



# Linkages between gully erosion susceptibility and hydrological connectivity in Tropical sub-humid river basin: Application of Machine learning algorithms and Connectivity Index

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## ABSTRACT

Hydrological connectivity from upslope to downslope of valley floor and main channel, triggered the gully initiation and associated land degradation continue occurring off-site erosion as considered most effective drivers on potential sediment detachment. Present study attempted to identify the linkage between gullies erosion susceptibility (GES) and hydrological connectivity pathway in sub-tropical humid river basin Kangsabati (KRB) using four machine-learning algorithms (MLALs) such as Random Forest (RF), Support Vector Machine (SVM), Extreme Gradient Boosting (XGB), Artificial Neural Network (ANN) for GES mapping, and connectivity index (IC) for hydrological connectivity mapping. Thirty-five controlling factors were selected using Boruta's approach to produce GES mapping, while frequency ratio (FR) was applied to determine the significant role in each individual class of controlling factors on degree of gully susceptibility. To achieve the efficiency of using MLALs, AUC of ROC including sensitivity, specificity, accuracy, F, and Kappa index were employed to compare in each model. In testing datasets, AUC values reveals that RF (0.99) and XGB (0.99) were well performed and predicted to GES followed by ANN (0.97) and SVM (0.87). FR depicts the most contributing factors of barren land and laterite followed by rainfall erosivity, degraded forest, single crop, and elevation to GES. IC result showed that values range (-11.52 to 0.49) address the three connectivity categories i.e. not connected (NC), gully connected but not reach (CNR), and gully well connected (WC). Correlation analysis clarified that double crop ( $R = 0.82$ ), topographical wetted index ( $R = 0.77$ ) and slope ( $R = 0.044$ ) are prolonged WC for large downslope in north-western sub-basins of upper catchment and western, eastern sub-basins of lower catchment, while dense forest ( $R = -0.71$ ) and vegetation cover ( $R = -0.82$ ) forms NC gullies and CNR to channel due to interrupted upslope in central sub-basins of upper and lower catchment. Finally, research findings could provide to take strategy for sustainable land uses policy.

## 1. Introduction

Land is an essential component of the earth's surface as provided survival opportunities and fulfils the necessary demand of human beings through the various way likes agriculture, forest, industry, residence, etc. (Saha et al., 2021); however, man is regarded as a crucial responsible agent for modification, management and intended way of land resource utilization (Turner et al., 1995). In contrary, sustainable land use arrangements always preserve the basic fundamental functional

processes amongst the biosphere community, increase the quality of life and maintain their positive interaction with the environment (Yao et al., 2018). In India, disorganized land use arrangement in the entire Chotanagpur plateau of western West Bengal has been facing under sub-aerial denudation process caused by intensive water induced soil erosion through the gully formation and its development (Saha et al., 2021).

Generally, gullies are rapidly developed through the shifting of underlying unconsolidated material from uplands to valley bottoms with

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