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Remote sensing in soil erosion assessment
for land resources management

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Remote sensing (RS) and geographical information system (GIS) have emerged as the most reliable and effective tools for generating land resources information in a cost-effective and time-efficient manner. Advances in spatial, spectral and radiometric resolutions of the remote sensing sensors provide a wide opportunity to the user to characterize land resources at different scale. The Revised Universal Soil Loss Equation (RUSLE) is widely used for assessment of soil loss and using this equation, erosion assessment was carried out in Bareli watershed of Seoni, Madhya Pradesh.

Key words: Land management, Remote sensing, RUSLE model, Soil erosion

SOIL erosion is a natural geological phenomenon associated with the hydrologic cycle. It occurs when the impact of water or raindrops detaches and removes soil particles causing the soil to degrade. Soil erosion gets further aggravated due to anthropogenic factors causing loss of top fertile soil from agricultural lands and reduction in reservoir capacity as well as downstream water quality due to siltation. Soil erosion can never be stopped completely, but it can be reduced to some extent by adopting suitable soil conservation measures.

Several research studies have proved that remote sensing (RS) and geographic information system (GIS) technologies provide reliable and precise information about eroding areas, vegetation cover, soils, landform and lithological units with reasonable costs in large areas. Several models for predictive evaluation of soil erosion have been integrated into RS and GIS for spatial assessment of soil erosion. Universal Soil Loss Equation (USLE) and its revised version, RUSLE, both are being used worldwide for the estimation of surface erosion.

RUSLE factors estimation

The RUSLE approach is compatible with GIS environment and the factors used in the model can be precisely derived from the remote sensing data. Mathematically, the RUSLE incorporates five factors as given below:

$$A = R \times K \times LS \times C \times P \quad (1)$$

where, A is the computed spatial average of soil loss over a period selected for R, usually on yearly basis (t/ha/y); R is the rainfall erosivity factor (MJ mm ha/h/y); K is the soil erodibility factor (t/ha/MJ/mm); LS is the slope length steepness factor (dimensionless); C is the cover management factor (dimensionless, ranging between 0 and 1); and P is the erosion control (conservation support) practices factor (dimensionless, ranging between 0 and 1).

Rainfall erosivity (R) factor: The R-factor measures the impact of rainfall on erosion in MJ mm/ha/h/year and it is designed to represent the input that drives the sheet and rill erosion process through climatic factor. It is generally determined as a function of the volume, intensity and duration of the rainfall. Its calculation, therefore, requires detailed data regarding the quantity and intensity of the rainfall.

Soil erodibility (K) factor: The soil erodibility factor (K-factor) represents both susceptibility of soil to erosion and the rate of runoff. The K-factor is estimated from soil physical and chemical properties.

Slope length (L) and slope steepness (S) factor: The LS-factor indicates the effect of topography on erosion, which is proportional to the length and steepness of the slope. The LS-factor map can be derived from the Digital Elevation Model (DEM) using the equation:

$$LS = (\text{Flow accumulation} \times \text{Grid size})/22.1)^{0.4} \times (\sin(\text{slope}) \times 0.01745)/0.09)^{1.4}$$

where, flow accumulation is a raster of accumulated flow to each cell and grid size is the length of a cell.

Cover (C) factor: The C-factor represents the effect of cropping and management practices on erosion rate. It is defined as the ratio of soil loss from land cropped under specific conditions to the corresponding loss from clean-tilled or continuous fallow. The value of C depends