basic, or "framework" geographic data [9] for many parts of the world. It is also a website and set of software tools that allow users to contribute to, download, or otherwise interact with the database. In addition, OSM is a community that interacts through various channels including email lists, IRC channels, in-person conferences, meet ups and mapping parties, wiki pages and the OSM website. Finally it is a set of shared values and participant-enforced rules that guide how to should interact with the tools, data and community.

People active in OSM participate for a wide variety of reasons, but many focus on the ideology of and opportunities created by nonproprietary geospatial data [3]. Some come from private sector firms and want to deliver data or software applications to clients. Others enjoy mapping bicycle routes or historic areas; still others are enthusiasts who want to map their own neighborhoods alongside others in their communities. Research reveals that through these combined efforts in urban areas, the quality of maps, though varied, is generally high [13, 26].

Just before the Haiti earthquake, interest by the OSM community in humanitarian and development work was finding its footing, with a growing contingent who believed that the values of data openness and civic participation lent themselves well to these contexts. At the July 2009 State of the Map—the annual OSM conference—a number of "lightning talks" discussing application in developing countries indicated growing interest [29]. The first known use of OSM for humanitarian purposes was in the response to the October 2009 Tropical Storm Ondoy in the Philippines when OSM data were used by MapAction in situation reports and damage assessments [21, 24]. Several months later, the Haiti

earthquake rapidly catalyzed and mobilized the prior but still fledging interest in humanitarian uses of OSM [15, 46].

5 The Crisis Mapping Response

5.1 Creation of the Map: January 2010–March 2010

Initial Mapping At the time of the earthquake, much of the available spatial data for the quake-affected area were in formats inaccessible to GIS users or were not detailed enough to guide response efforts. OSM itself had only a portion of the road network. Other major web-based maps had even less information. There was a clear and immediate demand for accurate and up-to-date maps to help guide logistics and support other elements of the response.

Facilitated by existing personal connections made through various open-source software projects, the International Crisis Mappers Conference and network, the Camp Roberts experiments [23], the Crisis Camps organized by The World Bank and others during 2009, the ecosystem of volunteer technologists began monitoring, collecting, collating and analyzing information from a range of sources across traditional and social media. Digital Globe, GeoEye and others made pre- and post-event high-resolution imagery available under permissive licenses [35]. Ideas that previously only been discussed in the hallways of barcamps and conferences were implemented post haste in hopes that they would support the array of actors responding to Haiti's earthquake.

OSM coordinated activities primarily through one of their existing listservs, and supplemented with IRC and the Haiti page on a wiki. The listserv of the International Conference of CrisisMappers was also used to coordinate OSM's activities along with other volunteer technology projects. Volunteer mappers took advantage of the imagery releases but also drew upon historic maps from the CIA and elsewhere [43, 44]. Roads and building footprints were among the primary types of information digitized, but mappers also attempted to identify damage to infrastructure and the impromptu camps set up by Haitians who had lost shelter [18]. In addition, the community provided rapid extracts of the database in formats that could be easily consumed by the traditional GIS tools used by responders; created new visualizations of the dataset; and developed a number of web services and products intended to facilitate the digitization of imagery or the use of OSM data [44].

Progress was rapid. A co-founder of HOT, Mikel Maron, blogged roughly 53 hours after the earthquake struck that over 400 unique editing sessions had taken place with significant improvements to the dataset were already visible [25]. An analysis of contributions to the OSM database for Haiti from January 12-February 12 found that there were close to 600 individual contributors during that period. Importantly, the same research also showed that the majority of individual contributors were from the pre-existing OSM Community, rather than new contributors [5], contrasting with other reports of disaster volunteerism [33, 47].

Fig. 1 Progression of the OSM dataset. Screenshots from January 10, January 12, and February 5, 2010, arranged clockwise (**a**, **b**, **c**). *Source* Mikel Maron and Shoaib Burq

Analysis by Haklay conducted in January 2010 found that in urban areas affected by the earthquake, OSM contained more detail than both the road dataset in common use at that time by the UN and Google Maps (2010b). However, as most of these data were created by digitizing satellite imagery, it was primarily composed of the geometry and location of major features only, and lacked significant attribute details such as road names and building uses at that time (Fig. 1).

Use on the Ground, Pre-Intervention by HOT Through the efforts of volunteers, OSM became the most detailed map of the quake-affected area available. Though use on the ground during the response is difficult to quantify, we know the following: many of the major GIS users involved in the Haiti response relied upon OSM, including OCHA and UNICEF [2]. Maps using OSM data were seen in many of the offices of the UN agencies operating at the UN Logistics Base ("LogBase"), a set of tents and trailers next to the international airport. The Fairfax County Virginia Urban Search and Rescue Team reported using OSM data on Garmins to assist with navigation [15]. Surveyors funded by the International Organization for Migration (IOM)—an organization that figures prominently over the next 18 months of HOT activity—added street names as early as February 2010 to assist with resettlement efforts [Fred Moine, personal communication]. The Executive Director of MapAction wrote that he "hesitate[d] to understate [OSM's] importance in our work in the field" [15]. The Mission 4636 and

Ushahidi projects used OSM both as a basemap and to assist the geotagging of incident reports coming in via SMS, Twitter and other sources [28].

5.2 Launch of the Humanitarian OpenStreetMap Team

The value of OSM for humanitarian work was first suggested in 2007 [22], based on the observation that the map was built on open data that could be readily changed by anyone with knowledge of a geographical area, and access. Future members of what would become the Humanitarian OpenStreet Map Team, or HOT, participated in many of the mobilizing 2009 events, which provided fertile opportunities to share ideas, strengthen personal connections, and develop and test tools including Walking Papers, a paper-based form of geospatial data recording during surveying that could be later digitized [23]. Some pre-Haiti humanitarian work including digitizing roads in Gaza; and making OSM data available in response to the October 2009 Tropical Storm Ondoy in the Philippines [24].

However, when the Haiti earthquake struck in January 2010, HOT was still an informal organization without defined roles or even a clear mission statement. HOT members met in mid-January 2010 to draft a further strategy for how to best support the relief effort [30], which included ideas for on-the-ground support. Subsequently, a World Bank-funded mission in February 2010 included OSM representatives who were able to document some of the uses of OSM by the response. Then, in late March with funding provided by MapAction, HOT launched its first mission to Haiti: a two-person effort spanning 3 weeks [37].

6 "Embedding" the Mapping Work in Haiti

Upon arrival, the team had no concrete plan of action or official host within the UN LogBase, the operations center near the Port au Prince airport where many international organizations were based. However, through personal connections to the International Office of Migration (IOM), HOT obtained a working space in the IOM tent and permission to camp at the edge of LogBase. The team used connections to gain the trust of other relevant GIS data users and producers there.

6.1 Building Trust and Identifying Needs

The team cast a wide net in their outreach. They arranged numerous meetings, gave presentations and launched a set of OSM training sessions, which attracted ultimately over 70 people during the three-week mission. These sessions—what the OSM community had historically called "Mapping Parties"—were facilitated

by hardware kits purchased and assembled in the US and brought to Haiti. Locking pelican cases contained a laptop, GPS devices, printer/scanners, and USB drives preloaded with software and OSM data so that sessions could run without access to the internet.

This outreach served multiple purposes. The first was to further raise awareness of OSM among the GIS community active in Haiti. Many of the involved in the response had heard of or had already used OSM in some fashion; however, face-to-face meetings with these users helped build trust in the OSM dataset, allowed HOT to communicate the OSM vision, assist with technical questions, and better understand needs of users and their organizations.

Second, face-to-face interaction helped identify OSM champions within the response. Several of these champions later joined HOT as volunteers or paid employees. This early advocacy also led directly to a critical, funded partnership with IOM that allowed the OSM effort to persist in Haiti for a much longer duration, as we will explain.

A Vision for Collaborative Mapping in Haiti The face-to-face work of the mission also allowed for detailed technical discussions around the data collection priorities of the GIS community, which was important for the development of the HOT Humanitarian Data Model (HDM), a standardized way of collecting and sharing data that could be used as a way of facilitating collaborative approaches to mapping in Haiti. The teams could see that numerous heterogeneous field data collection and surveying activities were proliferating by the multiple organizations operating at LogBase, only sometimes in coordination with the Information Management Working Group. Multiple databases of schools, health facilities, and water and sanitation infrastructure were being designed, and scores of Haitians were being trained as surveyors by different groups. HOT felt that if the various efforts could be convinced to adopt common data models and to contribute the data they collected to OSM, this would benefit the whole of the response.

These promising collaborations, and the hope of facilitating further collaboration with others propelled HOT's ongoing work in Haiti. This vision also articulated the organization's goals eventually in at-risk developing regions beyond Haiti, seeding the idea that early, pre-disaster involvement led by local individuals and organizations could have better effect. HOT also recognized the importance of coordinating with the national government, which was suffering greatly from the earthquake. Between 20–40 % of Haiti's civil servants were injured or killed, and 28 of 29 ministry buildings were damaged or destroyed in the earthquake [17]. In the wake of these heavy losses, the government struggled to respond effectively and manage the influx of international organizations [7]. While neither the government or the responding agencies ever adopted OSM to the extent that HOT believed possible during its early work in Haiti, this vision was central to the ways in which the group conducted its work and outreach.

Fig. 2 First mapping party in cite soleil. *Source* Authors

6.2 Partnerships and Localization

Haitian Civil Society In addition to outreach to international organizations, a key goal of HOT was to work with Haitian civilians to grow local ownership of OSM. Based on the prior success of the MapKibera slum-mapping project in Nairobi [12], with which several members of HOT were involved, the team worked to build connections with groups in Cite Soleil, one of Port au Prince's largest informal settlements. The first mapping party took place in Cite Soleil with about 15 people from the community on March 29, 2010 (Fig. 2).

Deepening the Relationship with IOM and Cite Soleil The second and third HOT missions to Haiti, supported by the World Bank, took place in May and June. By July 2010, members of HOT had spent a total of 52 days in-country and provided formal OSM trainings for around 300 Haitians and internationals, gave presentations and held meetings with numerous actors within the response effort and Haiti's government and civil society. Furthermore, residents from Cite Soleil who had attended the initial mapping party began to accompany HOT to deliver training in Haitian Kreyol, broadening the reach of the growing OSM community.

IOM sponsorship of the first three missions allowed HOT to spend significant time with IOM staff, facilitating social relationships between the organizations, and for HOT to come to understand IOM's work and priorities. HOT understood this to be an important relationship in the achievement of its goal to "embed" the map in Haiti for long-term use. Several IOM units began to express interest in how the OSM platform and the nascent OSM community in Haiti could support IOM's work. This lead to a contract between HOT and IOM—and transformed the nature of HOT's work in Haiti.

7 Expansion and Dispersion of OSM Work

7.1 Camp Mapping: Building the Team

In August 2010, HOT undertook its first IOM-funded mission to Port au Prince. This work was part of a broader effort of facilitating connections between IOM and the residents of the internally displaced persons (IDP) camps. HOT was responsible for designing and overseeing a process through which camp residents would participate in mapping critical camp infrastructure. The resulting maps would help IOM camp management efforts as well as be posted in public areas of the camps themselves. Significantly, IOM also agreed to hire 21 Haitian mappers full-time, the core of whom were the original HOT recruits from Cite Soleil. As a result of this investment by IOM, both HOT and the nascent Cite Soleil OSM community would organize themselves in new ways.

A Global Outlook, and the Incorporation of HOT Until this point, HOT was still an informal organization. A listserv had been set up in March 2010 where the Haiti work as well as volunteer support to new emergencies in Chile, Pakistan, and elsewhere was discussed. This facilitated some degree of broader coordination within the growing organization. However, ongoing work would need to be supported by funding in some form. Funding for the first three Haiti missions had all been channeled through third-party groups who were willing to adopt some risk by providing administrative support to the team. However, to move forward with IOM in Haiti, HOT needed to incorporate. In August, HOT incorporated as a US-based non-profit because many (though not all) of its board members resided there. The draft Articles of Incorporation were posted on the OSM wiki and discussed on the HOT listserv, furthering strengthening its identity among the distributed members. The initial board was comprised primarily of those who had travelled to Haiti on the missions, an influence that shows the significance of the Haiti event to shaping the future of HOT.

Community Localization, and the Incorporation of COSMHA The Cite Soleil residents hired by IOM served as both community mobilizers as well as surveyors. They trained and worked with residents in one of IOM-managed camps to map community assets. They had developed an identity and a working organizational structure of their own. A listserv for discussing the OSM in Haiti hosted conversations in French, English and Haitian Kreyol. A Facebook group further facilitated interaction and a sense of community. With the encouragement of HOT, the group decided to incorporate as a non-profit organization, COSMHA—the Comunite OpenStreetMap de Haiti.

7.2 The Cholera Outbreak: Proving the Model

The first reports of cholera in the central plain of Haiti came in October 2010. By the time of the fifth HOT mission arrived in November, there were serious

concerns that cholera would spread through the country's poor water and sanitation infrastructure as well as its healthcare facilities to become a national epidemic. HOT, because of its relationship with IOM, was privy to many of the internal conversations relating to these concerns and began to advocate for refocusing the mapping team on the problem. This advocacy was driven both out of desire to contribute, but also as a strategic move to place OSM at the center of what appeared to be a significant new challenge facing the response effort.

The team had been making steady progress on the camp mapping activities but now their attention accordingly shifted toward locating cholera response infrastructure. Instead of working with camp residents to map their surroundings in predominantly urban areas, the mapping team now rode mini-buses and motorcycles to more rural areas. The IOM Mapping team, after just two months of operation, was charged with providing a weekly updated list of cholera response infrastructure to the UN Health Cluster, which coordinated the cholera epidemic response. These efforts, in the face of the new crisis, demonstrated the validity of HOT's belief that local actors, given proper technical assistance and sufficient resources, could take a leading role in crisis mapping activities in Haiti. Future pre-disaster work by HOT in Indonesia and elsewhere would be driven by similar conviction.

As a result of the increased visibility of the team due to the cholera project, HOT and its allies within IOM were able to push for an expansion of OSM activities. Beginning in January 2011, 1 year after the earthquake, IOM hired an additional 20 mappers from COSMHA, doubling the size of the team and providing funds to support the launch of satellite offices in Leogane, Jacmel, and Gonaives. As part of the plan, someone from HOT was then based in Haiti full-time to assist with project oversight, coordination, and training. This was HOT's first full-time employee.

7.3 Differentiation and Dispersion

This phase was a time of heightened OSM mapping activity in Haiti. Over 300 new volunteers participated in OSM training sessions between January and March 2011. Baseline surveying was completed for 31 communes during this period, a significant addition to the coverage and detail of the OSM dataset. In addition to the geographic and team expansion, increased effort was made to bring a number of other humanitarian organizations into the OSM Haiti community. Several of these hired full-time staff of their own to work on OSM.

However, the rapid growth in OSM activities in Haiti during this time presented new challenges. HOT and COSMHA struggled to simultaneously manage a geographically dispersed team while ensuring quality of the data being captured. Decline in general Haitian-relief funding as well as management changes in IOM as the reconstruction period came to an end strained relations between HOT and IOM. IOM was unhappy with the costs associated with the project, while HOT believed that further investments should be made to continue the development of

COSMHA's technical skills and status as an independent organization. Support for HOT and COSMHA within IOM began to decline in April and largely ended by June 2011, 1.5 years after the quake. By that time however, OSM was well established in Haiti. With the support of other donors and volunteers, both HOT and COSMHA are still active at of the time of this writing.

8 Discussion

HOT as an organization emerged by operating with a set of value-infused goals within a difficult and real-world context. It was through the creation of strategies to achieve those goals in response to uncertainties about a number of political, technical, social, financial, and geophysical issues in the environment that post-earthquake Haiti afforded that HOT came to define its vision for what it could do as a long-lived enterprise, and the approaches it would take to do so.

8.1 Instantiation of Ideals and Institutionalization of Practice

OSM in Haiti had distinct meanings for the different groups that engaged with it. Recalling Lin's positioning of OSM as a boundary object [20] that brought together "social worlds" [38, 39], we consider what our account reveals about the entities affected by and operating upon the map.

The existing, world-wide OSM community that remotely contributed much of the initial data through map tracing in the weeks following the earthquake saw the effort as a tangible means of contributing to the disaster response effort that had an additional consequence of demonstrating the value of the open data ideology. With some exception, the responders working in the field immediately after the quake were primarily consumers, rather than contributors, of the OSM data. They used it because it was freely available and contained more detail than alternatives. Some may have found the unorthodox method of its production either problematic or inspiring, but the decision to participate in OSM by using the data was largely driven by pragmatic concerns.

Many of the members of COSMHA saw the project as a means to participate in a response that had marginalized much of the Haitian population [36]. To some, the primary element certainly may have been financial: participation in OSM was a well-paying job with an international organization. However, much of the private conversation indicated more idealistic goals of helping their country and rebuilding their communities. It was not uncommon for the team to spend evenings and weekends voluntarily mapping their neighborhoods in addition to their full-time paid responsibilities.

Though Lin identifies government as one of the primary social worlds involved with OSM [20], HOT's on-the-ground experience was quite different. Even though the unique circumstances of post-quake Haiti might suggest more opportunities for OSM adoption, Haiti is not alone in this regard: Governments have struggled to articulate their relationship to volunteered geographic information projects [9].

HOT's work brought organizations and people to the map, and to the idea of community mapping. Its original values were clear, but how to materialize them were realized on the ground, in the face of both challenge and opportunity. HOT played a significant role in the articulation work necessary to create and maintain OSM as a boundary object across diverse groups involved in the response and reconstruction work in Haiti. HOT's commitment to shepherding the map and its social practices demonstrates that though crowdsourced projects (like the initial, remotely generated OSM Haiti map) can bring an effort quickly to a useful point, sustaining the effort requires careful management of relationships between entities, and between entities and their mutually produced artifact.

8.2 The Influence of Haiti on HOT and OSM

The extended Haiti effort helped transform HOT from an informal group to a registered non-profit organization with full-time staff, and is where HOT developed, tested and refined approaches and strategies that have since been deployed in other parts of the world. Several examples illustrate this influence. First, HOT worked during early missions with responding organizations to develop the Humanitarian Data Model (HDM) which guided what information to collect while surveying, and was based on the expressed needs of field-workers active in the country at the time. Efforts to simplify and finalize the HDM are ongoing, but the needs for such considerations are well-established [14]. Second, HOT went on to develop new software in response to lessons learned in Haiti: The HOT Tasking Manager supports the coordination of tracing efforts among multiple workers by allowing users to reserve particular sections of the map. The HOT Export Tool makes it easier to quickly extract particular portions of the overall OSM database, a common need expressed by many responders that HOT had to deal with in a patchwork approach during the Haiti response. These software now have wide use in HOT's subsequent projects in many parts of the world. Finally, there has been a shift in the overall conception of OSM by its more traditional community members to see it as now including humanitarian and development efforts.

8.3 Technology-Supported Social Entrepreneurship

We might consider the activities described here as a form of social entrepreneurship; that is, an entrepreneurial effort where the objectives are not for profit,

but for social change. Such a view extends how people envision the increasingly popular ideas of micro-task based "human computation" to instead appreciate the broader commitments of digital contribution. It recognizes that a great deal of work must be done to make connections between on-line work and off-line humanitarian work in the field (see [45] for critique). Even in on-line efforts, the structures that sustain self-organizing groups are formalized by and around a smaller set of people who can propagate those structures over time [42].

As an entrepreneurial effort around new forms of data generation, it incorporates new ways of working that combine distributed work for critical parts of the effort, and localized work for differently critical other parts. It deeply integrates the materiality of technology and engages multiple social worlds. We think of this as *technology-supported social entrepreneurship* to call out this special intersection of social activism with technology that is itself self-consciously imbued with values of "how the world should work," as a HOT member explained.

It may be unnecessary in the future to call out the "technological" in social entrepreneurism, but for a time, we see value in drawing such attention because it enlightens how ideation of human organization unfolds around multiple facets of technological artifacts. At the core of this entrepreneurial effort reported here is the production, management and shared ownership of geospatial data, a valuable commodity to many industries, which is what makes OSM objectives both contentious and groundbreaking. When fiscally valuable data become available for humanitarian efforts, and certainly when concerted effort and funding go toward making such data accessible, editable and consumable by many, those actions themselves show a social entrepreneurial spirit that demonstrates new models for civic participation, innovation, and activism.

9 Conclusion

We see both the creation of HOT and its immediate work in Haiti as a serious attempt to secure OSM's role—and its ideology—in humanitarian self-help and external aid. The decisions during its first 1.5 years of existence are oriented toward making OSM useful and meaningful over a sustained amount of time and in a particular place. HOT's value-driven work sought to bring different social worlds together as a long-term sustainability strategy for OSM in Haiti. It is unlikely that the map's mere existence would have been enough to meaningfully sustain it within the country. The HOT effort in Haiti, and the subsequent creation of COSMHA, were concerted attempts to employ a workforce and set of partnerships to instantiate a domestic OSM effort in Haiti, and as model for what OSM and other volunteer technology communities could do, and have done since, in humanitarian efforts beyond Haiti.

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