SURFING THE WAVE: USING SOCIAL MEDIA TO GATHER USABLE DATA ON FLOOD EXTENTS

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ABSTRACT

Floods, and other natural disasters, present a challenge to local communities: during a major event, the priority is attempting to reduce the damage; however, knowing exactly how widespread the flooding was is necessary to evaluate computer models and plan work to mitigate further damage during future events. Unfortunately by the time the emergency response has been carried out and attention is turned to data collection, evidence and information is often no longer readily available.

The explosion of social media in recent years has seen a greater number of recorded observations captured by the public during natural disasters that includes precise time and location information with a large geographic distribution. Using social media to solicit photos from the public during a natural disaster provides an opportunity to collect first-hand data that requires minimal effort and financial investment.

Following the widespread flooding in Christchurch on 3-5 March 2014, GHD tested the potential of social media to collect real time data. By using a social media platform, we hoped to reach people where they were – lowering the barriers to participation and broadening the audience.

All photos received through this Facebook page were geocoded, allowing the geographic spread of the data to be easily seen and overlaid with other sources of information. The results show that social media has strong promise in the collection of data during natural disaster events such as major floods.

KEYWORDS

Social Media, Facebook, Flooding, Flood Mapping, Modelling, Data Collection GIS.

1 INTRODUCTION

On 3-5 March Christchurch received 150 mm of rain (Botanic Gardens Rain Gauge, Harrington 2014). The storm had disparate impacts across the city – in some areas it has been estimated as a 1/100 year event but in others not even a 1/10 (Harrington 2014). Widespread flooding was reported across the city. The Avon and the Heathcote Rivers both burst their banks in multiple places and several major arterials were closed (Christchurch City Council 2014).

The standard approach to understanding the impacts of an event of this magnitude is to mark peak water levels on buildings, fences and other landmarks for subsequent surveying. Christchurch City Council launched a major effort to do just that as soon as council officers could turn their attention from the emergency response – with staff in the field 36 hours after the rain stopped (Colin Forsyth, pers. com). However, by the second day of field work, direct evidence of flood extent was already fading (Kate Dawkings and Jalan McGrory, pers. com). This highlights the central difficulty of natural hazard management: during a major event, the priority is attempting to reduce the damage; however, knowing exactly how widespread the flooding was is necessary to evaluate computer models and plan work to mitigate further damage during future events. Unfortunately by the time the emergency response has been carried out and attention is turned to data collection, direct evidence of impacts is often no longer readily available.

An additional challenge for flood modeling in particular is that many streams, even those running through urban areas are ungauged. Due to the nature of its failure mode relative to wastewater and water supply, upgrades to the stormwater network are often deferred – until flooding occurs. In many modeling projects calibration efforts are focused on matching peak flow (e.g DHI 2014, Atiquzzman et al. 2009, but see Horritt and Bates 2002). This puts local authorities in the unenviable position of explaining to ratepayers that they need to wait for the *next* event to begin planning mitigation options. A richer data set on flood extent could enable model refinement and options testing to begin almost immediately.

Using social media to solicit photos from the public during an event provides a partial solution to these problems. It provides an opportunity to collect needed data with only a small investment of effort and also gives community members a platform to contribute. The explosion of social media in recent years means that there are now many more recorded observations during natural disasters – with more precise time and location information, and greater geographic distribution – than could ever be collected by paid staff, even if they had the time to collect data during the event (Goodchild and Glennon 2010).

In order to leverage these new data sources to full effect, however, they need to be organized into a form that allows both quick overviews and examination of fine detail. The techniques used to interpret these data also need to accommodate their limitations – they are ephemeral, of mixed quality and haphazardly located. Geodatabases are a mature technology well suited to storing and managing these data.

2 USING SOCIAL MEDIA

Social media is generally defined as platforms where the audience also creates the content. Facebook is perhaps the most well-known, but other platforms have emerged in recent years (Leverage New Age Media 2014). The large and engaged user base lends itself to crowd sourcing projects. Crowd sourcing is "the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people" (Marchionda 2014); before the invention of the internet, particularly social media, this would have been an arduous, time consuming and costly task.

Social media crowd sourcing can be distinguished from 'crowd sourcing' more generally. Many crowdsourcing projects build a custom application for collecting data and thus depend on an enthusiastic user base to seek them out and fill out data (Gao et al. 2011, Goodchild and Glennon 2010). GeoNet is probably the most well-known example of 'crowd sourcing' natural hazard data in New Zealand. In contrast, crowd sourcing using social media uses an existing platform which lowers development costs and substantially broadens the user base (Marchionda 2014).

Following the widespread flooding in Christchurch on 3-5 March 2014, we were interested in the possibility of crowd sourcing flooding data for use calibrating hydraulic models. Given the reactive nature of this project - we started this pilot project days after the event - we decided to test the potential of social media in the hope that the residents of Christchurch had stored photos that could be uploaded with ease. We chose a fast and low cost approach for this pilot project, both in terms of budget and effort; a Facebook page named "Christchurch Flood Info Collection". The page was leveraged through personal social networks and an investment of $250 in advertising purely through Facebook.

2.1 WHY FACEBOOK

In using an existing, broadly popular social media platform, we lowered the barriers to participation and broadened the audience (Marchionda 2014). There are a number of platforms that are popular in New Zealand, and choosing the correct platform was critical to the success of the Christchurch Flood Info Collection campaign (Leverage New Age Media 2014).

When choosing the platform we considered a number of factors including usage in New Zealand, demographics and ease of use. Our knowledge of social media sites was a significant factor as the campaign needed to be started within hours of deciding to attempt data gathering using social media. We considered two platforms, which we believed had the following in New Zealand to be able to deliver the results required: Facebook and Twitter.

Facebook is the most widely used social media platform in New Zealand with 2.4 million users country wide, significantly more than Twitter at 351,845 users (Ad Corp, 2013). We also considered that Facebook had the edge regarding ease of use and a wider demographic. The Facebook page format also facilitates display of photographs, which can both provide useful data and promote interest in the page.

Table 1: Social Media Statistics (Data from Ad Corp, 2013)

Social Media Site	New Zealand User Accounts	Percentage of Population
Facebook	2,400,000	53.69%
Youtube	2,278,597	50.98%
LinkedIn	731,283	16.36%
WordPress	642,700	14.38%
Tumblr	572,288	12.80%
Twitter	351,845	7.87%
Pinterest	264,557	5.95%
Instagram	246,314	5.51%
TripAdvisor	211,880	4.74%

Knowledge of the potential for Facebook advertising was also a significant factor in our decision, as Facebook allowed for the direct targeting of specific communities that were affected. We hypothesized that many Facebook users would be taking photos of surface flooding in their own neighborhoods and on their own properties and sharing it with their friends. By providing a low-effort way to share that information we hoped to broaden the base of information beyond those complaints already gathered by Council through its call center.

Due to the low cost of entry we decided to set up a Facebook page and monitor progress for the weekend to determine if the page would deliver any results.

2.2 SETTING UP THE FACEBOOK PAGE

The Facebook page "Christchurch Flood Info Collection" was set up in the evening of the 7 March 2014, effectively three days after the event we were seeking information on.

Set up time for a basic page such as "Christchurch Flood Info Collection" is minimal, in this case under half an hour including adding photos, and the first two posts on the timeline. We chose a "Community Page", which is a page about a topic that doesn't have official representation (Facebook, 2014). This was important as it does not require the page to be branded (Figure 1). The merits of branded vs. non-branded campaigns are further discussed in section 2.2.1.

Figure 1: Christchurch Flood Info Collection Banner (Facebook, 2014)

The page was set up with the description "A place to collect information on the Christchurch flood. This information will help us understand how vulnerable different parts of Christchurch are to flooding." Based on advice from GHD's corporate communications team (Ryan Orr, pers. Com) we also included "If you need emergency assistance please contact emergency services" to reduce the risk of page receiving posts requesting emergency assistance.

The Facebook page allows users to "like" the page, which represents a connection to the page, and to share information on the page's 'timeline' (where the public were asked to post their flooding photos). The page also allowed users to send private messages to the administrators of the page and to view photos uploaded by "Christchurch Flood Info Collection"

As shown in figure 2 our first communication on the page was simple, requesting people comment as to their flooding issues with information on the location and depth along with a hashtag to see if we could start a trending topic on Facebook. As we had minimal page likes at this time the post only reached 563 people.

Figure 2: Christchurch Flood Info Collection First Post (Facebook, 2014)

Another important aspect of the page set up was leveraging personal connections; the authors of this paper asked personal connections to like and share the page to friends. A large number of GHD staff also shared the page on Facebook. The page was also shared on other social medial platforms including Twitter and LinkedIn, directing people back to Facebook to post their flooding photos.

Following the first post it was decided that relying on flood depth to be reported by the public could be difficult to verify and that we were missing out on potential information that could be gained by asking for photos of the flooding. The post shown in figure 3 was therefore put up on the page on the morning of the 8 March. The post was deliberately humorous as we were attempting to target a younger demographic (ages 18 – 35), making the assumption that this demographic would more likely have photos of the flooding saved with the knowledge of how to quickly upload and share them. This was critical to the success of the page, reaching almost 3,000 people. A weakness of using a humorous image like the one in the advert to the left is that it is not clear that the image is not from Christchurch, and it could be interpreted as making light of a potentially life threatening situation.

Figure 3: Christchurch Flood Info Collection Second Post (Facebook, 2014)

2.2.1 ANONYMOUS V BRANDED PAGE

As time was of the essence when the page was set up, agreement was not sought from the communications teams at Christchurch City Council or GHD to set up the page with branding, therefore the page was set up independently. This approach has its strengths and weaknesses.

Having the page set up without a brand results in no carry over brand association, the strengths of this being that if a Facebook user has had a bad experience with the associated brand than this can result in negative messages being posted to the page. Conversely, a previously positive experience with a brand can result in positive messages being posted to the page with users more likely to promote the page. A weakness of no brand association is that it isn't possible to leverage off existing connections so a page audience needs to be built from scratch. Should a branded page be set up similar to "Christchurch Flood Info Collection" in the future, there is a potential benefit of keeping public informed and also using the page after the event for public relations, posting the results of the photo mapping and any plans to resolve flooding issues.

2.3 MANAGING THE FACEBOOK PAGE

After reviewing activity over the first several hours, we realised that keeping the page active would be key to achieving the maximum engagement possible in a short timeframe. We also decided that undertaking marketing on Facebook was necessary to grow page likes and page engagement.

2.3.1 MARKETING STRATEGY

In realizing that we had a limited time before interest in the flooding waned we used Facebook's advertising functions extensively to grow page likes and page engagement. Facebook allows users to sponsor posts on Facebook using specifically developed advertising methodologies designed to result in Page Post Engagement, Page Likes, Clicks to a Website, Website Conversions, App Installations, App Engagement, Event Responses, Offer Claims. We focused on building Page likes and Page Post Engagement. Our strategy was to build the Audience of the Facebook page (page likes) then target these people with requests for flooding information.

In the first 2 days the page was live we extensively targeted page likes to build the pages audience. Building the number of likes was important as people who have liked the page see posts from the page in their timelines more frequently, leading to better page engagement. From a total of 850 page likes 132 page likes were derived directly from page advertising, another 300 were derived from friends of the 132 people who liked the page. An example of the sponsored post used to build page likes is shown in figure 4.

Figure 4: Christchurch Flood Info Collection Sponsored Post – Likes (Facebook, 2014)

Once the "Christchurch Flood Info Collection" page had greater than 500 people connected to the page via likes we diverted most of our advertising towards building page engagement. Having Facebook users engage with the page was key, given our aim of crowd sourcing flood photos. An example of the post used to build page likes is shown in figure 5. This post was the most successful advertisement, being liked 52 times, commented on 11 times and shared 20 times. Once the public could see photos starting to be submitted page engagement built and further photos were submitted. Often users would submit information more than once following a successful initial post.

Figure 5: Christchurch Flood Info Collection Sponsored Post – Page Engagement (Facebook, 2014)

The features of Facebook were used to specifically target the 260,000 people who live within a 20km radius of Christchurch who have Facebook accounts (Facebook 2014), making the advertising directly relevant and increasing its efficacy.

2.3.2 AUDIENCE ENGAGEMENT

As collecting flooding data was the aim of the "Christchurch Flood Info Collection" Facebook page, engaging with the audience was important. By keeping the page active potential submitters could see that information submitted was actively being used and appreciated, and this also gave a more personal feel and established a connection between the submitter and the page. Every post or message to the Facebook page was responded to within hours, often within minutes, with both a personalised messaged thanking the supplier of the information and a request for any additional information that may have been missing from the information supplied. A quick response was important especially when a request for further information was required; we found that users responded quickly up to half an hour following their comment or post.

2.4 RESULTS

Although the Facebook page was set up three days after the event it reached 82,000 people and gained 850 page likes. The public submitted more than 70 photos and 3 videos, while 20 comments were made on the page.

2.4.1 AUDIENCE

As discussed earlier, our strategy to gain the most information from the Facebook page was to build the audience of the Facebook page (page likes) then target these people with requests for flooding information. Initially the speed of audience (likes) gain was slow, taking half a day to obtain 100 likes. However once this watershed value was reached the speed of audience gain was surprising. Figure 6 below shows the number of likes each day; 700 likes were received in the 24 hours between 8-9 March.

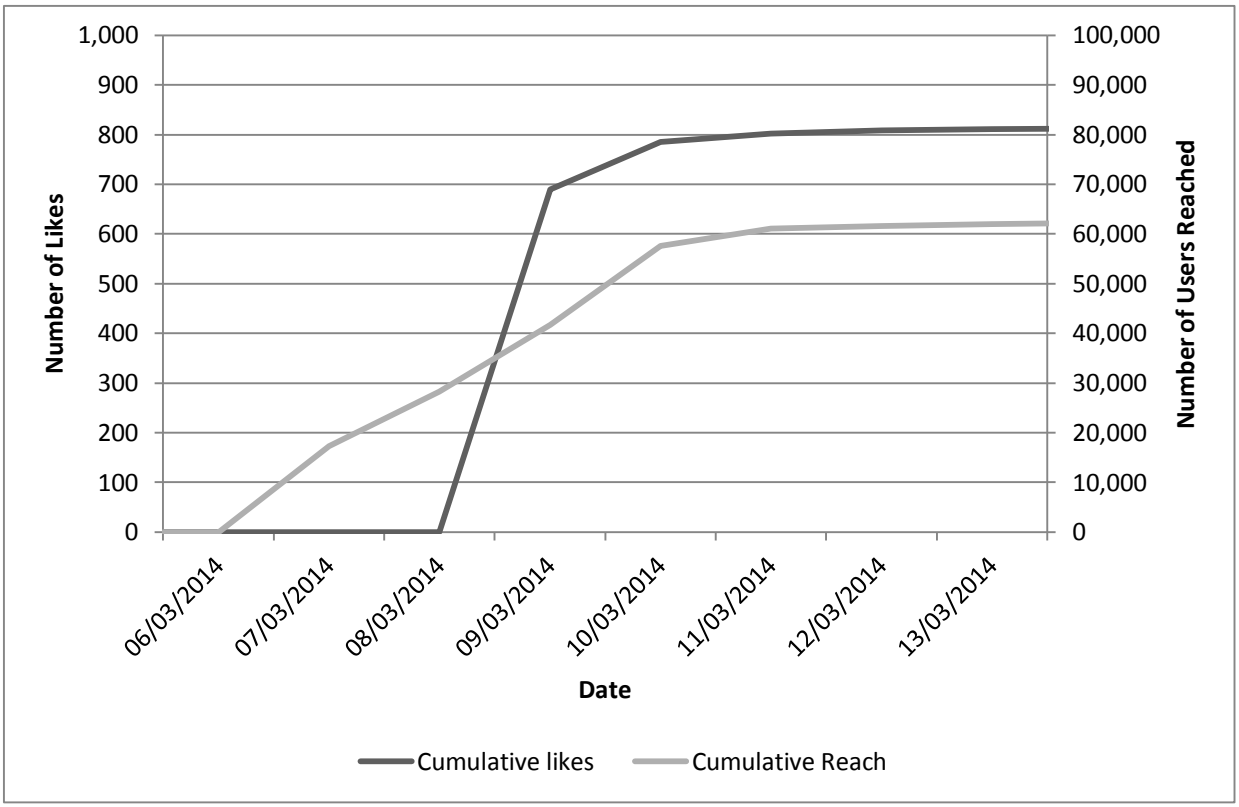

Figure 6: Cumulative likes and Cumulative reach (Facebook, 2014)

Figure 6 also shows total reach; a staggering 62,000 people had seen the page or a post authored by the page seven days. Facebook advertising was the key driver for the large number of people reached in such a short period of time.

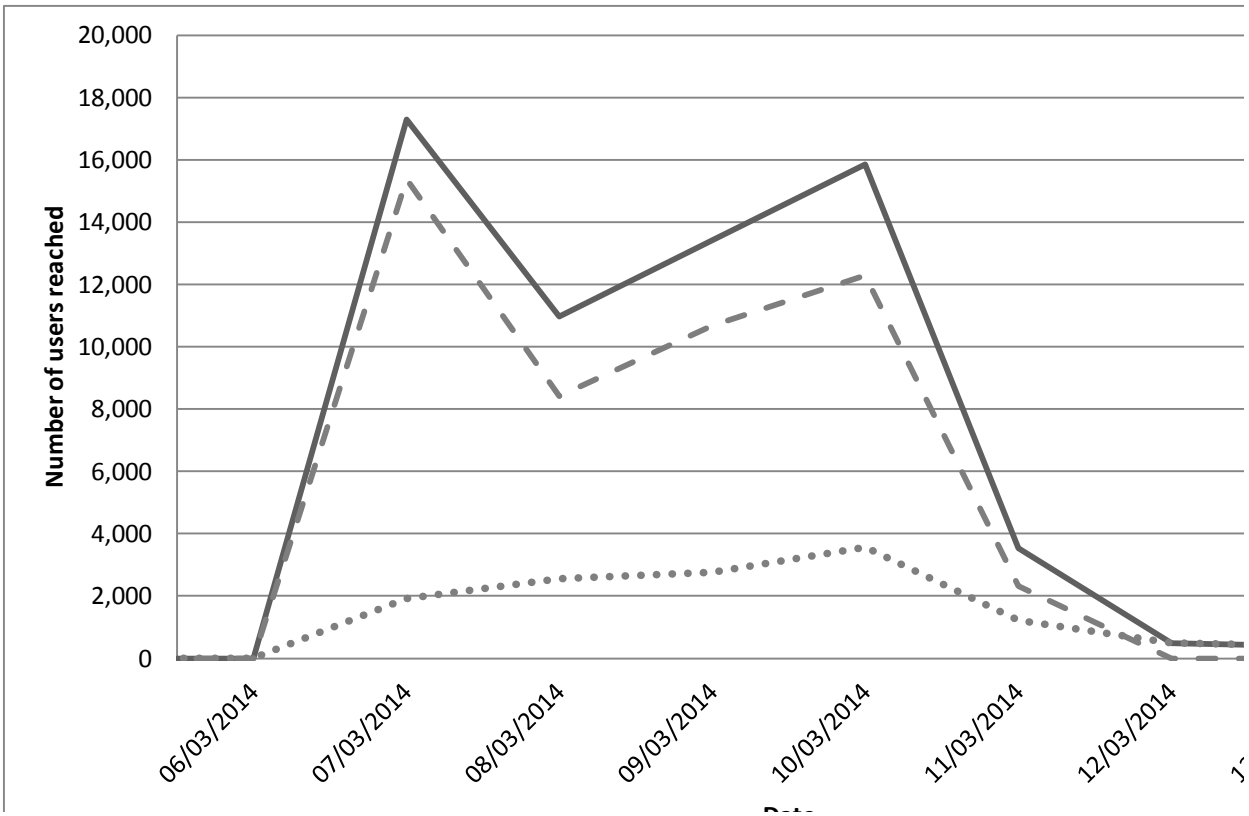

Figure 7: Number of Users Reached per Day ("Daily Reach" (Facebook, 2014))

The effect of the Facebook advertising in increasing reach is clearly shown in Figure 7. Initially, the daily paid reach was almost equal to the total reach. As momentum built and more users were submitting information to the page the organic reach (non-paid reach) started to build to a maximum of 4,000 users per day. The organic reach reduced slowly as activity on the page reduced, this is in contrast to the paid reach which reduced in line with advertising spending.

The figure below, taken directly from Facebook, shows the demographic data of people who have liked the "Christchurch Flood Info Collection" Facebook page. Our initial assumptions on the demographic we were most likely to reach were proven wrong as only 39% of the people who liked the page were within our target age range of 18 – 35. This suggests that Facebook can be used to gather information from a wider audience and may be more representative of society than originally thought.

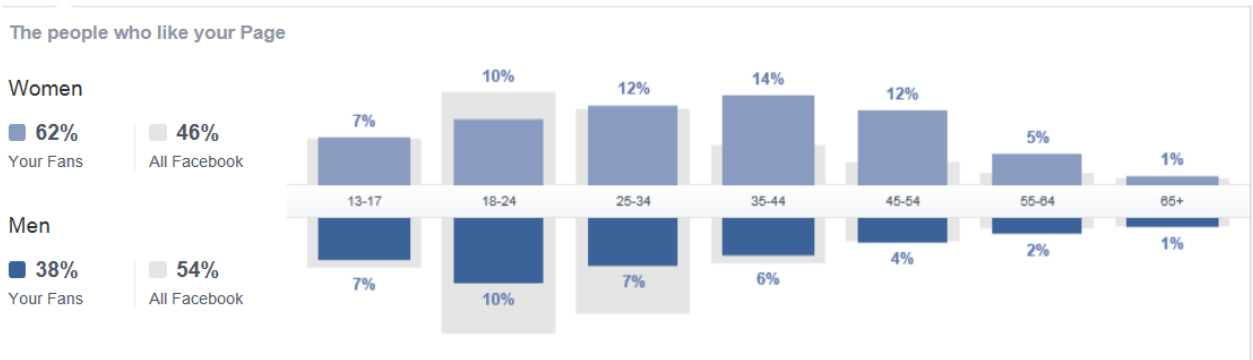

Figure 8 Audience demographics (Facebook, 2014)

2.4.2 FLOOD DATA SUBMITTED

People posted information on the page in the form of text, photographs and video. Although data was slower to be submitted than expected, we received 70 photos and 3 videos which were then able to be geocoded as discussed in section 3.1.1. Samples of the photos submitted are shown in figure 9 below.

Figure 9: Sample of photos submitted (Facebook, 2014)

We had requested that submitters specify the depth, location and time of flooding shown in the photographs. In general most people provided this information however as discussed earlier some further communication was required with submitters to confirm some details of the submitted information.

2.5 AUCKLAND FLOODING PAGE RESULTS

A similar page was set up for Auckland in an attempt to replicate the Christchurch page, seeking photos from the storm on the 16 April 2014. The page achieved 700 likes in 3 days which compares favorably to the 850 of the Christchurch page, however there were significantly fewer photos submitted to the page. This can be attributed to the localised nature of the flooding in Auckland as flooding was isolated to areas of the coast susceptible to storm surge. There were limited locations of pluvial and fluvial flooding as the Auckland storm was of significantly lower magnitude than in Christchurch. This suggests that there is a threshold of storm event below which this approach is not effective.

3 USING THE INFORMATION GATHERED

One challenge with collecting information about flood extent from the public is in organizing the data received so that it can be used to best effect (Gao et al 2010, Goodchild and Glennon 2010). GIS and specifically, Geodatabases are a well-established technology for doing this. A GIS allows users to rapidly move between coarse overviews of a whole city to quickly identifying the information relevant to a particular area. This becomes particularly important as the number of data points increases. For example, the CCC call center received over 500 complaints relating to the stormwater issues during and immediately after the event (Owen Southen, pers com), viewing the geographic clustering of these reports provides an easy way to ‘triage’ and identify priorities for investigation. In addition, bringing the data into a GIS allows the reports from the public to be systematically overlaid with other information, such as model predictions or the layout of the stormwater network. Once zoomed in to an area of interest, the details of each record can be viewed (Figure 10). This is a vast improvement over spreadsheets sorted by address or folders full of photos.

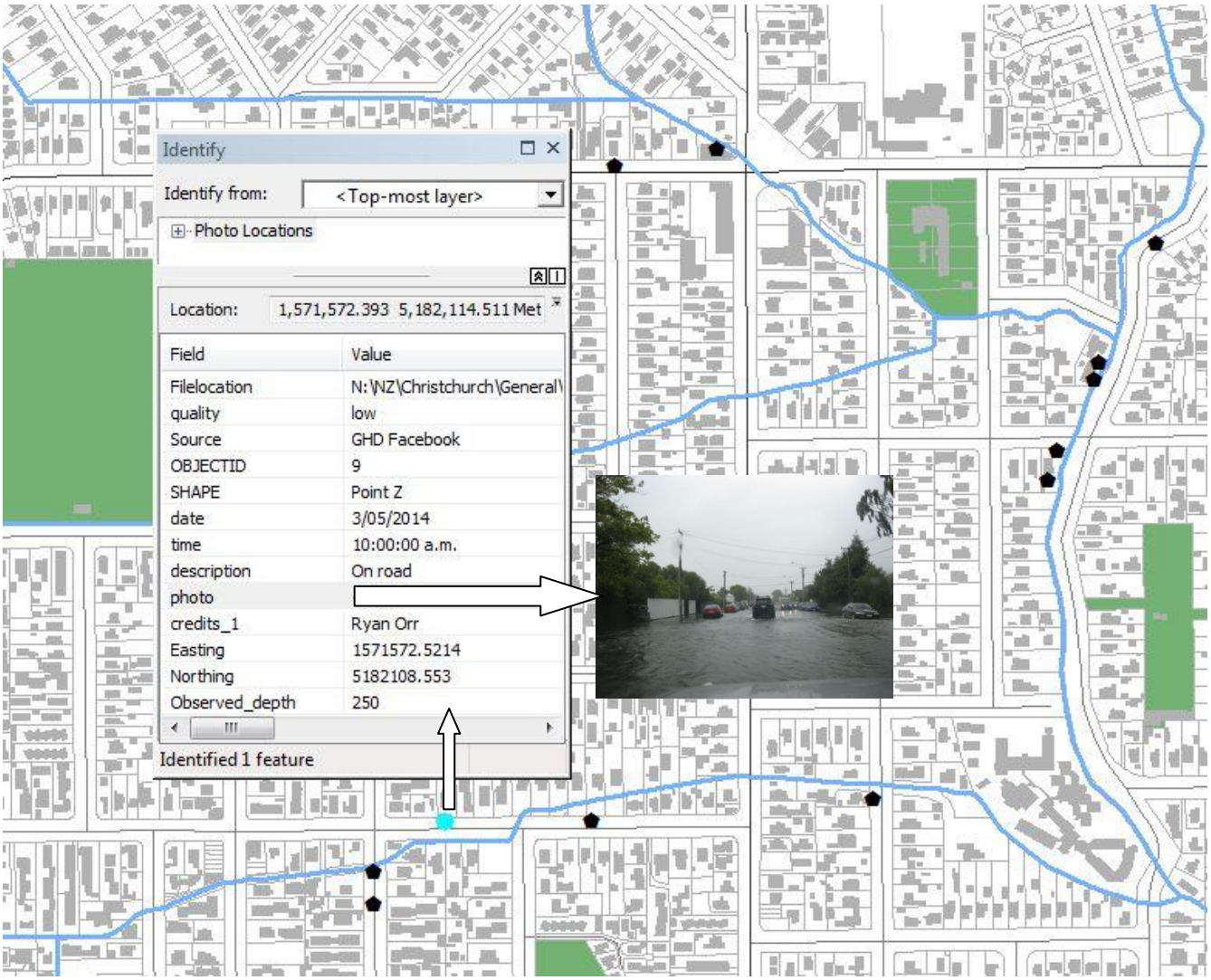

Figure 10: Example of interactive use of GeoDatabase to get fine details of an observation.

3.1.1 GEOCODING

We located all the photos we received spatially (geocoded) and brought them into a GIS. Locations were estimated based on comparing visible landmarks to reference imagery; therefore the location was recorded based on the location of landmarks in the photo rather than the location of the photographer. In a some cases the photo did not have sufficient detail to record the position precisely and in these cases the street address was used instead. In some instances, we received multiple photos from a single location. Each user and photos of different aspects (i.e. no common references) is recorded as a separate location.

3.1.2 COMPARISON TO MODEL PREDICTIONS

15 photos (20%) contained enough detail to estimate flood depth to coarse categories: 1, 2, 3, 4. These categories were selected with reference both to the types of landmarks visible in the photos (car tires, letter boxes, boundary fences) and to flood levels that affect residents. We found that where users self-reported flood depths, these often conflicted with our estimates from landmarks of known height visible in the photos. This could be because the photo didn't capture the worst flooding visible to the photographer, the landmark visible in the photo did not reflect the average depth over the whole photo, or an unconscious upward bias in depth estimates by the photographer reflecting the emotional impact of observing flooding on one's own section. This discrepancy will need to be considered for any future projects that wish to rely on self-reported flooding depth.

Although the proportion of photos where flood level could be estimated was low, the entire data set could be used to assess flood extent, which many modellers consider to be the first step in assessing a 2D prediction (DHI 2014) We compared our observations to the 50 year flood extent, as represented by the CCC flood management areas. Several photos fell outside of the FMA (Figure 11). There are multiple potential causes for

this: (a) local failure of the stormwater system, (b) the storm exceeded the 50 year threshold in some areas, or (c) deficiencies in the model predictions. A detailed knowledge of the gaps between predictions and reality can guide response and recovery work.

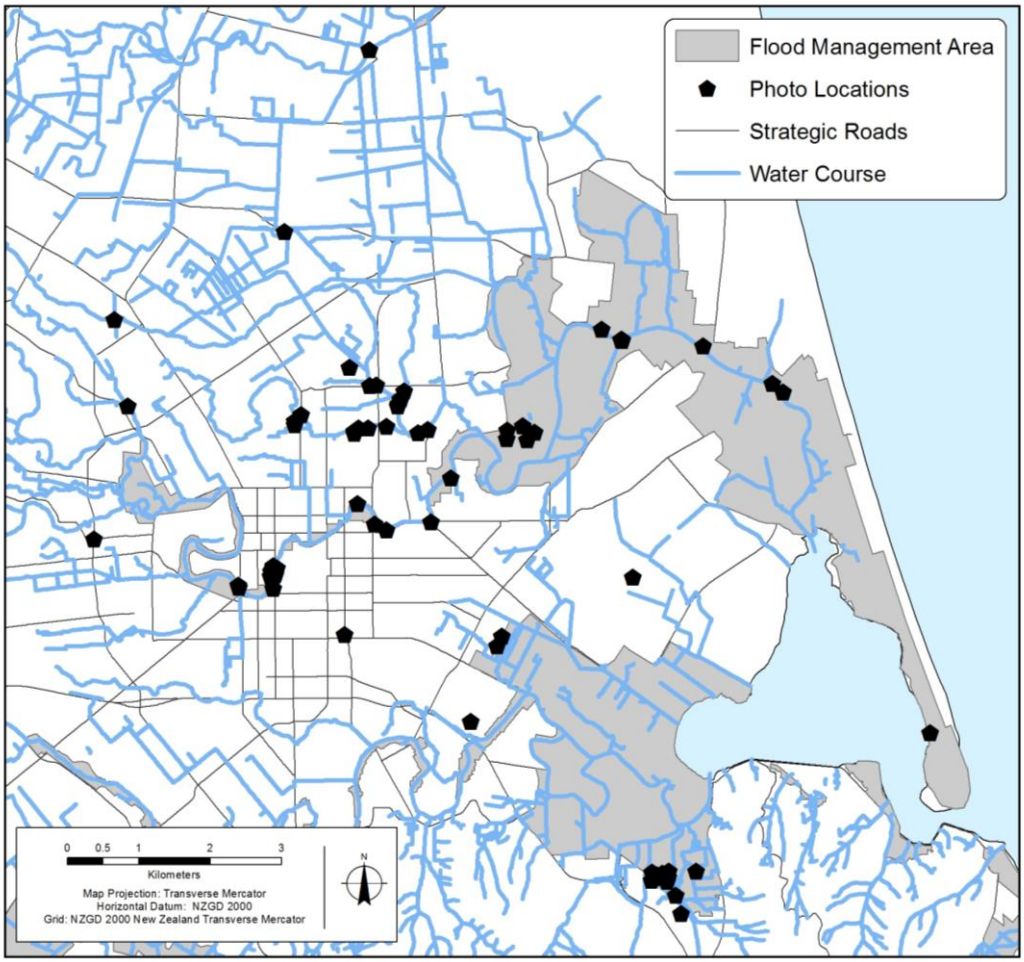

Figure 11: Comparison of received photo locations and flood management areas (proxy for predicted flood extent)

4 FUTURE DIRECTIONS

4.1 SOCIAL MEDIA PLATFORM SELECTION

We chose Facebook for our trial because it has a broad user base and a low cost of entry, both monetarily and in set-up time. Our choice of platform did have some drawbacks, however. Although we captured data in near-real time, we still needed to geocode the locations manually as Facebook removes the geocoding for privacy reasons, this meant the data was not ready in time to guide field crews sent out to assess flood damage in the immediate aftermath of the storm. Additionally, the level of effort required for geocoding scales directly with the success of the social media campaign – making it hard to budget for.

Crowd sourcing websites such as geoavalanche.org automatically geocode photos when submitted, setting up a website such as this for flooding would save a significant amount of time however these sites will never produce the number of responses that Facebook will due to the size of the audience. A middle ground would be to develop a Facebook integrated application with privacy permissions set such that uses could upload photos with the geocode still attached. It is our expectation that an approach such as this would be a tradeoff between the quantity and quality of data provided by each person and the number of people who participate. Each additional step in the process of submitting the data will drive away potential users.

A drawback of our single platform approach is that it could not reach people who do not have facebook accounts. A coordinated campaign across social and traditional media with an email address for those community members who do not use social networks (Figure 12) would broaden the reach considerably. Information solicited via traditional media would obviously be received well after the event, and thus could not be used to guide storm-clean up or flood-mark surveying efforts.

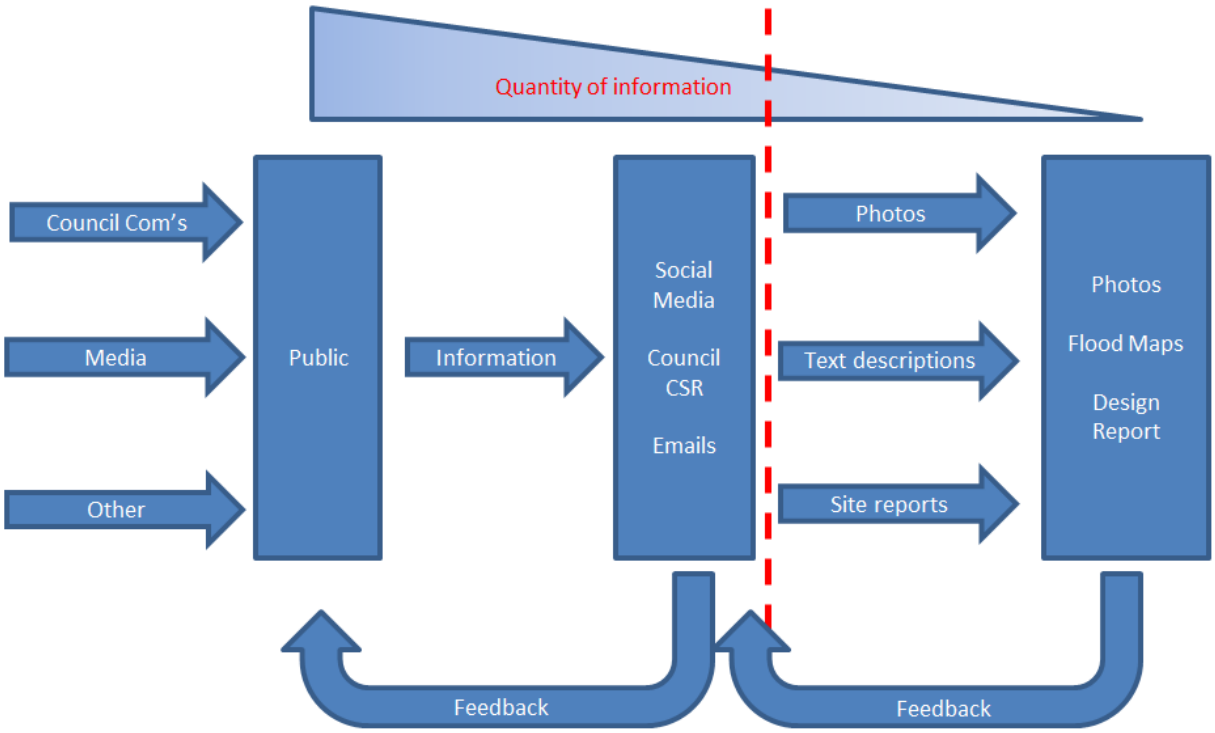

Figure 12: Diagram of future crowd sourcing approach.

The need for broad market reach is underscored by recent developments in Christchurch. Subsequent to our project a Mayoral Taskforce was convened to examine flooding issues in Christchurch. Through the publicity surrounding this project, 68 households were identified who had severe flooding issues (including 11 with at least two episodes of over-floor flooding), but who had not previously contacted council about it (CCC 5 June 2014). This indicates that relying on call center reports alone for estimates of flood severity may be insufficient. It also indicates a need for alternative means of engagement with the public.

5 CONCLUSIONS AND RECOMMENDATIONS

The results show that social media has clear promise in collecting data during extreme events. Moreover, although this data is lower quality than direct observations by trained engineers, it can be used in evaluating and calibrating flood models and other engineering analyses. Based on our experiences, we have identified a number of refinements in processing and analyzing the data and innovations in the use of social media platforms that should improve the effectiveness of this type of approach in future events:

1. Reaching out to the public through social media works. There are a lot of people who are keen to help their community, even if they don't have a specific complaint for council.

2. The scale of the event is important – the page received much less attention in the subsequent April flood events in both Auckland and Christchurch. Future projects will want to consider the merit of raising their profile versus participation fatigue in setting the trigger level for subsequent campaigns.

3. Leveraging the personal connections of the project team is an effective way to build support – particularly if an unbranded approach is chosen. This suggests that campaigns will be more effective if they gain internal buy-in before launching a public campaign.

4. No one social media platform reaches all community members. Future campaigns should consider a multi-platform approach, including traditional media (Figure 12).

5. If a crowd-sourcing application depends on members of the public to estimate flood depth, then it would be beneficial to develop and test a scale that references everyday objects well in advance of deployment

6. Facebook was a low-cost way to gather information, but it strips location information from uploaded photos, requiring a manual post-hoc geocoding, based on self-reported photo location. Exploring alternative platforms that would not require this manual effort would increase the speed with the data could be made available and reduce the overall cost of the project.

7. With a slightly larger (several hundred observations) dataset, interpolation and prediction techniques developed in other disciplines for 'presence-only data' should be applicable to crowd-sourced flood data. This would allow a flood extent to be estimated directly from the supplied data.

ACKNOWLEDGEMENTS

Thanks to Barry Potter, Martin Smith and Colin Forsyth of GHD for initial support and funding, and for helping us to refine and develop our ideas. Tim Preston and Gary Payne advanced our understanding of the broad spectrum of crowd sourcing applications. Josh Bird did the geocoding of the received data and Anita Collins assisted with formatting and editing the text.

Thanks also to Graham Harrington and Owen Southen of Christchurch City Council for their support, valuable insight into the needs of territorial authorities and access to flood-related customer service requests. Our thanks also to Andrew Skelton from Auckland Council for being sufficiently interested in the Christchurch experience to support the trial in Auckland.

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GLOSSARY

GENERAL

CCC – Christchurch City Council
DHI – Danish Hydrological Institute
Geocode - To using other geographic data, usually street addresses, to assign geographic coordinates to a data point.

FACEBOOK SPECIFIC

Like – On Facebook, clicking Like is a way to give positive feedback and connect with a page or things you care about.
Messages – Messages are similar to emails but only with people on Facebook.
News Feed - News Feed is an ongoing list of updates on your facebook homepage that shows you what's new with the friends and Pages you follow
Page - Pages allow businesses, brands, groups and organizations to connect with people on Facebook
Timeline – A timeline is a collection of the photos, stories and experiences that tell your story on your page.
Organic Growth – Growth in Likes or page engagement achieved through unpaid means.
Paid Growth – Growth in Likes or page engagement achieved through paid advertising on Facebook.
Reach - the number of people who have seen your post / page.