Republic of Iraq
Ministry of Higher Education and
Scientific Research
University of Diyala
College of Engineering

Evaluation of Himeran Reservoir Sedimentation by Using HEC-HMS Software

A Thesis Submitted to the Council of College of Engineering University of Diyala in Partial Fulfillment of the Requirements for the Degree of Master of Science in Civil Engineering

By

Yousif Wathiq Ameen

BSc. Civil Engineering, 2014

Supervisor by

Prof. Dr. Thair H. Abdullah Al-Jubouri

Assist. Prof. Dr. Qassem H. Jalut

2017 **IRAQ** **1439**

Acknowledgment

Foremost, I would like to express my sincere gratitude to my advisors DR. Thair H. Abdullah and Dr. Qassem H. Jalut for the continuous support of my MSc study and research, for their patience, motivation, enthusiasm, and immense knowledge. Their guidance helped me in all the time of research and writing of this thesis. I could not have imagined having a better advisors for my MSc study. I Like to thank our teachers in the Department of Civil Engineering for their effort throughout the duration of my studies. My thanks and gratitude to the Deanship of Engineering College for all facilities provided, Also, I should not forget the Ministry of Water Resources' thanks to the Center for Studies and Engineering Design for providing the required data. Last but not least, I would like to thank my family and my friends who supported me and gave me confidence during the period of my studies.

Evaluation of Himeran Reservoir Sedimentation by Using HEC-HMS Software

By

Yousif W. Ameen

Supervisor by
Prof. Dr. Thair H. Abdullah AL-Jubouri

Co-supervisor by
Assist prof. Dr. Qassem H. Jalut

ABSTRACT

Hemrin dam is an important dam located on the course of the Diyala river. The sediment problem has greatly effect on Hemrin dam and its reservoir. Simulation for sediment entering and deposition in Hemrin reservoir was done using Hydraulic Engineering Center-Hydrologic Modeling System (HEC-HMS 4.1 software). Several input data were used for simulation such as precipitation data for the basin , watershed characteristic, geometric boundary for Diyala river and Hemrin reservoir and water release from Hemrin reservoir. The calibration processes for the model was done by using field measurement data for water discharge from Diyala river and good agreement was reached. The adopted period for simulation was 34 years started from 1981 up to 2014 and the result obtained show that the average annual sediment discharge load to Hemrin reservoir is($3.43x10^6$ ton) while the average annual sediment deposited is ($3.25x10^6$ ton) , the results show that the peak sediment discharge load occurred in November 1984.The simulation suggest that about 49.5% of mass of sediment deposited as clay while the all sediment load out from reservoir as clay. While the silt formed 40.3% of mass of sediment deposited while the sand and gravel are 8.9% and 1.3% respectively. The results prove that there is a strong link between precipitation depth in the basin and sediment entering to Hemrin reservoir. The sensitivity analysis was done by using cover factor and soil erodibility factor for sub basins in the watershed and this processes show that these two factor have large effect on sediment entering and deposition in Hemrin reservoir.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

List of symbols

Symbol	Definition	Dimension
A	watershed area	L^2
A_o	the area of reservoir	L^2
A_s	Surface area of reservoir	L^2
B	top width of the water surface	L
B_J	percentage of active layer composed of material grain class(j)	-
C_e	entrainment coefficient	-
C_f	cover and management factor	-
c	wave celerity	LT^{-1}
D	depth of water	L
d	particle diameter	L
d_{50}	particle size of which 50% is smaller	L
g_s	unit sediment transport capacity	MT^{-1}
H	the reservoir depth at the dam	L
h_o	depth to which the reservoir is completely filled with sediment	L
I_{avg}	average inflow during time interval	L^3T^{-1}
K	soil erodibility factor	-
L	length of control volume	L
LS	the topographic factor	-
M	channel width	L
n	number of grain classes	-
O_{avg}	average outflow during time interval	L^3T^{-1}
P	the support practice factor	-
Q	in or out flow rate from reservoir	L^3T^{-1}
Q_r	surface runoff volume	L^3
Q_s	transported sediment load	MT^{-1}
q	water flow rate	L^2T^{-1}
q_{cr}	critical water flow rate	L^2T^{-1}
q_s	is bed load transport rate	L^2T^{-1}
q_{peak}	the peak runoff rate	L^2T^{-1}
S_o	Channel bed slope	-

s	specific gravity	-
s_d	sediment deposited in reservoir	M
s_i	sediment inflow into the reservoir	MT^{-1}
s_{sus}	suspended sediment in reservoir	MT^{-1}
s_{out}	sediment out from reservoir	MT^{-1}
TE	Trap efficiency	-
T_C	total transport capacity	MT^{-1}
T_P	the time of peak	T
T_J	the transport potential for each material grain class	MT^{-1}
t_{lag}	the basin lag	T
U_p	the unit hydrograph peak	L^2T^{-1}
V	average channel velocity	LT^{-1}
V_o	the sediment volume below new zero elevation of the dam	L^3
V_s	the sediment volume	L^3
V_w	water volume in reservoir	L^3
Δt	the excess precipitation duration	T
ΔS	storage change	L^3
ω	particle fall velocity	LT^{-1}
ν	kinematic viscosity	L^2T^{-1}
μ	hydraulic diffusivity	L^2T^{-1}
γ	unit weight of water	$ML^{-2}T^{-2}$
γ_s	unit weight of solid particles	$ML^{-2}T^{-2}$
τ_o	bed level shear stress	$ML^{-1}T^{-2}$
ŋ	channel elevation	L
λ_p	active layer porosity	ML^{-3}

CHAPTER ONE

INTRODUCTION

1.1 General

The sedimentation is result of erosion which occurs in watershed , transported by with flow and deposited in the reservoir. Soil erosion outlined as the detachment of soil particles from soil mass . This procedure occurs because of some outside effect equivalent to wind , gravity and rainfall . The volume of soil eroded from the watershed depends on many factors that can summarized as fallow the characteristic of rainfall including amount and intensity, the type of soil in watershed ,land cover and topography , the size of soil particles and drainage networks characteristic such as size slop and shape (Yang, 2006). The transport of sediment means the movement of sediment particles. The basic mechanism responsible for the movement of particle is drag force exerted by water flow on individual grains (Henderson, 1966) . The sediment particles usually have three modes of motion(rolling , saltating and suspended), the transport of particles by saltating and rolling is called bed load transport , while the suspended particles are transported as suspended load transport (Van Rijin,1993). Deposition is the final stage of sedimentation process. When the river inter the reservoir the velocity of flow begins gradually to decrease and the solid particles will deposits . The volume of sediment that deposited in the reservoir depends on reservoirs trap efficiency which depends on particle size of sediment , the shape and size of reservoir and operation plan (Yang, 2006).

1.2 Sedimentation in Reservoirs

Sediment transport within the rivers and its accumulation in reservoirs has grown to be an essential challenge that as a rule must be considered. When water flows into the dam reservoir, it carries some amounts of sediments embedded within turbid inflow into the reservoir. These sediments will deposit along the bed of the dam reservoir as the water velocity is reduced. The longitudinal accumulation of sediments in a reservoir may be separated into three main zones depending on sediment characteristics, namely the zone of coarse sediments, delta, and fine sediments. As is conceptually illustrated in the Figure (1.1).

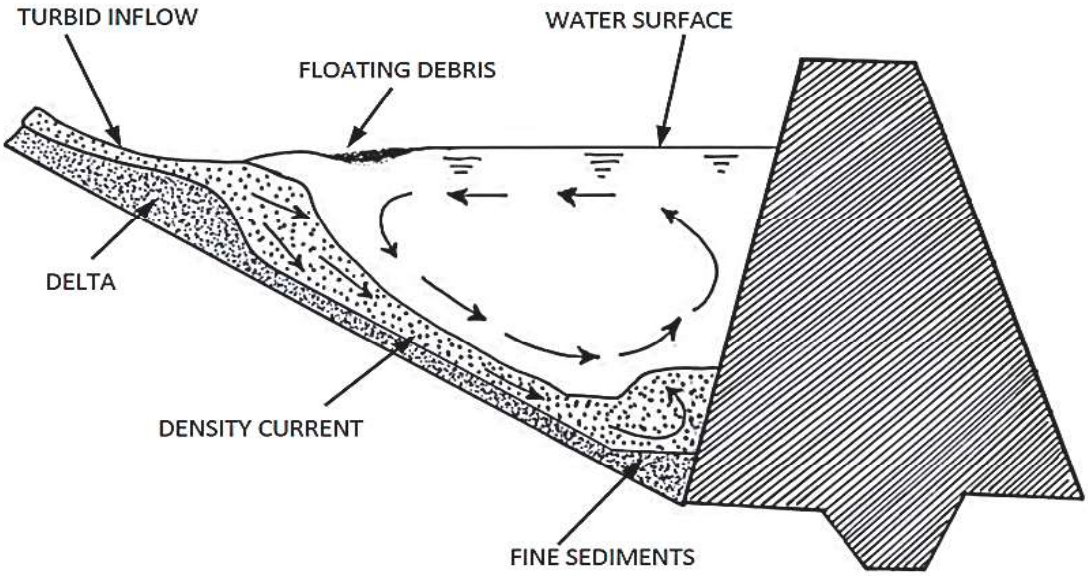

Figure (1.1) Longitudinal profile of reservoir bed (After Morris and Fan 2010)

The longitudinal deposition along the bed profile and the settling patterns differ from one reservoir to another, as is affected by many factors such as geometrical shape of the reservoir, discharge conditions, flood events, size of sediment particles of the inflowing load, and operating conditions of the reservoir(Morris and Fan ,2010).

1.3 Statement of problem

Sediment is the principle problem which affects the useful life of reservoir , causing several problem such as reducing the storage capacity of reservoir, The sediment may deposit near the intake of hydro power and thus cause harm to hydropower system . The sediment accumulation will rise the bed elevation of reservoir and therefore loss flood control .

1.4 Objective

Evaluation of sedimentation in Himeran reservoir by simulating the sedimentation processes using HEC-HMS 4.1 software.

1.5 Methodology

• Collection of data from the study area

• Use HEC-HMS as model

• Model calibration and sensitivity analysis

1.6 HEC – HMS

HEC- HMS 4.1 is a computer program designed by US Army Corps of Engineers, the user for this program become able to do a simulation for precipitation – runoff process . One of the options in this model is sediment transport simulation which enable the user from routing the sediment in each element in the watershed including that the deposition in the reservoir(HEC-HMS user manual,2015).

1.7 Thesis Layout

Chapter one :- contain an introduction about reservoir sedimentation, the objective and methodology of the study and simple description for HEC-HMS 4.1 software.

Chapter two:- is a literature review of investigation related to subject, important research focused on reservoir sedimentation and methods used for predicting reservoir sedimentation.

Chapter three:- contain the theory, equation, assumptions and limitation used by the Hydrologic Engineering Center (HEC) for designing HEC-HMS 4.1 software.

Chapter four:- is a description of the Diyala river basin and Himeran reservoir Which were used as case study.

Chapter five:- show the model calibration, result obtained from simulation for sedimentation in Himeran reservoir and sensitivity analysis.

Chapter six:- explain the conclusions that are reaches at from this study and some recommendations for future research work.