“Did You Feel It?”: A Community-based Approach to Natural Hazard Assessment

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Abstract

India is a nation subject to a wide range of natural hazards. Our research focused on tectonically induced natural hazards including volcanoes, earthquakes, and tsunamis. Developing more efficient and effective methods of monitoring and reporting these natural hazards will enhance public knowledge of areas at risk. A qualitative, low-tech classification method such as the USGS Modified Mercalli index (MMI) has the potential to provide a more complete assessment of the spatial distribution and extent of damage caused by natural hazards because it works in areas that do not have seismic instruments. The 2004 Sumatra earthquake and the recent 2011 India-Nepal Border Region earthquake were chosen as case studies to demonstrate the nature of USGS MMI assessment. MMI responses from the USGS were georeferenced to map layers. The resulting maps provided an accurate assessment of earthquake intensity as a result of more egalitarian data collection methods. This sort of community-based data collection has potential to be utilized as an assessment tool for India’s other natural hazards.

Data Collection

- MMI data was extracted from the USGS “Did You Feel It?” report. 2011 earthquake data was obtained from the Indian Meteorological Department.
- Volcano location data was obtained from Global Volcanism Program Smithsonian Institution.
- India state and global country shapefiles were sourced from Furman’s GIS data network.

Methods

- Maps were created using ESRI ArcMap.
- USGS MMI “Did You Feel It?” survey responses were imported to ArcMap and georeferenced to a base map layer of India for figures 5 and 6. A multiple ring buffer was also used to better demonstrate response distribution concentrically from the epicenter.
- Figure 7 was generated by georeferencing data from the Smithsonian’s Global Volcanism Program and the India Meteorological Department.
- Timestamps for each response were recorded by the USGS, but were not reported on their website

Background

Seismic activity is related to volcanic eruptions. Although volcanic eruptions are not as prevalent on the mainland, earthquakes have a profound impact on India both historically and recently. The 2004 Sumatra earthquake occurred undersea when the Indian plate subducted beneath the Burma plate. The earthquake triggered a series of tsunamis (Figure 3), which reached the Indian mainland (see Figure 4). These tsunamis were responsible for the deaths of over 225,000 people across 12 countries.

The two major methods of earthquake classification are Moment Magnitude scale (MMS) and Modified Mercalli index (MMI). The Moment Magnitude is a quantitative scale that measures the energy released by an earthquake. The Modified Mercalli index is a qualitative way in which earthquake intensity is reported. This index classifies earthquakes into 12 different categories based on public observation of physical manifestations as a result of seismic activity (Figure 2). This index of seismic activity provides accessible information on earthquake intensity, regardless of the scientific or technical background of the individual. The United States Geological Survey (USGS) has used this scale since 1931 to monitor seismic activity around the world.

“Did You Feel It?” is a qualitative survey designed by the USGS for the general public to self-report perceived phenomena caused by earthquake activity. This survey collects online data from respondents who report on local seismic phenomena. Location, personal experience, and observable physical effects are all covered in the questionnaire and used to classify the seismic event on the MMI (Figure 1).

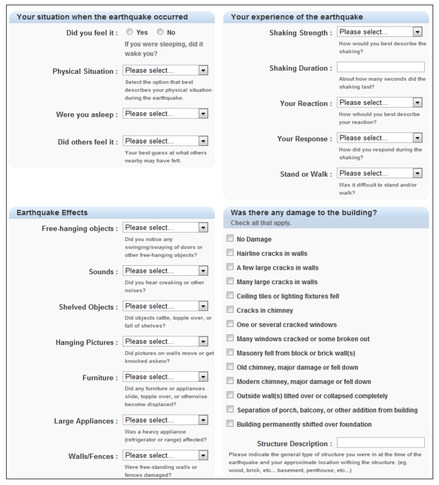

Figure 1: USGS “Did You Feel It?” self-report form. Reported qualities and location of the perceived quake event are fit to the MMI scale and provide qualitative and spatial information to characterize the earthquake.
Source: http://earthquake.usgs.gov/earthquakes/dyfi/form.php?network=us&code=2004slav&lang=en

Richter	Modified Mercalli	Effect
2	I	**Instrumental.** Not felt except by a very few under especially favorable conditions detected mostly by Seismography.
	II	**Feeble.** Felt only by a few persons at rest, especially on upper floors of buildings.
3	III	**Slight.** Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration similar to the passing of a truck.
	IV	**Moderate.** Felt indoors by many, outdoors by few during the day. At night, some awakening. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing motor cars rock noticeably.
4	V	**Rather Strong.** Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
5	VI	**Strong.** Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
	VII	**Very Strong.** Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in ordinary structures; considerable damage in poorly built or badly designed structures.
6	VIII	**Destructive.** Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of factory stacks, columns, monuments, walls. Heavy furniture overturned.
7	IX	**Ruinous.** Damage considerable in specially designed structures; well designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
	X	**Disastrous.** Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bend greatly.
8	XI	**Very Disastrous.** Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bend greatly.
	XII	**Catastrophic**. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Figure 2: Magnitude equivalents of the MMI scale. Source: http://www.cdera.org/doccentre/fs_earthquakes.php

Figure 3: Sumatra tsunami, Krabi Province, Thailand. Source: http://upload.wikimedia.org/wikipedia/commons/2/2d/2004-tsunami.jpg

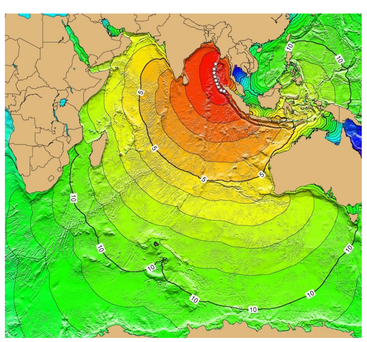

Figure 4: Map generated with Tsunami Travel Times (TTT) software calculated from the location of the 2004 Sumatra earthquake. Contours are in 1 hour time intervals from epicenter. Source: http://www.ngdc.noaa.gov/hazard/icons/2004_1226.jpg

Results

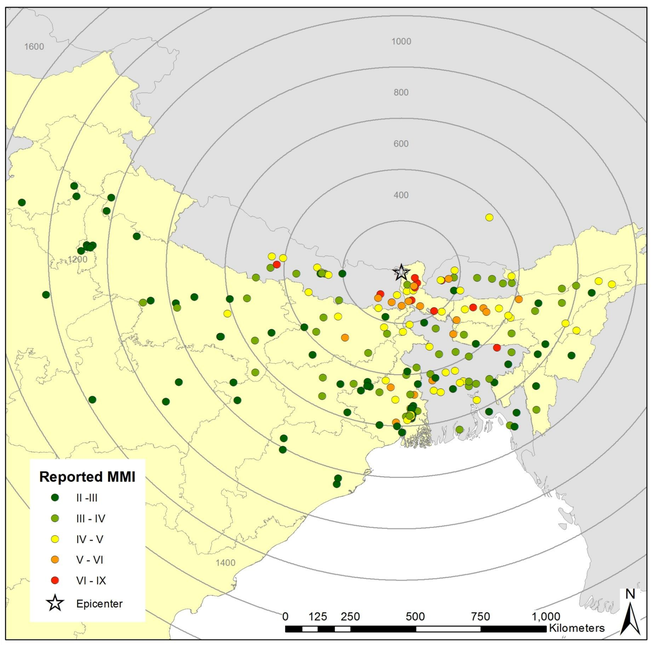

Figure 5: The India-Nepal Border Region earthquake occurred September 18, 2011, 06:10:48 PM local time. This event had a magnitude of 6.9 at a depth of 19 km and was classed as MMI IX.

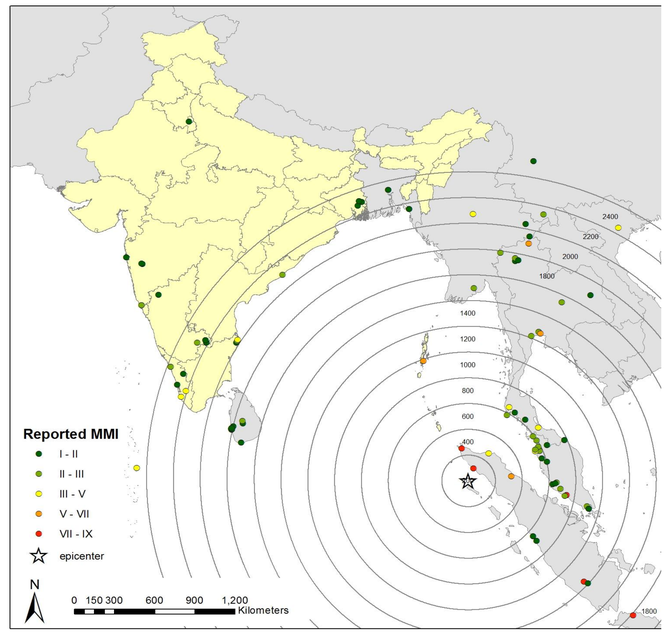

Figure 6: The Sumatra earthquake occurred on December 26, 2004 07:58:51 AM UTC at a magnitude of 9.1 and a depth of 30 km and was classed as MMI IX.

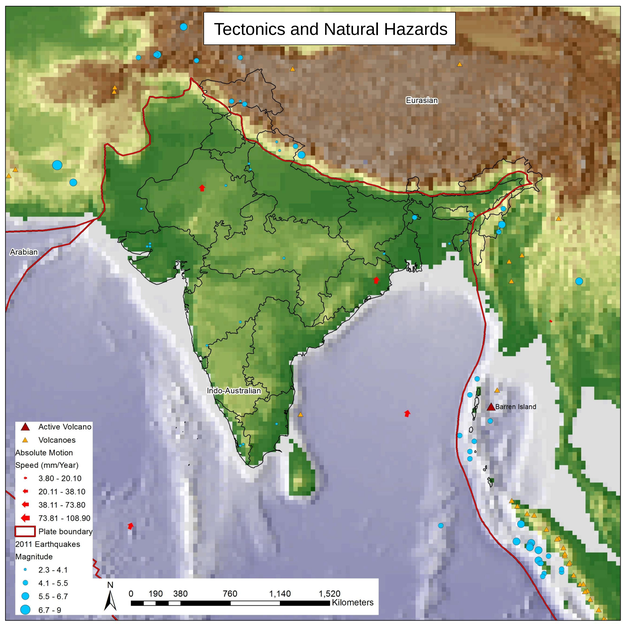

Figure 7: Map of earthquakes that occurred in 2011 and volcanoes proximal to India. Tectonic movement leading to seismic activity is also responsible for volcanic activity. There are three volcanoes in India, two of which are located in the Andaman & Nicobar Islands.

Discussion

Magnitude alone does not fully characterize an earthquake event, as this only measures the intensity of the event. The MMI scale is useful for characterizing earthquakes because it measures the destructiveness of seismic events since it includes property damage and physical manifestations of the event as perceived by witnesses.

The USGS’s “Did You Feel It?” assessment is useful in earthquake characterization. It is an important tool for connecting the nonscientific community with scientists. This type of online self-reporting survey is easily understood because it is written in accessible language to those inexperienced with science terminology.

However, use of this tool does require literacy as well as Internet access and knowledge of the USGS website. Urban areas (major cities) are more likely to report seismic events using this tool than rural areas. Responses are limited by a lack of temporal information. Responders will not always complete reports at the time of experiencing seismic activity. There is no timestamp on survey responses, which means that it is not easy to distinguish reports of initial seismic activity from aftershocks. This discrepancy may account for some anomalous patterns in aggregate MMI classifications. Additionally, this type of data collection is only possible on land and not from points in the ocean.

Greater participation is necessary to improve data coverage. Paradoxically, it is also important for people who do not perceive seismic events to report this lack of perception on the USGS website. This improves data coverage of seismic events.

This type of general population-based data collection could be extended to other types of natural disasters. People “on the ground” are more likely to have better information during an earthquake or other natural disasters than officials, and their responses may aid in better natural disaster planning and rescue efforts.

References

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Acknowledgements

We would like to thank Dr. Suresh Muthukrishnan and our India study abroad group.