INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
PhD-17 SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Land and soil degradation pose a serious environmental challenge globally, leading to a decline in land productivity and ecosystem sustainability. In India, nearly 29.77% of the total geographical area is affected by land degradation, with water erosion being the dominant process. Therefore, accurate assessment of soil erosion is essential for effective land and water management. The Revised Universal Soil Loss Equation (RUSLE) is widely used to estimate soil loss from rill and inter-rill erosion, in which the rainfall erosivity factor (R) represents the erosive potential of rainfall. Estimation of the R factor requires high temporal resolution rainfall data (≤30 min), which are limited in India. To address this limitation, the present study utilizes the Integrated Multi-satellitE Retrievals for Global Precipitation Measurement (IMERG) half-hourly rainfall dataset (2001–2020) to assess rainfall erosivity over India. A high-resolution national R-factor map was generated and its spatial and temporal variability was analysed. The results revealed strong regional variability, with a national mean R factor of 2188.79 $MJ \cdot mm \cdot ha^{-1} \cdot h^{-1} \cdot yr^{-1}$, ranging from 68.28 in cold-arid regions of Himachal Pradesh to 18,864.2 in Assam. High erosivity zones were primarily observed in Northeast India and the Western Ghats. Seasonal analysis indicated that the Southwest Monsoon (June–September) contributes the majority of annual erosivity, while winter months show minimal influence. Trend analysis demonstrated substantial inter-annual variability during 2001–2020, with significant increasing trends mainly observed in parts of Rajasthan and Northeast India. Conventional use of mean annual erosivity may underestimate soil loss under extreme rainfall conditions. To overcome this limitation, a return period–based rainfall erosivity analysis was performed. R factors corresponding to 2-, 5-, 10-, 25-, 50-, and 100-year return periods were estimated, revealing that most annual erosivity values fall within the 2–5 year range. This approach provides a more reliable basis for soil conservation planning and structural design. To improve rainfall accuracy, IMERG data were calibrated using the India Meteorological Department (IMD) daily gridded rainfall through a modified Daily Spatio-Temporal Disaggregation Calibration Algorithm (DSTDCA). The calibrated dataset (IMDMERG) identified additional erosivity hotspots in the Western Ghats, Northeast India, and parts of the Eastern Ghats. The study also evaluates future rainfall erosivity under climate change using CMIP6 projections (SSP245 and SSP585) for the Pamohi watershed, Assam. Two approaches namely multiple linear regression and rainfall disaggregation were employed. While the regression-based method proved computationally efficient, the disaggregation approach better captured extreme rainfall intensity. Overall, this research provides an integrated and robust framework for rainfall erosivity assessment to support sustainable soil conservation and land management strategies.