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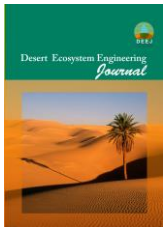

Identifying Meander Formation-Prone Areas Using Logistic Regression and SVM Models: A Case Study of Part of Khorramabad River

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Extended abstract

Introduction: Analyzing the morphological patterns of rivers is crucial for better comprehension of the rivers' current status and their potential for prospective alterations, thereby enabling effective river management. Meandering is one of the most important river issues that influences human activities along riverbanks. Therefore, this study sought to prepare the map of meander formation-prone areas using Kernel Logistic Regression (KLR), Bagging Kernel Logistic Regression (BKLR), and Support Vector Machine (SVM) models in the northern part of Khorramabad River, Lorestan Province.

Materials and methods: The data used in this study included the land use data extracted from Sentinel-2 satellite images, digital elevation model, slope and aspect, geology, and lithology, distance from the fault, distance from the road, topographic wetness index, and some geometric attributes such as topographic position index, profile curvature index, plain curvature index, and terrain ruggedness index, together with the data obtained from field surveys. To this end, a Sentinel-2 satellite image of the study area taken on 15/05/2021 with less than 10% cloud cover and no geometric errors was extracted from the European Space Agency website. Moreover, pre-processing (geometric and radiometric) of the image was performed in ENVI5.3 software and SNAP software, which are specifically designed for processing Sentinel satellite images. Then, atmospheric correction was applied using the Sen2Cor plugin in SNAP software. Subsequently, land use was estimated using a supervised maximum likelihood classification method based on pixel-level training samples. To study meandering in the northern part of the Khorramabad River, a 200-meter buffer zone was considered based on river topography, agricultural lands, access network, and other relevant factors. All input layers in Arc GIS and SAGA-GIS were clipped based on the 200-meter buffer map and entered into the model. On the other hand, 70% of the total data collected for meandering analysis was used for training the model and the remaining 30% was used for testing the model. It should be noted that the training samples used in this study consisted of samples of meandered cases along the studied waterway. Finally, to compare the performance of different models and select the best one for generating meandering potential maps, RMSE, MAPE, NS, and CORR error metrics were used.

Results: This study investigated the potential of the Khorramabad River for meandering and meander formation. To analyze different parts of the river, three main segments were designated, including the northern part consisting of kilometers 0 to 4, the middle part consisting the kilometers 4 to 8, and the southern part consisting the kilometers 8 to 14. The meandering potential was generally assessed in all three parts mentioned above. Accordingly, the highest level of meandering was observed in the middle and southern parts of the river. On the

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other hand, most of the meanders found in the northern part were well-developed and stable, as they are located in mountainous areas, thus being relatively tough and erosion-resistant. In the coastal zone, due to the soft and erodible nature of the sediments, meandering may expand, and meanders can develop into horseshoe shapes, an example of which can be observed in the middle part of the river, i.e., at kilometer 8.5. As the topographic position index along the river displays a concave pattern, this factor tends to promote meandering both in the longitudinal and lateral directions of the river. However, in areas with a convex pattern, the factor hinders meandering.

The high numerical value of the topographic wetness index along the banks of the Khorramabad River which indicates high moisture and wetness conditions makes the banks susceptible to landslides and erosion, which in turn contributes to meandering. Moreover, it can be argued that the overall condition of convex curvature in Khorramabad River and its floodplain has contributed to a decrease in meandering, as the flow velocity is higher in convex bends compared to the concave ones, thereby acting as an inhibiting factor for meandering. While the curvature of the profile varies at nearly every pixel level, its values tend towards negative in parts where the river is located near ridges, indicating increased erosion. Conversely, positive values suggest increased sedimentation due to a decrease in flow velocity.

Characterized by simpler conditions, the Kernel Logistic Regression Method examines areas with the potential for meandering, thus selecting a smaller and narrower extent for prediction. In contrast, the Support Vector Machine Method acts more strictly and selects a broader range. However, the method is considered to be more accurate, as RMSE and MAPE evaluation statistics bear the minimum values of 0.15 and 0.20, respectively, while the NS and CORR statistics enjoy the maximum values of 0.83 and 0.85 compared to other methods, respectively.

Conclusion: Meandering in the river located north of Khorramabad is a process influenced by geomorphological and hydrological features, leading to agricultural land degradation, reduced production, and increased suspended sediment load. From a geomorphological perspective, this study can play a significant role in river engineering. Therefore, activities such as channel modification, shoreline protection, dredging, and sand mining cannot be carried out without knowledge of river engineering.

Keywords: Meandering, Khorramabad River, Riverbank, Remote sensing, Land Use, SAGA-GIS.