Study of Flood Inundation Maps for Wadi El Arish

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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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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Thesis Summary

One third of land area on the Earth is arid or semi-arid, where the water is serious, either lack or excess. In the eastern of Egypt Sinai peninsula is located, and due to the importance of Sinai as a one of the major development axes for the government which try to increase/encourage the investment in this region of Egypt, The flood protection is a highly important issue due to the damage, danger and other hazards associated to floods to human life, properties, and environment.

Digital geospatial flood inundation mapping can be a powerful tool for flood risk management. Flood risk preparedness, communications, warning, response, and mitigation can be enhanced by flood inundation mapping that shows flood water extent, depth, and velocity over the land surface. Flood inundation maps that accurately reflect observed and forecasted hydrodynamic conditions enable officials to make timely operational and public safety decisions before and during flood events.

To get the runoff for inundation maps hydrologic model had setup to get the response of watershed for Rainfall. Through the hydrologic modeling some parameters had been considered like soil type and cover, land use which change with time, any obstacle in the flood stream will change water behavior.

Wadi El-Arish had been attacked in 1975 by a significant flood event, the event is the simulated event in this study, while the Shuttle Radar Topography Mission (SRTM) had been used to simulate the wadi terrain. The boundary of the flood inundation had been studied. A hydrological model of wadi El-Arish basin, using HEC-HMS was coupled with an 1D-hydraulic model of wadi stream, using HEC-RAS to generate flood inundation depth and extent of this event.

The maps showing that the water depth along the wadi varying from 0 to 9m, and velocity distribution showing the range of velocities between 0 and 4.5m/s.

Keywords: Wadi El-Arish, Sinai, Flood Inundation, HEC-HMS, HEC-RAS, GIS, Remote Sensing, hydrologic modeling.
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February 2016
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<td>RS</td>
<td>Remote Sensing</td>
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<td>SCS</td>
<td>Soil Conservation Service</td>
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<tr>
<td>CN</td>
<td>Curve Number</td>
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<tr>
<td>DEM</td>
<td>Digital Elevation Model</td>
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<tr>
<td>1D</td>
<td>One Dimension</td>
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<td>Two Dimensional</td>
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<td>GIS</td>
<td>Geographic Information System</td>
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<td>HEC</td>
<td>Hydrologic Engineering Center</td>
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<tr>
<td>HMS</td>
<td>Hydrological Modelling System</td>
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<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
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<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
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<td>RAS</td>
<td>River Analysis System</td>
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<td>SRTM</td>
<td>Shuttle Radar Topography Mission</td>
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<td>WL</td>
<td>Water Level</td>
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<td>XS</td>
<td>Cross section</td>
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<td>UH</td>
<td>Unit Hydrograph</td>
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<tr>
<td>IWR</td>
<td>Institute of Water Resources</td>
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<td>HSG</td>
<td>Hydrologic Soil Group</td>
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<tr>
<td>NEH</td>
<td>National Engineering Handbook</td>
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<td>ARC</td>
<td>Antecedent Runoff Condition</td>
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<td>SMA</td>
<td>Soil Moister Accounting</td>
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<td>TIN</td>
<td>Triangulated Irregular Network</td>
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<td>DTM</td>
<td>Digital Terrain Model</td>
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<td>GIUH</td>
<td>Geomorphologic Instantaneous Hydrograph</td>
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Chapter 1
Introduction
1 INTRODUCTION

1.1 Background and problem statement

One third of land area on the Earth is arid or semi-arid where potential evapotranspiration exceeds rainfall (McKnight and Hess 2000). These areas, collectively called ‘the arid and/or semi-arid zone’, constitute much of the Earth’s land between latitudes 18 and 40° north and south of the equator and include most of northern and southern Africa, the Middle East, western USA and the southern areas of South America, most of Australia, large parts of central Asia and even parts of Europe (NOAA 2010). Arid and semi arid areas face globally the greatest pressure to deliver and manage water recourses; as the Hydrology of it is very complicated. The nature of the storms is strange in formation and generation. It is classified as high intensity and short duration. The intersection between the surface hydrology and ground water hydrology add more difficulties in such areas. The flash floods are very common hazards as over 3000 disasters were recorded by the Centre for Research on the Epidemiology of Disasters since 1900 (available at http://www.cred.be). So far, the societies are still attacked by flash floods in spite of the availability of advanced technologies. Therefore, flash floods are continuing to claim lives of many people all over the world and cause serious damage to property, infrastructure and incur economic losses (Colombo et al. 2002).

Sinai falls in the arid and semi-arid region and it is undergoing a rising development, and increasing of population. Wadis commonly provide the most practicable routes for roads and other infrastructure; population increase, economic development and urbanization lead to increasing pressure for construction in flood prone areas. Floods, although infrequent, can be extremely damaging and represent a threat to life as well as property. Furthermore, such threats are likely to increase.

Sinai is highly influenced by flash floods and therefore need great attention. Because of its topography, as a towering plateau from south to north composed of old igneous rocks, it has a lot of high volcanic peaks. The most important Mountains in Sinai are St. Catherine, Oum Schumer, and Al-Thabt. At the edge
of these mountains towards the north Al Teeh plateau, which descend to the north, represent two-thirds of Sinai area with average height of 1000 m. The water of Teeh Sailiya plateau also goes towards the East and the West, where deep valleys make their way toward Gulf of Aqaba and Gulf of Suez. Wadi Al-Arish stems from the plateau Ajkah then crosses this plateau, and takes its way towards the Mediterranean where the outlet near the town of El Arish. Due to the importance of Sinai as one of the major development axes for the government, which try to increase/encourage the investment in this region of Egypt, the flood protection arises as a highly important issue due to the damage, danger and other hazards associated to it because of the larg dray wadi (Wadi El Arish) located in it. The wadi was subjected to severe thunderstorms on 17th and 18th January 2010 followed by extreme violent flood that had not been known in Sinai since 1980. On 17th and 18th January 2010, severe flash floods hit Sinai Peninsula, Egypt owing to heavy rains from which flood of wadi El Arish was the worst. The flood led to the death of six victims and dozens of people were wounded and many missing. It fully devastated 592 houses and partially damaged 1487 houses as the water level reached 2 m above the surface of the ground. The water washed away cars, autotrucks, trees, roads and electric and water lines. Damages were estimated as 137 million Egyptian pounds (Official governmental spokesman, 2010).

Flash flood, occurred at the last five years in different Egyptian cities spatially in Sinai, triggered the need of flood risk assessment study, and an early warning system for the area highly affected by those floods. Among natural hazards, flood inundation is one of the most frequent and destructive hazards, which normally affects a large area and causes extensive damages and loss of lives.

1.2 Objectives

The study aims to aid in establishing an early warning system for the study area through determining the right of wadi to prevent any development in it to avoid damage and losses. Theoretical storms will be assumed during analysis and the response of the study area will be modeled to determine the flood inundation. The benefits of this study are (a) to develop flood inundation maps of the downstream reach of wadi El-Arish (from El-Arish To Al Hassana) in order to detect flood prone area, (b) recommend actions to reduce flood impact on the