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Simulating the Influence of Rangeland Conditions Improvement on Sarbaz River's Discharge and Sedimentation

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Extended abstract

Background and objectives: Protecting water, soil, and organisms, rangeland vegetation is naturally spread over the earth like an umbrella. On the other hand, vegetation changes either cause an improvement or irreparable damage to water and soil resources. Therefore, knowing the effect of vegetation changes on hydrological components of the watershed, including base and peak flow, is a prerequisite for any management planning at the watershed scale. However, the issue takes on particular significance in arid and semi-arid areas, where there is no sufficient quantitative data and the land cover and land use classes are widely dispersed. Therefore, this study sought to calibrate and validate a model for simulating runoff and sediment in the Sarbaz watershed using the soil and water assessment tools (SWAT). What follows presents a scenario concerning the simulation of the influence of improving rangeland vegetation on hydrological components of the Sarbaz basin using a recalibrated and validated model.

Methodology: This study used the SWAT hydrological model to investigate the effect of vegetation changes on discharge and sedimentation in the Sarbaz River watershed located in Sistan and Baluchistan province, enacting the scenario of improving rangeland conditions from poor to moderate. To this end, HRU was obtained from the combination of land use, soil, and slope class maps. Then, surface runoff, sediment, and chemical elements were calculated for each HRU, each sub-basin, and the watershed, respectively. On the other hand, ninety-seven hydrological response units were obtained based on digital height lines of 21 sub-basins after combining three maps. Then, following the preparation of the intended parameters and input data, the model was calibrated for 17 years from 1999 to 2016, and validated over a five-year period from 2017 to 2021. Finally, the model was implemented for the present time based on preliminary data, and then the scenario of improving the pasture conditions from poor to moderate was enacted to determine the influence of vegetation on runoff and sediment.

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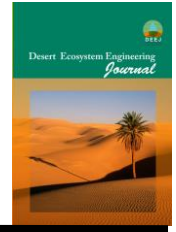
Results: The sensitivity analysis revealed that the alpha parameters in the return flow (v_ALPHA_BF) and the initial curve number of American soil conservation (CN-SCS) for medium humidity conditions exerted the greatest influence on the calibration and validation of the simulation. The results obtained from runoff calibration were found to be 0.76 Nash-Satkif coefficient and 0.86 explanation coefficient, and 0.53 and 0.58 for sediment, respectively, indicating acceptable rates for runoff (on a good floor) and sedimentation. Moreover, the results of the scenario concerning the improvement of pasture conditions from poor to moderate suggested a 46% and 15% reduction in the flood volume and total sediment, respectively, indicating the great influence of vegetation increase on Sarbaz River's stability.

Conclusion: Preserving rangeland plants requires the protection of water and soil, and ultimately maintaining the balance of an ecosystem. However, quantifying the influence of vegetation on runoff and sediment requires modeling and simulation. Accordingly, the current study used water and soil assessment models to construct its intended scenarios. The area of poor pastures in the study area covers nearly 81% of the region. It should be noted that the status of the pastures could be improved through appropriate grazing methods such as modification and flooding, making the flow continue in dry periods and thus reducing the flood damage in the study area. Generally, this study found that the average amount of surface runoff was decreased by 46.88%, indicating the effectiveness of the enacted scenario in reducing flood discharge. Moreover, the peaks of sediment in the diagram were decreased. Also, the average sediment was found to have decreased by 15.53% at the outlet of the basin, suggesting a significant reduction of sediment in the basin. Therefore, it could be argued that the scenario enacted in the current study worked well and that relevant organizations, especially the General Directorate of Natural Resources and Watershed Management of Sistan and Baluchistan province may play it out in the study area. Such a change could be made with suitable methods to improve the conditions of the pasture, including modification and flooding, leading to the continuation of the discharge flow in dry periods and the reduction in flood damage and loss of water and soil in the study area.

Keywords: Simulation, Rangeland Conditions, Scenario Construction, Discharge, Sediment, Sarbaz City