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Assessment of Spatial Heterogeneity of Hydro-sedimentological Disturbance Index in the Samian Sub-Watersheds

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1-Introduction

Disturbances are environmental fluctuations or destructive events that affect the spatial and temporal patterns of an ecosystem, community, or population. It alters resources, bedrock availability, or the physical environment (Pickett and White, 1985). The disturbance is widely recognized as a fundamental determinant of community development in most ecosystems. This is an essential basis for assessing patch dynamics, replacement, and biodiversity (Huston, 1994; Pickett and White, 1985). Utilization of land uses of watersheds without considering technical support causes damage that leads to environmental imbalances and has significant consequences for soil protection and hydrological regime, reducing agricultural lands and soil impoverishment. Assessing their status involves considering many issues and factors that differ at different spatial scales, human impact, and management (Dai et al., 2004). Hydro-sedimentology is an important concept for better understanding the processes that occur at a watershed scale that affect water, sediment dynamics, and other systems (e.g., biological activity) in different temporal-spatial studies. Quantitative estimation of hydro-sedimentology nexus is a combination of functional and structural features, which is important for identifying sediment transport areas, flow, and sedimentation paths such as landslides, sewage flows, and sedimentation areas (Zanandrea et al., 2021).

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2-Methodology

According to the Durães and Mello (2014) approach, sediment transport (ST), hydrological stress (HS), recharge potential of groundwater (Rec), and soil erosion potential (SEP) factors were first calculated. The sediment transport (ST) was calculated based on the set of measurements of total suspended sediments and their flow and sediment curves using the logarithmic relationship between water discharge and sediment discharge for the statistical period of 1994-2014 and 20 stations in the watershed. Besides, hydrological stress (HS) including analysis of the relationship between mean volume and minimum flow (Q90) was obtained using daily flow statistics. Recharge potential of groundwater (Rec) also includes a set of past flows, consisting of base flow analysis during the hydrological year. Finally, soil erosion potential (SEP) was calculated using the EPM model. The weights (w) of these four factors were determined using the Shannon entropy method. After standardization of criteria between 0 and 1 by the maximum method (Eq. 1), the HSDI index was calculated based on Eq. 2 for the whole Samian watershed.

$$Xi_{normalized} = \frac{(X_i - X_{min})}{X_{max} - X_{min}} \quad (1)$$

Where Xi is the measured value, Xmin and Xmax are the minimum and maximum values of the criteria to be standardized, respectively.

$$HSDI = \sum (w_1 \cdot ST + w_2 \cdot SEP + w_3 \cdot HS + w_4 \cdot Rec) \quad (2)$$

This index is divided into six classes: very low (0–15), low (25–15), medium (45–25), medium to high (60–45), high (75–60), and very high (more than 75).

3- Results and Discussion

The present study is formulated based on the hydro-sedimentologic disturbance index (HSDI). According to the results, the maximum and minimum values of the Samian watershed ST factor in sub-watersheds 19 and 3 are 845.68 and 0.78, respectively, which have the highest sediment due to the location of sub-watershed 19 at the watershed outlet. The maximum and minimum values for the HS factor in sub-watersheds 21 and 6 were obtained with the numerical values of 0.93 and 0, respectively, which in turn can lead to sediment abundance, soil moisture, and habitat stability; due to the location of the largest amount in the central part of the watershed, which has a higher population density. In addition, the maximum value of the Rec factor in sub-watershed 27 with a numerical value of 1.63, which can be interpreted due to its location in lowlands and the presence of flooded rivers, and the lowest value of the factor is related to sub-watershed 3 in the northeast with a numerical value of 0.03. This sub-watershed is located on a high slope. The maximum and minimum amount of SEP in sub-watersheds 25 and 6 were estimated to be 1451.73 and 472.72 t ha^{-1} y^{-1}, respectively. The results of SEP also showed that in sub-watersheds where 100% of their use is rangeland, the amount of erosion is less than where the entire area of the sub-watershed is agricultural use.

4- Conclusions

The HSDI helps assess and differentiate sub-watersheds according to the degree of disturbance associated with land and water, making it possible to allocate resources for conservation accurately. According to the mentioned results, the HSDI in Samian sub-watersheds is classified into four categories (very low, low, medium, and medium to high). Sub-watershed 19 is located in the medium to high class, sub-watersheds 21 and 27 in the medium class, sub-watershed 13 in the low class, and the rest of the study sub-watersheds were in a very low class. Based on the analysis of the study criteria for assessing the hydro-sedimentologic disturbance of the Samian watershed, it was found that in general, the watershed, except in the north and center parts, has a low disturbance.

Keywords: Human Management, Hydrological regime, Samian, Sediment yield, Water resources management, Samian Sub-Watersheds.

5-References

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