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Land Use Dynamics and Impact on Regional Climate Post-Tehri Dam in the Bhilangana Basin, Garhwal Himalaya

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Abstract: Land use and land cover (LULC) changes are a dynamic process determined by natural factors as well as the degree of human interaction in spatial and temporal perspectives. The present study focuses on analysing the LULC changes in the Bhilangana basin post-Tehri dam construction in the Garhwal Himalaya. Landsat series satellite images were used for three time periods to quantify spatial and temporal changes in the LULC using unsupervised classification techniques. The calculations of the areal coverage and change detection were carried out using the ArcGIS 10.3 software. The study finds that LULC changes were observed in the area surrounding the Tehri reservoir. The area under forest cover decreased by 54.71 km^2, which is −5.7% of the geographical area, followed by agricultural land by 6.06 km^2 (−0.4%) and scrubland and grass cover by 4.23 km^2 (−0.28%) during the decade 2000 to 2010. Gradually, due to compensatory afforestation, forest cover increased by 5.65% in the period 2010–2020. A significant relationship with climatic variability is also established with LULC change in the region. The presence of a large water surface at a high altitude modified the albedo and air temperature and increased the atmospheric humidity and precipitation pattern. This study would be vital in understanding the climatic variability in the Himalayas and its impact on the community, environment and climate.

Keywords: land use change; change detection; remote sensing; climatic variability; Tehri reservoir; environmental impact; precipitation

Citation: Parihar, S.M.; Pandey, V.K.; Anshu; Shree, K.; Moin, K.; Ali, M.B.; Narasimhan, K.; Rai, J.; Kamil, A. Land Use Dynamics and Impact on Regional Climate Post-Tehri Dam in the Bhilangana Basin, Garhwal Himalaya. *Sustainability* **2022**, *14*, 10221. https://doi.org/10.3390/su141610221

Academic Editor: Linshan Yang

Received: 14 July 2022
Accepted: 15 August 2022
Published: 17 August 2022

1. Introduction

Land use and land cover (LULC) changes have emerged as an important issue in the recent past as they significantly modify the energy exchange, in turn affecting climate and environment at a regional and global scale [1–3]. The broader impact of land use dynamics can be observed in the changes in the surface albedo, land degradation and loss of forest cover, which is a source of terrestrial carbon sinks and biological life [3]. The modification of natural landscapes, ecosystems and management practices through human activities can be defined as land-use change [4,5]. The LULC dynamics have a crucial impact on the environment, and it is an easily detectable indicator for the livelihood and sustainability of resources. The mountain ecosystems are more fragile across the world [6,7], particularly in the Garhwal Himalayan region of India due to large-scale development projects and human interference [8–10]. Therefore, a detailed and precise assessment of land use dynamics is essential to understand the effects on the environment and ecological systems [10].

The construction of big hydropower projects in mountainous regions induces large-scale LULC change [11–14]. Hydroelectric projects are considered renewable and clean energy, though they bring massive changes due to the submergence of upstream catchments [12,15]. Apart from that, rehabilitation and resettlement further aggravate the situation due to the clearing of forest cover for the construction of highways, towns and