Earthquake Report – a worldwide earthquake and volcano real-time reporting platform

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SUMMARY:

Since mid-2010, earthquake-report.com has presented socio-economic information news on all felt and damaging earthquakes and volcanoes in real-time and multiple languages. The beauty of earthquake-report.com is that an earthquake in Papua New Guinea, for example, is given as much analysis as one in Japan. The added bonus of the use of the historical damaging socio-economic earthquake and volcano information of CATDAT makes this tool of use to the worldwide natural disaster community. In addition, the full earthquake analysis is presented through the use of all country-based and provincial seismological bureaus and news services in addition to on-the-spot reports from social media. Each article is validated by a dedicated group of earthquake engineers, seismologists and earthquake and volcano enthusiasts. Detailed annual reviews of earthquake and volcano losses are also presented. The potential of earthquake-report.com has been seen through its Twitter, Facebook and other social media users and will continue to expand.

Keywords: CATDAT, Socio-economics, casualties, economics, earthquake-report.com

1. INTRODUCTION

Since mid-2010, www.earthquake-report.com has presented socio-economic information news on all felt and damaging earthquakes and volcanoes in real-time and multiple languages. It was founded by Armand Vervaeck, who saw the need for a dedicated earthquake reporting site through the Haiti 2010 earthquake when there was a lack of credible earthquake information being produced on the web and a lack of awareness in the tourism industry of earthquake threats.

Since then, earthquake-report.com has grown into the largest earthquake news reporting site combining seismological information, socio-economic impacts and analysis and social media to produce dedicated articles for every potentially dangerous earthquake.

The earthquake-report.com and CATDAT rating system of historic earthquakes is also produced to show the relative danger level and damage level of each earthquake in real-time. A "Have you felt it?" service has been employed for all worldwide earthquakes and volcanoes, with exceptional results. The added bonus of the use of the historical damaging socio-economic earthquake and volcano information of CATDAT makes this tool of use to the worldwide natural disaster community. Situation reports for major events using insight from full earthquake analysis are presented through the use of all country-based and provincial seismological bureaus and news services as well as on-the-spot reports from social media. The seismological data are presented in various forms.

Each article is validated by a dedicated group of earthquake engineers, seismologists and earthquake and volcano enthusiasts, many of whom support the site through reports, news and aid. Examples of some of the parameters that are presented for each earthquake include: on-the-spot death, injury and homeless tolls; building and infrastructure losses; economic losses; and rapid loss estimates - from news, national disaster management, fire and police department agencies and other sources. In addition, data on the building inventory, living conditions, exposed population and earthquake risk of the earthquake location are presented. Earthquake-report.com has used over 80 languages so far to gather reports, including Amaric for Eritrea, and asks supporters of the site for translation help when needed to bring the information to the public. The information is presented in English and is then automatically translated using Google into 20 languages for the public. Where possible, translators help the site.

The beauty of earthquake-report.com is that an earthquake in Papua New Guinea, for example, is given as much analysis as one in Japan. A case study of the effects of the Tohoku earthquake in 2011 and the Biem Island earthquake in 2011 are both discussed from the events reported on recently in this paper.

Detailed CATDAT annual reviews of the damaging earthquake and volcano socio-economic losses have been published giving global context, including comparison of the year's losses with historical losses. Twitter and other such social media tools are used in many cases as the earthquake and volcano detector, even before analysis comes through online from the usual earthquake reporting services. The potential of earthquake-report.com has been seen through its Twitter, Facebook and other social media user networks and will continue to expand in the coming years. Over 9,000,000 pageviews have occurred since the start of 2011.

2. THE GOALS OF EARTHQUAKE-REPORT.COM

Earthquake-report.com is the information part of SOS Earthquakes, a non-profit organization specializing in earthquakes, with 5 important goals:

- bringing the best possible, highest quality earthquake information, including CATDAT data.
- providing free or cheap technology tools for mass media (QuakeSOS iPhone application)
- providing Quick and Structural aid to earthquake victims all over the world (still to be organized)
- giving rational, unbiased, geophysical, seismological, engineering and scientific earthquake details.
- working on earthquake preparedness and prevention.

Earthquake Report also supports QuakeSOS, the earthquake emergency iPhone Application.

Earthquake-report.com bridges the gap in-between science and basic understanding. News in the site not only appears very quickly, but attempts are always made to present “Added Value” and “Scientific/Social Insight” news that you will not find anywhere else, as well as data from CATDAT indicator, socio-economic, loss and damage databases (Daniell, 2009-2012). SOS Earthquakes and Earthquake-report.com were founded in August 2010 and use damage data from over 12000+ damaging earthquakes through the CATDAT Damaging Earthquakes Database (Daniell, 2003-2012, Daniell and Vervaeck, 2012a).

Each damaging earthquake reported on includes many parameters, including seismological information (magnitude, hypocenter, intensity, spectral values) from many different agencies, building damage data (damage levels, important infrastructure etc.) from local and international newspapers, disaster management agencies and additional sources, ranges of social losses (deaths, injuries, homeless, and affected) from each available source, and economic losses (direct, indirect, aid, and insured) (Daniell et al., 2011b). It also includes additional analysis undertaken through the rapid earthquake loss estimation software, EQLIPSE (Daniell, 2011a). For each dangerous earthquake, the database is used to give details of the nearest historic earthquakes and also the possible impacts in the area where appropriate. A process diagram is shown in Fig. 2.1.

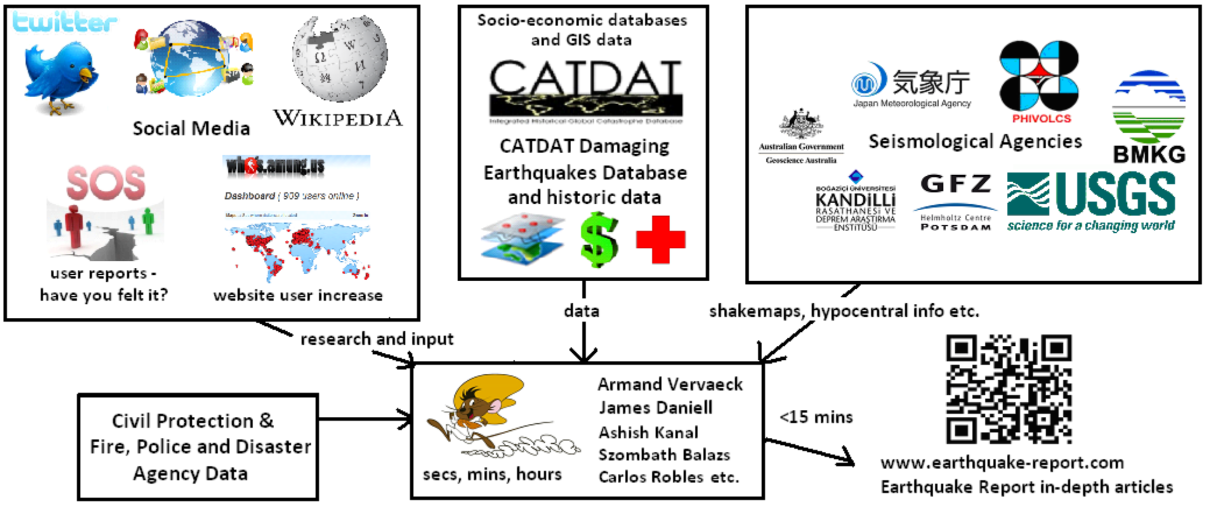

Figure 2.1. The Process used in creating an earthquake report (As of 2012, real-time components are used).

2.1. The Earthquake-report.com rating system of earthquakes

In conjunction with the CATDAT damage rating system explaining the final losses of earthquakes in terms of colours and numbers explained in Daniell et al. (2012b), the Earthquake-report.com system refers to a relative or absolute amount of danger from an event, given the initial hypocentral information. This methodology makes use of all available rapid earthquake loss systems worldwide in order to bring the information about the earthquake as fast as possible to the public. The system runs in over 20 different languages.

Table 2.1. The Earthquake-report.com Word Ranking System for earthquake danger

Classification	Criteria
Green	Not Dangerous –no physical danger
	• Felt earthquakes with Intensity exceeding II-III • Earthquakes of minor interest • Earthquakes with magnitude greater than 4.0. • Highly unlikely to produce a CATDAT Damaging Earthquake
Orange	Moderate Danger, Minor Danger of a damaging earthquake
	• Alert from PAGER, GDACS, QLARM, CATDAT EQLIPSE or seismological agency shakemaps (EMSC, BMKG etc.) show that a population will experience an intensity V (MSK, EMS or MMI) or greater. • Alert from GDACS shows Orange. • Similar historic earthquakes have given some form of damage. • The earthquake occurs at shallow depth within 10km of a major urban centre with population greater than 10000, with a magnitude greater than Ml4.0 or ground motion exceeding possible damaging level. • An earthquake occurs in a worldwide location where panic is likely to occur due to risk perception, uncommon earthquakes etc.
Red	Very Dangerous, Disastrous
	• Alert from PAGER shows a Yellow, Orange or Red rating for Social Losses. • Alert from PAGER for Economic Losses is in Orange or Red for all nations, and Yellow for nations with a GDP less than $100 billion USD (2011). • Alert from QLARM shows Fatalities and/or Injuries. • Alert from EQLIPSE shows fatalities or injuries to be produced or economic losses exceeding 0.003% of GDP. (Daniell, 2011a) • Alert from any source shows collapsed structures, mass evacuations, homelessness, major economic losses, fatalities or injuries. • Alert from GDACS shows Red or an Orange deemed to be a major alert. • Similar historic earthquakes have caused damage exceeding CATDAT Orange. • Any earthquake bringing in the need for international assistance.

Catastrophe	Catastrophic (CATDAT Damaging Earthquakes Database - average of 3 per year)
	• Expected to be CATDAT Red or Catastrophe via any analysis (EQLIPSE or otherwise). • Through first news, social media report. • Any earthquake bringing in the need for major international intervention. • Ml7.0+ earthquake below a heavily urbanised area with additional Red or Dark Red ratings from all systems.

From 29th July 2010 to 24th April 2012, over 26000 earthquakes were looked at from seismological agencies such as USGS, EMSC, BMKG, GEOFON, GA, JMA and others. From this, 25447 Green ratings, 561 Orange ratings, 53 Red ratings and 5 Catastrophe ratings were given shown in Fig. 2.2.

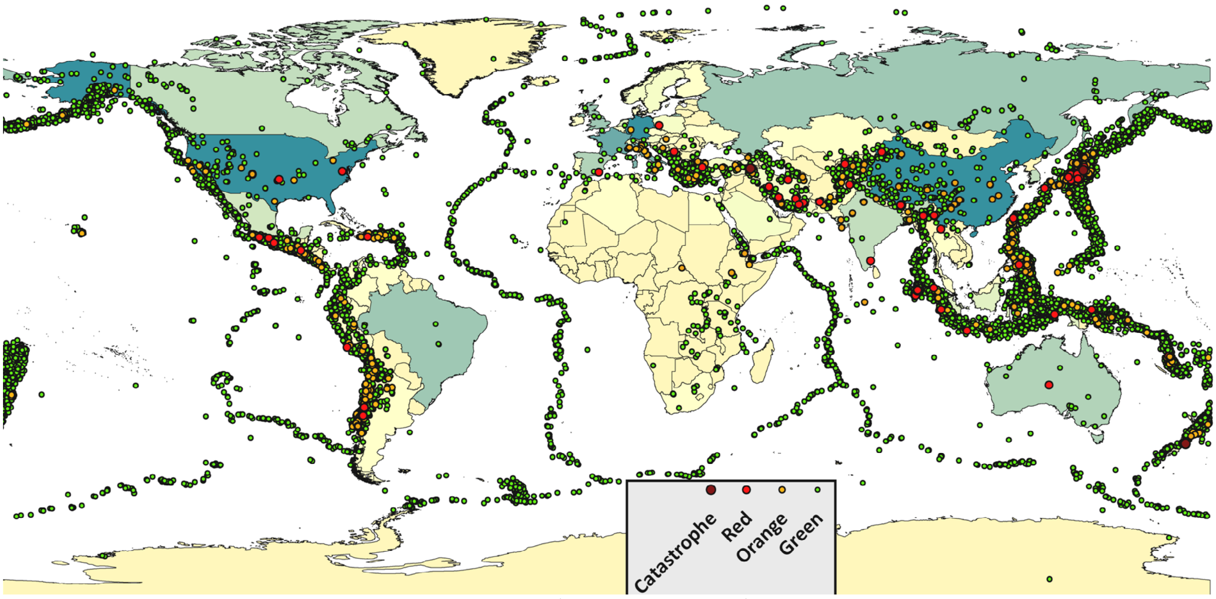

Figure 2.2. Earthquake Danger ratings from 29th July 2010 to 24th April 2012 on Earthquake-Report.com

2.2. Damaging Earthquakes documented by earthquake-report.com in 2010, 2011 and 2012

Since Earthquake-report.com was started, reports have been undertaken for over 500+ earthquakes. In addition, damage data has been collected for over 250 damaging earthquakes.

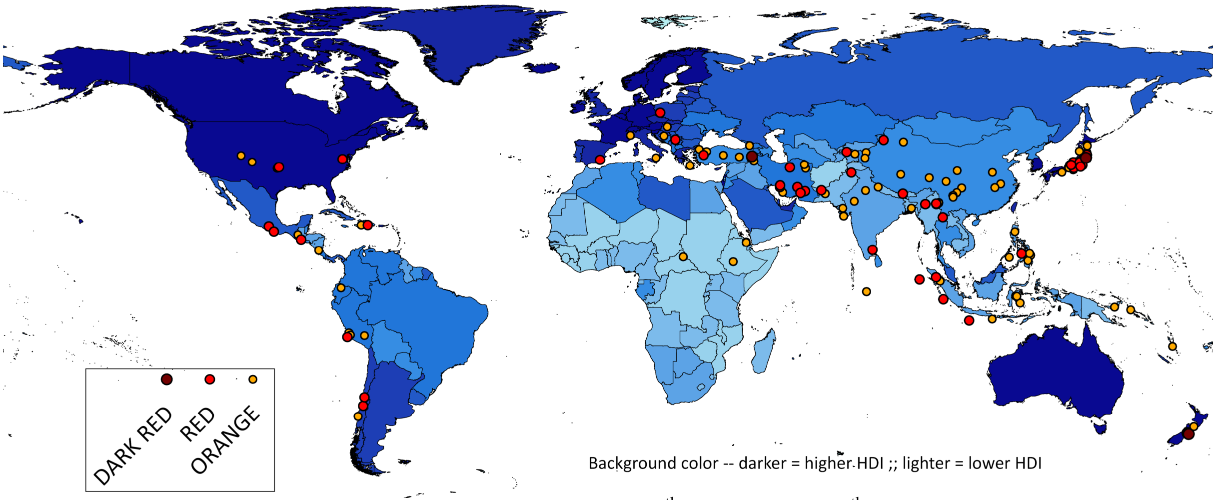

Figure 2.3. CATDAT Damaging Earthquake ratings from 29th July 2010 to 24th April 2012 reported in in-depth articles on Earthquake-report.com

Of these, around 170 earthquakes were entered into the CATDAT Damaging Earthquakes Database under the ranking criteria providing interactive input into this largest worldwide socio-economic earthquake damage database. CATDAT Orange indicates damage, CATDAT Red indicates a fatal earthquake or major economic loss, CATDAT Catastrophe indicates extreme damage, fatalities and/or economic loss. The details can be found in Daniell et al. (2012b).

3. CASE STUDIES OF BIEM ISLAND, PNG AND TOHOKU, JAPAN

In-depth analysis is undertaken to examine socio-economic loss and effect data and details for every potentially damaging earthquake. As an example comparison, two earthquakes with very different levels of information will be compared – Biem Island earthquake in Papua New Guinea on 31st July 2011 and the Tohoku earthquake in Japan on 11th March 2011, seen in Table 3.1.

Table 3.1. A comparison of the specifications of Biem Is., PNG, vs. the Tohoku, Japan, earthquakes

Parameter	**Biem Island, PNG (31-07-2011)**	**Tohoku EQ, Japan (11-03-2011)**
Magnitude	6.6Mw-6.8Mw	9.0Mw
Hyp. Depth (km)	5-10km, below Bam EQ	24, offshore
Max. Intensity Expected	IX-X	IX
Tsunamigenic	No	Yes (Pacific-wide)
Total damaged buildings	0	1182533 (129500 destroyed)
Fatalities	0 dead, 0 missing	15844 dead, 3451 missing = 19295
Injuries	0	5652
Homeless	0	Approx. 450000
Economic Losses (USD) incl. nuclear disasters	0	\$594.5bn (\$479bn-\$710bn) Total \$334.5bn (\$295bn-\$374bn) Direct
As a % of Nominal GDP (PPP)	0	12.66% (10.20%-15.12%) Total 7.13% (6.28%-7.97%) Direct
Population density in affected regions	Schouten Islands, East Sepik (6 volcanic Islands, 3 of which close) Biem Island (approx. 600/km^2), 2000 Kadover (approx. 100/ km^2), 300 Blup Blup (approx. 300/ km^2)	Miyagi (321/km^2), 2337513 (Sendai City (1305/km^2), 1031704) Fukushima (154/km^2), 2028752 Iwate (90/km^2), 1330530 Ibaraki (486/km^2), 2964141 Chiba (1203/km^2), 6201046
HDI (2011)	0.466 (153rd/187)	0.901 (12th/187)
Non-Income HDI (2011)	0.475 (157th/187)	0.940 (10th/187)

3.1. The Biem Island Earthquake of Papua New Guinea

One of the remotest earthquakes to be covered in 2011 was on Biem Island in Papua New Guinea. Earthquake-report.com has built a network of earthquake-interested readers as well as additional contributors. However, in some of the remotest parts of the world it is still difficult to gain accurate information into the effects of earthquakes. Regions in Africa, locations in Papua New Guinea and Iran continue to be the most difficult locations to gain credible reports. In addition, data from most islands without constant internet connections are also reasonably difficult to access. In these instances, phone calls, emails and any possible means are used to contact people who may have had information on possible impacts of the earthquake (or volcano).

The Earthquake-report.com website was the only source of information for this potentially very damaging earthquake, due to inaccurate existing population models from other alert systems, as the population was underestimated significantly from automated systems. Through the initial research done after each potentially damaging earthquake, the epicenter of the earthquake was only 6 km from Bam (Biem) volcano island, an island populated by approx. 2000 indigenous people, seen in Fig. 3.1. From the rapid loss PhD inventory, the building typologies are wooden, some with stilts, with reed and wooden roofs according to the worldwide building inventory developed as part of the study of Daniell (2011a). However, the worldwide building inventory is based on a level 1 approach with at most level 2 data; thus, local changes and differences in the building stock usually occur.

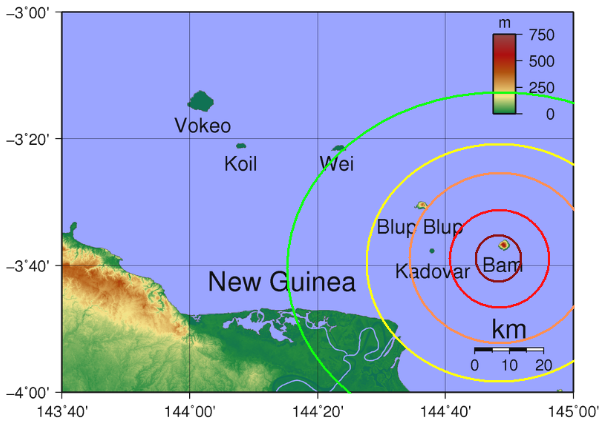

Figure 3.1. Left:- The Schouten islands impacted upon by this earthquake, Right:- Part of the local structures on Biem Island, as seen on QuakeTV.

The social media networks were alerted, our QuakeTV article on Youtube was put up and more information was sought about the building typologies, and the potential impacts. Contact was made through email with Jason Stuart, a missionary near Wewak on PNG, who had been to the island before. Another group of missionaries, the Buser family, were also located on Biem and helping the locals. Initially, a few of their Youtube videos gave us further insight into the building typologies:

"I have talked with some of the Biem people who were on the island when the earthquake occurred and they said the same as we had heard before–lots of shaking and no damage... The Biem people build using traditional materials–hardwood posts, section of coconut palm as bearers, and hardwood studs, with woven walls and thatch roofing, all of it tied together with vines. I suspect that the reason there wasn't significant damage is that things are fairly flexible. Our family usually lives in a village in the interior of East Sepik province where the house construction is similar. Unless there are rotten posts or bearers, it is very rare for these houses to collapse... my only guess is that the way the houses are tied with vines allows for a lot of "give and take"."

In addition, a few days later, further confirmation was given of no damage on the island from the Buser family, despite the probable ground shaking of 0.3-0.4g and an intensity X given by the USGS ShakeMap. The work done collecting the information from this earthquake showed the use of such a network and the great help of all of the supporters of earthquake-report.com. It also fills an important gap, giving earthquake engineering and seismological insight into earthquakes that would otherwise go unchecked. As well as this, it allowed a check that the earthquake was not to be entered into the CATDAT Damaging Earthquakes Database. Other earthquakes and volcanic eruptions were also covered in a similar fashion, including June 2011 Eritrea (Nabro) earthquakes and volcanic eruption, and the El Hierro volcanic eruption, showing the importance for earthquake-report.com to search, analyse and disseminate such information (Vervaeck and Daniell, 2012).

3.2. The 2011 Tohoku Earthquake and Tsunami

The Tohoku earthquake was the largest article string in www.earthquake-report.com, with over 1,000,000 views and constant coverage over the last year, including much added value in terms of analysis. Data from seismological agencies (mostly JMA and USGS) for the earthquake mechanism, PGV and ground motion data and aftershock information, from PTWC and JMA for the tsunami updates, from the local Japanese newspapers (NHK etc.) for initial ground information, from Twitter and other social media and from the CATDAT Damaging Earthquakes database for historic earthquake information were combined in the first minutes after the disaster into a data-driven article. TV telecasts were also used for the effects of the tsunami. These data culminated in the initial reports, along with the Earthquake-report.com Red Ranking.

From FDMA and NPA data, and data from the national fire and police agencies, up-to-date damage and casualty data were presented. This was converted into GIS format for easy viewing by the public and included excel spreadsheets of municipality level data available for public download in English, checked and validated, as seen in Fig. 3.2. This updated data continued to be provided over the next 6 months and proved useful to many catastrophe risk companies, insurers, capital return companies, banks and consulting firms.

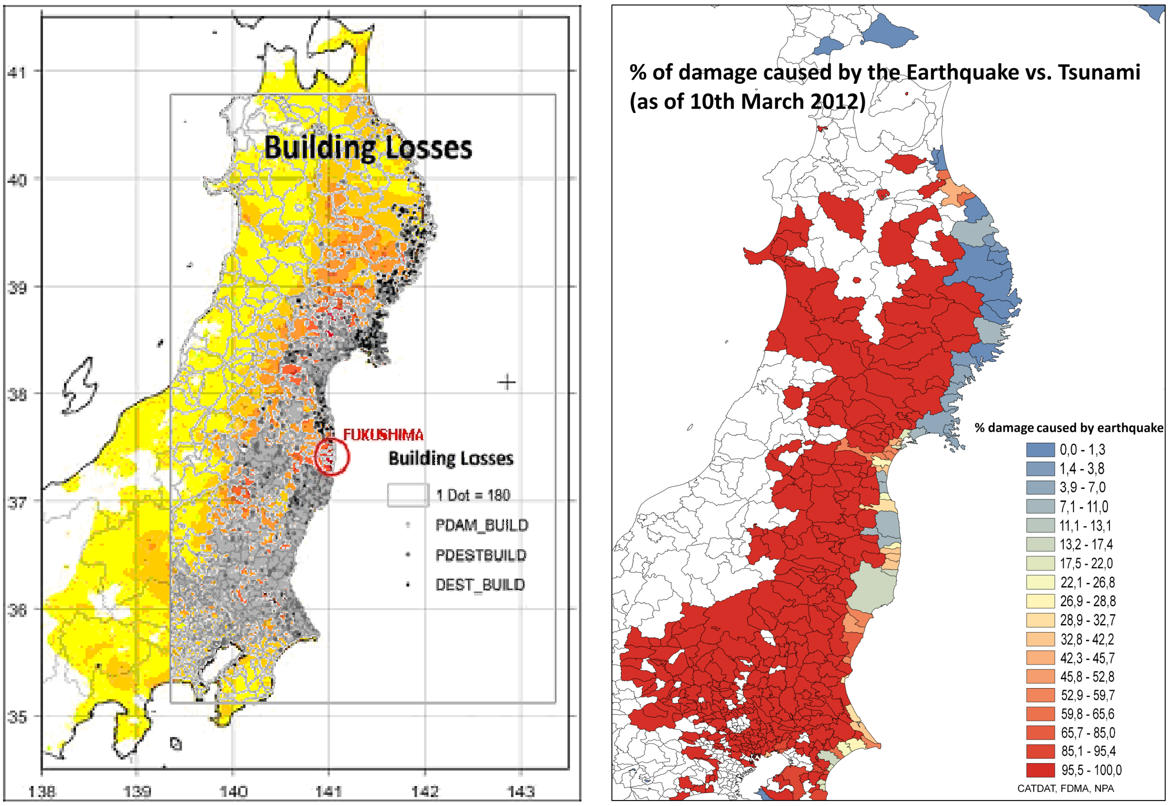

Figure 3.2. Left:-The JMA intensity map as compared to the building losses (grey = damaged, black = destroyed), Right:- The disaggregated earthquake versus tsunami damage in each municipality

Within 50 separate articles, each spanning a few days, and associated situation reports, a detailed update of damage data, economic losses and social impacts (homelessness, injuries, deaths) of the Fukushima disaster was given to the public. Much work was also done to analyse the sectoral losses, and to disaggregate the tsunami, earthquake and powerplant losses using information from each municipality to create non-coastal vs. coastal losses, as well as to use historical Japanese damage ratio data and tsunami inundation maps to further disaggregate losses in the coastal municipalities and plot the 1.2 million buildings damaged.

Approximately 70% of the capital stock is inland as compared to around 30% of the capital stock on the coast in the provinces of Miyagi, Iwate, Fukushima and Ibaraki, according to the Japanese Cabinet Office. Extrapolating the damage in other prefectures, the Japanese Cabinet Office estimate should be about $231 billion, once $23 billion loss in other prefectures is added. In addition, the estimate of the Miyagi Prefecture of incurred direct losses (incomplete as of 17/10/2011) is 11% greater than the original Cabinet estimate. With currency changes and this increase, the direct loss estimate from the Japanese government appears to be $271 billion (without the additional $58-71 billion expected from Fukushima as seen in Table 3.2) (Daniell et al., 2011f).

In the case of the 2011 Tohoku earthquake and tsunami, it is difficult to know the final discretisation of earthquake and tsunami losses; however, the possible outcome is about 39% economic losses due to tsunami ($127 billion) and 43% due to the earthquake ($144 billion), with about 18% due to the Fukushima disaster ($59 billion). Direct losses are in the order of $335 billion, with indirect losses around $260 billion expected with all impacts combined (Khazai et al., 2011). Without the tsunami, the earthquake would still have caused 40-45% of the total damage seen (Daniell et al., 2011d).

Table 3.2. Combined analysis of Japanese municipality economic loss as a result of the Tohoku earthquake, as produced on www.earthquake-report.com as part of the CATDAT Situation reports in conjunction with CEDIM

In Billion USD	Earthquake	Tsunami	Powerplant
Direct Loss Inland	77	0	30-41
Direct Loss Coastal	48-81	112-145	28-30
Total Direct Loss	125-158 (42%)	112-145 (39%)	58-71 (19%)
Indirect Economic Loss	69-132	64-113	51-91
Total Economic Loss	194-290 (41%)	176-258 (36%)	109-162 (23%)

It will also never be known how many died due to the earthquake, as separate from the tsunami; however, the autopsies give us an indicator that we can expect that about 1.4% of the 4.2% people crushed were probably in earthquake collapsed houses. By current NPA estimates, 91.4% of people drowned as a result of the earthquake. Using the municipality data in GIS, this value corresponds quite well to the 175 non-tsunami impacted deaths that have been recorded in the non-coastal areas. Some of the non-coastal municipality deaths, however, were due to heart attack, fire or landslide.

As of 13th March 2012, 16278 have been killed and 2994 are missing (19300 in total), according to FDMA. NPA estimates have been consistently lower, with the current 25th April 2012 death toll being 15857 dead and 3057 missing (18904 in total). Of the approximately 19100, around 650 are assumed to have died from earthquake-related stress and chronic disease. Around 265 should be earthquake-collapse related. Around 230 could be related to other causes, such as fire, landslides etc. This has made this earthquake the deadliest earthquake since work started in earthquake-report.com.

3.3. CATDAT-HiDE-Earthquake-report.com Damage Data Visualisation

Beyond the spectrum of reporting on earthquakes, the earthquake-report.com platform was used to launch a visualisation of natural disaster data from CATDAT for historic earthquakes, floods and volcanoes. Given the extensive CATDAT natural disaster socio-economic loss databases, this was an easy method for visualisation for the public to generate knowledge from the data and to the disseminate it. An evaluation exercise was undertaken evaluating the approach that HiDE takes to facilitating data exploration and sharing findings using Twitter. The example dataset includes 760 selected earthquake events, 200 volcanic events and 2700 flood events between 1988 and 2010.

HiDE is software that lets people construct information graphics using visual variables such as position, size and colour to encode data in different ways at different hierarchical levels. This makes various kinds of comparison possible. HiDE integrates with Twitter, enabling graphics to be shared along with short commentary about what the graphic tells us. HiDE can import and export graphics using the HiVE language. HiVE is automatically exported with every tweet. It can be copied and pasted to and from HiDE and used as a means to record, share, archive and recreate graphics produced at different times and by different people (Slingsby et al., 2011).

The Earthquake-report.com community was asked to take part in the following steps allowing for interaction between the users and the researchers:

- Download: the HiDE software and the CATDAT dataset
- Explore: by building successive graphics to reveal structure, compare patterns and generate insights into Natural Disaster losses in the last 22 years.
- Tweet: save graphics and comments to record your exploration and share your insights. You may also like to post graphics and comments onto your blog.
- Search: Use the #viztweet and #catdat hashtags on Twitter to find out what others are saying
- Discuss: Try out the graphics that others have built and respond to their comments.
- Feedback: Let us know how you got on by filling in our questionnaire.

This software allows graphics such as the following for visualisation of historical major losses from

1988-2010. Fig. 3.3 (left) shows earthquakes, floods and volcanoes ordered by the ISO3166-2 country code, coloured by the highest economic losses (darker=higher), and with box size showing the relative number of fatalities per year in the total disaster. The tsunami of 2004 dominates the losses, with the Kashmir (PK) 2005, Sichuan (CN) 2008 and Haiti (HT) 2010 earthquakes showing the highest death tolls; yet the highest economic losses are from Kobe 1995 and Sichuan 2008. In Fig. 3.3 right is a view of economic losses per month from earthquakes, floods and volcanoes. It can be seen that most flood losses occur between May and August, when the Asian typhoon season occurs. Similarly, this is the case for fatalities seen in red. Volcanoes and earthquakes show an expected random trend.

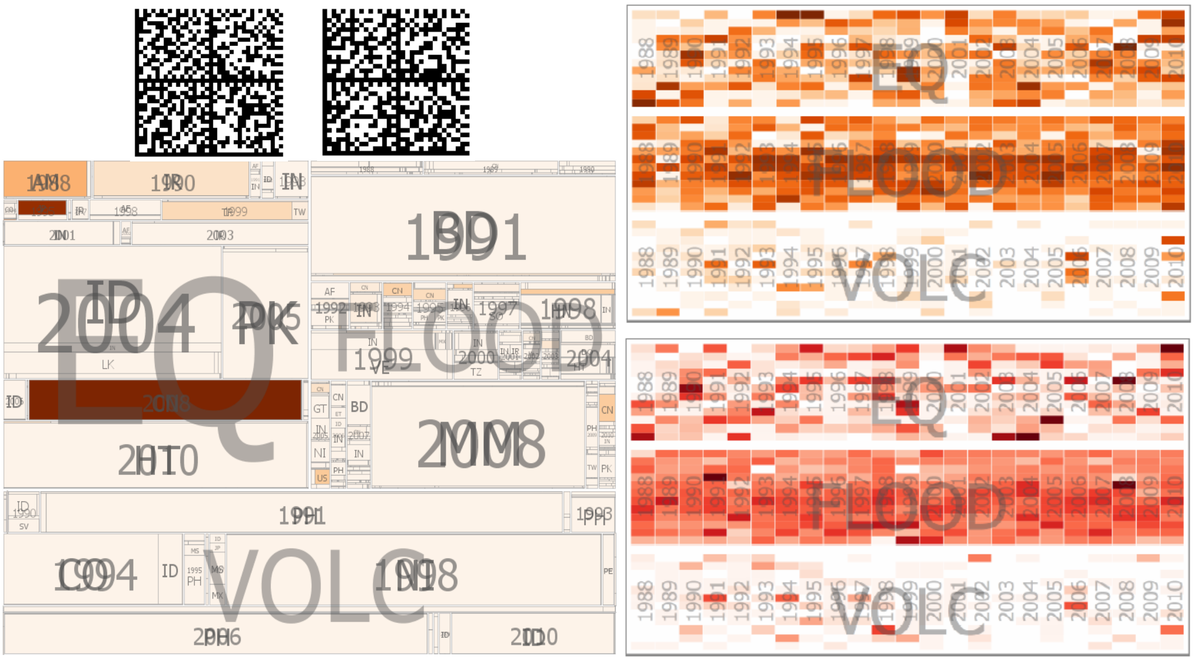

Figure 3.3. CATDAT-HiDE software outputs of earthquakes, floods and volcano losses from 1988-2012, including QR Codes – Left (Daniell and Slingsby, 2011c): Ordered by size (fatalities), colour (economic losses); Right (Slingsby et al., 2011): Upper -Economic Losses per month arranged by year, Lower -Fatalities per month

Unfortunately, the release of the software also occurred at the time of the Christchurch 2011 and Tohoku 2011 earthquakes, meaning that lower viewership occurred than otherwise would have been the case. However, this collaborative work between CATDAT, Earthquake-report.com, CEDIM, giCentre (City University London) and the Willis Research Network in evaluating interactive visual approaches for data analysis was just one way that earthquake-report.com has instigated synergy in the past 18 months. The intention in the future is for greater synergies to be built and for other interactive natural disaster projects to be promoted to the worldwide community.

4. CONCLUSION

The Earthquake-report.com website has grown significantly over the past 20 months, with exponential growth from each new damaging earthquake. The website provides much socio-economic analysis and information on each earthquake as well as methodologies using social media that allow for greater depth of data and reporting than ever before. The danger rating of earthquakes is shown once an earthquake has occurred, correlating very well with the damage that was seen, and also allowing the website users to gather a quick impression of an earthquake. Examples have been given of the Tohoku earthquake, showing the reporting and analysis undertaken where a wealth of information is available, in comparison to the Biem Island earthquake, the effects of which were only reported on by Earthquake-report.com, and very little information was available.

In addition, the potential of Earthquake-report.com to reach earthquake-interested users through research has been shown through the use of HiDE to view natural disaster losses. With each new earthquake, Earthquake-report.com will continue to report earthquake and volcano social and economic effects in the fastest and most accurate way.

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