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Probabilistic Arias Intensity Maps of Uttarakhand State (India)

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Abstract

Uttarakhand, an Indian state in the western Himalayan region, is highly seismically active and falls under zone IV (severe) and V (very severe) as per the seismic code of India. The region is home to some highly significant hydropower and infrastructure projects which are either operational or in the planning phase in the region. Therefore, it is vital to determine the area to be impacted by the high seismicity of this region. As Arias Intensity is a very efficient measure to quantify the strength of ground motion, none of the prior studies tried to map the Arias Intensity distribution throughout Uttarakhand. Therefore, in the present study, Arias Intensity is mapped for the Uttarakhand state by the Cornell–McGuire approach. A thorough earthquake inventory was created, considering all earthquake occurrences within a 300 km radius of the research area, incorporating events of magnitude (M_w) > 4 from 1900 to 2020. The inventory was declustered and homogenized into a commonly used moment magnitude scale. Ten distinct seismogenic area source zones were established in the study area. Seismic recurrence parameters for all sources were computed using the earthquake inventory and tectonic framework. The hazard evaluation at the bedrock level was conducted using a logic tree framework that included regional and global attenuation models. The findings were presented in terms of Arias Intensity hazard maps for 475 and 2475 years return period. It was observed that Arias Intensity values vary from 0.15 to 2.13 m/s for 475 year return period and 0.21 to 6.23 m/s for the 2475 year return period. Approximately 80 % of the study area was found to be vulnerable to co-seismic hazards. The ground motion intensity estimated in this study will assist in the effective planning of major infrastructure projects and earthquake-induced landslide hazard assessment.

Keywords: Arias intensity, PGA, Uttarakhand, PSHA, Logic tree, Attenuation model