

STUDY AND DETERMINATION OF MORPHOLOGICAL CHANGES OF DOUGH RIVER IN NORTH OF IRAN USING GIS

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ABSTRACT:

Gorgan River, with its length of 325 km is one of the largest rivers in the Caspian Sea basin. It crosses sensitive erosion reaches and finally joining the Caspian Sea from the Eastern side. The Gorgan River morphology has changed in the last century, due to the geological, topographical and climatologically conditions, as well as due to the human impact. In the following research, morphology of a 13 km long river reach in the vicinity of Gonbad City has been studied. For this purpose, the longitudinal and cross section maps of this reach were prepared, basing on the old documents from the year 1967 and later compared with recent ones, from the year 2003. Further on, some morphological parameters of the Gorgan River have been measured and calculated as for example: sinuosity length, meander length, width of meander belt, average curve radius, amplitude and sinuosity coefficient. It could be concluded, that the number of meanders has increased from 22 to 28 and the meander coefficients from 3.21 to 3.47 respectively. Finally, by means of the t test (Spss software), for some of the morphological parameters in the selected river reach, significant changes have been proved.

1. INTRODUCTION

Rivers and plains fluvial have been the core of formation and maturation of human civilizations since many centuries ago. So those, the shore of rivers are considered as appropriate places for agricultural, industrial and commercial activities. In this regard, this is significant to investigate and study on these phenomena to intention to recognized accurate information and knowledge and assessment of problems and factors toward protection and optimized use of natural resources (Gharib.R and Masoomi, 2006).

Rivers subject influence by natural phenomena and human activities which lead to bed erosion or lateral movement (Zahiri and Jafari, 2006). The movements influenced by natural trend or dissonant human activities along the rivers rout and their dimensions, are the logical reaction of river in regards of establishment a new balance. Any structural and non-structural measurement for rivers must be done based on specific river regulations because any change, even locally, can be lead to larger new effects along the river, so, it can be concluded that, before any activity in river system its better to predict the reaction of it (Telvari, 2004).

Naturally, large flood events are most important and effective factors in linear movement of meanders and also on wave length of it. In case of small flood events, meanders are subject to lateral movement which affects on the wave range (Telvari, 2004, Hoer and et.al, 2006 and Mohammadi and et.al, 2006). Bertodi and Billy (2002) investigated on influences of flood severity on river morphology in part of Sesina River and concluded that, small flood events transfers river meanders towards downstream while large ones combines some meanders

and remove some of them, causes the decrease of sinuosity, number of meanders and also development of straight patterns in river system. The purpose of this research is investigation, recognition and assessment of morphological changes of Gorganrood Great River in vicinity of Gonbad by regarding to comparing of available maps in 2 time periods.



Figure 1. A river menader in Rio Cauro, Cuba

2. MATERIAL AND METHODS

Gorganrood Great River is one of the most important rivers of Caspian Sea river basin which is originated from Narchi Mountains with 1875m height and Bilikoooh with 1598m height in 37km distance from Kalaleh. Gorganrood irrigates the North

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area of Gorgan plain and in Mahichopaghli which nears with Khajehnafas, flows to Caspian Sea from East coast. The length of Gorganrood is 325km. annual mean volume which is estimated in Basir Abad hydrometer station for a 20 years period is equal to 450MM. Maximum discharge peak in Gorganrood is 3000m³/s which was occurred in flood event in

August 2001. In this research in order to assessment of Gorganrood morphological changes in vicinity of Gonban, initially, a reach with length of 13km was selected, coordinate of start and end point of this reach is shown in Table1 and Figure 1 is illustrating the plan of study reach in vicinity of Gonbad and morphological parameters of one of its meanders.

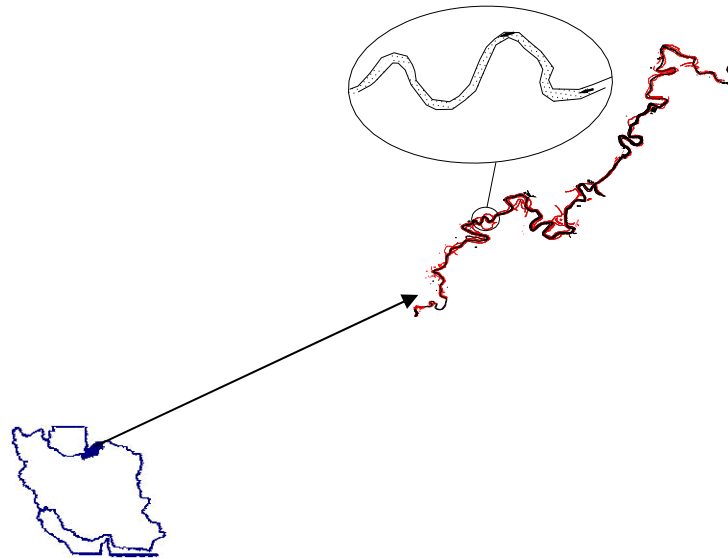


Figure 2: Longitudinal section of study reach and one of its meanders

Reach Name	Start Point		End Point	
	Latitude	Longitude	Latitude	Longitude
Gorganrood	37° 16' 04"	55° 10' 05"	37° 13' 48"	55° 07' 11"

Table 1. Coordinates of study reach

In regard to assessment of Gorganrood great river morphological characteristics digitized topography map of Iran Army Geography Department in 1:50,000 scales was prepared. Beside this, satellite images of Landsat, ETM+, for July 2000 was available. For using of satellite images in first step some modifications have done. These modifications are as follows: geometric corrections, radiometric corrections and georeferencing. These operations give more real and clear view from study area which leads to less error and better image interpretation, finally color composite (RGB) has been created. According to correlation index between various bands (7 bands) best color composite were chosen which was 3, 4, 5. In this color composite river morphology and the other important factors in above mentioned study is more visible. As it clear, accuracy of satellite images is depended to the pixel size of them, on the other hand, in ETM+ images the 8th band pixel size is 14.5m while the rest 7 bands are 29m, so for ultimate results, image of 8th band which is known as Pan, was combined with the other bands image, this operation was done using Fusion command. Beside this, in order to assessment of the morphological condition of the study reach in the end of study period, year 2002 Landsat Satellite images, 1:2000 scaled plan map, longitudinal sections with 1:2000 scale and also the cross sections (1:100) which have been prepared by the Golestan Province General Water Organization in 2003, were used.

For calculation of the morphological parameters of the available meanders in two periods (before and after the flood event) in study reach, initially the available meanders were identified, following this, numeral factors of the meanders such as: wave length (vertical distance between two similar points on the two continues meanders on the river axis), curve length of the meander (length of the central line of the river, from one turning point to the next one), radius of the curve (radius of the circle which is tangent with the most length of the meander) and central angle of the meander (angle between two line connected to the turning points of a meander) and meander width or amplitude calculated in AutoCAD2006 software.

The above mentioned parameters calculated using mathematical analistic methods for both periods of time according to the coordinates of the left and right banks of the river. For estimation of the width and depth of each cross section after flood event, the cross sections map with 1:100 scale which were available were used. Totally, 71 cross sections in the study reach which is ended in Gonbad city were investigated in this research. In addition, in order to optimize the accuracy of the process, outdoor observation was done many times form various sections of the study reach. Afterwards, statistical analysis and comparison of the morphological parameters of the meanders were accomplished in SPSS software using T-test method, in two periods of time, before and after August 2001 flood events.

3. RESULT AND DISCUSSION:

According to the measurement and investigation on the meanders quantitative parameters of Madarsoo river, before and after flood event in August 2001, and comparison of the meanders with similar numeral shapes, it can be concluded that it is not possible to adopt the meanders form with the sinusoid shape. Because, with the comparison between meander shapes with each other, this is clarified that there is not any similarity

between even 2 meanders, it means that there is not any 2 similar meanders in terms of length and shape.

Assessment of study reach shows the decrease in the number of meanders before and after of the August 2001 flood event, from 41 meanders to 28 meander, respectively. On the other hand, base on the available map of cross sections of the study reach the mean width and depth of each cross section is calculated. The result of this process is describing in table 2, which is included, the statistical characteristics of the study meanders.



Figure 3. An oxbow meander in Madarsoo river, Iran

Parameter	Abriviation	Temporal Period	Max	Min	Ave	Std	ancyLimit of Signific
(m) Length	L	Before Flood Evnet	822	174	383.7	171.6	%5
		After Flood Events	1539	388	871.2	296.7	
(m) Wave Length	λ	Before Flood Evnet	627	63	262.9	127.9	%1
		After Flood Events	1402	223.5	673.1	296.6	
(m) Radius of curvature	R	netBefore Flood Ev	180	19	79.3	41.2	%1
		After Flood Events	1469.5	63	274.6	293.3	
(m)Menader Width	A	Before Flood Evnet	377	27	121.2	72.8	
		After Flood Events	388	82.2	214.9	83.4	
Central angle	θ	Before Flood Evnet	292.5	64.5	155.9	60.2	
		sAfter Flood Event	215.5	42.5	124	45.4	
Coefficiant	$L/(\lambda/2)$	Before Flood Evnet	6.02	2.12	3.1	1.1	%1
		After Flood Events	4.53	2.05	2.7	0.5	

Table 2: Statistical Characteristics of the Meanders of Study Reach in Madarsoo River, Before and After of the August 2001 Flood Event

River Type	Central angle	Temporal Period	Frequency
Semi meander	0-41	Before Flood Evnet	0
		After Flood Events	0
Not-matured meander	41-85	Before Flood Evnet	5
		After Flood Events	6
Matured meander	85-158	Before Flood Evnet	19
		ood EventsAfter FI	18
High matured meander	158-296	Before Flood Evnet	17
		After Flood Events	4
Oxbow meander	>296	Before Flood Evnet	0
		After Flood Events	0

Table 3: Changes in Meanders Curves in Madarsoo River before and after Occurrence of the August 2001 Flood Based on the Central Angle

3.1 Central Angle of the Meanders:

According to the Kornis (1980) classification, frequency of the central angle of meanders of the Madarsoo river before and after occurrence of the August 2001 flood is calculated and is shown in Table 3.

By consideration to the above mentioned results, it is clear that, the maximum frequency of central angle of the study reach belongs to the developed (matured) meanders type, both before and after occurrence of the August 2001 flood. Further more, the number of complete developed meanders type is decreased from 17 before flood event to 4 after that. On the other hand, in study reach there is not any observed semi-meander and oxbow meanders type.

3.2 Average Width of River

Investigation of this research proved that occurrence of big flood of August 2001 in Golestan, lead to wondrous changes on Madarsoo river width. In other words, minimum and maximum river width is increased from 6m and 11 m before flood event to 13.5 and 163.3 m after that, respectively.

3.3 Curvature Coefficient

Results of the curvature coefficient calculation clarified that this morphological parameter is decreased from 3.1 before flood event to 2.7 after that. This decrease can be due to the high rate of erosion process during flood event and consequently increase of the river width. This result is conformed by Leys, K. F., and Werritty, A. (1999) and Bartholdy, J. and Billi, P. (2002) results. Also, statistical tests show that curvature coefficient has significant difference in two studied time periods in 1% surface.

3.4 Meander Radius

Assessment of the average of the meander radius in two studied time periods indicates that radius of the meanders is increased due to the flood event, which is the evidence of the development of the meanders. Also, statistical tests show that meander radius has significant difference in two studied time periods in 1% surface. If the study reach classified in three equal sections, each section 10km, it can be concluded that with surveying toward the downstream of the river the meander radius is increasing. The later result is in contrast with Pirvan et. al. (1997) research results. Figure 3 is illustrating the trend of the meander radius changes in study reach before and after occurrence of August 2001 flood.

REFERENCES

- Alijani, B., and Gol Parnian, T. 2004. Synoptic patterns of Gorgan river's floods. *Quarterly Geographical Journal of Territory*. 1:2.1-20.
- Al Yasin, A. 2000. Utilizing of River Engineering for Dez and Karuon Rivers. Iranian Large dams committee press. 603p.
- Bartholdy, J., and Billi, P. 2002. Morphodynamics of a pseudo meandering gravel bar reach. *Geomorphology*. 42:293-310.
- Farazjoo, H. 2003. Assessment of the effect of vegetation cover changes on flood hydrograph in Golestan dam basin by using GIS and Hec-HMS model. M.Sc thesis of watershed management. Gorgan University of Agricultural Sciences and Natural Resources. 176p.
- Julien, P. Y. 2002. River mechanics. Cambridge university press, 434p.
- Hauer, C., Liedermann, M., and Habersack, H. 2006. The Influence of Human Impact to River morphology and aquatic ecology at the Austrian Kamp River. *Geophysical Research Abstracts*. 8:07430.
- Ghraib Reza, M., and Masoumi, H. 2007. Zohreh River Morphology and its variation in Hendijan Delta. *Proceedings of the 7th International River Engineering Conference (in CD)*. Shahid Chamran University, Ahvaz.
- Kouchak Zade. S., and Yousofi, K. 2002. Sediment transport theory and practice. Tehran university press. 446p. (Translated in Persian).
- Mikaeili, A. R., Abdoli, A., and Amini Nasab, S. M. 2005. Physical pattern of the Madar-Sou stream in Golestan national park. *Journal of Agricultural Science and Natural Resources*. 12:3.100-111.
- Mohammadi, A., Firoz, S., Mosaedi, A., Bahrami, A. R., and Bemanzadeh, M. 2007. Study and Determination of Morphological Characters of Gorganrud River. *Proceedings of the 7th International River Engineering Conference (in CD)*. Shahid Chamran University, Ahvaz.
- Morid, S. 2004. Study of Morphological changes and their trends in Karuon river applying RS technique. University technical report. Tarbiat Modares University. 63p.
- Mosaedi, A. 2002. Investigation on explanation and enlarge damage parameters of East Golestan August 2001 flood. University technical report. Gorgan University of Agricultural Sciences and Natural Resources. 40p.
- National Geographical Organization publication. 2003. The phrase geographical book of Rivers in the I. R. of Iran-Caspian sea watershed. Second Volume. 327p.
- Telvary, A. R. 2004. Fundamentals of river training and engineering. Ministry of jahad-e-Agriculture. Agricultural Research and Education Organization. Soil conservation and watershed management institute press. 454p.