Regional probabilistic seismic hazard assessment in Bangladesh

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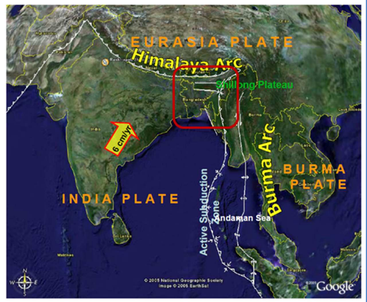
This presentation summarizes input data, procedures and results of probabilistic seismic hazard assessment (PSHA) in Bangladesh in the framework of the project 'Geo information for Urban Planning and Adaptation to Climate Change'. It is a cooperation of the Geological Survey of Bangladesh (GSB) and the Federal Institute for Geosciences and Natural Resources (BGR) of Germany. The main aim of the project is to provide city planners with "Ground Suitability Maps", which display different geo-factors. Seismic hazard is one of the geo-factors that contributes to these maps. For the derivation of "Ground Suitability Maps", the influence of the local underground conditions will be taken into account additionally. A major part of Bangladesh is located in earthquake prone regions due to active tectonics. The Indian plate moves north-eastward towards the Eurasian plate at a velocity of about 6 cm/year. This motion leads to thrusting to the north (Himalaya) and to subduction to the east together with strike-slip mechanism. The thrusting and subduction processes have caused large historical earthquakes even inside Bangladesh (e.g. 1885 Bengal Earthquake M7 and 1918 Srimangal Earthquake M7.6). Therefore, it is crucial to assess seismic hazard in urban planning in Bangladesh. The input databases were compiled from the literature, reviewed and evaluated in this study. These are earthquake catalogs, the distribution of active faults and ground motion prediction equations. The most consistent and reliable databases were selected to be used in PSHA. The data of the earthquake catalog were declustered to eliminate the duplicated events, aftershocks and foreshocks. The spatial distribution of areal seismic sources was characterized using the distributions of earthquakes in the catalog and active faults. The completeness analysis of the earthquake catalog was performed and the Gutenberg-Richter magnitude recurrence distribution was derived for each seismic source. The results of PSHA are presented in the form of peak ground acceleration (PGA) maps with 10% exceedance probability in 50 years. As usual in regional PSHA, the results were compiled assuming bedrock as underground condition (so-called engineering bedrock with shear velocity of Vs30≥760 m/s). The northern and eastern parts of Bangladesh show the highest seismic hazard with PGA around 0.4 g with 10% exceedance probability in 50 years. This observation was expected because of the active tectonics in these parts.

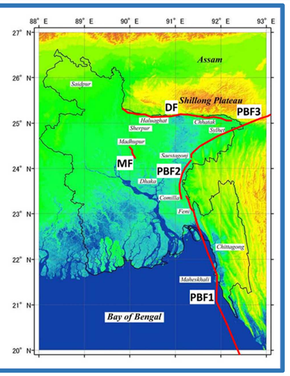
Tectonic situation

The Indian plate moves north-eastward towards the Eurasian plate with a velocity of about 6 cm/year. This motion leads to thrusting to the north (Himalaya) and subduction to the east together with strike-slip mechanism.



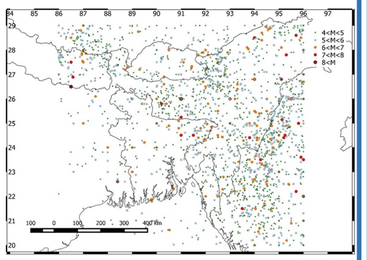
Active faults

Five active faults were identified in Bangladesh in CDMP (2009) by interpretation of satellite photos:
Madhupur Fault (MF)
Dauki Fault (DF)
Plate boundary 1 (PBF1)
Plate boundary 2 (PBF2)
Plate boundary 3 (PBF3)
CDMP: Comprehensive Disaster Management Program



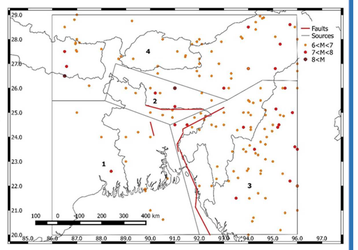
Earthquake catalog

The earthquake catalog of Kolathyar and Sitharam (2012) was selected, as the magnitude scale of this catalog is uniform in terms of moment magnitude.
Declustering: The duplicated earthquakes, the aftershocks and foreshocks were removed from the earthquake catalog (Gardner and Knopoff, 1974).



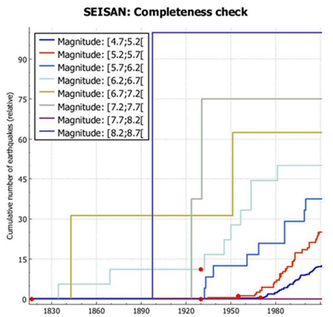
Spatial distribution of areal seismic sources

The areal seismic sources were characterized based on the clusters of major events and tectonic features.



Completeness analysis

The magnitudes were divided into magnitude classes and the period of completeness was identified for each magnitude class of each seismic source (Stepp, 1972).
The earthquake catalog is complete from the point of time from which the cumulative number of earthquakes increases at an evidently larger rate than that in the previous periods.



Source 2

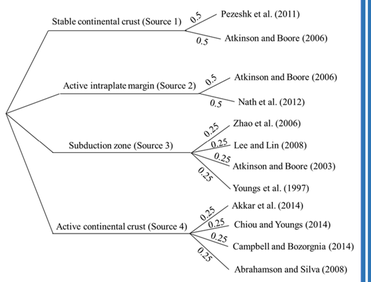
Gutenberg-Richter magnitude recurrence model

The Gutenberg-Richter parameters of each seismic source were determined based on the method of Weichert (1980) which considers the case of an incomplete earthquake catalog. In this method the events of each magnitude class are distributed in the completeness period.

	Activity rate (1/year)	b	M_{min}	M_{max}
Source 1	5.4	1.20	4.7	7.7
Source 2	4.7	1.00	4.7	8.6
Source 3	31.4	0.90	4.7	8.0
Source 4	26.1	0.99	4.7	8.3

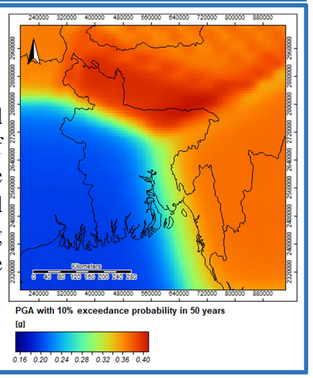
Ground motion prediction equation (GMPE)

The GMPEs were taken from Haque et al. (2020). They are based on the verifications using regional data in Nath and Thingbaijam (2011).
The updated versions of four GMPEs in Haque et al. (2020) were used in the present study.



Results: Regional PGA map

The northern and eastern parts of Bangladesh show the highest seismic hazard with PGA around 0.4 g with 10% exceedance probability in 50 years.



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