



Modeling the effectiveness of natural and anthropogenic disturbances on forest health in Buxa Tiger Reserve, India, using fuzzy logic and AHP approach

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Abstract

Forests are the most valuable natural resource to protect organisms as well as ecosystem at a different level. With the rising change of land use and land cover pattern due to anthropogenic and natural disturbances, this resource is now subjected to experience constant exploitation and degradation. This paper explored the level of disturbances on forest health in Buxa Tiger Reserve (BTR), a foothill ecosystem of Himalaya. Sentinel-2 data (2019) and fuzzy logic models were executed to understand the forest health status by using different vegetation indices. GIS-based Analytical Hierarchy Process (AHP) was applied to know the beat-wise spatial disturbances of natural and anthropogenic factors in the study area. Then, disturbance maps were categorized into five zones from very high to very low. The result reveal that overall imprint of natural disturbance in BTR was a little bit high (very high = 13.76%, high = 31.58%, moderate = 15.91%, low = 27.03%, very low = 11.72%) in comparison to anthropogenic disturbance (very high = 11.09%, high = 19.07%, moderate = 24.47%, low = 20.01%, very low = 25.36%), but beat wise it varies significantly. Finally, the effectiveness of both disturbances on forest health was judged through correlation statistics. The forest beats (ID: 2, 4, 6, 7) which cover the core area of BTR have experienced less natural and anthropogenic disturbances with healthy and dense forest cover. On the other hand, less disturbance with poor forest health was found in hilly areas of buxa road and chunabhati beats (ID: 9, 15). Moreover, the effective natural and anthropogenic disturbances were mainly responsible to deteriorate the forest health adequately in most of the areas of BTR.

Keywords Foothill ecosystem · Forest health · Fuzzy logic · AHP · Disturbance

Introduction

Forest has been recognized as a regulator of the biogeochemical cycle on the planet earth and provides explicit and implicit benefits to humans and other organisms. Disturbance affects the functions of ecosystem service and causing a threat to biodiversity; thus, the analysis of factors behind the forest disturbance is a primary concern for the conservationist (Jain et al. 2020; Dale et al. 2001). The impact of human activates on the landscape has been determined by the nature, intensity of disturbance and its effectiveness (Zipperer et al. 1990). Deforestation and degradation of forest resource are an inescapable problem all around the

world subsequently due to the extension of agricultural field, urbanization and so on (Ouédraogo et al. 2010). To reduce the negative impact of human activities on natural habitats, in many parts of the world protected areas are delineated to maintain the balance of ecosystem for conservation of wild-life and sustainable utilization of natural resources (Eken et al. 2004; Ikpa et al. 2009). The protected areas like reserve forest are stored more carbon in comparison to its surrounding landscape, the area lost its potentiality due to degradation and deforestation (Scharlemann et al. 2010; Kelatwang and Garzuglia 2006; Dimobe et al. 2015), elsewhere the water and atmospheric circulation of a particular landscape are also nourished by vegetation. Himalaya and its surrounding landscape are highly sensitive to geohydrology; climatic aspects create an impact on the sustainability of the mountainous environment (IPCC 2001; Eriksson 2006; Chen and Lee 2003). Earthquake, landslides, soil erosion, slope failure accelerated by severe rainfall storm are common natural phenomena experienced by this landscape (Alexander 2008;

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