American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-4, Issue-7, pp-233-245
www.ajer.org
Research Paper Open Access

Simulating the Erosion and Sedimentation of Karun Alluvial River in the Region of Ahvaz (Southwest Of Iran)

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ABSTRACT : *Since the rivers are the main basic and accessible resource of water for miscellaneous uses, the erosion and Sedimentation condition of rivers are of a great deal of importance. Karun River, the greatest river of Iran, has a considerable interest because of strategic and environmental conditions regarding its water projects planning, agriculture, water supply of cities, and industrial units. The morphological changes due to erosion processes, sedimentation, and Sediment transport affects the hydraulic structures like Intake port, irrigation systems, and pump stations. Thus, the present research deals with the simulation of erosion and sedimentation processes and also considering cross section geometric changes, prediction of river thalweg, and total sediment load of Karun River using HEC-RAS model. The simulation periods of this research is 10 years from 2001-2011. The results show that the Karun River has had sedimentation in its most cross sections while the erosion has been rarely observed. Additionally, the Englund–Hansen and Ackers–White sediment transport functions propose better results about the river changes. According to the HEC-RAS results and the measured data, river training of dredging is necessary at the studied site especially at the Ahvaz urban areas. Also, at the river parts which are under erosion the stabilization procedures for the banks and walls, is suggested. The result of this work can be an appropriate pattern about the situations of Karun and effects of erosion, sediment transport, and sedimentation processes.*

KEYWORDS: *HEC-RAS Model, Manning roughness coefficient, Thalweg, Sediment transport, Dredging.*

I. INTRODUCTION

Rivers are the most important resources of water supply for various uses. Thus, the knowledge of river situation and erosion and sedimentation conditions are the main priorities of each engineering project of the river. The river is a dynamic system undergoes continuous changes always. The knowledge of sedimentation phenomenon including the erosion, sediment transport, sedimentation, and consolidation of sediments are of a great deal of importance. Reasonable estimate of sediment transport rates in alluvial rivers is important in the context of a number of water management issues (Bhattacharya et al, [1]). Sediment transport is a widely studied topic in which numerous researches have built models for predicting bed material transport rates in an alluvial river (Bhattacharya et al, [2]). Information on soil erosion and its effects on water quality at catchment scales are increasingly sought by catchment managers (Merritt et al, [3]). Among several problems resulted from complicated erosion processes, the deposition of sediments are more important especially in rivers having the ability of high sedimentation level.

Karun River is of a great deal of importance as the greatest river of Iran because of climatic conditions, environmental effects, strategic location, hydraulic structures, and procurement of great agricultural plans, and water supply. Since Karun River has many hydraulic structure from its upstream to Persian Gulf downstream such as huge dams and bridges, the morphological and sedimentation condition of the river undergo widespread changes. The study of Karun River situations from hydraulic standpoint especially in downstream of these structures is an inevitable issue. Sedimentation in Karun River results in several problems in using high potential of the river in addition to problems for intake equipment's and pumps stations causing damage of mentioned structures. An important point is that the loafing capacity of the river decreases because deposition of sediments resulting in morphological changes. In other words, the great rivers like Karun have miscellaneous plans and projects, thus knowing and prediction of river conditions in order to optimum fulfillment is of considerable importance. Karun River has specific properties in river reach of this research from Ahvaz-Farsiat as follows:

i) The Karun River passes through Ahvaz as the center of Khouzestan province, Therefore, potential flood control, water transportation, city proportion and etc have strategic importance.
ii) There are a lot of hydraulic structures in Karun River route including huge bridges.

iii) The river reach have several meanders and islands having diverse vegetations. Thus, the study of erosion and sedimentation situations of the Karun River is important.

The main gold of this survey is evaluation of erosion and sedimentation conditions of Karun River that it reach passes through Ahvaz city.

The river engineering researchers have widely considered the erosion and sedimentation processes using different methods. Einstein, [4] has been one of greatest researchers in sedimentation field. The elementary researches of erosion and sedimentation were performed by Bagnold considering the transport of sand particles. He divided the transport particles into 2 bed load and suspended load (Bagnold, [5]). Van Rijn also performed valuable researches about sediment transport (Van Rijn, [6]). Nowadays, mathematical models are important instruments for study of rivers. Sediment transport in areas such as rivers, lakes or coast, can be modeled by mathematical model with a hydrodynamical component and a morphodynamical one (Morales de Luma et al, [7]). The sediment transport in alluvial rivers resulted from interactions between hydraulic conditions and the river bed characteristics (Azarang et al, [8]). The studies on river engineering through numerical and mathematical methods have been developed because of the great upsurges in computer science. Mathematical models are useful instruments to solve the problems of erosion, sediment transport, and sedimentation in river. There are advanced mathematical models which perform the simulation process of catchment sediment and river reach efficiently. The models like HEC-6, HEC-RAS, SSIIM, Seflow, MIKE-11, GSTARS, and Susflow have been widely used by many researchers to simulate the erosion and sedimentation situation of the rivers. The HEC-RAS model has been added to this list as water engineering software being able to simulate the sedimentation situation of the river widely used in simulation of different rivers of the world. The main mentioned researches are as follows: HEC-RAS model has been used to predict the sedimentation conditions in mountainous rivers (Rathburn et al, [9]). To simulate the scouring, erosion, and sedimentation in ephemeral channels, the HEC-6 model has been utilized (Canfield et al, [10]). Gibson et al have considered the capability of HEC-RAS model to calculate the sediment transport of the river (Gibson et al, [11]). In our previous research reported at 2015 in Persian, we have used the HEC-RAS model to consider the erosion and sedimentation of Karkheh River in Iran. Karun River has been widely studied in Iran because of high importance of this river and having critical engineering plans along this river. Shahinezhad et al, have used the GSTARS model to study the erosion and sedimentation processes of Karun River in suburban area of Ahvaz and reported the Ackers – White and Toffaleti as the superior relations (Published in Persian). Also in our published paper at 2010 in a Persian journal we have applied the CCHE1D software for hydraulic and sedimentation simulation of Karun River which is in agreement with Englund- Hansen as the best sedimentation load equation and sedimentation of 2.5 million tons per year estimated for Karun River in this reach.

II. MATERIALS AND METHODS

Karun Catchment

From hydrological classification, the Karun Catchment is a subset of Persian Gulf and Oman Sea. The Karun Catchment is located in Khouzestan, Lorestan, Chahar Mahal Bakhtiari, Kohkiloye - Boyer Ahmad, and Isfahan provinces. This catchment is limited to Dez Catchment in north, Zayandehrood Catchment in west, Zohreh and Jarahi Rivers Catchments in south, and Dez and Karkheh Catchments in east. This catchment has an area about 67257 km^2. Important cities of this catchments include Yasuj, Shahrekord, Masjedsoleiman, Shoushtar, Ahvaz, Abadan, and Khoramshahr. 67% of Karun Catchment is the mountainous areas and 33% of it is the plains and foothills which major of it is located in Khouzestan plain (Behan Sad Consulting Engineers Co reported in Persian, 2010). The figure 1 depicts the Iran and Karun catchment.

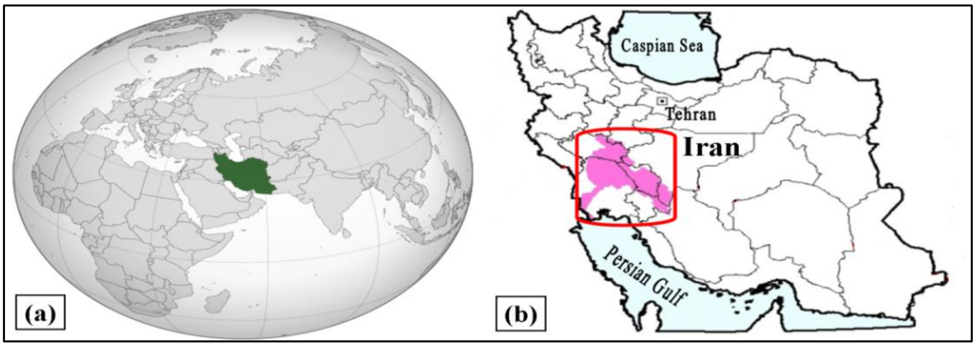

Figure 1: Location of Iran in the World (Wikipedia) and b Karun River Catchment in southwest of Iran

Karun River

The head water of Karun River is in central Zagros Mounains and Zardkouh Bakhtiari located in Kouhrang and its first great branch is called Kouhrang. Karun River is the greatest river of Iran and is 900 km long. Four main branches of Karun are: Khersan, Ab Vanak, Ab Kiar, and Bazoft. River reach of Karun in this research is considered as an old river becasue of lits low slope and having wide cross sections. Also, this river is classified as the suspended load in Ahvaz-Farsiat reach because of low slope and high depth and The sinusoidal coefficient of the river is around 2 (Behan Sad Consulting Engineers Co reported in Persian 2010). The bed load of the river in this reach is considered 10% of suspended load. Karun River has a braided river in under study reach. Figure 2 shows the parts of Karun in under study reach passing through Ahvaz city.

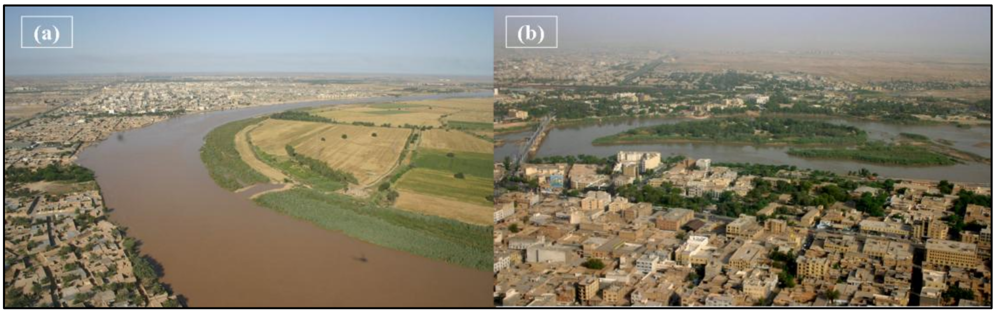

Figure 2: Images of Karun River in Ahvaz city, a Suburb of Ahvaz City and b Center of Ahvaz

In this paper, the statistic data of 2 hydrometric stations in upstream and downstream reach in Ahvaz and Farsiat were used. Table 1 shows the data of two mentioned hydrometric stations.

Table 1: Specifications of the Ahvaz and Farsiat hydrometric stations

Station Code	*Station Name*	*River*	*Longitude (UTM)*	*Latitude (UTM)*	*Equipments*	*In Operation*	*Altitude (m)*
21-309	Ahvaz	Karun	3469350	280701	Limnograph Staff gage	1950	9.787
21-465	Farsiat	Karun	3451555	263017	Staff gage	1973	3.015

The area of Karun Catchment is 61088 km^2 in hydrometric station of Ahvaz and its mean annual discharge is 673 m^3 per year. Also, the amount of specific discharge of sediment is 173.65 ton per year in km^2 while the specific discharge of sediment in hydrometric station of Farsiat is about 178.41 ton per year per km^2 (Behan Sad Consulting Engineers Co reported in Persian, 2010). Figure 3 shows hydrometric stations of Ahvaz and Farsiat on Karun reach.

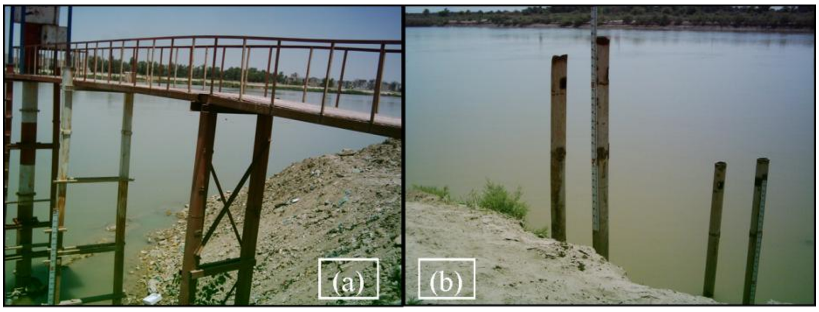

Figure 3: Images of Karun hydrometric stations, a Ahvaz station b Farsiat station

Figure 4 shows the Karun Plan and location of hydrometric stations on google earth software.

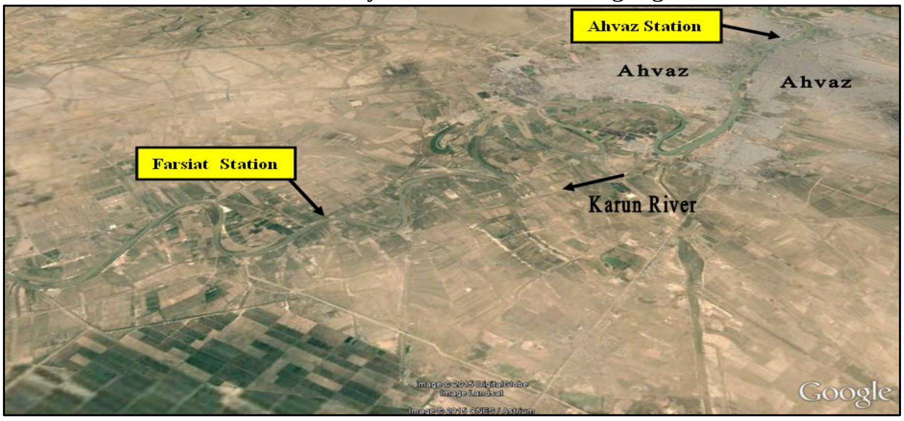

Figure 4: Studied Plan of Karun River and hydrometric stations of Ahvaz and Farsiat

Karun River Bridges

Hydraulic structures such as bridges have built on Karun River in Ahvaz. These bridges highly influenced the river flow regime and sedimentation pattern. Hence they have introduced in brief here; now 8 bridges are in operation in Ahvaz. First of all is Siah Bridge which has 1050 meters long, 6 meters wide and 52 bases that built in 1929 for train passing between Tehran, Khorramshahr and Abadan. Second bridge or Sefid Bridge built at the center of Ahvaz for traffic and counted as the forth cantilever bridge of the world at its building time of 1936. It has 501 meters long and 9 meters wide. Shahid Daghayeghi Bridge with 496 meters long and 15 meters wide built in 1970 at the upstream of Karun River. Naderi Bridge is the forth bridge with 576 meters long and 17 meters wide built in center of Ahvaz city in 1977. Fifth Bridge at the downstream of Karun River has 480 meters long and 31 meters wide built in 1996. Sixth Bridge named Foolad has 400 meters long and 20 meters wide, is situated at the southern of Ahvaz. Seventh one is Kianpars Bridge built in 1996 with 490 meters long and 16 meters wide and the last one Ghadir Bridge with 643 meters long and 13 meters wide has finished in 2011. The Images of Figure 5 indicate to some of these bridges.

Figure 5: Bridges have built on the Karun River in Ahvaz; a Siah Bridge,

b Sefid Bridge and c Ghadir Bridge

HEC-RAS Model

In this research, HEC-RAS model 4.1 has been used for simulation proposed by US army. The mentioned software is able to simulate the steady flow, gradually varied flow, water quality, and sediment transport and the sedimentation simulation ability has been added to its newest versions. This model has an advanced graphic having a lot of abilities to display the software outputs. The sediment load part of this model has been developed to simulate the one dimensional deposition of sedimentation and erosion of the rivers. The main capabilities of HEC-RAS are as follows:

- Ability of the river network simulation,
- Using different sediment transport functions,
- Dredging of open channels and rivers,
- Sedimentation studies in dams,
- Estimation of scouring,
- Evaluating of sedimentation in rivers and channels (Brunner, [12],[13]).

New version of this software has been designed to simulate the erosion and sedimentation of the rivers and open channels. A geometric file of the river, a quasi-unsteady flow file, and a sedimentation details file are needed to create the conditions similar to the river in HEC-RAS model. In this software, well known equations are used to determine the total sedimentation load. The results are dependent upon the selected function of sediment transport (Brunner, [12],[13]).

In sedimentation analysis of HEC-RAS, the sedimentation control volume of each section is considered. The vertical part of sedimentation control volume is defined with Max Depth or Min Elevation. The cross section of sedimentation file of software is defined by Station Left and Station Right determination. The HEC-RAS provides the possibility of sedimentation in wet area of cross section while the erosion of river is just caused in defined area (Brunner, [12],[13]). Some properties of sediment transport formula of HEC-RAS software are summarized in table 2.

Table 2: Specification of sediment transport functions that were used in HEC-RAS model (Brunner, [12],[13])

Sediment TransSport Formula	*Sediment Grading*	*Method of Calculation*
Ackers-White 1973	Sand-Gravel	Laboratory
Englund-Hansen 1967	Sand	Laboratory
Larsen 1989	Silt-Gravel	Laboratory-Field
Toffaleti 1968	Sand	Laboratory-Field
Yang 1973-1984	Sand-Gravel	Laboratory-Field
Wilcock 2001-2003	Sand-Gravel	Laboratory-Field

Also, the Energy, Momentum Equations and Continuity of sedimentation Equations are the main equations of HEC-RAS mathematical model (Brunner, [12],[13]).

Data of Karun River for Running the Model

The necessary data to simulate the Karun River in under study river reach from hydrometric stations of Ahvaz-Farsiat includes the data of geometry, river flow and sedimentation. The cross sectional maps of 2001 of Karun River have been used for geometric data. In mentioned river reach which is about 48 Km, the data of 46 cross sections have been selected. These data has been taken from water organization of Ahvaz associated with ministry of force. Figure 6 shows the Karun plan in HEC-RAS and location of cross sections on it.

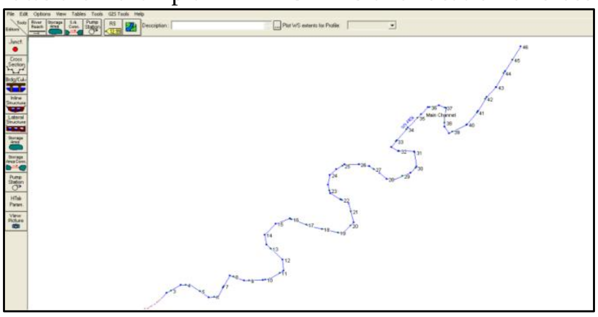

Figure 6: Karun River cross sections in the studied reach which have been lain out at the HEC-RAS model

Figure 7 is an example of the geometry of the cross-sectional view of Karun River.

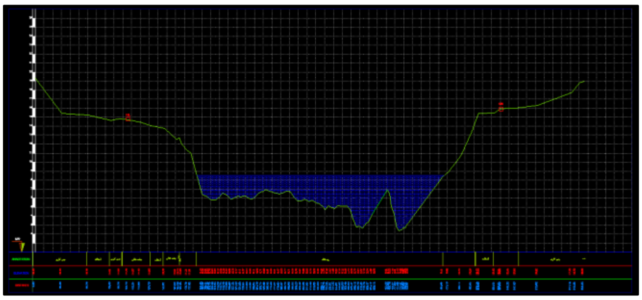

Figure 7: Geometry of the cross-sectional view of Karun River

A quasi-unsteady flow is needed for simulation in HEC-RAS model which should be defined in upstream and downstream of studied boundary conditions of the river. In this research, a time series of flow is determined as the upstream boundary of Karun River in Ahvaz hydrometric station. In quasi-unsteady flow, the variable steps are considered in HEC-RAS model and a 24 h period of time has been considered in this work. Figure 8 shows the hydrograph of input flow of Karun in upstream boundary.

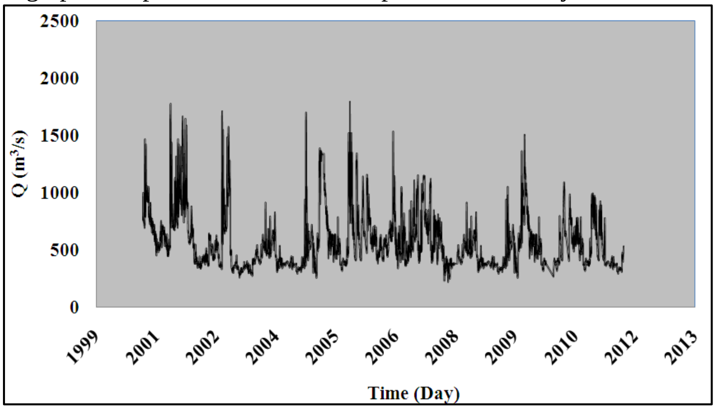

Figure 8: Inflow hydrograph of Karun River at the upstream and Ahvaz hydrometric station during the simulation

The relation between water level and flow or the Discharge–Stage is considered for the downstream boundary. Since the downstream boundary of the river is located in Farsiat hydrometric station, this point has been selected as the boundary condition of the Karun River. Figure 9 show the Discharge–Stage of Farsiat hydrometric station.

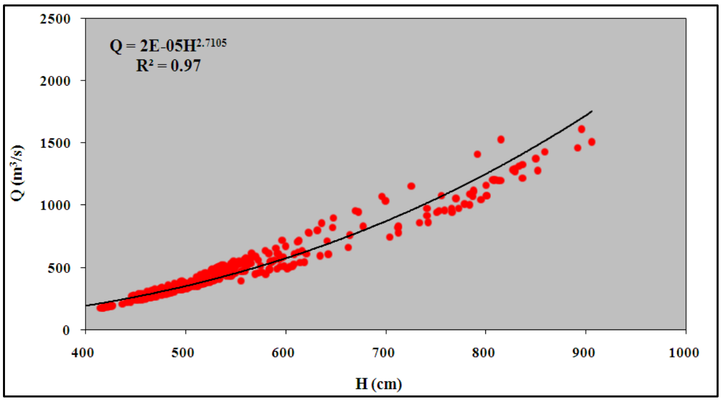

Figure 9: Discharge-stage curve of Karun River at the downstream and Farsiat hydrometric station

The size of sediment particles plays an important role in erosion and sedimentation of the river, defining the sedimentation part in HEC-RAS, each cross section should have a gradation curve in a discrete bed.

In under study river reach from upstream to downstream, the cross sections having the statistics and data of gradation have been used and the interpolation data have been used to determine the gradation of the bed in cross sections which have no data. The specific weight of sediment particles of Karun River in this reach are 2.65, the shape coefficient is 0.6, and the density of gravel, sand, and clay particles are 1489, 1041, and 480 kg/m^{-3} respectively. As can be seen in Figure 10, the gradation curves of river bed are depicted in hydrometric stations of Ahvaz **a** and Farsiat **b** in upstream and downstream of the river, respectively. Considering the gradation curves show that the gradations gets smaller from upstream to downstream. In other words, the particles include large and medium sand particles near the Ahvaz while more tiny particles are observed near the downstream.

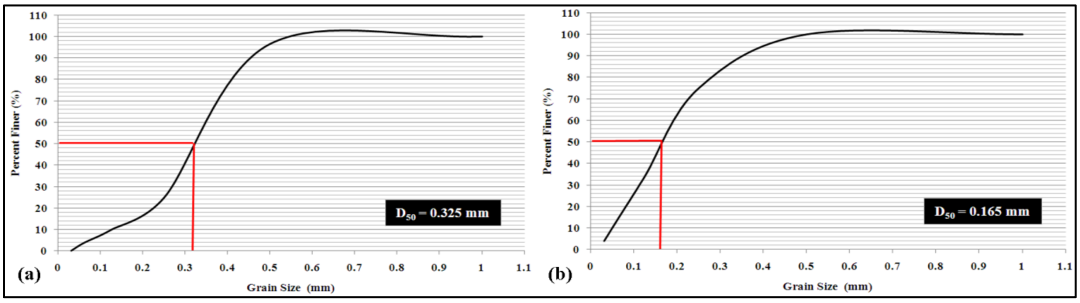

Figure 10: Particle size distribution curves of the Karun River in a Ahvaz station and b Farsiat station

The rating curve determines the sediment discharge into the river based on the river flow. To obtain the flow discharge-sediment load curve, the data recorded in hydrometric station are used. In this work, the data of Karun River in upstream are taken from Ahvaz station. Figure 11 shows the curve of Ahvaz station during the simulation process.

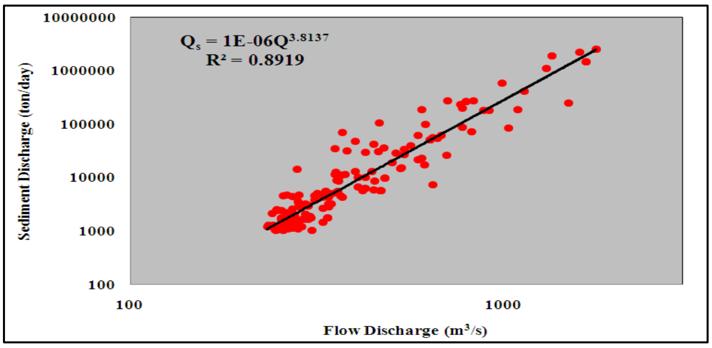

Figure 11: The relevance of flow discharge and sediment discharge of Karun River at upstream and Ahvaz hydrometric station

III. RESUALTS AND DISCUSSION

Hydraulic Calibration of Model

The calibration of calculated data by the model is performed using the measured values in hydrometric stations. In hydraulic flow, the river flow and water level are used for calibration of the model. The Manning roughness coefficient of flow resistance is considered as the calibration parameter of the model in flow section in such a way that the change of this coefficient makes the calculated data of model and observed data closed. In Karun River, based on the gradation curves along the river reach and calculating the sediment particle size using experimental relations, the initial values of Manning roughness coefficient were determined. Table 3 shows the experimental methods to estimate the Manning roughness coefficient.

Table 3: Experimental methods for determining the Manning roughness coefficient

Method	*Formula*
Strickler 1923	$(D_{50}^{1/6})/21.1$
Muller 1948	$(D_{90}^{1/6})/26$
Keulegan1 1938	$(D_{50}^{1/6})/46.9$
Keulegan2 1949	$(D_{90}^{1/6})/49$
Keulegan3 1949	$(D_{65}^{1/6})/29.3$
Lane and Carlson 1953	$(D_{75}^{1/6})/39$

Then, considering the recent researches (Azarang et al. 2010) and applying the model for steady flow in 1500 $m^3.S^{-1}$ flow and drawing the water level profile along with Ahvaz-Farsiat (according to figure 12), the Manning roughness coefficient was considered 0.03 for the river bed and 0.045 for floodplains.

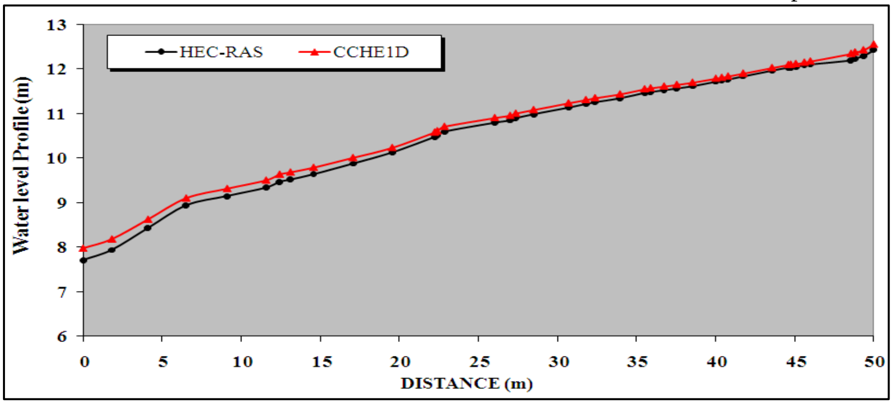

Figure 12: For the hydraulic calibration of Karun River, the water surface profile from HEC-RAS model compared with CCHE1D model

Verification of sediment formula

Having calibrated the model hydraulically, it is needed to evaluate the model for sedimentation calculations. To this, the HEC-RAS model results should be compared with experimental data and the correspondent data with experimental values should be the basis of next calculations. In this work, the cross section geometric figure of Karun River in upstream and downstream stations and the best sediment transport functions were selected to estimate the geometric changes. Figure 13 shows the geometric changes of Ahvaz cross section predicted by selected methods.

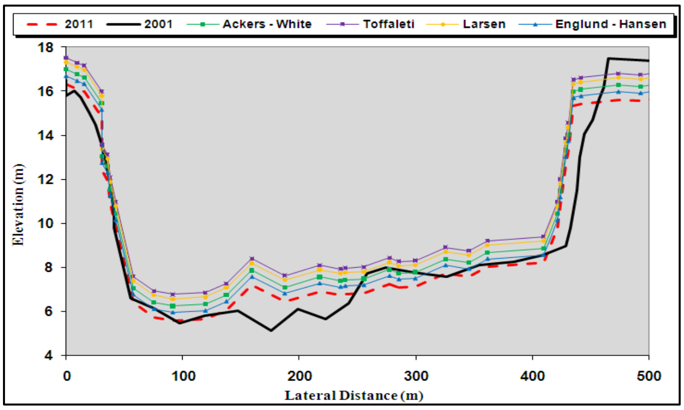

Figure 13: Prediction of cross-section changes of Ahvaz station with different methods

Also, Figure 14 shows the best methods to estimate the geometric changes in Farsiat station.

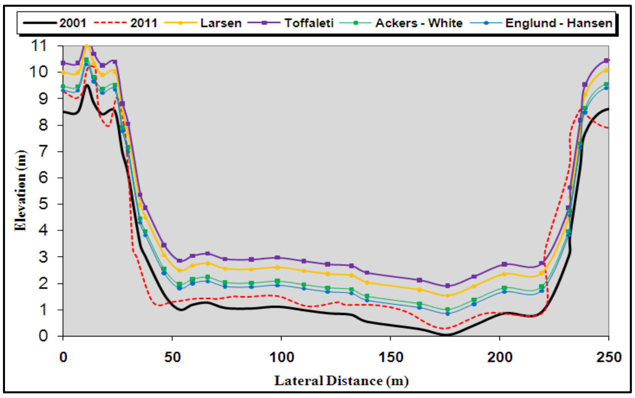

Figure 14: Prediction of cross-section changes of Farsiat station with different methods

As can be seen in Figures 13 and 14 the cross section located in stations have had the highest sedimentation during the simulation period 2001-2011. In other words, the highest bed level increase has been observed based on the HEC-RAS model results using sediment transport functions. Comparing the different methods, it can be seen that the Toffaleti method estimates the highest value of sedimentation and the Larsen methods estimates the second highest value. Also, the Englund–Hansen and Ackers–White are the best methods to estimate the geometric changes of Karun cross section in Ahvaz –Farsiat reach. According to the Figures 13 and 14 the Englund–Hansen, Ackers–White, and Toffaleti have the best estimation of geometric changes in cross section of Karun River, respectively.

Prediction of thalweg changes

The Karun River Thalweg is an important criterion in geometry of the river cross section to define the potential of erosion or sedimentation. The Thalweg is of a great deal of importance in sailing and the stability of coasts. It undergoes changes during the time affected from river phenomena. The Thalweg of Karun was estimated using the sediment transport functions in 48 Km of river from Ahvaz to Farsiat stations. Figure 15 compares the initial Thalweg of Karun River and calculated values by different methods of simulation.

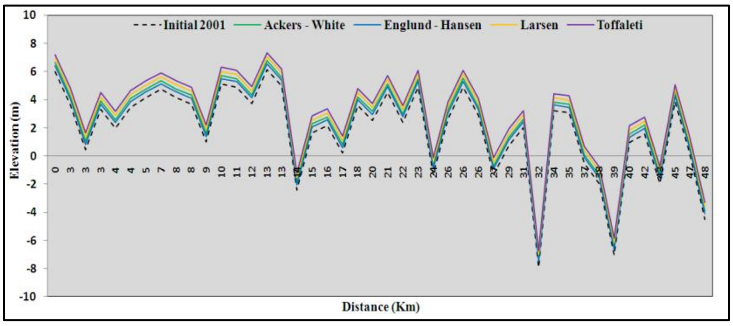

Figure 15: Prediction of thalweg changes of Karun River in the reach of study by different methods

As can be seen in Figure 15 the Toffaleti method has predicted the Karun River Thalweg higher compared to other methods and the Englund –Hansen and Ackers–White stand in next places, respectively. The Thalweg changes estimated by Englund–Hansen and Ackers–White are shown in Figures 16 and 17 as can be seen; the sedimentation has been occurred in most cross sections while the erosion and reduction of Thalweg has been rarely observed.

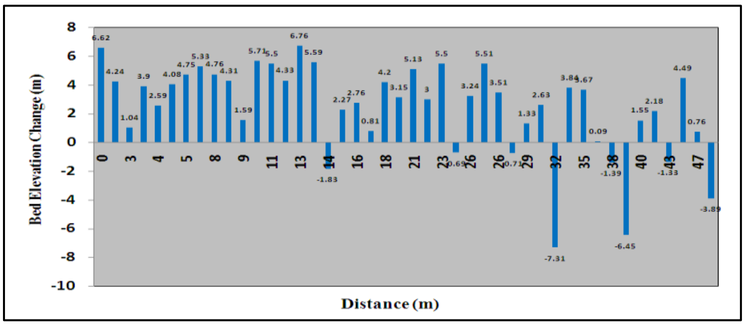

Figure 16: Prediction of thalweg changes of Karun River in the reach of study by Ackers-white method

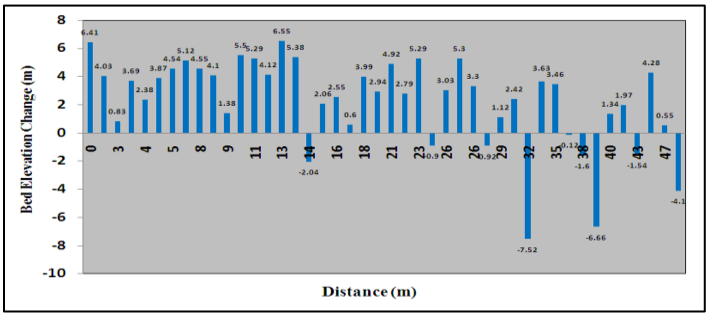

Figure 17: Prediction of thalweg changes of Karun River in the reach of study by Englund-Hansen method

Sediment Total Load

Base on the hydraulic properties of the river and sedimentation particle size, each river has a specific sedimentation potential. The inlet of sediments higher than the transport capacity results in sedimentation. Contrarily, the sediment amount lower than the transport capacity results in erosion. The total load of the river is the sum of load bed and suspended bed of the river and is one of most important outputs of the Hydraulic part of HEC-RAS model as an important index in river engineering plans. Thus, the sediment total load can play an important role in hydraulic behavior of the river. In Karun River, the bed load of the river has been considered as 10% of the suspended load. Figures 18 and 19 show the estimation of sediment total load of the Karun River in upstream station of Farsiat using the superior sediment transport functions.

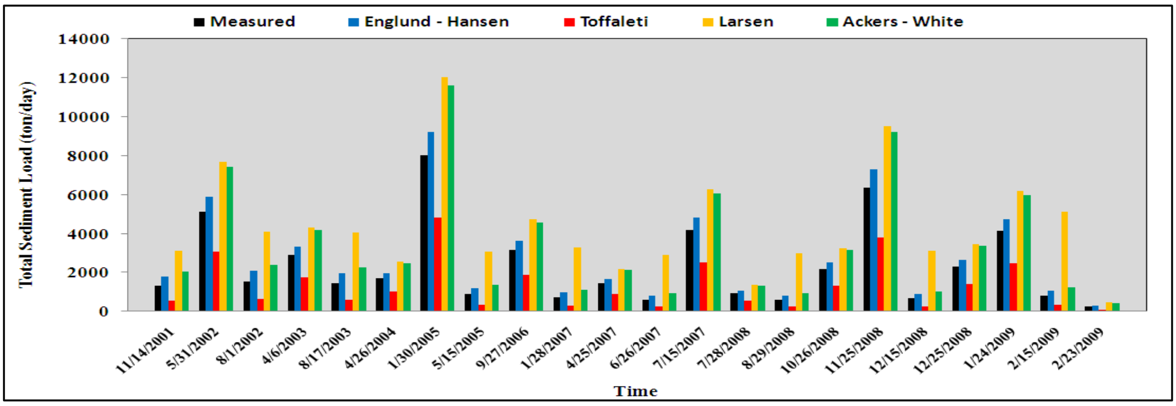

Figure 18: Estimation of total sediment load of Karun River at Farsiat stations with different method

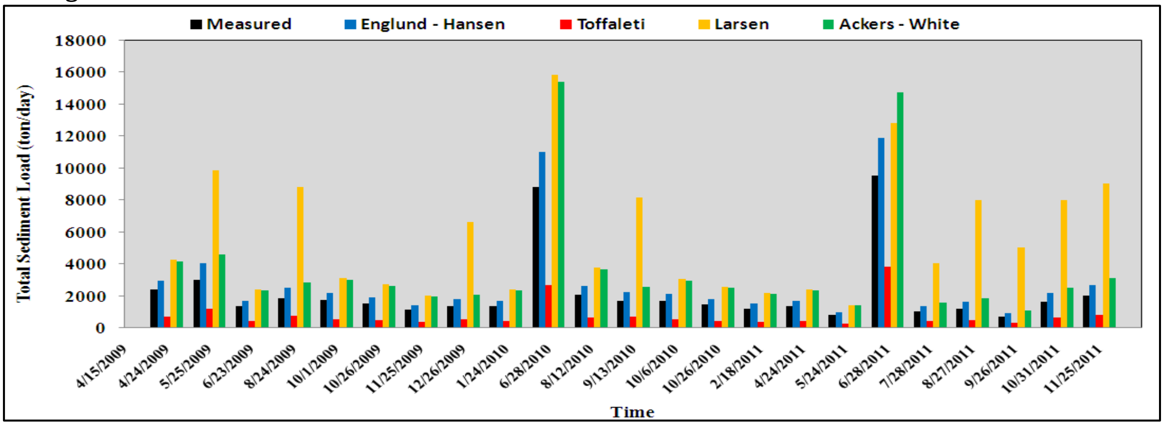

Figure 19: Estimation of total sediment load of Karun River at Farsiat stations with different method

Since the measurement of sediment load of Karun River has not been continuous in Farsiat station and only performed in special days of year, there are limitations in comparison of calculated results of the model with different models. The Nash-Sutcliffe criterion was used to select the best method to estimate the total sedimentation load of Karun in Farsiat hydrometric station and compare the obtained results with observed data. The Nash-Sutcliffe relationship is as follows:

$$NE = \frac{F^2 - F_1^2}{F^2} \qquad (1)$$

$$F^2 = \sum_{i=1}^{N} \left(Q_{oi} - \overline{Q_{oi}}\right)^2 \qquad (2)$$

$$F_1^2 = \sum_{i=1}^{N} \left(Q_{ci} - \overline{Q_{ci}}\right)^2 \qquad (3)$$

Where:

NE = Nash-Sutcliffe coefficient,

Q_{oi} = observed discharges,

Q_{ci} = calculated discharges,

$\bar{Q}_{oi}$= Mean observed discharges,

$\bar{Q}_{ci}$= Mean calculated discharges.

This relation considers a range from - ∞ to unity in which the coefficients near unity show values of higher accuracy. Table 4 shows the Nash-Sutcliffe criterion values for different methods of total sedimentation load estimation.

Table 4: Nash-Sutcliffe criterion values for total sediment load equations

Sediment Transport Formula	*Englund-Hansen*	*Ackers-White*	*Larsen*	*Toffaleti*
Nash-Sutcliffe coefficients (NE)	0.74	0.61	0.50	0.39

As can be seen, the Englund – Hansen and Ackers – White, Larsen, and Toffaleti have the most accurate estimation of total sediment load in Karun River in downstream station of farsiat.

Assessment of erosion and sedimentation

Considering the HEC-RAS model results and field observation and measurements concluded that in most of the studied region especially in Ahvaz city river reach, due to the low slope (0.000337) and very low flow speed, numerous hydraulic structures such as bridges, wide-being of river channel and etc. sedimentation occurred at the most regions and the river was mostly braided. Sedimentation and island formations at the Karun River glen especially at the Ahvaz city region made lots of problems such as reduction of capacity of flood flows and decrease of river depth that influenced waterway transportation purposes like sailing and canoeing which needs correction and provision appropriate river width and depth. Figure 20 shows the island formation of Karun River in Ahvaz region.

Figure 20: View of the islands formed by the river sedimentation at the downstream;

a Siah bridge and b Naderi bridge

As it seen in the figure usually sedimentation occurs after the bridges which is for reduction of flow speed and consequently by reducing of flow energy the suspended sediment particles would be deposited and form the islands at the river path. The images **a** and **b** of figure 20 show the islands at the downstream of Siah and Naderi Bridges, respectively.

Dredging and sediment removal are executive solutions to reduce the accumulation of sediments in the river bed and increase of flow depth for appropriate deliver of flood which are necessary for Karun River training in Ahvaz region. Karun River dredging operations in the city of Khorramshahr near the Persian Gulf is already done. Images illustrate the views of the impact of the operations and training of the Karun River in the city of Khorramshahr.

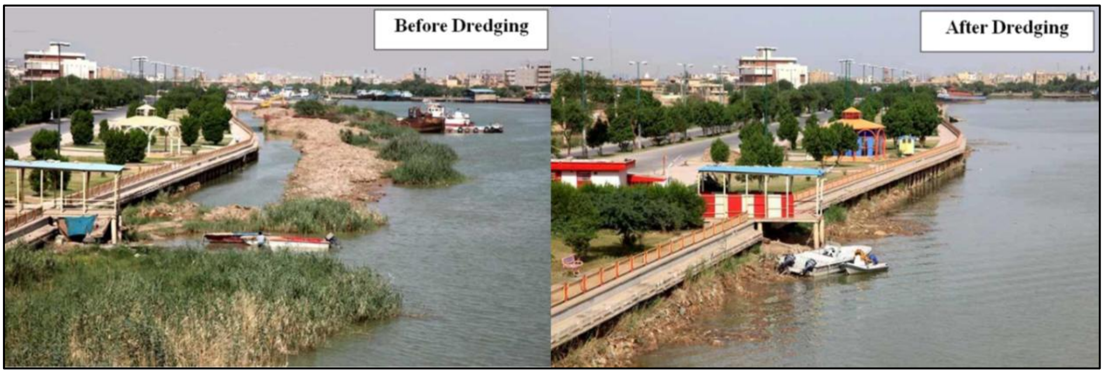

Figure 21: Dredging operations of Karun River in the Khorramshahr city

Figure 22: The impact of dredging operations in order to Karun River training in the Khorramshahr city

Moreover, erosion occurred at the banks and walls of the river at various cross sections that an example of stepped erosion of Karun River in the southern of Ahvaz has shown (Fig. 23).

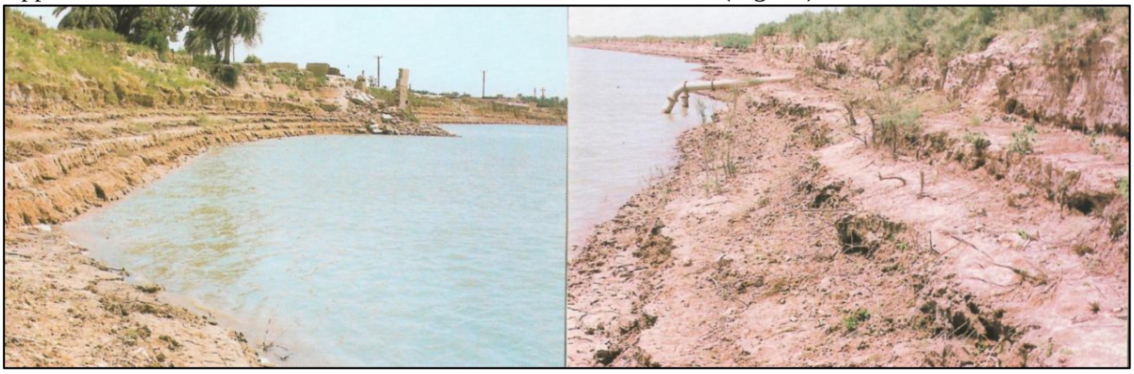

Figure 23: The erosion of the Karun River banks in the southern of Ahvaz

To prevent the erosion, stabilization of river banks procedures should be applied which included the operations for making the eroding river walls stable. Natural ways to protect river margins are vegetation, stone-fill revetment, gabion revetment, precast concrete blocks, pile driving and plate driving, bankhead and etc. which are the conventional methods of glen modification and erosion control of the river side which recommended utilizing for Karun River.

IV. CONCLUSIONS

Karun River is one of most critical rivers in Iran and the studied river reach of this work is Ahvaz-Farsiat is of a considerable importance since it passes through the Ahvaz as the capital of Khuzestan province. Karun River is classified as an old and braided river having suspended load. Karun River has a considerable suspended load regarding its long pathway and passing through miscellaneous geological formations resulting in a high concentration of river which leads to more erosion of bed and river walls and increase the sediment load of the river. In the present work, the HEC-RAS model was used to simulate the sedimentation condition of the Karun River. First of all, the model was calibrated for hydraulic conditions of the river and the Manning roughness coefficients of 0.03 and 0.045 were considered for bed and flood plains of Karun River, respectively. Then, the geometric cross section changes of, prediction of Thalweg profile variations, and estimation of total sediment load were performed using the sediment transport functions. The HEC-RAS results indicate that the Karun River has majorly experienced sedimentation and the bed level increase has been widely observed during the simulation period from 2001-2011. Also, the total sediment transport functions of Englund – Hansen and Ackers – White functions give results of higher accuracy compared to other methods. For the purpose of Karun River training at the reach of study and due to the results of HEC-RAS model, river bed dredging at the regions with sedimentation and stabilization of banks which are erodible are highly suggested. It noteworthy that the sediment transport functions of this work have been proposed as more appropriate functions not necessarily meaning that they give results of higher accuracy in other case studies since each sediment transport function is based on specific geometric, hydraulic, and sedimentation and are not able to be generalized to different conditions of other case studies. Thus, the geometric, hydraulic, and sedimentation conditions of each sediment transport functions and also the river reach of study are of critical importance in optimized application of these methods.

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