**AIN SHAMS UNIVERSITY**
**FACULTY OF ENGINEERING**
Irrigation and Hydraulics Department

# Storm Water Management and Urbanization Growth in Mega City
## Case study: East Cairo - Egypt

A Thesis Submitted in Partial Fulfillment for the Requirements
of the Degree of Master of Science in Civil Engineering
**(Irrigation and Hydraulics)**

By

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**Cairo 2017**

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Date: 21/01 / 2018

## Abstract

The continuity of urban expansion that has been observed in the Fifth Settlement, Cairo, Egypt will cause an increase in impervious areas, and accordingly will have an effect on the hydrological parameters and natural water cycle, such as increasing runoff volumes and decreasing the maximum soil infiltration potential. No studies were performed to examine the effect that the change in land use would have on the hydrological parameters of the watersheds in this area.
However, a great deal of research has been done in several locations from around the world that are available to study and serve this purpose. Most of the research was based on a combination of remote sensing with the Soil Conservation Service model in order to automate the calculation of runoff and test the impacts of urban expansion on runoff by connecting the two modeling results with spatial analysis techniques on Geographic Information System (GIS). The Long-Term Hydrologic Impact Assessment model run on a GIS is a relatively simple, user-friendly model that uses the Curve Number (CN) method to estimate changes in surface runoff between different stages of development.

Results showed that the percentage of impervious areas increased over 10 years of urban expansion by about 30% of the total area of the catchment. Also, the runoff depths increased by an average of 15%, and the runoff volumes increased approximately 10 times more than under natural conditions. Finally, this study provides useful information for land-use planning, management and the proposed methods that can serve as a useful tool for future impact of land-use studies. Also, from this study, it recommended to divide the study area as much possible into several sections, and to study each section as a standalone area in order to guarantee more accurate results related to faster classification.

**Key words :** Storm; Precipitation; GIS; Sustainable; Satellite; image; Catchment; Runoff; Hydrological; Negative; Impact; tool;

# *CONTENTS*

**Chapter III: Definition of the Problem And Study Area**



**Chapter IV: Methodology**



**Chapter V: Model Application and Results**



**Chapter VI: Conclusion & Recommendations**

# List of Figures

# List of Figures

# List of Photos

# List of Tables

**Table** **Page**

# List of Symbols

| Symbol | | Dimension |
|---|---|---|
| $\gamma$ | Specific weight | $ML^{-2}T^{-2}$ |
| A | Surface Area function in water level | $L^2$ |
| $A_f$ | Surface area of filter bed | $L^2$ |
| $A_{RH}$ | Area contributing to runoff | $L^2$ |
| C | Rational coefficient | Dimensionless |
| CN | Curve Number | Dimensionless |
| D | Rainfall event duration | T |
| FE | Filter Efficiency | Dimensionless |
| $F_c$ | Final infiltration capacity | $LT^{-1}$ |
| $F_o$ | Infiltration capacity | $LT^{-1}$ |
| I | Rainfall intensity | $LT^{-1}$ |
| $I_a$ | Initial abstraction | L |
| K | Field hydraulic conductivity | $LT^{-1}$ |
| $P_r$ | Pressure | $ML^{-1}T^{-2}$ |
| P | Total rainfall | L |
| P_in | Total Rainfall in inch Unites | L |
| $P_{RH}$ | Average rainfall over period | L |
| Q | Flow rate | $L^3T^{-1}$ |
| $Q_i$ | Inflow rate | $L^3T^{-1}$ |
| $Q_o$ | Outflow rate | $L^3T^{-1}$ |
| $Q_{out}$ | Outflow rate function in water level | $L^3T^{-1}$ |
| R | Hydraulic radius | L |
| $R_d$ | Excess runoff depth | L |
| $R_{di}$ | Ratio of drained area to the infiltration area | Dimensionless |
| S | Maximum soil potential | L |
| SL | Overall slope of the channel | $LL^{-1}$ |

# List of Symbols

| Symbol | | Dimension |
|---|---|---|
| S_in | Maximum soil potential in inch unites | L |
| $S_v$ | Storage volume | $L^3$ |
| V | Velocity | $LT^{-1}$ |
| $V_r$ | Void ratio of fill material | Dimensionless |
| $V_{tv}$ | Water treatment volume | $L^3$ |
| $V_{RH}$ | Volume of usable rainwater | $L^3$ |
| Z | Elevation at centroid | L |
| $d_f$ | filter bed depth | L |
| $h_f$ | Average height of water above filter bed (half-maximum height) | L |
| $h_T$ | Total Depth | L |
| g | Gravitational acceleration constant | $LT^{-2}$ |
| n | Manning's coefficient | $TL^{-0.3}$ |
| q | Infiltration coefficient from percolation test | $LT^{-1}$ |
| t | Time | T |
| $t_c$ | Constant determining how quickly the infiltration decreases | $T^{-1}$ |
| $t_f$ | Time required to water volume to percolate through filter bed | T |

# CHAPTER ONE

# INTRODUCTION

## 1.1 General

Increased densities and concentrations of residential, industrial and commercial buildings and facilities are referred to either urbanization growth or urbanization development. An increase in the continuity of urbanization growth over decades will cause an increase in impervious areas, which will have an effect on the hydrological parameters and natural water cycle by increasing runoff volumes and decreasing the maximum soil infiltration potential, as shown in figure (1-1). This research focuses on assessing the negative impacts that occur as a result of growing urbanization, and accordingly proposes mitigation measures.

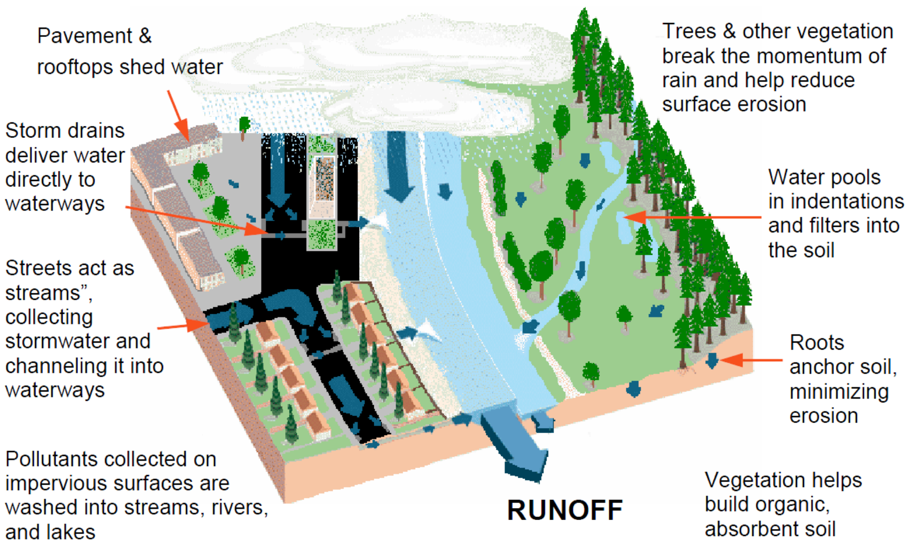


Figure (1-1) Resulted runoff from impervious areas

## 1.1 Study Objective

Land-use change in urbanizing areas can significantly changing the hydrology of a watershed and can have serious impacts runoff depths, downstream flooding, and groundwater recharge rates. Most currently available models used in estimating the hydrologic impacts of urbanization are not well suited to long-term hydrologic analysis or are too complex and data intensive for widespread practical application. The Long-Term Hydrologic Impact Assessment model run on a Geographic Information System (GIS) is a relatively simple, user-friendly model that uses the Curve Number (CN) method to estimate changes in surface runoff between different stages of development.

This research investigates the changes in runoff depths which resulting from the transformation of rural-lands to urban-lands within 5th settlement watershed between years (2006-2016) and propose an applicable solution by SUDS techniques to absorption the difference runoff volume between these two years.

## 1.1 Organization of Work

This thesis is organized in six chapters as follows to study the impacts of the urbanization growth in Cairo east especially in the 5th settlement basin, on the hydrological parameters

**Chapter one:** gives an introduction about the subject and the organization of the work and objectives.

**Chapter two:** presents brief notes and literature review about urbanization impact, sustainable drainage system techniques SUDS and previous studies around this field.

**Chapter three:** presents the problem definition which related to the study area.

**Chapter four:** presents the model development under the ARC.GIS interface.

**Chapter five:** presents the model application to the selected problem, the model results, the discussion and analysis.

**Chapter six:** presents the main conclusion of the research and also states the recommendations to be taken into consideration in the future.