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REVIEW ARTICLE

Looming seismic threat: a comprehensive review of earthquake hazard in the Kashmir Valley, North-western Himalaya, India

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Abstract
The Kashmir Valley in the north-western Himalaya, recently reclassified into Seismic Zone VI, faces a severe and compounded earthquake risk, driven by intense tectonic compression from the ongoing India-Eurasia collision. Its location within the prominent Kashmir seismic gap, where significant strain has accumulated over centuries, indicates a high potential for a major, destructive earthquake. This natural hazard is critically amplified by local geological and socio-economic vulnerabilities, including thick, liquefiable sediments, rapid unplanned urbanisation, and a prevalence of non-engineered construction. This review synthesises geodetic, seismological, and geological data to evaluate the region's seismic hazard and disaster risk. Geodetic measurements confirm high rates of crustal shortening, while historical and contemporary seismicity reveal a pattern of persistent stress accumulation. The study concludes that the convergence of high seismic potential with acute physical and social vulnerability creates a scenario for a widespread catastrophe. To mitigate this risk, the study advocates for an integrated disaster risk reduction strategy. Key recommendations include the urgent development and implementation of an Himalayan Earthquake Early Warning System (HEEWS), stringent enforcement of seismic building codes, including the retrofitting of critical infrastructure, and the revitalisation of proven traditional construction techniques like Taq and Dhajji Dewari. Furthermore, success hinges on translating seismic micro-zonation maps into community (at ward/panchayat level) awareness programs and strengthening institutional training capacities. Proactive, multi-tiered governmental policies are essential to build resilience and safeguard the sustainable development of the region.

Keywords Kashmir himalaya · Seismic gap · Seismic risk · Resilient infrastructure · Capacity building

Introduction

Jammu and Kashmir (J&K) has distinct topography, climate, and strategic importance. It is a multi-hazard prone region vulnerable not only to natural disasters such as earthquakes, floods, landslides, avalanches, high-velocity winds, and snowstorms, but also to human-induced hazards, including road accidents, fires, etc. (Romshoo et al. 2018). The persistent threat of earthquakes, particularly in the Kashmir Valley, is fundamentally rooted in its complex geological and tectonic framework (Chandra et al. 2018; Bilham 2019; Rajendran et al. 2020; Mandal et al. 2023). The region lies along the tectonic boundary where the Indian Plate continues its northward convergence and collides with the Eurasian Plate (Jain et al. 2012; Chatterjee et al. 2013). This collision, initiated around 50 Ma ago, is the primary driving force behind the formation and evolution of the Himalayan Mountain Belt (Searle 2013).

The immense pressure generated by this ongoing convergence causes crustal shortening and the continuous uplift of the Himalaya, with stress accumulating along an intricate network of fault systems accommodating the motion of these massive plates (Searle and Treloar 2019). The Indian Plate currently moves northward at approximately 5 cm/yr, thrusting beneath the Eurasian Plate, a process that has shaped the Himalayan landscape over millions of years and continues to drive seismicity in the region (Chatterjee et al. 2013; Mo 2024). This is reflected in the long seismic history dating back to 2082–2041 BCE, which underscores its susceptibility to large earthquakes (Bilham 2004). Recent

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