

Geospatial Modeling and Multivariate Analysis of Soil Erosion Susceptibility for Panchkula District of Haryana, India

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ABSTRACT The paper presents a geospatial modeling for 13 soil erosion stimulating factors – which affect the detachment, transportation, segregation, and bondage of soil particles. ALOS PALSAR DEM ALOS (Advanced Land Observation Satellite) PALSAR (Phased Array L-band Synthetic Aperture Radar) reveals the stream order, texture, geomorpho-tectonics, relief, and geometric characteristics. Vegetation cover and Land Use/Land Cover parameters were derived from Sentinel-2 MSI satellite image. The results reveal that 4%, 79%, and 17% area of the district are at very high, high, and moderate soil erosion susceptibility risk, respectively. Spatial distribution of soils under very high soil erosion susceptibility was found where loamy textured soil with alluvium geomorphology filled with sparse vegetation over steep slopes containing high stream power and drainage density meets high precipitation. It is inferred that rainfall is the most influencing factor, followed by vegetation cover, soil texture, and other factors. Various vegetative, mechanical, soil, and water conservation measures were suggested for conservation of the topsoil, reduction of the ferocity of the floods, and improvement of the groundwater regime.

KEY WORDS Geospatial modeling, Multivariate analysis, Soil erosion susceptibility, Weighted overlay analysis

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INTRODUCTION

Soil is the basic natural constituent of our biosphere for the existence of any kind of life form by providing all necessary commodities such as food, fodder, and fuel besides rendering physical support and acting as a medium for other biochemical processes. Classic examples of the disappearance, due to the mismanagement of soil resources, are the human civilization of Mohenjo-Daro and Harappa (Tainter, 1988). Globally, soils have been facing continuous qualitative depletion due to various natural and human caused excessive exploitative activities, leading to top soil erosion, reckless mining activities, excessive cultivation of land, overgrazing, improper utilization, and deforestation. These have lead to a disturbed natural balance between the soil, climate, and vegetative cover (McMichael and McMichael, 1993). Soil erosion is a also a naturally occurring process, due to physical forces of flowing water (floods, wind, moving glaciers, and tillage, which affects all landforms by eroding away of topsoil which is rich in

organic matter, fertility, and soil life (Grabner *et al.*, 2006). In India, where rural inhabitants amount to nearly 70% of the population and with primary dependency on agriculture for supporting their livelihoods, an area of 126 million hectares under various degrees of soil erosion is a major concern (Maji *et al.*, 2006). Soil water erosion is regarded as a multivariate and very dynamic spatial phenomenon (Renard, 1997). As per the figures given by Space Applications Centre (2016), nearly 37.4% of the total degraded area is under the impact of water erosion (SAC, 2016). Various types of water erosion vis-a-vis gully, stream channel, rill, sheet, and splash (due to raindrops) erosion result in loss of topsoil and deformation in physiography and terrain. Soil erosion severity depends on multitudinous factors such as intensity of rainfall coupled with the type of slopes, soils, and land use categories (Maji *et al.*, 2006). Soil erosion has certain direct effects such as loss of soil and water, gully development, and reduced soil fertility, which eventually induce reduction in productivity and disruption of water balance and quality (Sharma and Singh, 2017). Various

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undercutting of hill surfaces, and channel banks. Structural measures should include staggered contour trenches, peripheral trenches, staggered trench, moisture conservation pits, gully plugs, spurs, studs, check dams, silt retention dams, relevant crate wire structures, and drop structures.

Bioremedial measures include vegetative/brushwood check dams across channels, vegetative spurs in single or double lines, vegetative filters, vegetative hedges, agroforestry, grass barriers, agrostological measures, vegetative gully plugs and stabilization by planting trees, and mulching with local vegetation species.

In addition to structural and bioremedial measures, the effective closure to animal grazing and illicit felling of vegetation with people's active participation can be the most effective social fencing measure in rehabilitation of degraded catchments. Self-motivation and awareness are needed to boost among the local people by functioning NGOs and public functionaries. Soil erosion calculations, landslide prone hotspots, and proposition of locations for implementation of various measures could be explored specifically.

CONCLUSIONS

Soil erosion is one of the biggest threats being faced by the present civilization. This one phenomenon alone is capable of depriving generations of sustainable produce and quality water. Without undermining the grave danger of soil erosion, it is the need of the hour to understand the risk or susceptibility of various sensitive ecosystems toward soil erosion. Panchkula district of Haryana which falls in the lower Siwalik region is one such sensitive agro-ecosystem. In the present study, 13 factors, namely, rainfall, vegetation cover, soil type, geology, geomorphology, slope angle, stream power, slope length, topographical curvature, drainage density, topographic wetness, land use/land cover, and slope aspect, were identified as soil erosion stimulating factors. Based on weighted overlay analysis, it was concluded that rainfall is the most influencing factor, followed by vegetation cover, soil texture, and others. It was further concluded that 79% of the study area is highly susceptible to soil erosion, 17% is susceptible to moderate erosion, while only 4% of the district is susceptible to very high erosion risk. Thus, to conserve the sensitive agro-ecosystem of Panchkula, soil erosion susceptibility through advanced technologies of RS and GIS would go a long way and carve the path ahead for the future.

AUTHOR CONTRIBUTIONS

“Conceptualization, P.K. and R.K.; methodology, P.K. and R.K.; software, V.A.; validation, P.K., R.K., P.S., and V.A.; formal analysis, P.K. and R.K.; investigation, P.K., R.K., and P.S.; resources, V.A., R.K., and P.K.; data curation, P.K. and P.S.; writing—original draft preparation, P.K.; writing—review and editing, P.K., R.K., P.S., and V.A.; visualization, P.K.; supervision, R.K. and V.A.; and project administration, P.K. All authors have read and agreed to the published version of the manuscript.”

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DATA AVAILABILITY STATEMENT

In Appendix A, data supporting reported results can be found.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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