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## Soil quality assessment in a chronosequence of landslides in Garhwal Himalayas, Uttarakhand, India

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LANDSLIDES are one of the destructive geological processes that occur throughout the world. At global scale, the landslides are one of the major natural disaster which deteriorate the soil quality at a very large scale. In the Indian Himalayan Region (IHR), the Garhwal Himalayas of Uttarakhand landslides occurred very frequently in rainy season due to the presence of fragile rocks, active tectonic activity and unplanned anthropogenic activities. Landslides causes the loss of soil nutrients and vegetation which in turn deteriorate the soil quality. They can have an enormous effect on biodiversity and significantly alter the soil quality. The rate of soil development is essential for determining the recovering capacity of soil after the losses occurred due to landslides and erosion.

Therefore, the present study analyzed the natural recovery of soil quality in terms of soil characteristics with the passage of time (chronosequence) in 4 disturbed sites of different ages i.e., 6-year-old (L1 site), 16-year-old (L2 site), 21-year-old (L3 site) and 26-year-old (L4 site) including control (undisturbed) site in the Garhwal Himalayas of Uttarakhand. 76 soil samples were collected from all the selected sites at two depths i.e., 0-15cm and 15-30cm. The collected soil samples were analyzed for various physical (bulk density (BD), particle density (PD), total porosity (TP), moisture content (MC) and sand, silt and clay content) and chemical characteristics (pH, electrical conductivity (EC), soil organic carbon (SOC), soil organic matter (SOM), mineralisable nitrogen (MN), available phosphorus (AP) and available potassium (AK). Principal Component Analysis (PCA) was done with all the 14 variables which are significantly different in order to establish minimum data set (MDS). The MDS includes SOC, AP and clay content on the basis of the PCA results. The soil quality index (SQI) was calculated using Integrated Quality Index (IQI) equation. Landslide affected sites L1, L2, L3 and L4 and control site had mean SQI scores of 0.136, 0.279, 0.447, 0.604 and 0.882, respectively.

The results have demonstrated that the control site had much better soil quality in comparison to the landslide affected sites because of its better nutrients content and better physical characteristics. The results have also shown that the soil quality tends to increase with the age of landslide, but the soil quality has not reached to the pre-disturbance level in a period of 26 years. The SQI shows the variations in landslide affected sites which could be used to detect variations in soils of disturbed areas. The results will also provide crucial information for evaluating the

consequences, designing, and implementing restoration strategies.