Simulation Hydraulic Of Karoun River In Iran With Purpose Indicate Capacity Changes Of River Flow With HEC-RAS Model

Samaneh Abdeveis[1]*, Fatemeh Zakeri Houseini[2], Narges Zohrabi[3], Mozhdeh Jamei[4], Hamed Khedmati[5]

[1,2]Department of Basic Sciences of Water Resources, Khouzestan Water and Power Authority, Iran.
[3]Department of irrigation, Science and Research Branch, Islamic Azad University, Khouzestan-Iran
[4]Department of Agro Meteorology, Khouzestan Water and Power Authority, Iran
[5]Young Researchers club, Science and Research Branch, Islamic Azad University, Tehran, Iran

Abstract

Generally, a river system from source point to the discharge point is subjected to continuous morphological changes for example degradation or aggradations of bed River. The present study attempts to investigate the morphological changes of the Karoun River and explore the effects of the river floods especially within Ahvaz region. In this regard, the observed changes in the rating curve at Ahvaz and Farsiat stations over a specified period showed that for a constant elevation of water surface, the river flow has reduced. In this study the changes of the water level profile using whit hydraulic model HEC-RAS was simulated and profiles were plotted with floods of a 2 to 200 years return period. The results showed that the water profile level with same return period flood for 2000 and 2004 year between Ahvaz-Farsiat stations has increased. This indicates the aggradations of the bed due to sedimentation process. This demonstrates a reduction in the river flow capacity.

Key words: Karoun River, Ahvaz, Morphology, Flood, HEC-RAS Model.

Introduction

It is evident that the study of water resources in a region are critical to the economic and societal development planning and flood occurrence as one of the natural events that has always been threatening the human communities residing along the rivers .Due to the destroy nature of this phenomenon, numerous efforts have been made to understand the causes and consequences of it. Studies of the river morphology changes and its impacts as one of the floods create causes are important.Chuenchooklin et al (2007) used mathematical simulation model river analysis system (HEC-RAS) for the estimation of main hydraulic parameters of the Yom River. The results of HEC-RAS when using the upstream river discharge in the Yom River in to Sukhothai approximated 400 cu.m/s, shown that if the retarding pond with the storage capacity of 32 million cu.m, and a diversion channel with the capacity of 50-100 cu.m/s were constructed. The reduction of water levels almost none flood occurred in Sukhothai city. At present, most river flood forecasts are conducted using a two-step procedure. First, flood routing is conducted, normally using hydrological models. The resulting flood peaks are then converted to water level forecasts using a steady flow hydraulic model, such as HEC-RAS. Recently, the HECRAS model has been extended to facilitate unsteady flow analyses (Hicks and Peacock, 2005). Adams et al (2012) have been described about the Ohio River Community HEC-RAS Model (Model) and include some preliminary results. The Model is a cooperative effort involving the U.S. National Weather Service (NWS), Ohio River Forecast Center (OHRFC) and the U.S. Army Corps of Engineers (USACE), Great Lakes and Ohio River Division (LRD), Water Management Division. Salajegheha et al (2009), used of output of the HEC-RAS hydraulic model, for two- and three dimensional floodplain mapping and analysis in the Arc View. David and Smith (2000) studied a hydraulic behavior of river by using HEC-RAS software and their results showed the capability of HEC-RAS in simulating hydraulic behavior of river. Yang et al (2006), First with HEC-RAS simulated water surface profiles throughout the system for six different design storm events then used result of model in digital elevation model (DEM). In the final, flood plain zones for the six design storms were reproduced in three dimensions. Khouzestan province is located in the southwest of Iran with several great rivers that plays a significant role in the water system of the country. Karoun river as the greatest river across the country carries a vast volume of water annually through Khouzestan plain and finally to the Persian Gulf. The length of Karoun is about 890 km and its watershed is about 62570 km^2. The present study deals with the changes to the flood occurrence of the Karoun river and the arising threats due to it in the Ahvaz urban region Studies of the river morphological variations and its impacts as one of the flood create causes are important.

Material and methods

In this study,the reach of Karoun river was began about 11 km upstream from Ahvaz hydrometric station (X:284395 Y:3473380) and its end was in the Farsiat station (X: 263058 Y:3451563).The study reach is as long as 60 km. Fig.1 shows the situation of Karoun river.

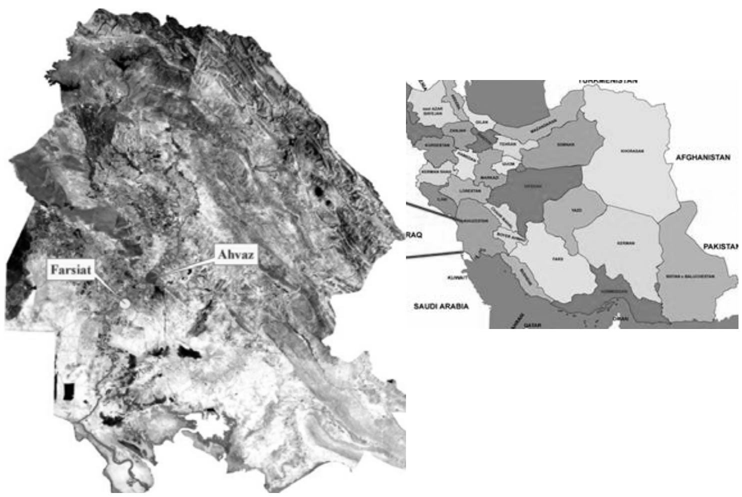


Figure 1. The situation of hydrometric stations on Karoun river

HEC-RAS Model (USACE,2002): This model is capable of performing one-dimensional flow calculations in steady and unsteady condition. The hydraulic analysis component of steady flow in this model has been provided to calculate the water level profiles under gradual varied flow. The major procedures used for calculations are based upon solution of the one-dimensional energy equation.

Long-term Morphological Changes: For this purpose time values are placed on the X direction of a coordinate system while stage variations are place on the Y direction and then different stages are plotted against time variations for a specific discharge .If points representing different stages corresponding to the related discharges are changed slightly in relation to time, hence the bed changes over time are insignificant and the river cross-section is considered to be nearly stable. However, if these points show an either ascending or descending trend over time, it indicates sedimentation or bed erosion.

Data required by the Model: In order to run HEC-RAS model, geometric and hydrologic data and boundary conditions are required.

A) Geometric Data: The cross-sections of the river taken in 2000 were used as geometric data. These sections begin about 11 km upstream Ahvaz station and end with the Farsiat station. The reach under study was as long as 60 km.

B) Manning Roughness Coefficient and Model Calibration: HEC-RAS Model calibrate with estimate the values of roughness coefficient for the main channel and river banks. Field observations and interpretation of site photos and also with using previously study was selected. Finally after several run model and were been observation and calculation values of water level in up stream channel the n value has been consider 0.029 for flood plains and 0.027 for main channel.

C) Hydrologic Data: To investigate the variations of water level profiles, discharge values with return periods of 2 to 200 years were used .In this study the flood frequency analysis at the Ahvaz station where is upstream boundary condition of the river reach were used .In this analysis with Hyfa two-parameter gamma method has the best fitting. The results of the analysis are shown in Table (1).

return period (year)								Distribute	statio n
200	100	50	25	20	10	5	2		
7580	6934	6272	5587	5360	4628	3834	2580	Gama (II)	Ahva z

Table 1 . Discharge with different Return period

D) Boundary Conditions: Considering the fact that the Karoun river flow along the studied reach is subcritical, providing the boundary conditions of the downstream to the model is necessary. Thus, stage-discharge values of the Farsiat hydrometric station (2001 and 2004) as downstream boundary conditions to simulate the flow and determine the water level profile of the river reach were used.

Finally with these information's the cross-section of the river and the stage-discharge values of the Farsiat station as the down stream boundary conditions of the river and floods with return periods of 2 to 200 years as up stream boundary conditions were defined to model. Model was calibrated after several run and were been near observation and calculation values of water level in up stream channel with regulation n value. Then the model was run with boundary conditions of down stream for 2001 and then for 2004, but in two run of model conditions of up stream (Hydrologic Data) river and geometric data are constant.

Results and discussion

A) **Results of Long-term Morphological Changes:** Based on this method, the stage-discharge of 40 years at Ahvaz station and 14 years at Farsiat station was considered. Such were chosen flow discharges of 1000, 1500 and 2000 cu.m/s and their stage-time curves were developed for the both stations (Fig.2 and 3).These figures show that the curves demonstrate an up sloping trend. The existence of different stages for a constant discharge indicates that the water level is increasing. Change stage for constant discharge show that water level is increasing.

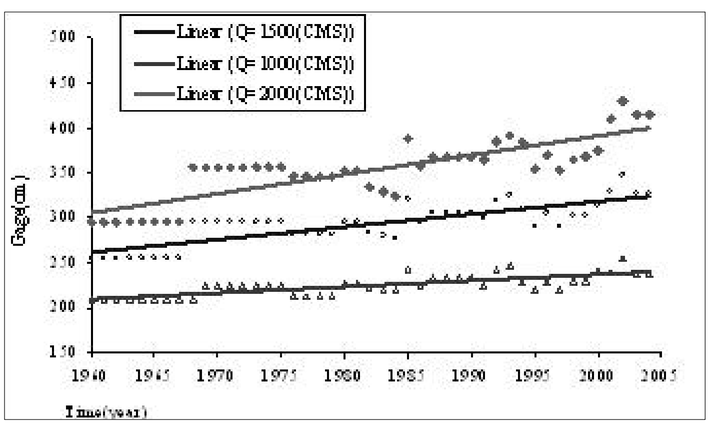


Figure 2. Long-term changes (increase) stage with constant discharge Karoun River - Ahvaz station

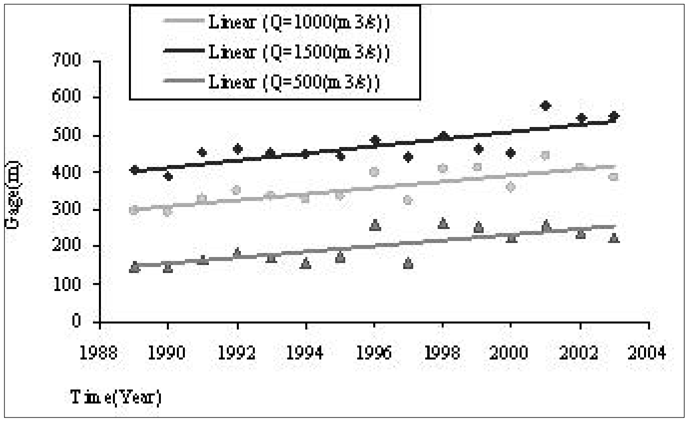


Figure 3 . Long-term (increase) Stage with constant discharge , Karoun-Farciat station changes

B) Results of model

In order to investigate the impacts of riverbed aggradations on water level profile in Karoun River, Table (2) presents water levels for floods with different return periods at Farsiat station for two years of 2001 and 2004 with their differences. Note that the values of the last column in Table (2) have been calculated with the assumption that the walls at the either end of the cross-section in the model are vertical. Figure (4) to (11) represent the water level profile curves over the river reach under study for 2001 and 2004.

Table 2. Water levels for floods with different return periods at Farsiat station for 2000 and 2003

Return periods	Discharge	Water levels(2000)	Water levels(2003)	Water levels difference
year	(cu.m/s)	(m)	(m)	(m)
2	2580	9.05	10.69	1.64
5	3834	10.35	13.30	2.95
10	4628	11.13	1496	3.83
20	5360	11.86	16.48	4.62
25	5587	12.08	16.96	4.88
50	6272	12.76	18.38	5.62
100	6934	13.42	19.76	6.34
200	7580	14.06	21.11	7.05

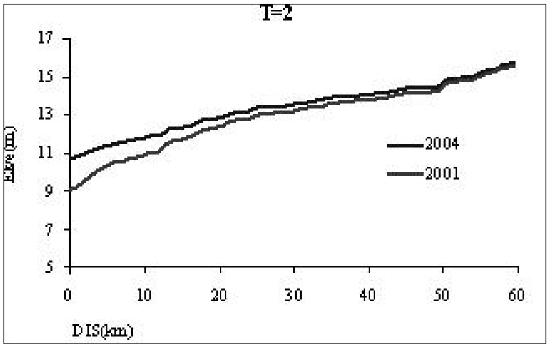


Figure 4. Difference of water level profiles r.p 2year

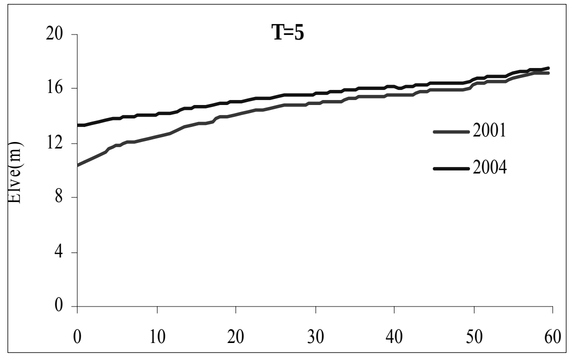


Figure 5. Difference of water level profiles r.p 5year

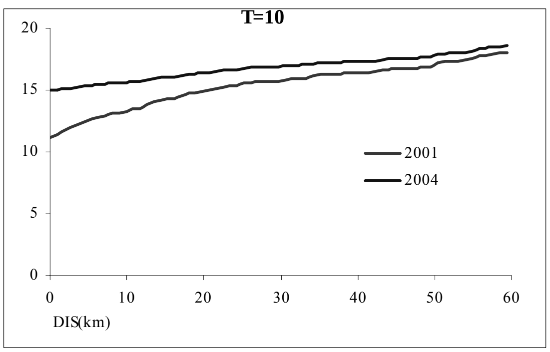


Figure 6. Difference of water level profiles r.p10 year

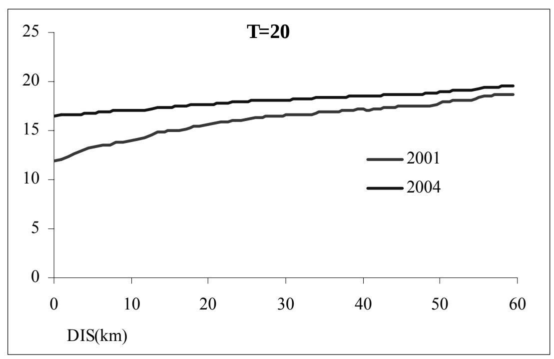


Figure 7. Difference of water level profiles r.p20 year

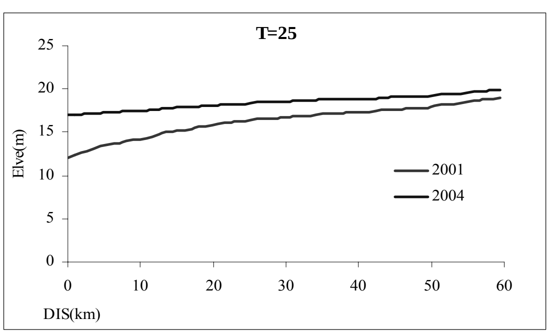


Figure 8. Difference of water level profiles r.p25year

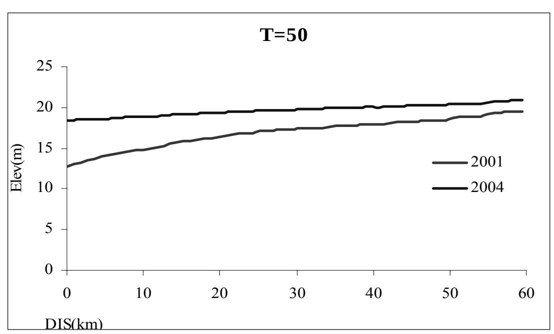
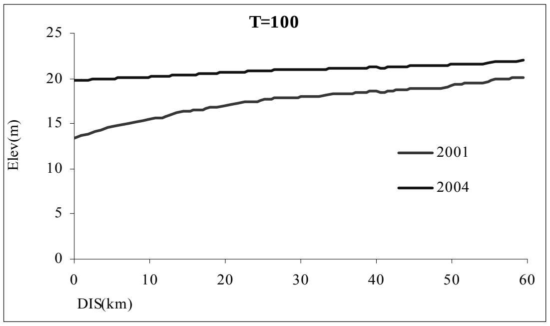


Figure 9. Difference of water level profiles r.p50year



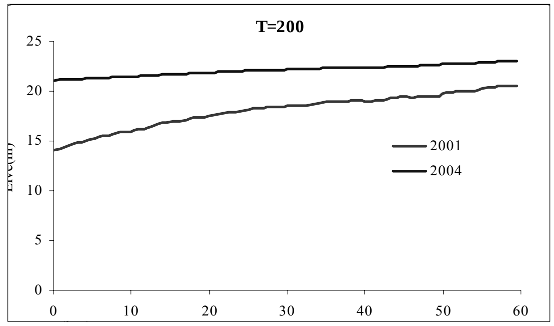


Figure 10. D… of water level profiles r.p100year

Figure 11. D… of water level profiles r.p200year

The results of the model showed the water level profile with a discharge of different return periods has increased in recent years (Fig 4 to 11). The difference of water level profiles well indicates the morphological changes in form of bed aggradations. This shows that the flow capacity of the river channel has decreased and consequently the flood plain on the margins of the river with a given discharge of the same return period has increased.

C) Variations of Water Levels at the River Sections

Variations of Water Levels at the River Sections were indicated by Figures (12) to (17) too. Considering the fact the water level increase is represented by the model by two vertical walls at both ends of the section. Some sections have been selected as sample with a given discharge of return periods of 2 and 5 years for 2004.This sections show discharge with the return period of 2 years is full and beyond which it flows into the marginal flood plains.

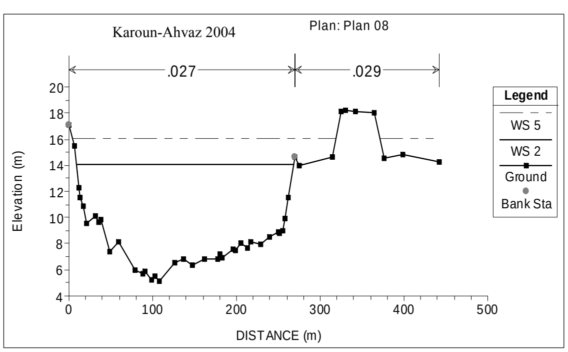


Figure 12. Ahvaz station (2004)

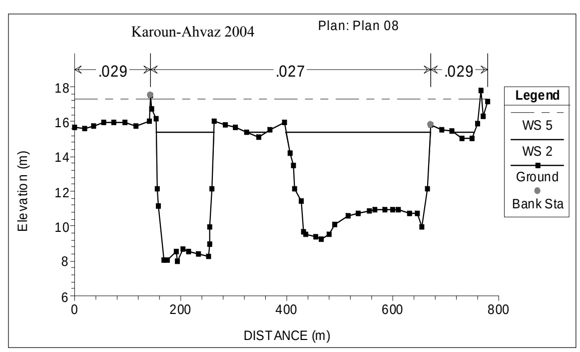
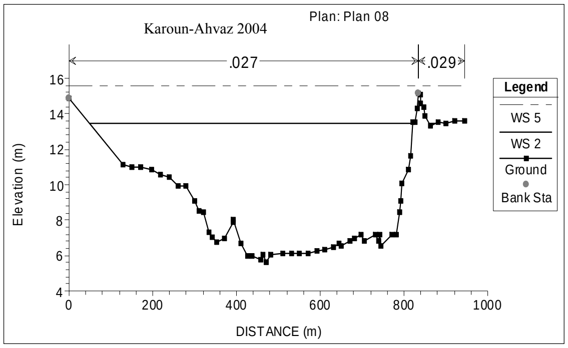


Figure 13. 1 km distance-up Ahvaz station



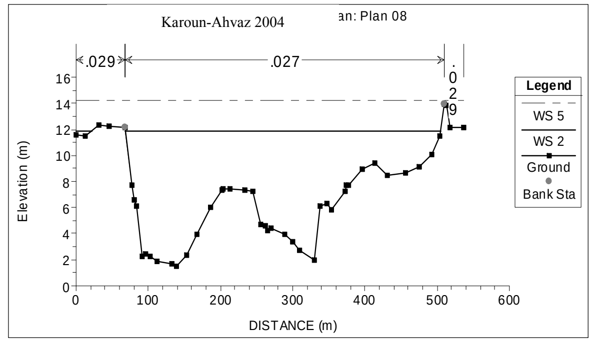
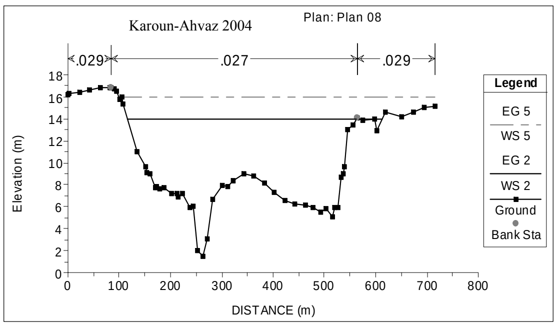


Figure 14. 12 km distance-down Ahvaz station

Figure 15. 30km distance-down Ahvaz



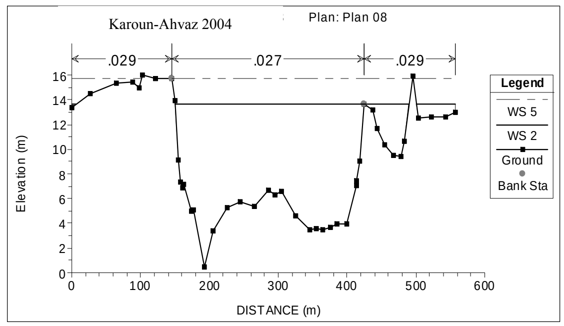


Figure 16. 4 km distance-down Ahvaz station

Figure17. 8 km distance-down Ahvaz station

Conclusions

The results of HEC-RAS Model run in case study show that the water level profile with a discharge of different returns periods has increased in recent years. Also the difference of water level profiles well indicates the morphological changes of Karoun River in form of bed aggradations. This shows that the flow capacity of the river channel has decreased and consequently the flood plain on the margins of the river with a given discharge of the same return period has increased. Considering the existing signs of bed aggradations of the Karoun River especially within the Ahvaz region, the flow capacity of the river channel can be increased through continued dredging operation and thus the consequences of the flood can be mitigated within the region.

Acknowledgments

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References

1. Chuenchooklin s, Mekprugsawong ph, Chidchob p. 2007. The river analysis simulation model for the planning of retention area and diversion channel for flood reduction in the lower Yom's river basin. Thailand.
2. Hicks FE, Peacock T. 2005. Suitability of HEC-RAS for Flood Forecasting. Canadian Water Resources Journal. Vol 30(2): 159–174.
3. Adams T,Chen s, Davis R, Schade T,Lee D. 2012. The Ohio River Community HEC- RAS model. http://www.erh.noaa.gov/ohrfc/hecras.html.
4. Salajegheha A, Bakhshaeib M, Chavoshic S, Keshtkara AR, Najafi Hajivara M. 2009. Floodplain mapping Using HEC-RAS and GIS in semi-arid regions of Iran. http://journals.ut.ac.ir/
5. David A, Smith A. 2000. HEC-RAS 2.2 for backwater and Scour analysis-phase one. Department of Civil and Environmental Engineering. University of Kansas Lawrence. Kansas. pp: 88.
6. Yang J, Ronald D, Townsend R, Daneshfar B. 2006. Applying the HEC-RAS model and GIS techniques in river network floodplain delineation. Canadian Journal of Civil Engineering.
7. USACE1:US-Army Corps of Engineers. 2002. HEC-River Analysis System. Hydraulic reference Manual, Version 3.1.http://www.hec.usace.army.mil/software/hec-ras/, 2002.