# The Study of Bank Erosion in Kashkan River Meanders

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**Abstract:** Kashkan River is an important branch of Karkheh River. The water basin of this river up to Poledokhtar station is 9400 km$^2$. After passing 270 km and confluence with Seymareh River at western south of Poledokhtar city, the river (which is now called Karkheh River) flows toward Karkheh Dam. This river due to its morphological characteristics includes various meandering and braiding reaches. Bank erosion at the meanders damages valuable agricultural lands and aggravates the danger of floods. The knowledge of the river behavior is useful for its training. To study the periodic changes of the river plan form, topographic maps and satellite photos were compared together and field inspections accomplished. For determining the meanders characteristics and their development rates, numerous field inspections were done and satellite photos used. On the basis of geometric characteristics of the meanders and using empirical relations, the rates of bank erosion at critical reaches were predicted and some technical ideas suggested.
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## Introduction

Problems recognition of rivers meander erosion causes better remedy for protecting against their risks and damages. Problems such as land demolition in river behavior and sediment accumulation behind the dams are some of the aftermaths of bank erosion in meandering rivers. Kashkan River meander causes removing the valuable agricultural lands, and also causes increasing the flood risk, side structures are also at risk. Finally, farming efficiency fall could increase the villagers immigrations rate. Due to national planning, Kashkan meander problems are studied priorities about water. In figure 1, Kashkan basin and sub-basin and in figure 2, its hydrography network in Lorestan Province is shown.

## Meander Geometric Characteristics

Leopold has presented figure 3 to show the characteristics of a meander loop parameters including curvature radius(R), river width (B), meander wave length (L), amplitude (A) and other geometric characteristics. Central angle is an important parameter which is studied in the meandering rivers. The angle of two rays of both sides of a bend is called central angle. Using the central angle, Kornise (1980) has suggested a quantitative-based division in order to categorize the level of 'being meander' in alluvial rivers. It is shown in table 1.

## Meander Geometric Relations

Friedkin and Leopold have presented the Meander Geometric Relations as followed in the relationships 1 and 2 respectively.

$$A = dW^n \quad (1)$$

$$A = 2.7\ W^{1.1} \quad (2)$$

Where, w is width of meander belt, A is amplitude; n and d are fixed coefficients. Relationship 2 is used in English system. The different extensional forms of meander loops are shown in figure 4.

Table 1- Quantitative-based division of alluvial rivers

| Central angle(degree) | River Morphology |
|---|---|
| – | straight river |
| < 41 | Semi Meander river |
| 41 – 85 | Undeveloped Meander river |
| 85 – 158 | developed Meander river |
| 185 – 296 | More Developed Meander-like river |
| More than 296 | River Ox-bow |

## Materials and Methods

Using of sat pictures (ETM) and comparing with its maps of 1958 of mapping organization of Iran, the changing of the river path process was studied, that is explained below.

First, maps 1: 50000 were scanned and special points coordinates exchanged to metric coordinates. Then, the river path was determined and digitized and kept to compare with previous pictures in a separated file. Regarding that pictures should be matched with maps, pictures coordinates correcting based on that maps was conducted. Considering that in some cases it is require knowing the distance and area or perimeter they converted to the UTM coordinate upon which the essential measurement could be done.to do this, zone position should be

determined firstly, then the proper projection system taken. An elliptical (Clarc 1880) and (WGS 84) have been taken. The latitude level that has been taken is the free level of Oman Sea and then using softwares as GIS Ilwis and Arc info the special points with certain coordinate have been converted to the UTM coordinate system and this coordinate has been delivered to the both of the topographic maps and sat photos. to better specify the river path and to make photos more clear, color composites know as false color composite was used that the best composites which specify the river path area, by trial and error was among 1, 3, 4 ETM and 1, 5, 7 ETM bands (figure 5-left and 5-right respectively) which after making color composition of bands and adding related layer to the map that has been obtained by digitizing 1:50000 maps, we can observe the changes in river plan. Of course this overlapping of river plan has causes some errors that it has been tried to minimize them.

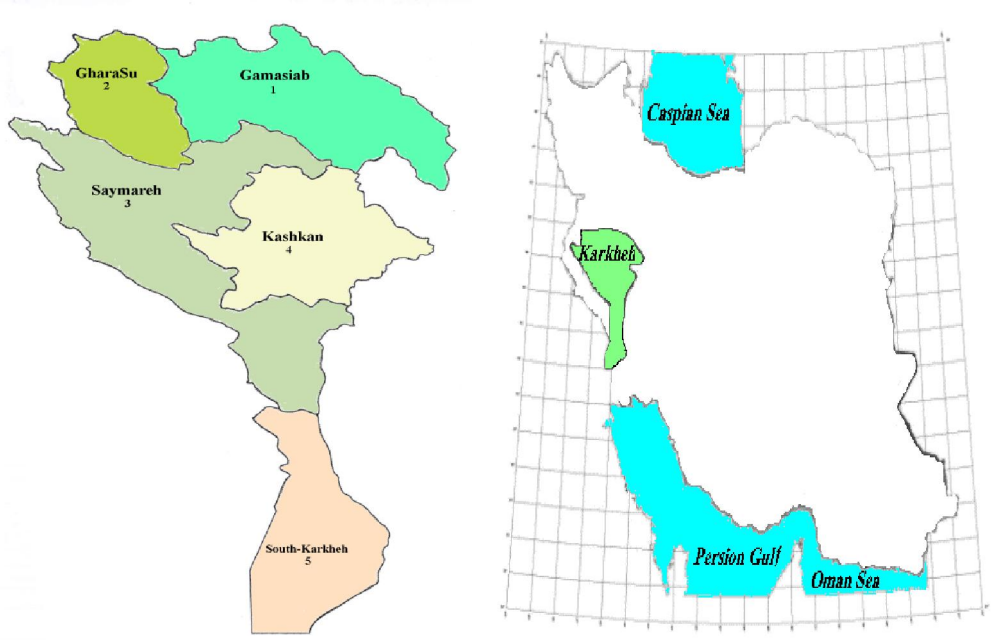



Figure 1- Karkheh basin and its Kashkan sub-basin

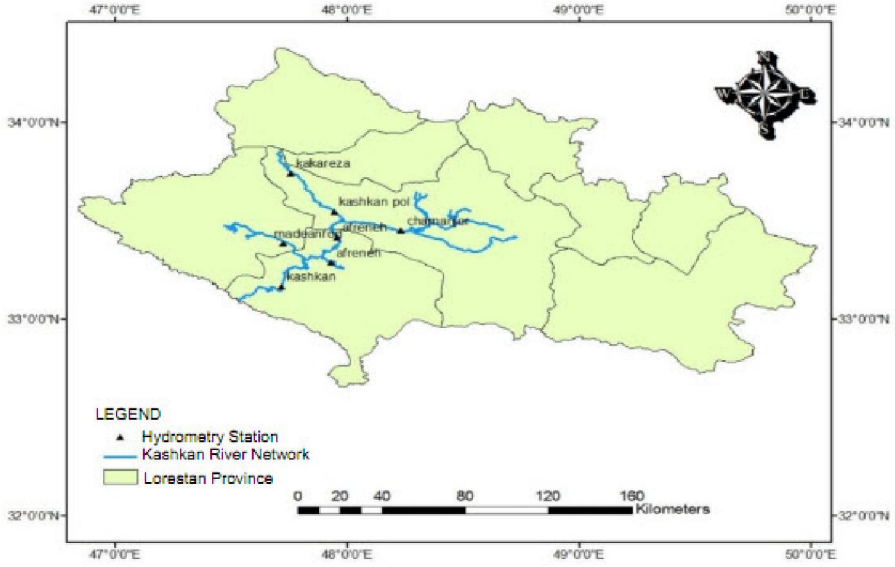



Figure 2 – Kashkan hydrography network in Lorestan Province

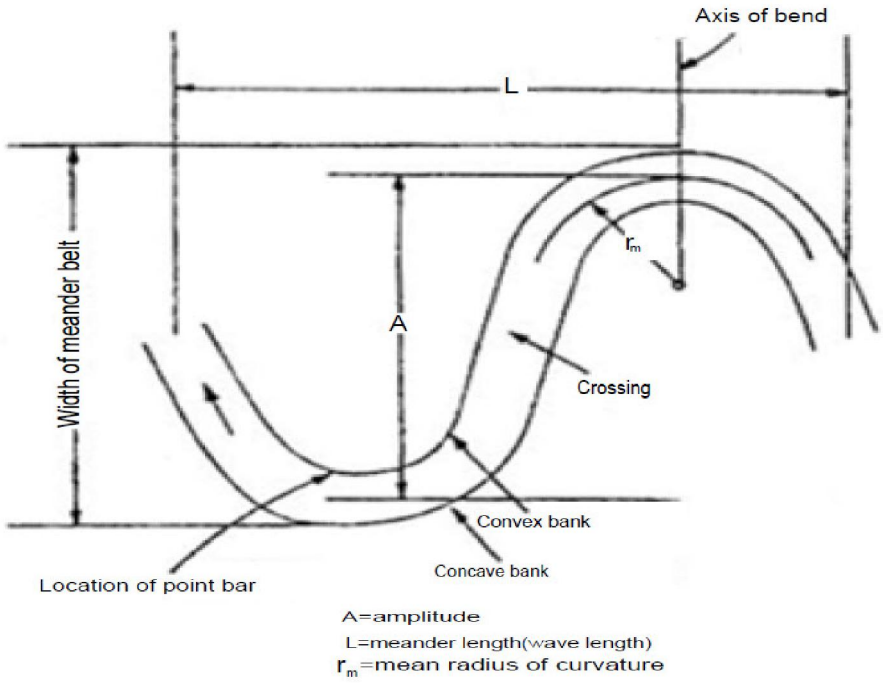
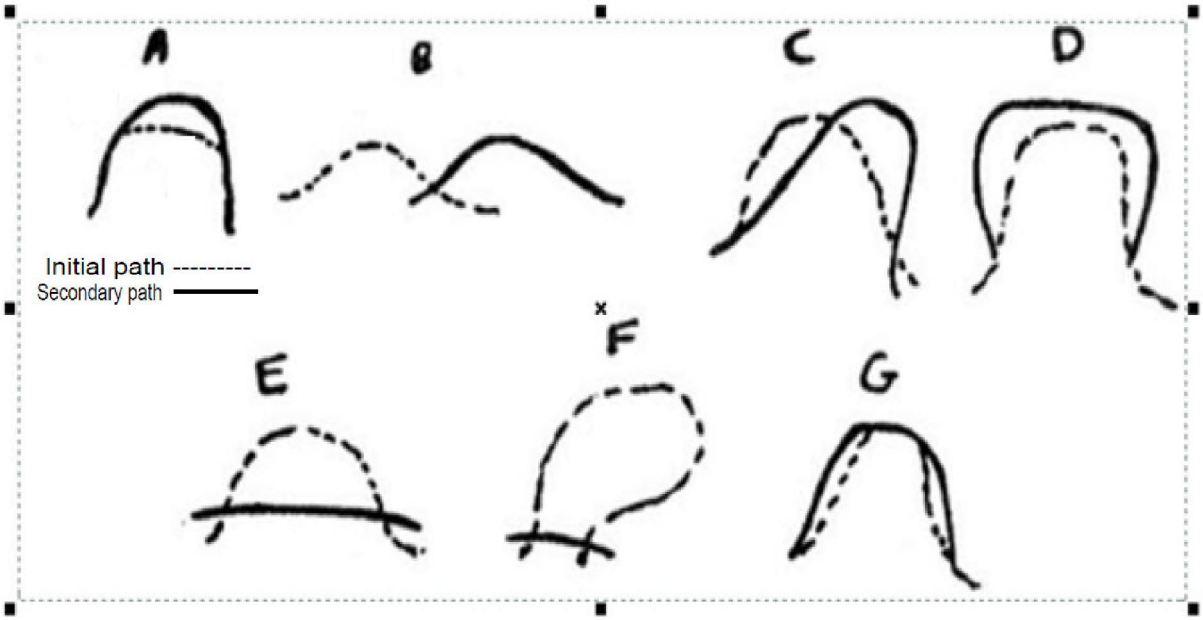



Figure 3 –geometric characteristics of a meander bow




/E=Chute-cutoff/F= Neck-cutoff/G= Lateral extension =Translation/C= Rotation /D= Conversion B/ A=Extension

Figure 4- different extensional forms of meander loops

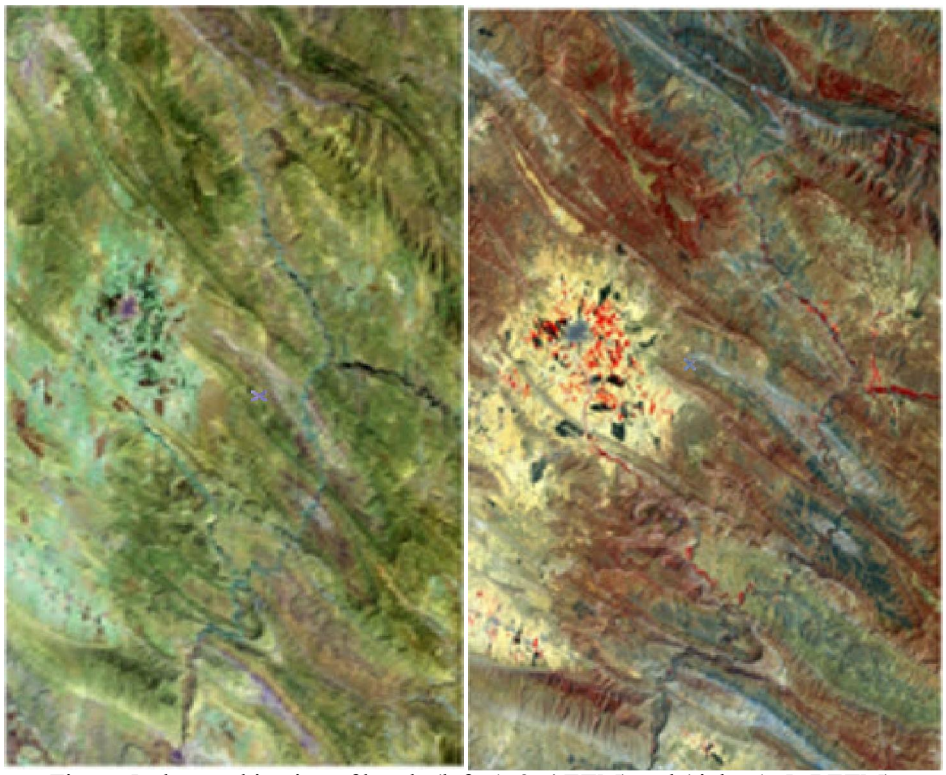


Figure 5- the combination of bands (left: 1, 3, 4 ETM) and (right: 1, 5, 7 ETM)

The taken reach to compare two plans should has following conditions.

1. It should be suited on an alluvium area, since at a rocky and mountainous area the displacement and change in the rivers plan path mainly occur as a result of tectonic processes and bank erosion by river stream has minor role.
2. On the map, both in the old and new plans of the river there should be two specific right and left bank. In other word, the river width should be specified. Because if the river path on the map is only a single curve, considering the scale of 1:50000 maps that is one millimeter on the map is equals 50 meter on the field and taking eye's error into consideration, determining the displacement rate will be accompanied with error or even obvious mistake.
3. There wouldn't be errors caused by matching river's old and new paths as a result of gathering sat photos.

The reach to predict the bank erosion that is obtained from sat photos should has the following conditions:

1. It should be located at an alluvium area because in a rocky or mountainous area the bank erosion by the river stream has minor role.
2. Comparing the old and new plans of rivers it should be specified that the reach would be erosive and it underwent more erosion than other ones.
3. It should have two successive meander loops with a specified width of meander belt.
4. Observations had been done of the river and regarding the nature of the work, it had been tried to visit the river whenever the stream decreases relatively. As in this position the alternate bars, point bars and the bed erosion pattern are specified more and better and the mutual effects of the river hydraulic and its plan geometry can be easily evaluated.

Finally, six regions include Cham palk, Golhu Solfa, Khatereh, Charkhestaneh, Dooab and Dule bozorg were selected to predict their bank erosion.

Also, a reach of the river with 108 kilometer length was considered to measure the geometrical characteristics such as arc radius and arc length, finally considering central angles of each meander loop, its situation in present can be specified. The maximum loop extension till its stabilization can be predicted (Leopold and Wolman, 1960). The calculation sample for the meander in the Cham palk area (Figure 6 & 7) is as following:

Width of meander belt (W) = 550 m, $A = 2.7W^{1.1}$, A=10309.2ft=3143 m

"A" is the amplitude of the meander (Figure3) in the stable position.

The maximum value that river should advance to stabilize naturally=A-W=

3143-550=2593 m,

Hence, the maximum value that river should advance to stabilize naturally, from every side = 2593/2=1296.5 m

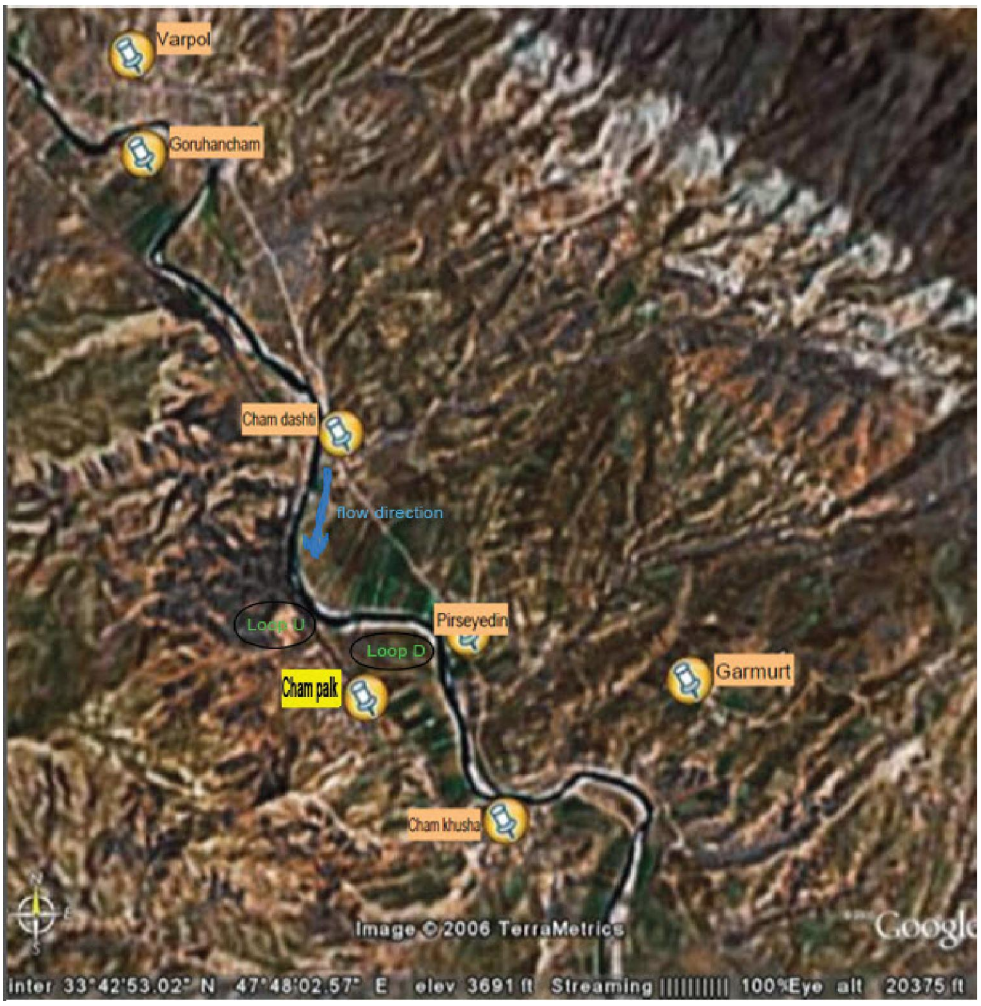



Figure 6: Loops U (upstream) and D (downstream) in Cham palk area


Figure 7: Loops U (upstream) and D (downstream) in Cham palk area

**Results**

Figure 8 shows the central angle of the meander loops. Figure 9 shows the frequency percent of meander Progress at the studying area.at present among 49 studying loops in a reach by 108 kilometer length between Varpol and Teimurabad regions, 6 percent of loops have not been developed. In other word, in this reach, the river meanders have much potential to develop. In Charkhestaneh area the river takes a wide braided pattern. Also in a reach of the river's path in Cham palk area this state is seen. At Kashkan bridge because of the decrease in speed and sedimentation the river has an island (braided) pattern. The ox-bow pattern is seen in Golhu sofla region.

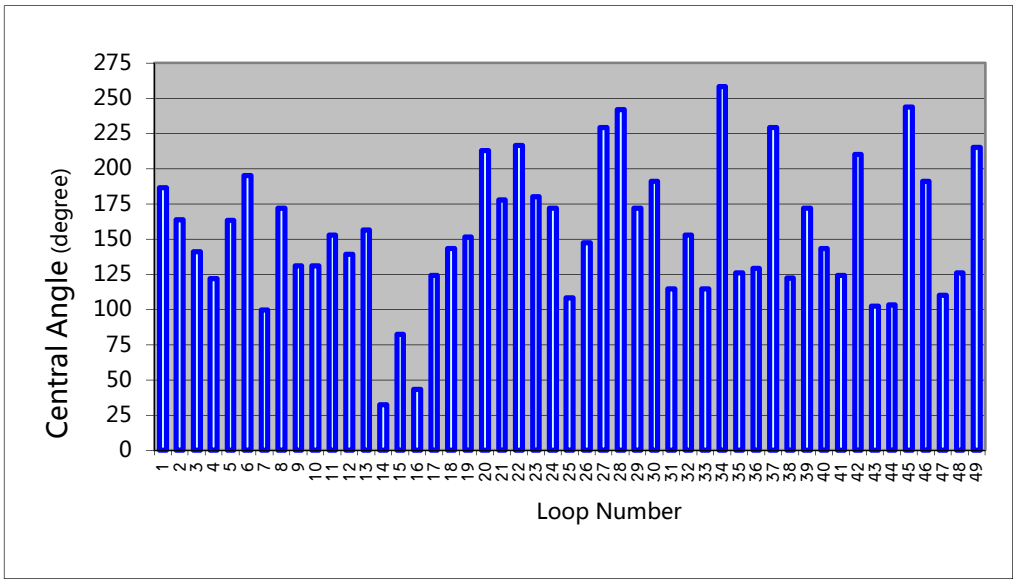



Figure 8: Central angle in erosive loops of the Kashkan River

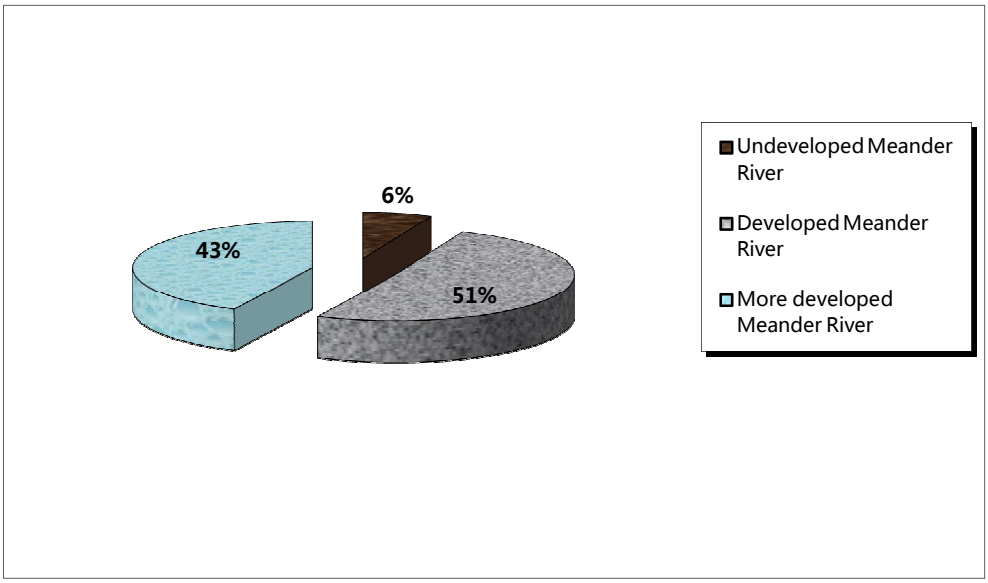



Figure 9: Frequency percent of the meandering progress in the erosive loops of the Kashkan River.

**Conclusion**

Kashkan River since 1958 that related maps are available has undergone bank erosion in its flood plain reach. This erosion in some regions is more and in others is less. In meander bends the rate of erosion is more than other parts that have weaker curvature. The maximum erosion has occurred in the distance between Khatereh and Amirabad regions such that in Charkhestaneh the displacement of river's plan has occurred about 260 meters. The river also has altered its pattern in this area because of the enormous erosion and it takes a braided pattern. At the

downstream of the Kashkan Bridge also plan displacement is seen about 150 meters. The river at the distance between Cham khusha and Golhu sofla has less displacement than Khatereh and Amirabad region. In this reach, river displacement is up to 56 meter.

Based on calculating, it is predicted that on the average the river will advance from every sides in Golhu sofla and at the upper area of the Cham palk 1297 meter (Figures 7&8) to stabilize naturally. The river may have less distance to the stability point at the reachs which had extreme erosion in the past than other reachs. Also it is possible that the river will be more erosive at the reachs which had relatively less erosion to reach its stable point. As an example for the first state it can point to the Charkhestaneh region and for the second one to the Cham palk. But just because the river had less erosion in the past it can't be certain that it will be more erosive in future to reach its stability. Meander loops geometry and obviously width of meander belt are determinant, for example it can point to the Golhu sofla area.

Floods at the year of 2005-2006 a wide range of the precious lands at Charkhestaneh area had been vanished that if the river right bank in this section and close to the village semi-deep well will not be stable, we will see this event again in future.

Generally, the river needs bank stability and engineering practices from Cham palk and Cham dashti to Kashkan-bridge upstream in order to protect agricultural lands. But this doesn't mean to not requiring this in other reachs of the river but because in the mentioned reachs border there are more lands it has more priority.

For the future researches the followings are recommended:

1. The river physical model at erosive intervals can be prepared and doing experiments on the model to complete results.
2. One good solution to study the bank erosion rate of the river during various times is to signify the river bank and following erosion trend through this way. Doing this together with on-time visiting, even the effects of the stream fluctuations and flood streams on the meander extension can be examined.
3. Sampling of the bed (bottom and sides) materials and their gradation analysis can made other results about erosion in the meanders.

**Bibliography**

1-Habibi, M. and A.H. Haghiabi. 2003. An Experimental Investigation on the Threshold of River. Meandering. Pajouhesh-va-Sazandegi, 15, 3-4, 48-55.

2-Haghiabi, A.H, and M .Habibi, M, R, Ahmadipoor, N. Javaheri. 2005. Creation and Change Opinions of Meandering Rivers. Lorestan University.

3-Haghiabi, A, H, 1376.The Hydraulic– Geometric Study of River Channel Changes (case study on Ghezel Ouzan River). M.S. Thesis of Irrigation Structures, Agricultural College, Tarbiat Modares University. Iran

4– Chang, H.H. 1988. Fluvial Processes in River Engineering. John Wiley & Sons, Inc., New York.

5- Friedkin, J. F. 1945. A laboratory study of the meandering of alluvial rivers. U. S. waterways Exp. Sta., Vicksburg, Mississippi.

6- Lopold, L. and M.G. Wolman. 1960. River Meanders. Bulletin of the Geological Society of America. 71: 769 – 794.

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