Chapter 8

Case Study: Citizen mapping of the BP oil spill

8.1 Grassroots mapping in crisis response

In late April 2010, the Deepwater Horizon oil rig exploded and sank, initiating what may be one of the worst environmental disasters in US history. [70] As the spill grew in size, I contacted Stewart Long of GonzoEarth.org and Oliver Yeh of 1337arts.com, both of whom I had collaborated with in recent aerial mapping projects. Long has made use of remote control aircraft to capture map imagery, and Yeh specializes in high-altitude photography using weather balloons, having captured imagery from a balloon at altitudes of over 90,000 feet. We decided to travel to the Gulf Coast area to spearhead a citizen effort to map the oil spill's effects. After making phone contact with Anne Rolfes of LABB, a New Orleans-based environmental activist group, Yeh and I flew to New Orleans on May 5th 2010, followed by Long on May 6th.

Figure 8.1: Volunteers at the Louisiana Bucket Brigade in New Orleans plan a mapping trip on May 7, 2010.

With the cooperation and extensive support of LABB and other interested New Orleans residents, we began leading almost daily trips to use balloons and kites to map coastal areas. While not attempting to produce imagery of the entire coastline, which stretches several thousand miles from Louisiana to Florida, the mappers focused on acquiring high resolution imagery of specific sites, with the goal of producing 'before and after' maps. The trips relied on the availability of free transport to affected areas, but in the initial days of the project this was not a problem, as fishermen and charter companies began calling in to offer rides at no charge. Increasingly large areas of the Gulf of Mexico were being closed to fishing, and with their livelihoods at risk, many in the fishing industry were eager to participate in the documentation of the spill. [54]

8.2 Comparing Grassroots Maps of the spill to other sources

Beyond the importance of establishing an independent monitoring effort of the oil spill's effects, the disaster was an opportunity to apply the low-cost mapping techniques refined and documented on GrassrootsMapping.org to a problem of immediate import, and on a large scale. While many overflights were occurring, there was no publicly available, orthorectified imagery available in the initial weeks of the spill; up-to-date imagery was supplied mainly by the Moderate Resolution Imaging Spectroradiometer (MODIS) sensors aboard NASA's Terra and Aqua satellites.[1] MODIS is limited to 250 meter resolution, and while the daily images available were very useful in determining where along the coast was being hit by slicks and sheens, they were not of high enough detail to show any specific damage. [40][2]

Figure 8.2: The BP oil spill on April 29th, 2010. The upper left corner shows the tip of Louisiana. Imagery from NASA's Terra satellite, using the MODIS sensor.

By contrast, the imagery collected by the LABB/Grassroots Mapping teams was up to 3cm nominal resolution, and could be repeatedly captured over the course of days or weeks. This level of high resolution imagery, as James Aber et al. point out, 'bridges the scale and resolution gap between ground-based observations of wetlands and conventional airphotos and satellite images' [1], and both balloons and kites have previously been explored as feasible platforms for wetlands monitoring.

[1] Since then, overflights by National Oceanic and Atmospheric Administration (NOAA) have appeared in the 'historical imagery' section of Google Earth. These cover a great deal of affected coastline but are of relatively poor resolution compared to LABB/Grassroots Mapping imagery.

[2] For more information on the MODIS sensor and its abilities, see http://modis.gsfc.nasa.gov/about/specifications.php

[1][51] Michiro Miyamoto in particular has used balloon imagery of 15cm resolution to classify vegetation types 'to the genus and species level'. [51] In LABB/Grassroots Mapping imagery, even individual bird species were identifiable, and coral, oil smears, and schools of fish are visible in many photos. In addition, the unfolding nature of the oil spill crisis made it important to visit and map sites both before and after oil was sighted, and periodically afterwards. The potential for a set of maps of the same site, taken at intervals, to depict progressive damage to ecosystems and economies was a powerful new dimension to the project.

8.3 Independent monitoring and media blackout

As the crisis progressed, it became clear that BP was attempting to restrict access to affected areas by means of airspace restrictions, closing public beaches, and preventing boats from entering some areas. The Breton Sound was closed to the public in mid May, and flyovers were restricted to a minimum of 4,000 feet, making it difficult to photograph or identify features on the ground. [62] With reduced public and media access, many became concerned that because of the close collaboration between BP, the Coast Guard, and NOAA, the government was complicit in the media blackout. Even on the ground, LABB mappers found that many cleanup workers were prohibited from talking about what they were doing. [25] This gave our mapping effort even greater importance, as our imagery was among the best available for many areas, and the support we received from local fishermen in getting to sites helped us to sidestep issues of access which limited many in the mainstream press.

Figure 8.3: Streaks of oil, terns, and, in the lower left, pelicans, on a sandbar in the southern Chandeleur islands, Louisiana coast, on May 9, 2010.

8.4 Adoption and sustainability

The most challenging aspect of organizing the oil mapping project was to train a group of inexperienced but committed volunteers to use Grassroots Mapping tools such as balloons and kites, in often adverse weather conditions up to 3 hours travel from our home base in New Orleans. That a number of volunteers have continued not only to make trips on their own, but to bring and train others to map, has been both impressive and gratifying.

Between May 7th and July 22nd, over 47 participants made 36 trips to gather mapping data, or almost one every other day. While only one trip has failed to return with any imagery at all, 64% of trips returned with 'excellent' or 'useable' data, suggesting that better quality control mechanisms might result in a higher success rate. Still, over 11,000 images have been taken, with plans and

Figure 8.4: A map of Isle Grand Terre, Louisiana on May 27 2010, stitched by Stewart Long

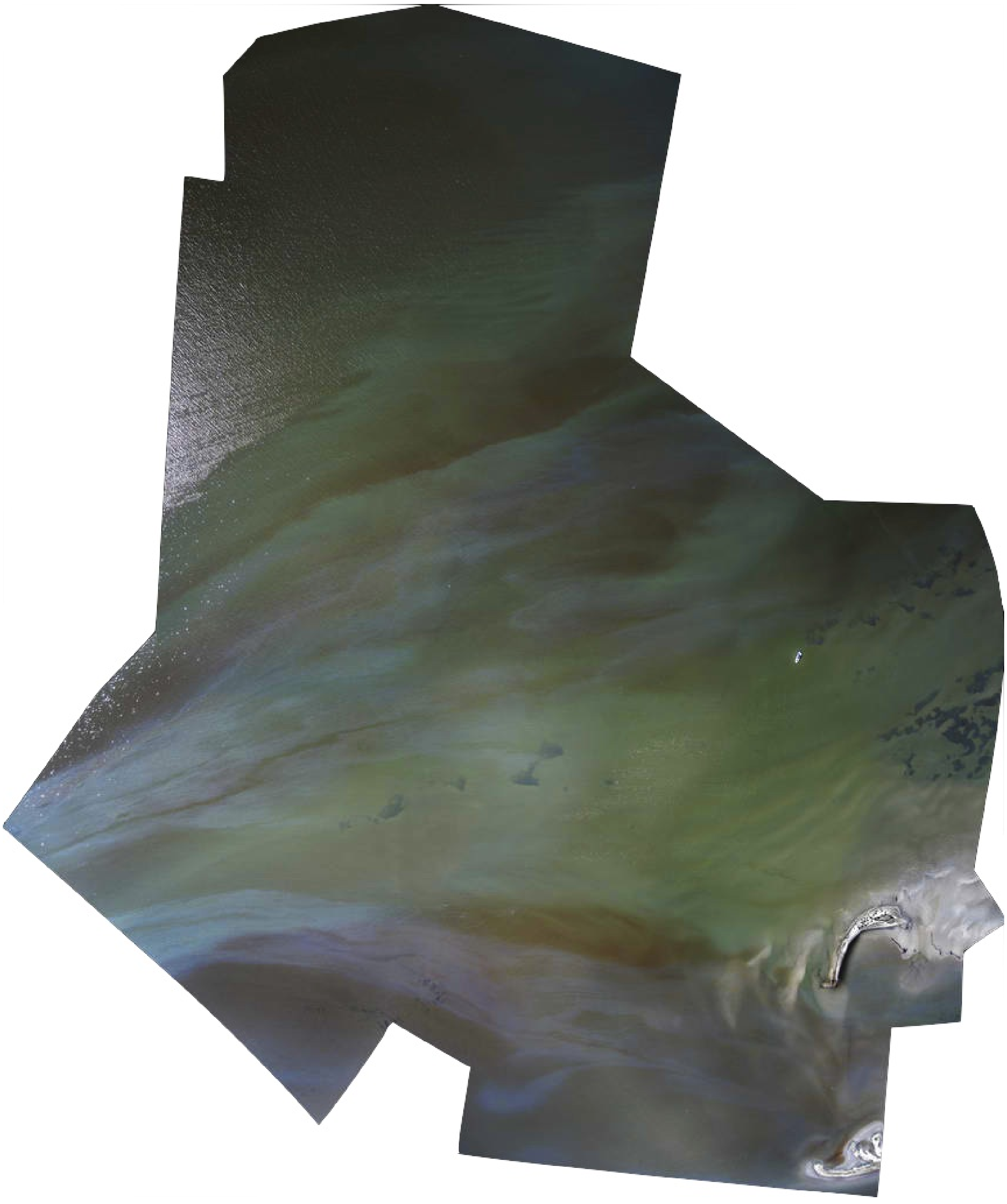

Figure 8.5: A map of the southern Chandeleur Islands on May 9 2010

funding in place to continue mapping through January 2011.

8.4.1 Workshops and trainings

One factor that likely played a major role in the rapid adoption of Grassroots Mapping techniques was the early emphasis on training. With LABB, we organized a workshop in the first week of mapping for potential volunteers in New Orleans, where we demonstrated the use of the tools in a hands-on manner, flying kites and capturing a sample data set. In addition, trips to mapping sites have continued to attract new volunteers, and the teaching of aerial mapping techniques to newcomers has been a priority throughout the project. We have been lucky that LABB has combined their outreach programming with aerial mapping trips, resulting in a steady flow of new mappers.

Participation has followed several interesting trends. As shown in Figure 8.4.2, while over 30 people participated in a single mapping trip, far fewer were part of a second or third trip. However, a committed group of leaders have been participants in six or seven trips; these have ensured a continuous and regular mapping effort across the initial fifteen weeks of the project.

Particularly encouraging was the participation of two mappers who had seen just a single presentation about the project, and were inspired to begin balloon mapping on their own. Assembling their own kit based on information available on the Grassroots Mapping website, Don and Justin Blancher contacted us with hundreds of photos of Perdido Point, Alabama. Delighted, we arranged a transfer of files and Stewart Long created a map within a few days. As of August 2010, the two continue to contribute new data.

8.4.2 Collaborations

From the start of the project, the Grassroots Mapping mailing list and wiki were a focal point

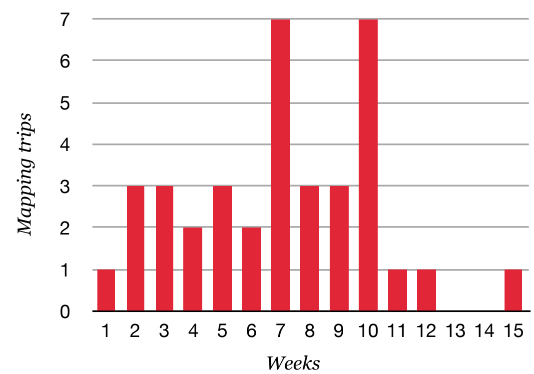

Figure 8.6: Number of mapping trips per week. A drop in trips starting in week 11 was due to high summer heat and the absence of several of the project's main trip leaders who were on vacation.

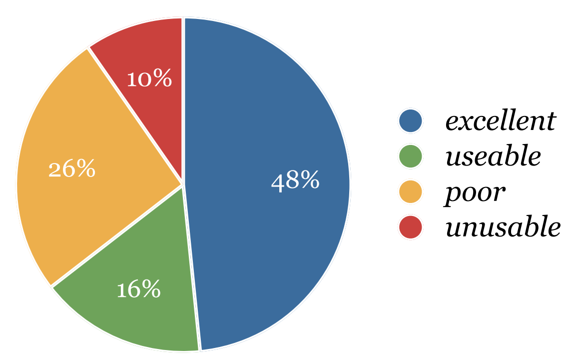

Figure 8.7: Success of mapping trips, based on number of images captured

for collaboration, and members of the wider Grassroots Mapping community helped identify local helium sources, coordinate volunteers, and even pay for plane tickets. On the ground, there was also considerable ad-hoc collaboration, with Oliver Yeh of 1337arts and Stewart Long of GonzoEarth leading trips and trainings on multiple occasions. However, over the first several weeks, Shannon Dosemagen of LABB, and Kris Ansin of the University of Tulane's School of Public Health and Tropical Medicine emerged as leaders of local mapping trips, and their efforts have ensured that mapmaking has continued for close to three months since our initial efforts. Long and I have played a supporting technical role in managing, processing, and publishing stitched maps of the data, and advising the LABB team on equipment setup and maintenance.

Throughout the project, we made parterships with a variety of other organizastions to share boat trips, imagery, and to collaborate directly on capturing imagery — among these were the Blue Seals, Greenpeace, Americorps, and many individuals who volunteered their time, money and abilities. This dense web of collaborations has formed a backbone of support for the effort, and ensured its regularity and sustainability. While the urgency of the disaster itself surely played a role in forging such a network of mutual support, such strong local participation must be an integral part of **any** participatory mapping effort which expects to be sustained beyond an initial burst of enthusiasm.

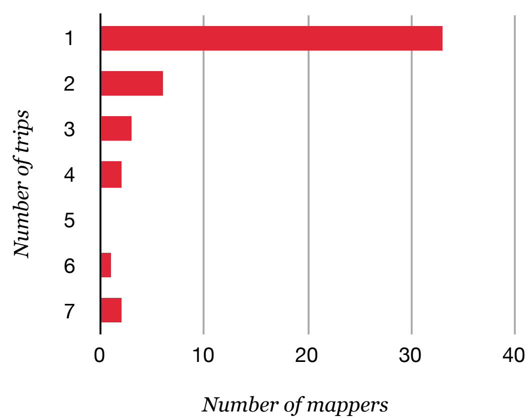

Figure 8.8: Number of mapping trips per mapper

8.4.3 Costs and funding model

Mapping the spill incurred a range of new costs; not only is there a virtually unlimited potential area to map, but the intention to repeatedly map each site meant that there is no obvious completion criterion for the effort — trips are led and imagery is captured as often as possible given the constraints of time and money. While the costs of equipment were still in the range of $150-200 per kit, travel turned out to be the most expensive part of the project. Not counting the hours of donated time and associated fuel costs on boats, planes, and in cars, a typical day in a chartered boat cost approximately $400, and even teams visiting only the shoreline had to travel for upwards of 3 hours each way from LABB headquarters in New Orleans.

Various donors and institutions were generous in their support of the project, including the Center for Future Civic Media, the Lafourche Port Commission, the Washington Post, Development Seed, and many more.[3] In order to meet ongoing expenses, on May 29th I created a proposal at Kickstarter.com with help from filmmaker Kristian Hansen. Kickstarter is a site where individuals can elect to 'back' a project financially, receiving rewards for different levels of support. For $50, we offered to put backers' names on a balloon; for $1000, we promised to send backers a complete Grassroots Mapping Kit. However, the vast majority of donations are at the $25 level, and a total

[3] For a full list of contributors please see the Acknowledgements

of 145 contributors backed the project with $8,285 by June 21, 2010.

Funding the project in this manner rather than via larger institutional grants seemed appropriate for an already citizen-led, independent effort to document the oil spill's effects. For many, contributing a small amount or even simply spreading the word was the only means of participating. For these reasons the choice of Kickstarter as a means to financial sustainability is especially appropriate to the project's mission.

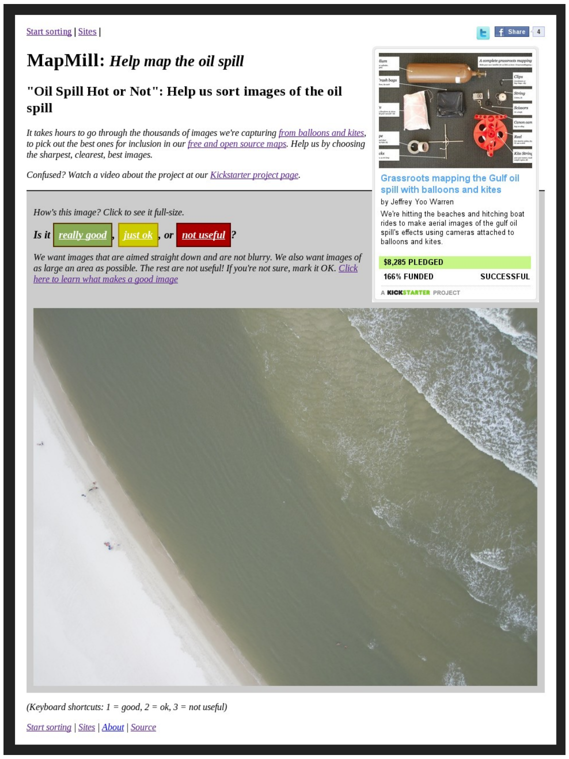

Figure 8.9: MapMill.org image sorting website developed in response to the high-volume data submission from the Gulf of Mexico during the BP oil spill.

8.5 Image processing and map stitching

Throughout the project in the Gulf of Mexico we have relied heavily on Adobe Photoshop for manual orthorectification of maps, due to its proven track record and known limitations. Other tools such as Map Warper and Cartagen Knitter were limited by their dependence on OpenStreetMap base data, though Cartagen Knitter has since gained the ability to display a base layer of tiled satellite imagery, and may see increased usage for future map data sets. Photoshop produced Tiled Image File Format (TIFF) images which were processed into GeoTIFF and cut into tiles using the **gdal2tiles.py** script. This generated both a TMS and a KML for viewing online. Maps were also uploaded to Flickr for public viewing, though at a lower resolution, since Flickr limits uploaded files to 10 megabytes in size. In addition, the most permissive license provided by Flickr was Creative Commons Attribution, so maps were annotated as Public Domain data in each image's description field.

Those in the project who were able to produce stitched maps, including myself and Stewart Long with some help from David Riallant and Cesar Harada, were challenged to keep up with the fast pace of map data submission. New data sets arrived as often as every other day, and a single set typically included hundreds of images to be sorted, processed for brightness and contrast, and stitched. A large monitor and a powerful computer were required, and even my own 8-core 3 GHz workstation took up to 10 minutes for each transform on larger maps. These issues, as well as the difficulty in including a broader group in the stitching effort, highlighted the need for a completed Cartagen Knitter tool, even as it took time away from its development.

One tool I developed in response to this overwhelming amount of data was called MapMill, avail-

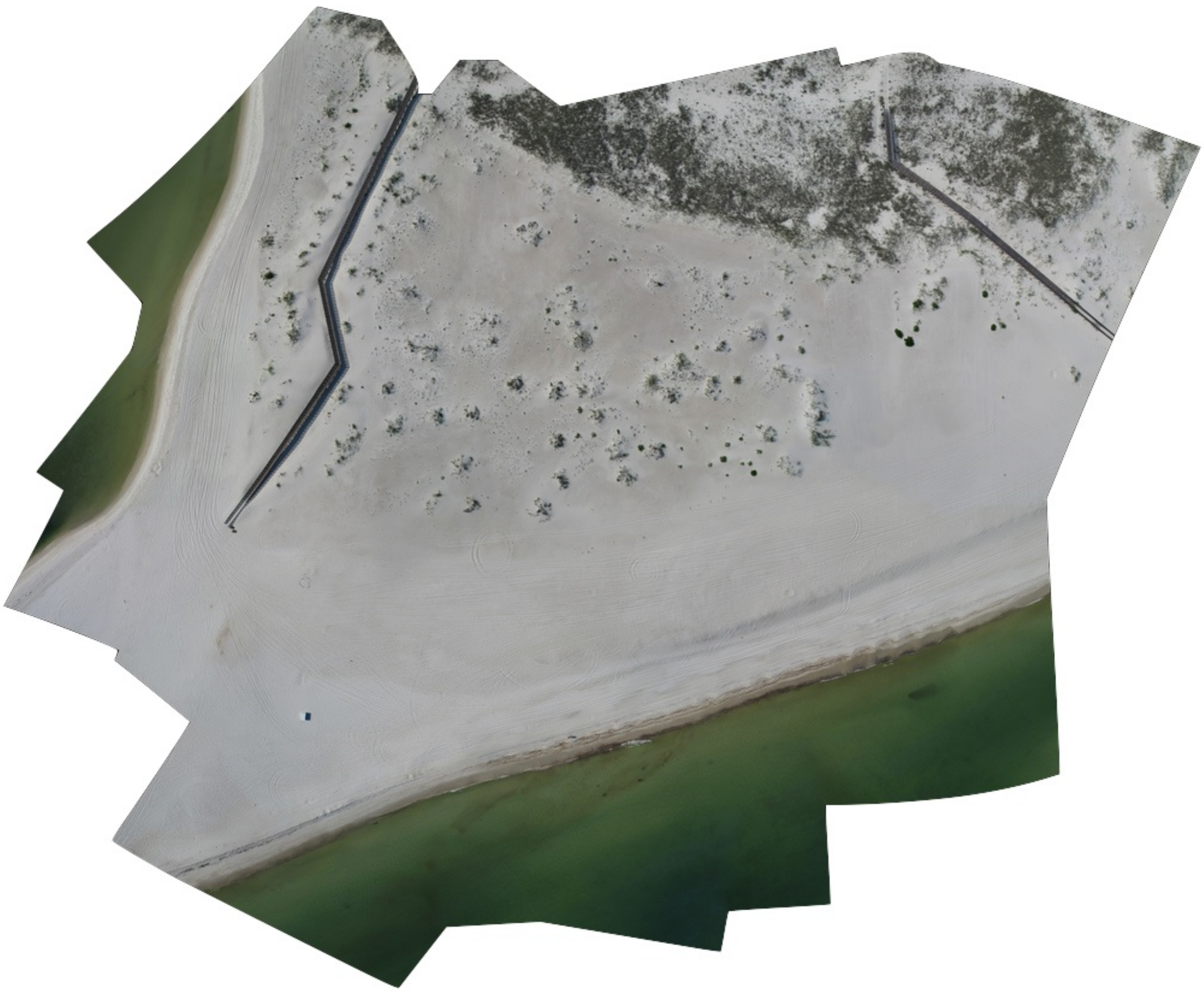

Figure 8.10: A map of Perdido Point, Alabama, from imagery captured by Justin and Don Blancher and stitched by Stewart Long.

able at mapmill.org. As sorting through images often took a substantial amount of time before orthorectification or stitching could begin, visitors of MapMill were presented with an aerial image, and asked to rank it as ‘really good’, ‘just ok’ or ‘not useful’ in an adaptation of the interface to the well-known ‘HotOrNot’ website. A one-page visual guide was offered to demonstrate what constitutes a ‘good’ image, highlighting crispness, good exposure and downward-facing camera angle. In the 50 days following its launch on June 16th, 2010, images have been ranked more than 23,000 times, demonstrating that a voluntarily crowdsourced means of image processing may be viable.

8.6 Overflights and a broader data strategy

As more organizations such as the Blue Seals and the Louisiana Environmental Action Network became involved, opportunities arose for the capture of data from donated airplane flights. While this was outside the scope of the Grassroos Mapping Kit, we took every opportunity to gather such data, and several of the datasets we have published were captured by volunteers on such flights, or were donated and released into the public domain. This has helped bridge the gap in scale, methodology, and image quality between our balloon and kite derived imagery and more conventional techniques, and in retrospect may help those in crisis management situate our work in a larger data gathering strategy.

Figure 8.11: Data collected and processed by the Grassroots Mapping team, displayed as tiles in the LABB Ushahidi instance.

8.7 Integration with Ushahidi

The LABB team had already set up an instance of the Ushahidi mobile-phone based crisis reporting tool for crowdsourced information gathering, and this continues to be one of their main priorities and most publicly visible responses to the spill. To better integrate our aerial mapping data with the Ushahidi platform, I inserted TMS layers of our data into the OpenLayers-based Ushahidi map display, so that report locations would appear overlaid on aerial imagery where available. This generated a feedback loop for mappers, who would often look to Ushahidi to identify clusters of oil sightings which made good candidate sites for aerial mapping.

8.8 Documentation

The disaster and the incredible support and diligence of the LABB mapping team also generated a wealth of both qualitative and quantitative information on the volunteer-led effort to apply Grassroots Mapping tools toward the collection of crisis information. Mapping team leaders filled out a form describing a variety of information from weather conditions at the site to the condition and performance of the gear. Leaders built deep experience in gathering data and teaching others, and many wrote blog entries or spoke to the press about their experiences. Beyond serving as a valuable independent record of the spill, this case study lays solid groundwork for the application of these tools to other environmental, social, and political crises. A similar online form for data submission should be an integral part of any future aerial mapping effort.

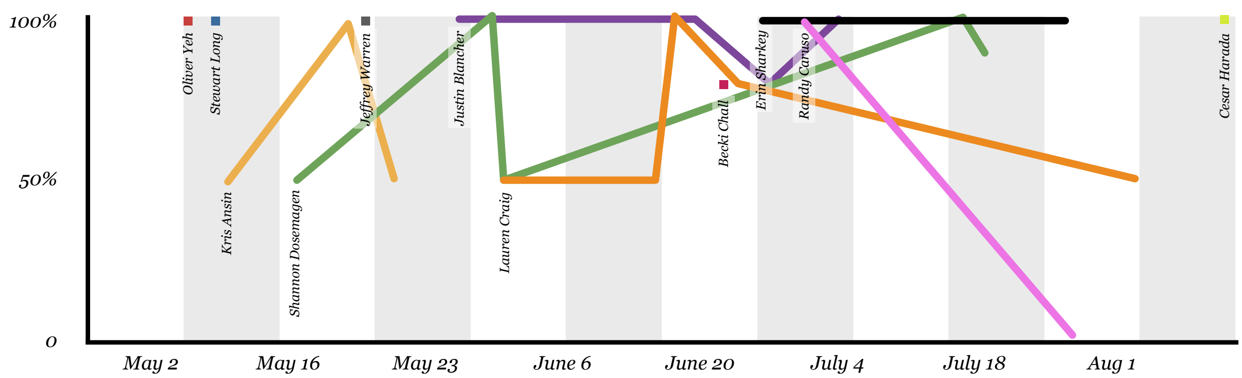

Figure 8.12: Success of mapping trips over first 100 days, based on evaluation of resulting imagery by GonzoEarth

8.8.1 Analysis of data collected

New imagery continues to arrive from mapping trips across the Gulf Coast, but the data we have so far is useful for examining what factors affect the success rate of mapping attempts, as well as for assessing the increase in data quality as participants gain experience and the techniques mature. Of course, it is also of interest to quantify our results to date in terms of resolution, extent, and fidelity.

Trip results were rated on a percentage scale as imagery was reviewed, based on the image sharpness, continuity, and angle of capture, straight downwards being ideal. The average rating over the first 33 trips was 75%; while I expected a correlation between experience mapping and success rate, as seen in Figure 8.8, no such relationship is apparent. Participants did use both kites and balloons regularly, with 45% of trips using kites and 55% balloons. Based on reported and best-guess estimates of altitude, 14 trips which used balloons reported an average altitude of 725 ft and 10 trips using kites reported an average altitude of 670 ft. Most participants preferred balloons, citing easier control given reasonable wind conditions. In general, difficulty with the tools was less of an obstacle to success than adverse weather conditions. (See Figure 8.1)

One challenge was to maintain good communication between those processing imagery and stitching maps, and those visiting sites and capturing images. The former were typically working remotely, and beyond the data submission form we asked each trip leader to complete, there was relatively poor communication between the two parties. This led to delays when map stitchers were unable to identify where images were taken, or difficulties when trip leaders did not understand the stitching process well enough to know what constitutes good source imagery. The use of the Cartagen Knitter in this process may address these problems by making the orthorectification and stitching process more intuitive and accessible to those who capture imagery. Reducing dependence on outside technical assistance promises not only to put local participants in greater control of the entire process, but to improve overall understanding of the stitching process and thus yield better source aerial imagery from mapping trips. In any case, future efforts should facilitate open communication between participants at different stages of the process to ensure good results.

8.9 Licensing and data use

The assembly of a public domain archive of data on the disaster, including GeoTIFFs, TMS and raw images, is a valuable goal in itself. Due to increased mapping activity after the Katrina disaster, much imagery of the coast already existed, however not at such good resolution. Our inclusion of pre-spill imagery will, as participant Adam Griffith put it, 'remind us what the land should look like'. [32] The post-spill maps will help to identify and assess the environmental and economic damage which coastal ecologies and communities have sustained.

The project is ongoing, and even after our current funding and timeline end in January, there is potential to perform ongoing mapping at longer intervals. While the immediate needs of providing imagery to the public and the media have been met, our longer term goals of using the data for litigation and environmental monitoring will require collaboration with those communities, and plans are already in motion to present the data at relevant venues.

Our choice of a blanket public domain policy has meant that with the exception of some donated imagery, all our data has been released into the public domain and may be downloaded and republished without permission. We expect this to facilitate its adoption by researchers, litigators, and other activists, just as it has amongst the media. Already, images have been republished by the Boston Globe, the New York Times, and many other news agencies. Much of the data has even be licensed to Google for use in the Google Earth and Google Maps products. This reversal — small organizations providing imagery to Google instead of the opposite — stands in contrast to the licensing bottleneck which caused so much controversy in the Haiti aid community, as discussed in Section 4.4.1.

Figure 8.13: Volunteers launch a balloon at Grand Isle, Louisiana. Photo courtesy Adam Griffith

As more such projects unfold[4], I hope that the successes we have had in the Gulf Coast will not only provide a wealth of relevant information for

[4]See Chapter 10.1

Table 8.1: Success of image capture in varying weather conditions during over 33 mapping trips led by LABB and other Grassroots Mapping volunteers between May 7th and July 22nd, 2010.

Conditions	Balloon or Kite	# of images	Est. max altitude (ft)
	balloon	222	1500
	kite	184	
	kite	54	
	balloon	318	
steady wind grew to 20 mph	kite	200	1000
	balloon	118	
	balloon	182	
windy	balloon	100	350
very windy	kite		300
good wind	kite		1000
lots of wind	kite		1000
good wind	kite		1000
good	balloon	124	750
good	balloon		350
7-8 mph	balloon	362	300
poor wind	kite		500
very windy	both	213	1000/1000
good	balloon		800
	balloon	665	700
stormy	balloon		1000
low wind	kite		200
7-8 mph	balloon		400
very windy	kite		
windy	kite	472	350
low wind	both	166	
windy	kite	398	350
	kite	200	
mild steady wind	balloon	323	400
difficult wind	balloon	1000	500
	balloon	900	300-600
wind in wrong direction	balloon	50	500
	kite	325	
good wind	balloon	971	1000

other would-be mappers, but that our work will inspire others to adopt these practices in new and interesting ways.