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Soil loss estimation based on RUSLE model for Bakraha catchment

Background

Haphazard construction work combined with extreme rainfall events in the hills of Nepal have resulted in a significant increase in the sediment yield in many hilly catchments. High sediment influx alters the dynamic equilibrium of the channel causing higher deposition due to the reduced sediment transport capacity in the lower reach. Such processes have led to the continuous aggradation of the riverbed to such extent that the adjacent villages are now well below the river bed level at many places. Under such condition, the risk of flooding and consequent damage to the adjacent areas naturally increases. Riverbed aggradation due to excessive sedimentation has not only a negative impact on the river morphology but it also adversely affect the functionality of the flood mitigation structures.

Materials and Method

Revised Universal Soil Loss Equation (RUSLE) (Renard and Ferreira, 1993) model was used to measure spatial distribution of soil erosion in Bakraha catchment, Eastern Nepal (Figure 1). However, RUSLE is appropriate only for the estimation of sheet erosion and rill erosion, not for gully erosion. Despite its limitation, the model combines several parameters to give reasonable estimates of soil erosion. This research may contribute to enhance knowledge base for soil erosion database.

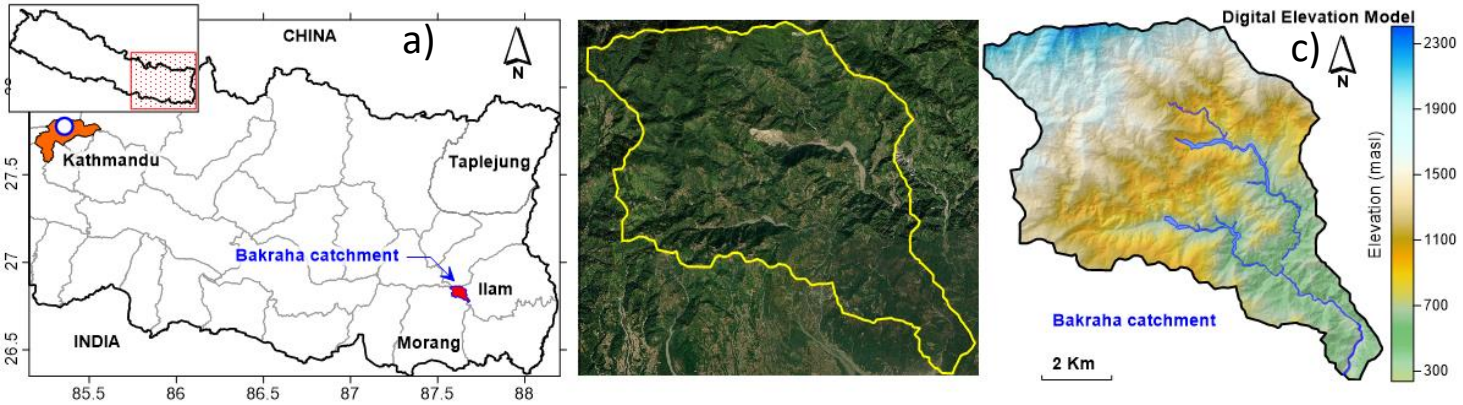

Figure 1: a) Location of study area; b) satellite imagery and c) Digital elevation model (DEM)

This study used various datasets developed from different sources. Applied datasets and their relevant sources are listed below.

Table: Datasets used for the RUSLE model

Data Sets	Data Source	Factor
DEM (SRTM 30 m)	https://earthexplorer.usgs.gov/	Slope length and steepness (LS) and support practice (P)
Soil Data	Soil map prepared by FAO www.fao.org/geonetwork	Soil erodibility (K)
NDVI from Landsat 8	https://earthexplorer.usgs.gov/	Land cover management factor (C)
Rainfall Data	Rainfall data for the period of 2008-2018, prepared by Department of Hydrology and Meteorology, Government of Nepal	Rainfall erosivity (R)

The RUSLE was designed to compute the mean annual soil loss for ground slopes where flow convergence/divergence can be neglected, i.e., planar slopes, common in agricultural lands. The RUSLE is expressed by an equation,

$$A = (R) \times (K) \times (LS) \times (C) \times (P)$$

where, A = soil loss (t ha^{-1} yr^{-1}), R = rainfall erosivity factor (MJ mm ha^{-1} h^{-1}, yr^{-1}), K = soil erodibility factor (t h MJ^{-1} mm^{-1}), LS = slope-length and slope steepness factor (dimensionless), C = land management factor (dimensionless), and P = conservation practice factor (dimensionless).

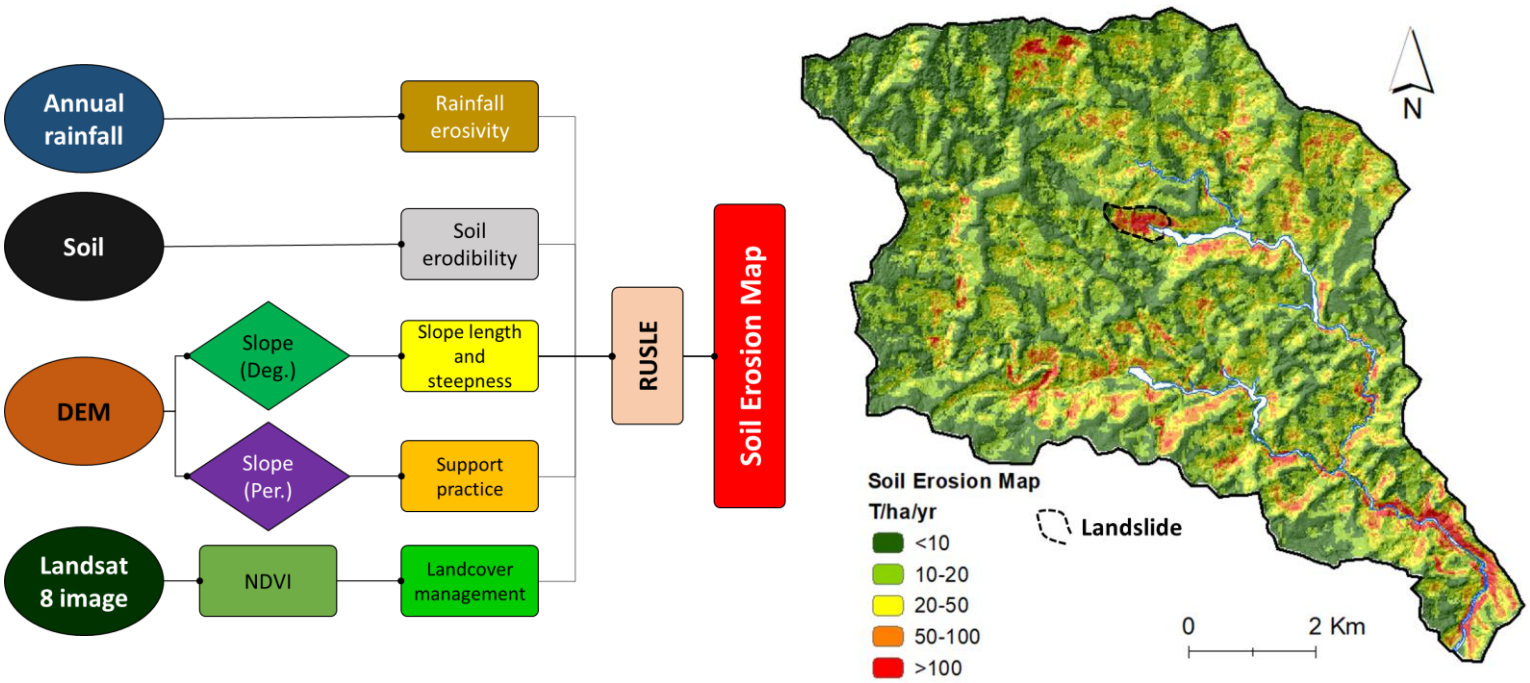

Figure 2: a) Methodological Framework and Soil Erosion Map

Results and Discussion

The potential areas for soil erosion has been identified. The soil erosion rates were classified into five various classes based on rate of erosion that is found in specific location where about 1.96% of the land fall under extreme risk (>100 t $ha^{-1}yr^{-1}$). The major erosion occurred in the agriculture area as well as the areas of steep slope. Also it was observed that the sediment yield from the landslide area is also greater. Therefore, along with downstream flood control works, the landslide management activities would also be carried out simultaneously. Regions which are very prone to soil erosion have to be paid high attention for application of appropriate stabilization or control measures. Conservation measures like terracing, contouring, and grassed waterways could also be used frequently.

Remarks

A projection of soil erosion mapping based on remotely sensed data and GIS platform has been outlined at Bakraha catchment using RULSE model. It was assessed that major erosion occurred in agriculture area and steep slopes. Counter measures should focus on minimizing the erosion loss from the upstream including river improvement works in the downstream.

Reference

Renard, K. G., and Ferreira, V. A. (1993). RUSLE model description and database sensitivity.

FOR FURTHER INFORMATION:
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