

## Engineering geomorphology investigation of the Shandak River (East of Iran)

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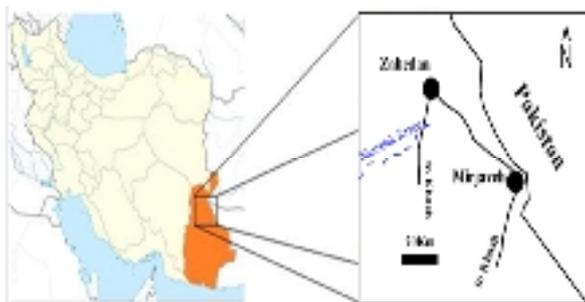
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**Abstract:** Shandak River in South East Iran. The aim of this study was to determine changes in direction, longitudinal and transverse profile and set of stable and unstable parts of the river. In this study, library studies, field visits and sampling of the bend of the river, explore the aerial photographs of morphological characteristics, such as length and radius of curvature, the general trend of movement and erosion, and the channel width was calculated in GIS. The results show that the pattern of the river is gravelly arterial bed. According to the results of the geometric parameters, 50 percent of bends unstable and 50% are stable. The minimum and maximum width of the river, respectively, 10 and 250 meters. Classifying the morphology, the river is part Sloper rivers. Classification Rusgen first part Shandak River, in the C1 to C2, C2 to C4 in the second and third sections are placed in Group B4 and B5. Comparing 1971 and 2014 aerial photographs, 3-bend in the river has changed course.

**Key words:** Engineering geomorphology; Shandak River; Geology; GIS

### 1. Introduction

River is one of the key elements of the Earth's ecosystem is constantly on the rise, development of civilizations and societies have played a significant role. Rivers are important not only in the face of the Earth's surface, but human life forms on Earth have specified. (Taloori, 1987). Erosion and sedimentation of rivers affected by the change are varied such that it can change direction, longitudinal and transverse displacements, taking shortcuts, change of river bed elevation change, change, aggregation and transformation of geometric features pointed the way (Hey, 1986).



**Fig. 1:** Geographical location map of the study area

Access to the area by Zahedan- Khash asphalt road so to Mohammad Abad village sidetrack is possible (Fig. 1). The aim of this study engineering geomorphology Shandak river, on the river morphology, to determine changes in direction, involvement in agriculture, river erosion mechanisms and reaction channels is investigated in terms of pattern and transverse and longitudinal

profile and ultimately determine the Glen is stable or unstable.

For this purpose, according to the geology and topography of the area, the river was divided into three sections, each interval morphological characteristics, such as length and radius of curvature, the general trend of movement and erosion, channel width and shape etc. GIS software was calculated by the method of calculation of geometrical parameters were analyzed and interpreted. Comparing 1978 and 2014 aerial photographs were marked changes in the river.

### 2. Geology

Divisions of the geological structure of the study area, in the eastern part of the East flysch zone. Rock units include a variety of rock types ranging from granite, schist and hornfels granodiorite is seen that often turned to the East and West, sedimentary rocks outcrop of flysch.

### 3. Classification of river morphology

Shandak River Study of the classification of the river system (in terms of age, shape, morphology, and from the perspective of Rusgen) is classified and studied.

#### 3.1. Classification of River of age

In parts 1 and 3, erosion has been superseded bed erosion, and has a gentle slope; and also to be able to cross the river sediment transport is a component of mature rivers and in Section 2, the

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dominant erosion, increasing the depth of the show that the level of the river is young.

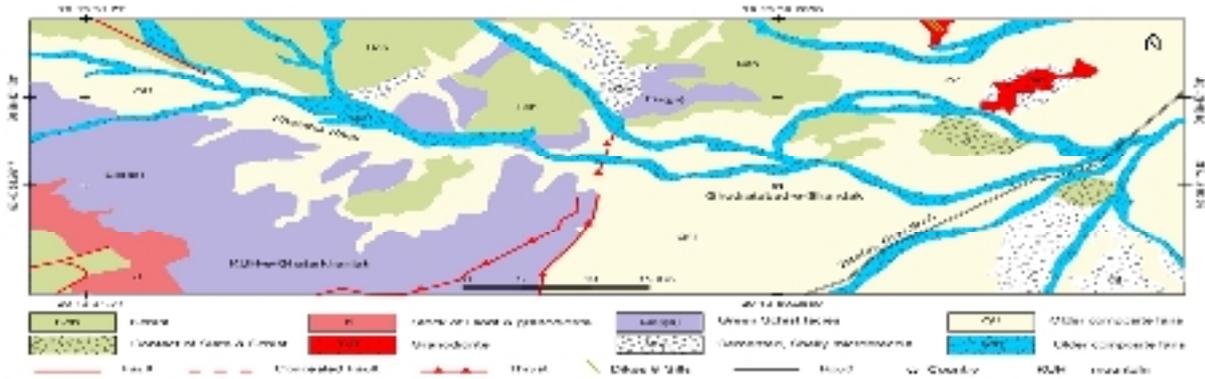


Fig. 2: Geological map of the study area (adapted from sheet Geological Survey 1: 100,000 Zahedan)



Fig. 3: The boundary between the first and second sections of the river Shandak decrease with increasing depth and width (see the South West)



Fig. 4: The boundary between the second and third river Shandak decrease with increasing depth and width (see to the north)

### 3.2. Classification of the river

Shandak River, the 4 screws of sections 2, 3, or meander pattern inscribed Meanders and the rest of the arterial pattern with a gravelly bed, and in Section 1, the pattern of direct river bed is rocky. Shandak River, according to the

average slope of 0.2 to 0.6 per thousand, and the average annual rate of 69.4 cubic meters per second, according to the criteria Leen (1957) and Leopold Volman (1960), generally in the arterial bed of gravel placed.



Fig. 5: Gives an example Braided river bed gravel (view to the south)

### 3.3. Classification of river morphology

Depending on the type of substrate (Fig. 5-1 and 5-2), River Shandak of Section 1 to Section 3, with increasing slope and increase the depth of the channel is encountered, so the morphology Shandak river, the river is Sloper will. 3.4 Classification of the freedom of BedShandak River in this category, in Sections 1 and 2, among the Rocky River bed is controlled in Section 3, is located in alluvial rivers.

### 3.4 Classification of rivers hydraulically

According to the division (Hey et al., 1982), the river is part of the mountainous rivers.

### 3.5. Classification of Rivers stability

Based on aerial photographs, redirect the river, was designated in 1987 and 2014, section 1, is little changed, and in this sense is stable, but sections 2 and 3 have been many changes, so we can Shandak said the river is unstable.

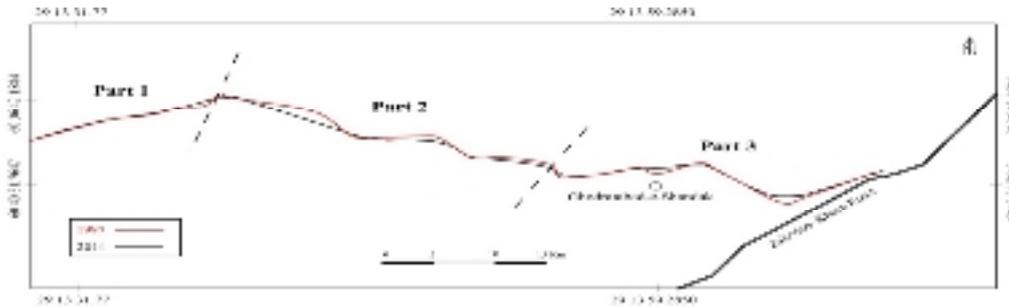


Fig. 6: Changes in Glen Shandak in 1987 and 2014

### 3.6. Classification of genesis

The river, which is part of the stream, which in its current direction, nothing seems to function, but the geological structure of the area, but on the other hand, the geological structure of the area, has set a channel path.

### 3.7. Classification of river classification system Rusgen

Rusgen classification, features such as the shape of the plan, slope, average litter size, the ratio  $W / D$ ,  $En$ , and sinusitis than calculated. The average width of the river is 30 meters; width to depth ratio of cross sections (in most bosses) is more than 12.

Table 1: Characteristics of the study and classification of river

Part	River Plan	Particle size	Mean dip (on 1000)	W/D	Si		
					Max	Mean	Min
1	Straight	Gravel	0.2-0.6	> 12	Direct river		
2	Like Meanders	Gravel	0.2-0.6	≥ 12	1.42	1.24	1.04
3	Meanders	Gravel	0.2-0.6	≥ 12	1.51	1.49	1.46

Due to the characteristics of the river (Table 3,1) and Fig. 3,4 (classification Rusgen level II), Part I Shandak River in C1 to C2, C2 to C4 in the second and third part of the B4 and B5 takes.

Morphological analysis of river banks of the River Stability of Three hydraulic, empirical and qualitative occurs. Shandak River based on a qualitative assessment of the stability of the banks of the river, through simple and practical techniques, such as topographic maps and aerial photos and visits to local authorities.

### 4. River Engineering polymorphic method

Table 2: Characteristics of the studied river bend Shandak

No.	L	AM	Si	R	W	R/W	
1	4230	3560	780	1.18	138	45	3.066
2	1186	980	400	1.21	148	30	4.93
3	890	650	400	1.37	135	60	2.25
4	600	420	280	1.42	130	56	2.32
5	1214	1164	150	1.04	175	28	6.25
6	1139	764	530	1.49	133	37	3.59
7	3576	2368	750	1.51	128	32	4
8	3472	2379	771	1.46	135	34	3.97

According to Table 3, the calculated curve 8, four (4, 6, 7 and 8) with Synvsyth larger than 4/1, are unstable, which can be affected by low gradient river, finer material bed and river sediment

transport capacity is low. From the table above it can be concluded that the river from Part 1 to Part 3 are going to be more volatile.

**Table 3:** Determine the range of stable and unstable river on the geometric parameters of each interval

Part	Si	R/W	River type on Si	River type on R/w
1			Direct river	
2	1.23	3.76	Stable	Expand
3	1.48	3.85	Unstable	Expand

**5. Changes in Cross River**

Transverse sections of the river due to erosion and sedimentation Shandak internal arc bends have experienced localized increase and decrease. Farmers also play a role in changing the width of the river is the river. In Table 5 the minimum, average and maximum river Shandak provided.

**Table 4:** The minimum, average and maximum width of the river

Min (m)	Mean (m)	Max (m)
10	130	250

**6. The role of erosion in the river morphological changes**

Erosion of the river geomorphic changes Shandak, three types of erosion, wind, and the next man, are discussed further in the study is described separately.

**6.1 Wind erosion**

Active processes of morphogenesis in the East, the wind (Alai Taleghani, 2005). 120 days winds from the northern hemisphere are the most popular medium scale wind systems effects in eastern Iran, West and southern Afghanistan and northern Pakistan, is shown.

**6.2. Human erosion**

Human activities such as removal of vegetation in the river, as a result of overgrazing, bushes and trees to fuel you, plowing farmland river to product and Privacy stream capture and structures on on it (the bridge and fountain), development of agriculture in the context of border rivers and streams, etc. play a role in the process of erosion in the past, present and there.

**6.3. Bank erosion**

One of the largest sources of river sediments, river erosion is due to the influence of the characteristics of river channels, flood zones in the development and management of water resources is very important (Tahrshmsy et al., 1388). Erosion-prone coastal waterways of the damage to agricultural land, adjacent facilities and widening of the stream flow (Samadi et al., 1384).

**7. Concluding**

Shandak streams, rivers are classified in terms of age, in sections 1 and 3, the group of mature rivers and in Section 2, the level of the river is young.

Shandak River 4 screws, parts 2 and 3, or Meanders meander pattern inscribed, and the rest of the arterial pattern with a gravelly bed, and in Section 1, the pattern has followed the Rocky River bed directly.

Shandak of river morphology, the river is Sloper. Shandak river classification in terms of freedom of media in Sections 1 and 2, among the Rocky River bed is controlled in Section 3, is located in alluvial rivers.

According to the division (Hey et al., 1982), the river is part of the mountainous rivers.

Shandak River, stream component that is that in its current direction, nothing seems to function, but the geological structure of the area, but on the other hand, the geological structure of the area, has set a channel path.

Rusgen classification level II, Section I Shandak River in C1 to C2, C2 to C4 in the second and the third in Group B4 and B5 are placed.



**Fig. 7:** Tafvny and honeycomb weathering rocks sides of the river (see the East)

Of 8 bends studied, four (4, 6, 7 and 8) with Synvsyth larger than 4/1, are unstable, which can be affected by the low slope of the river bed material and low finer sediment transport capacity the river. From the table above it can be concluded that the river from Part 1 to Part 3 are going to be more volatile. Shandak River that borders on the sector and changes in the lithology is stable.

Transverse sections of the river due to erosion and sedimentation Shandak internal arc bends have experienced localized increase and decrease. Farmers also play a role in changing the width of the river is the river.

In examining the role of erosion in the river geomorphic changes Shandak, three types of wind erosion, human and lateral play a role in changing the way, and the flood of the river.

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