REVIEW ARTICLE

REVIEW ON LAND USE, LAND COVER ANALYSIS AND SOIL LOSS ESTIMATION THROUGH RUSLE AND GEOSPATIAL TECHNOLOGIES

Sundeep Kumar Antil,[1]* M.S. Sidhpuria,[1] Mukesh Kumar,[1] Sanjay Kumar[1] and Nitin Bhardwaj[2]

[1]*Department of Soil and Water Engineering, COAE&T, CCS HAU, Hisar, Haryana, India*
[2]*Department of Math & Statistics, COBS&H, CCS HAU, Hisar, Haryana, India*
Email: sundeepantil@gmail.com

Received-06.07.2022, Revised-18.07.2022, Accepted-28.07.2022

Abstract: The changes in land use and land cover over the land surface are contributing factors to soil erosion due to their effects on soil health, nutrient status, and sedimentation in water bodies. Understanding the processes that cause soil erosion allows one to more quickly Identify locations in a landscape that are prone to erosion and address the issue in a systematic way. The geospatial technologies and their integration with soil erosion models have been widely employed to predict the potential status of soil erosion around the world. The purpose of this study was to evaluate the usefulness of geographical information system and remote sensing techniques in determining land use land cover and soil erosion prediction.

Keywords: Digital Elevation Model, Land use, Land cover, RUSLE, Soil erosion, Watershed Prioritization

INTRODUCTION

The continuing silting of waterways and reservoirs due to soil erosion from catchment areas is a major concern. The accumulation of eroded soil diminishes the reservoir's capacity, increases flood risk, and degrades the water quality downstream as a result. Crop production, population pressure, anomalous rainfall events, and shifting agriculture on hill slopes all lead to changes in land use and cover. Once a certain amount of silt has accumulated in lakes, rivers, and reservoirs, it promotes soil erosion and poses different dangers to society. Approximately 80 % agricultural land of the world is affected by moderate to severe erosion (Ritchie *et al*., 2003). About 29% of soil being taken to sea by rivers, 10% gets deposited in reservoirs and storage facilities and remaining 61% get displaced from its place for a variety of reasons (Narayan and Babu, 1983). It is possible to minimize soil erosion and safely get rid of large amounts of runoff by increasing organic matter into the soil (Bishnoi, *et al*., 2021).

USLE models are widely accepted all over the world because of their simplicity and low input data requirements for runoff and soil loss predictions (Wischmeier and Smith, 1965, 1978; Renard *et al*., 1991). It is possible to study and find solutions to more difficult hydrologic problems using Remote Sensing (RS) technology, compared to conventional methods. Geographic information systems (GIS) offer a faster and better way to manipulate and analyse spatial data and assess various morphometric watershed parameters. Geographic information systems (GIS) are excellent tools for reducing soil loss by developing some land use management strategies (Jain *et al*., 2001).

Land Use and Land Cover analysis through Remote Sensing and GIS

*Corresponding Author

Although the terms "land usage" and "land cover" are frequently used interchangeably, they have distinct meanings. There are many different types of land cover, such as vegetation, settlement, waterways, bare soil, and so on. Land cover data provides a starting point for thematic mapping and change detection in the study area. Land use, on the other hand, refers to what the land is used for, such as agriculture, wildlife habitat, or recreation. The use of RS and GIS technologies to map land use and cover gives researchers the opportunity to look into alternative uses for the land. The IRS-P6 LISS-III satellite data for 2011 was used and examined the land use and land cover and discovered a dramatic shift in scrubland, wetlands, and the river in Ambala district since 2001. Using RS and GIS technology, the wasteland can be identified as a suitable location to conduct sericulture practises at the right time of year (Kumar *et al*.,2021). For land use and land cover assessments, Landsat satellite imaginaries are frequently used in GIS environments because of its freely and long-term availability. Data from three different Landsat satellites collected over three different time periods (1978-1999, 1999-2017, and 1978-1999-2017) were used to assess the land use and cover change of Bangladesh's Halda Watershed, and a significant shift from vegetation (35.1%) and water class (85.47%) to agriculture, bare soil, and settlements were discovered (Chowdhary *et al*., 2020). As a result of the rapid industrialization and urbanisation taking place, it is necessary to quickly prepare a land use and land cover map. (Guler*et al*., 2007). The changing pattern in the research area can be examined by combining the various imaginary data sets. In this study, Landsat-5 Thematic Mapper (TM) and Sentinel 2A (Multispectral Instrument) MSI data were used to analyze the change patterns in land use and land cover (LULC) for the periods 1988–1996, 1996–2008, and 2008–2017 in the Rani

Khola watershed in Sikkim in the Himalayas (Mishra *et al*., 2020). In India, the Western Ghats, NDVI and NDWI measurements using Landsat satellites from 1988 to 2018 revealed wide disparities in forest and water resources that have only recently been documented. Changes in land use over time can be used to forecast future changes in land and water bodies and their impact on the surrounding environment (Panaskar *et al*., 2019). Land use and cover classes were generated using LISS IV satellite images and village cadastral Moussavi maps, and 64 % of the Adalpur Micro watershed's total geographic area was classified as cropland, while 23 % was classified as a wasteland in 2007. The LULC analysis is much helpful in adoption of appropriate land management practices in the watershed to the users.

Integration of RUSLE with RS and GIS

The relationship between rainfall intensity duration and return period is very helpful in planning the soil conservation, runoff disposal and flood control measures (Antil *et al*., 2010). Long-term soil erosion and its effects can be predicted and assessed with the help of RS, GIS and erosion prediction models. USLE was used to predict the spatial distribution of sediment yield on a grid basis using data from GIS and RS software. There was a small but significant difference between the estimated and measured sediment yields, indicating that the watershed's sediment yields were correctly estimated (Pandey *et al*., 2007). Less than 6 per cent of Haryana's total geographical area was found to have soil loss greater than the tolerance limit, but contributed to the 25 per cent of total soil loss of the state when analysed using the USLE equation (Yadav and Sachdev 2008). Watershed management activities has improved the socio-economic status through livelihood improvement, education status, and crop diversification in Shivalik region in Haryana state (Singh, *et al.*, 2007a, 2007b, Antil, *et al*., 2010), in the impact of watershed management activities various programme related to watershed management, crop diversification, pulses, ginger and are being taken up in the watershed The Dikrong River Basin in Arunachal Pradesh experienced an average annual soil loss of 51 t ha^{-1} yr^{-1}. Those areas with moderate to severe erosion potential were classified as "moderate," "high," "very high," "severe," and "very severe" (Dabral *et al*., 2008). The combined maps of monthly rainfall, vegetation cover, and soil erosion risk can be used to monitor soil erosion risk at the national level (Panagos *et al*., 2015). Weighted overlay index approach generated a probability zone map showing that the majority of the study region falls within the low probability zone, and only a minor percentage of the study area falls into the high and very high probability zones. Soil management and conservation practices in the Nethravathi Basin can certainly benefit from the findings. On the basis of soil erosion intensity in Tripura, India, 23 subwatersheds were delineated to estimate the potential and actual soil loss, as well as to identify the most erosion-prone sub-watersheds in the mountainous region and noticed that forest areas were less erosive (Ghosh, *et al*., 2013). GIS software was used to analyse the rainfall factor of RUSLE in the Lebna watershed, Cap Bon, Tunisia, for a period of nine years. The watershed's soil map was digitized for estimation of soil erodibility, and an index for soil erosivity was assigned to each soil unit. ArcGIS software was used to create a DEM by digitizing contour lines from topographic maps and calculated the LS factor. Based on the LS distribution, they were able to distinguish and confirm the validity of the results.

To establish an effective culture and governance in support of management practices that reduce soil erosion, the combination of USLE and spectral indices could be a vital part of integrated soil management, especially with a view to evaluate and mapping of soil erosion risk (Jazouli *et al*., 2017). A high rate of erosion was found along the main course of the Muhuri River when soil loss was quantified using the integration of USLE with GIS and RS (Bera, 2017). In the tropical plateau fringe, the RUSLE model could be useful (Mahala, 2018). High-severity areas should be prioritized for erosion control programmes in the future to reduce the siltation rate in the reservoirs (Bouhadeb *et al*., 2018). Also checking of large amount of runoff and improvement in soil health through organic compound may serve the purpose of erosion control (Kumar *et al*., 2019).

Soil erosion on cultivated land can be prevented by altering the cultivation calendar and implementing intercropping. To further reduce soil erosion, introduction of broadleaf trees is a good initiative to mountainous areas (Pham *et al*., 2018).

Practitioners and policymakers concerned with soil and water conservation know that soil erosion is a major contributor to degradation of the natural resources. Soil erosion was a serious problem in large parts of Nainital District, necessitating immediate action to prevent landslides and stop further erosion. Soil erosion had occurred at a rate of 0 to 40 ha^{-1} yr^{-1}, depending on the location (Kumar *et al*., 2021).

Watershed Prioritization Approaches

An analytical hierarchy process (AHP) approach was used to strengthen prioritization and to remove biases from the Andipatti watershed in micro-watershed prioritization process. In ungauged watersheds, the results of prioritization may be more appropriate because the index values gave importance to the severity of the problem in each micro-watershed on a comparative scale. Using a GIS-based multi-criteria priority index, planners can gradually implement sustainable development measures(Balasubramani *et al*., 2019).It was found that about 70% of the Kelani river basin area in Sri Lanka has low to moderate erosion severity (12 t ha^{-1} yr^{-1}), which necessitates urgent erosion control measures to ensure a sustainable ecosystem in the basin and suggested that the RUSLE results should be refined with sub-basin level with real-time erosion estimations in the basin (Fayas *et al.*, 2019). Considering the All India Soil and Land Use Survey (AISLUS) suggestion the study area was classified in six classes of slope, and the watershed area was divided into 15 classes. On the basis of the sediment yield index method the subwatersheds were prioritized and watershed with the highest SYI value received the highest priority Soil and water conservation measures were urgently needed in high priority watersheds with high SYI values, but they were less urgent in low priority watersheds with good vegetative cover and low SYI values (Gajbhiye *et al*., 2014, Khan *et al*., 2001). The delineation of watershed boundaries in the Kangra district of Himachal Pradesh in the western Himalayas was carried out using both automated and manual methods in order to examine the feasibility of such a method. It takes a lot of time and effort to manually draw the boundaries of a watershed. Watershed delineation can be automated using open source software and a freely available database, making it much easier to perform than the manual method (Kumar and Dhiman, 2014). Prioritization based on morphometric parameters is time-consuming, whereas Principal Component Analysis can identify new meaningful underlying variables for watershed prioritization (Sharma and Meshram, 2017).The watershed and sub watershed could be prioritized through morphometric parameterswhich include most likely drainage parameters and basin shape parameters and suitable sites could be identified for soil and water conservation measures and appropriate structures could be suggested. (Pandey *et al*., 2011).For the purposes of ranking, the defined watersheds were evaluated according to a set of parameters that both directly and indirectly influenced the likelihood of erosion. Geomorphometric parameters were supplemented with data on land use and cover to arrive at final prioritized composite values. They concluded that information is significantly helpful to watershed planners and managers especially in prioritization of watershed management programs and their implementation. (Puno and Puno, 2019).Data on the estimated value of soil loss could be quickly gathered using GIS methodology for any part of the investigated area (Shinde *et al*., 2010).

The first-order streams dominated the sub-watershed and slope and local relief influence the stream segment development and reported as a useful tool in strategic planning for erosion control and soil conservation. In 67 villages in the Pavagada area, Tumkur District, Karnataka, and a small portion in Ananthpur District, Andhra Pradesh, India, and the sub-watersheds were prioritized through an integrated approach. A knowledge-based weightage system was adopted by them in accordance with local terrain and field conditions. The researchers grouped each villages/sub-watershed studied into three categories: high, medium, and low priority. They prioritised villages/sub-watersheds with a large economically weaker population over others (Vittala *et al*., 2008).

CONCLUSION

Remote sensing and GIS are particularly effective tools for large-scale digital mapping of land for environmental investigations. To avoid overuse and damage to the landscape, a time-series analysis of land use and land cover can be used to predict future changes. Integration of soil erosion prediction models with remote sensing (RS) and geographical information systems (GIS) can enable environmental management groups, policymakers, and the general public to better comprehend the surrounding environment.

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