

scientifically trained women workforce missing in the parentheses of other jobs (including family duties) are to be brought back to the mainstream with the help of WOS-A scheme then immediate changes in the structure of the scheme is mandatory. Otherwise, as in the present condition, WOS candidates will eventually drop out of the scientific arena after completion of one/two projects.

Therefore, the difficulties faced by us during execution of WOS-A project have led us to write this article and we have

not only pointed out the problems/drawbacks of the scheme but also have suggested possible solutions. We think there is ample scope for improvement of the scheme so that it becomes really helpful not only to the women scientists but to the Indian science as a whole.

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## Seismic threat to the Chitwan and Hetauda Duns, Central Nepal

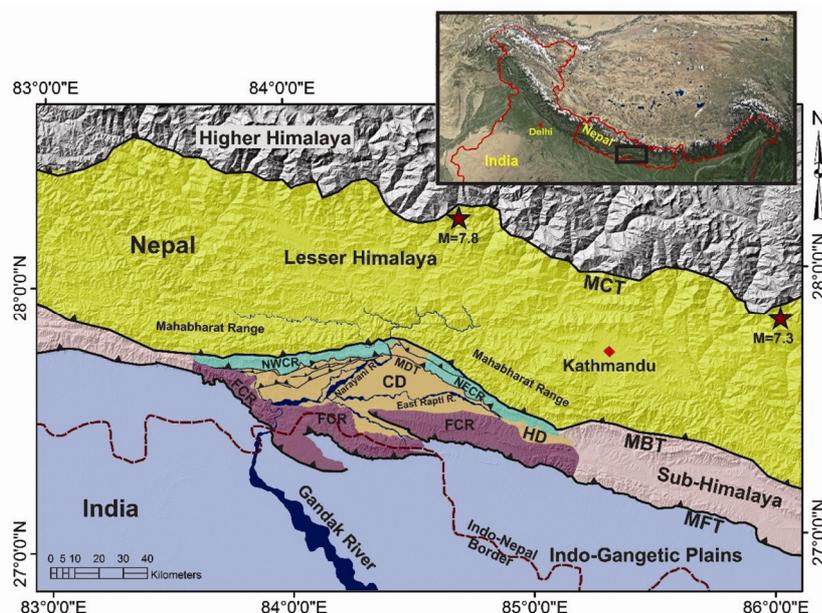
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Flat land (or plains) in a Himalayan country like Nepal is very significant. In general, such plains occur along the Himalayan front marked by the Siwalik hills (both as Indo-Gangetic plains to its south and intermontane valleys to its north); these areas also accommodate significant part of the total deformation in the Himalaya and are prone to large earthquakes as evidenced by past surface

ruptures<sup>1</sup>. A large part of the plain area in Nepal is contributed by intermontane valleys (duns) developed within the Sub-Himalayan Siwalik belt (locally known as the Churia zone). The Chitwan Dun in Central Nepal represents one such intermontane valley developed to the SW of Kathmandu. With an area of about 1575 sq. km, the Chitwan Dun is the largest intermontane valley in Nepal (Figure

1). To its east lies another smaller intermontane valley called as Hetauda Dun with an area of ~150 sq. km. These duns comprise Nawalparasi, Chitwan, Parsa and Makwanpur districts with moderate population density (~260 persons per sq. km)<sup>2</sup>. Some major townships of Central Nepal such as Ratnanagar, Bharatpur, Narayangarh and Hetauda are located in this valley. The Narayani and East Rapti Rivers flow through the Chitwan Dun thus supporting large scale human settlement and agricultural activity in the valley. The E-W/Mahendra Highway – an important connecting route between Kathmandu (northern Nepal) and the Indo-Gangetic plains of Nepal and India – passes through these duns. This highway is important for trade, commerce and tourism. The southern part of the Chitwan Dun is occupied by the Chitwan Wildlife Reserve (developed along the Frontal Churia Range) that is home to many species of plants and animals and is also an important tourist destination of Nepal. Large scale industrialization and agriculture are being promoted in this region over the last few decades. Thus, a good fraction of Nepal's economy depends on these intermontane valleys. Establishment of several educational institutions and medical colleges in the Chitwan Dun also makes this area important.

The Chitwan Dun is bounded to the south by the Frontal Churia (Siwalik) Range which is developed due to thrusting along the Main Frontal Thrust



**Figure 1.** Map showing location of the Chitwan Dun (CD), Hetauda Dun (HD) and epicentres of 2015 major Gorkha earthquakes (marked with red star). Note the structures present within the Chitwan Dun (base map – hill shade Shuttle Radar Topographic Mission Digital Elevation Model). Inset: Location of the duns in regional context showed on Google Earth image.

(MFT). Siwalik ranges are also formed to the north of the Chitwan Dun (Inner Churia Ranges) by thrusting along the Central Churia Thrust (CCT)<sup>3</sup>. The Lesser Himalayan Mahabharat Range lies to the north of the Inner Churia Ranges. The region around the Chitwan Dun marks an absence of great earthquakes ( $M_w > 8$ ) in the last few centuries<sup>4</sup>. The 2015 Gorkha earthquakes originated to the north of the Chitwan Dun but failed to produce any surface rupture along the Himalayan Front<sup>5,6</sup>. High rate of convergence between the Indo-Eurasian plates along the Central Himalaya and transfer of stresses to the Central Nepalese Sub-Himalaya due to failure of southwards rupture propagation of the Gorkha earthquake<sup>5,6</sup>, point towards the vulnerability of the intermontane valleys in Central Nepal for future seismic hazards. Several active out-of-sequence thrust segments displacing Quaternary landforms to the north of MFT have also been identified in the Chitwan Dun<sup>7</sup>. Studies in the Western part of Nepal show higher Pliocene–Quaternary deformation rates to the north of MFT due to shortening along the out-of sequence thrust segments/splays (Main Dun Thrust: MDT)<sup>8</sup>. Stud-

ies of the Gorkha earthquake also revealed post-seismic loading along the MDT segment (located nearly 50 km SE of Chitwan and Hetauda Duns)<sup>9</sup>. Thus, the active thrusts identified in the Chitwan Dun can form potential zones of surface rupture (apart from MFT) during future large magnitude earthquakes.

The Chitwan and Hetauda duns form strategic location for socio-economic activities in Central Nepal. A large scale future earthquake in this region can cause high disruption of communication networks, farming and industrial activities, cultural activities and tourism; thus causing economic setback to Nepal. It will not only affect human settlement but also the rich wildlife fauna and flora of this region. Therefore, there is an immediate need of detailed study and seismic risk monitoring along the Chitwan and Hetauda duns.

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