Effect of numerical models of flow hydraulics and sediment distribution of reservoirs

Hamid Reza Zahabi, Mahdi Amiri, Ramin Amini
[1.] Student of the Shahrood University of Hydraulic Structures
[2.] Faculty Member, Islamic Azad University, Gonabad Branch, iran
[3.] Department of Civil Engineering, Shahrood University of Technology, Shahrood, Iran

Abstract: In this paper we provide a detailed numerical model is presented for predicting the accumulation of sediments in the reservoir. Generally, the pattern of accumulation of sediments in the flow of the dam, reservoir geometry, reservoir storage, and sediment grain size dependent. The main effect of sedimentation in reservoirs, reservoir storage volumes decrease and significant impact on water resources Predict the amount of sediment entering the reservoir and its distribution during operation of the tank is important and it works in the planning, design, operation and maintenance of the tank should be considered.

[Hamid reza zahabi, Mahdi Amiri, Ramin Amini. **Effect of numerical models of flow hydraulics and sediment distribution of reservoirs**. *Life Sci J* 2013;10(6s):522-526] (ISSN:1097-8135). http://www.lifesciencesite.com. 81

Keywords: numerical modeling, reservoir sedimentation, sedimentary

Introduction

Phenomena of erosion and sedimentation, destructive effects on the environment and human life are important. One of the main effects is to reduce the volume of reservoirs. When the other tank can already do in order to serve its useful life is over. Since many models for simulation of sediment entering the reservoir is proposed that most of these models are based on experimental observations. Deposition including phenomena such as erosion, transport and deposition of sediment effect on them. These phenomena are part of the evolutionary and can also be affected by human activities and natural conditions may change over the years and they have provided the cause of natural disasters. select the appropriate model for simulation, one of the requirements is an applied study. Inappropriate choice model leads to the neglect of some important physical processes in the mining results are wrong or the excessive time and cost of preparing the input data and simulation is unnecessary. Suitable for understanding the capabilities and limitations of existing models, the simulation of physical processes affecting the recognition issue should be examined.

Mathematical models of the most important factors that would deposition to could be due to the limitations of numerical methods used, ease of use, ability to pre-processing and post-processing of data and information available and the environment study pointed out.[1]

Accumulation of sediments in the reservoir:

To calculate the concentration and accumulation of sediment in the dam reservoir, the inflow of sediments, density and specific weight of sediments mixed coefficient Trap Reservoir must be examined.[2]

$$y = 100 \times (1 - \frac{1}{1+ax})^n$$

Y: Trap factor in percent (vertical axis chart (1)

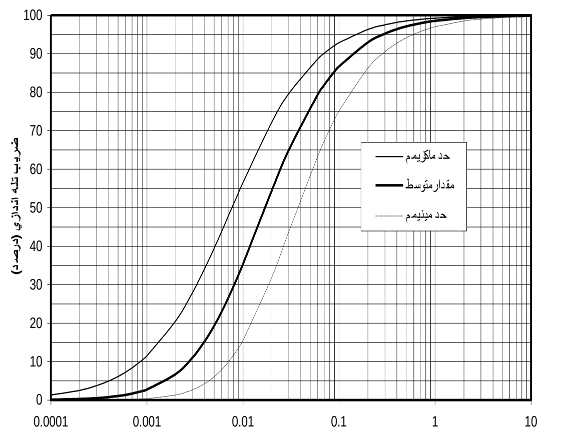
x: the ratio of reservoir capacity to annual inflow volume flow (horizontal axis of the graph (1)

n, a: coefficients are constant for curves of Figure (1) values are as follows:

A - For coarse particles (high curve) n = 1, a = 130

B - for the grading of sand and medium (middle curve) n = 1.5, a = 100

C - for fine particles (lower curve) n = 2, a = 65



Annual inflow to the reservoir volume
Figure 1

[1] Bajestan Shafai, Mahmoud (1378). "Hydraulics of sediment", Shahid Chamran University of Ahwaz, Second Edition.

[2] Emami, S. A. (1379). "Sediment Transport", published by Amirkabir University Jihad

Graph of the average range for calculating and estimating the amount of sediment accumulated in the reservoir and the upper and lower curves show the limits of this volume.

Estimation of sediment accumulation in the reservoir

In estimating the amount of sediment accumulated in the reservoir, the main factor is the particle density. Specific gravity specific gravity of sand, silt and clay composition of the inflow into the reservoir is calculated .Since the lifetime of reservoir sedimentation occurs to calculate the total volume of sediment gravity values must be calculated for each year and this is due to the compression of time will be. The next step is to estimate the sedimentation tank. The maximum speed and average speed of fall of particle flow in the reservoir tank trap coefficient figure.[1]

Trap a reservoir coefficient decreases with age because of the accumulated sediment reservoir capacity will be reduced over time. The reservoir filling may be a long time however expected useful life of the tank while the other tank to end service fails to perform its intended ¬. To obtain the volume at any time of the particle density and compressibility are used.[2]

$$\mathrm{Cap}_{i,j+1} = \mathrm{Cap}_{i,j} - (\mathrm{Trap}_{i,j} * \mathrm{Compac}_{i,j})$$

$$\mathrm{Trop}_{i,j+1} = \mathrm{Ration}_{i,j+1} * (q_t)_{i,j+1}$$

$$*** \ \mathrm{Ration}_{i,j+1} = \frac{\mathrm{Cap}_{i,j+1}}{q_{i,j+1}}$$

$$Cap_{i+1,1} = Cap_{i,12}$$

Where: Cap_ (i, j)Mqdarhjm my tank in months I've j
Trap_ (i, j) th coefficient trap in the month I've j
Compac_ (i, j) coefficient of material compaction
Ration_ (i, j) is the coefficient of the equation is obtained ***

Pricing mechanism in the reservoir sediment

Rapid changes in the velocity of the river flow entering the tank, ¬ coarse particle deposition will seed. Continue to flow in the reservoir delta deposition of coarse particles on the seed in the dam until the entire sediment tank is full.[3] The process carried out in slowly so that it may take 50 to 100 years of sediment dam reservoir is full. As a general rule[4], indicating that the reservoir sediments investments in 1997 were made by predecessors According to the most important problems in reservoir sediments are marked.

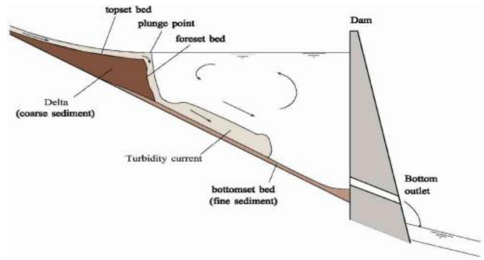
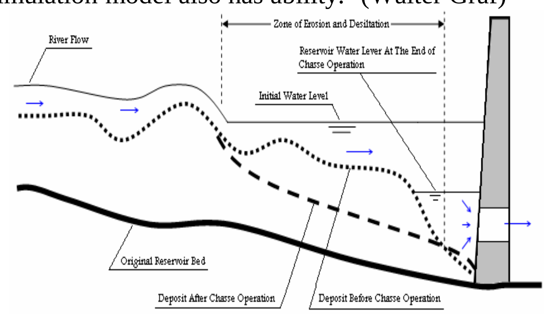


Figure 2: The general rule of sedimentation in reservoirs, predecessors, 1997

Numerical simulation of non-steady flow of water and sediment from the tank bottom drain valve away from the dam and using the governing equations of one-dimensional models have been. In this model the effect of air flow turbulence Turbulent Diffusion and interaction with the vessel wall were observed. In this model, we consider the effect of any lateral movement and the irregular geometry of the reservoir simulation model also has ability.[5] (Walter Graf)



Schematic view of the deposition process by removing the chassis from the bottom discharge valve.

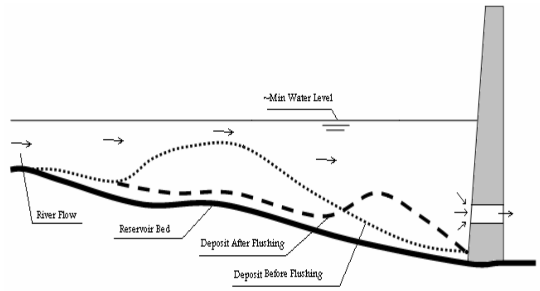
[1] Daryl B Simons and Faut Senturk., *"Sediment Transport Technology"*, Water Resource Publications, 1992

[2] Seyed Amir Emami, sediment transport, Jahad Amir Kabir University Press, 1379

[3] 3 sloff Krishnappan B.G. 1985, "Comparison of MOBED-2 and HEC-6 River Flow Models ", Canadian Journal of Civil Engineering, 12: 464- 471, 10.1139/185-054.

[4] ultrasonic Doppler velocity profiler. In: Third international symposium on ultrasonic doppler methods for fluid mechanics and fluid engineering. PSI Proceedings 02-01. 2002. p. 59–66

[5] Khosronezhad, Ali, Kamal Ghazanfari, and MA Mohamad mirzayi Zarandi, 1385



Schematic view of the current flood discharge containing large amounts of sediment

Materials and Methods

Numerical models are a useful tool for predicting sediment transport. Numerical modeling of mass transfer numerical model for suspended sediment mass conservation equations are solved for the sediments in the hydraulic field. In this paper a numerical model based on the three main dimensions of the model is one-dimensional, two-dimensional and three-dimensional studies have been.

One-dimensional model

One-dimensional mathematical model for the analysis of sediment transport in rivers and reservoir intervals are used. Sediment transport processes are simulated in one-dimensional flow field. Numerical models to investigate issues such as sediment deposition, and sediment being washed sediment below the dam are used.[1] Model of one-dimensional non steady state equation for the mean surface mass balance of suspended sediment to settle.

$$\frac{\partial(\mathrm{A}c_i)}{\partial t}+\frac{\partial(\mathrm{Q}c_i)}{\partial x}=\frac{\partial}{\partial x}\left(\mathrm{A}D_x\frac{\partial c_i}{\partial x}+S_i\right)$$

In which the cross-sectional area m^2, Dubai ($m^2\,\sec^{-1}$), the average volume of sediment concentration area, the line emission coefficient for x, terms of deposition and erosion.

More than one-dimensional model, mainly for non-cohesive sediment simple processes that are designed to simulate the sediment transport capacity is too sticky. These models consist of HEC-6 has been developed by the U.S. Army Engineering. GSTARS 3.2.1 EFDC1D model by Yang and colleagues in 2003 and in 2001 was presented and colleagues, one-dimensional sediment transport models including Summit, sedimentation and suspended sediment particle size class of adherent and non-adherent with. it is different. Platform consolidation model, a model for predicting the time variation ¬ bed depth, porosity, bulk storage and shear resistance. In summary, the model of sediment transport ¬ possible to analyze the deposition process- making the tanks were used, have been described.

Two-dimensional model

The year 1990 began studies of two-dimensional models. These models extensive information about water depth and bed height in rivers, lakes, estuaries, and rivers that provide the users. Models of two-dimensional diffusion equations - the diffusion calculation of the average width and depth of appropriate boundary conditions is resolved. Dimensional model for the deposition of sediment in the channel and port where we can study the changes of the depth and width of the money that is used. Following the publication of the equation - two-dimensional diffusion of sediments transported by considering the average depth is given.

$$\frac{\partial(Dc_i)}{\partial t}+\frac{\partial(Duc_i)}{\partial x}+\frac{\partial(Dvc_i)}{\partial y}=$$
$$\frac{\partial}{\partial x}\left(D_xD\frac{\partial c_i}{\partial x}\right)+\frac{\partial}{\partial y}\left(D_yD\frac{\partial c_i}{\partial y}\right)+S_i$$

In depth D , respectively V,U , the velocity component in the direction diffusion y,x ، D_y, D_x coefficient and the average depth y,x of C_i the sediment concentration.

Three-dimensional numerical models

When two-dimensional models of hydrodynamics and sediment transport processes in physics is not well stated is a problem Around the base of the hydraulic structures such as bridges or streams near the three-dimensional structure of the flow is everywhere, three-dimensional models are used. Calculating three-dimensional model of the flow sedimentary layer and the concentration is different. Three-dimensional models of the diffusion equation - diffusion for sediments with consideration of appropriate boundary conditions are solved.

$$\frac{\partial(c_i)}{\partial t}+\frac{\partial(uc_i)}{\partial x}+\frac{\partial(vc_i)}{\partial y}+\frac{\partial(wc_i)}{\partial z}$$
$$\frac{\partial}{\partial x}\left(D_x\frac{\partial c_i}{\partial x}\right)+\frac{\partial}{\partial y}\left(D_y\frac{\partial c_i}{\partial y}\right)+\frac{\partial}{\partial z}\left(D_z\frac{\partial c_i}{\partial z}\right)+\frac{\partial}{\partial y}z(ax_i)$$

In W,V,U Velocity component in order to z,y,x ، D_z,D_y,D_x Diffusion coefficient for z,y,x و C_i Volumetric concentration of sediment and u Sediment fall velocity.

Conclusions

A different conclusion about the real conditions of the model has been adjusted. For example, in 1985,

[1] Cross-Sectionally Averaged Equation

compared Krishanapan ¬ HEC-6 model and the convention between MOBED-2 did. He was comparing the two sections, the first section, the main difference between basic equations of the model with each one, and in the second part ¬ input data similar comparison between integrated convention ¬ two models for predicting sediment transport modeling was like .input data to a range of rivers and dams of South Sichuan is Gardiner. Compare the predictions of the two models with the measured data shows that predictability model MOBED-2 compared to model HEC-6 is superior and model HEC-6 to determine the coefficient of Manning and within the context of a calibrated wide and hard ¬ and time need. Also in 2010 Shooshtari comparison of alternative models of sediment transport in rivers and reservoirs, and the model GSTARS3, does not require a lot of data to calibrate the proposed model can be useful for assessing changes in volume of water stored in the reservoir ¬ GSTARS3 numerical model doses used. With respect to the routing of sediment particle size, formation and destruction of an armored layer, adjustment of channel width, slope stability, lateral canals and other things to consider are site specific conditions, we can solve many engineering problems in quasi-two-dimensional case and stable with a minimum of information needed for calibration and testing is appropriate. Olson's (1994) model SSIIM for similar ¬ Prototyping sediment in the reservoir, located in Costa Rica and Thailand applied and stated the data ¬ field completely accessible if not ¬ can compare ¬ positive results and calculated data, ¬ Available established.[1]

Reference

1. Walter H. Graf, "Hydraulic of Sediment Transport".
2. M. S. Yalin, "Mechanic of Sediment Transport".
3. Fan Jiahoa and Jang Rujin, "On methods for the desiltation of reservoir", Int.
4. Seminar of Experts on Reservoir Desiltation, Tunis, July ۱-۴, ۱۹۸۰.
5. Fan Jiahoa, "Turbid density current in reservoirs", Academic Ainica Ministry of
6. Water Conservancy and Electric Power, China.
7. P. Kerssens, A. Prins, and L. Van Rijn, ۱۹۷۹, "Model for suspended sediment
8. transport", Journal of Hydraulic Division, ASCE.
9. S. Chatterjee and S. Ghosh, ۱۹۸۰, "Submerged horizontal jet over erodible bed",
10. Journal of Hydraulic Division, ASCE.
11. Cheng Lung Chen, ۱۹۷۱, "Sediment dispersion in flow with moving boundaries",Journal of Hydraulic Division, ASCE.
12. Atkinson E. 1995, "A Numerical Model for Predicting Sediment Exclusion at Intakes", HR Wallingford
13. Palmieri, A., Shah, F., Annandale, G.W., Dinar, A. 2003 " Erosion and Sedimentation by High-Energy Density Turbidity Flows on Steep Slopes".
14. Frentte, M. and P.Y. Julien, 1996. Physical Processes Governing Reservoir Sedimentation Processes of the International Conference on Reservoir Sedimentation, Vol. 1, and Colorado State University, Font Collins, Colorado, sept. 11-16, PP: 121-142.
15. Julien, Y., 1998. Erosion and Sedimentation, Cambridge University Press, PP: 242- 246. 0-5210636339-6 paperback, 0-521044237- 0 hardback, ISBN.
16. Mahmood, K., 1987. Reservoir Sedimentation, Extent, Mitigation, World Bank Technical Paper, Washington, D.C.
17. Sloff, C.J., 1997. Modeling Reservoir Sedimentation Processes for Sediment Management Studies. Proc. Conf. Hydropower into the next century, Portoroz, Slovenia, Aqua Media Int., UK., Sept. 15-17, pp: 513-524.
18. US Army Corps of Engineering, Hydrologic Engineering Center, 1995, HEC-6: Reservoir Sediment Control Application, 609 second street, Davis, ca 95616.
19. Chang, H.H., 1985. Generalized Computer Programm, FLUVIAL-12, Mathematical Model for Erodible Channal. EAD/EAD513/F11-Users manual.pdf
20. Yang, C.T. and Simoes, F. J. M. (2002). User's manual for GSTARS3, U.S. Bureau of Reclamation, Technical Service Center, and Denver, Colorado, USA.
21. Thomas, W.A. and W.H. McAnally, 1985. Reservoir Sedimentation Handbook, Design and Management of Dams. Reservoir and Watersheds for Sustainable Use, pp: 11.18. McGraw Hill. ISBN: 0-07-043302-X.
22. Spasojevic, M. and F.M. Holly, 1990. Numerical Simulation of Scour and Deposition in a Channel network. Int. J.

[1] Olsen, N.R., 1994. Sediment transport modeling review current and future development, J. Hydr. Eng., 134.DOI1060/2008

Sediment Res., 18 (1): 32-49.www.waser.cn/journal/full text/2003-1/03.pdf.

23. Lee, H.Y., H.M. Hsieh, J.C. Yang and C.T. Yang, 1997. Quasi-two Dimensional Simulation of Scour and Deposition in Alluvial Channel. J. Hydr. Eng., 123(7): 600-609.DOL: org/10.1061/ASCE 0733-9429.
24. Olsen, N.R., 2010. User's manual for SSIIM, Department of Hydraulic and Environmental Engineering the Norwegian University of Science and Technology
25. Krishnappan B.G. 1985, "Comparison of MOBED-2 and HEC-6 River Flow Models ", Canadian Journal of Civil Engineering, 12: 464- 471, 10.1139/185-054.
26. Shooshtari, M.M. and A. Adib. and M.H. Ranginkaman, 2010" Evaluation of Variation of Useful Storage of reservoir in Stream Dams by GSTARS3 Software, African Journal of Agricultural Research Vol. 5 (1), pp. 060-069, 4 January.
27. Olsen, N.R., 1994. Sediment transport modeling review current and future development, J. Hydr. Eng., 134.DOI1060/2008
28. Seyed Amir Emami, sediment transport, Jahad Amir Kabir University Press, 1379
29. Emami, S. A. (1379). "Sediment Transport", published by Amirkabir University Jihad
30. Bajestan Shafai, Mahmoud (1378). "Hydraulics of sediment", Shahid Chamran University of Ahwaz, Second Edition.
31. Khsrvnzhad, Ali, Kamal Ghazanfari, and MA Mhmdmyrzayy Zarandi, 1385, de-sedimentation tank reservoirs, Part II: the results of field measurements, numerical simulation of the White River Dam sediment removal operations Shas, Fourth Conference on Research exchange experiences, Engineering, Kermanshah, Mahab Consulting Engineering Company, Iran Water Resources management Company,