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Modeling of Sediment Transport Upstream and Downstream a Barrage: A review

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Abstract .

River sediment movement is a crucial and intricate process. Knowing the types and quantities of sediment delivered by rivers is crucial for effective water management. This paper presents a comprehensive review on the analysis the sediment distribution in the region (upstream and downstream Kufa barrage), verify the numerical model results (Such as HEC-RAS, SSIIM, Mike and another models) via the measurement data (field and laboratory data) from river. Advantages, disadvantages, the river morphology (Examine the fluctuations produced by the existence of the dam) the reproduction of model processes and practical applications were discussed. Most of sediment studies did not fully cover sediment transport problems because of the complex character of sediment transport and its different conditions.

Keywords: Sediment transport, numerical models, empirical equations, barrage.

1- Introduction

Because of the interaction of subsurface processes, which are currently poorly understood, sedimentary processes are a tremendously complex subject. Lack of knowledge of the dynamics of rivers, marshes, offshore areas, harbor estuaries, and reservoirs led to unsustainable dangers to human economic and social well-being. In this regard, it is clear that sectoral strategies have an impact and that integrated human intervention management is not well understood. Science still has numerous unanswered questions regarding sedimentary flow estimation and qualification [1]- [4].

There are four different methods of hydraulic transport of sediments: The first category consists of objects that move in this way and are referred to as bed loads: slide, roll, or saltate along the bed. The second type of particle is called suspended load and consists of smaller, slower-falling particles that are frequently entrained in suspension in water for an extended period of time. The interplay between the suspended and bedload yields the bed material load. The third category, referred to as the "wash load," consists of much smaller particles that are always in suspension and do not condense on the bed or become a part of it. Combining both the wash load and the bed material yields the fourth kind [5]- [7].

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The analysis of sediment transport of flow processes in streams is one of the most well-established fields of study in hydraulic engineering sciences. Even though sediment travel in natural bodies of water has been studied extensively over the past decades, there really are various theoretical or descriptive in nature equations and equations that can be employed to fairly forecast the percentage of siltation in rivers. The majority of these equations are the result of specific flow and sediment properties. When utilized to calculate the sediment load for circumstances comparable to those from which they were generated, they have all produced positive outcomes. On the other hand, when they applied for various conditions, very poor results were obtained. Numerous river engineering issues required the use of field research and laboratory testing [8]- [10].

In hydrodynamic and sediment transport research and modeling, field measurements are crucial. Drawing a traverse line or lines across a surface is the process of transect sampling as shown in Fig. 1 [11]. At regular intervals, samples are obtained along transect lines at the surface and at one or more specified depths. The distances between sampling locations in a transect are determined by the length of the line and the samples number to be gathered. A number of transect lines may intersect as well as be parallel or not parallel to one another. The sampling objective is the same as with steady sampling if the lines are parallel. The ease with which individual traverse lines can be set up and moved is the main advantage of transect sampling.

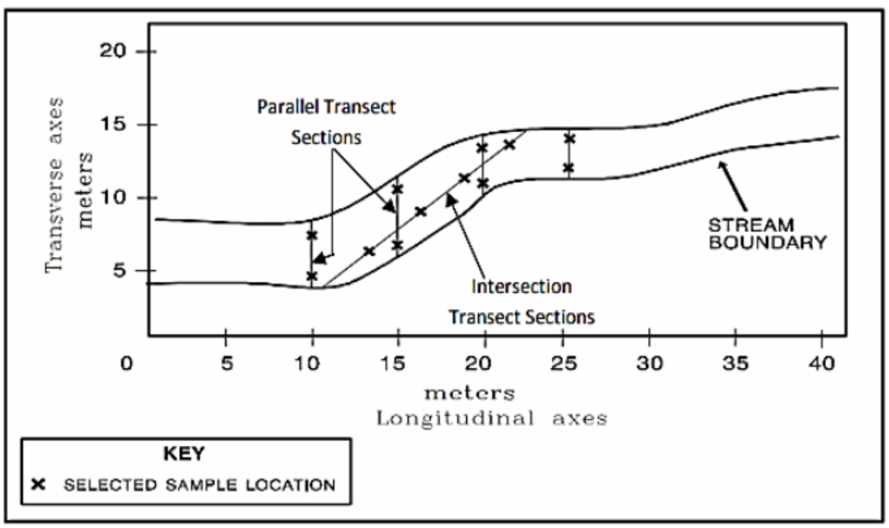

Fig. 1: Transect sampling [11].

The ADCP (Sound Doppler Current Profiler) technology is now widespread used in river design to determine bed maximum height, top width, water level, cross section neighborhood, flow rate, and discharge. They work by projecting sound pulses from their own transmitting faces into the water environment, where they are reflected by particles in the air and the precise moment of one's return to the transmitting face is detected, see Figure 2 [12].

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Fig. 2: SonTek river surveyor ADCP [12].

1.1.Measurements of Sediment

The elements of the sediment loading in addition to potential regional bases of sediment were investigated.

I. Bed component sampling in the study reach for sections (1,2,3): one bed material sample was taken for the (a, b, c) location, while the two sections (4,5) were unable to obtain samples owing to section dredging. The Van Veen's grab, a highly helpful tool for sampling bed material, was used to collect the samples [13, 8]. See Fig. 3.

II. Suspended load sampling is to determine the amount of suspended particles in the stream flow and record how much sediment was present. The suspended silt along the water column can be measured using point-integrating sampling techniques [14]. Depending on the intended level of measurement accuracy, the quantity and location were calculated.

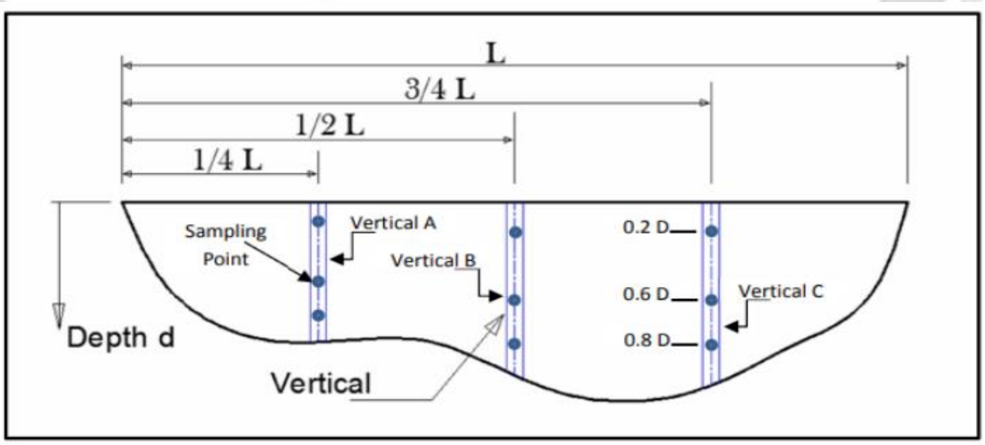

Fig. 3: Selection of sampling verticals [26].

2. Experimental Measurements

I. Specific Gravity of bed material is an important parameter. It is defined as the dry weight of material within a unit volume. ASTM D422.63 was used to determine the bed materials' specific gravity [15], [8], [16], [17]. For all locations (all sections used in the study), the bed material's specific gravity was 2.65 on average.

II. Moisture Content According to ASTM D 422.63 the moisture content was measured by taking (10-15) gm of the bed material sample and placing it in dish. The total weight is taken (dish plus sample), before and after drying in oven of 100˚C for 24 hr.

III. Grain Size Allocation: the specimens bed substance was evaluated using the fine mesh strainer analysis method, and "a hydrometer analysis method based on Stoke's law. The soil was examined using the "(D - 422 Standard) Particulate Analysis of Soils Test Method [18], [8].

IV. Suspended load analysis: the suspended load analysis was performed using TSS apparatus using filter paper pore size according to the mean size (d50) of bed material [16], [19].

2.1. Numerical Models

Some models are used for sediment transport like:

2.1.1. SSIIM Model

The SSIIM1.0 Model is a numerical three-dimensional model. This program was created in 1993 by Dr. Nils Reidar B. Olsen. The program was designed for use in hydraulic, sedimentation, environmental, and river engineering. The program's primary goal when it was first developed was to model sediment flow in typical river/channel geometries. Physical model studies for fine sediments have revealed that this is a challenging task to perform. When compared to other CFD (Computational Fluid Dynamics) programs, SSIIM's key advantage is its ability to simulate sediment movement with a moving bed in a complex shape [20], [8], [21].

2.1.2. HEC-RAS Program

The numerical software package HEC-RAS is used to calculate the flow and hydraulics of rivers. The Hydrologic Engineering Center, a research division of the U.S. Army Corps of Engineers, created it. Three hydraulic components were included in this software for flow analysis: computations of steady flow water surface profiles; unsteady flow simulations; and calculations of moveable boundary sediment transport. Calculations for movable beds and sediment routing can be done using HEC-RAS [22]- [25].

2.1.3. MIKE Model

MIKE 21 model from the Danish Hydrodynamic Institute (DHI). Mike 21 It is a useful instrument for managing future pollution, such as silt, oil spills, particle tracking modules, etc. Below are some researches that use the MIKE model [26]- [28], many other models, as an example, two-dimensional morphodynamic and hydrodynamic models, were used for sediment [29].

2.2. Empirical Formulas

There is not a single method that can be regarded as being suited for use in all rivers to evaluate sediment transfer, despite the fact that several sediment transport formulas have been constructed utilizing data from laboratory and field experiments. Only the rivers under examination exhibit the best performance from the obtained formulas. These result from variations in river shape and environmental arrangement, as well as from hydraulic factors and measurement techniques [30]- [34].

2.2.1. Pi Theorem

This formula characterizes only this particular channel; it is obtained depending on data collected from fourteen different cross-sections through the whole channel. Other data used for formula verification. The variables used for field and laboratory work and their relationship can be given as follow: $F1(\rho s, \rho w, D35, D65, V, Rh, S, g, Qs) = 0$, by dimensional analysis, [35], [36], [37], [38], [31], [33].

2.2.2. Alghazali Formula

A new technique for dimensional analysis was proposed by reference [39]. The method just requires that the repeated variable matrix be converted into an identity (or unit) matrix [39].

3. A Review of Sediment Transport Modelling

3.1. Using Numerical Models

Schmidt et. al. (2005) studied sedimentation occurs at a rate of around 150,000 cubic meter per year upstream of the last Rhine barrier at Iffezheim, posing serious issues with flood protection. The dynamics close to the barrage are described in this work using the outcomes from a two-dimensional hydrodynamic and morphodynamic models. Analysis of the flow structures at various discharges is done, and the outcomes have been compared to field measurement data, especially in the area of sedimentation. It is shown how well a flow directing structure works to reduce sedimentation, and recommendations are provided for additional research.

Otun J. and Adeogun B. (2010) Fluvial sediment discharges into the Kubanni dam and reservoir were examined. Some fluvial discharge measurements were conducted to describe the fluvial deposits and determine the amount of accumulated sediment deposited over time. They claimed that both measured and unmeasured sediment loads are included in the overall sediment load. A total of 20,387,000 kg/year of sediment was dumped into Kubanni Reservoir.

Un Ji et al. (2016), the influences of reduced sedimentation at the Nakdong River Estuary Barrage (NREB) in Korea were quantitatively examined with regard to various sediment management options employing the calibrated and verified two-dimensional model. The flood event and the channel geometry of the 3.8 km segment upstream of the NREB that was surveyed before and after dredging in 2007 served as the basis for the modeling conditions. As a result, floods might naturally remove half of the sediments dredged in 2007 without the need for dredging. The sedimentation height dropped over the whole simulation phase, with the lowest and highest decreases ranging from (0.3 - 1.3) m, according to the arithmetical simulation of sediment flushing. The most significant quantitative reduction in sedimentation was achieved by the channel contraction method, with sediment flushing and dredging following. Together, sediment flushing and channel contraction together resulted in a 10% increase in the amount of sediment that could be removed.

Alak Hassan (2014) investigated how sediment had been transported upstream of the Al-Amarah barrage. Flow velocity measurements were taken in the field, river cross-sections were drawn using the ADCP (Acoustic Doppler Current Profiler), and comparisons were made to use a working model and the three-dimensional numerical model SSIIM. The study's goal was to see if the numerical model (SSIIM) could accurately predict the allocation of sediment in the study achieve by comparing model results to those observed in the field. A new sediment transport formula, as well as the suggestion and verifying of soil infiltration rating curves, are also presented.

Khassaf and, Jabber (2015) investigated and modeled the sediment transport on the Euphrates river up-stream of the Al-Shamia Barrage in Al-Diwaniya, Iraq. Utilizing HEC-RAS version (4.1), in which the ADCP device took field measurements. The Enguland-Hansen formula from this model has been proven to be the most accurate when compared to field results. The average annual sediment transport load estimated through this formula is around (209000) tons, whereas the average annual sediment transport load measured in the field is about (140965) tons.

Kayyun and Mouhamed (2015) represents a model (of the flow field and the movement of the sediment), analytical research, and a calculation of the sediment deposition for the Al-Betera river reach upstream of the Al-Betera regulator in the Maysan Governorate of Iraq. These objectives were achieved using the SSIIM Model and field measurement approaches. The results demonstrated that the SSIIM Model is a powerful fluid flow model for trying to assess and forecasting water flowing, sediment transport, and layer deposition. A sediment transport curve was constructed using suspended sediment lots and lots and river discharge data from 1984 to 2014. The findings were acceptable for the river bend where the study was carried out. The grid, roughness of the bed, and sediment factors, on the other hand, should be selected with appropriate amounts for convergence objectives, taking into consideration the variation of hydraulic and sediment different factors over time and space.

Al-Ansari, et al. (2015) states that the major river in Iraq is the Tigris. They looked into the sediment at the river's bed in a reach that was upstream and around 18 km from Baghdad's center. The survey of 65 cross sections included the collection and analysis of 46 sediment samples. The bed's predominance of fine sand was observed (90.74 percent). 2.49 phi (0.177 mm) was the median size on average within the reach, and 2.58 phi was the mean size (0.16 mm). The sediments also had a modest degree of sorting and were leptokurtic, fine skewed, and skewed. Owing to the building of the Adhaim reservoir on the watercourse, that was previously the Tigris major source of silt before trying to enter Baghdad, reduced the size of the bottom sediments compared to previous studies. Moreover, the discharge of the Tigris from 1983 to 2013 (715 m^3/s) reduced by approximately 40% and 30%, respectively, when tried to compare to times periods 1931-1956 (1208 m3/s) and 1956-1980 (1015 m3/s), because of climate change and dam building up-stream from Baghdad. This has reduced the river's capability and competency.

Jassam and Abed (2021) constructed a research on the morphology and transport of sediment in the Diyala river which used the HEC-Ras program. The river's selected length for the current study was 193 km, starting at Diyala Weir and ending at the point where the Tigris River and Diyala River converge. Samples of suspended-load and bed-load have been gathered, and certain cross-sections were surveyed, during the fieldwork period, which lasted from June 2020 to August 2020. Between 0.2 and 0.6 meters were the results of the invert change from the sediment model's simulation for the river's actual condition from 2018 to 2019. In addition, previous investigations into this river revealed that the daily and annual sediment discharges were, respectively, 227.7 tons per day and 83531.93 tons per year. The inversion change values in the simulation results for the prescribed timeframe, which corresponds to five consecutive flood years, range from -1.25 to 1.4 m. Raising the riverbank level in some areas of the grasp and/or constructing training cross-sections in other areas of the grasp increased the water's capacity.

Esmaeel (2021) studied the movement of sediment south of Iraq's Al-Amarah barrage and tested the effectiveness of two numerical models, specifically the (3D-SSIIM) and (2D-Mike 21 Flow Model FM), to represent the study area and simulate its characteristics, particularly the concentrations of suspended sediments, in addition to flow velocities and water levels. They then compared their results with the field data for each model separately to decide which model was most accurate. A new formula based on the principle of dimensional analysis was also developed as part of this study to compute the suspended sediment load rates in accordance with the parameters and data of the study region. It also involved developing suspended sediment grading curves unique to the research area.

Vinther et al. (2004) studied the geographical and temporal variance in sediment and water flow through a tidal divide in the Danish Wadden Sea. From September to November 1998, three locations along a 3 km length were used for measurements and calculations of the transfer of water and silt. The findings demonstrate that throughout a tidal cycle, suspended sediment transport is often directed northward, but in a few instances, suspended sediment movement is directed southward.

Omran et al (2019) reviewed the concentration of sediment transported in the Iraqi city of Al-Hilla-Diwaniya by the Hilla river. The volume of sediment load in the river section under study was determined using the HEC-RAS version 5.0.0 program. The Yang technique has been employed to calculate the transport function, the Ruby method was used to calculate the fall velocity, and the Thomas (Ex5) method was used as a sorting method. Four cross-sections along the river reach (at 0+000, 1+000, 2+000, and 3+000) for a length of 100 m for each station were chosen. This project (Hilla- Diwaniya River) is not suitable for irrigation because the results showed that there is no variation between the four stations that were chosen for recording sediment transport concentration, flow velocity, effective depth, and effective width. All the above studies rearranged in Table below.

Table 1: Studies using different numerical models

Researcher name	Study area	Numerical models	year	Ref.
A. Schmidt et. al.	Upstream Rhine river at Iffezheim	a two-dimensional hydrodynamic and morphodynamic models	2005	29
Haun Stefan et. al.	hydropower reservoir	the three-dimensional numerical model SSIIM	2013	41
A. Alak Hassan	upstream of Al- Amarah barrage,	The three dimensional numerical model SSIIM	2014	8
Abed Kareem R., et al.	Al-Ghammas Barrage, upstream	The three dimensional numerical model SSIIM	2014	44
S. I. Khassaf and, A. M. jabber	Up-stream of Al-Shamia Barrage on the Euphrates river at Al-Diwaniya	HEC-RAS version (4.1) in	2015	45
T. S. Kayyun and N. H. Mouhamed	upstream of Al-Betera regulator – Maysan	The three dimensional numerical model SSIIM	2015	46

	Governorate			
W. A. Jassam and B. Sh. Abed	Diyala river	HEC-Ras software	2021	48
A. J. Esmaeel	Down-stream of Al –Amarah barrage south of Iraq	Two numerical models namely, (3D-SSIIM) and (2D-Mike 21 Flow Model FM)	2021	6
Un Ji et al.	the Nakdong River, Korea	Two-dimensional model.	2016	42
Esmaeili Taymaz et. al. et. al.	Dashidaira reservoir in northern Japanese	A fully 3D numerical model (SSIIM)	2017	43
Z. A. Omran, et.al.	Hilla Diwaniya river	HEC-RAS version (5.0.0) program	2019	50

3.2. Using Empirical Formulas

Bagnold (1966) created a sediment transport model based on streams. In that model, Bagnold presupposes that the sediment is delivered through the suspended and bedload modes. Grain-to-grain interactions in the flow carry the bedload of sediment; turbulent diffusion in the flow supports the transport of suspended sediment. The formula is

$$\frac{\gamma_{s-\gamma}}{\gamma}\, q_{bw}\ \tan\alpha = \tau\, \upsilon\, e_b$$

Where γ and $\gamma_s$are specific weights for water and sediment, respectively, $q_{bw}$is bed load transport rate (weight per unit width), Tan α proportion of tangential shear force to vertical shear force, τ shear stress along the bed, eb efficiency coefficient, and v average flow velocity.

Engelund and Hansen (1972) developed a sediment transport function using the similarity principle and Bagnold's stream power notion. Engelund and Hanson discovered that the method would work for dun beds and higher flow regimes with sediment sizes greater than 0.15 mm. the formula is

$$q_s = 0.05\, V^2\, \gamma_s\ \left(d50/g(Gs-1)\right)^{1/2}\ \left(\frac{\tau_0}{(\gamma_s-\gamma)d50}\right)^{3/2}$$

Where $q_s$is the bed-material sediment discharge by weight per unit width, V is the depth-average flow velocity, $d_{50}$is the median diameter of the bed materials, g is the gravitational acceleration, $\tau_0$is the shear stress along the bed.

Ackers and White (1973) employed dimensional analysis based on the flow power idea, as described by Bagnold, to definite the rate of sediment transport by a number of dimensionless factors.

$$C_t = C\, G_s \frac{d_{50}}{h}\ \left(\frac{V}{V_*}\right)^n \left(\frac{F}{A}-1\right)^m$$

$$F = \frac{V_*^n}{\sqrt{g\, d_{50}(G_s-1)}}\left[\frac{V}{\sqrt{32}\, log\left(\frac{10h}{d_{50}}\right)}\right]^{1-n}$$

Where: C_t= total sediment load, h= average depth of flow (m), V_*= shear velocity (m/s), (C, A, m, n) are constants, and d_{50}= partical diameter (m).

Brice in 1982 discovered the stream bend and bank erosion during his search. This is a momentum equation-based model. This is an attempt to propose an alternative explanation to the one that has previously been offered for the proven association between bend migration and the curvature ratio. Begin says that the elimination of matters from the toe of the bank and the ensuing geotechnical bank failure are caused by basal erosion. The shear stress operating on the bank, that is more than the critical shear stress, is what causes basal erosion. By analyzing the longitudinal momentum equation near the bank the shear stress acting on the bank can be calculated:

$$\frac{F}{A_b} = \frac{\rho.Q.U_c}{H_c.Rc.\emptyset}\sqrt{2(1-cos\emptyset}$$

in which F= the total force acting on the bank; A_b = the bank area on which the force is exerted it, is equal to the water depth near the outer bank, H_c, multiplied by the length of bank in this section, L, A_b =H_c .L =H_c (R_c.Φ); R_c=radius of curvature near the outer bank. He assumed that the downstream flow is uniform and the velocity is constant along the bend and he found that the shear stress when is maximal for (1.3≤Rc/W≤4.1), in which W=top width of flow, and this value is well and this value is well in accord with the observations of Hickin and Nanson.

Van Rijn (1984a) introduces a technique that makes it possible to calculate transport of bed-loading as the sum of the saltation height, bed-load concentration, and particle velocity. In order to standardize the numerical model utilizing the lift constant as a free factor, experiments using stones units (transported as bed load) were used. The model was applied to determine the saltation heights and lengths under various flow circumstances. The computational outcomes that were used to establish straightforward correlations between the saltation properties of sediment accumulation in the bed-load layer is calculated utilizing calculated bed-load transport proportions. It is a straightforward statement that describes the bed-load concentration in relation to the suggested flowing and sediment circumstances. A confirmation investigation utilizing approximately 600 data displays that around 77 % of the expected bed load-transport proportions are within 0.5 and 2 times the examined amounts.

Yang (2003) using dimensional analysis (higher than 100 ppm by weight), we modified a connection for rivers with a high concentration of suspended solids. Yang relation is

$$\text{Log } C_t = 5.165-0.153 \log\frac{\omega\, d50}{\upsilon} -0.297 \log\frac{V_*}{\omega} +(1.78-0.36 \log\frac{\omega\, d50}{\upsilon} -0.48 \log\frac{V_*}{\omega}) \log(\frac{VS}{\omega}-\frac{\gamma_m}{\gamma_s-\gamma_m})$$

In which Ct concentration of sediment in ppm, υ is kinematic velocity of sediment-laden flow, v velocity.

Vinh et al. (2016) created model (The NESTING technique (Delft3D-NESTHD)) to simulate the dynamics of suspended sediment in the Mekong coastline region of the South China Sea (East Vietnam Sea). So as to standardize and validate the model design, the data were collected in situ throughout four time periods between 2012 and 2014. The scenarios that were developed correlate to various wave circumstances and river flow amounts normal of low flowing and flooding periods. The findings are addressed in light of variations (scenarios) in sediment accumulation and corrosion alongside the delta coast.

Khassaf, and Al-Rahman (2005) analyze the bed sediment load going into Haditha reservoir. To determine the application of each sediment transport formula, an examination of six sediments transport formulations (Engelund-Hansen, Ackers-White, Yang, Maddock, Graf-Acaroglu, and Karim-Kennedy) was conducted. The data were examined using depth integrated sampling from January 26 to March 10, 2003, and from June 15 to September 16, 2003. In addition, a new formula was created to forecast the ranges of hydraulic and sediment properties of the Euphrates river upstream of the Haditha dam. Based on the investigations, it was determined that the six formulas utilized needed to be modified in order to accurately represent the collected data. The four other models can not estimate the total sediment load as well as the Engelund-Hansen and Maddock formulas.
The new formula is

$$C= 55.1\ (\frac{V}{U_*})\ +10164.1\ (\frac{Rh}{B})\ +144.7\ (\frac{V}{\omega\ d50})\ -449.3$$

Where C= Concentration of suspended sediment in (mg/l), V velocity, w= The average falls velocity of sediment particle, Rh hydraulic radius, B bed width.

Al-Kizwini, et al. (2007) with the assistance of MS-statistic, investigated the movement of sediment and advanced a novel principle to determine the amount of sediment in the Kirkuk irrigation channel using regression analysis and the technique of dimensional analysis of the research area variables with the assistance of MS-statistic. The formula was developed through 14 cross-sections, and the data was collected by choosing 24 cross-sections along the length of the channel. The results of the proposed formula were validated by comparing them to the data from other sections, and they showed good agreement with the field measurements. The new formula is

Qs= ((Rh-(0.09*9*(Sg-1)))/V+ Rb(Sg-1) + ((0.3D35D65)/S) ^-0.34) ^1.1

where: Qs= Total sediment load (kg/sec); V= mean velocity (m/s); g = Gravitational acceleration (m/sec^2); Rh= hydraulic radius (m); Sg = specific gravity; S = slope of the channel; D35, D65= particle size for which 35% and 65% by weight of sediment is finer (mm).

Khassaf and Addab (2011) studied how sediments were transported and how much was present in the Al-Meshkab regulator channel. To investigate the characteristics and pace of sediment transport, twenty-four cross-sections were chosen throughout the Euphrates River reach. The practical portion of the study (lab and field activities) and the statistical portion were separated into two sections. The study included the proposition of an experimental principle that has been applied to appropriate the dimensionless formula and forecast the link between the sediment rate and the various factors. The disparities between the observed and projected sediment rates were investigated using an Analysis of Variance (ANOVA). The findings showed that the statistical model could not detect any statistically significant discrepancies between the observed and estimated sediment rate values. The new formula is

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$$Q_s = \rho_s\, g^{0.5}\, D_{50}^{2.5}\left[exp\begin{pmatrix} 1.11496\times10^{-2}\dfrac{Rh}{D_{50}} - 6.6551\times10^{-2}\dfrac{gD_{50}}{V^2} - \\ 1182.842S - 0.9385\dfrac{D_{50}}{D_{90}} - 2.2992\dfrac{\rho_s}{\rho_w} + 6.96176 \end{pmatrix}\right]$$

Where Qs = Total sediment load (kg /sec). V =Mean velocity (m/sec). g = Gravitational acceleration (m/sec²). Rh =Hydraulic radius (m). S = Slope of the channel. D50= Particle size for which 50 percent by weight of the sediments is finer (mm). D90= Particle size for which 90 percent by weight of the sediments is finer (mm).

Shamkhi and Noory (2019) investigated the Tigris River's suspended load calculation up-stream of the Kut Barrage. For the purposes of field sample and the assessment of hydrodynamic characteristics, five cross sections were assigned to the study reach. The study also involves laboratory work. The findings indicate that every sample from a bed is silt clay suspended around a Bagnold on a shield diagram. With an equivalent R2 of 1.0 and an RMSE range of 0.9 to 2.4, the relationship between the projected suspended sediment discharge by the Bagnold formulation and the field remark of held sediment flow shows suitable conformity.

Sulaiman, et al. (2021) The research attempted to determine the best formula for this website by analyzing the precision of various sediment transport models employing data gathered from the Euphrates River at the thermal power plant in then Al Anbar area, Iraq. Information on hydrology has been gathered. The effectiveness of those formulations has been evaluated using the precision of the estimates of the detected sediment loading with a specified difference proportion. According to the analyses, the Engelund-Hansen formulation was the most appropriate one for this river reach.

Dakheel et. al. (2022) employed directional analysis to develop a novel formula to calculate held sediment yield at the port of Khour Al-Zubair. Six cross-sections in Khour Al-Zubair port in Basrah province, southern Iraq, have been determined to conduct field measurements during the two tide times (Spring and Neap). Field amounts of hydraulic and fluid features, as well as sediment collection every two hours, were all component of the study's efforts to collect useful data for the development of an empirical formula. The correlation factor result (R = 0.97) suggests that the loads calculated using the suggested equation and the actual data are in good agreement. The formula is

$Qs=1.2883*10^{-4} *\rho_s\ v\ Rh^2\ (\frac{Ws}{V})^{-0.032}\ (\frac{d50}{Rh})^{0.374} *(\frac{S}{\rho_s})^{0.554}*(\frac{WL}{Rh})^{-0.172}\ (\frac{B}{Rh}Gs)^{0.421} *(\frac{VDmax}{\upsilon})^{0.582}$

where Qs is the suspended sediment load (kg/s), ρs is the density of sediment (kg/m³), V is the mean velocity (m/s), Rh is the hydraulic radius (m), Ws is the fall velocity of the particle (m/s), d50 is the median grain size (m), S is the salinity of water (kg/m3), WL is the water level (m), B is the width of the estuary (m), Gs is the specific gravity, Dmax is the maximum flow depth (m), and ν is the kinematics viscosity (m2 /s).

All the above studies rearranged in table below.

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Table 2: Studies using different Empirical formulas

Researcher name	Study area	Empirical formula	year	Ref.
A. Alak Hassan	upstream of Al-Amarah barrage,	Alghazali (2012) formula	2014	8
R. Bagnold	-	derived a stream-based sediment transport model	1966	51
Engelund and Hansen	-	Bagnold's source	1972	52
Ackers and White	-	Dimensional analysis	1973	53
Brice	-	a Model based on the momentum equation	1982	54
Van Rijn	-	Mathematical model	1984a	55
Yang	-	Dimensional analysis	2003	33
V. Vinh, et al.	-	The NESTING method (Delft3D-NESTHD)	2016	56
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4. CONCLUSIONS

This study discusses comprehensive review on the transport of sediments and how to calculate their quantity (field and laboratory work), numerical modeling applications has been provided, an empirical Formula used for suggested suspended load and the following can be summarized based on past studies that were reviewed:

- Part of these local and global studies have reached the derivation of equations for calculating sediments. Some of these equations intended for calculating a total load of sediments, the other part for calculating the bedload, while some of these equations intended for calculating the suspended load. But the problem is that these equations derived according to specific conditions for each study area, and cannot be applied to other study areas that have conditions different from the ones from which these equations were derived. In addition, these equations applied in other study areas, but gave poor results.
- Part of these equations concluded from laboratory data that have a limited number of variables and flow conditions, and that do not resemble the real conditions of the study areas. Therefore, they also gave poor results when applied it in conditions that different from the conditions of their derivation.
- Concerning the application of numerical models, it is also applied based on the conditions of each region, which has its conditions different from the other; these conditions considered as inputs for the model to purpose of simulation. But these models are considered the most effective tool in simulating sediments and flow.
- Finally, most of the above studies did not fully cover sediment transport problems because of the complex character of sediment transport and its different conditions.

5- Recommendations

I. Talking about complex basic concepts and mechanisms (3dim) and analyzing them more precisely by other researchers

II. Conducting a field survey of sports models for local and international researchers to cover the issue of sedimentation from all aspects and covering broader regions in the world.

III. Linking the modern techniques currently used in measuring sedimentation with the most prominent research published in this regard and focusing on the results of this research

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نمذجة نقل الرواسب في صدر وأسفل السد: مراجعة

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الملخص

تعتبر حركة الرواسب النهرية عملية حاسمة ومعقدة. إن معرفة أنواع وكميات الرواسب التي تنقلها الأنهار أمر بالغ الأهمية للإدارة الفعالة للمياه. يقدم هذا البحث مراجعة شاملة لتحليل توزيع الرواسب في المنطقة، والتحقق من نتائج النماذج العددية (مثل HEC-RAS، SSIIM، Mike وغيرها) من خلال بيانات القياس (البيانات الميدانية والمختبرية) من النهر. سيتم مناقشة المزايا والعيوب، شكل النهر (دراسة التقلبات الناتجة عن وجود السد) إعادة إنتاج العمليات النموذجية بالإضافة إلى التطبيقات العملية. تم تطوير صيغة تجريبية للحمل المعلق الموصى به من قبل الباحثين. لم تغط معظم دراسات الرواسب بشكل كامل مشاكل نقل الرواسب بسبب الطبيعة المعقدة لنقل الرواسب وظروفها المختلفة

الكلمات الدالة: نقل الرواسب، النماذج العددية، المعادلات التجريبية، السدة