

No Misunderstandings During Earthquakes: Elaborating and Testing a Standardized Tweet Structure for Automatic Earthquake Detection Information

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ABSTRACT

Social media have proven to be useful resources for spreading verified information during natural disasters. Nevertheless, little attention has hitherto been devoted to the peculiarities of constructing effective tweets (and tweet formats), or to common users' comprehension of tweets conveying scientific information. In this paper, social scientists and seismologists collaborated in order to elaborate and test a standardized tweet structure to be used during earthquakes, expanding on the results of a quali-quantitative research project. The tweet format is specifically designed to launch an innovative information service by Istituto Nazionale di Geofisica e Vulcanologia (INGV): tweeting the automatic detection of earthquakes with a magnitude greater than 3. This paper illustrates the steps of the research process that led to elaborating a tweet format that will be used in the next few months by the official Twitter account @INGVterremoti.

Keywords

Automatic detection, earthquakes, Twitter, tweet comprehension, tweet syntax

INTRODUCTION

The use of social media is emerging as a powerful tool for disseminating trusted information about earthquakes. Since 2009, the Istituto Nazionale di Geofisica e Vulcanologia (INGV) has increased its presence on social media, in particular on Twitter, YouTube, Facebook, Wordpress. The Twitter account @INGVterremoti provides constant and timely details about seismic events detected by the Italian National Seismic Network and felt by the population. After an earthquake is detected, as soon as the automated location is reviewed by a seismologist, the seismic parameters are posted on the INGV websites (cnt.rm.ingv.it and iside.rm.ingv.it) and tweeted by @INGVterremoti. Even though it is an automated system, it is directly monitored by seismologists on duty for seismic monitoring of the whole country. After the 2012 seismic sequence in Northern Italy, the account was awarded a national prize (Macchianera) as the "most useful Twitter account" as voted by the users. Currently, it has more than 122,000 followers (and is around the 400th Italian most followed Twitter account).

Nevertheless, since it provides only the manual revision of seismic parameters, the timing (approximately between 10 and 20 minutes after an earthquake) has been under evaluation. Undeniably, mobile internet and social network sites require more rapid and "real-time" information, because the population mildly affected by seismic waves immediately starts online conversations asking for details of the event, sometimes complaining about the slow reaction of official accounts.

During the last 18 months, INGV tested the tweeting of the automatic detection of earthquakes with magnitudes greater than 3 (M3+), obtaining reliable results to be released 1 or 2 minutes after a seismic event. During the spring and summer of 2014, INGV, in collaboration with social scientists, carried out research aiming at evaluating readers' comprehension of the tweets, both considering the tweet format currently adopted by INGV, and several proposed options for tweeting the automatic detection of earthquakes. Both the construction of a standardized tweet

structure, and the analysis of tweet comprehension by users were particularly important in our context. First, as of now, @INGVterremoti provides an automated tweet information service, without specific human account "moderation," nor any community management activity (users will not receive any answer if asking for clarifications or further details). Second, the specific information provided (e.g. earthquake's magnitude, location in terms of latitude and longitude, depth, etc.) refers to a set of scientific knowledge which is not widespread among the population. Tweet comprehension by the general (Twitter) public is particularly relevant, considering both INGV's role as a public institution, and the lack of other institutional Italian Twitter accounts providing timely and verified information during earthquakes.

Our goal is to improve tweets' effectiveness by introducing a standardized tweet format to be built according to research results (the proposed format is presented in the Conclusion section of this paper).

BACKGROUND

Research on the role of social media for disaster communication and management has adopted both a *bottom-up* perspective (focusing on emergent communication practices and on self-organizing processes, e.g. Starbird and Palen, 2011; White, Palen and Anderson, 2014), and a *top-down* perspective (focusing on institutional communication and emergency management processes, Hughes, St. Denis, Palen and Anderson, 2014; Giacobbe and Soule, 2014), sometimes able to foster a dialogue between researchers and practitioners (Hughes, Palen and Peterson, 2014).

While the construction of standardized and effective warning and alert messages in broader communication contexts has been analyzed by social scientists (e.g. Mileti, 1999), the peculiarities of producing tweets in crisis contexts have received far less attention. As Hughes et al. (2014) pointed out, "little research exists around the features and affordances of online media and how each can fit into an emergency management communication strategy."

More specifically, Twitter has often been analyzed with a focus on information

spread, influence dynamics, hashtag conversations, basic user metrics, both using quantitative and qualitative methods (see Weller, Bruns, Burgess, Mahrt and Puschmann, 2014), without specific attention to text structure; moreover, literature analyzing *Twitter syntax* has mainly addressed topics such as automated natural language processing (Han and Baldwin, 2011), and grassroots information filtering activities, including syntaxes allowing users to produce information “in machine readable form” (Starbird and Stamberger, 2010, p. 3; Starbird and Palen, 2011). Furthermore, even in the broader field of Internet Studies, a research and conceptual framework about user comprehension of social media postings has yet to be established. In this research, we only focused on user comprehension of @INGVterremoti’s tweets, without considering the broader topic of the standardization of messages coming from the public.

OUR RESEARCH PROJECT

Our research aimed at proposing a standardized tweet format for the account @INGVterremoti, expanding on the results of a quali-quantitative research project. More specifically, we focused on people’s comprehension of tweets, with special regard to messages spreading the automated detection of M3+ earthquakes.

In order to achieve this goal, we first conducted international benchmarking, analyzing the communication strategies and practices of relevant INGV counterparts. Secondly, we carried out 13 semi-structured interviews, including paper-based mock-up simulations, in order to reduce the variables to be tested with the survey, and also to obtain motivational and interpretation-related dimensions. Finally, we proposed a 51-question online survey. The main dimensions tested for user comprehension were the following:

- (a) the time format (UTC vs local time)
- (b) the label specifying the “provisional” nature of the data (i.e. that the tweet refers to the automated detection of earthquakes)
- (c) the best way to match the automated with the reviewed data in Twitter timeline

Moreover, we surveyed people’s (declared) information needs and expectations, as well as their information consumption practices, in the case of an earthquake.

RESULTS AND DISCUSSION

International benchmarking was conducted on 11 Twitter accounts reporting information about single earthquakes and indicated as relevant by INGV’s experts. The accounts were: @Emergenza24, @earthquakeBot, @QuakeReports, @NewEarthquake, @eqtw, @USGS_EQ_CA, @LastQuake, @emsc, @geonet, @INGVterremoti. Many accounts belong to private subjects or companies, others are managed by government agencies.

The analysis was conducted in 3 steps. Each step has been exemplified with two tweets from @earthquakeBot (1) and @eqtw (2).

Step 1: A tweet was selected and transcribed

1a) A 6.0 magnitude earthquake occurred in Solomon Islands. Details: <http://eqbot.com/xQs> Map: <http://eqbot.com/xQa>

1b) 6 – SOLOMON ISLANDS: Date: fri, 04 Apr 2014 11:40:32 UTC Lat/Lon: -10.5303/161.672 Depth: 63.77 <http://on.doi.gov/1j9OMSQ>

Step 2: Tweet syntax was extracted by reducing raw information to labels, as variable names. For instance, if the earthquake location was indicated as “BAJA CALIFORNIA, MEXICO” this information was transformed to “[AREA], [COUNTRY].” Some conventions were followed: text outside brackets is fixed text, square brackets ([]) indicate a variable, curly brackets ({}) indicate optional data (i.e. they are not necessarily present), angle brackets (<>) indicate complex group of information, slash (/) indicates alternative data (for instance “[COUNTRY/STATE]” means the country name or the state name can be present), backslash (\) is used as escape character (i.e. it means that the following character – for example a square bracket – is not used as a conventional meta-character, but is actually present in the tweet).

2a) A [X.X] magnitude earthquake occurred <[XX.XX]mi N/S/W/E of [Area], [COUNTRY]>/<North/South/East/West of [Area]/<in [Area]. Details: [shorturl] Map: [shorturl]

2b) [X.X] – [AREA]: Date: [Day, DD Mmm YYYY] [HH:MM:SS] UTC/Lat/Lon: [XXX.XXX/XXX.XXX]Depth: [XX.XX] [shorturl]

Step 3: Different items from Step 2 were labeled according to the information type. For instance, “[AREA], [COUNTRY]” was transformed to “-location.”

3a) –magnitude –location –details –map

3b) –magnitude –location –date –time –geo_coordinates –details/map

In the following phase, information types, tweet syntax and lexical choices were analyzed in order to propose some dimensions that could help to distinguish different communication strategies. Three dimensions were considered to be more interesting.

Discursive/schematic format concerns adherence to a natural language syntax or, on the contrary, to a schematic model. It is based on presence or absence of prepositions, conjunctions and other syntactical connectors.

Common/technical language concerns the way some information such as earthquake magnitude, location and date are expressed. For example, intensity and/or magnitude can be indicated with numbers or verbal labels (“intensity weak” in @geonet).

As for referential/spectacular style, a “referential” tweet gives objective (and preferably measurable) information. A “spectacular” tweet tends to indulge in evaluations, emphasis and to treat the information more as “breaking news” than as scientific data. Indicators of spectacular style are:

- Qualitative judgments (“FORTE”, i.e. “STRONG”, instead of precise magnitude to indicate earthquake intensity, @Emergenza24)
- Graphical emphasis (“+++#FORTISSIMO #TERREMOTO”, i.e. “+++#VERYSTRONG #EARTHQUAKE”, @Emergenza24, where

repetition of “+” sign is intended to call attention of the user)

- Verbal emphasis on the information more than on the event (“BREAKING/UPDATE/LIVE”, @Emergenza24, where adjectives describe features of the news and not of the earthquake).

The last two indicators are related to Roman Jakobson’s “phatic” function of language: according to Jakobson (1960) we have a “phatic” function when language is used to establish, prolong or discontinue communication (or to confirm whether the contact is still there).

There could be a relation among the different dimensions, even if they have not been investigated. Spectacular style, for example, seems to be consistent with common language, where verbal labels are used more than technical measurements. Another aspect that still has to be investigated is if dimensions are somehow related to the subject type: governmental accounts seem to be more technical and schematic than private ones. This also implies a reflection on the different targets these Twitter accounts have: seismic experts, media, citizens, enthusiasts.

Such dimensions have been taken into account in order to formulate the first prototypes of tweet formats to be further tested. More specifically, according to INGV’s identity and goals, the proposed formats are oriented towards “schematic format,” “technical language,” and “referential style.”

In May and June 2014, we conducted 13 semi-structured interviews involving 8 male and 5 female social media users currently living in Rome, Italy. Respondents’ age varied between 23 and 49, with a prevalence of under 35. Their educational level was medium-high (only one respondent had no University education); none of them had a specific seismological background. The reduced number of respondents was consistent with the exploratory nature of this part of the research; moreover, we stopped recruiting respondents as soon as we reached *saturation*.

In order to reduce the dimensions to be tested through the questionnaire, we introduced several paper-based mock-up tweets, asking respondents to explain in their own words the meaning of each single tweet. For each evaluated dimension,

we produced between 3 and 5 different tweets (aiming to provide the same information with different formats); after having explained the intended meaning of each set of tweets, we also asked respondents to express their preference (in terms of effectiveness). We also investigated more general topics, related to the kind of information they were looking for in case of an earthquake, also underlining respondents' motivations and interpretative patterns.

The first dimension aimed at stressing the “provisional” nature of the data presented by the tweets. In doing so, we proposed several labels, such as “automatic” (automatic), “stima provvisoria” (provisional estimate), “preliminare” (preliminary), “stima preliminare” (preliminary estimate), “dati preliminari” (preliminary data). The first point we need to underline was that the majority of respondents understood this set of tweets as “forecasting” an earthquake. As a result, we proposed an additional new label to be tested through the questionnaire (“registrato... di mag stimata...,” “registered... estimate magnitude”); we also decided to include in the questionnaire the 2 labels that were clearer, as users pointed out that “estimate” was central for understanding the intended meaning (“stima preliminare/preliminary estimate,” and “stima provvisoria/provisional estimate”).

Moreover, we tested the time and date format. As @INGVterremoti uses the U.S. date format (mm-dd-yyyy) and UTC time format, we included them, along with local time (CET) and date (dd-mm-yyyy) format. None of the respondents were able to understand U.S. date and UTC time formats, while just a couple of them recognized the label “UTC” as signaling “time zones,” without being able to translate it into local time.

A third dimension aimed at examining the most effective position for the label “provisional estimate” (or equivalents) within the tweet. According to effective (web) writing principles, our respondents agreed that the label was more visible at the beginning of the text. We decided, therefore, not to test this dimension through the survey, proposing to INGV to insert at the beginning of the tweet the information they value the most (be it this label, or the hashtag #terremoto – i.e. earthquake).

The fourth dimension aimed at evaluating the best way to match the automated

with the reviewed data in Twitter timeline. In order to test this, we used an experimental private Twitter account that was already proposing the automated data to very few INGV researchers. All the respondents experienced severe issues in finding the reviewed data starting from an automatic tweet: the only clues that proved to be useful were time and region, while the earthquake ID code provided by each tweet was totally ignored by them.

Building on interview results, we created a 51-question survey posted online between July 28 and September 12, 2014, and was promoted through social media and INGV's blog, obtaining 1224 completed responses. As the sample was autoselected, it cannot be considered representative of the whole Italian population: our respondents were disproportionately male (67% vs 33% females), and disproportionately well-educated (43.3% held a University degree, 4.5% a PhD, with 8.1% holding a degree in seismology-related disciplines); their mean age was 41; 72% were already followers of @INGVterremoti on Twitter. Therefore, we can assume that our respondents were more interested in earthquake related Twitter information than the average population. For instance, in case of an earthquake, 74% declared they would look for information on INGV's website, while 57% would turn to Twitter.

Respondents showed high levels of interest in obtaining “quasi real-time” earthquake-related information on Twitter. Namely, 92% considered it important or very important (4 or 5 on a 1-5 scale) to get official information within 2 minutes after a shake. Moreover, 81% preferred the combination of the automated and the revised tweet, 15% preferred receiving only the automated tweet, while only 4% preferred only the revised tweet; only 4 out of 1224 respondents declared preferring that INGV gave out no information at all on Twitter.

In case of an earthquake, the most relevant topics were the following (items receiving 4 or 5 on a 1-5 scale of “importance”): affected district (94.2%), exact epicenter location (latitude/longitude, 87.9%), damages to buildings and/or injured people (79.8%), approximate magnitude range (77.1%), casualties (74.7%), exact magnitude (71.1%).

UTC time format constituted an issue for Italian respondents: only 39% were able to identify the correct local time starting from UTC time; the percentage was

slightly higher among @INGVterremoti followers (42.4%), who were already used to such notation; around half of the users who had a higher knowledge of seismology (as tested with a 0-2 index) correctly dealt with UTC format (51.7%).

The labels to indicate the “provisional” nature of the data were tested with regard to both user comprehension and user preference. Tested labels were: (1) preliminary estimate; (2) provisional estimate; (3) registered... estimated magnitude. Results appeared goal-specific: label 3 was the most effective in communicating that “we can reasonably state that an earthquake occurred etc.” (96% of respondents correctly identified this answer, while label 1 obtained 88% and label 2 89%); moreover, it was the best label to avoid users from incorrectly identifying the data as “forecasting” a future earthquake (96% vs 90% and 94%); however, it was the least effective in communicating the provisional nature of the data (65% vs 90% and 93%). Moreover, respondents’ preference, which was asked after explaining the intended meaning of the tweet, went to label 2, followed by labels 3 and 1.

The numeric code (#INGV3355261) that was introduced to match provisional with revised tweets proved to be ineffective: only 28% of respondents correctly identified the revised tweet using the code, while 61% correctly identified it was based on district, magnitude and time. Overall, matching provisional and revised tweets appeared problematic: only 18% were “certain” they identified the correct match, while 35% believed that “it is complicated to identify the correct match.”

CONCLUSION

Results showed that respondents highly valued timely official information on Twitter, in the case of an earthquake: therefore, the launch of the automatic tweet seems to respond to a relevant user need.

The automatic tweet format has been built, and approved by INGV, according to the survey’s results. More specifically, respondents’ preferences about the information they value the most, in case of an earthquake, served as guidance for elaborating tweet syntax, in terms of topic choice and order of topics within the tweet (according to effective web writing principles suggesting to insert the most

relevant information at the beginning of the text).

Local time was chosen, instead of UTC time; the label “provisional estimate” was chosen as INGV valued the provisional nature of the data as the most important information to be conveyed, in order to avoid misunderstandings in case of differences between the provisional and the final estimate. The initially proposed numeric code for identifying the revised tweet was abandoned; instead, hashtags related to the earthquake location were proposed for magnitude 4 and over.

Therefore, the proposed format is:

```
\[STIMA PROVVISORIA] #terremoto {zona} [PROVINCIA] Mag tra [X.X] e [X.X] alle [HH.MM] IT del [DD-MM-YYYY] wp.me/pQI3O-1vJ{#terremoto[REG]}
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\[PROVISIONAL ESTIMATE] #earthquake {zone} [AREA] Mag between [X.X] and [X.X] at [HH.MM] IT on [DD-MM-YYYY] wp.me/pQI3O-1vJ{#earthquake[REG]}
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An example of tweet written in the proposed format is the following:

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[STIMA PROVVISORIA] #terremoto zona Reggio Calabria Mag tra 4.2 e 4.6 alle 12.26 del 15-01-2015 wp.me/pQI3O-1vJ #terremotoCAL
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The final version of the format is currently under internal approval by INGV. The provisional estimate of the magnitude will be expressed through a range (between... and...), which will be determined by INGV’s heads based on statistical analysis.

The tweeting of the automatic detection of earthquakes with M3+ should be open to the public in spring 2015. Further investigations of users’ reception of the service, and of the proposed format, will be carried out by our team.

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