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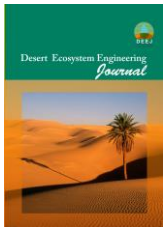

Comparative Evaluation of Soil Erosion and Sediment Yield Estimation in the Dowlatabad Watershed Using the EPM, MPSIAC, and IntErO Models

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Extended Abstract

Introduction: Soil is a vital, non-renewable resource fundamental to ecosystem stability and human subsistence. However, this resource is under constant threat from soil erosion—the detachment, transport, and deposition of earth materials by water or wind. This process degrades agricultural productivity by stripping fertile topsoil, impairs water resources through reservoir siltation and pollutant transport, and inflicts significant socio-economic costs. Given its status as a critical global environmental challenge, the accurate quantification of soil erosion is a prerequisite for effective watershed management and conservation planning. Empirical models offer a practical and efficient methodology for such assessments. This study therefore aims to conduct a comparative evaluation of three prominent empirical models—the EPM, MPSIAC, and IntErO for estimating soil erosion and sediment yield within the Dowlatabad Dehgalan watershed.

Materials and Methods: This study employed three empirical modelsof -the MPSIAC, EPM, and IntErO- to estimate soil erosion and sediment yield in the Dowlatabad watershed. The Modified Pacific Southwest Inter-Agency Committee (MPSIAC) model was applied by systematically quantifying its nine governing factors, which include surface geology, soil, climate, runoff, land cover, and land use. The overall erosion and sedimentation status of the watershed was subsequently determined based on the cumulative scores assigned to these parameters. The Erosion Potential Method (EPM) was then implemented. This required the evaluation of four key coefficients across distinct land units: the coefficient of watershed erosion and rock permeability (Ψ), the land use coefficient (Xa), the average land slope (I), and the soil and rock erodibility coefficient (Y). These coefficients were integrated to calculate the erosion intensity and resultant sediment yield. Finally, the IntErO model was utilized. As a comprehensive algorithm for predicting erosion and sediment transport, it integrates topographic, soil, geological, and land use data, supplemented by meteorological inputs such as precipitation and temperature, to simulate erosion processes and quantify potential sediment yield.

Results and Discussion: The evaluation of the governing parameters within the MPSIAC model revealed that land use (Factor Y7, score: 12.04) exerted the most substantial influence on soil erosion within the watershed. In contrast, surface runoff (Factor Y4, score: 1.78) was identified as the least significant factor. A comparative analysis of the three models yielded distinct estimates for the average annual soil erosion rate.

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The MPSIAC model estimated a rate of 9.034 t ha^{-1} yr^{-1}, while the IntErO model produced a closely aligned estimate of 10.01 t ha^{-1} yr^{-1}. The EPM model, which reports its output in volumetric terms, estimated 1068 m^3 km^{-2} yr^{-1} (equivalent to approximately 10.68 t ha^{-1} yr^{-1}, assuming a standard bulk density). Despite these differing erosion rates, the models demonstrated a notable convergence in their predictions of specific sediment yield, with values of 2.74, 2.88, and 2.65 t ha^{-1} yr^{-1} for the MPSIAC, IntErO, and EPM models, respectively.
A key point of divergence among the models was the calculated Sediment Delivery Ratio (SDR). The EPM model predicted a substantially higher SDR of 0.420, indicating a more efficient transport of eroded material from its source to the watershed outlet. Conversely, the MPSIAC and IntErO models yielded lower and more conservative SDR estimates of 0.247 and 0.210, respectively. This discrepancy highlights the differing theoretical approaches and structural assumptions of each model regarding sediment transport and deposition processes within the catchment.

Conclusion and Suggestions: Accurately quantifying soil erosion and sediment yield through direct measurement is often prohibitive due to technical, environmental, and economic constraints. Consequently, empirical models are indispensable tools, though their application necessitates a robust understanding of erosional processes and a critical evaluation of their accuracy under specific regional conditions. This study applied the EPM, MPSIAC, and IntErO models to the Dowlatabad watershed, revealing a significant methodological divergence in assessing erosion severity. While both the MPSIAC and IntErO models classified the region within a moderate erosion class, the EPM model indicated a severe erosion class. This discrepancy underscores the inherent uncertainty in model selection and the urgent need for proactive watershed management and soil conservation measures in the area. Regarding sediment yield, the estimated values were 451.026, 144.179, and 142.59 m^3 km^{-2} yr^{-1} for the EPM, MPSIAC, and IntErO models, respectively. The close agreement between the MPSIAC and IntErO models suggests a higher degree of reliability for these estimates in this context. In contrast, the EPM model's substantially higher sediment yield and previously noted high sediment delivery ratio (SDR) point to its more extreme and less conservative predictive behavior. Based on these findings, the following recommendations are proposed: Promote the Application of the IntErO Model: Given its performance, which closely aligns with the established MPSIAC model, the IntErO algorithm is recommended for further application and validation in watersheds of varying scales across Iran. This would help broaden the national toolkit for rapid and reliable erosion assessment. Prioritize Conservation Planning: The consensus among the models that the area falls within at least a moderate erosion class necessitates the immediate planning and execution of integrated soil and water conservation programs to mitigate ongoing land degradation. Implement Ground-Truthing Studies: To calibrate and validate these empirical models for local conditions, future work must correlate model outputs with direct sediment measurement techniques, such as systematic field monitoring and sediment sampling.

Keywords: Dowlatabad Watershed, Intero Model, EPM Model, MPSIAC Model.