Extended Abstract DOI: https://doi.org/10.64862/ajeg.2025.2sp.43.147 Open Access

Recommendations on Implementing Results of Seismic Microzonation in Bangladesh Based on Experiences from South America

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Received: September 18, 2025, Accepted: October 19, 2025

Abstract: Seismic microzonation studies have been carried out in different cities in northern South America, and we present the experiences of the implementation of their results in local seismic building codes aimed at seismic risk mitigation. In Bangladesh, ongoing German-Bangladesh cooperation projects have been dedicated generating Geo-Information for Climate-Change Resilient Urbanization, specifically geomorphological and surface data related to subsidence and flooding, geotechnical and geophysical data for foundation sustainability and the estimation of site effects (e.g. Günther et al., 2015). The datasets will be available for different project cities in Bangladesh and one of the challenges is ensuring local authorities and stakeholders use this information for reducing risks.

Keywords: ***Seismic microzonation, Municipal ordinances, Seismic hazard, Site effects, South America, Bangladesh.***

Introduction

Seismic microzonation helps identify site effects, such as seismic wave amplification, or induced effects such as soil liquefaction and landslides, caused by local geological conditions and geometry of near-surface sediments, responsible for building and infrastructural damage in recent earthquakes (Ansal, 2004). Key factors influencing ground motion include shear wave velocity distribution (particularly Vs30, the average shear-wave velocity in the topmost 30 m), depth of unconsolidated sediments and impedance contrasts to consolidated bedrock materials as well as surface topography. All these instances can significantly alter shaking amplitude, duration, and frequency content of seismic waves. They can be effectively assessed by seismic micro zonation studies (Bard, 1999). In many building codes, Vs30 is used to estimate local site amplification factors, and a semi-empirical method for such evaluations is implemented in the Natural Earthquake Hazards Reduction Program (NHERP) of the USA (Seyhan and Steward, 2014).

The implementation of the results of seismic micro zonation studies is critical for local seismic risk evaluation and associated mitigation strategies. They can be used as input for urban planning, emergency preparedness, and the development of localized building codes – both, for new constructions (supplementing national standards) and retrofitting existing structures. Local seismic hazard studies can guide post-earthquake reconstruction, making it an essential strategy for reducing seismic risk in urban areas (Bramerini et al., 2015). In this contribution, we focus on seismic risk by presenting experiences from different cities in northern South America (Caracas in Venezuela, Bogotá in Colombia and Portoviejo in Ecuador), and suggestions for implementing results from studies for climate resilient urban planning in Bangladesh.

Results

Geological, geotechnical and geophysical investigations have been conducted at a different level in several cities in Colombia, Venezuela and Ecuador, and seismic micro zonation maps based on the variations of Vs30 and depth of the seismic basement have been generated (Figure 1). The implementation in local seismic building codes, which complement the national building codes with specific design spectra, had variable success. Although in the Bangladesh project no specific design spectra have been defined, the local PGA maps (Figure 2), which define amplification factors with respect to the PGA at bedrock from the national building code (BNBC, 2020), together with other information like soil liquefaction and inundation potential, would justify local city ordinances to guide city planning. We consider legal implementation of the results crucial for an effective use of the information.

Conclusion

Seismic microzonation studies, which assess site and induced effects critical to earthquake damage, are effective tools for mitigating seismic risk. Legal implementation of study results is essential, as illustrated by examples from Colombia, Venezuela, and Ecuador. In Bangladesh, subsurface geo-information has been collected, and local PGA maps developed. To ensure effective use, local ordinances should complement the national building code.

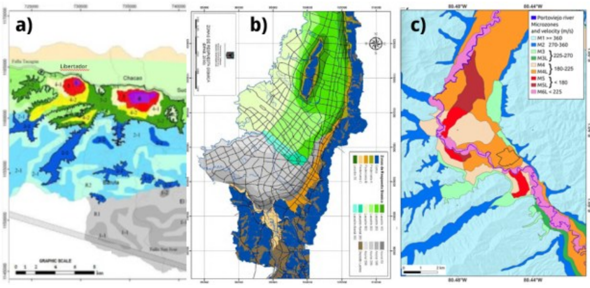

Figure 1, Seismic microzonation maps for a) Caracas (Venezuela; Schmitz et al., 2020), b) Bogotá (Colombia; Alcaldía de Bogotá, 2010) and c) Portoviejo (Ecuador; Schmitz et al., 2025).

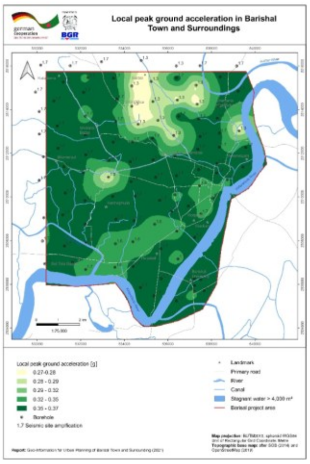

Figure 2, Local PGA (10% exceedance probability in 50 years) for Barishal, one of the project cities in Bangladesh (prepared by: Alam, Jabeen, Buchert and Günther) as provided from a WEBGIS. The circles correspond to the sites of boreholes with geotechnical and (partly) geophysical testing.

Acknowledgement

The authors acknowledge the German–Bangladesh technical cooperation project GICU, funded by the Governments of Germany (BMZ) and Bangladesh (MPEMR), and jointly supported by BGR and GSB.

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