

Local and Global Responses to Disaster: #eqnz and the Christchurch Earthquake

Associate Professor Axel Bruns

a.bruns@qut.edu.au

ARC Centre of Excellence for Creative Industries & Innovation

Queensland University of Technology, Brisbane, Australia

Dr Jean Burgess

je.burgess@qut.edu.au

ARC Centre of Excellence for Creative Industries & Innovation

Queensland University of Technology, Brisbane, Australia

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Axel Bruns and Jean Burgess

ARC Centre of Excellence for Creative Industries & Innovation

<http://mappingonlinepublics.net/>

Abstract *Building on innovative frameworks for analysing and visualising the tweet data available from Twitter, developed by the authors, this paper examines the patterns of tweeting activity which can be observed in the aftermath of the Feb, 2011 Christchurch earthquake. Local and global responses to the disaster were organised around the hashtag #eqnz, which averaged some 100 tweets per minute in the hours following the earthquake. The paper identifies the key contributors to the #eqnz network and shows the key themes of their messages. Emerging from this analysis is a more detailed understanding of Twitter and other social media as key elements in the overall ecology of the media forms used for crisis communication. Such uses point both to the importance of social media as a tool for affected communities to self-organise their disaster response and recovery activities, and as a tool for emergency management services to disseminate key information and receive updates from local communities.*

Keywords: *Twitter, Christchurch, earthquake, crisis communication, social media*

Introduction

The first months of 2011 were marked by a series of devastating natural disasters, from widespread flooding in the Australian state of Queensland during January to the earthquake and tsunami which hit the eastern coastline of Japan in March. The role of social media in disseminating news of these events, supporting the immediate disaster response, and tracking efforts at relief and rebuilding, has already been highlighted by a number of researchers (see e.g. Hughes & Palen, 2009; Mendoza & Poblete, 2010; Palen *et al.*, 2010; Starbird & Palen, 2010); and in Bruns *et al.* (2012), we examine the use of social media by emergency authorities in the Queensland floods. The present paper examines the use of social media, especially *Twitter*, in another major crisis: the earthquake which destroyed significant parts of the New Zealand city of Christchurch on 22 February 2011.

The February earthquake in Christchurch turned out to be particularly destructive because it may have been, technically, only an especially significant aftershock (magnitude 6.3) of the magnitude 7.1 earthquake that had previously occurred on 4 September 2010, which had already substantially weakened building structures in the area; the February earthquake and its aftershocks exacerbated that damage and caused a large number of Christchurch buildings to collapse. Additionally, the February tremor occurred at a relatively shallow depth of only 5 km, magnifying its effect on surface structures. In the event, the quake caused nearly 200 fatalities, affected a substantial percentage of the local population, and has been estimated to have generated some NZ\$15 billion in reconstruction costs (Rotherham, 2011).

The earthquake occurred at 12:51 local time, and in keeping with patterns observed in other recent disasters and other breaking news stories, social media played a significant role in disseminating early reports and information, including first-hand reports from affected local residents and journalists. In this paper, we specifically examine the use of *Twitter* in this process; here, we focus first on the central *Twitter* hashtag '#eqnz' (Earthquake New Zealand – hashtags are brief keywords or abbreviations, prefixed with the hash symbol '#', which users can include in their tweets to make these messages immediately visible to others following the hashtag) which fast emerged as the main mechanism for coordinating messages related to the event.

The rapid emergence of this hashtag, and the relatively limited use of other, alternative hashtags, is due not least to the fact that the February earthquake followed on so closely from the September tremor. In the September quake, there was confusion early on about which of several competing hashtags to choose (with #christchurchquake, #chch, #christchurch, #nzquake all making an appearance; and different hashtags being used by different authorities – see Seitzinger, 2011 for an account of the rapid progress of this “hashtag war”). Once consensus had been achieved and adoption by leading accounts had occurred, however, #eqnz became the quasi-official hashtag for the September 2010 and all subsequent earthquakes to

occur in New Zealand; and further iterations (e.g. #eqnzcontact, #eqnzaccom) were built on this convention.

In 2011, the conventions (especially the hashtag #eqnz) established in that earlier crisis remained accessible to local residents and authorities as part of their available repertoires for crisis communication, and could now be activated again. There was no need for lengthy discussions over which hashtag to use, and a sense of what major *Twitter* accounts were likely to provide important information about the event – and indeed, that *Twitter* would be a useful communications tool at all – was also already established.

Our analysis in this paper builds in the first place on a dataset of #eqnz tweets which we began gathering at 13:28 local time (some 37 minutes after the earthquake itself). The tweets were captured using a customised version of the open source tool *yourTwapperkeeper*, which accesses the *Twitter* Application Programming Interface (API) to retrieve all publicly available tweets containing specific hashtags and keywords, as well as capturing various ancillary forms of metadata about these tweets.

yourTwapperkeeper and similar tools are especially useful for the study of *Twitter* discussions which use a consistent hashtag (as is the case with #eqnz), or reliably contain specific keywords. At its most basic, the study of an individual hashtag enables researchers to examine the activities of an *ad hoc* issue public which has formed around that particular hashtag (cf. Bruns & Burgess, 2011a); individual studies can later be combined to explore the overlaps and interactions which occur between these specific publics if bridging tweets contain multiple hashtags. It should be noted that many other *Twitter* users may also discuss issues relevant to the hashtag, but (deliberately, or because they are unaware of it) refrain from including the appropriate hashtag; in the following discussion, therefore, we make no claims that what we observe is *all* the discussion of the Christchurch earthquake that occurred on *Twitter*, but it is the most visible part of that discussion.

Key Patterns of *Twitter* Use in #eqnz

We processed the dataset using the tool *Gawk*, with a range of custom-made scripts that extract key patterns of activity from the overall data (a detailed discussion of these scripts, and the scripts themselves, are available on our project website at <http://mappingonlinepublics.net/>; see esp. Bruns & Burgess, 2011b). To begin with, this enables us to identify the overall volume of tweets using the #eqnz hashtag (fig. 1):

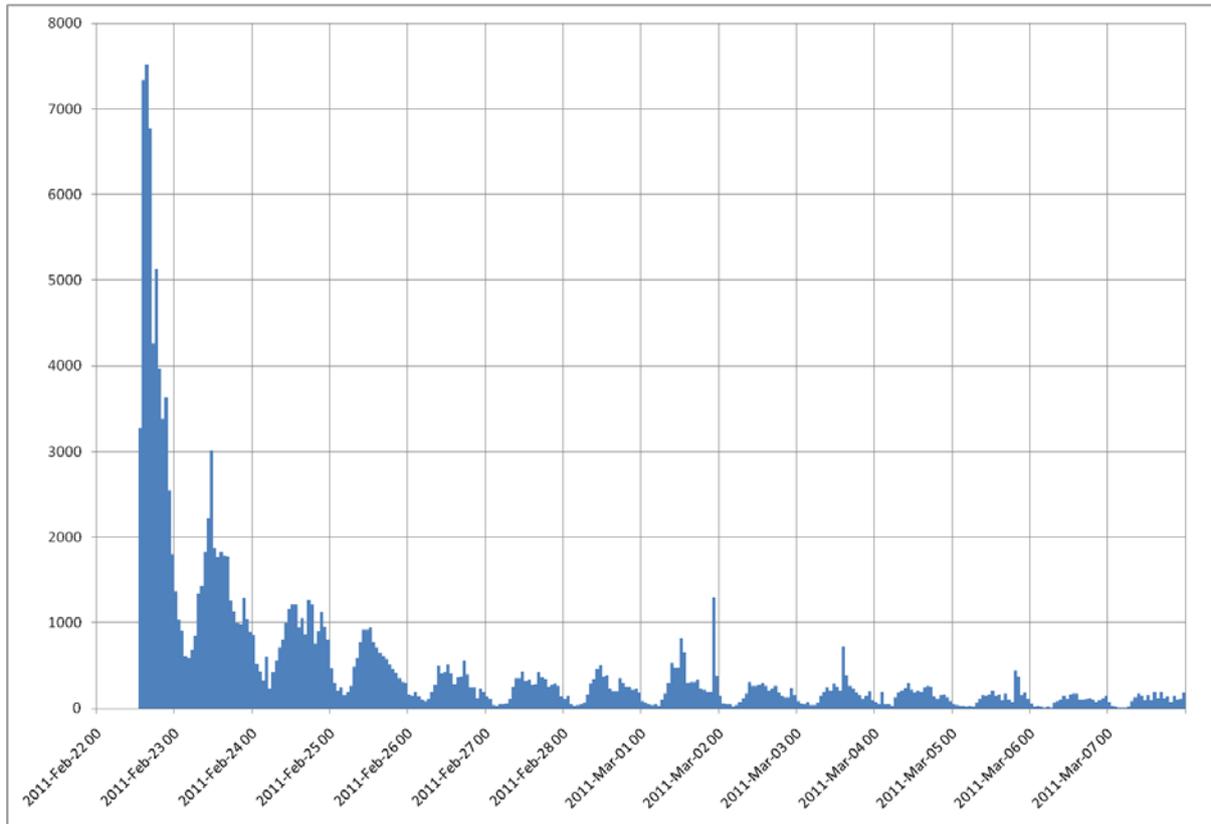


Fig. 1: #eqnz tweets during the fortnight following 22 February 2011

Twitter coverage of the earthquake spikes within the first hours of the event, at about 7500 tweets/hour (or just over two tweets/second) – this is the phase when locals and more distant onlookers alike are likely to be tweeting and retweeting the first reports emerging from the disaster area, in order to alert their own *Twitter* followers. Within two or three days of the initial disaster event itself, however, use of the hashtag has declined markedly, showing, perhaps, that the hashtag as a coordinating mechanism is no longer valuable for anyone but directly affected local users. (We will examine these hypotheses further in the following discussion.)

If so, the initial spike would provide a very clear illustration of what Alfred Hermida and Alex Burns have both described as *Twitter*'s role as a medium for 'ambient journalism' (Hermida, 2010; Burns, 2010): the platform may lie dormant for most of the time, used instead for largely non-journalistic purposes, but it is ready to spring into action as a major tool for news dissemination and discussion at a moment's notice. The analogy here is to ambient music styles: there, too, the music is designed to remain in the background for the most part, only occasionally drawing in the listener for more concentrated attention.

The sudden increase in reports about an earthquake in New Zealand (expressed for example by the appearance of relevant hashtags and keywords in *Twitter*'s 'trending topics') acts as mechanism to draw the attention of more and more *Twitter* users to the event – even if they are not directly affected by it –, and also leads some of them to participate in the #eqnz hashtag itself (if perhaps only by sharing and retweeting

other users' tweets), at least for some time; as the full situation becomes widely known, however, and as genuinely *new* news updates become less frequent, this activity is no longer as necessary as before, and their activities slow down. In this, *Twitter's* own coverage of the event probably does no more than mirror the patterns of news coverage in other media: during the first hours following the tremor, for example, many television channels may also have interrupted their scheduled programming in favour of continuous live coverage, but gradually the volume of news updates from Christchurch would similarly have declined in favour of restoring a broader balance of news stories. What remains after these first hours and days of intensive coverage should be expected to exhibit some markedly different characteristics, then – both on *Twitter* and in other media.

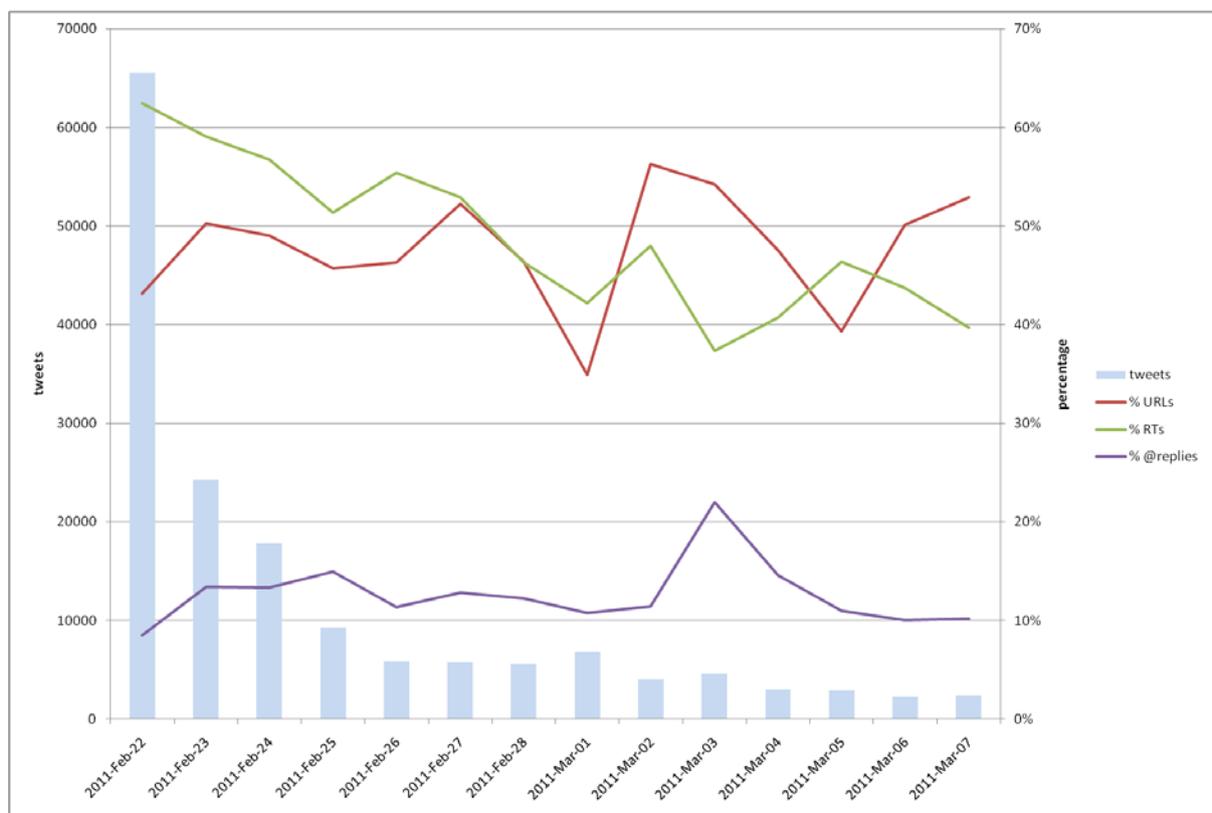


Fig. 2: percentage of #eqnz tweets containing URLs, (manual) retweets, and @replies, against total volume, 22 Feb.-7 Mar. 2011

This is also evident in the types of tweets being tagged with the #eqnz hashtag: as fig. 2 shows, some 60 per cent of all #eqnz tweets during the first few days of the crisis are (manual) retweets of existing messages – that is, take the form ‘RT @sender [original message]’, possibly with further comments added by the retweeting user.¹ This percentage declines markedly over the following days, to

¹ *yourTwrapperkeeper* does not enable us to capture retweets made using *Twitter's* ‘retweet button’, which results in verbatim, uneditable retweets; these are not included here, therefore. Further, beyond the standard ‘RT @sender [original message]’ format for retweets, a number of much less widely used alternatives also exist – e.g. ‘[original message] (via @sender)’ (cf boyd *et al.*, 2010). These have not been counted here. Our data on retweets is therefore likely to underestimate the total number of retweets in #eqnz.

around 40 per cent by early March, indicating an emphasis on sharing original information rather than passing along only a handful of key messages. Further, it is also notable that (excepting day-by-day fluctuations) the overall percentage of tweets containing URLs remains relatively constant, at an average of 48 per cent over the two weeks examined here: in combination with the continuous decline in retweets (that is, in messages containing more or less identical content), this means that the *diversity* of URLs being shared increases over the course of this fortnight.

Fig. 2 also indicates that over the course of the two weeks, the percentage of tweets containing genuine @replies (not counting retweets, which constitute a special kind of @reply) remains relatively steady, if at a relatively low average of 13 per cent of all tweets. This should not be misunderstood to indicate that #eqnz constitutes a group of *Twitter* users who all post individual messages and retweets to the hashtag space, but fail to engage with one another; however, it points to the observable fact that in many cases, responses to #eqnz messages no longer themselves contain the #eqnz hashtag, and are therefore no longer captured in our data. By analogy, by leaving out ‘#eqnz’ from their follow-on messages, users who have found one another on the public forum created by the hashtag are taking their conversation to a somewhat more quiet space (where they nonetheless remain publicly visible, of course, unless they resort to using *Twitter*’s private direct-messaging functions).

Taken together, these statistics on tweets, retweets, and @replies also enable us to identify the most active and most visible participants in the #eqnz hashtag community, then. Clearly emerging as the most active single account contributing to #eqnz is @CEQgovtnz, the official *Twitter* account of the New Zealand government’s Canterbury Earthquake Authority which was established after the first major earthquake in September 2010 (the agency has since been renamed as Canterbury Earthquake Recovery Authority, and now tweets as @CERAgovtnz); this account alone is responsible for nearly 2500 tweets during the first fortnight after the 2011 tremor, as fig. 3 indicates (amounting to nearly 180 tweets per day, on average). Other highly active accounts – if nowhere near as active as @CEQgovtnz – represent a diverse group of *Twitter* users, from government (such as the Christchurch City Council, @ChristchurchCC) to news organisations (radio station @NewstalkZB, newspaper @NZHerald) and volunteer efforts for gathering information about the areas affected by the earthquake (including @eqnz_live, which operated a crowdsourced map of the Christchurch area) and providing advice to survivors (like @operationSAFE, which offered guidelines for parents of traumatised children). A large number of the accounts represented here, however, are run by individuals pitching in to help disseminate information – from major and minor celebrities like *New Zealand’s Next Top Model* TV show judge Colin Mathura-Jeffree (@NZTopModelColin) and New Zealand ocean racing blogger @sailracewin to private accounts.

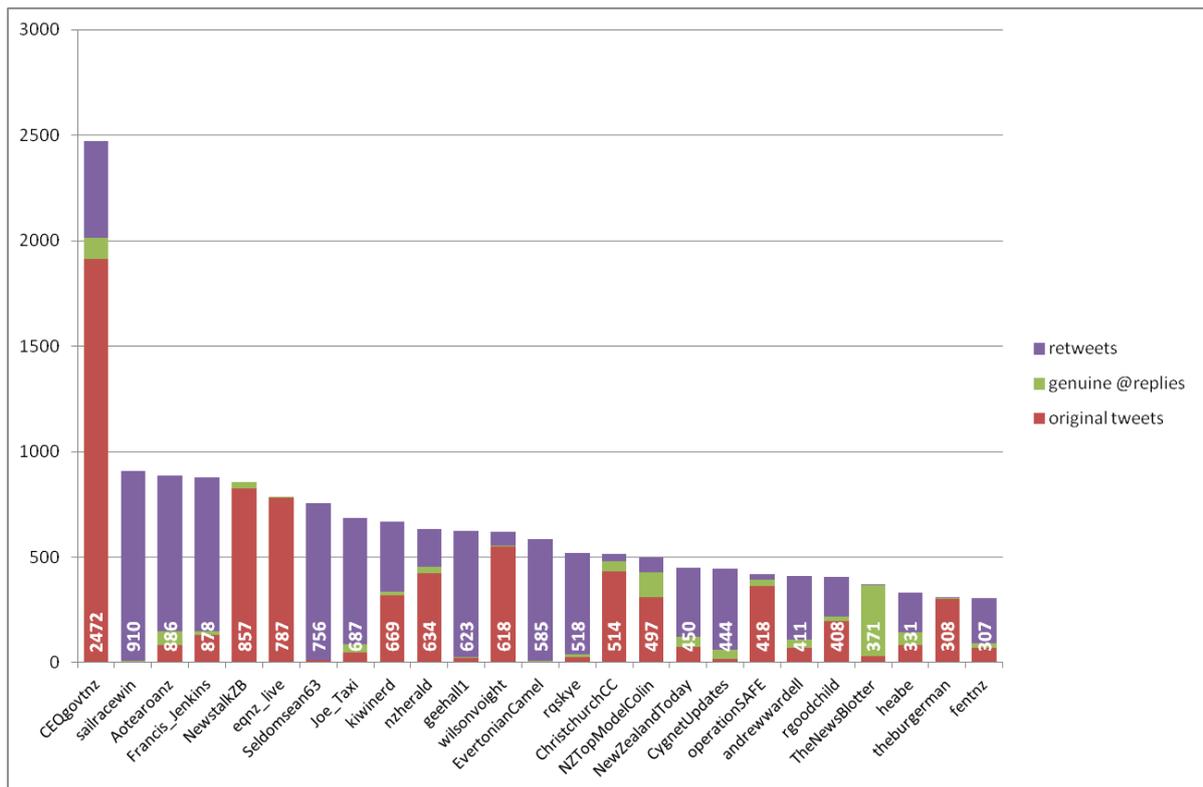


Fig. 3: 25 most active accounts participating in #eqnz, 22 Feb.-7 Mar. 2011 (total number of tweets, broken down into original tweets, genuine @replies, and retweets)

Activity patterns for these accounts are necessarily varying widely, depending on their ability to provide first-hand information. While leading account @CEQgovtnz is a major source of original information, for example (some 80 per cent of its tweets are non-retweets), all but eight of the second-placed @sailracewin's 910 tweets during the first fortnight were (apparently verbatim) retweets, and the same is true for a great number of the other leading accounts. Most likely, such users are engaging in their retweeting activities not primarily with the #eqnz community in mind, but are instead passing along what they believe to be the most important messages they have seen *within* the #eqnz space to their own group of *Twitter* followers, many of whom may not also follow #eqnz itself.

They act, in other words, as amplifiers of #eqnz-tagged messages, connecting this dedicated space for sharing information related to the disaster with their more amorphous, person-centred networks; in doing so, they serve as a discovery mechanism alerting their own networks of followers to the breaking news story and to the existence of dedicated hashtag coordinating the further dissemination and discussion of news about the event. This retweeting activity is precisely the point at which news shared on *Twitter* no longer remains an ambient commodity, passing by most users without being recognised, and instead turns active, recommended for greater attention by one or more of the users in one's personal network of *Twitter* connections. While the retweeting activities by @sailracewin and other similar users add little new information, they substantially boost the visibility of existing news

items, and the potential for the events covered in those news items to become major points of attention.

What follows is that the question of whose tweets are shared (as well as responded to) is important for understanding the information flows of major events on *Twitter*. This can be measured by examining the originating users mentioned in retweets and @replies in #eqnz (fig. 4). Here, news accounts (@NZHerald, Fairfax subsidiary @NZStuff, @TVNZNews, as well as the Australian @abcnews) and government accounts (@CEQgovtnz, @ChristchurchCC, as well as @NZcivildefence and @NZRedCross) clearly dominate the field; @NZHerald's 634 tweets during this fortnight received over 9100 retweets and @replies, for example (an average of 14 per message).

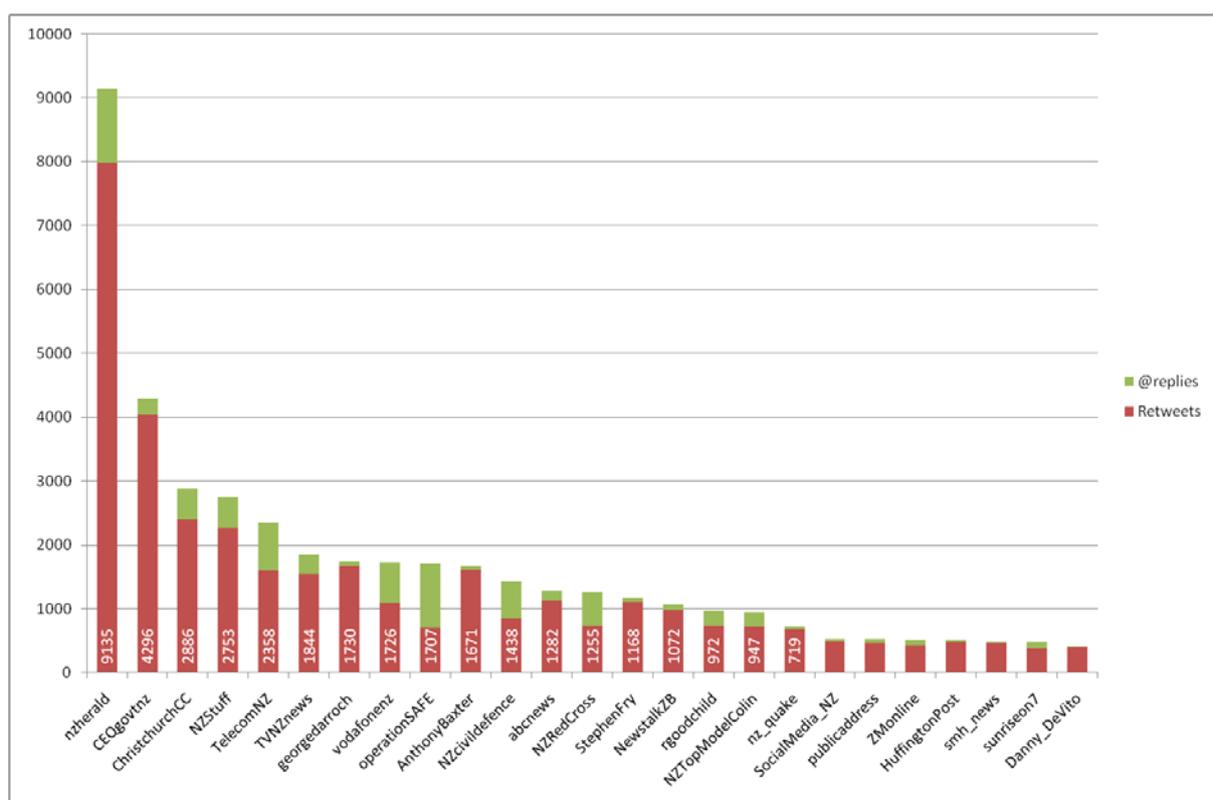


Fig. 4: retweets of and @replies to the 25 most visible accounts participating in #eqnz, 22 Feb.-7 Mar. 2011

Mobile telecommunications operators @TelecomNZ and @vodafonenz are also featured prominently here; both posted widely retweeted advisories on how to minimise the strain on their compromised networks shortly after the initial earthquake. Both accounts also received a comparatively high number of @replies (as distinct from simple retweets), containing both praise and criticism for their efforts at restoring normal services.

Such patterns are broadly comparable with what we have observed in the context of the January 2011 Queensland floods (Bruns *et al.*, 2012), with the exception of the predominance of the @NZHerald account. In Queensland, the *Twitter* account of the

Queensland Police Service (@QPSmedia), rather than a media organisation, led the field. The prominence of the *New Zealand Herald* account in this case may point to a greater level of interest and concern by *Twitter* users further afield – for example, by the large New Zealander diaspora in Australia –, who may be expected to search for (and retweet) media reports more than advisories from local authorities; additionally, the online coverage by the *New Zealand Herald* (and its own use of *Twitter* to disseminate this information) also lent itself well to generating such further amplification. Of the *Herald's* ten most retweeted messages containing links, four pointed to pages containing blog-style news update feeds for 23-26 February, two presented image galleries, and one linked to a special earthquake section on the paper's Website. The most-retweeted @NZHerald messages with links, however, pointed to external resources: Google's 'people finder' Web application, a *YouTube* eyewitness video of the quake's immediate aftermath, and the New Zealand Prime Minister's appeal for donations. Retweets of the messages mentioning Google's Web application, in fact, accounted for nearly 2,400 of all tweets mentioning @NZHerald.

Various personal accounts are prominent for more idiosyncratic reasons:

RT @georgedarroch: Incredible image of Christchurch, from the hills, moments after the quake. <http://i.imgur.com/0vZbD.jpg> #eqnz

was frequently retweeted, as were:

RT @anthonybaxter: Google has people finder up for #eqnz #christchurch <http://bit.ly/i0aAle> please RT widely

and comedian Stephen Fry's message of support:

RT @stephenfry: Oh dear, poor Christchurch. Another horrific earthquake. <http://t.co/S5nL3lq> #chch #eqnz <http://t.co/plUcmcP>

Additionally, while in fig. 4 @operationSAFE appears to have received an unusually large number of @replies, in comparison to retweets of its messages, this is largely because one of its messages was widely shared without using the customary retweet format:

#eqnz The world is with you! Help your family cope with quake stress with these tips. <http://bit.ly/bGneSz> #opsafe #DT @operationSAFE

From News to Recovery: #eqnz's Changing Nature

The overall patterns outlined so far only describe the uses of the #eqnz hashtag in an aggregate form. Fig. 1 shows substantial spikes in *Twitter* use during the first few days of the crisis, followed by lower but more sustained volumes of activity, pointing to the fact that the nature of #eqnz as a space for sharing and discussing information changes significantly over time. It is useful, therefore, to introduce a – necessarily

somewhat arbitrary – distinction between the first phase of the crisis, unfolding during 22 to 24 February 2011, and the rest of the fortnight until 7 March. During the first three days, which also represent a period of heightened news attention to the disaster, #eqnz activity reached more than 1,000 tweets per hour on multiple occasions; later, *Twitter* discussion continued at a much reduced level (or, as is also likely, diversified into a number of additional hashtags and follow-on conversations which are not included in our dataset). There was another brief spike above 1,000 tweets per hour in the evening of 1 March, as another major aftershock rattled the city, but this remains the sole exception.

A comparison of retweet and @reply patterns across these two periods clearly points to the differences between them (Table 1). In the immediate aftermath of the earthquake, news organisations, mobile communication providers, and a handful of individuals sharing first-hand images and advice are central; once this first phase of the event has passed, emergency and civic authorities become significantly more important sources of information, with @CEQgovtnz and @ChristchurchCC both in the top three, while the first individual *Twitter* user, @NZTopModelColin, is ranked only eleventh of the most retweeted accounts. The stronger focus on public advice and information during this second phase of the response is also documented by the presence of a number of other more specific sources: unofficial earthquake alert system @nz_quake, Earthquake Commission @EQCNZ, airline @FlyAirNZ, and the @BritishRedCross. Additionally, the presence of donation site Virgin Money Giving (@VMGiving), @NZLotteries, @Run4CHCH, and @redandblackday points to the fundraising and charity efforts which had already emerged during this time.

22-24 Feb 2011		
	Retweets	@replies
nzherald	5748	713
NZStuff	1736	312
AnthonyBaxter	1590	62
TVNZnews	1503	208
georgedarroch	1399	55
TelecomNZ	1289	592
abcnews	1131	127
StephenFry	1094	44
vodafoneNZ	1071	559
CEQgovtnz	689	137
rgoodchild	577	125
ChristchurchCC	573	211
NewstalkZB	554	44
SocialMedia_NZ	491	26
HuffingtonPost	478	25
NZRedCross	466	314
smh_news	457	13

25 Feb. - 3 Mar. 2011		
	Retweets	@replies
CEQgovtnz	3349	121
nzherald	2227	447
ChristchurchCC	1830	272
NZcivildefence	561	72
NZStuff	532	173
NewstalkZB	431	43
operationSAFE	399	547
nz_quake	350	22
TelecomNZ	314	163
VMGiving	277	9
NZTopModelColin	271	128
georgedarroch	270	6
NZRedCross	268	207
eqnz_live	240	29
3NewsNZ	200	28
EQCNZ	169	25
kalena	156	49

NZTopModelColin	451	97
publicaddress	405	41
ZMonline	380	81
sunriseon7	354	91
operationSAFE	305	456
NZcivildefence	299	506
safeinchch	168	815
NZhe	0	412

rgoodchild	155	115
nz_arukikata	154	3
NZLotteries	116	44
Run4CHCH	109	79
redandblackday	69	101
flyairnz	63	127
britishredcross	44	174
tweetbeat	0	177

Table 1: retweets of and @replies to the 25 most visible accounts in #eqnz, 22-24 Feb. / 25 Feb.-7 Mar. 2011

These changes point to a fundamental, if gradual, shift in how #eqnz is used: during the first few days, largely as a space for sharing and commenting on the news from Christchurch, and involving a greater number of users and, presumably, a larger percentage of users from further afield. The lack of verifiable geolocation information for participating users on *Twitter* prevents us from assessing this assumption more thoroughly, but it is also notable that (as fig. 5 shows) the total number of unique users participating in #eqnz drops considerably after the first few days, from some 20,000 on 22 February 2011 to a base level of 2,500 or less from 26 February onwards (with a brief spike above that level again on 1 March).

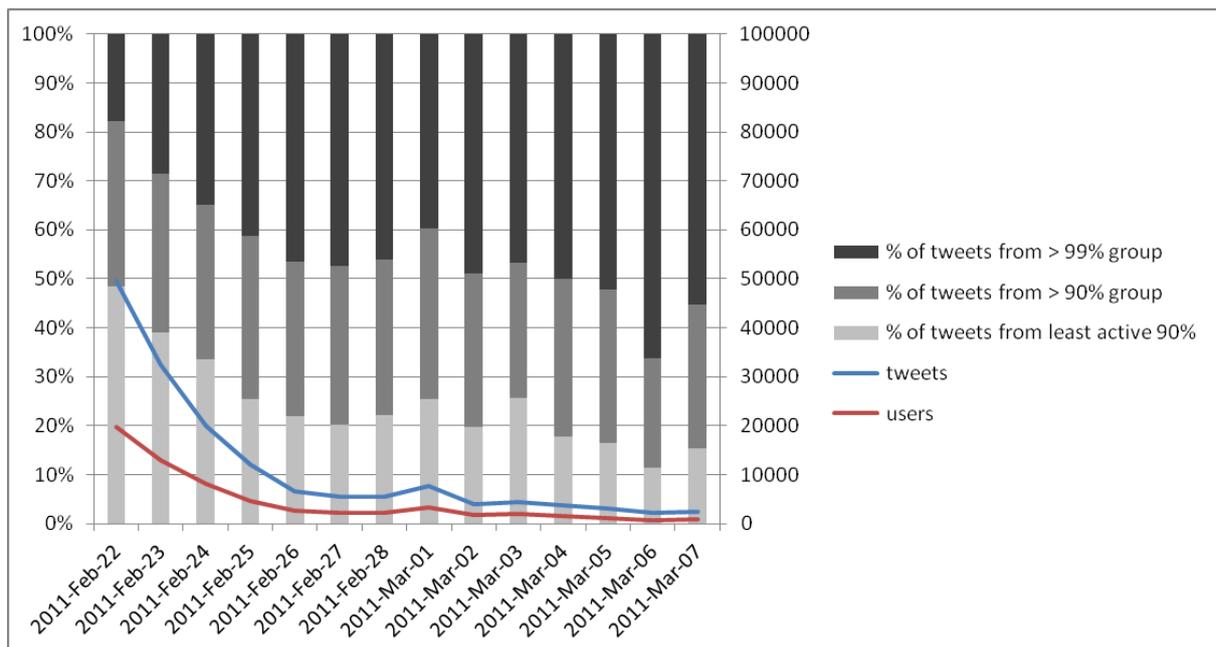


Fig. 5: numbers of tweets and unique users in #eqnz during 22 Feb.-7 Mar. 2011, and breakdown of tweeting activity into percentiles of more and less active users

It is also instructive to divide the total participating userbase into a number of distinct groups of more or less active users. While such divisions are necessarily arbitrary, here we apply the widely used 1/9/90 rule, creating three subsets of the total user community: a lead group containing the one per cent of most active contributors to #eqnz (having posted more than 49 tweets over the two weeks examined here); a second group with the next 9 per cent of second-most active users (with more than

seven but less than 50 tweets over the same fortnight); and a group containing the least active 90% of contributors (with seven tweets of less over the two weeks).

Fig. 5 also shows the respective contributions made by each of these groups to the total #eqnz tweet stream, and notable changes between the first few days and the rest of the fortnight are once again apparent. During the immediate information sharing phase, the least active group of users (two-thirds of whose contributions are retweets) generate more than one third of all tweets; on 22 February itself, they account for over 48 per cent of the nearly 50,000 #eqnz tweets, and – given the overwhelming amount of retweets they post – play a crucial role in rapidly disseminating news and updates across the Twittersphere, well beyond the #eqnz hashtag itself. By 25 February, their contribution has diminished to just over one quarter, and continues to decline further towards the end of the fortnight. Correspondingly, the two groups of leading users become more important: at the end, the top one per cent of most active users posts more than half of all tweets.

In combination with the reduced number of overall users, this may be understood as a gradual disappearance of more casual onlookers who were mainly sharing the news at the start of the crisis, but have limited interest in tracking recovery efforts in similar detail; what is left as they retreat from the conversation is a smaller ‘hard core’ of users who continue to use *Twitter* and #eqnz as an effective channel for sharing information that may be of relevance only to directly affected locals.

The 22 February 2011 Earthquake in Context

While observations of the changing nature of #eqnz during the February 2011 earthquake are valuable for highlighting how *Twitter* was used during this specific event, a longer-term perspective comparing the use of *Twitter* by Christchurch locals and authorities across multiple crisis events is also useful. The two obvious points of comparison for this purpose are the first major earthquake of the recent series, a magnitude 7.1 quake which struck early on 4 September 2010 and caused widespread structural damage but no immediate loss of life, and the further major aftershocks on 13 June (magnitude 6.4) and 23 December 2011 (magnitude 6.0). Here we compare the overall levels of *Twitter* activity after each event: fig. 6 shows the number of unique users participating in #eqnz for each day of the respective fortnights following the four quakes.

It is self-evident from fig. 6 that the 22 February 2011 quake found the greatest resonance on *Twitter*, by a substantial margin; this is also likely to be an indication of a notably greater participation in #eqnz by non-local *Twitter* users, especially during the first days of the crisis. Additional contributing factors are: the magnitude of the catastrophe (with substantial loss of life, and lengthy rescue operations): its timing (at lunchtime in New Zealand and mid-morning in Australia, leading to a greater immediate media response than the September 2010 quake at 4:35 a.m.): and the resultant amount of live coverage on television and in other media. The lower level of

resonance for the following aftershock on 13 June 2011, and a yet lower level for the quake on 23 Dec. 2011, can be explained in part by the waning attention by international *Twitter* users and mainstream media, and by the significantly more limited impact on Christchurch residents and infrastructure.

By contrast, the relatively low level of *Twitter* use after the initial earthquake on 4 September 2010 requires further explanation. In spite of the significant structural damage caused by that quake, *Twitter* use on the first few days following the disaster remains comparatively minor (only some 2,800 unique users participate on 4 September 2010 itself, posting 8,200 tweets); however, it *increases* after day two, and remains comparatively strong throughout the first week after the disaster. This may point to a new and rapid increase in community understanding of the value of *Twitter* as an additional channel for crisis communication, in the aftermath of the quake itself – a process of adoption which lays the groundwork for the much more sophisticated and substantial use of *Twitter* during the following earthquake event in February.

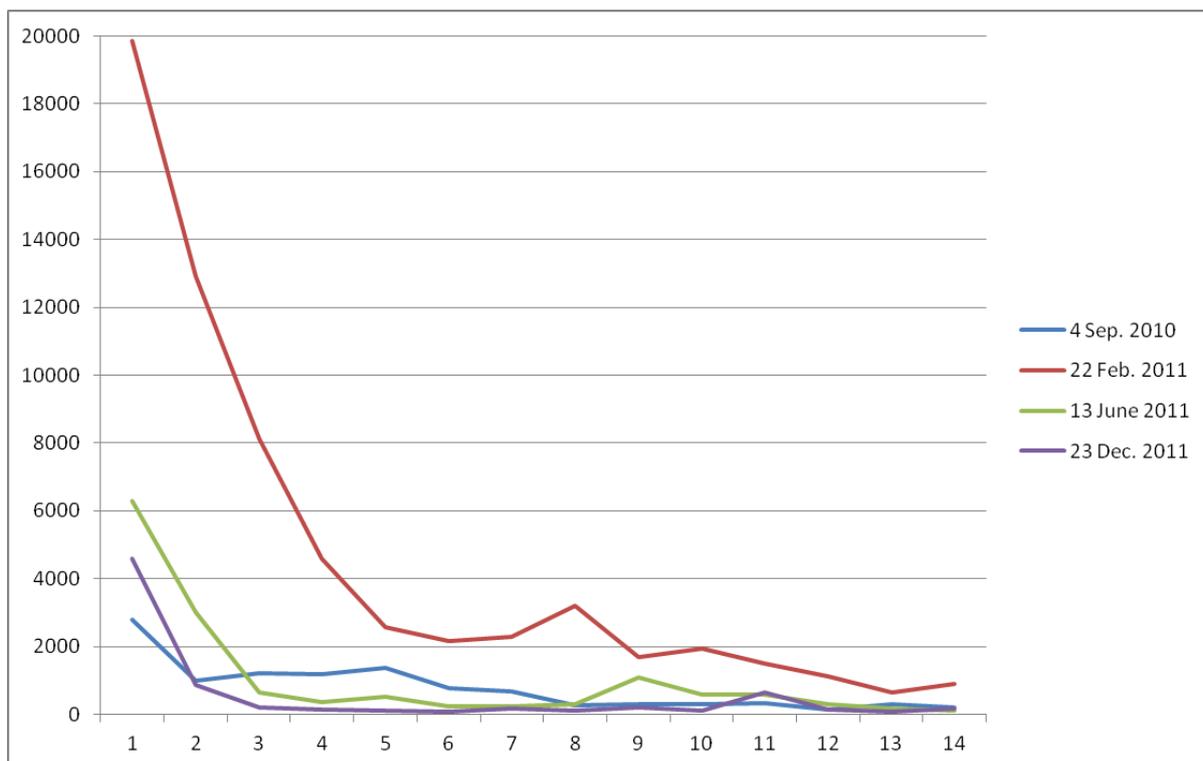


Fig. 6: number of unique users in #eqnz during the fortnights following the 4 Sep. 2010, 22 Feb. 2011, 13 June 2011, and 23 Dec. 2011 earthquakes in Christchurch

This more limited use of *Twitter* in the aftermath of the September quake also makes the volume of activities following the February disaster appear significantly more impressive: on 22 February 2011, by comparison, nearly 20,000 unique users participated in #eqnz, generating nearly 50,000 tweets. Indeed, the effects of experiencing (limited, but successful) *Twitter* usage after the September quake – as well as similar, widely publicised experiences of using *Twitter* in crisis communication, including the January 2011 Queensland floods (see Bruns *et al.*,

2012) and cyclone Yasi – should not be underestimated here: it is likely to have led a much greater number of *Twitter* users engaging with #eqnz in February 2011.

Beyond these overall numbers, it is also notable that over the course of these events, a more diverse ecosystem of leading accounts takes shape, and that these leading accounts are gradually assuming more important roles within the overall #eqnz communication process. Returning to the three groups of lead, active, and less active users determined by the 1/9/90 rule, it becomes evident from fig. 7 that the average daily percentage of tweets contributed by each of the top two groups during the fortnights following the four quakes has gradually increased with each subsequent event; this is most pronounced for the top one per cent of most active users. Where they accounted for an average of nine per cent of all #eqnz tweets during the 4 September 2010 event, by the 23 December 2011 quake they posted an average of over 17 per cent of all tweets; combined, the average contribution made by the top ten per cent of most active users grows from 47 to 57 per cent of all #eqnz tweets each day.

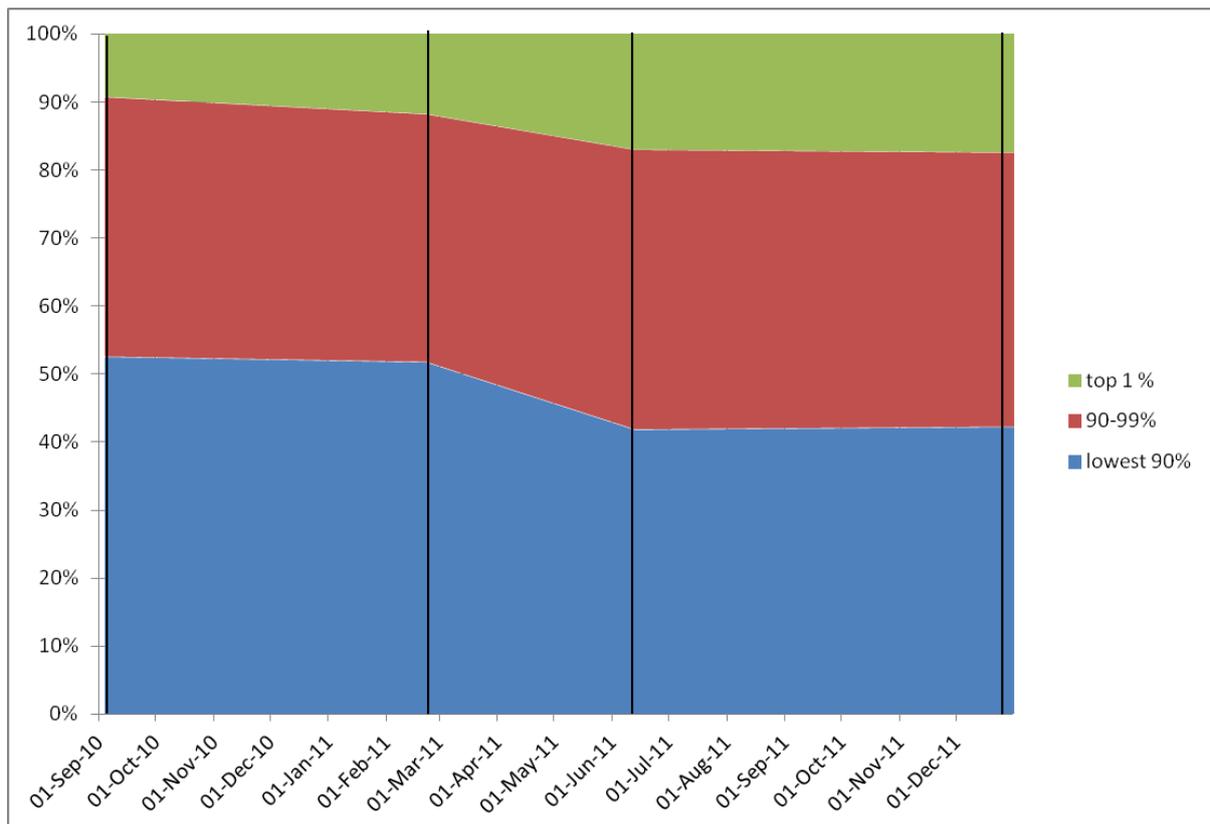


Fig. 7: percentage of tweets per day by each of the three user groups, averaged over each fortnight, for the earthquakes on 4 Sep. 2010, 22 Feb. 2011, 13 June 2011, and 23 Dec. 2011

Finally, it is also instructive to examine the comparative performance of the most visible accounts in each #eqnz event. Here, we focus on those *Twitter* accounts which received the most @replies and retweets during each fortnight (a valuable measure of visibility both within #eqnz and – through retweets – also well beyond it), and track the relative positioning on that leaderboard of all those accounts which

were placed in the top twenty on at least three out of four occasions (fig. 8). This analysis again makes visible the relative difference of *Twitter* communication around the 4 September 2010 earthquake from the other three events: only five of the eight prominent accounts which we track in fig. 7 were active during that first crisis at all; accounts important during subsequent events, such as those of the Christchurch City Council (@ChristchurchCC) or the Canterbury Earthquake Authority (@CEQgovtnz) – later renamed to the Canterbury Earthquake Recovery Authority (@CERAgovtnz) –, either did not exist at all yet, or failed to participate.

By contrast, by the time of the 22 February 2011 earthquake, a clear lead group of prominent *Twitter* accounts involving both government authorities, media organisations, and communications provider @TelecomNZ has become established, remaining in place also for the 13 June aftershock. The composition of that lead group changes again in the 23 December event, with news site @NZStuff and the renamed @CERAgovtnz remaining comparatively less visible, but all of the eight best-established accounts remain in the top twenty. Newcomers to this lead group in the most recent event include news-related *Twitter* accounts @BreakingNews, @3NewsBreaking, and @BreakingNZ, and the earthquake-specific *Twitter* feed of news site *Project 7*, @Project7NZ_eqnz, as well as the accounts of local electricity provider @OrionNZ and New Zealand earthquake update *Twitter* bot @geonet; should there be yet further major earthquakes in the Christchurch region, it remains to be seen whether any of the new accounts present in the top twenty during this latest event will be able to maintain their position, and should therefore be seen as genuine additions to the *Twitter*-based crisis communication ecosystem in Christchurch and New Zealand.

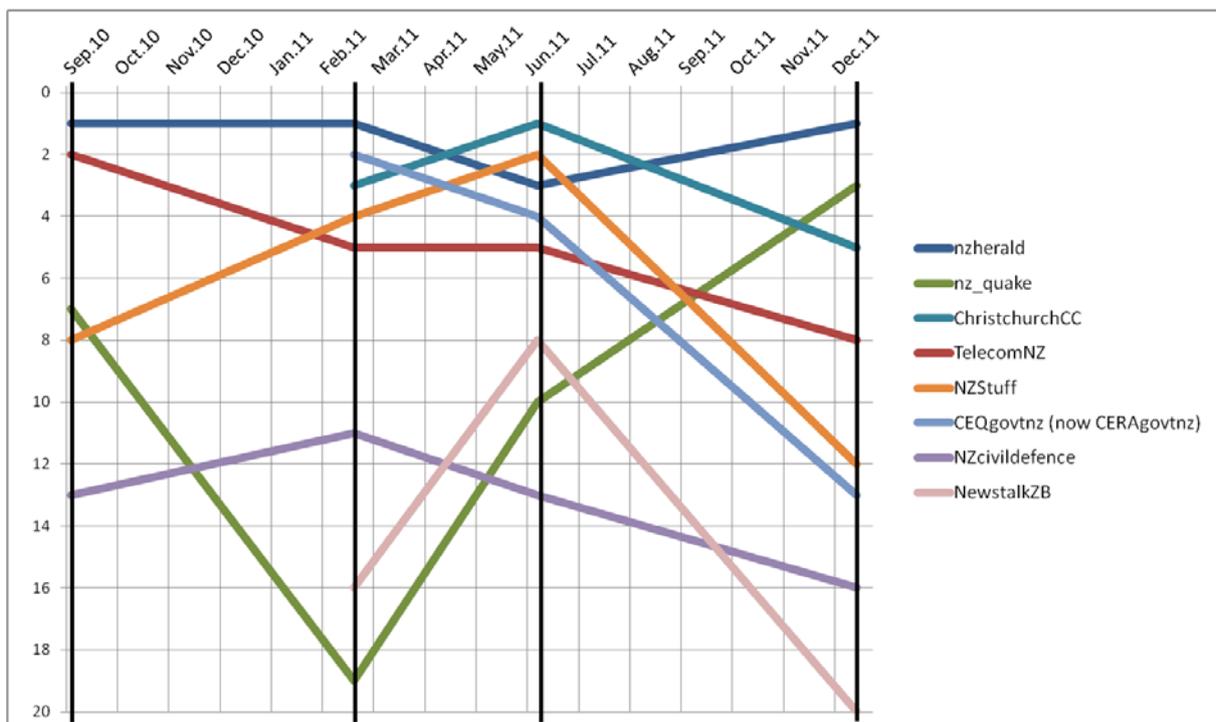


Fig. 8: ranking of leading *Twitter* users by visibility in #eqnz (counting @replies and retweets received), for the earthquakes on 4 Sep. 2010, 22 Feb. 2011, 13 Jun. 2011, and 23 Dec.

Overall, what has emerged since the September 2010 disaster is a persistent group of *Twitter* accounts which will continue the process of sharing and discussing information in #eqnz even after more casual users cease to contribute to a significant extent: these leading accounts have become part of the overall emergency communication infrastructure, and their contributions are made widely visible, beyond #eqnz itself, especially through retweets of their messages by other users. It is likely that many users – including both directly affected local residents as well as others with a continuing interest in news from Christchurch – are now directly following a selection of these accounts, or continue to track the #eqnz feed. Beyond this, the greater awareness of these tools for crisis communication also means that even users who may have temporarily unfollowed #eqnz or its key contributors are able to quickly re-follow them in the event of a further disaster.

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