Research Report

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We studied magnitude of completeness (M_c) and Gutenberg-Richter b-values variation with depth and space in the central Japan region for a period 2000-2012 using unified JMA catalogue. The events are selected in different depth intervals of 20 km from 0 to 100 km based on depth distribution. A number of polygons are selected for each depth interval based on the clustering of events. There are many methods and we applied maximum likelihood and stability of b values method for estimation of the M_c. The different values of the M_c found using different methods. There is no method for checking the reliability of estimated M_c. We proposed a graphical method by plotting the magnitude versus index for checking the reliability of estimated M_c. The method is quick, easy and found suitable in all the cases. From this method we found that the estimates of the M_c are lower and higher using maximum curvature and stability of b value method, respectively. The average of both the estimates provides a reasonable value based on the proposed method. The M_c estimation using the stability of b values is found sensitive to the missing events and higher values are found for larger missing interval. The M_c values are found to vary from 0.9 to 3.9 with lower and higher values correspond to inland and offshore region, respectively. In the inland region M_c vary from 0.9 to 1.7 depending on the location and depth interval. The higher value of the M_c between 3.1-3.9 is found for the southeastern offshore region.

These estimated M_c are further used for computing the b – values in the region. The lower and higher b-values are found for the northeastern and southeastern region, respectively for all the depth ranges. The b values are found to vary from 0.4 to 1.3. The b values are found to vary with depth which decreases upto a depth of 60 km and then increase for deeper depths. The same trend of b values is found before and after the Tohoku earthquake. The b values are found invariant with time.

The distribution of background and triggered events are important to understand the hazard estimates of a region. We study the distribution of triggered and background events in the central Japan, region. The background and triggered events are selected based on stochastic de-clustering method where the triggered and background events are defined based on the probability using space time ETAS model. The triggered events in the central Japan are found to be shallower than the background events.

We studied aftershocks of three large earthquakes in Japan region: (1) Hokkaido, September 25, 2003, M8.3, (2) Miyagi, August 16, 2005, M7.2 and (3) Tohoku, March 11, 2011,

M9.2. The variations of b values with threshold magnitudes are studied after these three earthquakes. The b values are becoming stable around one month after the Hokkaido and Miyagi earthquakes whereas it is unstable for a period of six month after the Tohoku earthquake indicating that smaller magnitude earthquakes are missing after the Tohoku earthquake at least for a period of six month.

The systematic shift in the magnitude of an earthquake catalogue is a common problem due to which it is difficult to find either earthquake catalogue is stationary or non-stationary. A magnitude shift may occur in a catalogue due to adoption of different procedure for estimating the magnitudes and adding new instruments in the network which measure different amplitudes of seismic waves. We generated synthetic earthquake catalogues of 500 events assuming different values of ETAS parameters and a constant b value equal to 1. The magnitudes of some of the events are shifted randomly by 0.1 to 0.2 to see the effect of such a change in a catalogue. A large error is observed in the estimated ETAS parameters due to such a shift. Further, stationary of the synthetic catalogue is studied based on Akaike's information Criterion (AIC) and change point is found significant corresponding to magnitude shift in the catalogue which indicates that stationary data sets become non-stationary for a non-homogeneous magnitude and vice-versa.

A 3-D ETAS model considering depth dependent behavior in ETAS parameters is developed and applied to the central Japan region. The 3-D ETAS model is a modification of earlier space time ETAS model which does not consider the depth component. The 3-D ETAS model will provide a better modeling of the seismicity in 3- dimension.

Delivered a seismicity seminar, submitted an abstract to AGU fall meeting - 2014, attended Japan Geoscience Union Meeting and presented a paper at 8th International Workshop on Statistical Seismology, Beijing, China. Provided peer review for the manuscripts submitted to different scientific journals almost one every month.

My stay at ERI was very fruitful and comfortable. I enjoyed excellent research environment at ERI which also gives an opportunity to have interaction with scientists from different parts of the world. My host Associate Professor Hiroshi Tsuruoka was very hospitable, easily approachable and discussion with him was always fruitful. The support received from the international office, Mrs. Satoi Itakura was remarkable.