AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Irrigation and Hydraulics

Modeling The Effect of Depression Areas on Outflow Hydrograph

A Thesis submitted in partial fulfillment of the requirements of the degree of
Master of Science in Civil Engineering

(Irrigation and Hydraulics)

By

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Cairo, Egypt
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Statement

This thesis is submitted as a partial fulfillment of Master of Science in Civil Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Acknowledgment

My sincere thanks to ***Prof. Ashraf M. El Moustafa*** for his continuous advice, recommendations, help, guidance and useful suggestions during my research work I will always be indebted for his encouragement and constructive criticism.

I wish to extend my sincere thanks to ***Prof. Ahmed Ali Hassan*** **and** ***Prof. Gamal Kotb and Prof. Abdel kawi Khalifa*** for their supervision, generous support with their notes and discussion added a great value to this thesis. Many thanks for their kind encouragement that gave hand in pushing the progress of this thesis.

Deep appreciation is extent to ***My Family*** (***Father, Mother, Doaa & Nesma***) for their assistance, prays, patience, understanding, moral support and continuous encouragement during the time spent in this study to pursue my goals more than they realize. I cannot express the love and gratitude I feel for them. I deeply appreciate their sharing.

Deep appreciation and many thanks to ***My lovely wife*** for her assistance, patience, understanding, moral support and continuous encouragement during the time spent in this study.

Deep appreciation and special thanks to ***Ahmed Hany*** for his assistance, guidance and continuous encouragement.

Many thanks to all my colleagues who helped me with solving many technical problems which faced me throughout the preparation of the thesis and special words to ***Khaled Asaad, Mohamed Refaat, Omar Zohny, Mohamed Gamal,*** and many others who gave the support for no favor.

I would like also to extend my thanks to all of my relatives and friends for their kind encouragement and prays that helped and pushed me to finzlize this thesis.

December 2019

ABSTRACT

The value of runoff peak discharge of any basin is the most important hydrological parameter that should be calculated accurately in order to determine the suitable protection strategy and perform suitable design for any proposed hydraulic structures.

There are many factors affecting the runoff peak discharge; meteorological factors (mainly rainfall characteristics) and basin morphological characteristics such as size, slope, land cover, shape, soil type, and depression/surface storage. This research discusses the reduction factors affecting the peak values due to the existence of depressions/surface storage along the watershed main stream using 2D hydrodynamic modeling approach.

In this research, the analysis has considered different characteristics of the depressions with respect to the location, return period and depression area as categorized by NRCS (1975).

The analysis results of this research have been compared with the adjustment factors for ponding and swamp areas developed by NRCS (1975). The research showed that the peak reduction may reach 90% of the watershed original peak flow if the depression is located along the watershed main stream and at its lower part with depression area equals to 20% of watershed area.

The research revealed that, The lower locations along the main stream are the most effective on reducing peak flow values and there is a proportional relation between depression area and the reduction percentage. The results showed that the watershed shape factor is one of the most important factors that should be taken into account when investigating the effect of depression on peak flows; as it may change the reduction factors globally.

The results indicate that the NRCS adjustment factor values can’t be used without considering other factors i.e. watershed shape factor, time to peak and depression depth, that may lead to underestimating or overestimating the resulting hydrograph.

Furthermore, the research affirmed that, locating depressions along the main stream is more effective than distributing the depressions within the whole reaches of the watershed.

Keywords: 2D hydrodynamic modeling, HEC RAS, Depressions, Surface Storage, Runoff Reduction Factor, Watershed Shape Factor.

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List of Abbreviations

1D	:	One-Dimensional
2D	:	Two-Dimensional
BMPs	:	Best Management Practices
CN	:	Curve Number
CN_w	:	Weighted Curve Number
DEM	:	Digital Elevation Model
DEMs	:	Digital Elevation Models
EMU	:	Eastern Michigan University
FAO	:	Food and Agriculture Organization
ft^3	:	Cubic Feet
ft^3/sec	:	Cubic Feet per Second
GIS	:	Geographic Information System
HEC	:	Hydrologic Engineering Center
HEC-HMS	:	Hydrologic Engineering Center - Hydrologic Modeling System
HEC-RAS	:	Hydrologic Engineering Center – River Analysis System
hr.	:	Hour
HRU	:	Hydrologic Response Unit
LFP	:	Longest Flow Path
m	:	meter
m^3	:	Cubic Meter
m^3/sec	:	Cubic Meter per Second
NRCS	:	Natural Resources Conservation Service
NSS	:	National Streamflow Statistics
R. F	:	Reduction Factor
SCS	:	Soil Conservation Service
SWAT	:	Soil and Water Assessment Tool
TIN	:	Triangulated irregular network
USDA	:	United States Department of Agriculture
USGS	:	United States Geological Survey
U. S	:	United States
WSEs	:	Water Surface Elevations
Yrs.	:	Years

List of Symbols

The following symbols are used in this thesis. Usually each symbol has one meaning, but if there is more than one meaning for any symbol, then the meaning will be given in the context in which this symbol is used. Other symbols, not listed here, are defined in the main text.

A	:	Watershed area, (hectares)
A_k	:	Watershed area, (Km^2)
C	:	Runoff coefficient
f	:	Infiltration rate
F	:	External Forces
F_P	:	Ponding adjustment factor
g	:	Gravitational acceleration
I	:	Rainfall intensity, (mm/hr)
Ia	:	Initial abstraction, (inches)
$\bar{I}$	:	Average rate of inflow during the time interval
K_u	:	Units adaptation factor,(360 in S.I system)
n	:	Manning's Roughness Coefficients
$\bar{O}$	:	Average rate of outflow during the time interval
P	:	Rainfall depth, (inches)
Q	:	Runoff dishcage rate, (m^3/sec)
Q_D	:	Excess rainfall depth, (mm)
q_a	:	Adjusted maximum discharge value, (m^3/sec)
q_p	:	Maximum discharge value, (m^3/sec)
q_u	:	Unit maximum discharge value, (m^3/sec)
R	:	Runoff depth, (inches)
S	:	Maximum potential retention, (inches)
ΔS	:	Change in volume of storage during the time interval
$S_o(x,y)$	:	Bed slopes in the x- and y- directions
S_f (x,y)	:	Friction slope in the x- and y- directions
t	:	Time
Δt	:	Time Interval
u	:	Fluid Velocity.
ρ	:	Fluid Density.
μ	:	Fluid Dynamic Viscosity
∇	:	Deferential Operator
∂	:	Partial deferential

CHAPTER 1   INTRODUCTION