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SEISMIC HAZARDS IN THE HIMALAYAS: EVALUATION OF SEISMICITY AND SEISMIC CHARACTERISTICS

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Abstract

Spatial distribution of seismicity and seismic characteristics (fractal dimension, b-value, energy release, reoccurrence period) are assessed for the Himalayan Region (26^0 – 35^0 N and 72^0– 98^0 E). The Engdahl, van der Hilst, and Buland (EHB) relocated earthquakes M ≥ 4.0 are selected for the period 1964-2009 from the International Seismological Centre (ISC) catalogues. The *Gutenberg - Richter* frequency-magnitude relation (b-value) is calculated by the Maximum Likelihood Method (MLM) as well as by the new alternative *Kaltek method.* The fractal dimension is estimated using the correlation integral method. The total set of events was also used for estimating radiated energy in the region. The probability of the occurrence of strong earthquakes (M ≥ 6.0) during a specified interval of time has been estimated on the basis of three probabilistic models namely, *Weibul, Gamma and Lognormal.* The model parameters (probability distribution functions) have been estimated by the MLM.

The large data set in the Himalayas made it possible to examine the b-value, fractal dimension (D), energy release and probability of strong earthquakes/seismic hazards in the region. The results are corroborative, and the zones of impending strong/large earthquakes are identified. Low b value contours are obtained in the Kangra (~0.58), Nepal (~0.48) and Sikkim (~0.68) areas, and the contours are parallel to the seismicity trends that also follow the Himalayan trend. These zones are identified with prominent low fractal dimension , D ~ 1.3 contours .This indicates clustering to earthquake epicenters in this block. Energy release in Kangra, Nepal and Sikkim is Low (~0.04×10^{20} ergs , 4.71×10^{20} ergs. and ~ 5.84×10^{20} ergs. respectively) and the contours trend along the MBT . Low energy released in the Nepal , Kangra and Sikkim region may be indicative of higher stress concentration for future release of the energy and is indicative for a probable earthquake in near future as energy is being accumulated here.

A comparatively higher b value parallel to the seismicity trend, is obtained in Uttarkashi (~0.8), Arunachal Pradesh (~0.76) and North East India (~0.77), and the trend is transverse to the Himalayan trend. Higher D (~ 1.97) values are obtained in Uttarkashi , Arunachal Pradesh and North East India . Pockets of high energy release contours in between these areas is visible in UttarKashi (~19.57×10^{20} ergs.) , Northeast India (~ 9.77×10^{20} ergs.), Arunchal Pradesh (~ 8.7×10^{20} ergs.). Comparatively high b value , high fractal

dimension and high energy released in these regions indicate remote probably of earthquake of magnitude more than 5.0 in near future.

The cumulative distribution of the observed time intervals using the Weibull, Lognormal and Exponential models was estimated. The cumulative probability is estimated for blocks containing Kangra, Nepal and Sikkm as these zones are indicative of probable earthquake in near future. Thus the b-value maps have identified the variable stressed zones, and the fractal dimension maps the fractal characteristics of the active fault zones. The energy release map, on the other hand, identified the zones of higher and lower energy release, thus indicating the areas of future probable earthquakes. The vulnerable zones (Kangra, Nepal region and Sikkim) have been identified by these maps are further corroborated with the probabilistic models to assess the seismic hazards in the Himalaya region.

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