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Analysis and Assessment of Stability of Givi Chay River Canal, in the North West of Iran, Emphasizing on Geological, Hydrological, and Human Features

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Abstract

1-Introduction

Rivers are dynamic forms of natural landscapes with different changes at different times and places. The effects of river adjustment caused by the natural factors require much longer span to reveal. However, sometimes the natural factors such as river floods, landslide, or earthquake can lead to canal adjustments in a very short time (Chaiwongsaen et al, 2019:153). In contrast, human activities can have a significant and rapid impact on natural processes and trends, resulting in a short time scale for river adjustments (Rinaldi & Simon, 1998:57). River canal instability plays a major role in erosion, destruction of beaches and riverbanks. This role becomes more significant when the canal and bed of the river is alluvial (Rezaei Moghadam, 2012:33). One of the key issues in studying the erosion and stability of rivers is the initiation of sedimentary particle movement. The motion of sediments occurs if the bed shear stress (available shear stress) induced by the flow exceeds a certain critical value. An alluvial canal, either artificial or natural, persists to deform its boundary by itself while transporting water and sediments. Therefore, erosion and riverbank instability have created major concerns worldwide over the past few decades and significant amount of money have been spent to sustain the riverbanks. Givi-Chay

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River which is almost 54 kilometers long, is one of the permanent rivers of Ardabil province, Iran; problems of bed and bank erosion are evident in different areas of this river and they damage agricultural lands and adjacent river installations. In addition, a review of the research shows that sufficient studies have not been carried out so far to reveal the stability, erosion and sedimentation process in Givi Chay River.Therefore, this study aimed to analyze and evaluate the erosion stability of Givi Chay River channel.

2-Methodology

In this research, the topography map with a scale of 1: 50000, geology map with a scale of 1: 100000, and google earth and Landsat Eight images, including OLI sensor (2019), bedrock maps and the Givi-Chay River area at a scale of 1:2000 hydrological data from two Abegharm stations (upstream of the dam) and Firoozabad (downstream of the dam) and field data are used. In addition, to control the results obtained by quantitative methods, field studies are applied for confirmation and verification. ENVI 5.3, Arc GIS 10.5, Excel, and HEC RAS software were also used for image processing and data analysis. The geomorphological parameters of the river and their variations including bending coefficient and central angle were measured. The curvature coefficient is one of the few criteria used in river shape segmentation using s=1/(y.2), i.e., by dividing the valley length by wavelength for each arc, it is calculated. The central angle of the arcs on each of the intervals was calculated using the relation A=180L / Rπ, where A is the central angle, R, of the fitted circle radius. The increased shear stress in the riverbed increases the load of the floor and the scour of the bed, which can affect the riverbanks as erosion, destruction, and rupture of the walls. Direct measurement of shear stress is a difficult task and therefore researchers have developed methods for indirect calculation of shear stress. Existing shear stress (boundary), lateral shear stress, and critical shear stress were calculated by means of equation 1, 2, and 3, respectively:

$$\tau = \rho wgRS \qquad (1)$$

$$\tau' = C\gamma gRS \quad (2)$$

$$\tau c = \theta c(p_s - p_w)gd \quad (3)$$

Relative Stability Index Calculation (RBS): Judet has introduced this index as the ratio of critical bed velocity to actual bed velocity. Olsen et al (1997) defined this index as the ratio between the critical shear stress and the shear stress of the sides .Relative stability index (RBS) was obtained using the following equations:

$$RBS = \frac{V_c}{V_b} \quad (4)$$

$$V_c = 0.155\sqrt{D_{50}} \quad (5)$$

$$V_b = 0.7\,V \quad (6)$$

3-Results and Discussion

Investigation of the morphology of the intervals shows that in the first, second and fourth intervals the conduit is sinusoidal and in the fourth interval, the pattern is meandering. In addition, according to the results of the study, the first, second and third intervals are developed in a very meandering manner and the fourth interval is just a meandering one. shear stresses in sections 4, 3 (second interval) are more than other sections, and given the direct relationship between shear stress and depth and width of sections, even under current conditions there will be phenomena such as scouring and damaging river bank and rivers. In addition, in terms of critical shear stress, the highest shear stress is in sections 3 and 7. Due to the relative stability values, sections 5 and 7 are stable and other sections are unstable. In the first period, the river flows into a valley bed, and in parts formed by erodible formations and at sections close to the dam, the river width is approximately increased. Therefore, sections 1 and 2, which pass through alluvial terrace sediments, are in unstable condition. In the second interval and immediately after the Givi Dam, the river passes through the valleys overlooking the Givi town, where the width of the bed due to the types of the banks decreases and the riverbed contains coarse sediments

covered by broken rocks. In other parts of the city of Givi, erosion conditions prevail and large volumes of flanking material (especially during floods) are eroded and loose flanks lead to the widening of canals and intra-canal ridges, and these sediments are clearly visible in bends, middle islands and marginal lands and steep banks. At sections where the river width is excessive and the slope decreases, the stability factor is almost high (sections 5 and 7). At the beginning of the third period, Firouzabad area is located on path of the flood of the previous interval and by joining Sanghor Chay, the river enters the mountainous part and the coastal areas have deep valleys with steep slopes. Along the river, due to collision with high mountains and rocky outcrops, the alternate route has a meander and river changes are subject to valley changes, and the meandering state is seen throughout the valley. In the fourth period, the river width is reduced and the riverbed is covered with coarse sediments, which extends to Ghezelozan.

4- Conclusion(S)

According to the study results, in the plain interval, the main factor affecting the river meandering is the alluvial formation; here, the slope is low and the meanders are inscribed and plain, whereas in the mountainous part, the river changes are subject to valley changes and the meandering state is seen throughout the valley. According to the values of shear stress, the lowest boundary and bank shear stress is in sections 5, 6 and 7 and the highest is in sections 4, 3, 11 and 12. The highest critical shear stress is in sections 3 and 7 and the lowest is in sections 4, 2 and 12. The study of the relative stability of the river shows that the river is more unstable in sections crossing the old and new alluvial terraces, and in sections where the river width is high and the bed slope and flow rate have a decreasing trend, the coefficient of stability is relatively high. The third and fourth intervals are mountainous and semi-mountainous, respectively. In these intervals the river width is small and there is no agricultural land use .Lithologically, most of the third and whole of the fourth period consist of Eocene igneous and pyroclastic formations and they are resistant to erosion and the existing alluviums are the result of transport of water from

sediments of other intervals.Therefore, the morphology of the river is affected by lithology and according to field evidence, the interval is stable .But the results of using mathematical and experimental methods have introduced the third and fourth intervals as unstable . Therefore, it can be acknowledged that the methods used in this study apply to the study of stability in rivers and alluvial intervals

Keywords: Shear stress index, relative stability, canal instability, Givi Chay River, North west of Iran.

5- References

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