

Qara-Chai River sediment survey of the Markazi province numerical model HEC-RAS.4

Amir Moradinejad, Amir Hamzeh Haghahi, HasanTorabi , Azadeh Jabari

Corresponding Author email: amir_24619@yahoo.com

ABSTRACT: Estimate the amount of sediment load and transfer it to a lot of land and water resources projects such as the removal of a river bend, narrowing rivers, flood control, navigation, water went, and the design of dams and reservoirs to store surface water is necessary. The purpose of this study was to estimate and calculate sediment transport capacity of the Qara-Chai river in the Markazi province. After the interval length of 31 km of the river and provide basic information such as cross sections, Information about the geometry of the river, at different levels of roughness coefficients, information about the sediment, suspended sediment and river bed granulation, information about the hydrology of the river system hydraulic boundary conditions and sediment discharge and flow model using HEC-RAS was estimated. The results showed that the equations Englund Hansen, Peter Meyer - Muller, and Toffaleti the measured data is closer than other relations One of these methods is recommended in the river. Also part of the diagram Halstrum and Shields River at the deposition and erosion of the part

Key Words: Erosion , Sediment transport, Qara-chai River, HEC-RAS.4.1

INTRODUCTION

Due to the complexity of the phenomenon of hydraulic and sediment in rivers and usually can not be solved by analytical equations, "Numerical methods are used. Several studies using different versions of HEC-RAS model to study the erosion and deposition in rivers and reservoirs was undertaken Among them was the al Kanfyld studies using HEC-RAS model of scour and sediment accumulation in the Cedar River were Krandh model [6]. The model also predicts Hole Rsbrn and fine sediment dynamics along the mountain rivers studied [11]. And HEC-RAS model for the study of Gibson and colleagues studied the river sediment transport calculations [8]. Several researchers in the interior of this model for the study of sediment transport in rivers and reservoirs which are used for example to research Behrangi et al [3]. Emamgholi Zadeh and colleagues [2], followers and colleagues [4], Hosseini [5], Asadi et al. [1] mentioned.

MATERIALS AND METHODS

Watershed Qara chai river ,located in Markazi, Hamedan, Qom province Qara-Chai River passes in the cities of Astana, shazand, Arak, Hamedan, Tafresh, Saveh, Qom. The river is the most important from the basin. Branches of these rivers originate in the mountains shazand And flows northward And continues to Salt Lake. Saveh dam built on the river and has operated since 1370. Qara chai river Length 540 km and 2300 meters altitude is the main source. Water consumption of Qara chai river is from cities and villages around the river reached And the surplus goes into salt lakes. River study area is From the shazand to the lower doab bridge The coordinates of longitude 49° 24' And a width of 36° 2' starts And to coordinate the longitude 49 ° 49' And within 36 ° 3' continues. Along the river in the study area is approximately 31 km. Plan map of the study area (Figure 1) is shown. In this paper, some parameters of Qara-Chai River metasediments in the Markazi province of perennial rivers were studied. Thus, an area 31 km in length using HEC-RAS model was simulated and studied. After entering the data of geometry and Manning coefficient in the region study, Daily flow hydrograph Doab Bridge station by years 1357-1391 were used as data flow Quasi unsteady. The information in the sedimentary of the results of 26 sediment samples at different substrate materials were used for grading and sediment rating curves in Doab Bridge station was considered as a boundary condition.

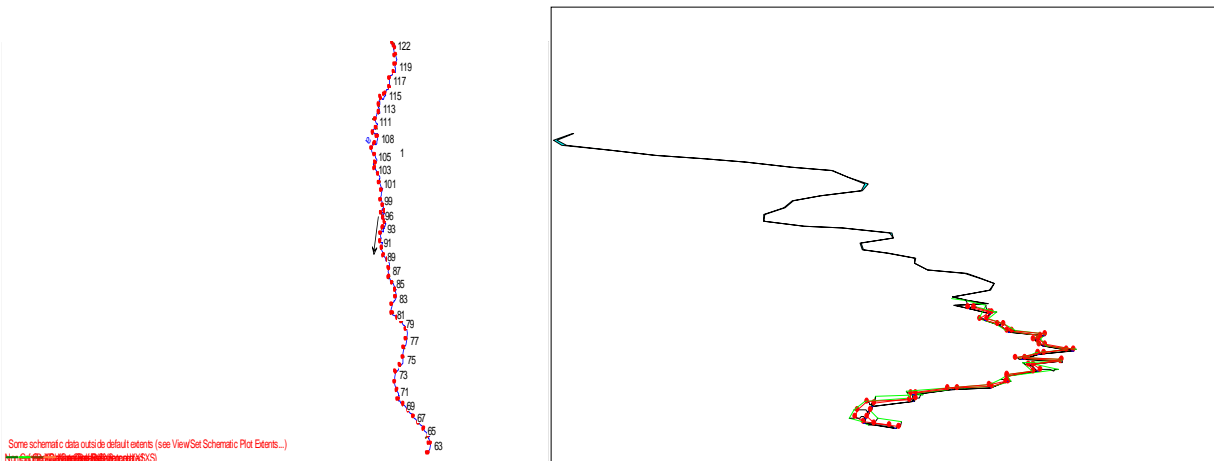


Figure1.

The Software by Engineering Department of the Army, America (USACE) has developed In its last edition in 2006 in addition to the previous features, the ability to analyze the deposition process, and the quality has eroded. In this model, the calculated sediment transport rates, different relationships are anticipated. for the study of the Suitable relationship of the river to the user to choose between them. The model are based on the sediment continuity equation , flow and sediment transport and deposition in the quasi-one-dimensional and quasi unsteady flow has been developed [12]. Exner equation of sediment flow dynamics takes place. Exner equation for sediment mass conservation equation given in equation (1) is [12]:

$$(1 - \lambda_p)B \frac{\partial \eta}{\partial t} = - \frac{\partial Q_s}{\partial x} \tag{1}$$

In this regard, B, across the river in metric units (meters), η height of the bottom of the river bed (m), λ_p porosity of the active layer, Q_s discharge sediment load carried (cubic meters per second), x distance (m) t time (s) are.

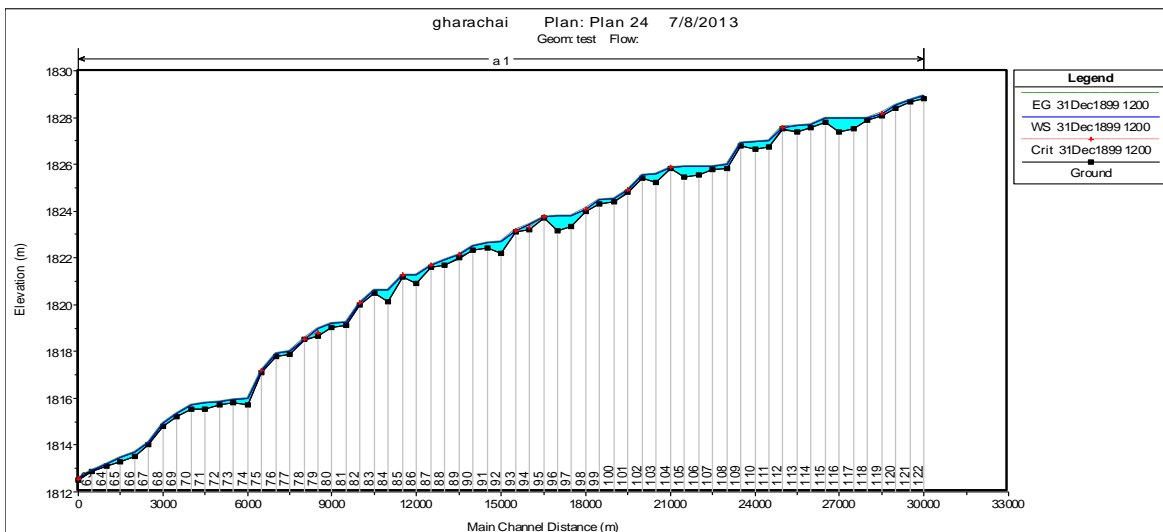


Figure 2. Longitudinal river profiles Qara-Chai River

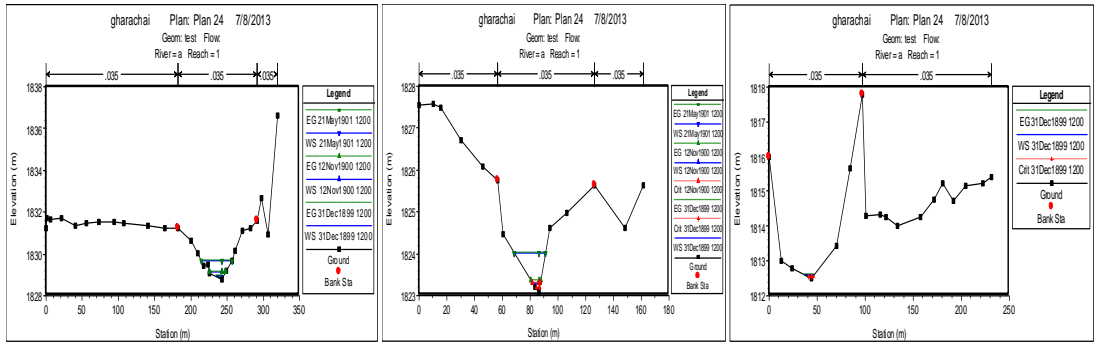


Figure 3. Cross-sections of the beginning, middle and end of the river

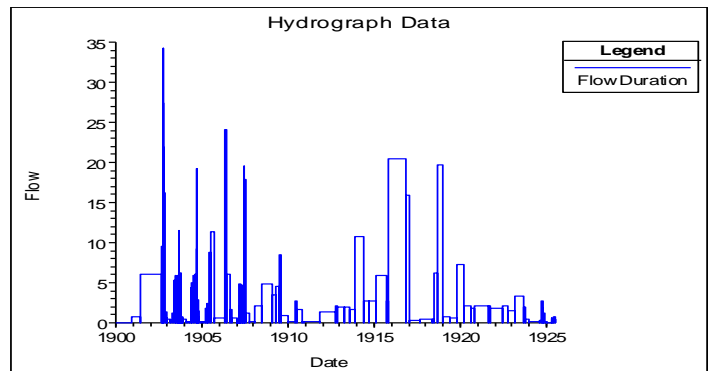


Figure 4. data on stream flow hydrograph in Doab bridge station during harvest time

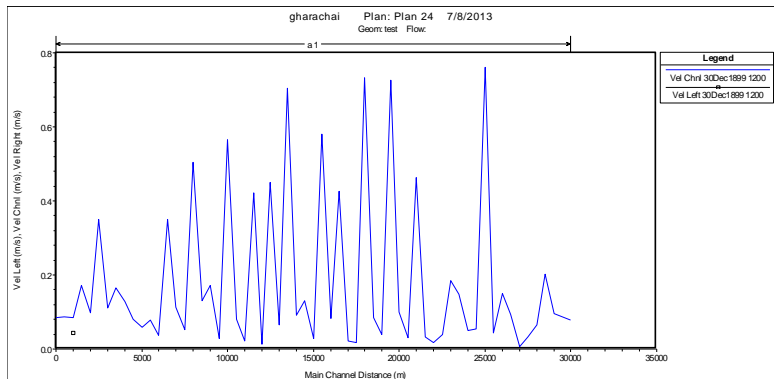


Figure 5. velocity profiles along the path

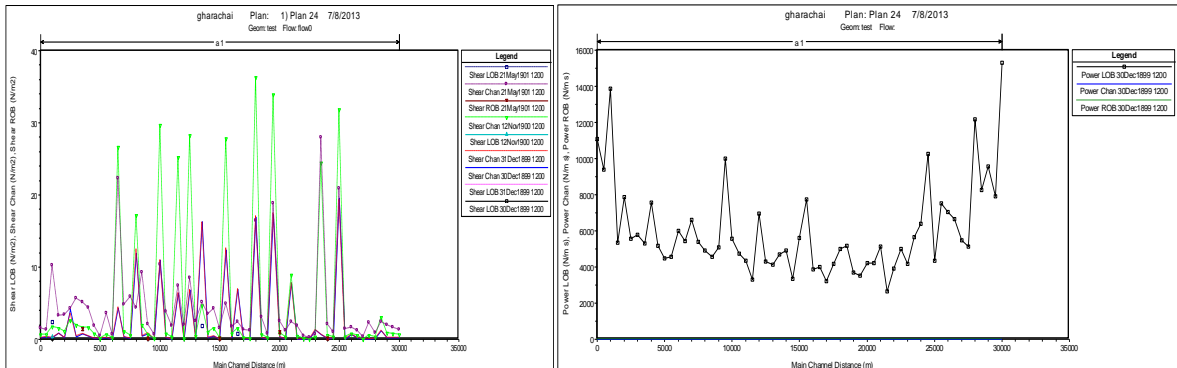


Figure 6. Profiles of shear stress and stream power along the path

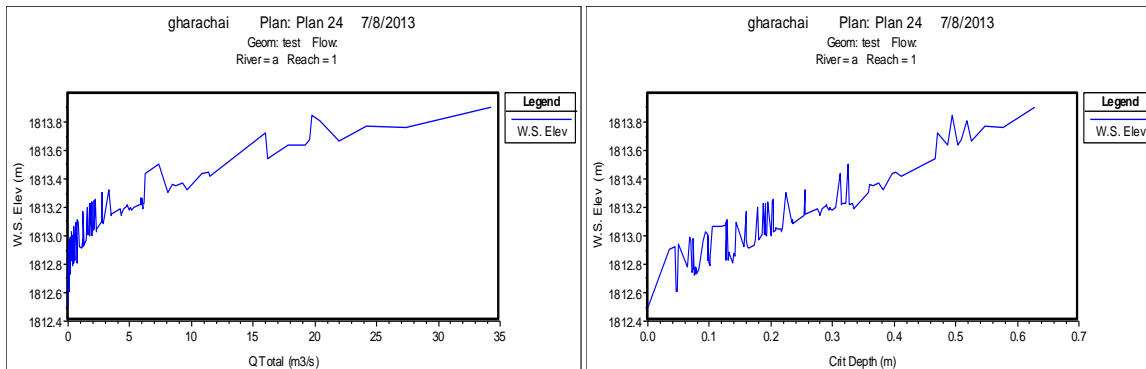


Figure7. the relationship between critical depth of flow and flow associated with water level

Hydraulic Modeling of River Flow

To use this model to simulate the flow hydraulics and sediment, river information, including geometric data, hydraulic and sediment were used. In geometry Section General Plan of the river with geometric cross sections are introduced into the model. A total of 62 sections over 31 kilometers of river produced model was introduced. Figure (2) and (3) the longitudinal profile of the river and its samples in Cross-section Hec-Ras model shows. The rate of 133 cubic meters per second was round 25 years old and was introduced to the model. To run the model needs to be introduced at the upstream and downstream boundary conditions were The order for the upstream boundary conditions of normal depth and downstream boundary conditions were used in the stage discharge relation. After simulation, the longitudinal profile of the river, the velocity, shear stress, stream power, Froud Number, sediment transport capacity was studied at different Sections

Hydraulic modeling of river sediment

Hec-Ras data needed for the software to simulate sediment transport and river erosion River bed material gradation in the range of (mainstream river beds and flood), in the range of upstream sediment rating curves, select the type of sediment transport equation and the selection equation is the particle fall velocity. To determine the Quasi unsteady flow in the model, the time series of upstream boundary conditions for a period of 33 years (1390-1357) and as normal depth downstream boundary condition in the model. Figure 4 shows the hydrograph inflows into Doab Bridge station. Water temperature data were also introduced into the model. Sampling was carried out along the river bed material After the deposition of material aggregation, data were introduced to the models. Figure 8 Curve Grading Gradation introduced to the model, is shown. Sediment boundary conditions in a sediment rating curve, which shows the relationship between flow and sediment model was defined. Robbie equation was used to determine the fall velocity and sediment transport. Coefficients of convergence and divergence for evaluating energy loss, due to the opening and narrowing occurs, are used. The coefficients of variation of velocity times cross next to a cross-section of the drops between sections are multiplied, be considered in the calculations. Convergence factor values (Cc) and divergence (Ce) courses for different situations by the Army Corps of Engineers Association of America suggested in this study, respectively, 0.1 and 0.3 was considered. Longitudinal energy loss due to the roughness of the river is one of the major drops in water level and flow rate in Hrmqt role has also been considered. Introducing the boundary conditions at the inlet and outlet of the flow upstream and downstream of the studied reach. For the calculation, the balance of normal depth for this River as the boundary conditions are considered.

Table 1. Maximum values, minimum, and average values in different sections of river

Shear stress	Power flow	Froude number	Within the upper	Sectional area	Velocity	Energy gradient	Parameters
(N/m ²)	(N/m.s)	-----	m	m ²	(m/s)	(m/m)	Unit
6.02	5.75	0.19	129.24	193.7	0.817	0.000412	Above average range
11.15	13.19	0.265	84.31	135.82	1.138	0.00089	Average of the middle range
14.5	18.45	0.301	100.68	139	1.156	0.00150	Low average range
10.48197	12.58787	0.251475	105.1454	156.8089	1.033607	0.000928	The average total
77	99	0.8	271.19	370.3	2.17	0.013227	Maximum
1.22	0.44	0.09	46.95	47.62	0.39	0.000068	Minimum

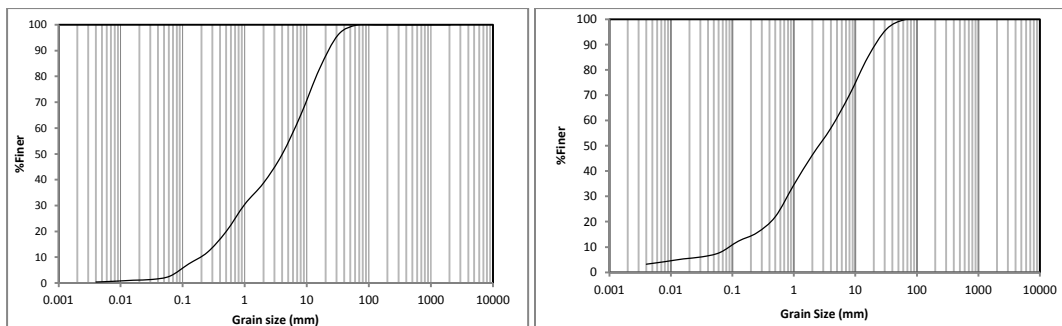


Figure 8. Curve Grading Dvnmvnh bed sediment particles introduced into the model.

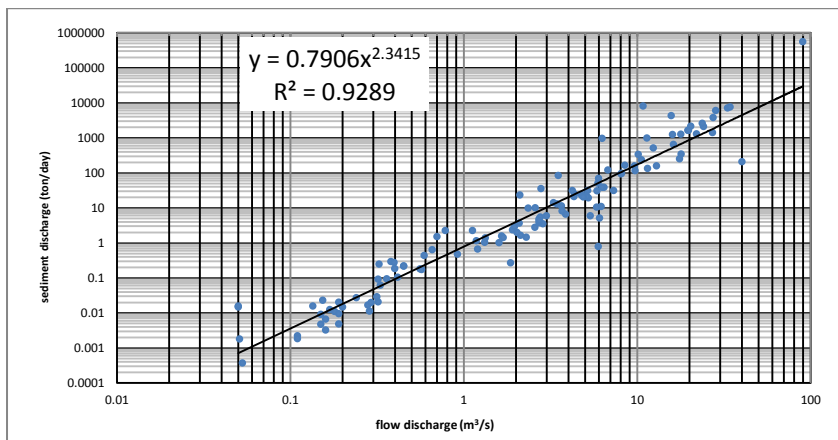


Figure 9. the relationship between water discharge and sediment load in Doab bridge station pole

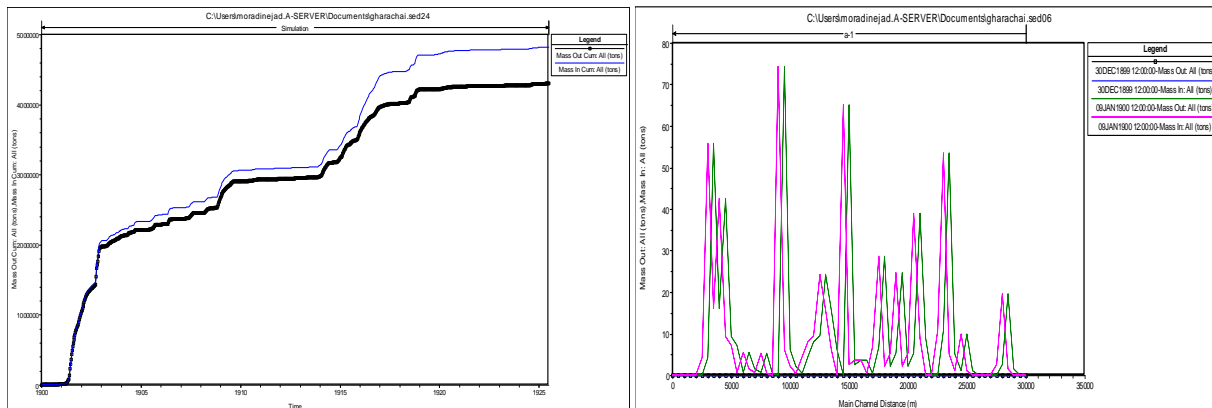


Figure 10. inputs and outputs of sediment mass changes with time

RESULTS AND DISCUSSION

As Sedimentation and Erosion Research aimed at assessing the Qara-Chai River in the study area is Geometric data, flow and sediment Qara-Chai River, the model and the model was run. Hydraulic flow was first studied Figures 12 (a, b, c, d, e, f) the Froude number, flow velocity, sediment transport capacity, Flow power, and shear stress Within the upper surface in different sections of the river shows. Table (1) the values of maximum, medium and minimum energy parameters, slope, cross-section, the width of the upper flow, power flow, velocity, Froude number and shear stress along the river to flow away back 25 years shows.

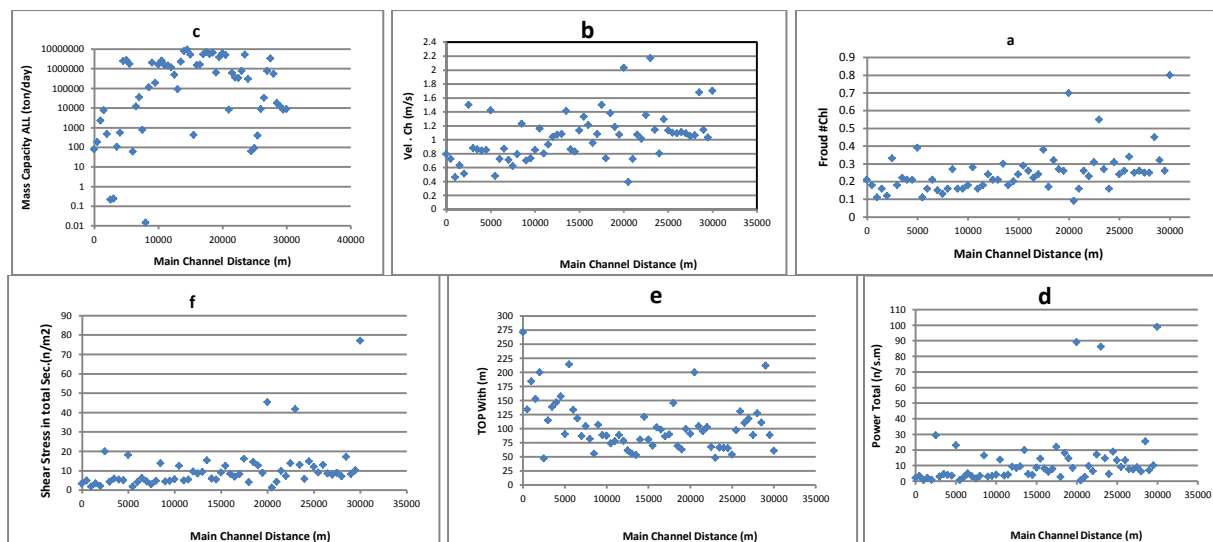


Figure 11. the parameters change during the course of (a) the Froude number, (b) the average speed, (c) carrying capacity (d) the power of (e) the width of the upper surface of the water (and) shear stress.

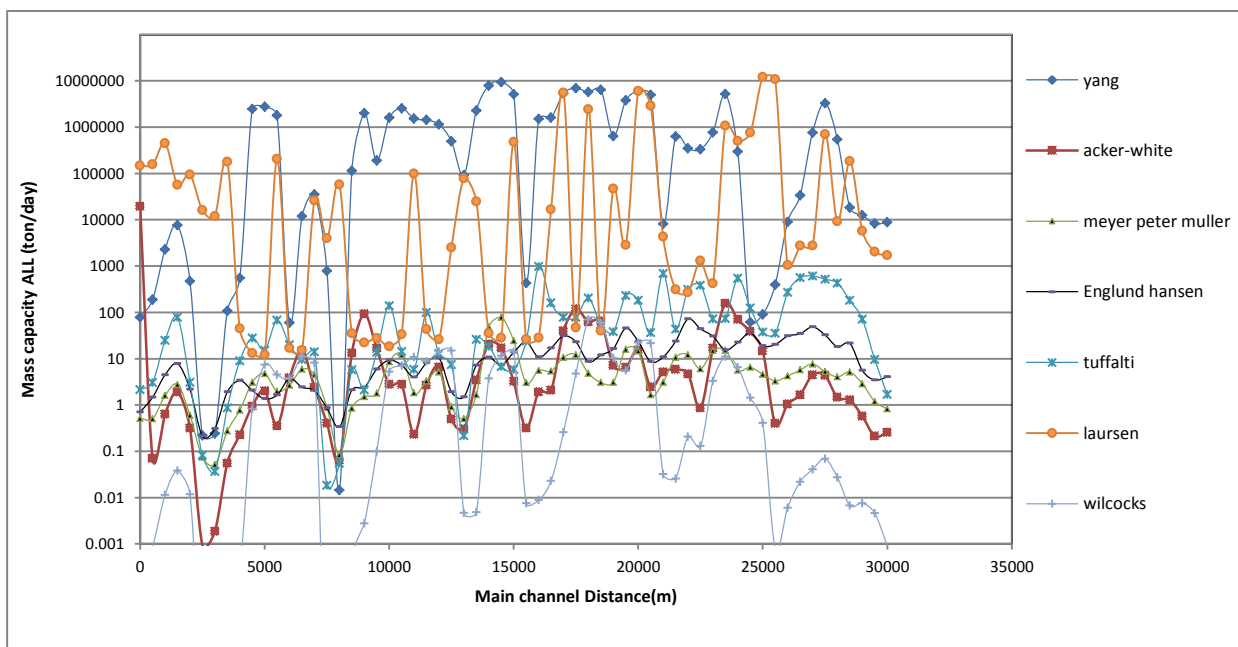


Figure 12. along the river sediment transport capacity of different methods

Table 2. sediment transport capacity of the Doab bridge station's from different methods

(m3/s)Flow	Sedimen Observation (ton/day)	Yang	Acker-white	Meyer peter-muller	EnglUnd hansen	Toffalty	LaUrsen (Copeland)	WilCocKs
34.25	7592.2	1.68E+07	4.49E+17	77.34399	3061.666	15269.58	1.17E+07	1.095062
21.92	1322.337	9928156	4.07E+16	57.86232	1333.599	7190.417	4833902	0.757035
11.46	133.6595	940057.8	4.61E+26	10.94993	179.3201	159.8684	282750.9	7.66E-02
19.17	1647.267	5645605	3.59E+15	50.10348	1372.338	3094.216	1336251	0.611234
5.01	21.83149	1405420	2.36E+30	19.15032	403.5366	416.2802	320310.5	0.180789
17.81	255.6346	3837447	4.19E+15	52.29888	1108.119	3205.754	482886.2	0.650181
2.76	5.477995	160397.7	2.34E+19	4.097247	37.03275	19.16803	10965.51	1.63E-02

The study of sediment transport in

One feature of the model is the sediment transport along the river. One feature of the model is check along the river sediment transport capacity. For the range of Case Study ,After entering the data Quasi unsteady flow and river sediments information Qara-Chai River The selected transfer functions of the deposition Model HEC - RAS with seven sediment transport function (Acker – White ,England, Hansen, Laursen (Copland), Meyer - Peter and Muller, Toffalti, Yang and wilcocks) was applied for Qara-Chai River. The results of solving the above equations show that the sediment carrying capacity of the range varies according to the different functions considered. For example, in Figure (12) sediment transport capacity along the Qara-Chai river with seven sediment transport equation is shown. Qara-Chai River was divided into three periods. Rich first (from the top of a slope, 10 km upstream from 0.000349), Rich Central (from km 10 to km 20 with a slope of 0.000545) End Rich (from km 20 to km 31 with a slope of 0.000747). Also The sediment transport capacity of the river with sediment transport equation Larsen Figure (12) shows the highest value. The maximal amount of sediment transport capacity of the river three kilometers Rich (20-30) 12100000 tons per day. As a result of the model calculation using equation Larsen (Copland) shows, Carrying capacity of the river upstream to the downstream side increases. Reason Increased Sediment transport capacity of the river upstream to the downstream side, Increase the slope of the river bed and thus increase the power of the river is eroding. The study shows that the shear stress in the range of from top to bottom, this value increases, The average shear stress, respectively, 6.02, 11.5, and 14.5(N/m²). The average value of the power flow is also increased accordingly (Figure 12). Calculations show that the average power in the range of elementary, middle Vanthayy respectively 5.75, 9.13 and 18. (N/m²). The energy gradient, Froude number, and the flow rate increases from top to bottom.

Comparison of model output with measured data

To evaluate the accuracy of model estimates of sediment transport in Qara-Chai River statistic Data measure the Doab Bridge station, was used to. Relationship between discharge and sediment load in the Doab Bridge station Figure (9) is shown. to compare Model results and measured data, model with Seven discharge equal amounts of 25/34, 92/21, 46/11, 17/19, 01/5, 81/17 and 76/2 cubic meters per second was performed. Forms (13) and (14) Table (4) the relationship between the rate of sediment transport capacity at the Doab bridge station measured and Seven sediment transport equation based on measured data show. According to the above two forms sediment measurements and calculations, there is a difference. However, this difference can be several reasons for such a measurement error, computational error and other reasons cited. Yang also said that this is All functions are provided solely sediment transport equations to estimate sediment transport rates And the sediment concentration at equilibrium (balance) ,Regardless of any deposits or erosion have been, Thus, if the wash load or high concentrations of fine particles, Equilibrium mention disgusting. And one of the reasons that the sediment load computed by these functions with what is observed in the river, Is different Not due to suspended particulates. For these river, according to the figur(13) and (14) values were calculated by the method Englund - Hansen rate Peter - Muller and Toffalti is closer to the observed value. and Wilcocks , Ackers - White and Laursen methods is a large difference between the observed value.

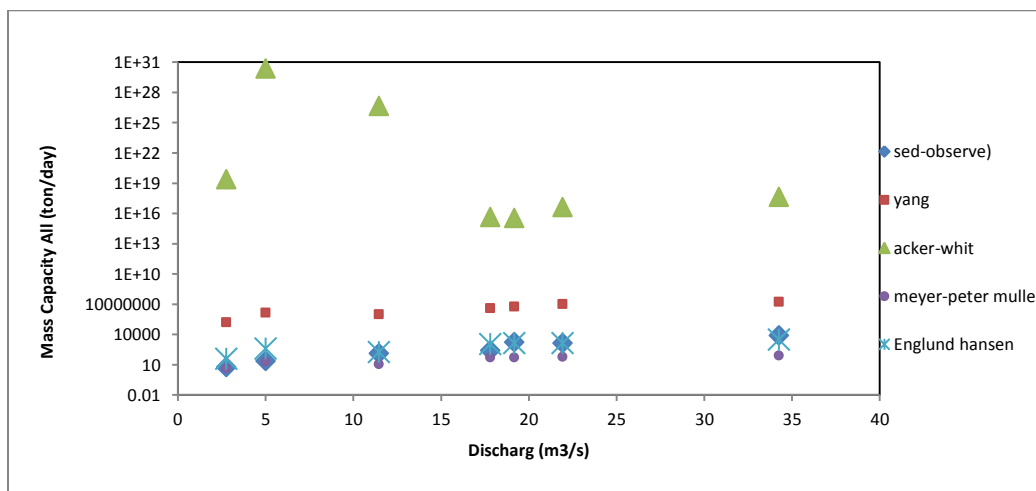


Figure 13. compares the measured results of the model and the observation Data

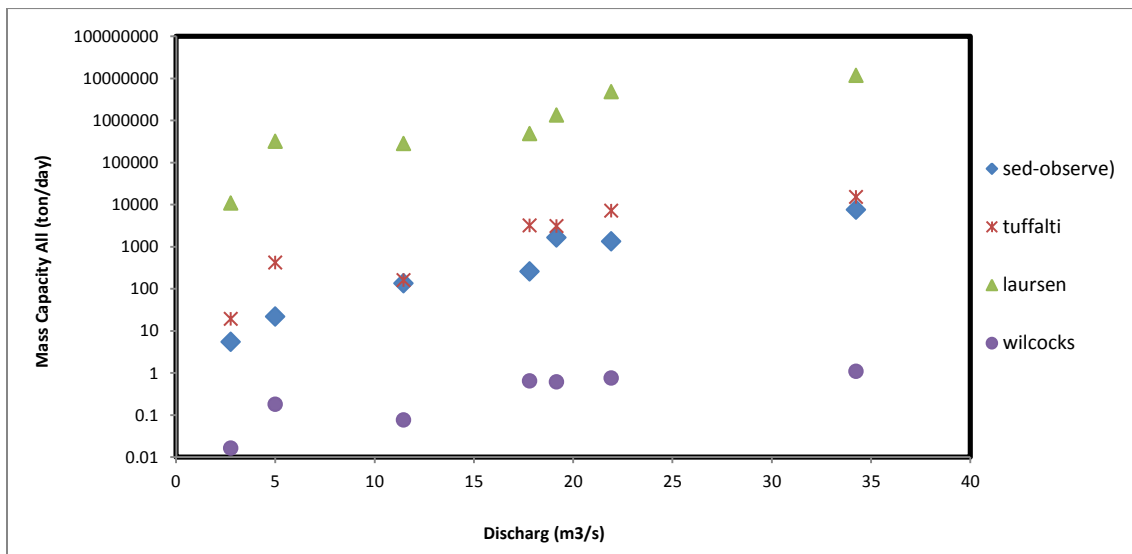


Figure 14. compares the measured results of the model and the observation Data.

The study of erosion, sedimentation equilibrium in Qara-Chai River

To check the status of erosion, sedimentation and equilibrium rivers in this study, we have used the standard Halstrum , Where the flow rate is plotted against the particle size. In this curves three areas of erosion and sedimentation equilibrium are distinct from each other. For the present study of 19 sediment samples were collected during the Qara-Chai River Was used. Since we need to estimate the average velocity of flow ,needed to use curved Halstrum was , The model was implemented. Figure (15) shows points plotted on a graph Halstrum. Halstrum draw 19 points on the curves show In some sections, the current situation is such that the river has eroded the status, In some sections Of the deposition.

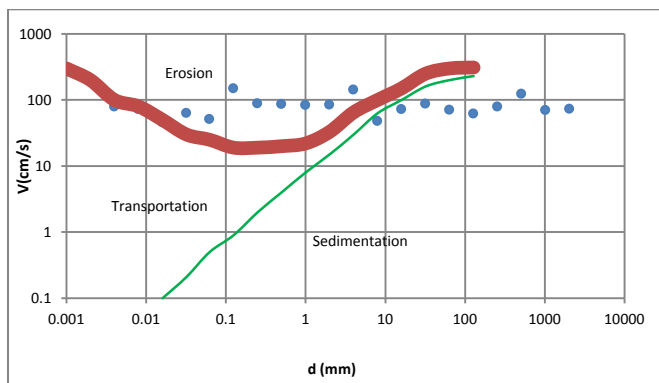


Figure 15. Status of erosion and deposition of sediment grains uniform in Qara-Chai River using standard Halstrum
Conclusions and recommendations

In this study, we evaluated the accuracy of the numerical model HEC-RAS deal will come the following results were obtained:

survy Seven Equation of the sediment transport Acker - White, England - Hansen, Laursen (Copland), Meyer - Peter muller, Toffalti, wilcocks and Yang ,show Sediment transport capacity is variable And calculated values of England – Hansen, Meyer Peter - Muller and Toffalti methods is closer to the observed value, Wilcocks, Acker - White and Laursen methods is a large difference between the observed value.

Englund Hansen sediment transport capacity of the river model range in elementary, middle and end the 2.69 , 14.1048 and 25.048 tons per day, respectively, Carrying capacity is increased from upstream to downstream, Longitudinal profile of the river bed slope of the river shows values in the range of respectively 3.49 , 5.45 and 7.47 per cent is, This increase in slope, Increased the sediment transport capacity of the river.

The study of erosion, sedimentation, and equilibrium standards Halstrum and Shields Qara-Chai River indicates, in the state of river erosion and sedimentation is the other half.

As the Saveh dam is located in Downstream , With regard to the functions Englund Hansen ,Meyer- Peter - Muller and Toffalti is a better estimate than any other sediment transport functions, Accordingly, it is recommended, To identify potential sediment transport rates in different parts of the river , And also this relationship can be used to estimate the sedimentation dam.

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