Master Thesis

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Applying Geographical Information Systems and Remote Sensing to Evaluate Flash Flood hazards: Eastern Side of Qena Bend, Nile Valley, Egypt

Ahmed Omar Abd El-Aziz Abd El -Mageed
40646

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Advisor
Dr.Amr Ali

Salzburg February 2014

Science Pledge

By my signature below, I certify that my thesis is entirely the

Result of my own work. I have cited all sources I have used in

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To anyone who has put ambition in my heart

Abstract

Natural Distastes are mostly occur in dry areas as a result of sudden climatic fluctuations. The flood is one of the most destructive environmental phenomena that cause severe damage and massive ruinous of infrastructure as well as material and life losses.

The models that deal with the flash floods differ in terms of sensitivity to predict them and depending on the exact calculations for sudden rain. This is to determine the amounts of runoff to flash flood as well as the curve number (CN) calculations symmetric. Moreover, it includes model of soil conservation service (SCS) through calculating the amount of rainfall and the amount of losses in the evaporation and absorption into the soil and carrying surfaces and then down to the estimation flow of the stream, which result the output in the drainage basins.

These models are mainly depending on the digital elevation models (DEM) in order to extract Morphometric elements and characteristics that describe the shape and size of the drainage network and all the various morphometric transactions.

The Geographical Information System (GIS) tools represents an affordable proposal for the establishment of the hydrological models based on analyzes of the spatial information, the integrated morphometric outputs, and the DEM that identifying runoff directions, drainage basins, and main sewers for the valleys to become an important input to the (SCS) model for the calculation of the flow of flash flood.

Moreover remote sensing data represents one of the most important elements in Environmental Studies of floods disasters through monitoring the human activity and the evolution of their urban and agricultural activity depending on the satellite imageries for different years (in this study, Landsat satellite from 1972 (MSS), 1984 (TM), 2005 (ETM +) to 2013 (LAND SAT 8) as well as high resolution satellite imageries (IKONOS, Quick bird) are applied to calculate the land use and monitor changes in land use).

The previous elements are integrated with each other through geographic information systems and remote sensing techniques to identify data networks, water storm drains and vulnerability places that are prone to risk exposure and safe places "what we might call idiomatically places of sustainable development and setting alternatives to the dangerous areas".

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It would not have been possible to write this thesis without the help and support of the people around me, to only some of whom it is possible to give particular mention here.

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List of Abbreviations

ASTER	the Advanced Space borne Thermal Emission and Reflection Radiometer
CN	Curve number
DEM	Digital Elevation Model
EMA	Egyptian Meteorological Authority
FFG	Flash Flood Guidance
GIS	Geographical information systems
HYDIS	Hydrological Data and Information System
LST	land surface temperature
NRCCS	Natural Resources Conservation Service
OFDA	Office of Disaster Assistance of Foreign Affairs
OLI	Operational Land Imager
SCS	Soil Conservation Service
Ungauged	Hydrological modeling technique for sub-drainage basins without rain Gauges
USAID	U.S. Agency for International Development
USGS	United States Geological Survey

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Chapter One

1.1 Motivation

The risk of sudden disasters mainly depends on the speed of decision making and the buffer zone in which the disaster has occurred: is it within the scope of human activity or in a remote area?

The flood disaster is one from those natural hazards that are associated closely with climate and that can beset infrastructure along with all the human activity manifestation whether it is agricultural activity or urban activity resulting in huge economic losses.

That is why warning systems are being developed in order to predict when such disaster is going to happen. The prediction can be shortly before the disaster or hours, it depends on both rain forecast and different weather information. Then the required procedures can be taken in order to overcome the flood and avoid human losses that may reach to hundreds of deaths.

The soil conservation service Model SCS has been developed in order to determine the net amount of flow depending on the amount of rain along with system curve number CN which may result in the possible existence of a relation between the soil, water runoff and the amount of water lost during a spate of water runoff.

The soil conservation service Model SCS requires hydrological modeling inputs of drainage basins in addition to morphometric transactions.

These studies require clear data for the areas of human population and urban clusters in order to be able to evaluate its relation to the disaster scope and to what extent it is influential, therefore the decision can be made in time. Place of human population are being studied through remote sensing data, to know its development over the consecutive years and therefore determine the trends of urban growth. Here lies the purpose of sustainable development which aims at establishing a community that is compatible with its environment.

The purpose of this study, is to integrate different sources of data (satellite imageries, topographic maps, contour maps, …etc.) to generate the hydrological modeling in order to produce a net flow of Flash Flood Guidance FFG at a specific time for un-gauged small sub basin. These guidance factors are used as a supplementary to determine the risk of sudden floods.

1.2 Problem statement

Floods represent major problem in many of the communities that suffer from poor planning, especially in the light of strong tendency to the sustainable development in those places and environments.

The study area is one of the most dangerous areas in the **Nile Valley** in terms of floods. This is not only for the high frequency of flash floods and human and economic losses, but also along the flash floods of many areas. Most famous floods are as follows:

1-November 26, 1968: three-damaged areas in flash floods violent, namely **Al-klahin**, that damaged about 4020 families and caused displacement of more than 2165 people. **Shaykhiyyah**: caused damages for 17 families and displacement of more than 94 people.

2-On March 13, 1975: damaged a spate **Ahamidat** village and left eight families homeless.

3-On 5 and 6 April 1975: the affected villages are **Karam Imran** and **ASHRAF** Eastern flash floods, medium, have been displaced from their impact 86 people, then another flash flood took place in April 1975 injured people in the village of **Karam Imran**, only 289 people affected.

4-In October storm, large area included a great stretch, villages have been affected **Higaza Bahary and Higaza Kebly,** those floods adversely affected 546 people of the village firstly, while adversely affected 12 May 1979 , and 2304 people later on.

5-On 12/30/1980: severe flash floods rushed profusely over 6 hours, and some villages damaged, and destroyed about 900 acres and 23 homes crash.
6-On April 20, 1985: the flash flood severely took place in the Valley of **(Banat Barre)**, and water penetrated **Khuzam Dam**, which was not used before and has been completely destroyed. The flash floods resulted in the deaths of 32 people.

7-.Khouzam and Higaza are also villages that suffered in February,1984. Floods led to the deaths of 13 people, and 20 people were missing. It has reached the amount of water carried by flood 12 million m3, and the speed water 5 km / h flash floods. 8- On 11/02/1994 more than 63 villages suffered from floods, and that resulted in the death of one person and affected 6856 families in **Qena**, who were demolished and cracked, about 2189 house flooded that cover about 4564 acres. Losses were concentrated in following areas:

- Nag Salem and Al-klahin

The flash floods led to the destruction of large number of houses, buildings, large agricultural tracts, as well as cutting the highway road between cities **Qeft, Quseir, Ezbet Karam Imran** and **Ezbet Gabriel,** and it caused the re-location of south east of the city of **Qena for** about 15 km. **Aezzbtan Valley** Serial have been affected by numerous valleys sited in the study area that have been affected by flash floods repeatedly, it had led to destruction of part of command area Agricultural **Asbetan**, and the demolition of many homes and number of cattle deaths.

- The mouth Wadi Qena

Railway between Qena – Safaga has been cut. The water load ranged from 70 cm depth, gravel, boulders and large blocks -which reached about 1 meter- demolished about 23 houses and damaged 900 acres.

When conditions are likely or imminent to having torrents, the public needs to be warned in a meaningful way and in a timely manner to minimize these effects. This warning Process includes the recognition of the beginning of the rains, and the collection and evaluation Data by human analysts or automated systems, and to identify the threat, notification, resolution ,Generation, response activation, public action and mitigation strategies(Carsell,2004).

It should be noted that in many places in the world disasters occurred as a result of not taking into consideration the risk of floods, a clear example in Egypt is Olympic Village that costs about billions of dollars for investment then destroyed as per the flood of **Wadi El-Arish** in Sinai at 2010.

The current National Weather Service (NWS) Flash Flood Guidance (FFG) model have been developed and distributed once or twice a day by 13 river forecast centers. Using a variety of hydrological modeling techniques at different levels. This can be a problem of technologies in local standards and the un-gauged sites which do not have data from which to analyze their own conditions. Figure (1-1) provides a clear picture of deficiencies in the output of the current model, as a result of the high spatial variation in the FFG Category:

If we are going to face this disaster, we must improve the management method of this problem and that can be tackled as the following:

1 - Taking into consideration the direction of sustainable development while taking decisions.

2 - To build a strong model in order to gain access to the floods, or at least identify the most risky places and the safest places for agricultural and urban expansion

3 - Take advantage of the analysis tools in GIS and remote sensing in treatment and avoid the problem through hydrological modeling of these valleys using GIS techniques. Moreover, building equations upon which hydrological models will be able to view the dimensions and extent of the problem, its impact, and extent of all this which will depend in some parts on digital elevations or cadastral data through systems on the GPS.

Hydrological and analysis techniques are necessary equations to simulate the processes. Hydrological modeling associated widely with GIS applications in the field of water Pollution is defined by quality, soil erosion, floods and (Brimicombe et al, 1996). Utilization GIS in flood modeling and mitigation specifically focused on hydrological modeling and graphical visualization and communication of flood hazard information.

1.3 Objectives

The main objective of this research is to determine the risky places in the study area and how to deal with these risks and safe places for sustainable development through those elements.

- To see places of human activities that are prone to the danger confrontation and classification of the nature in the use of the land in the study area.

- To investigate the ways in which geographic information systems and remote sensing modeling and analysis can enhance accuracy Ungauged sub-watershed hydrologic modeling techniques using a small set of actions for the development of water runoff response model in the context of geographic information systems.

- To monitor spatial changes to see trends expansions of human activity since 1972 to 2012.

- Develop a morphometric network analysis of the valleys located in the face of the study area through remote sensing data of digital elevation models (DEM).

- To create a database of morphometric analysis , rain data and other hydrological parameters.

- To determine risk places, of the sustainable development and the establishment of an integrated model of remote sensing data and geographic information systems (GIS).

1.4 Data sources

- National boundaries shape file for Egypt country, source: Egyptian survey authority.

- Geological data: The Egyptian Geological Survey and Mining Authority, 1981).

- Remote sensing data for generating base map and investigate the affect infectors:

  - ASTER GDEM (Advanced Space borne Thermal Emission and

  - Reflection Radiometer) Source: http://www.gdem.aster.ersdac.or.jp/

  - Landsat MSS Images for the study area (August 1972)

  - Source: http://www.landcover.org/data/landsat/

  - Landsat TM Images for the study area (August, 1999) Source: http://www.landcover.org/data/landsat/and Landsat ETM+ and OLI for the study area (FEB-2013) source: http://earthexplorer.usgs.gov/.

- Hydrological Data and Information System (HYDIS) precipitation mapping server available http://hydis.eng.uci.edu/gwadi/ .

Study area can be divided into two parts: the first is adjacent to the River Nile, which represents a mix between green agricultural spaces, urban areas, inside large canals and drains that take water from the River Nile-scale as well. The second is adjacent to the scope of the first, a home in the band Desert. It has a set of valleys that pour water corresponding to urban areas on the edge of the desert where the problem lies. In the first two is the change tracts of green areas (farmland), which is the Nile River across thousands of Sunnis turned into urban areas.
The second trend is the trend of expansion of urban areas towards valleys and estuaries, which sweep everything. The study will address changes on both sides to clarify the extent of the problem.

1.5 Approach

The Study is based on data collected since 1968 flood that belongs to statistical data, historical record, and remote sensing data starts from 1972 and until 2013 that is represented in the (specially satellite images Landsat - the digital elevation models DEM). The implementation of the steps of this study is as follows:

- To collect data from the aforementioned sources.
- Migrate different sources of data into a Geo database.
- Calibrate different sources of data to be matched with each other within single Geo-database.
- Apply a three-dimensional analyses, as well as spatial analysis method to create the hydrological analyses in GIS environment.
- Generating the morphometric transactions using statistical methods within GIS models using ArcGIS 10 – ESRI.
- Calculating the amounts of runoff during hydrological and morphometric transactions.
- Interpreting the Satellite imagery using Erdas Imagine and ENVI program for land use classification and then monitoring changes in land use from 1972 until 2013.
- Select dangerous areas based on previous elements using the model of weighted overlay.

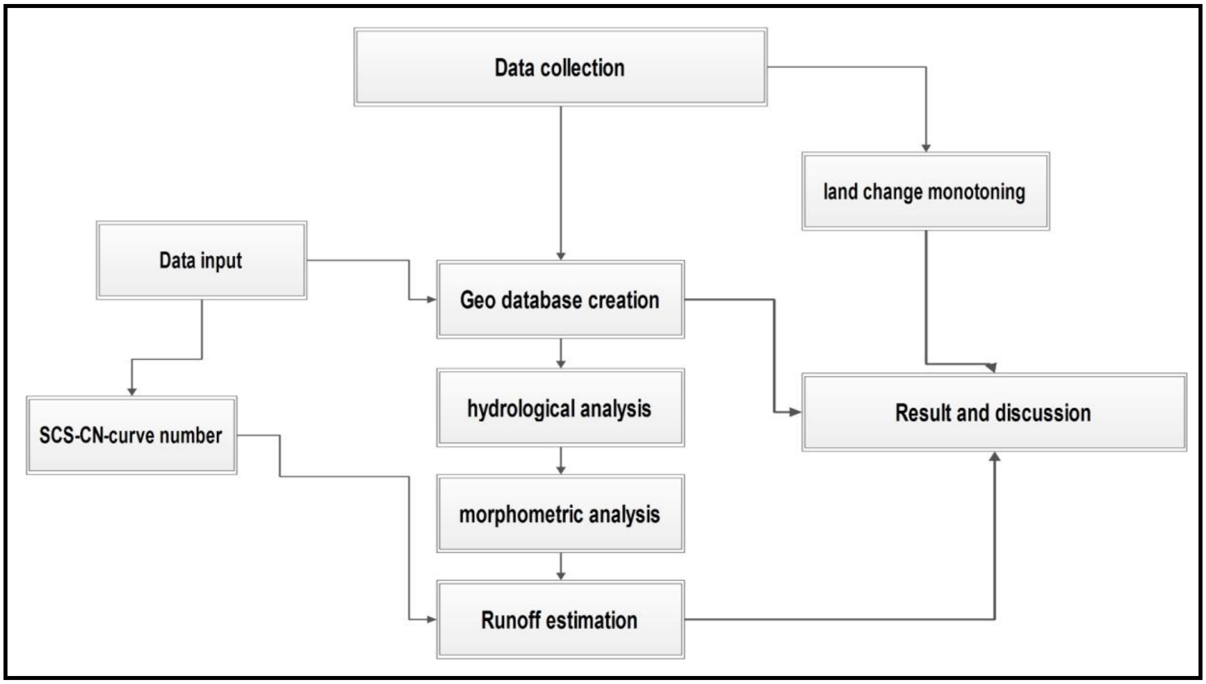


Figure (1-1) Methodology of the study

1.6 Expected result

The research aims to achieve three main points

* Study morphometric and the hydrological analyses of the study area and calculate the amount of flash flood runoff that extends to exits the basins in the study area

* Monitoring changes in land use and its directions in order to find out the direction of expanding

* Identify dangerous areas and safe places in order to be support the decision makers for a sustainable development perspective.

Chapter Two

2.1 Background

The natural hazards represent one of the trends that contribute to the integration of GIS and remote sensing in its study; as it helps in visualizing the dimensions of the problem. This happens through the detection of drainage network from digital elevation data (DEM), as well as Hydrological analyses like flow directions, watershed identification, the identification of water basins divisions, the extraction of main and secondary basin streams. Furthermore, various hydrological analyses will be used to come to an ideal hydrological model in GIS Environment.

Remote sensing data satellite images contribute in clarifying other dimensions of risk study via various analyses of the satellite images through the preparation of the data such as images classification, creating a land use map, the calculation of the changes in the places of human activity, and the study of the relationship with drainage basins as previously mentioned.

Through the above elements one can detect the areas that are highly exposed to danger. It is better than using through the weighted overlay analysis depending on all previous different elements as it provides a map of risky places and safety places.

Flash flood is an example for the natural disasters that threaten the aspects of civilization in different environments. When it is difficult to prevent the risk one must thoroughly understand it to be able to limit its danger.

Natural disasters are extreme events within the Earth's system that result in the death or Injury of humans. Furthermore, they cause the damage or loss of valuable goods, such as buildings, communication systems, agricultural land, forests, natural environment etc. (van Westen 2002).

The human activities in the study area at the mouth of the valley are in a great danger, what will happen if flash floods sweep away all every aspect of human life, whether agricultural or urban? In order to avoid the consequences a quick decision should be made and tools are needed to help in making such a decision to prevent this crisis. Flash Floods have been occurring in this area since 1938.

2.1.1 Hazards

There are different types of hazards; it depends on current environment and other elements. Hazards are divided into three types as the following:

2.1.1.1 Environmental hazards

The environmental hazards can be defined as environmental system which is fixed and any malfunction may occur affects the integrity of the system, herein lies the danger. The ecosystem in the human life is so balanced and any malfunction in this balance represents a big problem to the human life. The area near the surface of the earth can be divided up into: atmosphere, lithosphere, hydrosphere and biosphere.

2.1.1.2 Natural hazards

It can be defined as the dangers that occur by nature and affect the human life. These nature hazards are divided into two parts:

- Climate hazards: which occur due to changes in climate along with other factors like temperature, atmospheric pressure, tropical cyclones, over tropical, dust storms, local wind, waves, the dangers of the sea ice, the dangers of rising sea levels, drought, the dangers of direct Precipitation, floods, and finally natural fires that flare up in the forests.
- Geological hazards which include earthquakes, volcanoes and tsunamis that occur as a result of earthquakes, the dangers of landslides, and soil.

2.1.1.3 Geomorphological hazards

They are the dangers that occur as a result of geological and climatic factors and other parameters such weather dangers that occur in different geological rock structure on the basis of climatic factors of pressure, temperature, wind as well as rain influence.

It makes a difference in the contribution of each type of risk in the size of the dangers that occur on the surface of the ground. The danger may happen on a large scale, such as storms and floods; however, sometimes this danger has a small effect. Figure (2-1) shows the contribution of each risk in percentage from 1994- to 2003.

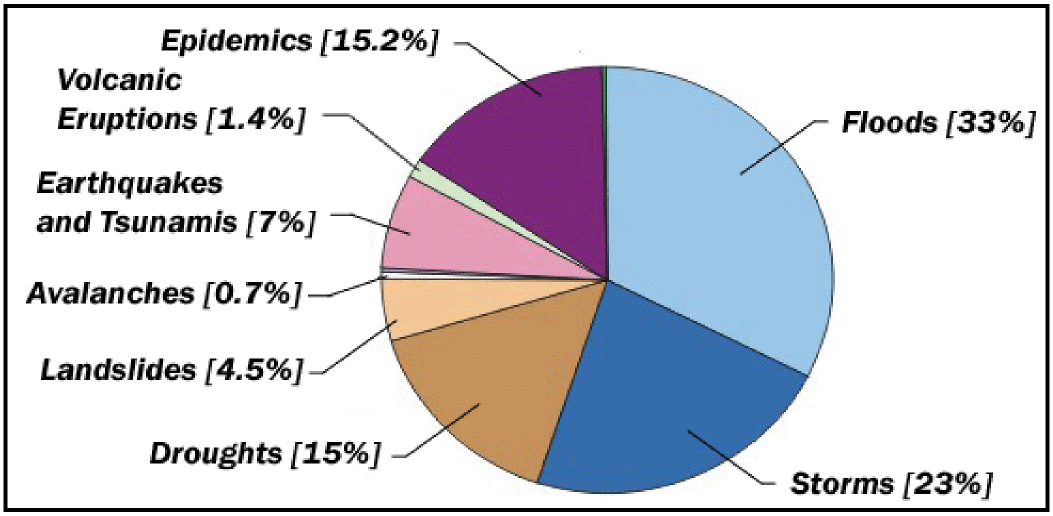


Figure (2-1) Natural disasters by triggering hazard averaged across the world, 1994 - 2003. EM-DAT: The OFDA/CRED International Disaster Database

2.1.2 Hazards management

The size and dimensions of a threat are important aspects to know how to overcome the threat. First revealing to what extent is the contact with humans for instance, when rain fall suddenly in a desert area far from human activity in all its forms, it does not affect it and it does not represent any danger in any way. Whether water evaporated or it was infiltrated into the sand, either ways it ended before it affects human the activities.

Secondly, how to manage the dimensions of this crisis from the time preceding the date of the prediction for the disaster. Also, what precaution the decision-maker is facing to avoid a forthcoming disaster and this we call the human is a key factor in the size of the disaster (ICSU 2005).

This study presents how the expansion of the urban area in stream mouths becomes an easy target for the hazard along with the flood. This is clearly shown in figure (2-2). This figure shows the recent impact of natural disasters in terms of human and economic loss.

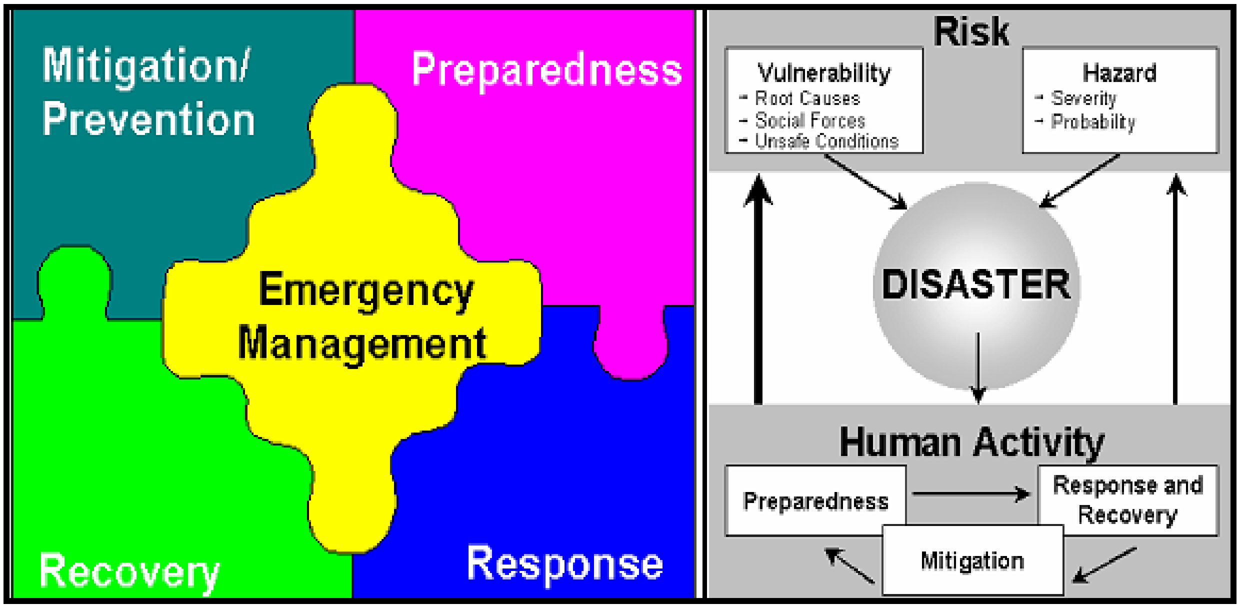


Figure (2-2) Disaster management (ICSU 2005)

In the recent years, society in general has become more vulnerable to natural disasters. Disaster response alone is not sufficient enough, as it yields only temporary results at a very high cost. We have followed this approach for too

Long. Prevention contributes in the improvement of safety; also it is essential to achieve integrated disaster management.

2.1.3 Flood

Flood occurs when surface water covers land that is normally dry or when water overflows normal confinements. The most widespread hazard, floods can arise from abnormally high precipitation, storm surges from tropical storms, dam bursts, and rapid snowmelt. The majority of floods are harmful to human settlements, and yearly flooding, on average, may endanger the lives 20,000 persons and affect 75 million people (Hazard 1997) the following table(2-1) shows the impact of floods on human in the last decade.

Table (2-1) Flood hazard data sheet (Westen 2002)

FLOOD HAZARD DATA SHEET

Number killed by declared flood disasters, 1980-89: 16,108
Number affected: 279,330,901 *(OFDA, 1990)*

Selected severe flood disasters of the 1990's

Year	Location	Deaths	Losses in US$ million
1991	China (Anhui, Jiangsu, Henan, 100 yr. flood)	2,470	12,500
1991	Bangladesh (cyclone storm surge)	140,000	3,000
1993	USA (Mississippi-Missouri)	50	17,000
1993	Nepal, India, Bangladesh	2,500	n/a
1993	China (Quighai, dam burst)	290	27
1994	Italy (Po and Tanaro valleys)	59	3,600
1995	China (22 of 30 provinces)	1,473	14,000
1995	India, Bangladesh (monsoon)	700	175
1995	South Africa (Kwazulu-Natal)	130	n/a

2.1.4 Flood types

There are many types of floods according to flood environment or its eco system each type can be strongly affected according to the zone of floods and its power.

The floods can be classified as flash floods, costal floods, and river floods.

2.1.4.1 Flash floods

These are usually defined as floods which occur within six hours of their beginning Heavy rainfall is one of the most dangerous types of floods. It starts with heavy rain that suddenly grouped in water streams and the larger the volume of rainfall the larger the eradication of any manifestations of human activity.

Figure (2-3) Effects of flash flood in study area in (1994)

2.1.4.2 River floods

They are often seasonal rains, but some floods are continuous throughout the year as a result of the continuity of the tropical rain that falls on the plateau lakes in the Nile River. They also contribute in the increase of water flow of Egypt. These floods are usually controlled by building dams. However, owing to their magnitude, they can inundate farmland as well as urban areas and force people to move to high residential areas.

2.1.4.3 Coastal floods

Some floods are associated with tropical cyclones (e.g. hurricanes and typhoons). Catastrophic flooding from rainwater is often aggravated by wind-induced storm surges along the coast. Salt water May flood the land by one or a combination of effects from high tides, storm surges or tsunami.

2.1.4.4 Flash Floods

Flash floods and weather-related hazards lead to many deaths zones that occur especially in dry environments. In addition to life losses there is a huge loss in resources, property infrastructure, roads, cities, and agricultural land. In the United States such disasters occur frequently. In fact, from 1996 to 2003 there was an average of 3000 recorded flood events per year at the national level. On the other hand, there were only about 1,000 tornadoes per year during this same time period (NRC, 2005)

Flash floods can be generated by various events such as: frontal systems, tropical systems, multi-cell convection, super cell convection, squall lines, derechoes, and other convective systems (Dowsell 1995). Events such as rapid snowmelt, dam failure, levee system failure, or prior long-duration low intensity rainfall can combine together with short-duration high intensity rainfall events to enhance flood conditions (Pilgrim et al., 1993).

Flow is a product of many factors that can be mentioned as follows

1 - climate factors: including thunderstorms, rain, depressions, low-Sudanese, global jet streams , regional, air masses, all kinds of draw, atmospheric pressure ,cycles of solar activity, the distribution of the ground ,water, cold fronts and hot and vibrational climate.

2 - Hydrological factors: include water velocity, the maximum amount of discharge, the average water discharge, load, quality and quantity of water, and movement.

3 - Losses: including evaporation, leakage (which affects porosity and permeability of soil moisture), texture and surface properties, the water level internal operations, surface and underground storage, and natural vegetation.

4 - Morphology of drainage basins: include all the characteristics of the basin and drainage network properties.

5 - Geomorphological processes: include some weathering operations, development of drainage systems, and underground operations.

6 - Human Factors: include construction at the bottoms and exits at the valleys, the structure of roads that act as obstacles in paths of the valleys, and dams.

Forecasting and warning of flash floods is challenging because forecasters must be able to predict the time of precipitation onset, the amount of precipitation, the duration, the intensity of the precipitation, and the time when the bank full flows may commence. The warning process for a flash flood event can be observed as shown in Figure (2-4)

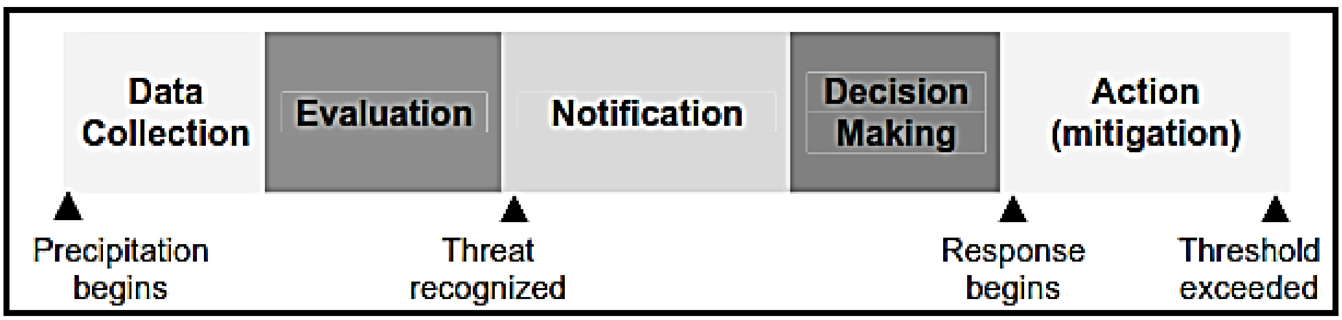


Figure (2-4) Flood time line (Carsell, 2004)

2.2 Hydrologic Modeling

The Hydrological modeling aims firstly at executing a simulation of what is happening in the area of interest (floods) start from the rainfall, the evaporation of water and condensation through runoff surface. Secondly a subsequent infiltration of the ratio of rain to soil as well as evaporation of the part at the end of the final exit of the flood, the quantity of remaining water and the time the water take to reach the mouths of the valley. We have two important aims. The first is to estimate the amount of remaining water from the flood because this could not represent any danger according to the amount of Guidance. Therefore, one cannot call it a hazard. The other aim is the flow velocity or latency of the human activity which is also a very important element. Figure (2-5) illustrates the stages of floods.

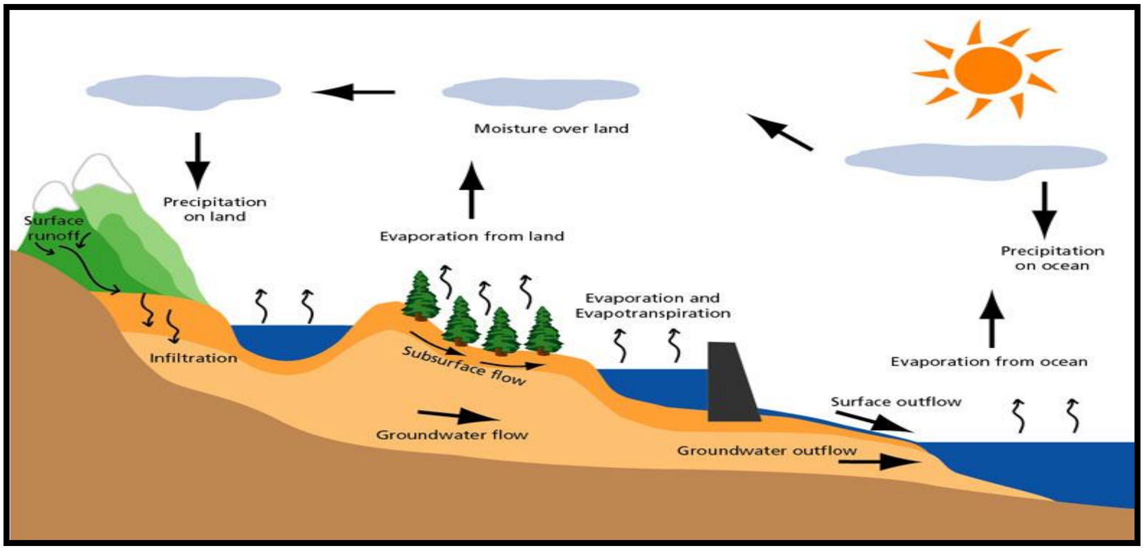


Figure (2-5) (Water cycle) GIs hydro 2009

The other aim is to use hydrological modeling in clarifying its general shape, details (study area), and present a full morphometric analysis of basins forms and valleys sizes, basins tributary, Valleys number, and complexity of each element for the study. Hydrologic models can simulate the watershed behavior by solving the equations that analyze the model.

The Physical processes occur within the watershed. Therefore, hydrologic models are usually used to simulate the watershed response for a given input. The hydrologic models take time Series data and produce another time series as output. For example, time series of rainfall data is used in rainfall – runoff models to predict the discharge at the watershed outlet. On the other hand, Arc Hydro describes the hydrologic features that are available in a watershed on a spatial Scale and also provides a link between these features by establishing a relationship between different features.

These hydrological modes must be assessed before delivery to guarantee their validity because they may cause serious mistakes during the application.

Sources of uncertainty in solution results within hydrologic models include (Butts, 2004):

• Errors in model inputs (boundary or initial conditions).

• Errors in recorded output data used to measure simulation accuracy.

• Uncertainties due to sub-optimal parameter values.

• Uncertainties due to incomplete or biased model structure.

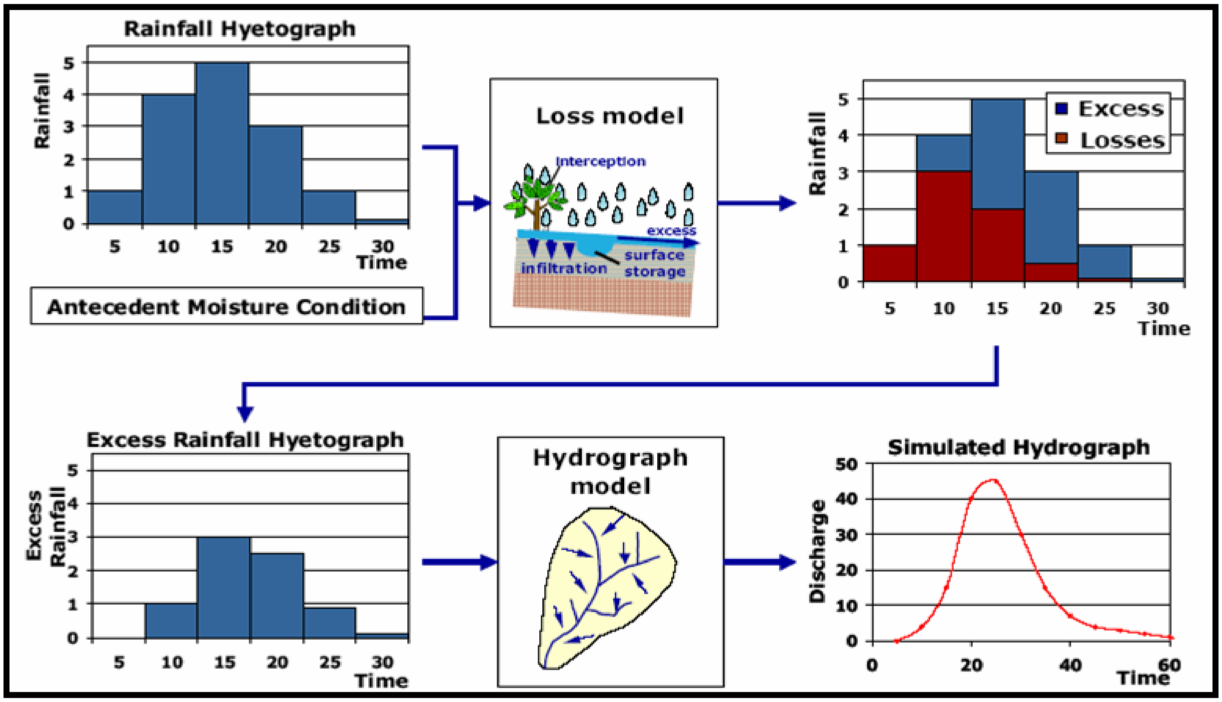


Figure (2-6) describes the general flood hydrograph simulation Process (McEnroe, 2003)

The three main applications of hydrologic modeling are for planning purposes, Management practices, and rainfall-runoff prediction (Singh, 1995). Permission then to test or establish a hydrologic system in the first amount of rain falling on the area determine the form whether it will be lost or not in addition to the amount of soil that vaporizes then it calculates the estimated amount that come out of the mouth of the valley as figure(2-6) shows that cycle.

The most common hydrologic modeling approach to accounting for ungagged small watershed prediction is the use of synthetic UH theory and stream routing procedures. Synthetic UH models can be developed through two approaches; 1st approach assumes that all watersheds have a unique UH related to hydrologic characteristics of the area inside the watershed boundary, and the second assumes that all UH plots can be generated from a single set of equations and curves (Bedient, 2002).Then UH and the resulting storm hydrographs are developed for each watershed within a basin network (Ethan Knocke2006)

2.3 Flash Flood Guidance (FFG)

FFG is a diagnostic tool for flood alerts and warnings - FFG system indicates the amount of rain to cause flooding in small ponds flood-prone FFG provides indicators of potential flooding through the Flash Flood Guidance and flash floods threat.

The GFFG is used to calculate the indicators known as diagnostic guidance torrents that are used to evaluate the possibility of flooding. The directive defines flash floods and rainfall for a certain period on a small basin to create minor flooding (bankfull) conditions at the exit of the basin. When used with meteorological forecasts and now casts from the same period of rainfall on the ponds, and a flash flood guidance leads to estimate the threat of floods (rainfall for a certain period exceed the value of flash opposite direction floods) for these small ponds.

Rainfall excess is the net rain that is left over after all hydrologic abstractions have been subtracted out of the gross atmospheric rainfall volume. Hydrologic abstractions include interception of rainfall droplets by vegetation or forest canopy, surface depression storage, and infiltration of rain water into the ground (McEnroe, 2003).

2.4 Remote sensing applications

The remote sensing science is defined as the science of acquiring, processing and interpreting images and related data from air craft and satellites (floyed f. sabins 1997). remote sensing science can provide a wide range of data about a lot of topics as geological analysis ,environmental changes, global warming and disasters through the instrument such as air craft and satellites.

According to the definition of remote sensing the study must be followed by the steps of remote sensing analysis to detect the results as the following:

2.4.1 Data acquiring

Acquiring data basically is to detect the needed data from satellite as images and aerial photography from air aircraft .the most popular use of data is the use of images which structured as row and columns .each intersection between row and columns called pixel. The pixel is the structured unit of images. Each image contains DN which describes all the information about cell (lillisand 2004).

Through this study multiple types of remote sensing data were used such as satellite images, digital elevation data DEM, and meteorological images to detect the meteoroidal parameter as temperature and rainfalls.

2.4.2 Processing data

Processing data is the procedure of converting row data into images (floyed f. sabins 1997). Processing also includes manipulation of data as image corrections, image enhancement, and image classification to arrange it for interpretation (lillisand 2004). Processing data mainly depends on computerized application according to mathematical algorithm for each process. A lot of processing should be executed for remote sensing data as follows:

2.4.2.1 Image rectification

Image rectification is to manipulate the process of correcting the noise and avoid any data distortion during scanning (floyed f. sabins 1997). The rectification process includes correcting the geometric distortion and data calibration radiometrically (lillisand 2004). There are many methods on image rectification as follows:

2.4.2.1.1 Geometric correction

Raw digital images usually contain geometric distortions so significant that they cannot be used directly as a map base without subsequent processing (lillisand 2004). The source of this distortion may be velocity of the sensor platform to factors such as panoramic distortion, earth curvature, atmospheric refraction, relief displacement, and nonlinearities in the sweep of a sensor's IFOV. Then the geometric corrections become adjusted to the distortion by ground control point GCP method.

2.4.2.1.2 Radiometric correction

The primary function of remote sensing data quality evaluation is to monitor the Performance of the sensors (M. ANJI REDDY 2008). The radiometric corrections are very important for radiometric data which is involved in a lot of applications such as converting radiometric correction data to digital number and investigate the information according to these numbers.

2.4.2.2 Image Enhancement

Low sensitivity of the detectors, weak signal of the objects presented on the earth surface, similar reflectance of different objects and environmental conditions at the time of recording are the major causes of low contrast of the image (M. ANJI REDDY 2008). The image enhancement techniques mainly aim to clarify the image to be more contrasted to human eye or digital analysis of remote sensing. The image enhancement techniques can be defined as the process of improving the visual interpretability of an image by increasing the apparent distinction among the features in the scene (lillisand 2004).There are many enhancement techniques such as: (lillisand 2004).

1. **Contrast manipulation**. Gray-level thresholding, level slicing, and Contrast stretching.
2. **Spatial feature manipulation**. Spatial filtering, edge enhancement, and Fourier analysis.
3. **Multi-image manipulation**. Multispectral band rationing and differencing, principal components, canonical components, vegetation components, intensity-hue-saturation (IHS) color space transformations, and decorrelation stretching.

2.4.2.3 Image classification

The overall objective of image classification procedures is to automatically categorize all pixels in an image into land cover classes or themes. (Lillisand 2004).

The images classification aims to detect the same class or category to be a specified phenomenon or feature according to its pixel data values.

The classification techniques are divided into two types: supervised classification and unsupervised classification each type aims to classify the images to reflect the land use of image or the features it contains.

2.4.2.3.1 Supervised classification

The supervised type as previously mentioned aims to detect image classification with data training as a class of interest or area of interest (AOI) to match with (AOI)(sample test) or make a group of classes. The training samples are representations of the known classes of interest to the analyst. Classification methods that relay on

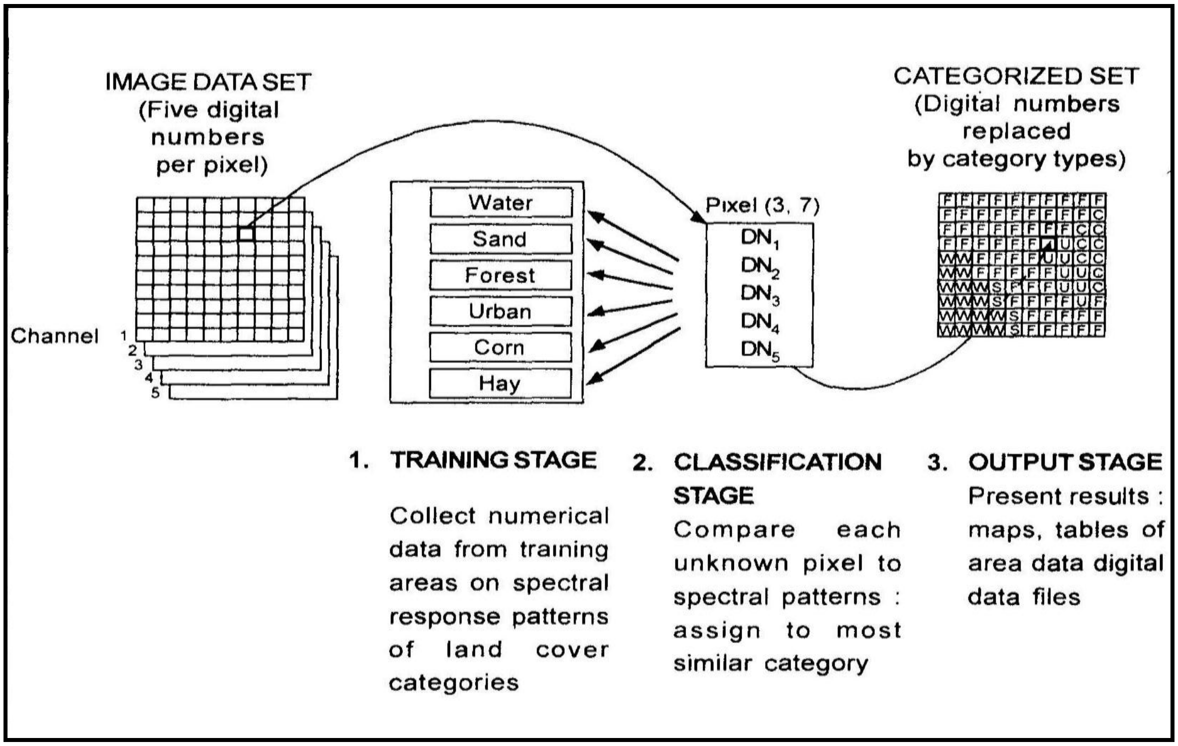


Figure (2.7) supervised classification flow chart

Use of training patterns are called supervised classification methods (M. ANJI REDDY 2008). The steps of supervised classification as shown in the flow chart figure (2-7)

2.4.2.3.2 2.6.2.3.2 Unsupervised classification

Unsupervised classification algorithms do not compare points to be classified with training data (M. ANJI REDDY 2008). It creates categories of classes without area of interest (AOI). Once similar features are matched together it forms a class. There are many methods of unsupervised classification as shown figure (2-8)

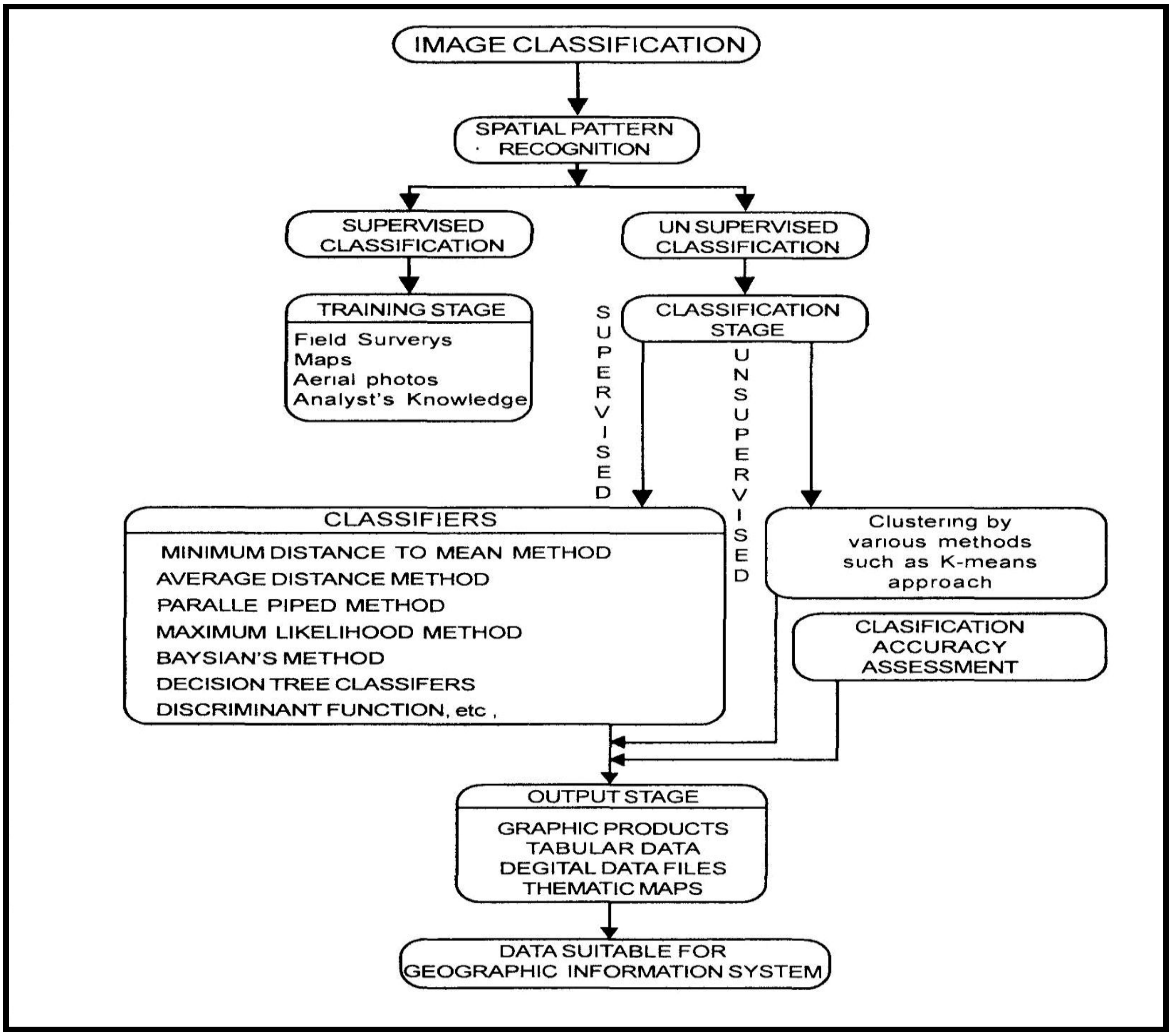


Figure (2-8) supervised and unsupervised flow chart

2.4.2.3.3 Object oriented classification

Object-oriented classification uses a two-step process that is intended to mimic the higher order classification processes, each composed of many intermediate processes. Object-oriented classification applies a logic intended to mimic some of the higher order logic employed by human interpreters, who can use the sizes, shapes, and textures of regions, as well as the spectral characteristics used for conventional pixel-based classification (James B. Campbell 2011).
The oriented classification is to monitor and classify objects at a lower level as sub pixel. The first steps of segmentation divide the feature to prepare for the classification at a level of pixel.

In object-oriented image classification, objects do not refer to individual entities such as roads and buildings that may constitute very important geospatial features in many applications. Instead, image objects are defined as contiguous regions of pixels that have a more uniform radiometric property among them than those across other regions (**Jay Gao, 2009)**.

2.4.2.4 Accuracy assessment

To provide a high quality result from remote sensing data the result must be tested by equivalent data from aerial photos, topographic maps, and sample test from field by using Global Positioning System (GPS) control stations. A common misconception about classification errors is that they can be eliminated through exercise of more care during classification (Jay Gao2009). Accuracy assessment techniques applied the sample data from the area of interest to compare it with result of classification and calculate the errors of classifications. The accuracy assessment methodology can be applied by six significant steps:

- To decide on a sample method that is appropriate for the purpose of accuracy evaluation.
- To select an optimum number of samples for each land cover.
- To compare them with the reference data.
- To generate an error matrix.
- To calculate the accuracy indices, including the Kappa index.
- To provide a confidence level for the evaluation.

The result of accuracy assessment report is shown as a matrix table of sample data comparison.

2.4.2.5 Change detection analysis

Successive imaging enables assessment of changes in the type or condition of surface features (James B.-2011). Many studies and researches aims to detect change analysis for any urban feature, cultivated areas, forest land cover or coastal beaches changes. Many of these analyses use images acquired at two points in time, known as bitemporal change detection. The data of change detection requirements' (images –topographic maps-land use maps) must be compatible with aim of study according to data resolution and data time.

Comparing images subsequent to classifying each is called post classification change detection. Post classification change detection consists only of comparing the "from" class and "to" class for each pixel or segment. Even though this operation is a simple raster GIS analysis, often it is not the first choice of most analysts. The reason is that the resulting accuracy is typically low, as it incorporates any errors presented in the original classifications, approximated as the product of the overall accuracies of the individual classifications (Coppin et al. 2004).

Before starting the processes, classification must be done for data images, satellite images specifications, and settings as mentioned below:

1. Acquired from the same or well intercalibrated sensors and acquired at the same time of day using the same IFOV and look angle.
2. For interannual analyses, acquired during the same season to minimize differences due to phenological changes.
3. Well coregistered, preferably to within two-tenths of a pixel or less (Dai and Khorram 1999).
4. Free of clouds in the area of analysis.
5. Corrected to top-of-atmosphere or (preferably) surface reflectance.
6. Free of other conditions not deemed part of the signal of interest. Examples of

This last point could include the presence of soil moisture differences when assessing changes in forest wetland canopy cover or differences in harvest dates when assessing changes in vegetative cover using anniversary date images acquired in autumn.

2.4.2.5.1 Change detection techniques.

There are many types or techniques for change detections. Spectral change detection techniques can be classified as follows (Dai and Khorram 1999):

- Visual interpretation change detection,
- Image algebra change detections,
- Transformation and data reduction change detection techniques,
- Classification change detection techniques.
- Statistical change detection techniques.

1- Visual change detection techniques:

Comparison of images from two dates is always the first place to start and is easily Accomplished using one of three basic techniques. In the first, known as a multi date color image composite, two suitable radiometrically calibrated and coregistered images are composited (in which all bands from both dates are stacked to form one image), then bands from different dates are chosen for display to highlight the change of interest. In The second, the images are not composited but are displayed with one on top of the other. Tools commonly available in most image processing packages can then be used to visualize change, through visual observation like swiping one image over the other and flickering between images.

The third technique is simply to view coregistered and geolinked images between the two images of interest the same geographical places but at different times.

2- Image algebra change detections.

The image algebra applied mathematical techniques between two images at pixel level depending on DN value of pixel for each image. Although there are many Possible algebraic operations, the most common ones are image differencing, image ratios, Euclidean distance, and change vector analysis.

3- Transformation/Data Reduction.

There is a variety of techniques by which the data in the original image can be transformed to new axes composed of linear combinations of the existing bands. The most widely used of these techniques are principal components analysis (PCA) and the tasseled cap transformation (James B.-2011).

Recall that PCA reorients the axes of multidimensional data space so that there is no longer any remaining covariance among the PC bands, which are linear combinations of the original bands. This operation results in a de facto ability to provide the same information content using fewer bands.

4- Classification change detection techniques.

The classification change detection techniques aim to achieve two objectives first monitoring changes detection between two images for different year. Second is to detect what changed the element? And what is the direction of change? What is the area of changing? For instance, if we are going to monitor change detection for a specified area which includes cultivated area, urban and water surface. The process of change detection depends on the classification of each element and calculates the area of elements in each image. Also, it calculates the increase or decrease of elements in each image.

5- Statistical change detection techniques.

There are numerous ways to compare images statistically, but one of the most widely used techniques is image cross-correlation using pixel neighborhoods or multitemporal segments.

The equation forms used only a single band for simplicity. Multiband correlations are feasible but, some methods may be absent while combining the bands in advance. (Such as a vegetation index), will result in a correlation matrix, thus increasing the complexity of interpretation. The Pearson product–moment correlation, r, between brightness values (or reflectance's) from a single band across two dates of imagery is defined as:

$$r = \frac{cov_{12}}{s_1 s_2} \tag{2.1}$$

Where s1 and s2 are the standard deviations of the brightness values found in each segment and cov12 is the covariance between brightness values of the two dates for the segment. The standard deviation for a given band, date, and segment is as follows

$$SD = \sqrt{\sum \frac{(y - \overline{y})^2}{n-1}} \tag{2.2}$$

Where y is the mean of all brightness values in the segment. Standard tests for the significance of the resulting correlation(s) can be used as an additional variable, as can the slope and intercept derived from a least-squares analysis of the brightness value pairs within the segment (Im and Jensen 2008).

2.5 Geographical information system (GIS).

Many definitions of geographic information systems (GIS) are not different from the value of this science in addressing the problems but it has different definitions of the science sections themselves.

USGS explains that GIS is computer system that is capable of capturing, storing, analyzing, and displaying geographically referenced.

While ESRI notes that GIS integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically. Many definitions over the past decades (Mnma 1990) resulted in the emergence of this term geographic information systems (GIS) and yet also what is known as a mechanized inventory of geographically distributed features and facilities (Longley et al, 2005)

Within this research we can form a perspective about the definition of GIS that matches the presented topics and explained the definition as per our study.

A GIS is identified as a spatial database, in which every object has a precise geographical location, brought together with software that can perform functions of input, management, analysis, and output (Goodchild, 1994).

Using GIS in this research aims to execute the analysis in the status that GIS using is the best using for problems solution. Use GIS include (Goodchild et al., 1999):

- When data are geographically referenced
- When spatial location is important to an analysis
- When data include vector data structures
- When the volume of data is large
- When data must be integrated from many sources
- When geographical objects have a large number of attributes
- When a project or model involves aspects from multiple disciplines
- When visual display of results is important
- When data are being extensively shared as input to other programs (Ethan 2006)

2.5.1 Spatial Data Analysis

Different ways of testing provides geographic information systems (GIS) tools for the analysis and testing of spatial data ESDA. It gives a better and wider understanding and a clear vision in which one can understand the data seamlessly to achieve more accurate decision and better quality.

Exploratory spatial data analysis (ESDA) is a subset of exploratory data analysis (EDA) that focuses on the distinguishing characteristics of geographic data, and specifically on spatial autocorrelation and spatial heterogeneity [Haining (1990), Cressie (1993), Anselin (1994, 1998a), Bailey and Gatrell (1995)]. The basis for ESDA is the perspective towards data analysis taken in EDA. EDA consists of a collection of descriptive and graphical statistical tools intended to discover patterns in data and suggest hypotheses by imposing as little prior structure as possible (Tukey 1977).

Through these definitions and other definitions it is apparently agreed that the GIS include data multiple spatial undergoing preparation to a database and then analyzed down to the final product. A map thematic or output to manipulate the problem and that the completion of the rest of the elements of people, hardware, and software specialized in introducing, analyzing and converting data from row to information that contributes in solving the problem of all that makes GIS a powerful tool and solve any problem facing human life.

2.5.2 3D analysis

The 3D Analyst extension provides the ability to view, manage, and analyze three-dimensional data from a local to global extent. This course provides thorough instruction in getting the most out of 3D Analyst (Esri 2010). Three-dimensional analysis allows of the many possibilities and outcomes such as access to TIN surfaces depending interpolation between points or pixels, which allows the shape to be similar to the reality as well as create contour maps and slopes, shadows and a lot of analysis by which information extraction figure (2-9)

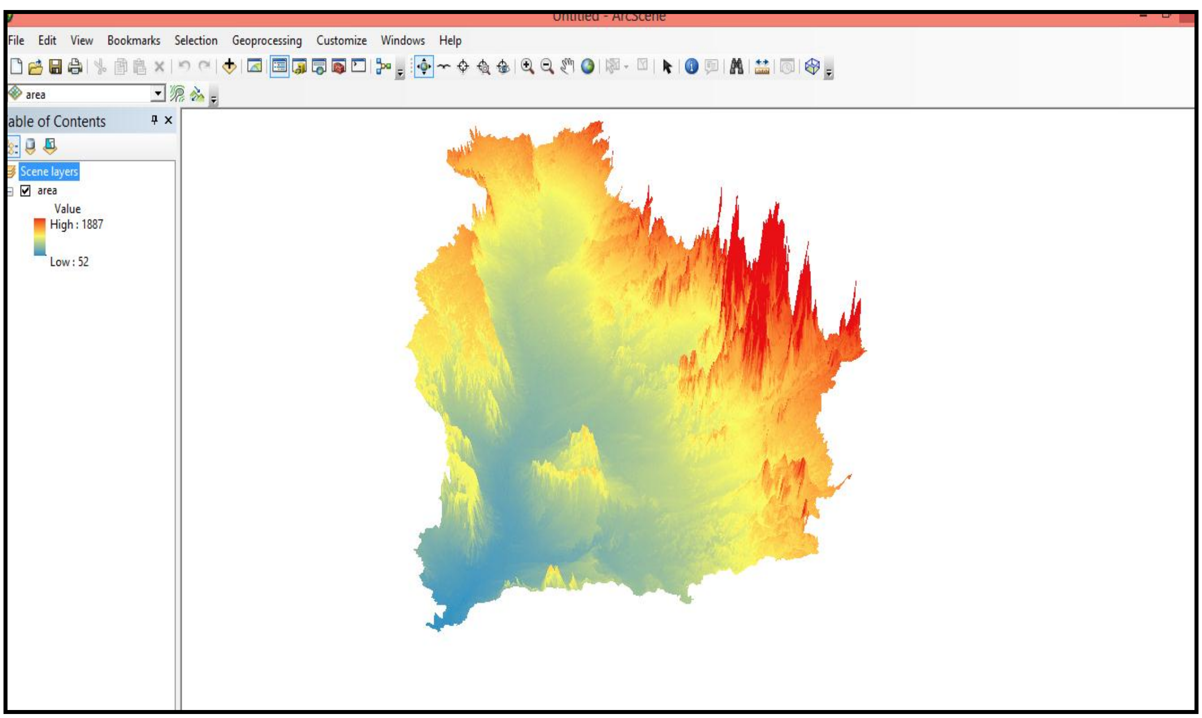


Figure (2-9) 3D view for Wadi Qena (derived from ASTER DEM 30)

Establishing 3D GIS while taking into account the integration of the necessary components and different types of objects require the solution of the following problems related to the spatial model representing reality

1) Design of a spatial model

•A design of an integrated data model, or a scheme, permitting the derivation of a unified data structure capable of maintaining all the components of the geometric representation of real world objects, whether obtained from direct measurements or from derivations, in the same database. Each geometric component must be capable of representing a real world object differently understood by different people.

2) Construction of a spatial model

• The development of appropriate means and methods for 3D data acquisition;

• coordinate transformation into common georeferencing when different components are to be included into one database;

•The development of a data structuring method that unites the data from various inputs of multi sources into an integrated database capable of being maintained by a single database management system;

• Designing of thematic classes to organize representation of real world objects with common aspects into the same category;

• solving the uncertainty arising from discrepancies from different data sets during the integration process and converting the uncertainty into a 'data quality' statement to be conveyed to the end user.

3) Utilization of a spatial model

• The utilization of existing components, such as 2D data and DTM (backward compatibility) and preparation of those components for future incorporation into the higher-dimension model (forward compatibility) to save the costs of repeating data acquisition.

Development of additional spatial operators and spatial analysis functions;

• development of maneuverable graphic visualization permitting the selection of appropriate viewpoints and representation enabling convenient, adequate uncovering of the details of objects stored in the database;

• Designing a 3D cartographic presentation of information, including name placement, symbol, generalization, etc.;

• Designing a user interface and query language allowing users access to the integrated database;
• The development of a spatial indexing structure that speeds up data retrieval and storage processes for the integrated database, including specific (database) views for each user group and guidelines keeping these views updated according to the core database;
• The development of tools for navigating among different models stored in databases at different sites and computing platforms.
4) Maintenance of spatial model
• Design updating procedures, including the development of consistency rules ensuring the logical consistency and integrity of the integrated database, especially during the updating process.

2.6 GIS analysis in hydrological studies

This section discusses the hydrological modeling over the dangers of Rainfall and runoff drainage basins and its danger on the areas of human activities, such as urban communities, agricultural or industrial activities.

GIS plays a significant role in hydrological systems. This study aims at dealing with the phenomenon of the floods which occurs as a result of the rainfall on the basins to the gathering of the water in the mouths of the basins.

Any study includes a combination of climatic data in the form of rain, the amount of evaporation and hydrological data that address drainage basins and morphometric analysis of the form of basin and basin area transition into the soil and its role that represents an important and influential factor in estimating the runoff in the basin.

All these factors are combined to form a hydrological model that analyzes GIS data in order to know the extent of the risk and the risky areas from the trend in the field of sustainable development planned on the basis of probability of the risk that could have been avoided through avoiding vulnerable sites.

When addressing the issue of integrating GIS with environmental and hydrological modeling, the following three themes stand out (Goodchild, 1996):

• Issues of spatial data; including availability, access, common formats, resampling, and accuracy
• Issues of modeling; including the development and structuring of models

• Issues of systems; including the design of GIS, data models, GIS functionality, and user interfaces

2.7 . GIS and modeling

The GIS modeling can be defined as the process of creating new GIS application from existing application. The GIS modeling also can be defined as an abstract and partial representation of some aspects that can be manipulated, to analyze the past, define the present and to consider possibilities of the future (Smyth, 1998).

The models are devices for producing missing data about the past or the present and for anticipating data about possible futures (water 2002).
GIS modeling can be classified according to the aim of the model, purpose, methodology and logic.

There are various types of models as previously mentioned as deterministic or stochastic models. Both deterministic and stochastic are mathematical models represented by equations with parameter and variables. A stochastic model considers the presence of some randomness in one or more of its parameter or variables, but deterministic model does not. (change- 2005).

Also static or dynamic models, a static model deals with the state of spatial data at a given. A dynamic model manipulates the changes of spatial data and interactions between variables in dynamic model time to show the process.

A model may be deductive or inductive. Adductive model represent the conclusion driver from a set premises these premises are known as “GIS Modeling (2005 John Porter). There are two categories of combining a model with GIS (Burrough et al. 1996):

• (Coupled/Linked) where the model functions outside GIS, using the latter as a source of input data creation and a means of displaying model output

• (Holistic/Embedded) where the entire model process is integrated within the GIS by writing it using standard analysis functions and available object oriented programming languages (Ethan 2006)

In this research, the first model will be used within the GIS environment through a hydrological analysis model that allows the entry of the data and analyzes morphometric and climate data. Moreover, other inputs will be synthesized. Some tools in the visual basic application will be created and executed to use specific formulas or specific applications in this environment.

The model is organized into three phases: first is the hydrological model; second is morphometric analysis and the third evaluates the weighted dangers to produce a reasonable map.

2.8 Application of Literature

Application of GIS in hydrologic modeling has addressed methods of utilizing GIS as a front-end and/or back-end analysis tool and the development of a coupled modeling environment (Ethan 2006).

Through geographic information systems (GIS), this model can present various hydrological analyses and extract streams and drainage basins. It is characterized by the integration of hydrological data, morphometric data, temperature data, and evaporation and absorption factors that follow SCS-CN to determine the amount of runoff.

GIS enables conducting these analyzes easily and accurately. It also displays them in an analytical form through the presentation of intensity discharge , flow velocity , the amount of rainfall and the amount of water loss (evaporation+ absorption +transpiration +surfaces storage); in the end, the amount of runoff could affect the flow by using geographic information systems. This model also enables identifying degrees of dangerousness through the integration of several elements, such as hydrological elements and morphometric elements like basin area, roughness degree and the remaining amount of discharge as well as models of Digital Elevation, slope, trends in output and other factors that are required to create a model.

2.8.1 Multi criteria analysis and support decision maker.

An umbrella term is to describe a collection of formal approaches which seek to take explicit account of multiple criteria in helping individuals or groups explore decisions that matter (Belton and Stewart (2002).

Multi-Criteria Analysis (MCA) is a decision-making tool developed for complex problems. In a situation where multiple criteria are involved confusion can arise if a logical, well-structured decision-making process is not followed.

Only MCDA methods consider the existence of a hierarchy of criteria (multiple objectives) and alternatives. Therefore, other methods that deal with multi- objective planning, particularly those that use single objective optimization with constraints as other goals, or use penalty functions, are not included. Comprehensive reviews of these methods can be found in Pukkala (2002) and Steiguer et al.2003).

A lot of data were used in disaster studies to support decision making analysis as remote sensing data images land cover and digital elevation model DEM data to extract hydrological model and morphometric parameter and finally runoff guidance .

A spatial decision support system (SDSS) is an interactive, computer-based system designed to assist in decision making while solving a semi-structured spatial problem (Sprague 1982). It is designed to assist the spatial planner with guidance in making land use decisions. A system which model decisions could be used to help identify the most effective decision path.

An SDSS is sometimes referred to as a policy support system, and comprises a decision support system (DSS) and a geographic information system (GIS). This entails use of a database management system (DMS), which holds and handles the geographical data; a library of potential models that can be used to forecast the possible outcomes of decisions; and an interface to help the users interact with the computer system and to assist in analysis of outcomes.

An SDSS usually exists in the form of a computer model or collection of interlinked computer models, including a land use model. Although various techniques are available to simulate land use dynamics, two types are particularly suitable for SDSS. These are cellular automata (CA) based models (White, R-2000) and Agent Based Models (ABM).

An SDSS typically uses a variety of spatial and non-spatial information, like data on land use, transportation, water management, demographics, agriculture, climate, epidemiology, resource management or employment. By using two or more known points in history, the models can be calibrated and then projections into the future can be made to analyze different spatial policy options. Using these techniques spatial planners can investigate the effects of different scenarios, and provide information to make informed decisions. It allows the user to easily adapt the system and to deal with possible intervention possibilities an interface allows for simple modification to be made.

Chapter Three

3.1 Background

This chapter explains the general features of the study area and the nature of the study. It also presents the background of the region, the characteristics, and factors that affect it.

3.2 The study area location and the general description

The Study area is located on the eastern side of the Qena meander between latitudes 25°N to 28°30 N and longitudes 32° E and up to 34° E. This is according to the map of the study area shown below that is aligned to some extent with drainage basins of Qena valley at north and Al-Surai valley and Al- Matula in the south. It is also connected with Qena meander from Qeft south to Nag-Hammadi north figure (3-1).

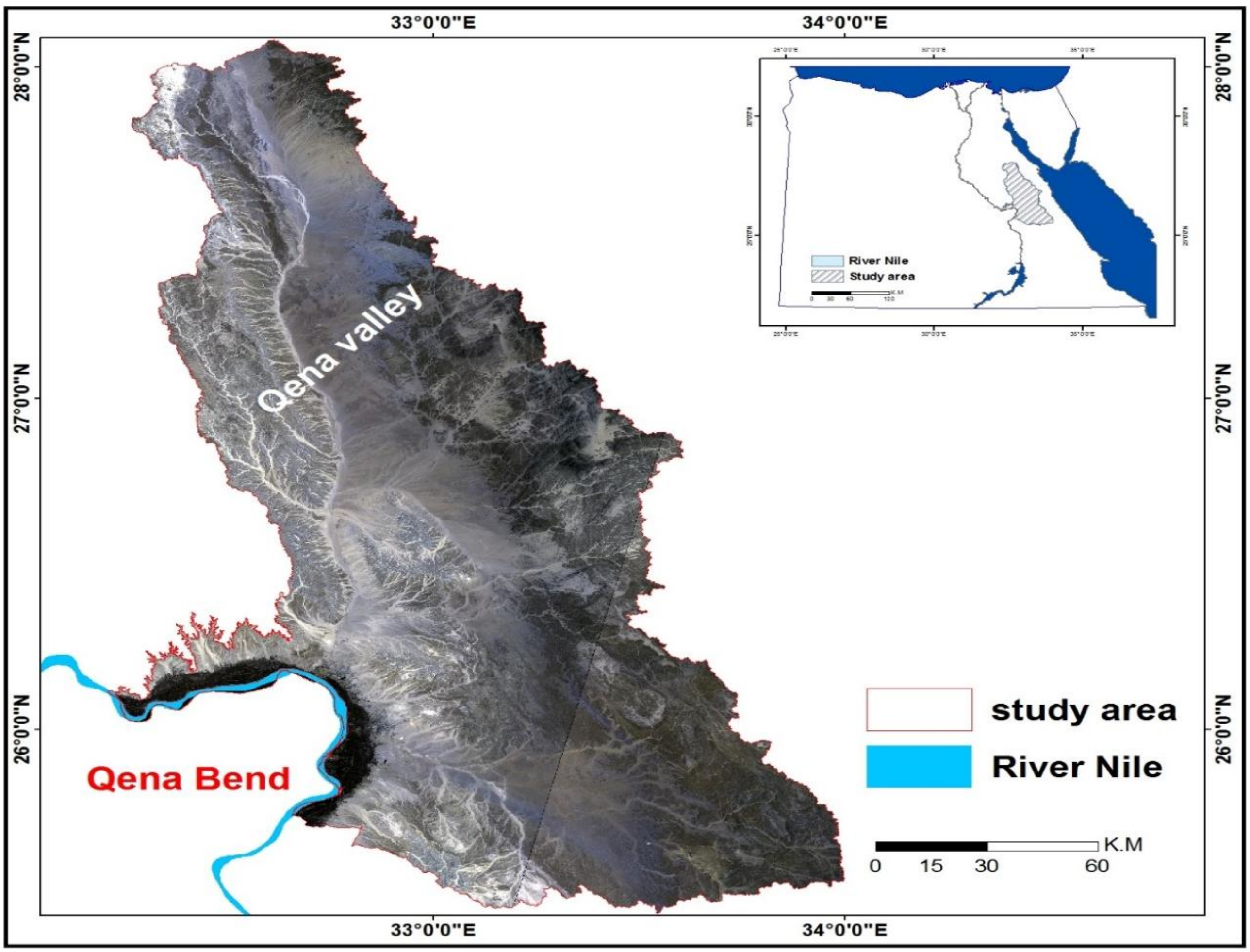


Figure (3-1) location of the study area

The area of this the region is approximately 25,000 square kilometers. It is extended from the Far East in the Eastern Desert to the Nile River in the west. It also includes floodplain contained between them and areas of human activity.

3.3 Climate characteristics

Climate is a very important factor in this study area, and it is the main factor that affects the study climate region through the rain, that is determined by the amount of precipitation as well as temperature, evaporation and then estimated losses from flood water.

The study area is located in the dry desert BWH climate where the temperature increases in

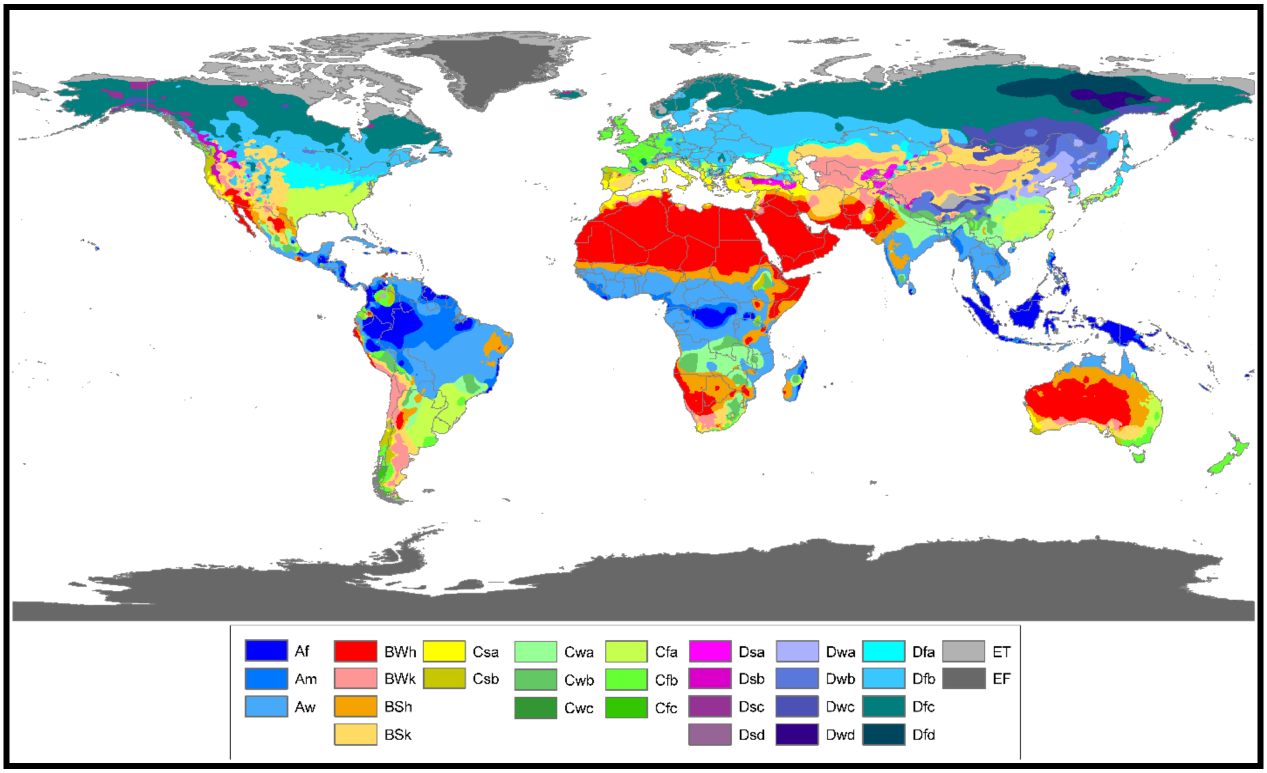


Figure (3-2) Köppen climate classification (BWh: warm desert climate)

Summer and decreases in winter and according to Köppen climate classification as shown in figure (3-2)

3.4 Temperature

Temperature which is Commensurate with the climate of extremism, which is located where the study area is and reached the highest recorded temperature in summer in July, 41degrees, and the lowest recorded temperature of 7.5 in January and night. The following table (3-1) indicates the temperatures throughout the year figure (3-3)

Table (3-1) temperature degrees The Egyptian Meteorological Authority (EMA),(1986-2005)

Month	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov
Maximum temperature	24.4	23	25.2	30.1	35.3	39	41.2	41	40.8	38.3	33.9	37.8
Minimum temperature	8.8	7	8	11.6	16.6	21.2	23.6	24.4	24.3	22.4	19.3	13.6
Monthly range	15.6	16	17.2	18.5	18.7	17.8	17.6	16.6	16.5	15.9	14.6	24.2

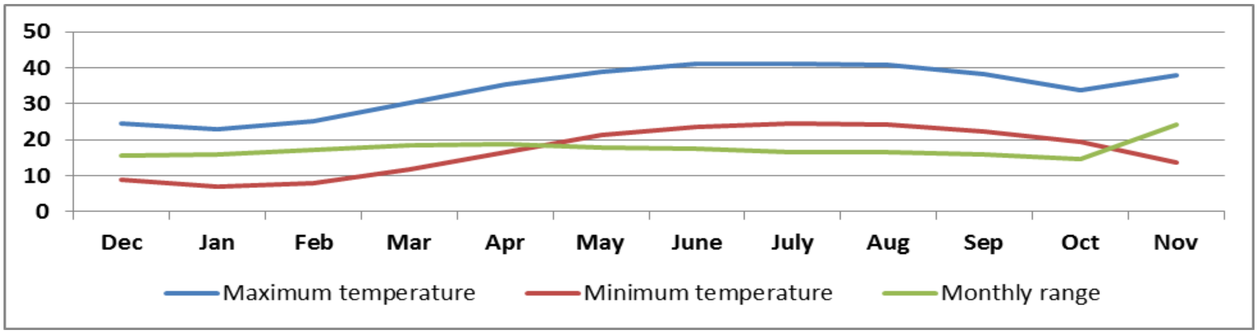


Figure (3-3) temperature degrees of study area depending on The Egyptian Meteorological Authority (EMA), (1986-2005)

3.4.1 Rainfall

The rainfall in the study area is unexpected, characterized by divergence, and rare. Those sudden rainfalls have a severe influence on the flood as it has reached the highest amount of rain in November in the period from 1964 to 2005. The Stupefy periods throughout the year are characterized by the rarity of rain an average of 3.2 mm a year. The following figure (3-4) illustrates the amount of rain during the year.

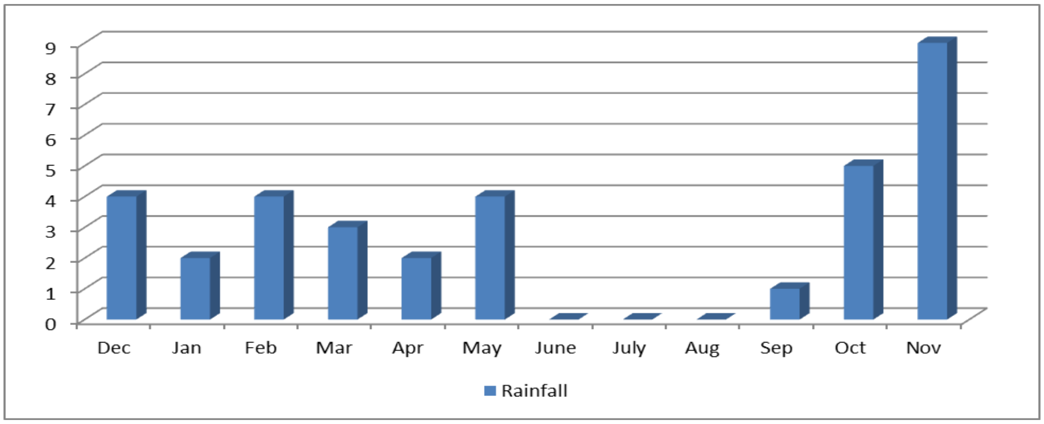


Figure (3-4) rainfall rates of study area depending on The Egyptian Meteorological Authority (EMA), (1986-2005)

3.5 Geological characteristics

The geological structure of the study area affects the accuracy of the results which reflects the extent of the contribution of the soil in understanding the characteristics of the area in terms of the type and extent of porous rocks that affect the accuracy of the region's hydrological modeling.

The study area is characterized by the diversity of geological structure from the basement rocks, Pre-Cambrian, and even quaternary Formations. The following figure (3-5) is a breakdown of the geological structure of the area.

Moreover, the geological structure affects the study of the problems of the study area as it gives an impression of the phenomena in the study area.

3.5.1 Pre Cambrian rocks

Pre-Cambrian Formations are the rocks which are based upon the rest of the different geological formations. This formation constitutes a part of Arabian Nubian shield that has been cratonized around the end of Precambrian (said 1990). The total area of these formations in the study area is about 7000 km, which constitutes approximately 29%. They are characterized by the complexity and hardness of the rock also they belong to igneous resulting from the outputs volcanic as well as some formation of metamorphic rocks, and these formation rocks of the younger granites, gabbro rocks, Hammamat group, Metagabro rocks and diorite and often these formations are concentrated in the east of the study area. One can say that they are the main barrier of draining the sources of valleys the Red Sea and the River Nile.

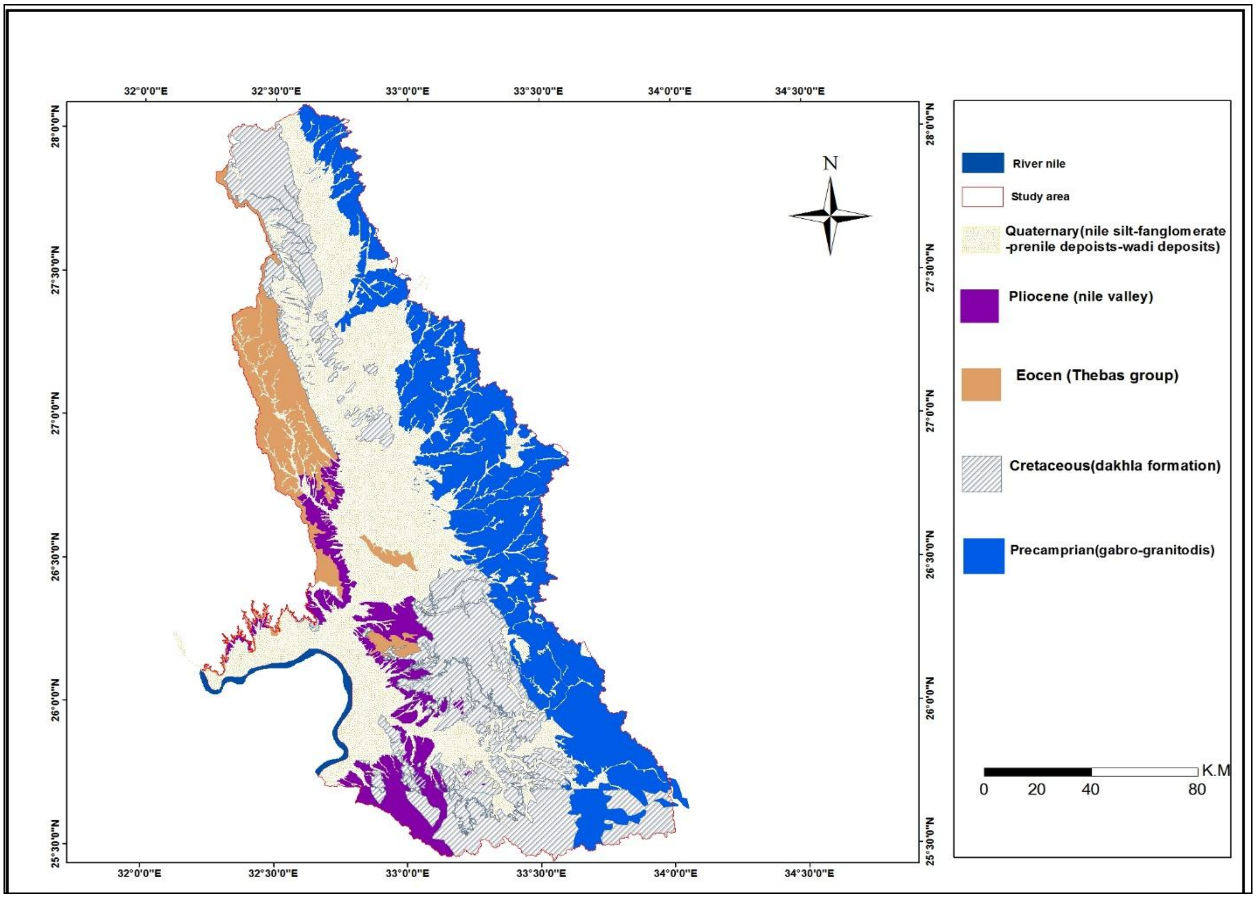


Figure (3-5) geological map of study area derived from geological maps of conco 1983

3.5.2 Cretaceous formations

These formations cover an area of 5500 km which constitutes about 21% and they consist of two types: (1) Upper Cretaceous that include clastic, carbonate rocks, and Nubian sand stone which includes clastic beds above the basement rocks, Cenomanian, in Qena Valley. (2) Lower Cretaceous that appears in different Formations along Qena valley.

3.5.3 Eocene formations

These formations include thick limestone section with chert concretions. These formations are shown as Thebes's formations and upper clay beds in Qena Valley. They cover 1800 km which forms 6.3% from the area of study.

3.5.4 Paleocene formations

The Paleocene formations include the upper part of Dakhla, Tararwan, and Kurkur, and the lower part of Gara and formations in Nile valley: Upper Dakhla beds and it covers 1680 km of the area, i.e. around 6.7%

3.5.5 Quaternary formations

The Formations quaternary contain many deposits including Nile silt, which represents most of the Flood plain. There are deposits called the Fanglomerate as well as pre Nile deposits, and the most common ones in the study area are Wadi deposits, which are distributed in streams valleys such as Qena Valley and Matula Valley and other small valleys. The area of these formations consists of around 9000 kilometers that constitute about 36% of the study area.

3.5.6 Faults

Through geological maps faults were extracted in the study area. The number of these faults was 2208 and their length covers about 6966 kilometers that were distributed in most parts of the study area and less in the middle and in places along the Floodplain as shown in figure (3-6) the consistency of trends faults, there is no common trend as in figure (3-7) they so much clearer in the form.

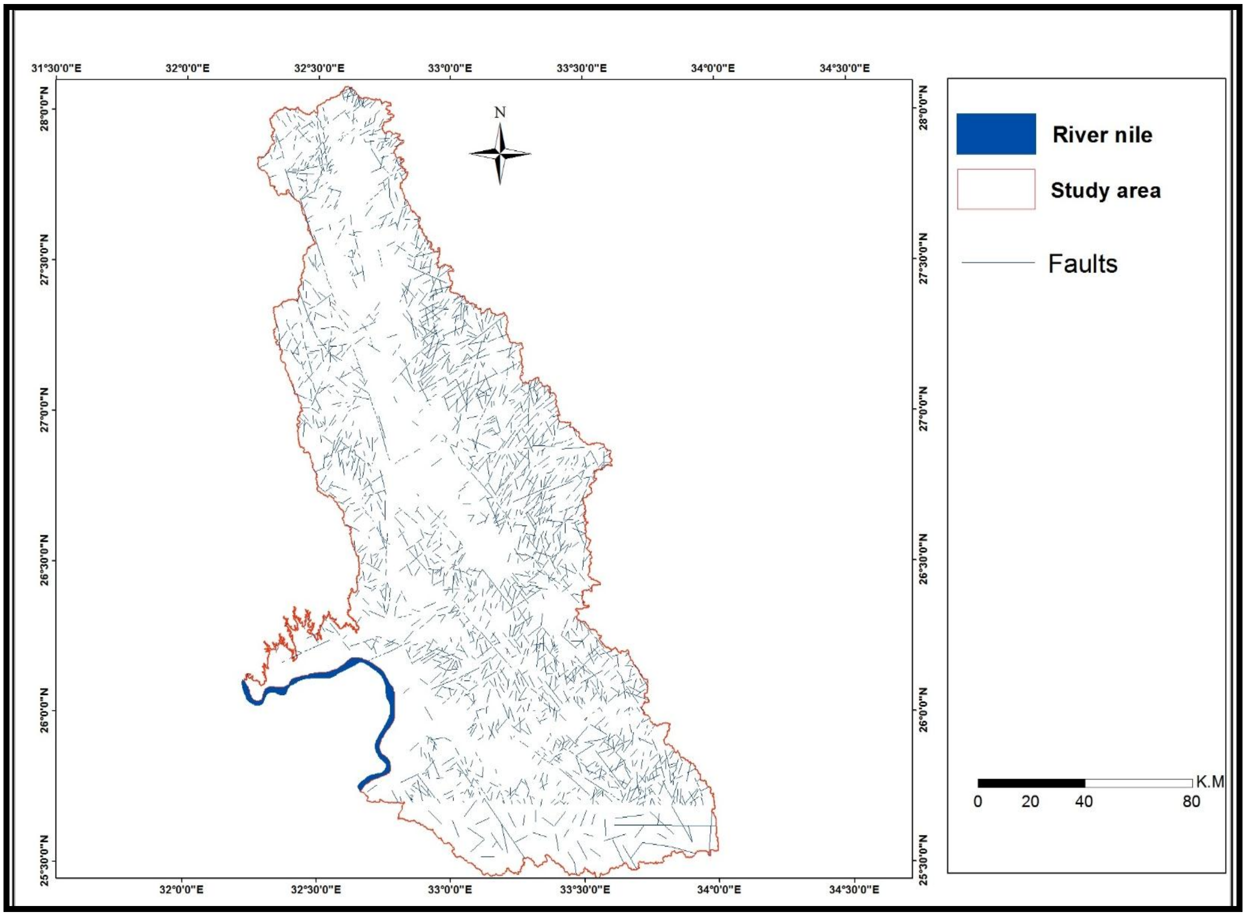


Figure (3-6) Faults distribution

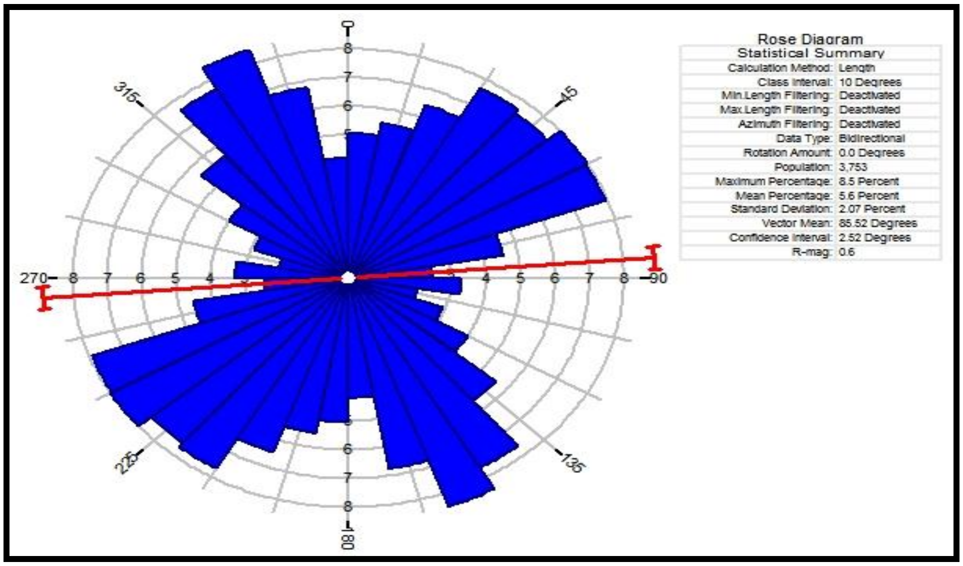


Figure (3-7) Faults direction statistical

3.6 Topographic characteristics of the study area

The analyses reflect the topographic feature of the region and slope levels, shadows and flow using directions and 3D analyses Through spatial analysis using spatial analysis tools (ESRI package) the above-mentioned analyses.

3.6.1 Elevation

Digital elevation models show the extent of the differences between the levels also they show the extent relief in the region that relied on Digital Elevation Models.

The highest point in the study area is + 1866 meters and the lowest point is 49 meters which is in flow. It reflects the difference of roughness in region as shown in Figure (3-8).

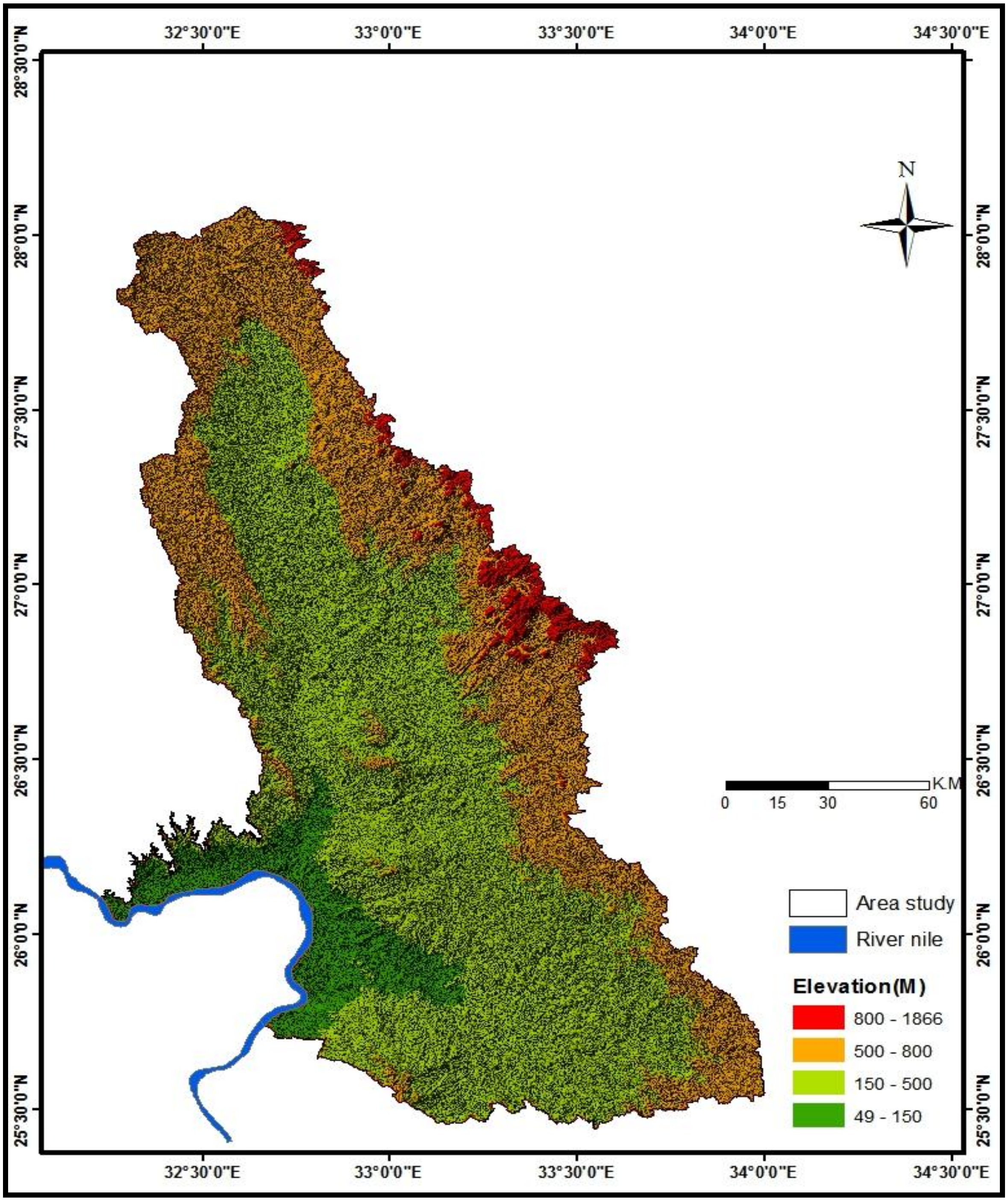


Figure (3-8) digital elevation model of study area

3.6.2 Slopes

Slope indicates the steepest downhill slope for a location on a surface (Esri 2012).

The slopes analysis reflects the direction of different elevation and explains the slopes ranges in the study area; and the highest slope area is 89 degree. This value is the most distributed in the study area. Figure (3-9)

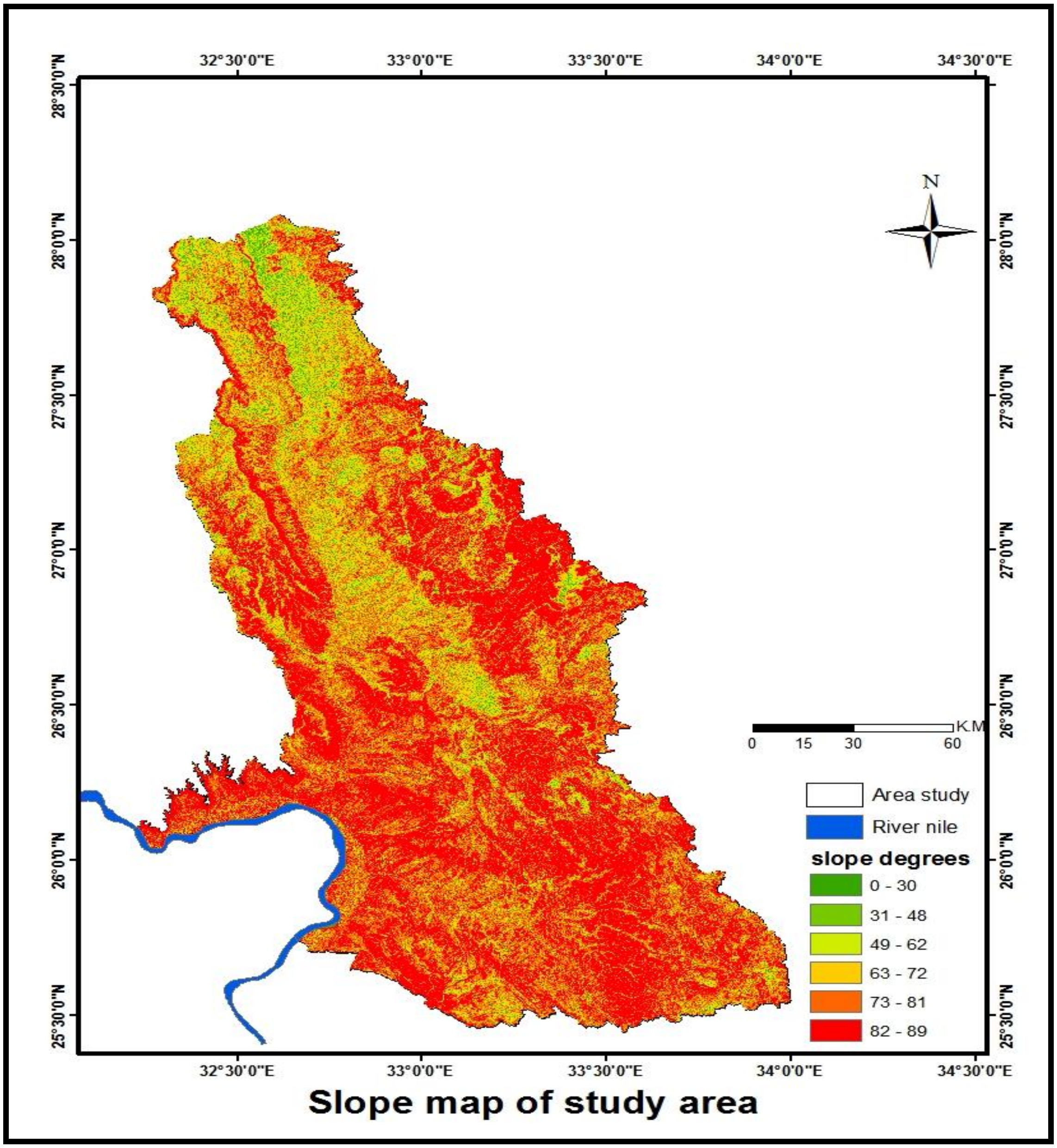


Figure (3-9) slope map of study area

And the general remark that can be observed in the study area is the trend of Slope, especially since it reflects the direction of the flow of basins as shown in Figure (3-10)

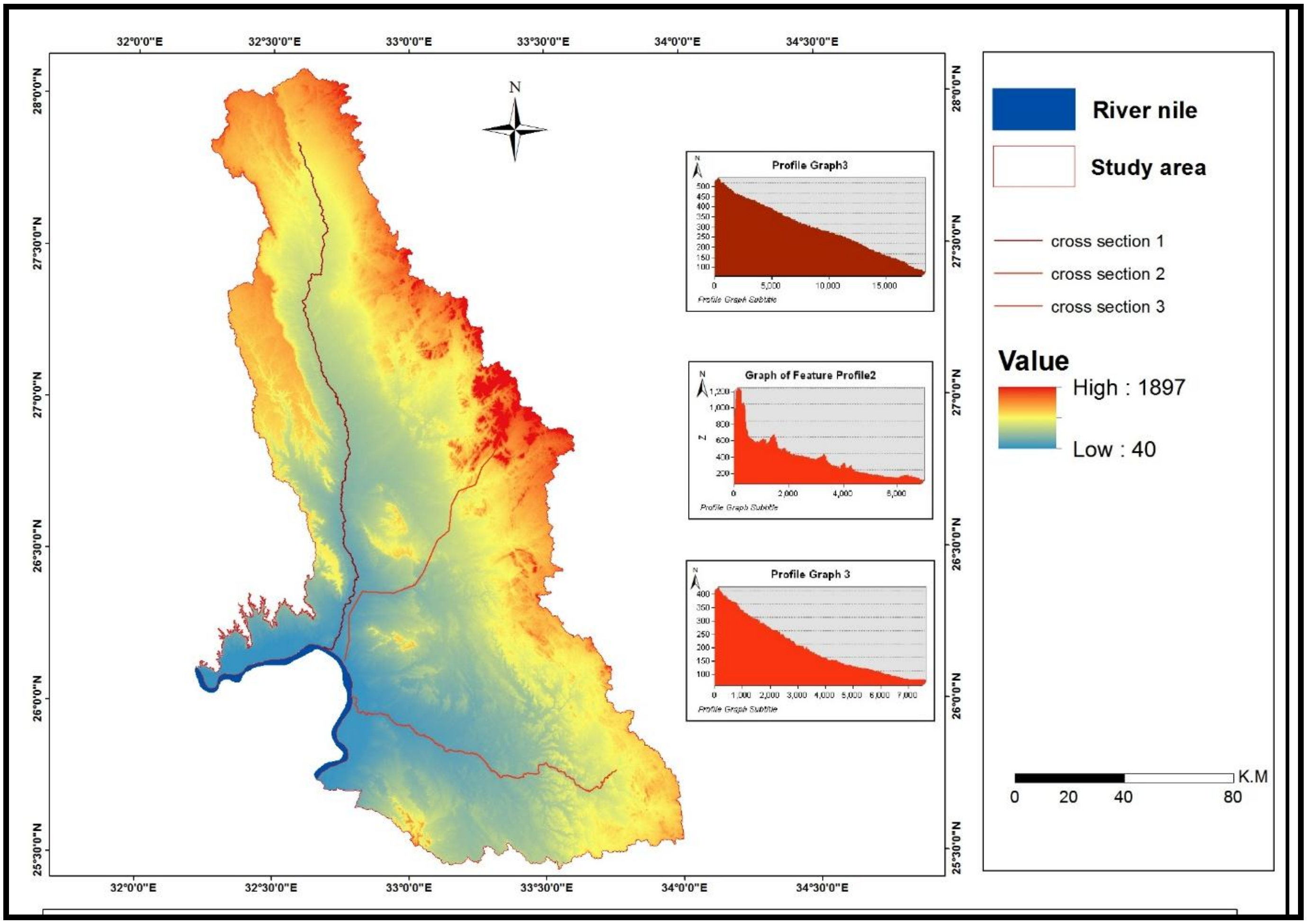


Figure (3-10) profiles map of study area

3.6.3 Aspect

Aspect denotes the downslope direction of the maximum rate of change in value from each cell to its neighbors. It can be thought of as the slope direction (Esri 2012).

It also reflects the values in the analysis aspect for directions from -1 up to 360 °and the Flat areas which have no downslope direction are given a value of -1 or less than -1 figure (3-11).

3.6.4 Hillshade

The Hillshade tool obtains the hypothetical illumination of a surface by determining illumination values for each cell in a raster (Esri 2012). The representation of the hill shade depends on the illumination position. They represent a good overview of the values and are slightly shown through figure (3-11).

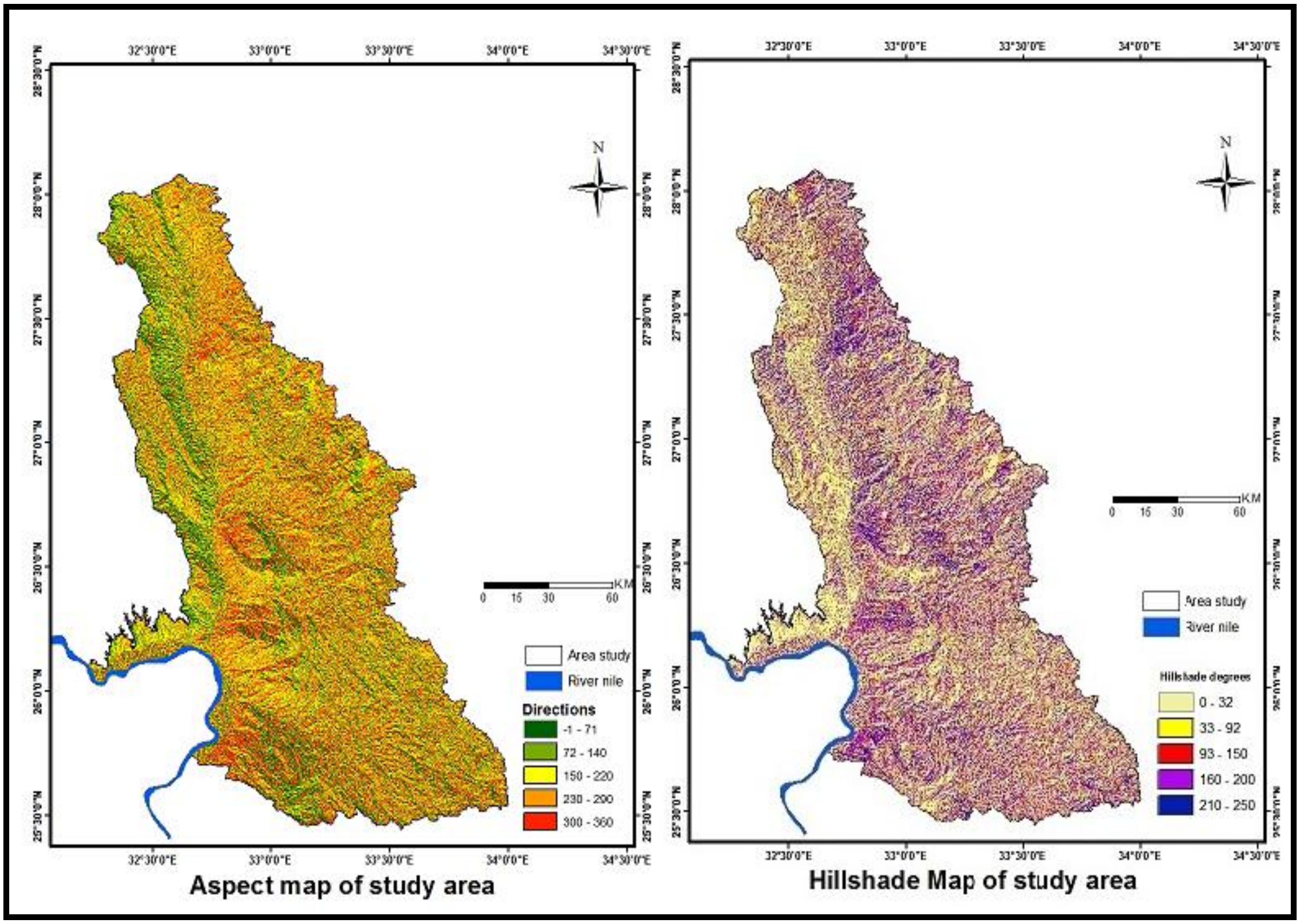


Figure (3-11) aspect and Hillshade map of study area

3.7 Drainage basins

The network discharge is only a reflection of the characteristics of the above-mentioned topographic decline, the direction of flow, and the differences in level. It is clear from this that the direction of network discharge is divided into two parts: the first goes out on the Red Sea and the second, which will be discussed goes out to the Nile Valley.

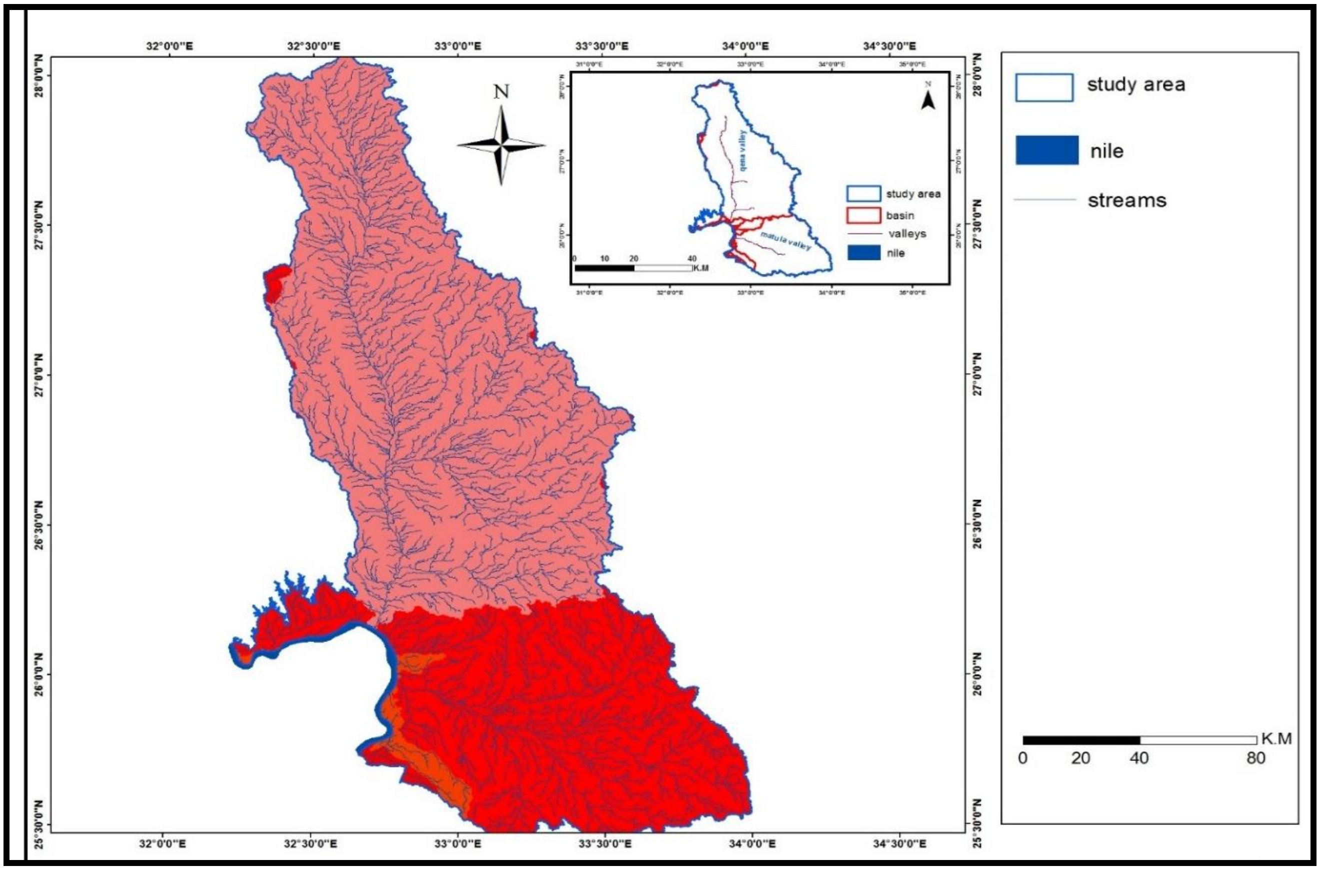


Figure (3-12) drainage basin of study area

Generally, in the map drainage basins, figure (3-12) shows that landmarks have two great drainages. First is the basin of Qena Valley, which is extended from the north in the direction of the general gradient to the south and southwest. The second basin Matula Valley that is extended from the south and south-east to the north and northwest and some small basins, their impact on the region study cannot be compared to that of the other two basins or the smaller basins in the northeast of the Qena bend.

Chapter Four

4.1 Background

This study aims to apply GIS and remote sensing to asses flood process and identify vulnerable areas .The following paragraph summarizes the main method used in this study

4.2 Preliminary stage

The preliminary stage focuses on the main elements of the methodology of study and introduce to the technique which has been used in study. The preliminary stage depends mainly on four elements. Figure (4-1).

The first elements is hydrological modeling, it is compatible with the second element which is flash flood guidance F.F.G modeling. Both elements depend on data which has been derived from digital elevation model DEM. The third element morphometric analysis also interacts with the previously mentioned elements. The hydrological model inputs and the equation of flash flood guidance F.F.G require mainly the morphometric parameter which is derived from digital elevation model data.

The analysis of digital image processing is the fourth element. Through this direction, the maps of land use are created according to multiple methods of classifications.

The change detection map will be created also according to image classification.

The all elements will have a specific weight on weighted overlay analysis.

Within this process, every element weighted must be detected to contribute in the final output of vulnerable places map and safety area map, as well.

The hydrological model shows hydrological characteristics. The flash flood guidance is used to estimate the runoff guidance of flash flood. The morphometric analysis describes and extracts morphometric descriptions and land change cove to display the directions of human activity and the directions of change detection. Moreover, it answer an important question: what is the relation between human activity and vulnerable place. All the previous elements are linked together to complete the risk Analysis results.

Before methodologies execution, preparation steps must be implemented as follows:

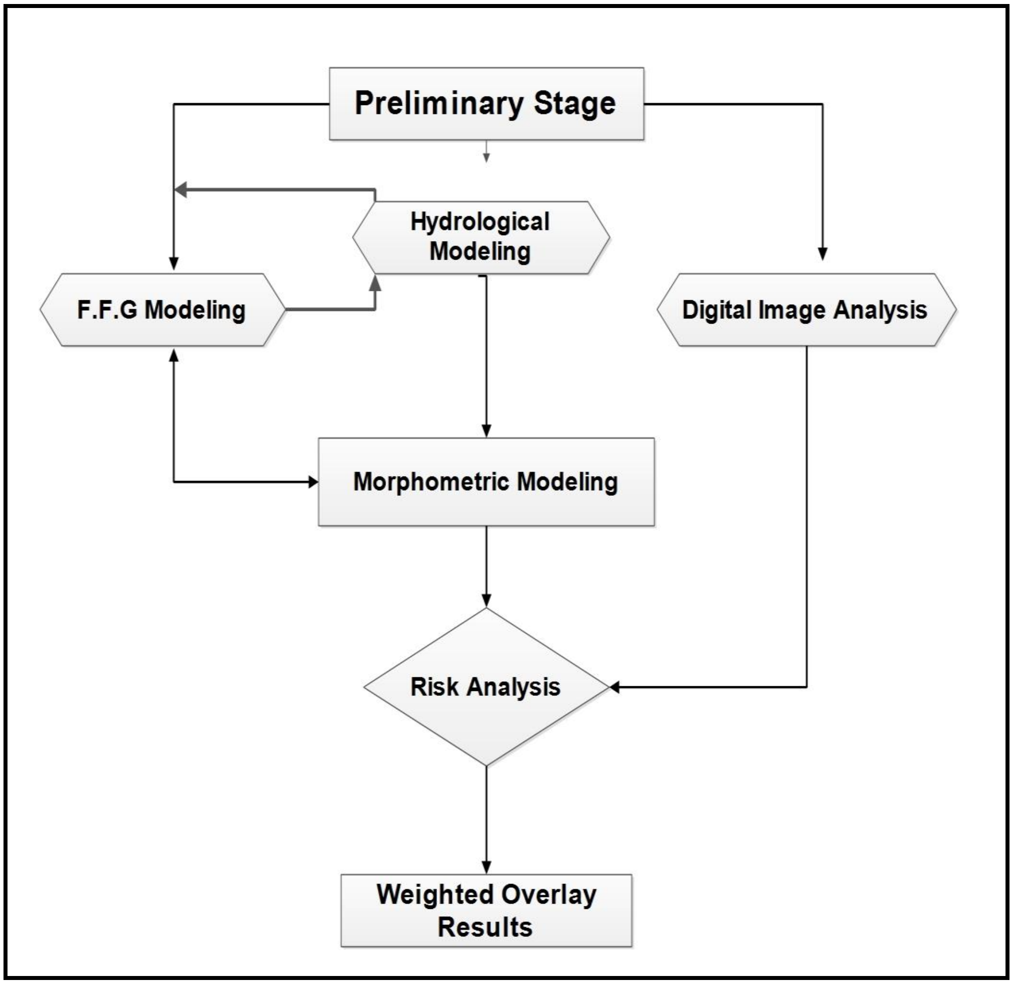


Figure (4-1) Stages methodology

4.3 Area selection

The study area was identified as mentioned previously in chapter three. of the proposal in terms of the study area and elements of the study

4.3.1 Data preparation

Different sources of data already used in this study such as remote sensing data, geological maps, topographic maps, and temperature data. The details of this data described in the following sections.

4.3.1.1 Data collection

The present study is based on a wide variety of spatial data that include remote sensing data, geological maps and topographic map and as well as attribute information as rainfall data and temperature data.

4.3.1.1.1 Remote sensing data

Two types of remote sensing data were used as the following:

Satellite images: The purpose of using these images is to specify land use in the study area and monitor spatial changes over 40 years starting from 1972 to March 2013. Moreover, these images were used to estimate land surface temperature (LST) to clarify the general temperature Characteristics of study area. The quality of the data from Landsat satellite with different historical data, different resolution and sensors as shown in the table (4-1). In addition to high resolution satellite images as Ikonos satellite and Quick Bird.

Aster DEM data: Digital elevation models are of accuracy of 90 meters, also the satellite data were used in hydrologic analyzes and morphological analysis

Table (4-1) Landsat data information

Landsat satellite images information				
Year	**sensor**	**Resolution**	**Bands number**	**satellite**
1972	MSS	56 meter	4 bands	Landsat 1,2,3
1984	TM	30 meter	7 bands	Landsat 4,5
2000	ETM+	14.25 meter	8 bands	Landsat 7
2006	ETM+	14.25 meter	8 bands	Landsat 7
2013 march	ETM+	14.25 meter	8 bands	Landsat 7
2013 June	OLI	14.25	11 bands	Landsat 8

Table (4-2) Ikonos and QuickBird data information

Satellite	**Number of bands**	**Resolution**
Ikonos	5 bands	0.8 m panchromatic 4-meter multispectral 1-meter pan-sharpened
Quick Bird	5 bands	panchromatic: 61 cm to 72 cm multispectral: 2.44 m) to 2.88 m)

And temperature data for real-time rainfall images, Meteosat infrared D159images, and weather reports to calculate the rainfall volumes. Also Hydrological Data and Information System (HYDIS) precipitation mapping .

4.3.1.1.2 Geological maps

The geological map of Egypt, Source: The Egyptian Geological Survey and Mining Authority, 1987 scale 1:250000. The geological maps are used in the study, to understand the geological setting of the study area and its impact on hydrologic and morphometric parameter

4.3.1.1.3 Temperature data .are taken from (The Egyptian Meteorological Authority (EMA), Located in Cairo, and Egypt).

Climate data were used to know rain data. This data can be used to calculate the amount of runoff in terms of the historical background.

4.3.2 Database Processing

Various data required for GIS were preprocessed as follows,

1. Digitizing existing topographic maps and geological maps by geo-referencing paper map, then convert data into digital form using on screen digitizing.
2. Generate a digital terrain model (DTM) to store in this system. The contour map; slope map; aspect map; relief shade map; 3D- perspective map were derived from the DTM.
3. Satellite imageries were set to classify land use that passing through geometric and radiometric correction.
4. GPS Field investigation data input to the system for land use classification data assessment.

Finally, the data organized into geo-database to be ready for analysis phase. Figure (4-2) shows sample of hydrologic map organization into geo-database .

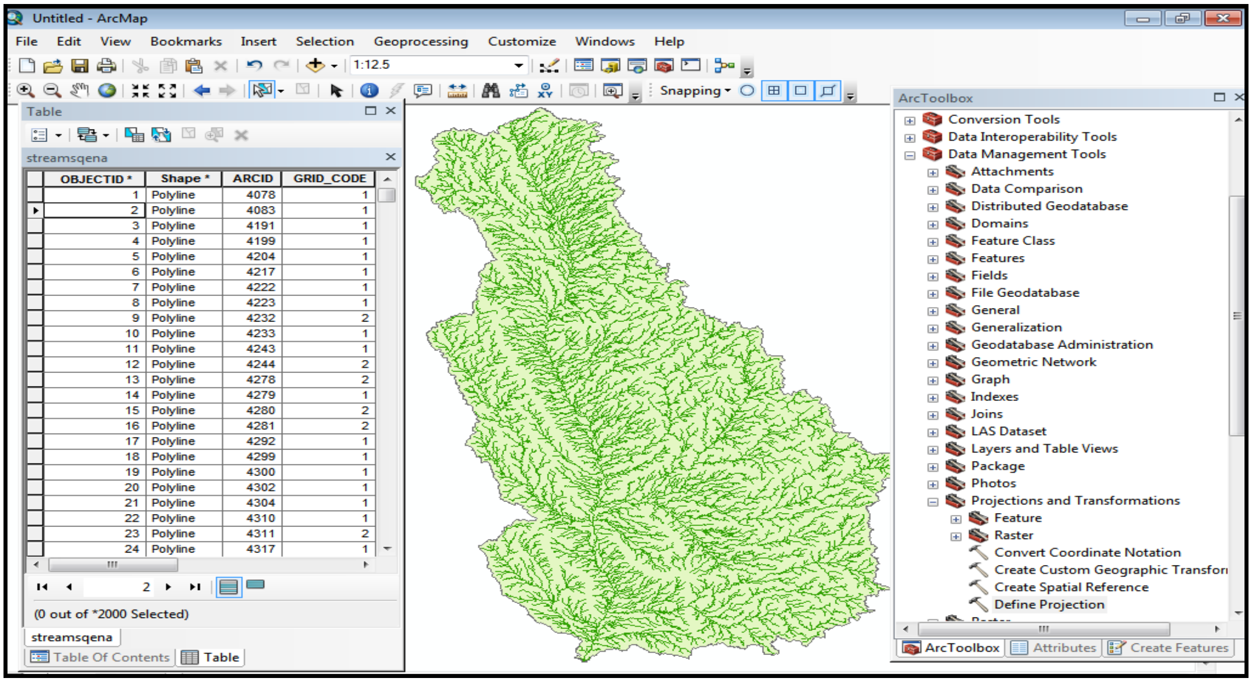


Figure (4-2) spatial data and attribute data

4.4 Literature review

A lot of studies focus on flash flood hazards as environmental disaster. The studies refer to morphometric analysis, hydrological analysis or flash flood guidance. A lot of studies discussed the disaster as dynamic action according to the historical records or the volumes of run off guidance. This study comes to make an integration between GIS and remote sensing data to preview a complete study for problems (FFG-hydrological modeling-morphometric analysis-land change analysis-weighted overlay analysis.

4.5 Embedded Flash Flood Guidance (FFG) Model

Hydrological research center HRC has invented this flash flood guidance system on a regional scale in Central America through a project funded by the U.S. Agency for International Development / Office of Disaster Assistance of Foreign Affairs (USAID / OFDA) and in collaboration with the NWS.

This System is implemented in Central America as it is known in America flash flood guidance system or central CAFFG. CAFFG is currently operational for each of the seven countries in the Central American region. The system is available for services Hydro meteorological in the region to be used as a diagnostic tool for the analysis of events related to weather conditions that can be the start of flooding (for example, heavy rainfall, and rainfall on saturated soil) and then to conduct a rapid assessment of the likelihood of floods in place. The system is designed (CAFFG) to allow the forecaster to add his/her experience with local conditions, the integration of data and other information (for example, output NWP) and any observations of local last minute (for example, measurement data non-traditional), to assess the threat of floods local communities. Evaluation is carried out for flood threat more than an hour to an hour for a period of six basins schedules 100-300 KM2 in size. Furthermore, using satellite estimates of precipitation along with regional data available on-site measurement of rainfall to obtain estimates - correcting the bias of the current volume of rainfall over the region. This data is used in precipitation and to update estimates of soil moisture (WMO 2007).

The importance of technical elements of the system Flash Flood Guidance is to develop and use debugger bias estimate precipitation satellites and the use of field-based hydrological modeling to determine the direction of physically flash floods threat. Now it can be applied to these elements in the system anywhere worldwide. Real-time estimates of rainfall data and high resolution of satellite now routinely available globally.

Databases of global digital terrain elevation and geographic information systems (GIS) can be used to identify small ponds and a stream in the network topology anywhere in the world. In addition, there are types of soil and the rules of global land cover data are available to support the spatial development of accounting models based on soil moisture physically. With this global data and information, cannot perform model CAFFG system anywhere (grabs 2010).

It is possible to create one or more of data, communication, and data that would analyze data processing centers of historical and near the existing real-time information to produce estimates directing floods threat of flash - the parameters which can be used for the development of flash warnings of floods. This can be linked to a network of centers in all regional centers around the world through global communication networks which can disseminate information to national facilities in poor countries with no warning or the ability of local flooding. These services would then produce national flood warnings using published data and information centers (WMO2007), in addition to any other local data and information readily available to them.

The implementation is also a mechanism for capacity-building for national facilities as well as services for the management of national disasters. Through the development of a technical tool, and the development and implementation of protocols centers, that will provide training and capacity building in the use of data and products to mitigate and effective response to threats of flash floods in all parts of the world figure (4-3)

4.6 Benefits Of Flash Flood Guidance

A key advantage of the guidance system floods is that it provides early awareness of imminent threats and local flooding to all societies of the world that are likely to be vulnerable. The real value of the system is to provide rapid assessments of the potential flood to allow an improvement worldwide in early warning of a sudden flooding. Thus allowing for more rapid mobilization and response agencies.(WMO 2007).

The model consists of a set of elements that affects the flash flood guidance as in the figure of (4-3)

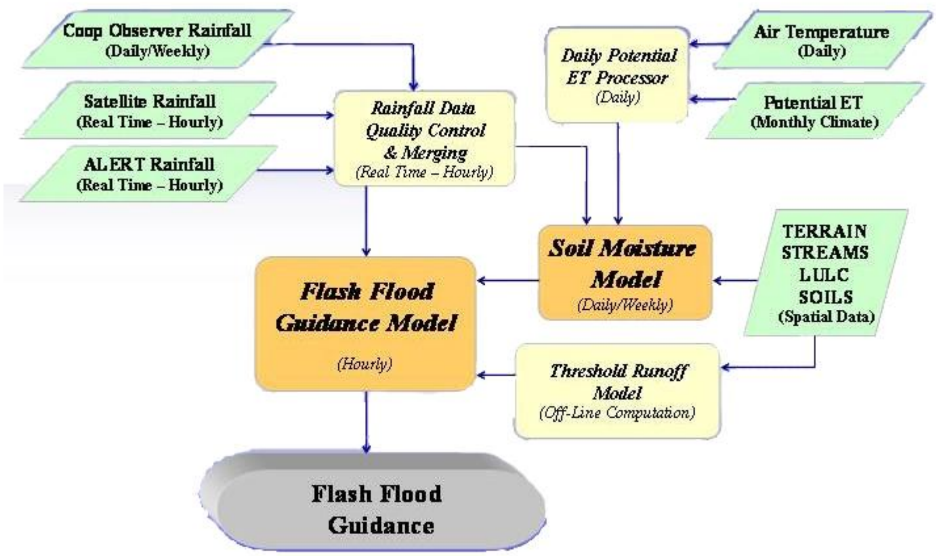


Figure (4-3) FFG elements flow chart (HRC)

Implementation will include the development of a global infrastructure to allow the generation and dissemination of data in real-time products. It can also host this infrastructure-related products, other global disaster mitigation, and response. Useful products will be developed to delineate high-risk flood areas globally for effective development planning in the future. Information soil water is also a by-product of directives flash floods operating system. This output may be a source of valuable information to complement other products of this kind in the region for agricultural use (WMO 2007).

This module aims to develop a mechanism characterized by accuracy and speed players to predict the risk of floods using a model based on GIS applications. This model will include a set of items to be resolved issue predict disasters, especially FFG (can this form of decision makers and analysts in disaster areas to evaluate their decision because activation Model takes no more than few minutes just supplied the amount of rain and some other transactions, which will be mentioned.

As it will be called danger to citizens if there are disasters far from human activity, for example floods in the desert, it is not considered a threat to humans, so the model will be given space for human element trends and expansions based on remote sensing data and analyzes sub pixel classification, which is given patterns of object oriented classification

Also, it does not exceed the model by default to locate runoff flood but will have another value, especially in determining the magnitude of the risk so it will determine the amount of rainfall in a given time, for example one or two hours, which would be of great importance to know what the final value of the flow that will be gathered at the end of the main stream, will the water be dangerous or not all this while taking in consideration including Topographic basins and their streams and geology of the region along with other factors

The data will be put in the form of sheet programmer and contains the results of flow depend on that model next mentioned

It is worth mentioning that the run-off depends on the amount of rain a basin can keep. This run-off can be achieved only when absorption becomes more than the amount of the rainfall, but if the reverse happens and the amount of the rainfall becomes less than the quantity of the basin water, the basin will be full and the water will flow.

$$q = \frac{(p - Ia)}{p + 0.8S} \tag{4.1}$$

$$Q = \frac{a(p - 0.2S)^2}{(p + 0.8S)} \tag{4.2}$$

$$S = \frac{1000}{CN} - 10 \quad (4.3)$$

$$Ia = 0.2S \quad (4.4)$$

Where:

Q – Direct Runoff P – Rainfall Total

Ia – Initial Abstraction S – Storage Retention

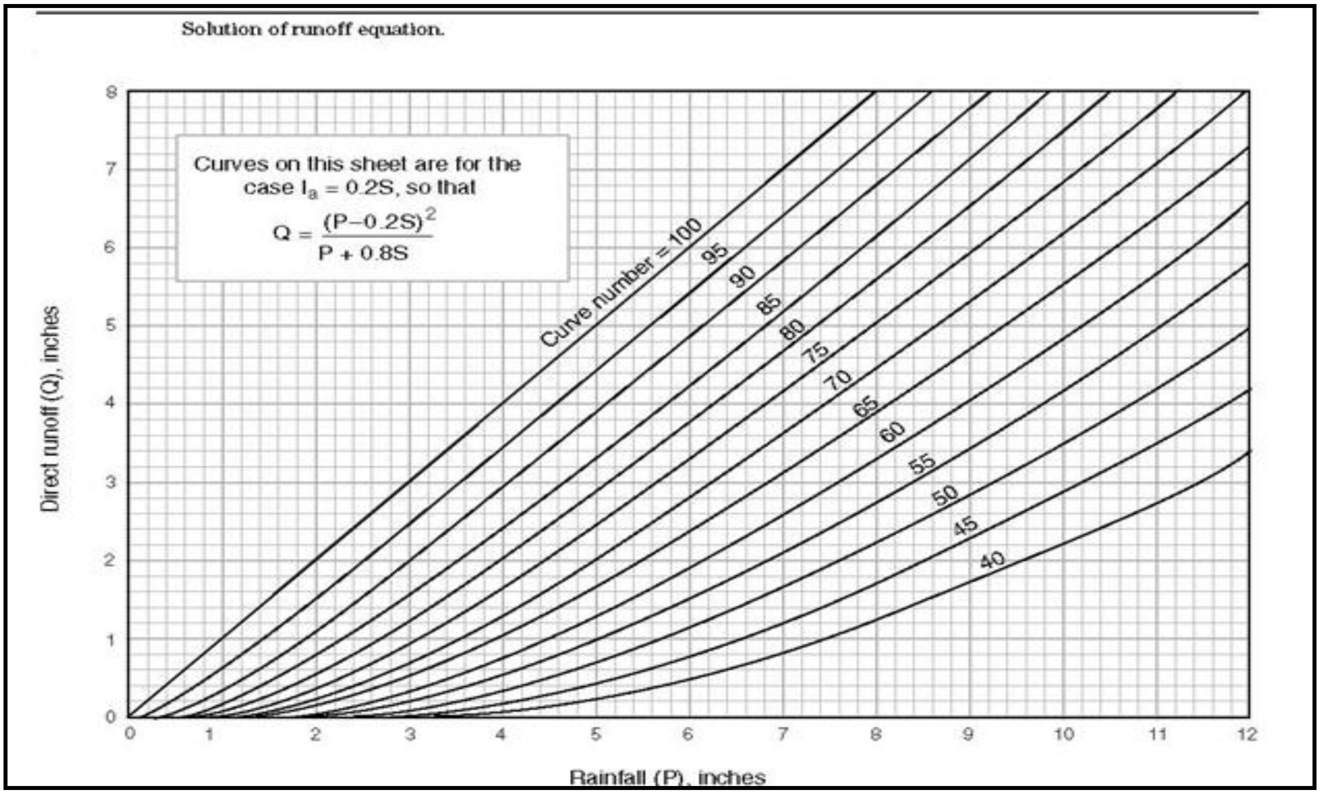


Figure (4-4) CN – Curve Number

It must be noted that runoff depends on the amount of rain a basin can keep and this can be achieved only by absorption if rainfall exceeded over the retention basin water quantity after the absorption of water in the soil, but if the amount of rain is large then water will fall. Absorption into the soil becomes less than zero.

CN is a very important factor in calculating the amount of drainage because the soil type in turn affects the amount of runoff and it also differs in the degree of soil water absorption than others.

4.6.1 Hydrologic Soil Groups

Group A soils have low runoff potential and high infiltration rates even when thoroughly wet. They consist mainly of deep, well to excessively drained sand or gravel and have a high rate of water transmission (greater than 0.30 in/hr). Soil Texture: Sand, loamy sand, or sandy loam

Group B soils have moderate infiltration rates when thoroughly wet and consist mainly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 in/hr). Soil Texture: Silt loam or loam

Group C soils have low infiltration rates when thoroughly wet and mainly consist of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr). Soil Texture: Sandy clay loam

Group D soils have high runoff potential. They have very low infiltration rates when thoroughly wet and consist mainly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr). ***Soil Texture: Clay loam, silty clay loam, sandy clay, silty clay, or clay***

Runoff curve numbers for cultivated agricultural lands [1]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2]	Hydrologic condition [3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

Figure (4-5) Hydrologic Soil Groups (NRCS 1986)

Runoff curve numbers for urban areas [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

Figure (4-6) Hydrologic Soil Groups (NRCS 1986)

Runoff curve numbers for other agricultural lands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4]	48	65	73
Woods—grass combination (orchard or tree farm). [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

Figure (4-7) Hydrologic Soil Groups (NRCS 1986)

$$v = 0.22279L/tc \qquad 4.5$$

$$Tc = 1.67\{L^{0.8}(S+1)^{0.7}\}/\{1900 * SL^{0.5}\} \qquad 4.6$$

$$Sd = 0.133Tc \qquad 4.7$$

$$SL = 0.86s1^{0.67} \qquad 4.8$$

Where

V is the flow velocity (m/s),

L is the basin length express units of meters

Tc is the concentration time (minutes)

SL is the average watershed land slope in percentage

Sd is the storm duration (hours).

The greater the decline in the basin the more flow velocity increase and time becomes the focus to reach the water quickly accumulated in the basin outlet which affects the degree of seriousness of the basin as in the following figure(4-8)(NRCS1986)

The value of the SL influential in this equation () which expresses the average slope basin. It also indicates how fast the flow is, as noted, but here's S 1 mean first order, their standard value of the SL, a 28.6 but yet it had to be sure of that value as it has been an equation already shown from the previous number or 28.4 or 28.5, and so on.

In other words, the above can be explained through Shallow Concentrated Flow After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow ***(NRCS 1986)***

$$T_t = \frac{L}{3600\,V} \qquad 4.9$$

Where:

Tt = travel time (hr)

L = flow length (ft)

V = the flow velocity (m/s)

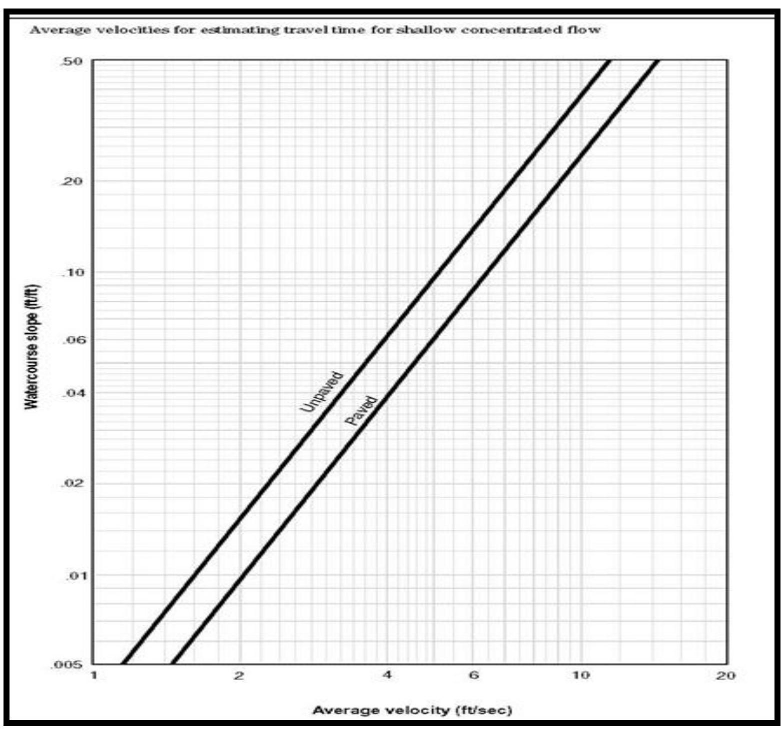


Figure (4-8) average velocity (NRCS 1986)

Different equations were used to verify the correct results of the estimated amount of runoff flooding or for determining degrees of risk as follows (*Bedient, 2003*).

$$Q = (p - 0.2S)2/(p + 0.8S) \quad 4.10$$

$$S = 25.4((\frac{1000}{CN}) - 10) \quad 4.11$$

QT=QA 4.12

QP=QUAO 4.13

Where:

Q is the depth of direct runoff (mm)

P is the depth of precipitation for a specific return period (mm),

S is the maximum potential retention (mm),

CN is the curve number,

QT is the volume of runoff (m3),

A is the Area of basin (Km2),

Q is the depth of direct runoff (m),

QP is the peak discharge (m3/s),

Qu is the unit peak discharge (m3/s/km2/mm)

The relationship is clear between those elements that have been mentioned to visualize the reality and to maintain runoff flood. There are some other elements that are influential but not obvious. These elements will be mentioned in the complete model of the runoff flood, and the following steps are shown in table (4-3), indicate other elements that affect the flow flooding.

Table (4-3) data sheet for study area according to NRCS method

Area $k.m^2$	**Length $k.m^2$**	**SL**	**CN**	**S**	**TC**	**V**	**SD**	**Q**	**QT**
1777.93	74000.5	28.8	96	10.58333	7.1444	2360.542	0.950208	0.18	320.0273
1748.639	87000.5545	28.6	63	149.1746	49.09248	403.8791	6.5293	0.17	297.2686
1400.233	90000.6391	28.6	63	149.17	50.44	4.6.62	6.70	0.16	224.03
841.624	54000.907	28.6	96	10.58	5.57	2206.7	0.74	0.17	193.88

Area $k.m^2$	**Length $k.m^2$**	**SL**	**CN**	**S**	**TC**	**V**	**SD**	**Q**	**QT**
762.122	56000.762	28.6	63	149.17	34.51	369.8	4.58	0.18	151.49
717.424	47000.2044	28.6	63	149.17	29.99	357.0811	3.98	0.19	144.80
651.596	65000.953	28.6	96	10.58	6.46	2290.15	0.86	0.15	107.61
489.3196	53000.162	28.6	63	149.17	33.02	365.76	4.39	0.18	117.61
401.562	46000.6954	28.6	96	10.58	4.90	2137.144	0.65	0.18	88.07
310.592	44000.762	28.6	96	10.58	4.73	2118.23	0.62	0.18	72.28
303.075	25000.950	28.6	96	10.58	3.01	1891.787	0.40	0.18	55.90
330.156	33000.130	28.6	63	149.17	23.69	336.637	3.15	0.18	54.55
229.292	32000.744	28.6	96	10.58	3.76	1999.789	0.50	0.18	41.32
212.072	47000.463	28.6	63	149.17	22.05	330.657	2.93	0.18	38.18
211.391	34000.131	28.6	96	10.85	29.99	357.081	3.98	0.18	38.05

The advantages of this model are to calculate the amount of water flowing based on data virtualization and data historic rain. Also, it helps in recording the largest amount of loss water in the Wadi of Qena larger of 58 mm in the period from 1964 to 1999. The addition of the ingredients to other Models will be fairly unchanged, including the analysis morphometric valleys and elements affecting rates of Table

Model database would be equipped with basic data for the final results of the analysis represented in morphometric analysis of the basins Direction of Change detection from remote sensing data Total Rainfall – Accumulative storm total (Ethan 2006)

• Excess Rainfall – Accumulative excess

• Saturation Rainfall – Additional rainfall required to satisfy initial abstractions

• Runoff CN – The computed storm event CN used within the FFG model process

• Peak Discharge – The current simulated peak discharge

• Vulnerability analysis – The current threat index, and previous flood duration

• One Hour FFG –Rainfall required in a one hour period to initiate flooding

• Three Hour FFG – Additional rainfall required in a three hour period

Storm Hydrograph – Simulated discharge for storm event at watershed outlet

• FFG – Evolution of predicted FFG thresholds through the course of a storm event

• Total Rainfall – Accumulative rainfall distribution

4.7 Hydrological model

The hydrological model aims at working on the data analysis of DEM (digital elevation model) to extract drainage basins, main streams, orders and finding flow directions. One can analyze those data to derive various morphometric transactions using ESRI Package: hydrologic analyzes and other analyzes as shown in the following figure (4-9).

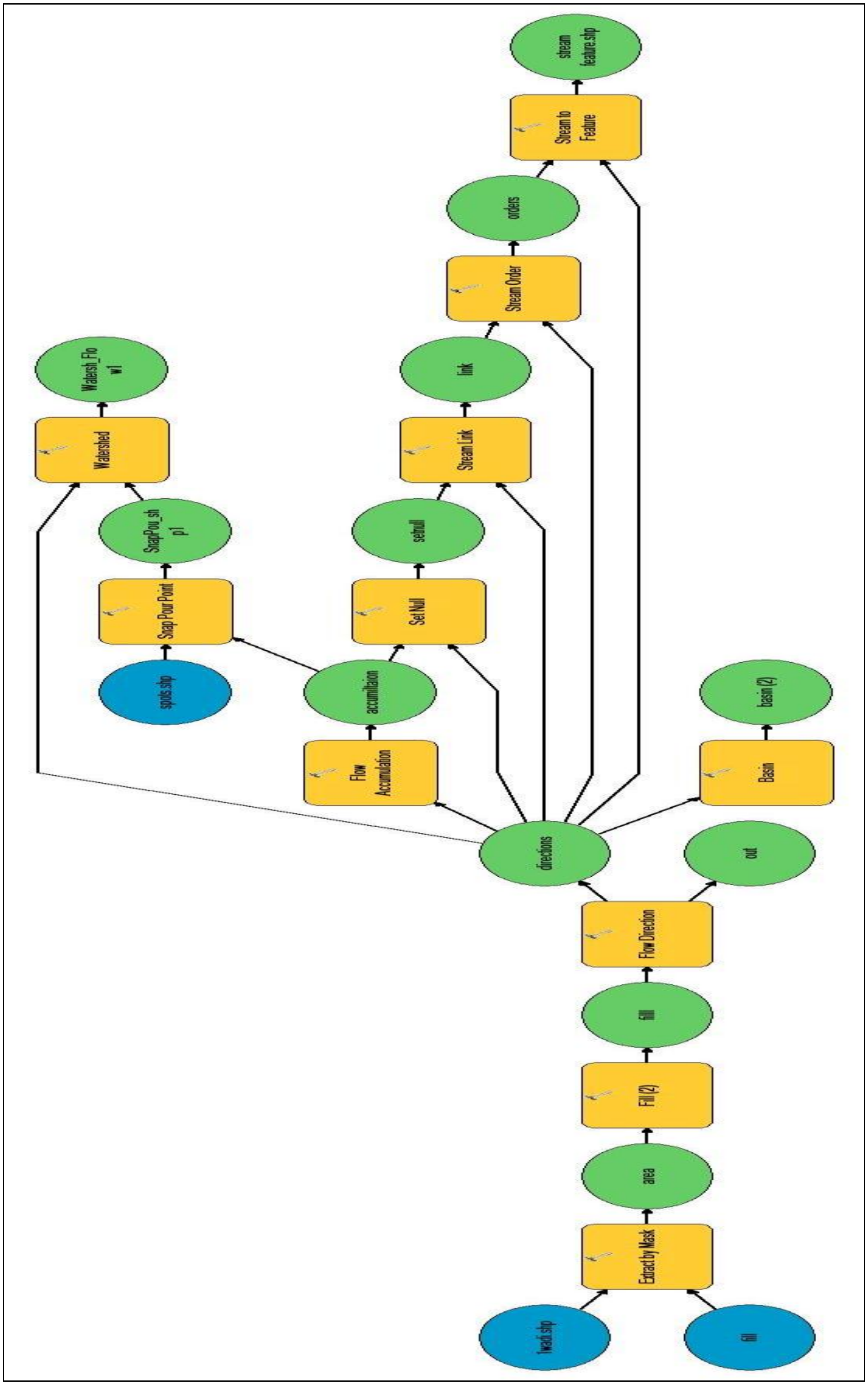


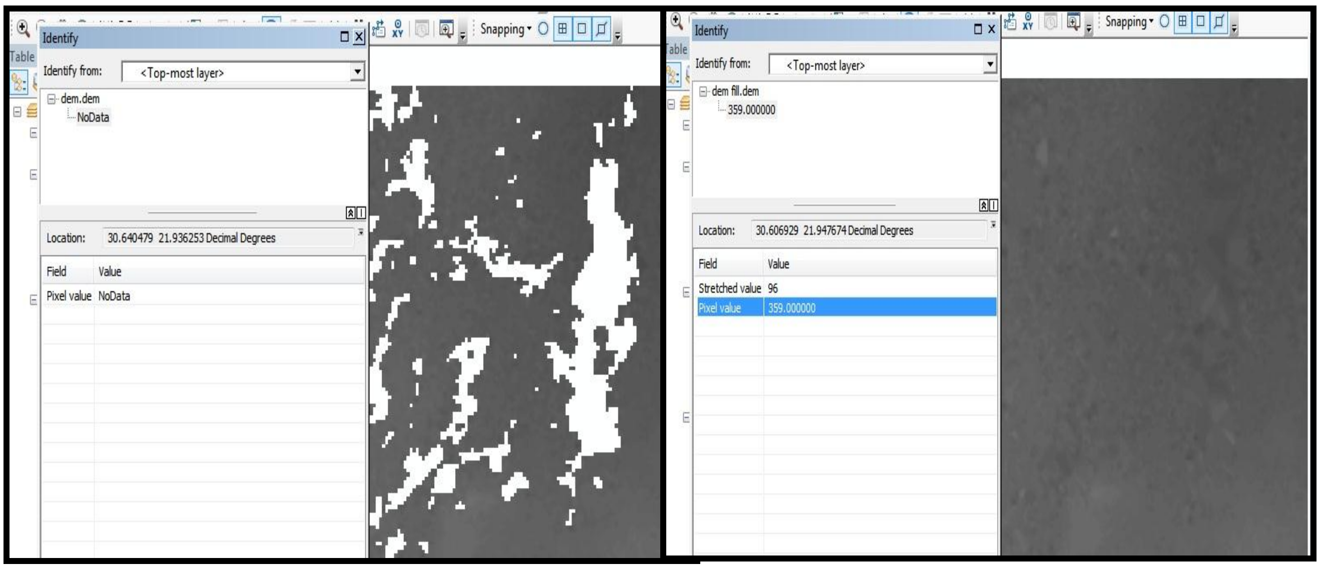
Figure (4-9) Hydrological model

4.7.1 Extract area of interest

Data has been dependent on the accuracy of DEM 30 and 90 meters in the hydrological analysis process. The extraction by mask in the ESRI package is used to detect the area of interest by using shape file from digital elevations models (Esri 2012, figure,)

4.7.2 Fill process

This tool is used to fill the gaps that can DEM files form. This is through neighborhood coefficient which recognize the value of others familiar with neighboring values of such pixels figure (4-10)



Before fill After fill

Figure (4-10) digital elevation model fill process

For example the area of interest (the lowest level) is 75 then I will fill gaps less than 75 which input elevation as raster and output must detected the finally Z limit: 75.

4.7.3 Follow direction

The flow direction procedure determines the direction of flow for each cell to its steepest downslope neighbor as:

Change in elevation/distance *100(moawad 2008)

This tool allows determining the direction of flow for each of the digital elevation model cells through the identification of maximum and minimum height of each cell of the cells and thus the direction of the slope, flow, and the process is done (Esri 2012).

4.7.4 Flow accumulation

This function depends on the flow, evaluates trends cells, and determines low and high values to determine the actual darning.

4.7.5 Set null

The use of set null determines the values of streams or least stream will appear when you extract dales depending on file Flow accumulation. Value is specified in the clause, for example, if we put in the expression that the stream that is less than 50 shall be as follows (Esri 2012)

Where the input parameters were (Input conditional raster: flow acc, Value lt 50, Input true raster or constant value: 1, Input false raster or constant value: "", Output raster: stream_net)

4.7.6 Stream link

We are using this as a tool to connect streams within the streams of the zone and Valley.

4.7.7 Stream order

Stream ordering is a method of assigning a numeric order to link in a stream network. This order is a method for identifying and classifying types of streams based on their numbers of tributaries. Some characteristics of streams can be inferred by simply knowing their order (Esri 2012)

The Strahler's method has been used to arrange the ranks in the valleys. This includes the way that if two orders of the same class are joined, the resulting order will be the one that follow these orders figure (4-11).

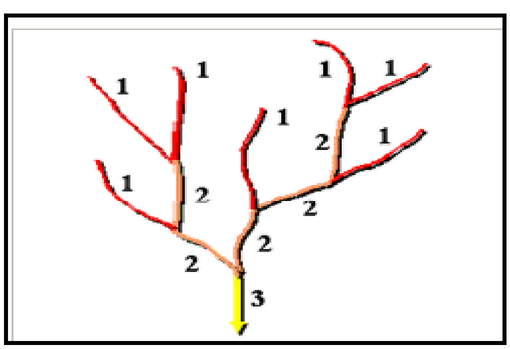


Figure (4-11) strahler stream ordering method (Esri 2012)

4.7.8 Streams vectorization

This tool enables us to convert the streams from raster format to .ship file vector format as shown in the following figure (4-12).

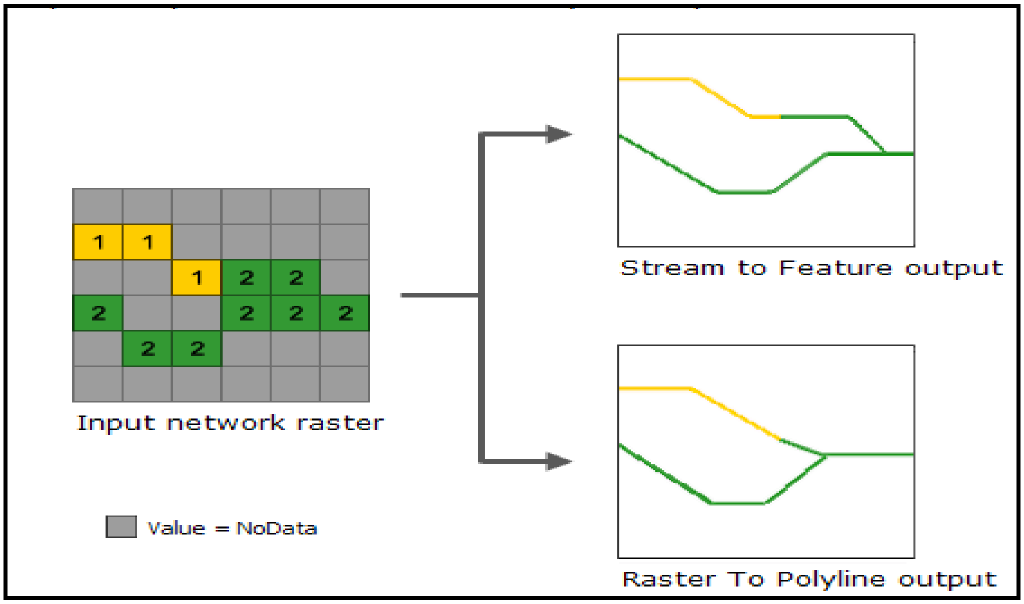


Figure (4-12) Comparing between raster streams and vector stream method (Esri 2012)

4.7.9 Building network

The network stream was built to determine the numbers of the orders and ensure the separation of all the other streams, orders, and numbers that are not repeated figure (4-13).

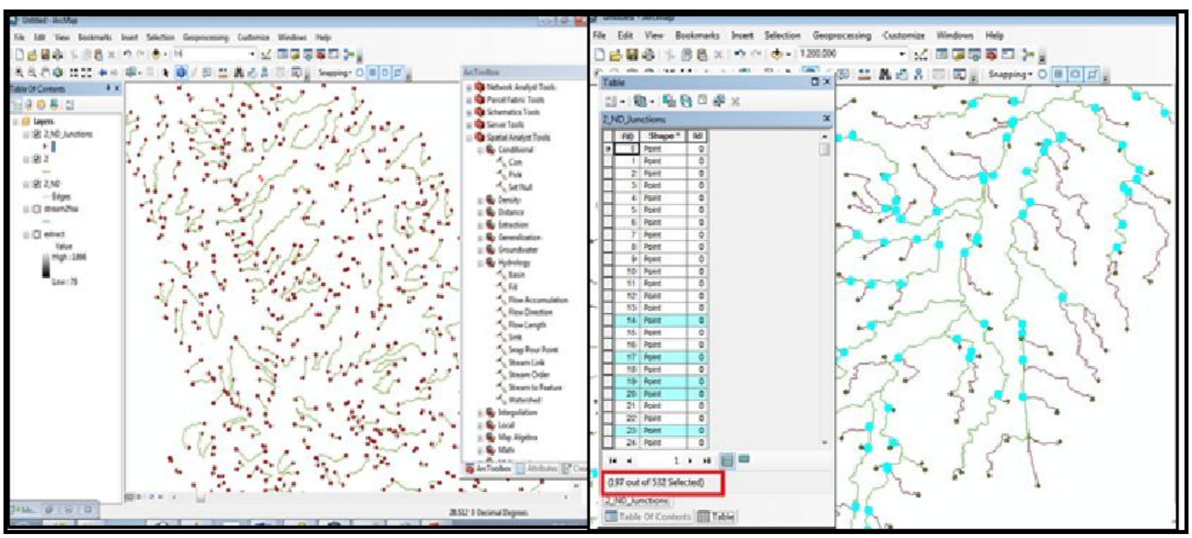


Figure (4-13) Building network

4.7.10 Basin

This tool enables the basin edge to be delineated depending on flow direction raster data set. The output also raster layer includes basin boundary that determines the boundary for every basin

4.7.11 Vectorization

To calculate a morphometric analysis for basin, the data must be converted from raster to vector (polygon).

4.7.12 Watershed

A watershed is the upslope area that contributes flow—generally water—to a common outlet as concentrated drainage. It can be a part of a larger watershed and can also contain smaller watersheds, called sub basins figure (4-14). The boundaries between watersheds are divided termed drainage. The outlet, or pour point, is the point on the surface at which water flows out of an area. It is the lowest point along the boundary of a watershed.

The pour point file depends on flow accumulation file to detect the outlet point for every draining basin then the process is ready to done as followed shape.

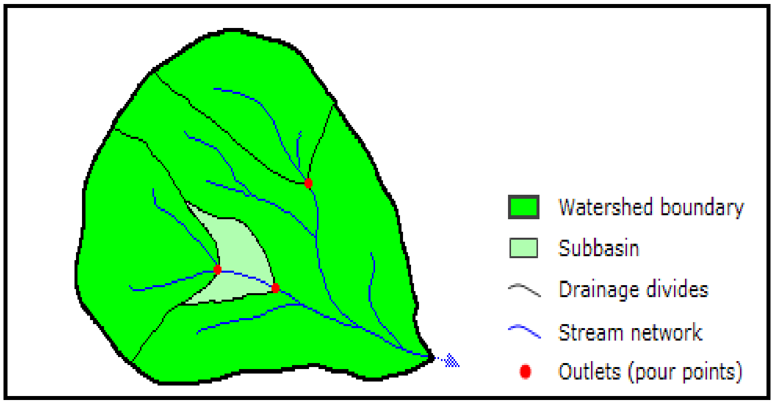


Figure (4-14) watershed components (Esri 2012)

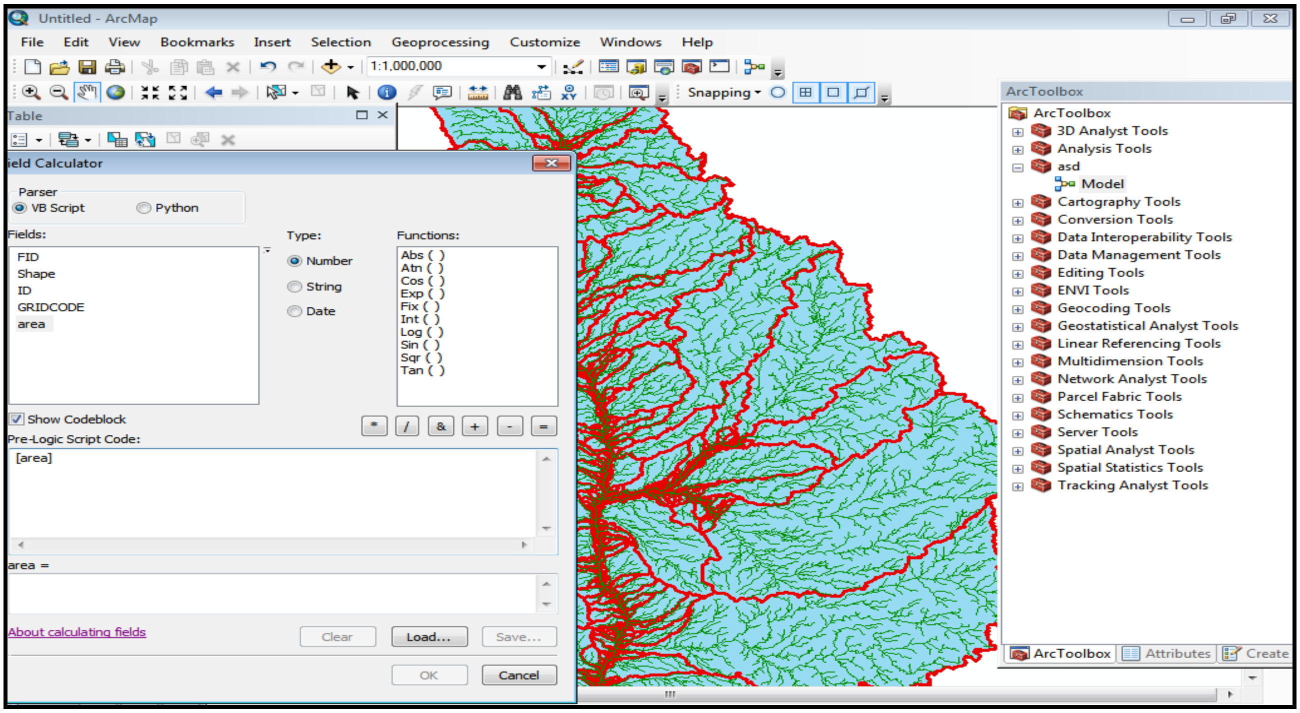


Figure (4-15) Calculate morphometric parmeters

then if the raster watershed is converted to vector polygon to complete the morphometric analysis within the field to calculate the process with attribute table in shape file or data set in personal geodata base figure (4-15).

4.8 Morphometric analysis

This model also includes morphometric analyzes, a main factor in estimating the amount of runoff Guidance as well as seriousness and following transactions belong to that were used in this analysis model.

4.8.1 Basin area (A)

The drainage basin area is one of the important factors in the morphometric analysis . Some studies have indicated that there is an inverse relationship between the basin area and the size of the final discharge, the greater the area of the basin, the more wastage rate of falling water, which reduces the risk of basin.

The calculation of the areas of the basins is conducted through a database basin in a GIS environment.

4.8.2 Basin length (Lb.)

Lenghth of a basian is expressed as the longest dimension of the basin parallel to the main drainage line (schumm 1956, moawad 2008)

The maximum length of the basin (k.m) and measured the length of basin in several ways, including the expense of the main stream of the basin or measure the distance between the estuary and the farthest point on the perimeter of the basin

4.8.3 Basin perimeter (p)

The total length of the drainage basin boundary (km) or along the dividing line between the basin and the other side of the basin.

4.8.4 Basin width

It is measured in several ways, including the apportionment of the drainage basin area on the maximum length of the basin or through the work of several measurements on the average basin.

4.8.5 Basin shape

The shape of the basin affects the duration of the crisis to the flow of runoff spate since its fall even estuary. The shape of the basin is studied by the indicators on its shape, which outlines many of the data affecting the shape of the basin, including the following indicators.

4.8.5.1 Rate of Circularity

It is calculated by the following equation by (Schumn1956)

Circularity rate = A km 2 / area of a circle with the same parameter km2 also from this equation

$$RC = (4\pi Au)/P2 \qquad (4.14)$$

Where:

π (Pi) =3.14

Au=Area of the Basin (km2)

P =Perimeter (km)

Increasingly Circularity basin if approached from the right one and is approaching the elongation closer to the value of zero and indicated that the small basin is closer to the elongation of large basin due to count the arrival of small to geomorphological advanced stage (khidre)

4.8.5.2 Elongation Ratio

Elongation rate reflects how close the rectangular basin and is expressed by the following equation ((Schumn1956).

Elongation ratio = diameter equal to the area of the basin / maximum length of the basin.

The value of the elongation increases if the result of value about one right the basin will be approaching the roundness

4.8.5.3 Basin Form Factor

This factor indicates low values for this parameter on the relative decline in the extension of this relationship for the sanctuary. It also increases the length of the basin and its shape will be similar to the shape of a triangle. If the value of the basin area for value of the long, the shape of the basin in this case approaching the shape of the box It is calculated from the following equation Horton (1932)

$$RF = A/Lb2 \quad (4.15)$$

Where A basin area Lb2=Square of Ba length

4.8.6 Basin slope

Basin slope plays a very important role in the morphometric transactions. When the surface of the basin slope is lower, the wastage of water, (either through evaporation or absorption into the soil), will be greater. Therefore, the basin slope is an important factor that affects the flow velocity and the time that is required for the flow Guidance.

Talk about the slope of the surface of basin, one must mention the following factors.

4.8.6.1 Relief Ratio (RH)

Basin Relief Ratio reflects the nature of its surface whether it reveals differences Relief along completely or is calculated from the following equation (Schumn1956)

WHERE

Rh =H/Lb. (4.16)

H=Total relief (Relative relief) of the basin in m

Lb. = Basin length

H=the difference between the highest and lowest points in the basin Surface

4.8.6.2 Relative Relief (R.R)

Reflect the relative terrain relationship between the highest and lowest level in the basin along the perimeter and is calculated from the following equation (strahler 1964).

WHERE:

$$RR = \left(\frac{H}{P}\right) * 100 \quad (4.17)$$

H=the difference between the highest and lowest points in the basin Surface

P=Basin perimeter

4.8.6.3 Ruggedness Number(RN)

The degree Ruggedness indicator with two effects first in the analysis morphometric as it reflects the extent of cut basin drainage higher the index indicates the efficiency of network discharges and other reflects how dangerous this basin from the rest of basins. This indicator does not take into account interruptions resulting from decline slopes and fractures (khidre 1997).

The score is calculated Ruggedness by the following equation (Doornkamp, & King, 1971)

WHERE:

$$RN = \left(\frac{D * H}{5280}\right) \quad (4.18)$$

RN Ruggedness Number

D Drainage Density

$D = \Sigma Lu / A$ (4.19)

Lu=Total stream length of all orders

A= Area of the Basin (km^2).

H=the difference between the highest and lowest points in the basin Surface.

It appears from the equation that there is direct proportion higher the density of drainage network and the degree Relief increased degree Ruggedness.

4.8.6.4 Ruggedness Value (RV)

Represents the value of Ruggedness relationship of basin relief ratio intensity discharge and also the higher the rate of Ruggedness and is calculated by the following equation.

Where

$$RV = \left(\frac{D*H}{1000}\right) \quad (4.20)$$

RV Ruggedness Value D Drainage Density

H=the difference between the highest and lowest points in the basin Surface

4.8.6.5 Hypsometric Integral (HI)

It reflects Hypsometric Integral relationship between the intensity discharge and pelvic Relief in terms of intensity discharge and basin area. On the other hand
it indicates the large value Hypsometric Integral offers geomorphological basin in the early stages and to the large area as well. While small value indicates the beginning of the age group of the basin as well as the small size and is calculated by Hypsometric Integral equation as the following (Chorly, 1957)

WHERE:

$$HI = \left(\frac{D*A}{D*H}\right) \quad (4.21)$$

HI Hypsometric Integral D Drainage Density

H=the difference between the highest and lowest points in the basin Surface

4.8.6.6 Geometry Number (GN)

It is a relationship between the drainage density, Relief basin, and the slope of basin and is expressed by the following formula

The higher the number geometry that indicates that it is limited basin slope and the contrary

WHERE: $GN = \left(\frac{D*H}{1000*SL}\right)$ (4.22)

GN Geometry Number D Drainage Density

H=the difference between the highest and lowest points in the basin

SL is the average watershed land slope in percentage

$$SL = 0.86s1^{0.67}$$

Where s1 is the number of first order stream.

4.8.6.7 Slope Rate (SR)

Average slope is a relationship between the horizontal distance to the length of the basin and the vertical distance to the elevation difference between the highest and lowest points in the basin. The greater the slope rate whenever the slow slope is an indication of the length of basin and thus slow stream discharge, the more losses increase and is expressed in the following equation (Schumn1956).

WHERE: $SR = \frac{L}{H}$ (4.23)

SR: Slope Rate L basin length

H=the difference between the highest and lowest points in the basin

4.9 Drainage system:

Drainage network is one of the most important elements that go into building Model hydrology and affects drainage density and the number of streams and other hydrological system efficiency and network morphometric analysis resulted will be mentioned later on.

Leopold Has pointed to that order is directly proportional to the volume the discharge through the following equation

$O \ \& \ Log_e \ Q$ (4.24)

Where:

O : order

Log_e Q: Logarithm of the volume of the discharge

4.9.1 Valleys number

Valleys number reflect indicates indication for the strength of the drainage system where it is, the more promising valleys indicates that the efficiency of drainage network (Khidre) and numbers intervention valleys as a main factor in transactions hydrological drainage systems were calculated numbers valleys through geographic information systems (GIS) and especially networks analysis

4.9.2 Valleys lengths

Valleys Lengths reflect the efficiency of the network valleys discharge. Whenever the valleys are long, the Guidance will take more time to the end of basin, and the losses from evaporation and absorption will be more, also the influence will not be strong into the mouth of the basin.

Through the database GIS, the numbers of the valleys can be calculated.

4.9.3 Bifurcation Ratio

Reflects the transition of normal and natural increase of the stream of the other and is expressed by the following formula (Strahler 1957)

Where: $Rb = Nu/Nu+1$ (4.25)

Nu = Total no. of stream segments of order 'u'

Nu+ I = Number of segments of the next higher order

It should be noted that the lower the rates Bifurcation increased the potential of floods

4.9.4 Draining density (D)

drainage basins have many different characteristics that influence how quickly or slowly the main river within them responds to a period of intense rainfall (Horton 1932)

$D = \Sigma Lu / A$ (4.26)

Where

Lu=Total stream length of all orders

A= Area of the Basin (km2)

4.10 Run-off

It is the intended surface flow amount of water remaining after the absorption of part of it inside the basin and the remaining water daring destined to end of basin

It is calculated from the following equation

½ D km / km 2 (4.27)

WHERE:

D Draining density

4.10.1 Stream Frequency

The frequency rate indicates the strength of the drainage network and the extent of cutting the surface of the basin and the network's ability to carry water Fallen and is calculated from the following equation

$Fs=\Sigma Nu/A$ (4.28)

Where

Nu=Total no. of streams of all orders

A= Area of the Basin (km2)

4.10.2 Drainage Texture (RT)

It shows how density of drainage network cut basin and interferes with the climatic and geological elements and is calculated from the following equation (Horton 1932)

$RT=\Sigma Nu/P$ (4.29)

Where:

Nu=Total no. of streams of all orders

P=Perimeter (km)

Morisawa, 1985 has established a relationship between texture topographic and drainage density as in the following table (4-4)

Table (4-4) relationship between texture topographic and drainage density (Morisawa, 1985)

The section	Drainage Texture	Drainage density k.m/km2	Basin characterize
the first	Roughen	Less than 8 streams / km 2	Porous rocks + good natural plant
the second	Median	From 8 - 20 streams / km 2	Porous rocks + rain falling large + good natural plant
the third	Smooth	20-200 streams / km 2	Non-porous surface + highly falling + limited of natural plant
the fourth	very smooth	More than 200 streams / km 2	Non-porous surface highly falling + Weak rocks and the absence of plant

4.11 Digital image analysis

The digital image processing main purpose in the study is to clarify the role of remote sensing data in research, as the study mentioned data processing in chapter two. The main process is as follows:

4.11.1 Image correction

The correction of images refers to manipulation and distortion in image like geometric correction and radiometric correction.

4.11.2 Image enhancement

The image enhancement techniques mainly aim to clarify the image in order to be more contrasted to human eye or digital analysis of remote sensing. The image enhancement techniques can be defined as improve the visual Interpretability of an image by increasing the apparent distinction between the features in the scene (lillisand 2004)

4.11.3 Image classification

The main objectives of classification are to make a category of features or extract an classes from image according to AOI then the classification is called supervised classification or no AOI classes according to non-index classification then called unsupervised classification as mentioned in chapter two. The supervised classification and unsupervised classification are used in studying. However, the object oriented classification is the main type used in studying according to its accuracy.

4.11.4 Object oriented classification (Sub pixel classification)

Object – based image analysis (OBIA), a technique used to analyze digital imagery, was developed relatively recently compared to traditional pixel-based image analysis (Burnett and Blaschke 2003). While pixel-based image analysis is based on the information in each pixel, object-based image analysis is based on information from a set of similar pixels called objects or image objects. More specifically, image objects are groups of pixels that are similar to one another based on a measure of spectral properties (i.e., color), size, shape, and texture, as well as context from a neighborhood surrounding the pixels

Sub-pixel classification is one object classification that depends on the unit cell if it monitors differences and on the lower classification of the cell, one object forms of his object oriented classification.

Sub-pixel Classifier is an advanced image exploitation tool designed to detect materials that are smaller than an image pixel, using multispectral imagery.

If we are talking about a study of the environmental hazards it exists already, the human behavior may make a greater threat by matching

zone threat, so the crisis closer to human activity whatever industrial, agricultural or Urban and through remote sensing data has been working on the classification of land use and tracking spatial changes over periods of time starting from 1972 until 2013 based on data object Landsat satellite whatever sensors (MSS-TM-ETM+). Work was based on the following steps: The classification system works this to reach 20% of the area of the cell that are working them and achieve high accuracy results in classification Consider the number that appears in the left the area of land covered by the Instantaneous field of view (IFOV) Sensors in

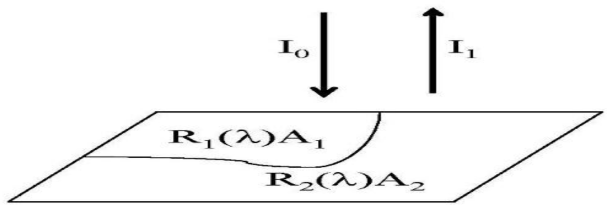


Figure (4-16) Sub pixel analyses pixel method

The time the picture was gained to capture frame sensors. This region can be considered Covered by one pixel. For simplicity, we consider that the area of land covered by the Pixel consists of two materials, one being relevant materials or other background material can be a combination of several separate materials, but a combination is considered one material (Erdas 2013) The MOI has reflectance R1 (λ) and covers area A1. The background figure (4-16)

Material (mixture) has reflectance R2 (λ) and covers area A2 such that A1+ A2 = A, the total area of the pixel. The incident irradiance on the Pixel is I0 (λ) and the upwelling radiance reflected by the pixel is I1 (λ). The pixel radiance is a mixture of the radiance due to the two materials,

$$I_1(\lambda) = I_0(\lambda)\left(\frac{R_1(\lambda)A_1 + R_2(\lambda)A_2}{A}\right) \qquad (4.30)$$

And radiance curing in the pixel as

$$I1(\lambda) = k(I0(\lambda)R1(\lambda)) + (1-k)(I0(\lambda)R2(\lambda)) \qquad (4.31)$$

Where

K, such that A1=kA, the radiance becomes

And atmospheric correction manipulated as the following equation shows:

$$P(\lambda) = k \times S(\lambda) + (1-k) \times B(\lambda) \qquad (4.32)$$

Where

S (λ) =R1 (λ) is the MOI signature B(λ)=R2(λ) is the background spectrum.

Also curing the environmental correction errors resulted from radiation scatting processes as well as improved sensor compensate as per the following equation

$$\mathbf{P}'(n) = (P(n) - ACF(n))\ SCF(n) \quad (4.33)$$

During classification, the software computes a set of residuals from each of the background

Spectra (general backgrounds and local neighbors) and various fractions using the following formula:

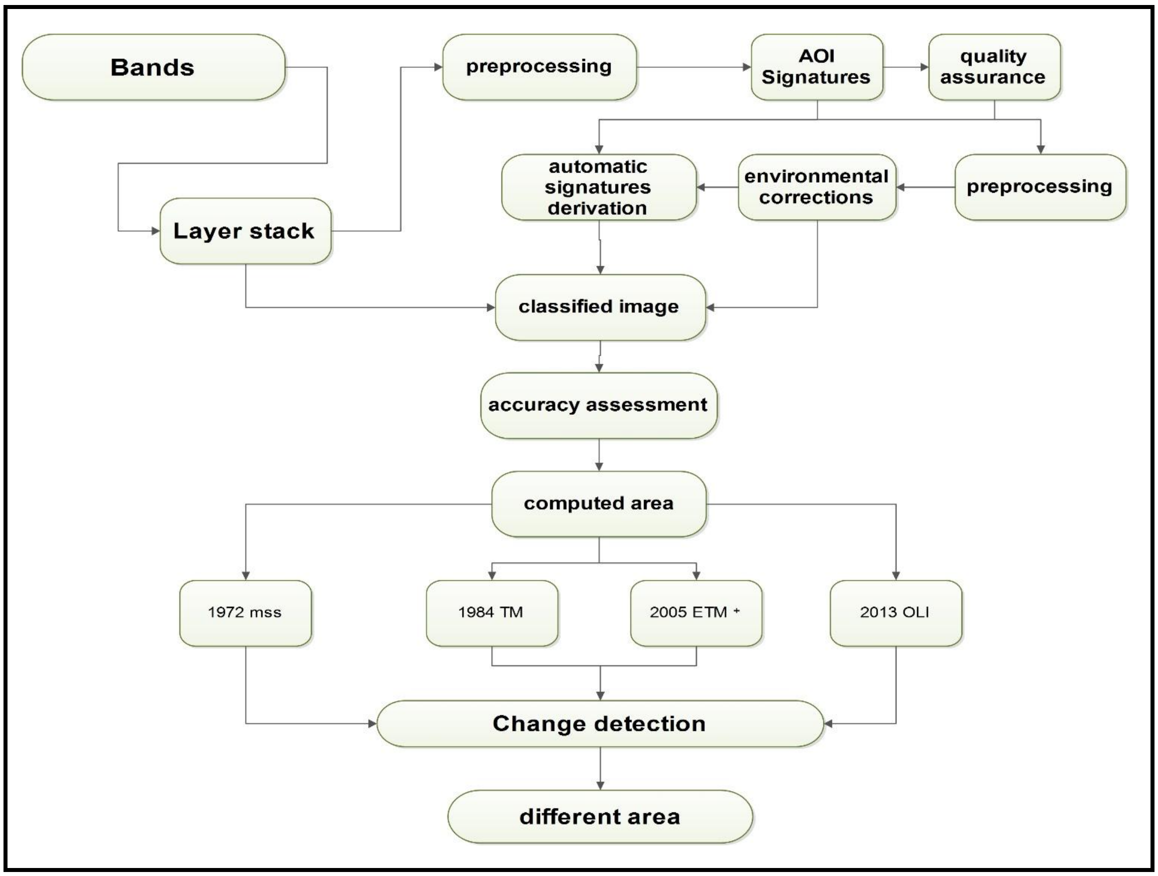


Figure (4-17) change detection with Sub pixel flow chart (Ahmed.O 2013)

$$P\ (n)\ k\ R\ (n)\ (k)\ B\ (n) \quad (4.34)$$

$$\mathbf{p(n)} = \left(\frac{\mathbf{P}'(\mathbf{n}) - (1 - \mathbf{k})\mathbf{B}(\mathbf{n})}{k}\right) \quad (4.35)$$

The correct residual should be very similar to the signature spectrum S (λ). The process is thus, one of finding the background spectrum and fraction that produce the residual that is closest to the signature spectrum (erdas 2013)

In this module to detect changes, observation, and land use changes over approximately 40 years ago the model used accuracy assessment to evaluate classified image depend on GPS points in field and compare them with classes in classified image to make a test for accuracy of work.

Using ground work reveals the extent of land use change, especially in front of the places the risk on the back edges of the study area figure (4-17).

4.12 Weighted sum

the weighted tool provides the ability to integrate, overlay or combine multi input to detect the similar character between them by the using weighted sum. That represent the overlapping between hydrological models the were referred to above and another analysis such as slope ,aspect, elevations, in addition to some elementes alone in hydrological model flow direction, watershed and others figure(4-18).

4.12.1 Weighted overlay

This model introduces all the above-mentioned elements showing the impact of each one on the degrees of dangers to show us how the value and weight of each of these elements influences the level or rate of seriousness. The weighted overlay tool enables making an intersection for each of the elements entered into the Model to show the dangerous areas and the most dangerous areas in the levels of risk. The use of ESRI package in the completion of this work and all elements that may affect risk are put in following chart figure (4-19).

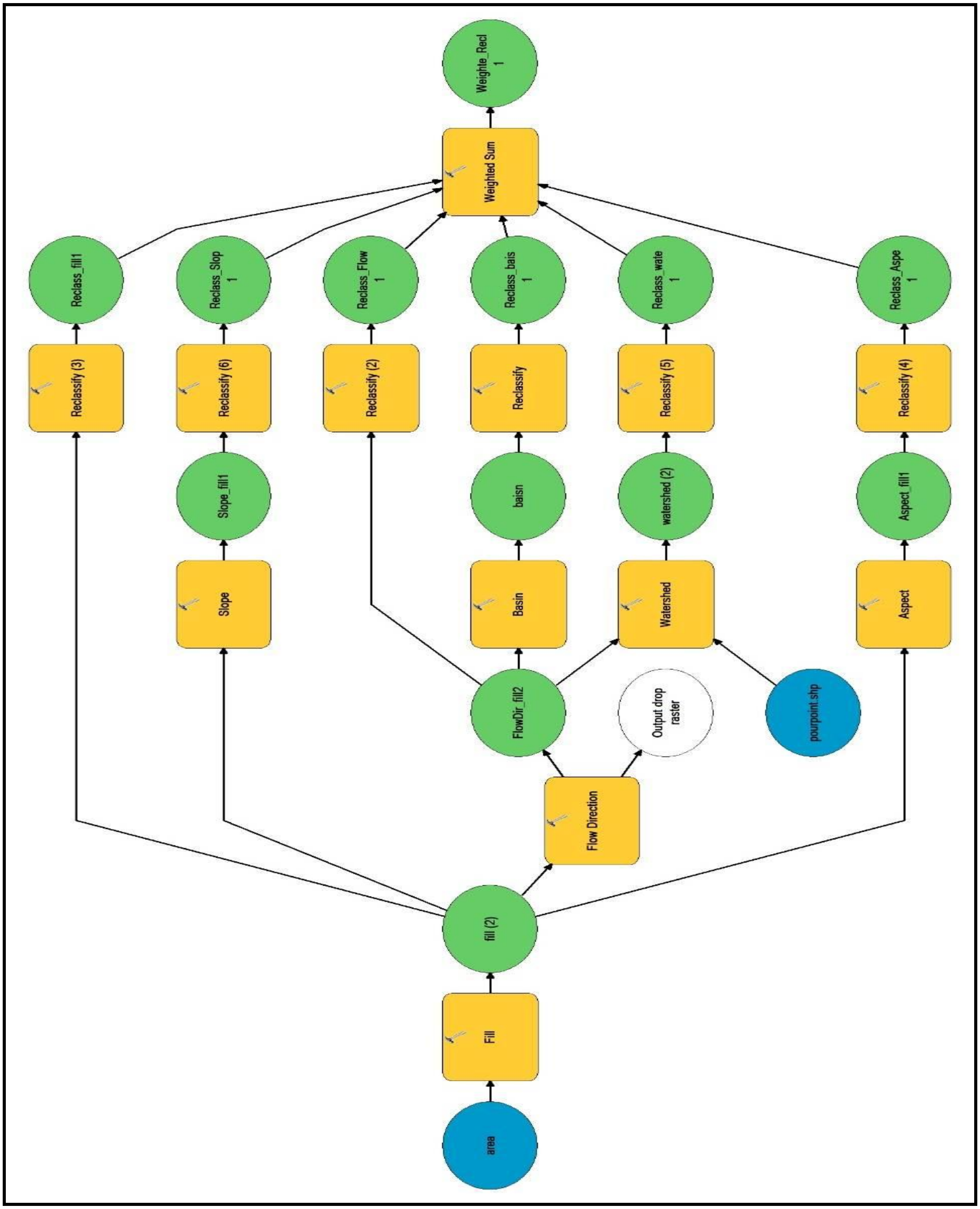


Figure (4-18) weighted sum model

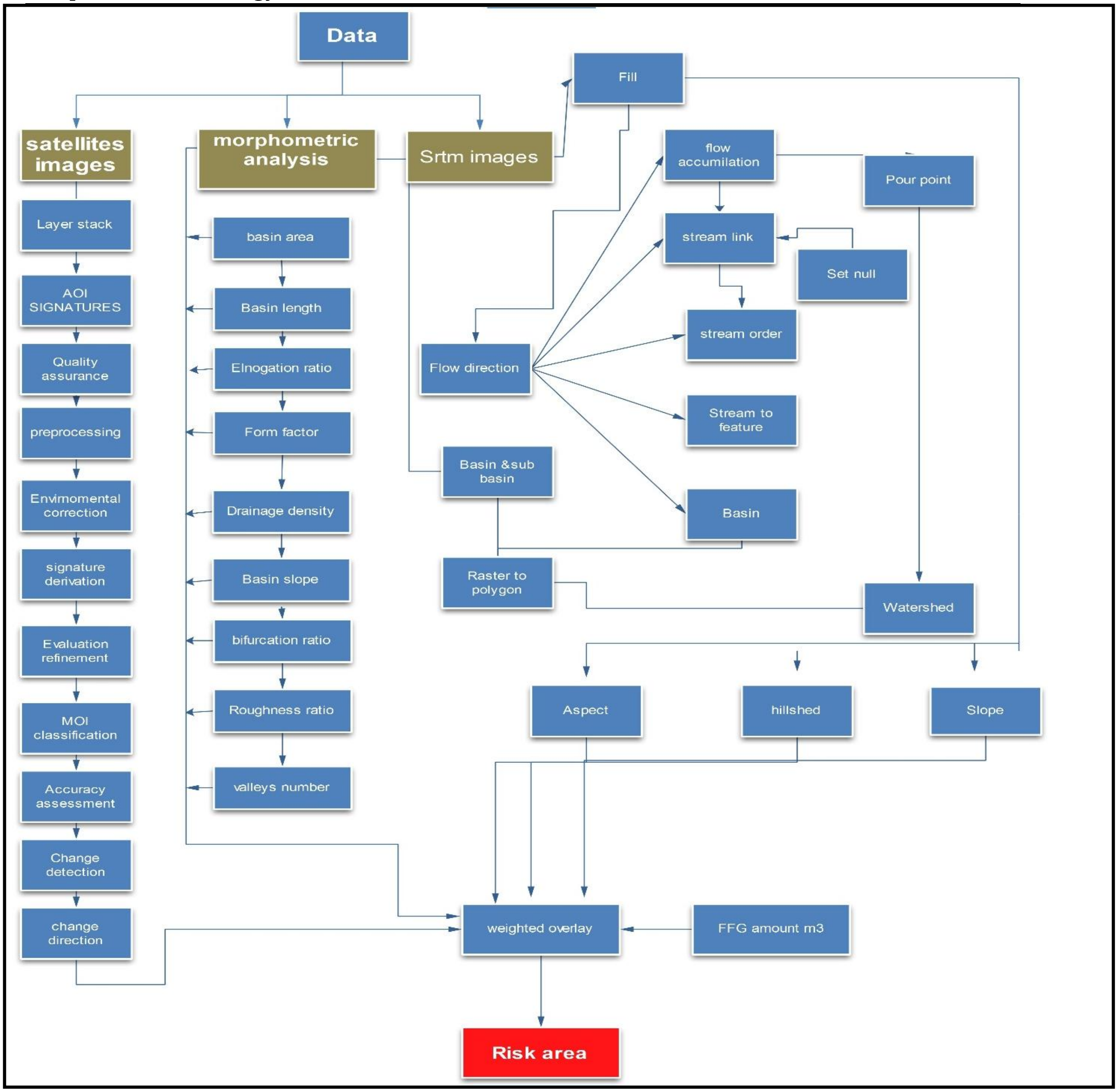


Figure (4-19) Model of risk area

Chapter Five

5.1 Background

This chapter presents the results of the study; as well as, discussion of these results based on the data that is used and the methods of analysis which have been studied. The results is divided to three main parts figure (5-1). The first part covers the morphometric characteristics of drainage basins and description of drainage basins. The second part is the estimation of flash flood guidance F.F.G depending on perception data and morphometric analysis. The third part is digital image analysis, classification to detect change detection analysis.

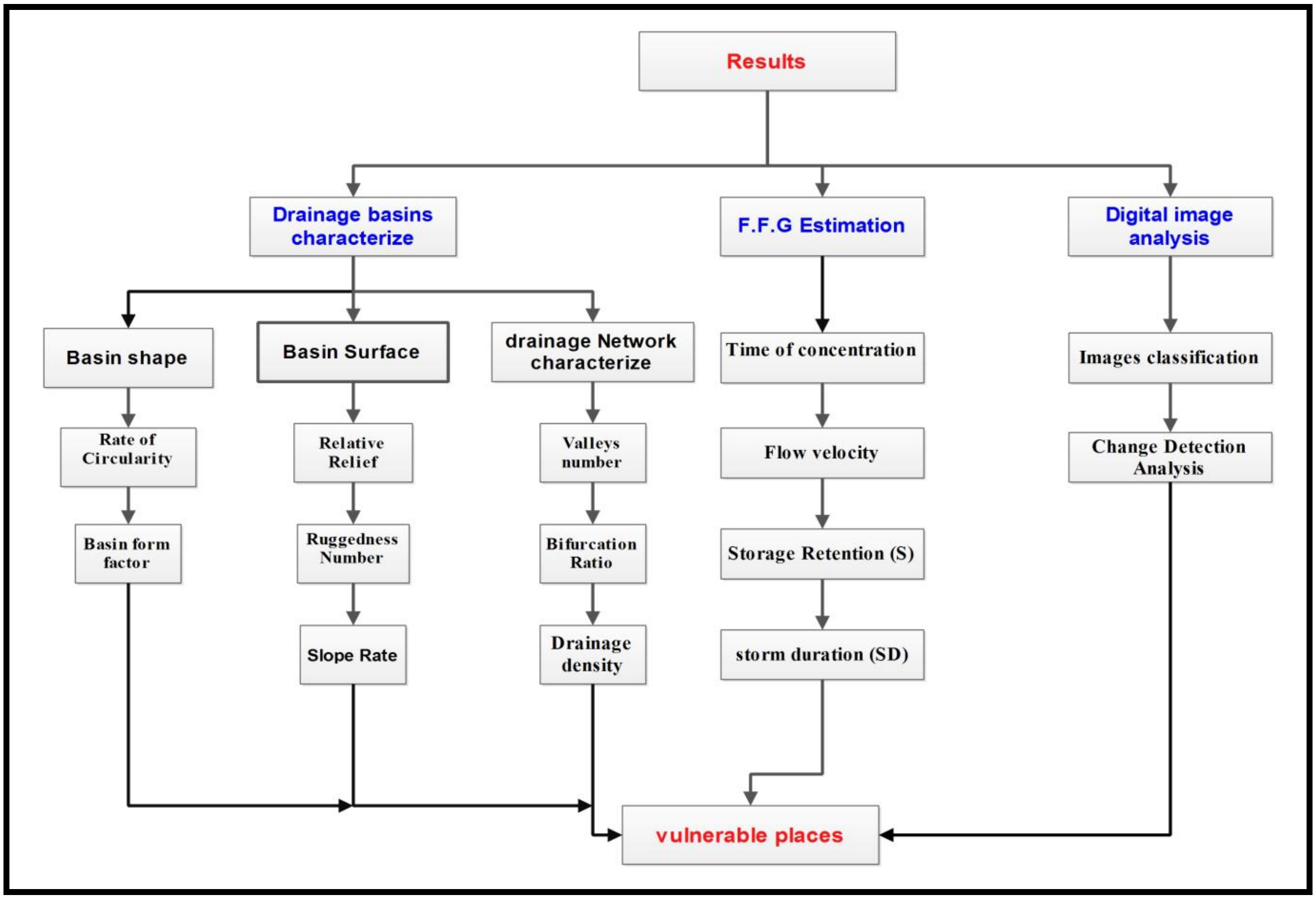


Figure (5-1) Methodology Diagram

5.2 Characteristics of drainage basins

The characteristics of drainage basins reflect the description of the environment or the area that we are going to talk about. The shape directly influences these characteristics to the extent that the influence of the contribution of these elements has an impact on the risk.

It has also been noted that the drainage basins in the study area are divided into two major basins:

- The first extends from the north to the south as represented in Qena Valley basin.
- The second is from the south to the north as represented in Wadi Matulla basin.

The secondary drainage basins under these two drainage systems are 81 basins, ranging from the large area to reach 6339 km2 in the north and among a very small sub-basins do not exceed 50 km2.

As previously mentioned, the area influences drainage system in terms of the flow velocity and wastage etc.

5.2.1 Basin shape

5.2.1.1 Rate of Circularity

The Rate of Circularity of the basin is gotten when the value of the rate of circularity is equivalent to one whereas this value of the rate of circularity is closer to zero the basin will be closer the elongation. The small area basins are often more inclined to rotate because they did not reach the advanced geomorphological stage yet while the larger area basins tend to elongate. This means that these basins reach the advanced geomorphological stage. The Rate of Circularity ranges from 0.0134 to 0.134 as shown in the following figure (5-2)

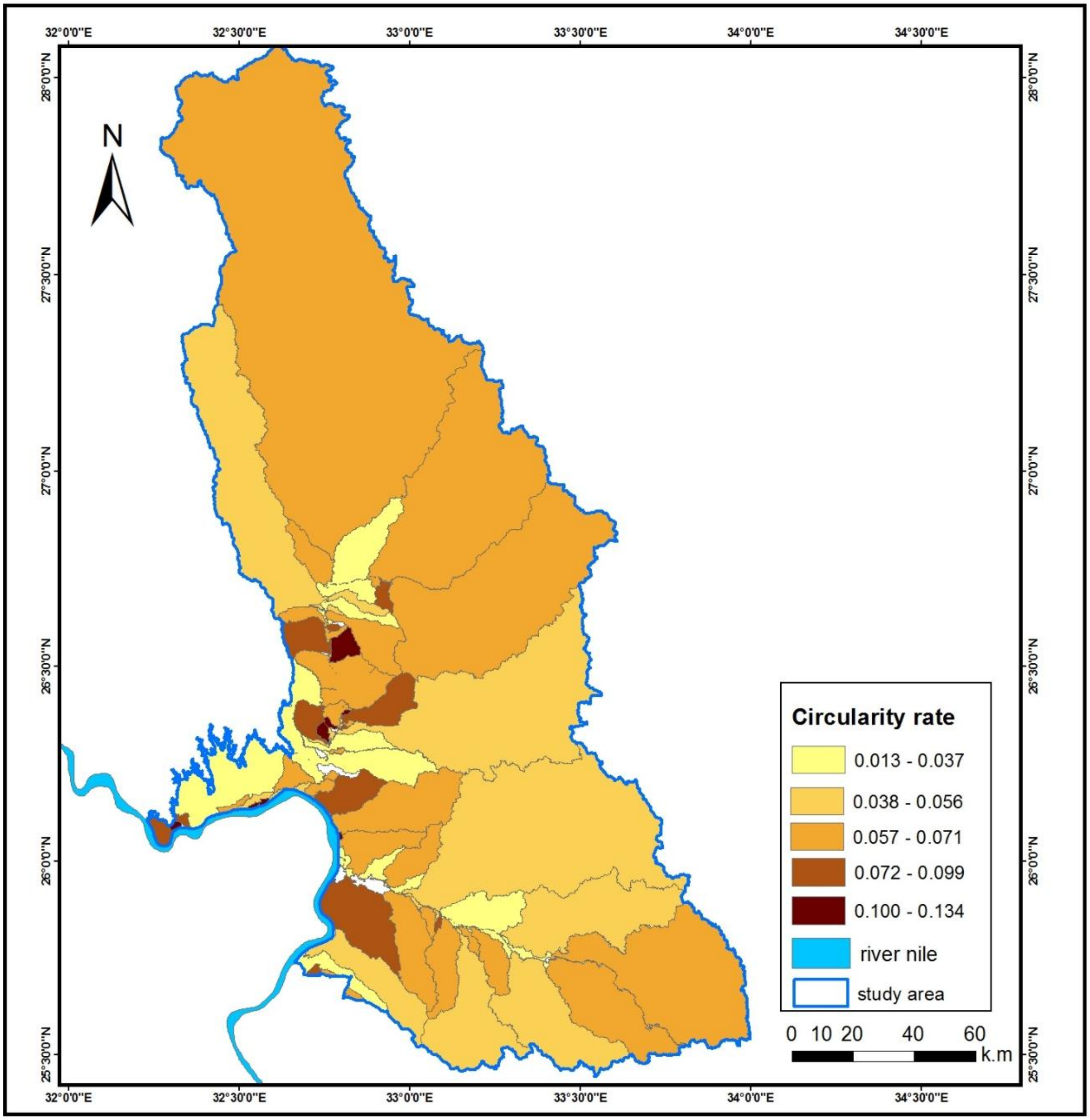


Figure (5-2) Rate of Circularity of study area

5.2.2 Basin form factor

Basin form factor expresses the consistency among the various elements of the shape of the basin. The low values of the Basin Form Factor indicate the decline of the basin of this parameter on the relative decline in the extension of this Relationship for a substitute, and then increasing the length of one end of this Parameter and allowed the basin of the shape of a triangle. If the value of basin Area for the value of the square of its length, the shape of the basin in this case approaches the shape of the square.

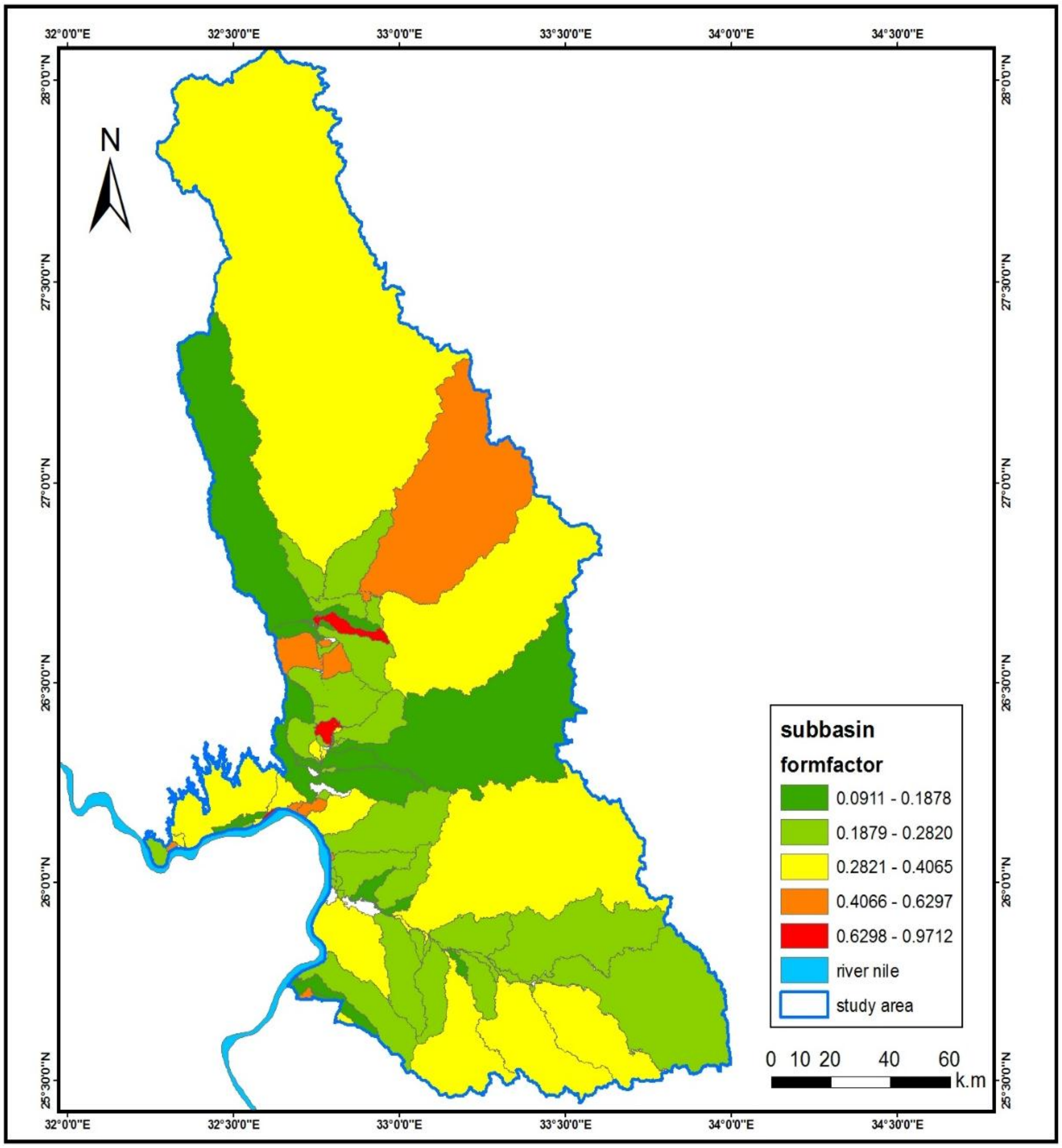


Figure (5-3) basin form factor

The values of the basin Form Factor range in the study area from .09 to .9 as the above-mentioned figure(5-3) indicates.

5.2.3 Basin surface

Many factors describe the surface of the basin and highlights the implications of such transactions on the study area and how the contribution of these factors is dangerous in the study area. The details of these factors emphasized at the below sections.

5.2.3.1 Relative Relief

Relative Relief represents the interrelationship between the different elevations in the basin and their relationship to the basin area. When the difference in the Elevation is great and the area of the basin is small, the Relative Relief will be high. The Relative Relief degree ranges from 1.4- to 265 degrees as in the following figure (5-4)

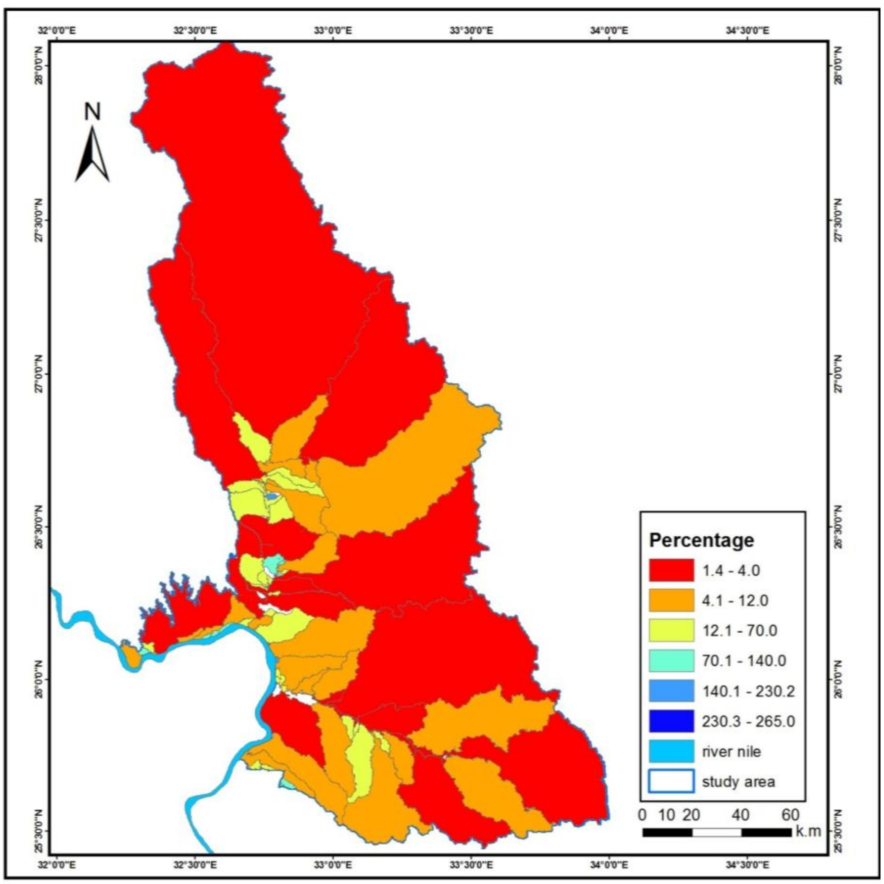


Figure (5-4) relative relief of study area

5.2.3.1 Ruggedness Number

degree of rugged Number increases when there is an increase in drainage density in basin on the hand. On the other hand it decreases when there is decreasing values in drainage density in the basin.

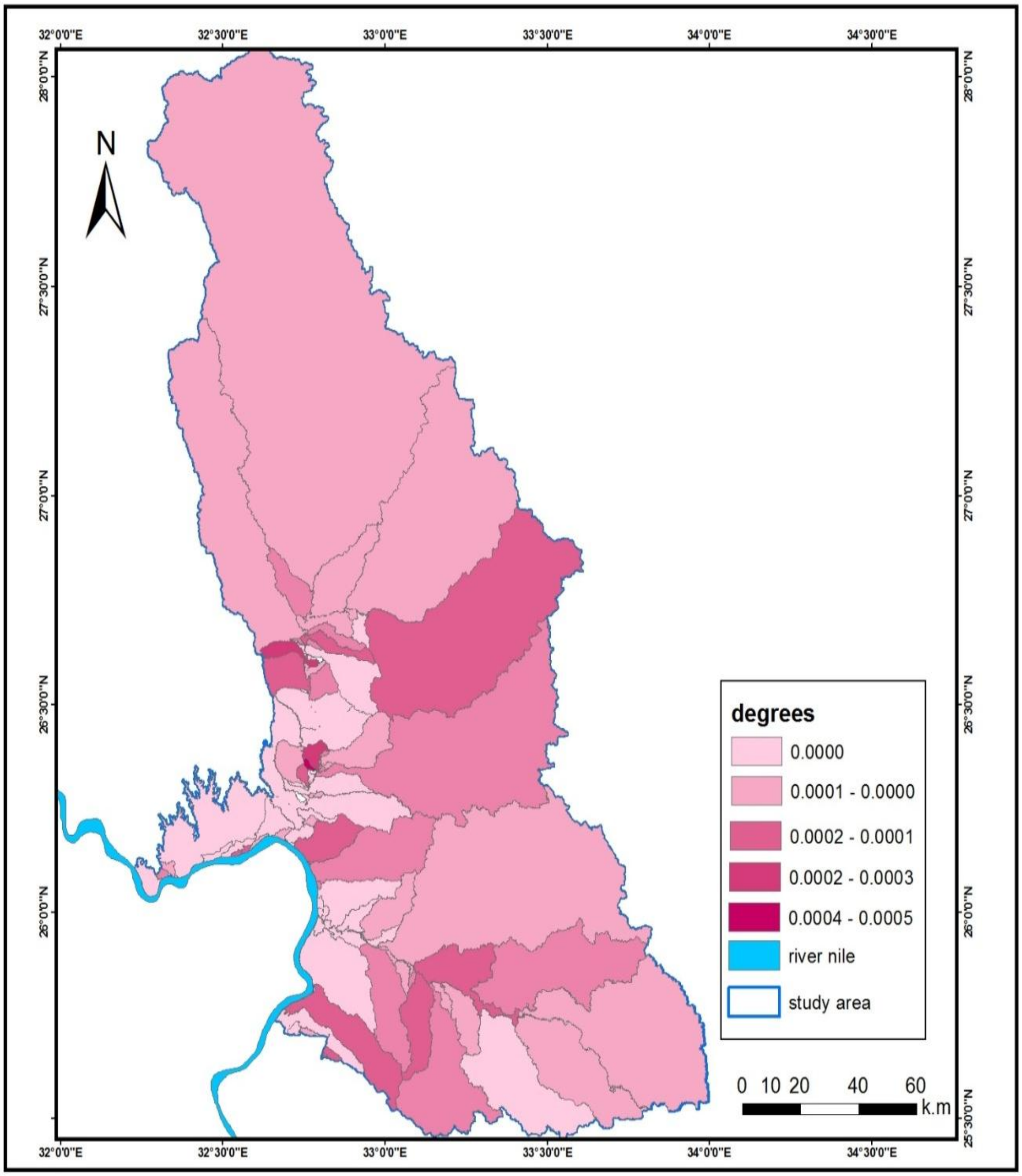


Figure (5-5) roughness number of study area

This factor measures the relationship between the rugged surface of the earth in the basin and the lengths of streams network drainage. When the degree of rugged number is high, the efficiency of drainage network in the speed of the transfer of water to the mouths of the valleys will be high. This is indicated in relatively small leakage losses. This leakage loss increases when the basin surface is flat.

Ruggedness degree range between 0 and 0.0005 as shown in Figure (5-5)

5.2.3.2 Hypsometric Integral

This parameter indicates the relationship between the basin area and the terrain basin (the difference between the lowest and highest points in the basin). It also refers to the group phase, which passes by the water basin as well as the amount of material carved out of the basin.

When the value of the hypsometric integral is high, the area of the basin is small and the Roughness values are high, and this indicates that the basin is somehow an old one. While the value of Hypsometric integration is low, the basin is a recent one and its area is small.

When the value of hypsometric integration is low in the basin, the flood will be more serious because the water of the flood will take less time to reach the mouths of basins since the roughness in the basin will be high. On the other hand, the opposite occurs in the case of high values of integration. The values range from .02 to 4.56 as in the form of (5-6)

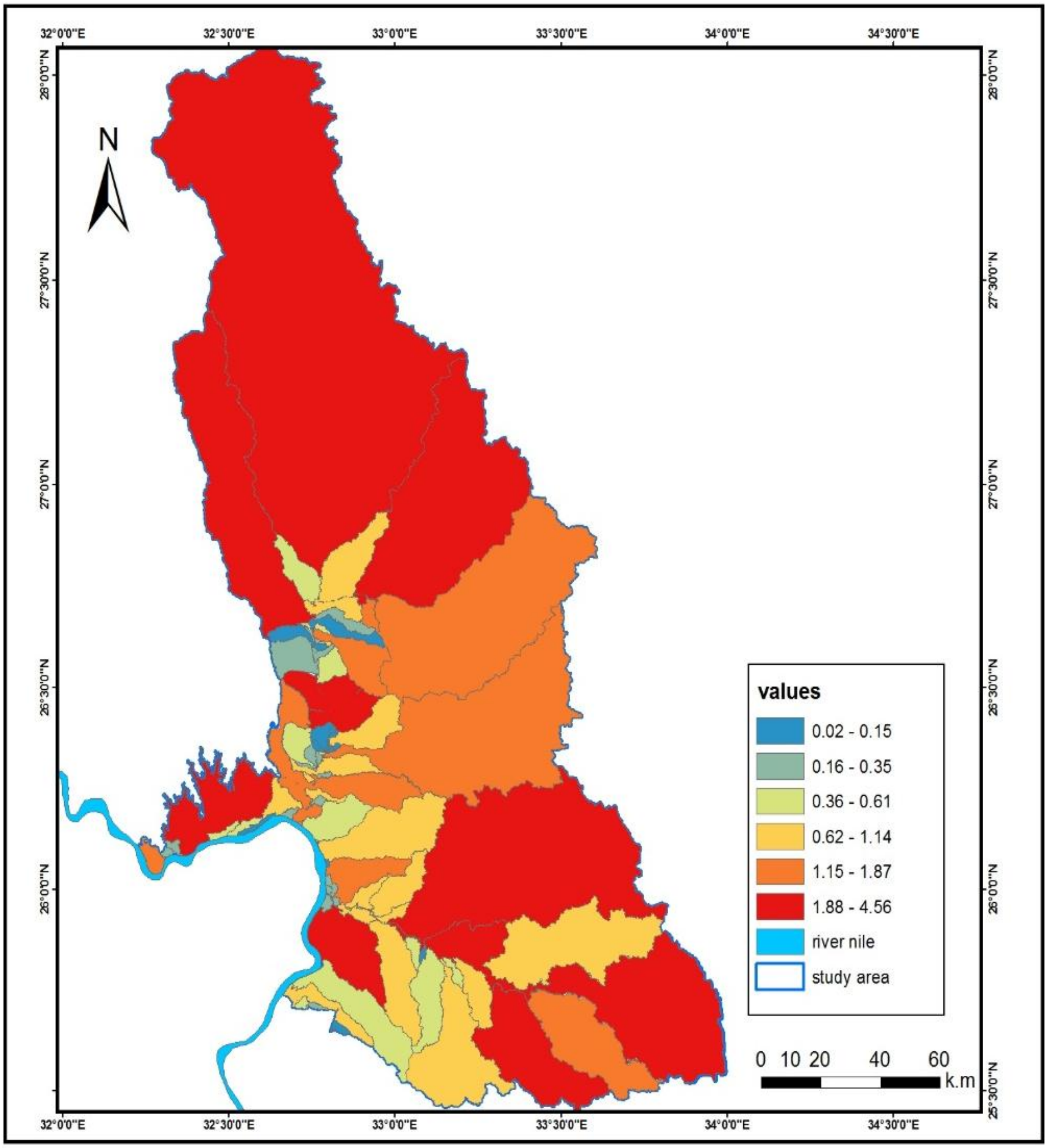


Figure (5-6) hypsometric integral

5.2.3.3 Slope Rate

The Slope Rate indicates the rate of decline in the interrelationship between the vertical difference of the levels of basin to the horizontal distance of the length of the Basin. Whenever the output is higher value, this indicates that a slow slope due to the increased length of basin,

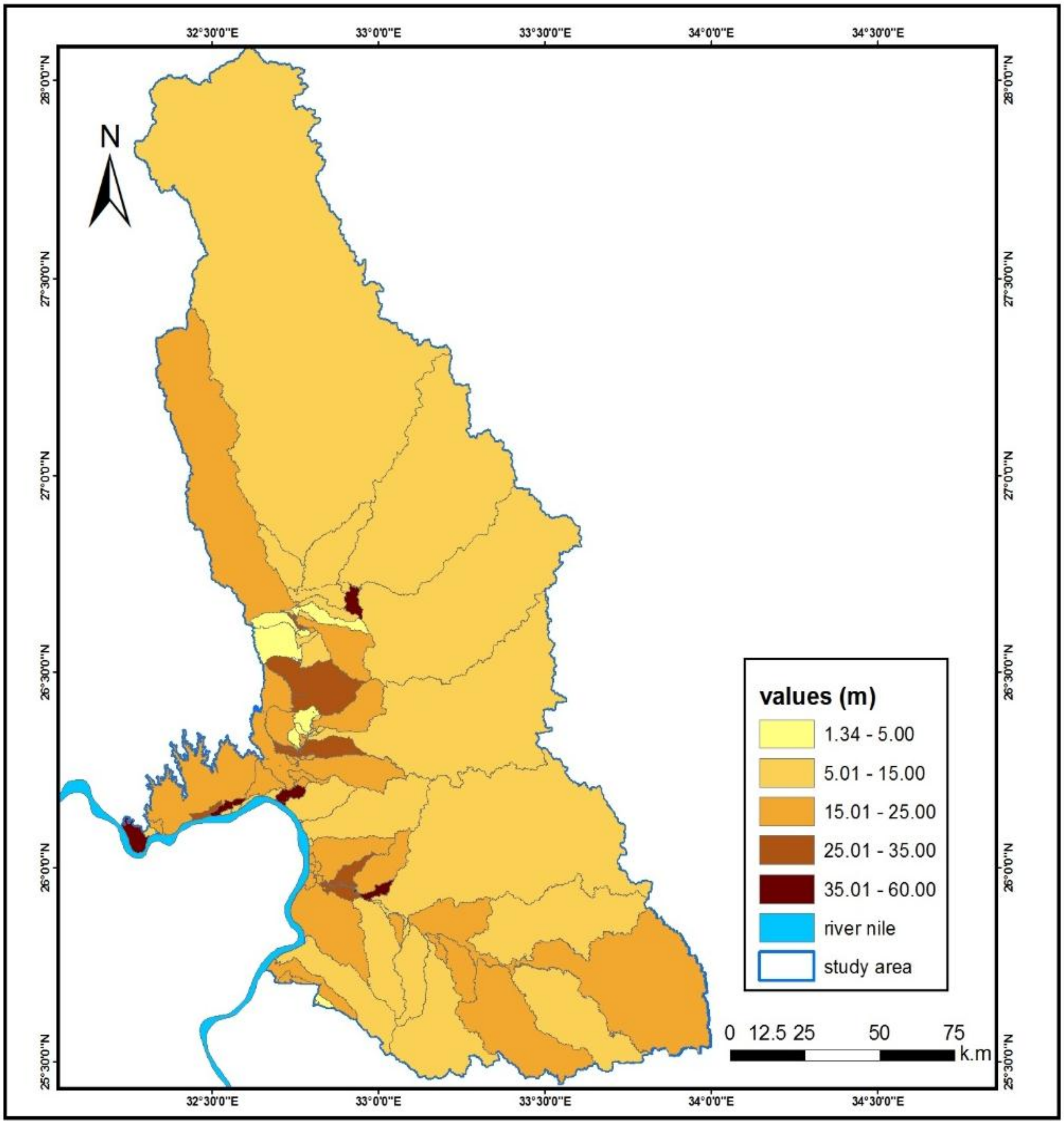


Figure (5-7) basin slope rate

and vice versa. It is recognized that the increasing slope leads to increase the flow velocity and bring the water to the mouth of the basin in a short period of time as well as the lack of evaporation and absorption losses. slope rates ranging from 1.3 to 60 as shown in Figure (5-7)

5.3 Drainage network characteristics

The drainage network characteristics is the element which mainly indicate the topography of study area and description of physical hydrology of network. The drainage network characteristics depend on some factors to describe it as follows.

5.3.1 Valleys number

Basin, which includes a large number of valleys, tends to have high efficiency in the process of transferring the production and vice versa. This means that general discharge in dry areas increases the number of valleys in the first order, because the Guidance resulting from the rain will mechanically remove the eroded solids in periods of drought. This results in high efficiency in the transfer of water falling from the adjacent surfaces to dry valleys, which helps to speed the transfer of runoff and impairment losses.

The numbers of the valleys in the largest basin can reach 35 thousand streams but they do not exceed 100 streams in the smallest basin as shown in figure (5-8)

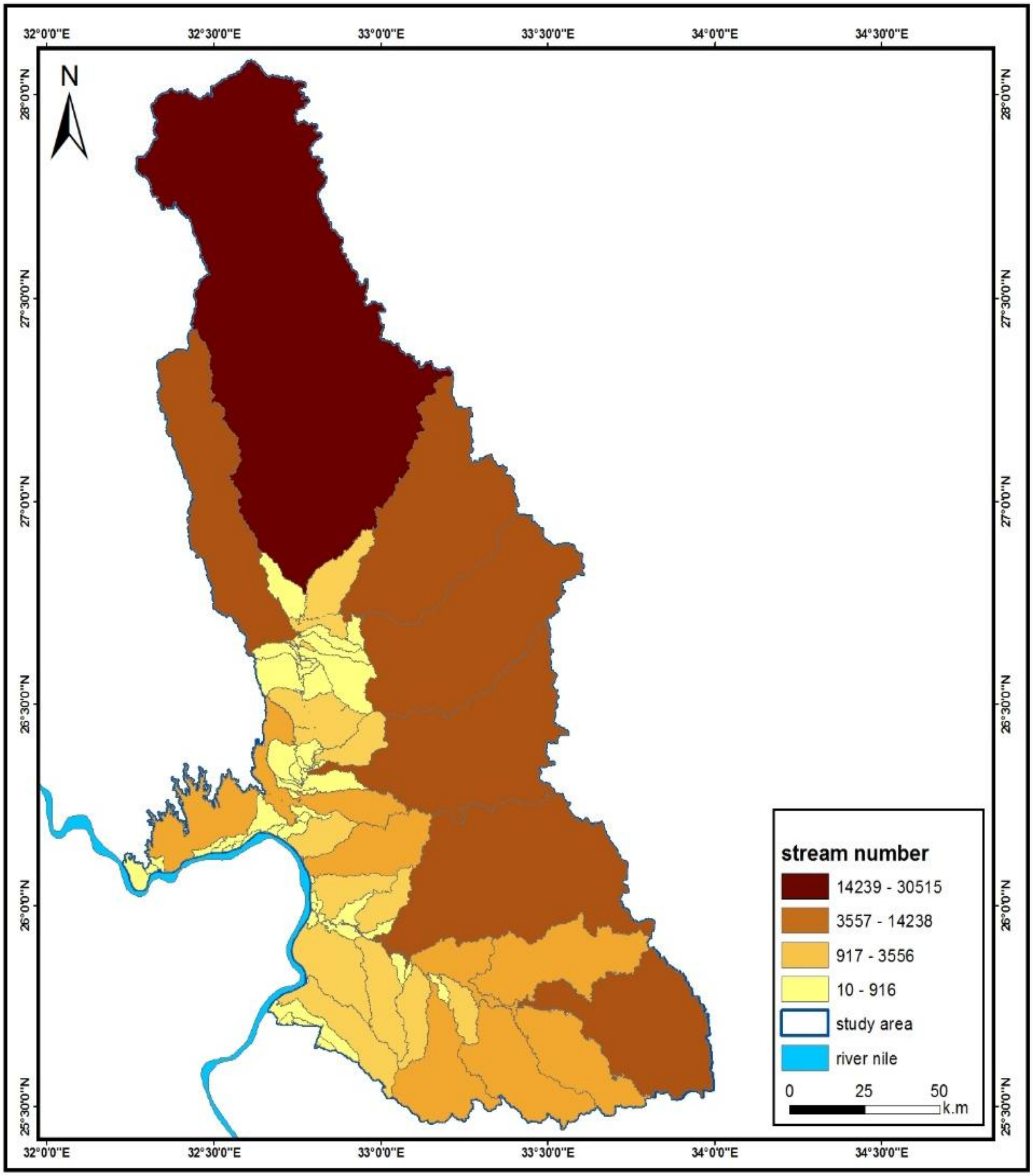


Figure (5-8) streams numbers

5.32. Bifurcation Ratio

The significance of the Bifurcation ratio in the study confirms the relationship between the engineering ranks and number of valleys. It also predicts the time period necessary for the occurrence of a flood summit in drainage basins.

The proportion of the Bifurcation ranges from 0.65 to 10 as shown in Figure (5-9)

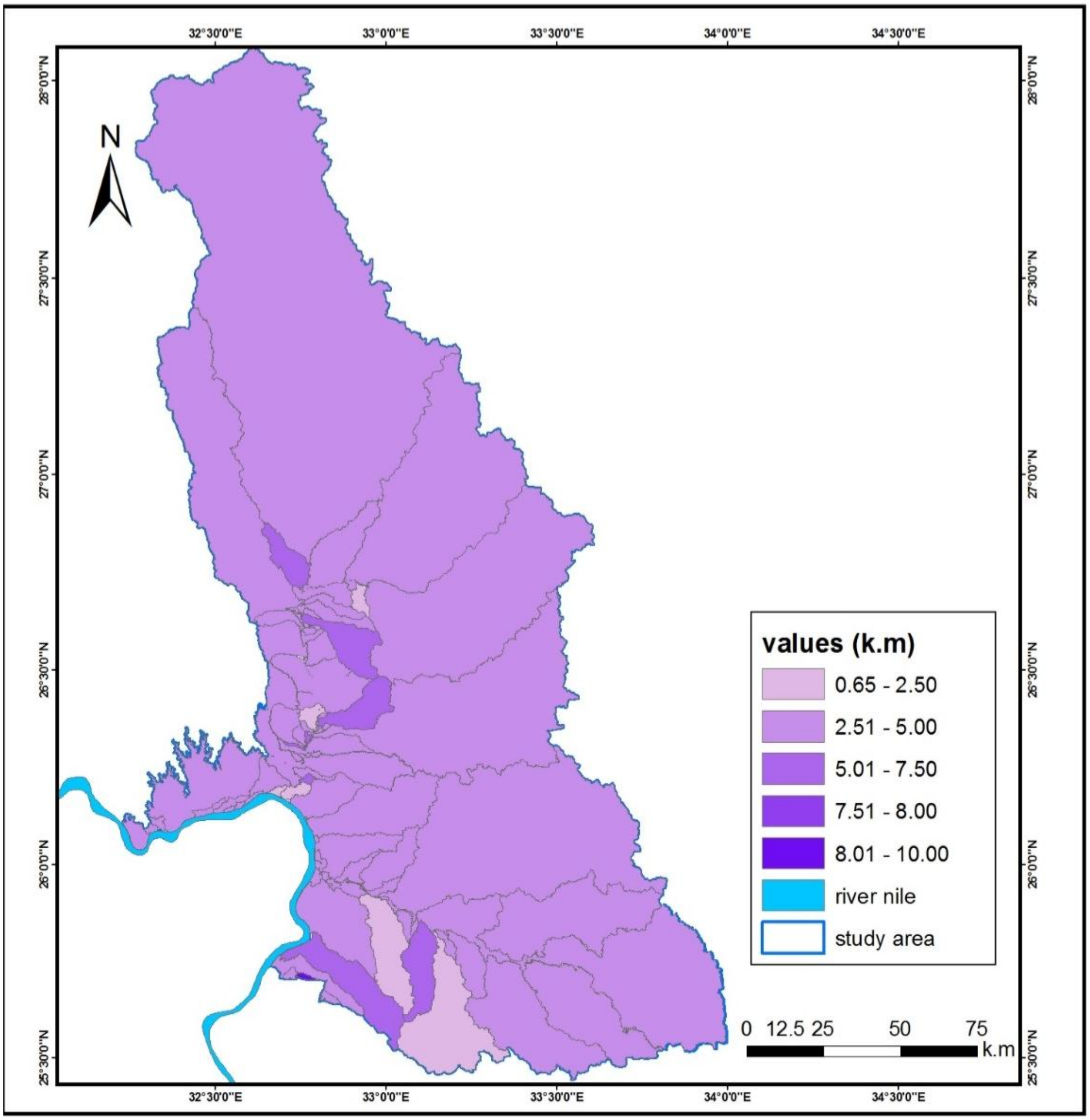


Figure (5-9) Bifurcation Ratio

5.3.3 Drainage density

The drainage density determines the time during which water in the Valley is transmitted. The time required for the flow of water for a distance – in the case of all other factors held constant - is directly proportional to the length of Valley.

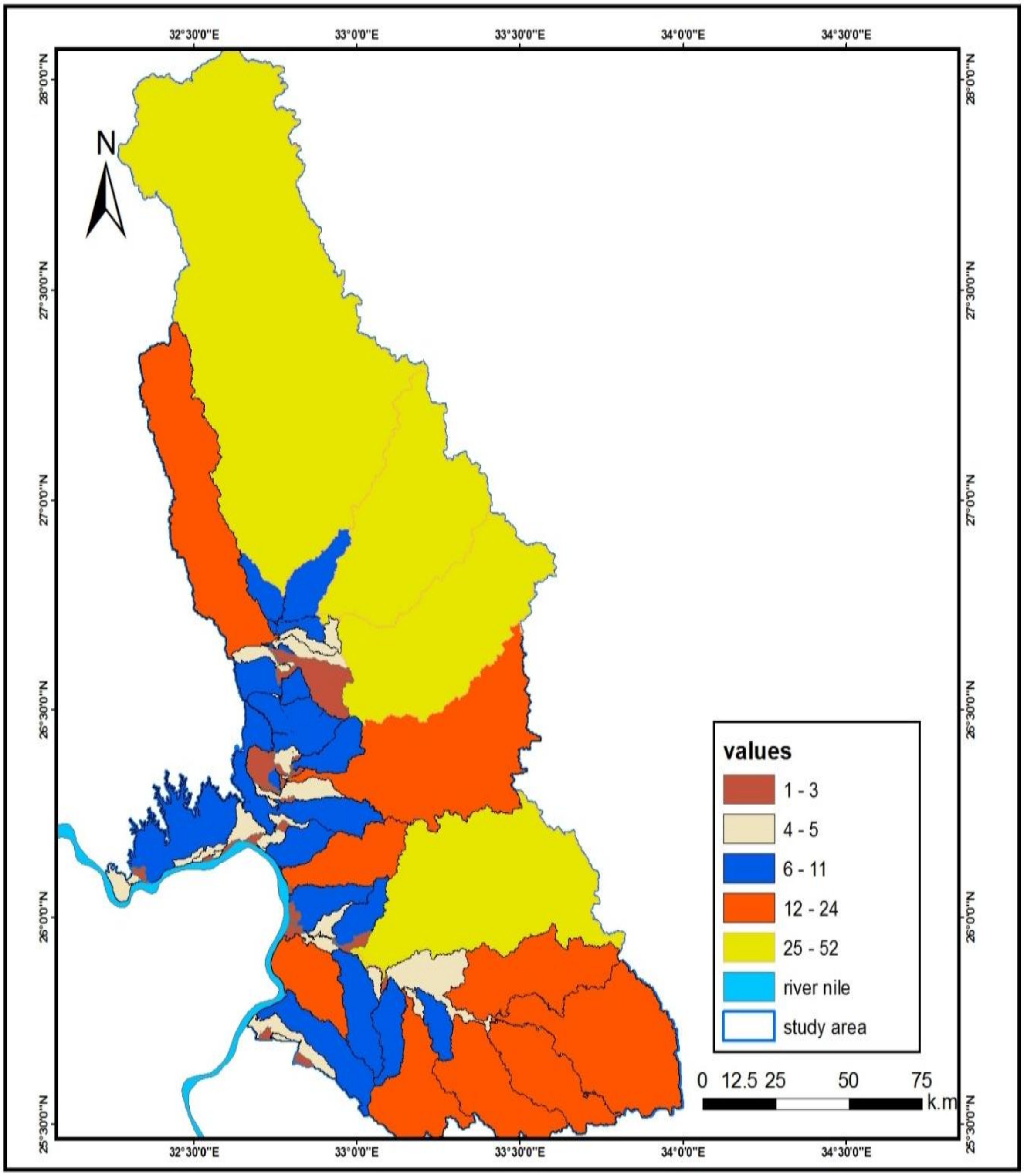


Figure (5-10) drainage density of study area

Generally, when the low values of the discharge density in the basin, the permeability surface configurations will be high, the area will be flat, and the vegetation cover will be dense. The proportion of density drainage ranges from 1 to 52 as in figure (5-10)

5.4 Estimate of flood quantities

The amount of Guidance runoff was calculated according to the NRCS method (National Resource Conservation Soil) for December 2010 flash flood .depending on the morphometric characteristics of the above-mentioned morphometric.

5.4.1 Time of concentration

One critical parameter in this model is the time of concentration which is the time it takes for runoff to travel from the most hydraulically distant point in the watershed to a point of interest. Usually the taken period is equal to the rainfall duration. It uses the largest technical cooperation. Therefore, distributions of rain was designed to contain the intensity of any rainfall duration event frequency that has been chosen. ((NRCS method).

The time of concentration values range in the study area from 0.08 to 2.21 hours as in the figure of (5-11)

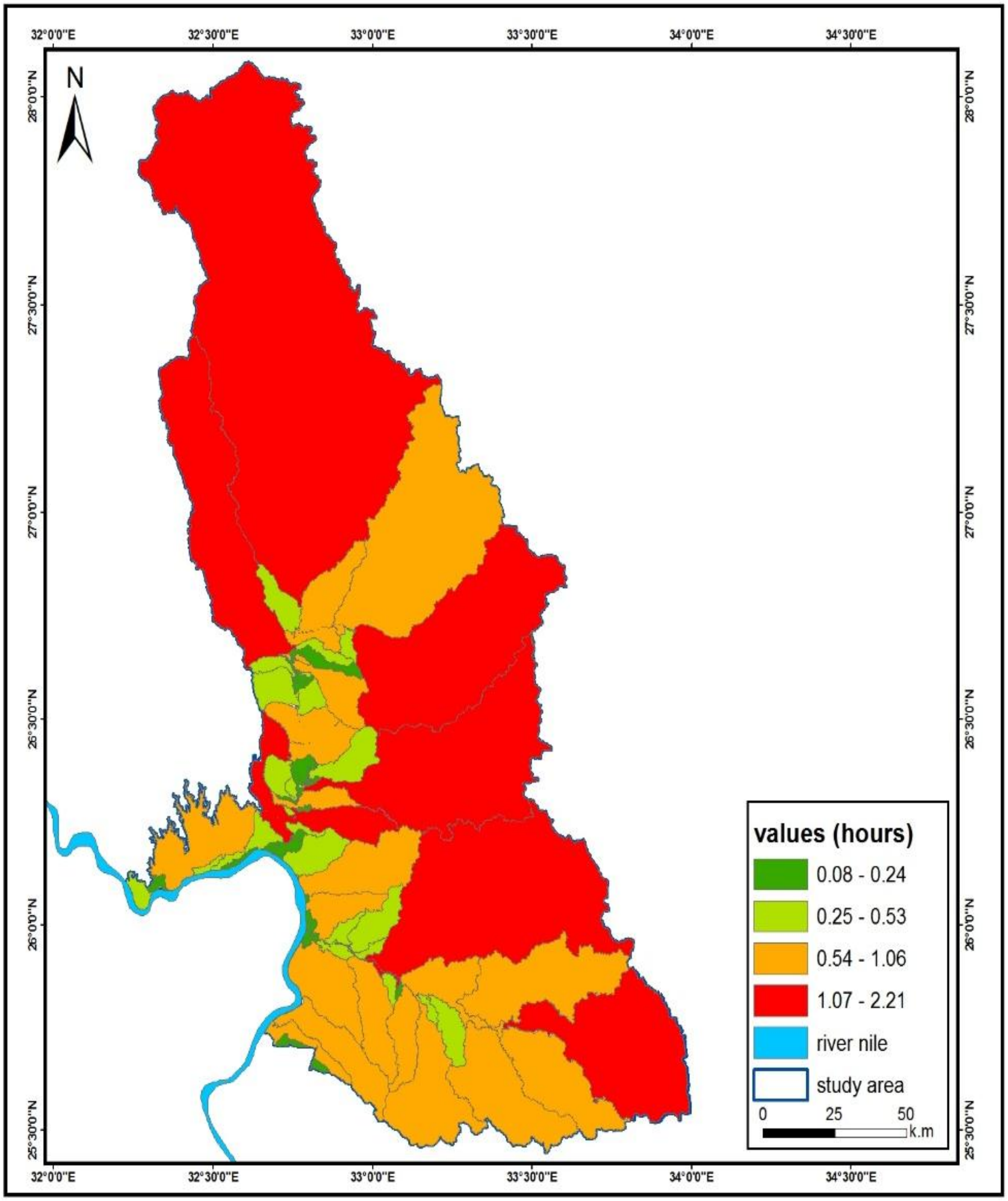


Figure (5-11) time of concentration

5.4.2 Flow velocity

Flow Velocity affects the spate and the seriousness of the flow. This important factor is calculated from the arrival time of the falling rain to the mouth of the basin. The value of the flow velocity ranges in the study area from 0.08 to 2.21 m / s, as in Figure (5-12)

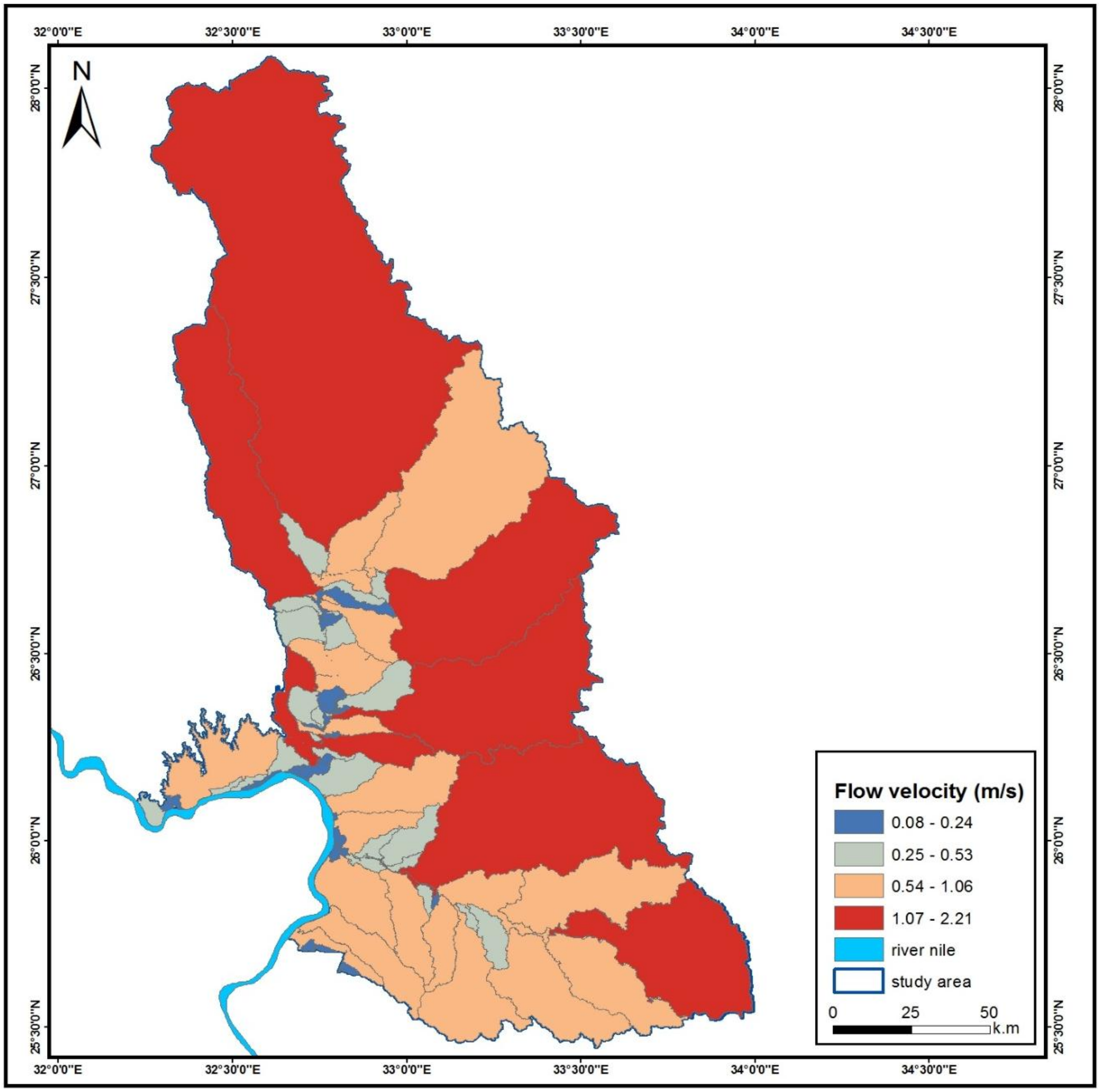


Figure (5-12) flow velocity of study area

5.4.3 Storage Retention (S)

The maximum Storage retention is an influential factor in spate runoff because the degree of soil's retention of the water is associated with the extent of absorption rate of the soil and the level of the ground water. This may lead to the increase of losses. The values of this factor in the study area range between 0 to 162 mm as it appears in figure (5-13)

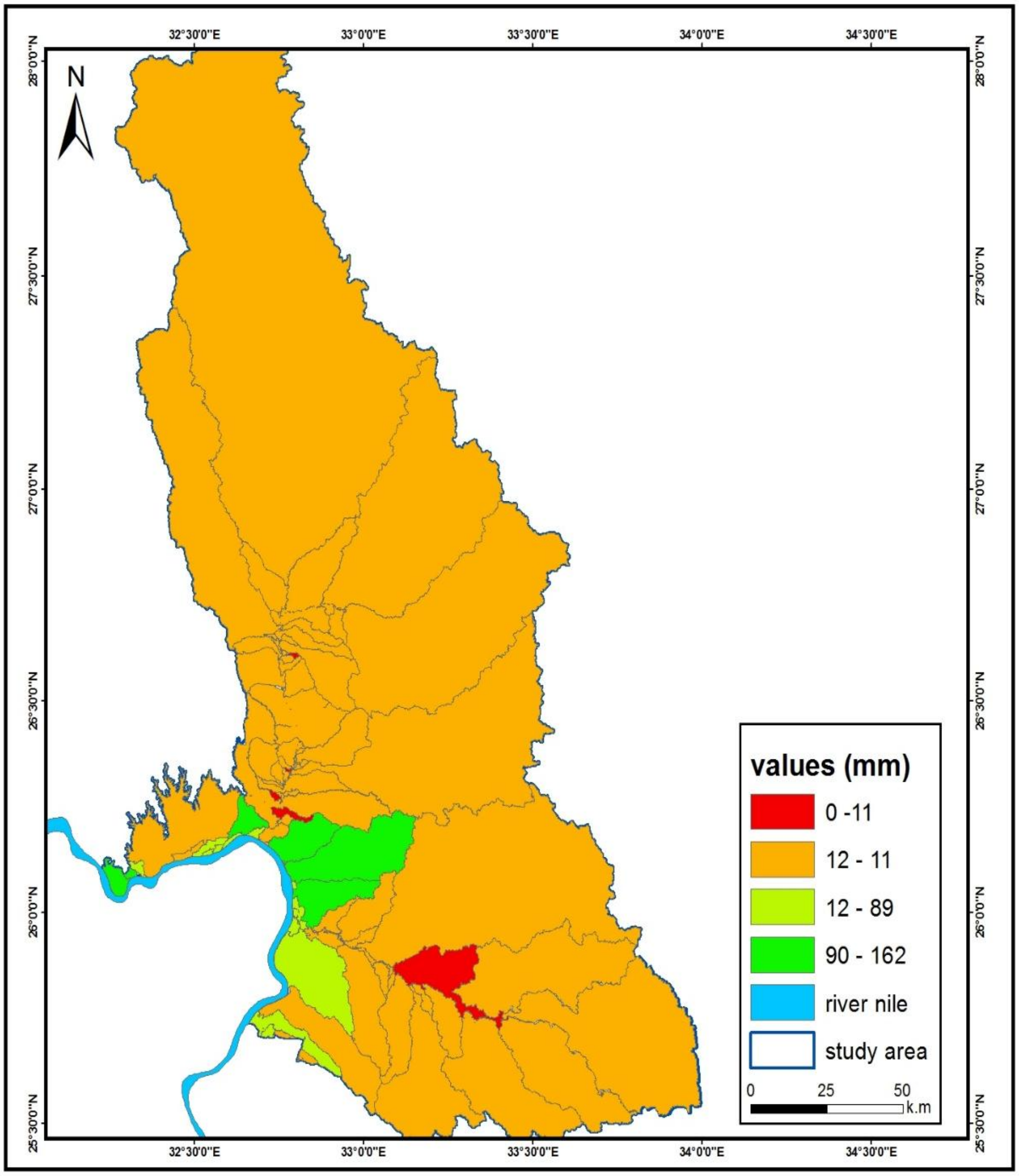


Figure (5-13) Storage Retention

5.4.4 Storm duration (SD)

The storm duration factor is the most important factor in spate flow equation and it is based on the time and duration of rainfall. The values in the study area range from 0.01 to 0.29 hours as in Figure (5-14)

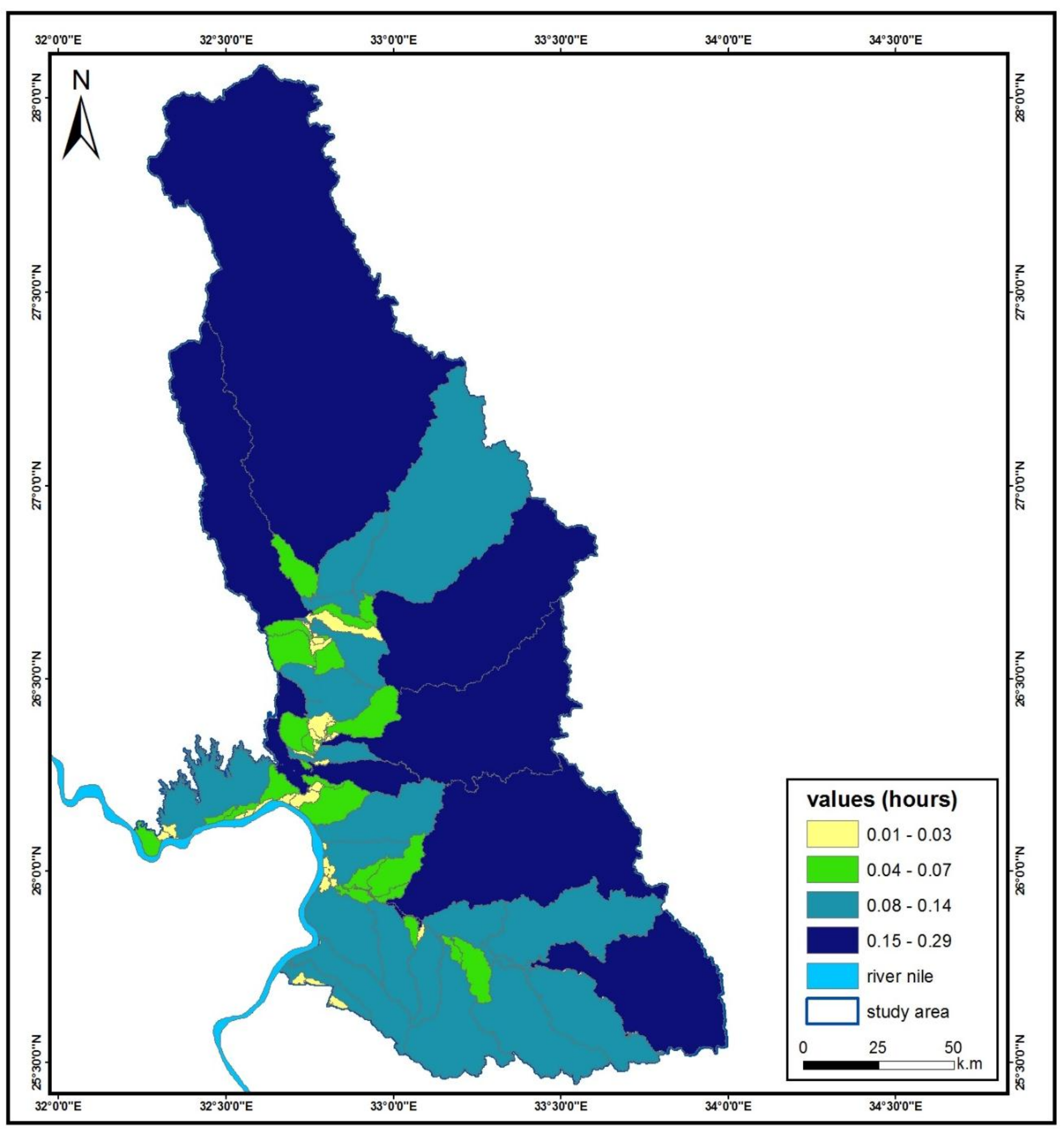


Figure (5-14) storm duration

5.4.5 Flash flood volumes

The previous elements that have been illustrated and mentioned in other studies make it possible to calculate the runoff volume of the flood in the study area in cubic meters, as in the following figure (5-15).

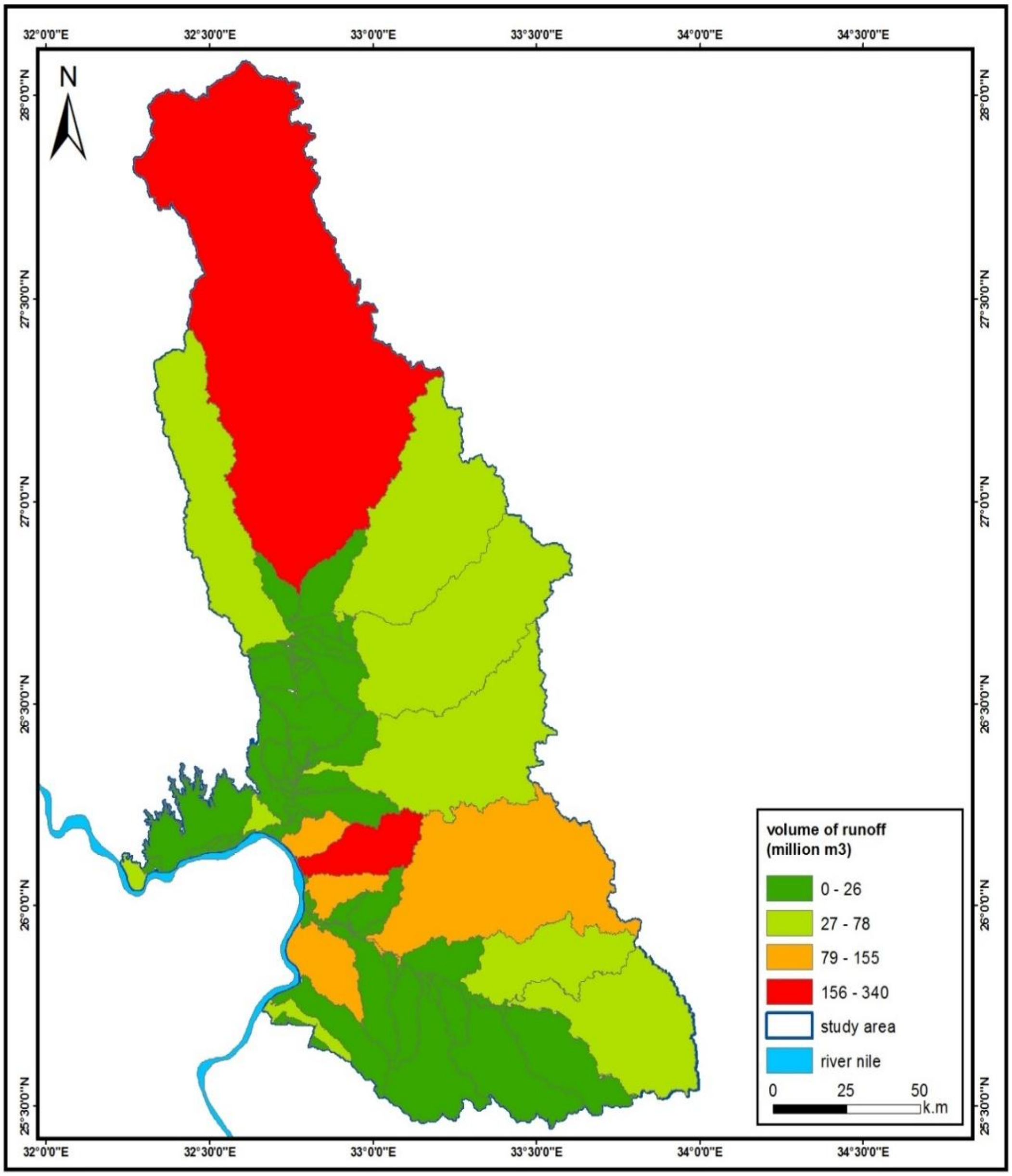


Figure (5-15) volume of runoff million m^3

5.5 The 28th January 2013 flood analysis

Area of study Suffered at various levels in the past years as the flood disaster range was notified depending on the strength flood which has resulted in flooding in some cases, deaths and massive destruction of homes and roads (table 5-1)

Table (5-1) Flash Flood Historical Record

Date	Affected villages/areas	Victims/damages
23 December 1955	Qena City	Destroyed many houses, roads and flooded cultivated lands.
26 November 1968	Klaheen Village.	Expelled 2165 persons.
	Shaykhiya Village.	Expelled 94 persons.
13 March 1975	El Hamydat Village.	Expelled 8 families.
5 and 6 March 1975	Karm Omran, Al Ashraf Al Sharqiya Villages.	Expelled 68 persons.
April 1975	Karm Omran Village.	Expelled 289 persons.
October 1979	Hegaza Bahry Village.	Expelled 546 persons.
	Hegaza Qebly Village.	Expelled 2304 persons.
30 December 1980	Vast areas of the region.	Destroyed 23 houses and 370 ha.
April 1983	Alklahin Village and	Destroyed many houses, roads and

Date	Affected villages/areas	Victims/damages
	neighbors.	flooded cultivated lands.
April 1984	Khozam and Hegaza Villages.	Killed 13 persons.
20 April 1985	Wadi Banat Bary and neighbors.	Destroyed Khozam Dam and killed 32 persons.
8 October 1994	Nag Salem, Alklahin, Hela, Hegaza, Abu Manaa, Abdel Qader Villages	Killed one person, expelled 6856 families, 1915 ha flooded, and destroyed the main highway (Qena-Safaga and Qeft- El Qusier).
2 November 1994		
13 November 1997	Upper Egypt: Aswan, Sohag, Asyut, Minya, Qena.	Killed 23 persons, thousands of hectares of land flooded and 260 houses destroyed.
30 December 2010	Nag Salem and Attyat Bdhna Villages	Destroyed 9 houses, Qena-Safga highway and Cairo Aswan highway.
28 January 2013	Alklahin and Karm Omran Villages	Broken down electricity and major roads for several hours, flooded cultivated lands

The analysis of flash floods depend on some data sources in order to have clearer results according to the input elements (aster data –meteorological data-satellites rain data-soil data) (figure5-16)

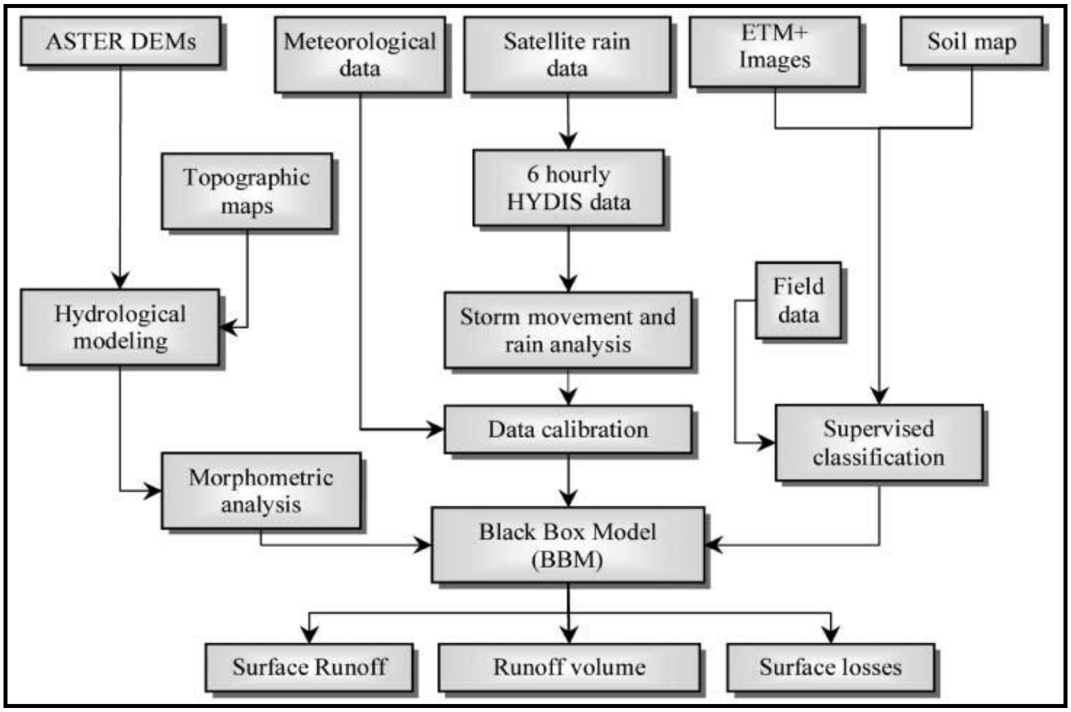


Figure (5-16) Rainfall analysis flow chart

And the output elements (surfaces losses –surface runoff) to estimate the runoff guidance

5.5.1 Weather condition analysis

Egypt, the Red Sea, and NW Saudi Arabia were battered by a thunderstorm from 28 to 30 January 2013. The storm dragged a severe weather event with potentially life-threatening. The antecedent weather conditions can be traced and summarized based on satellite real-time rainfall images, Meteosat infrared images, and weather reports as shown in (Figure5-18).

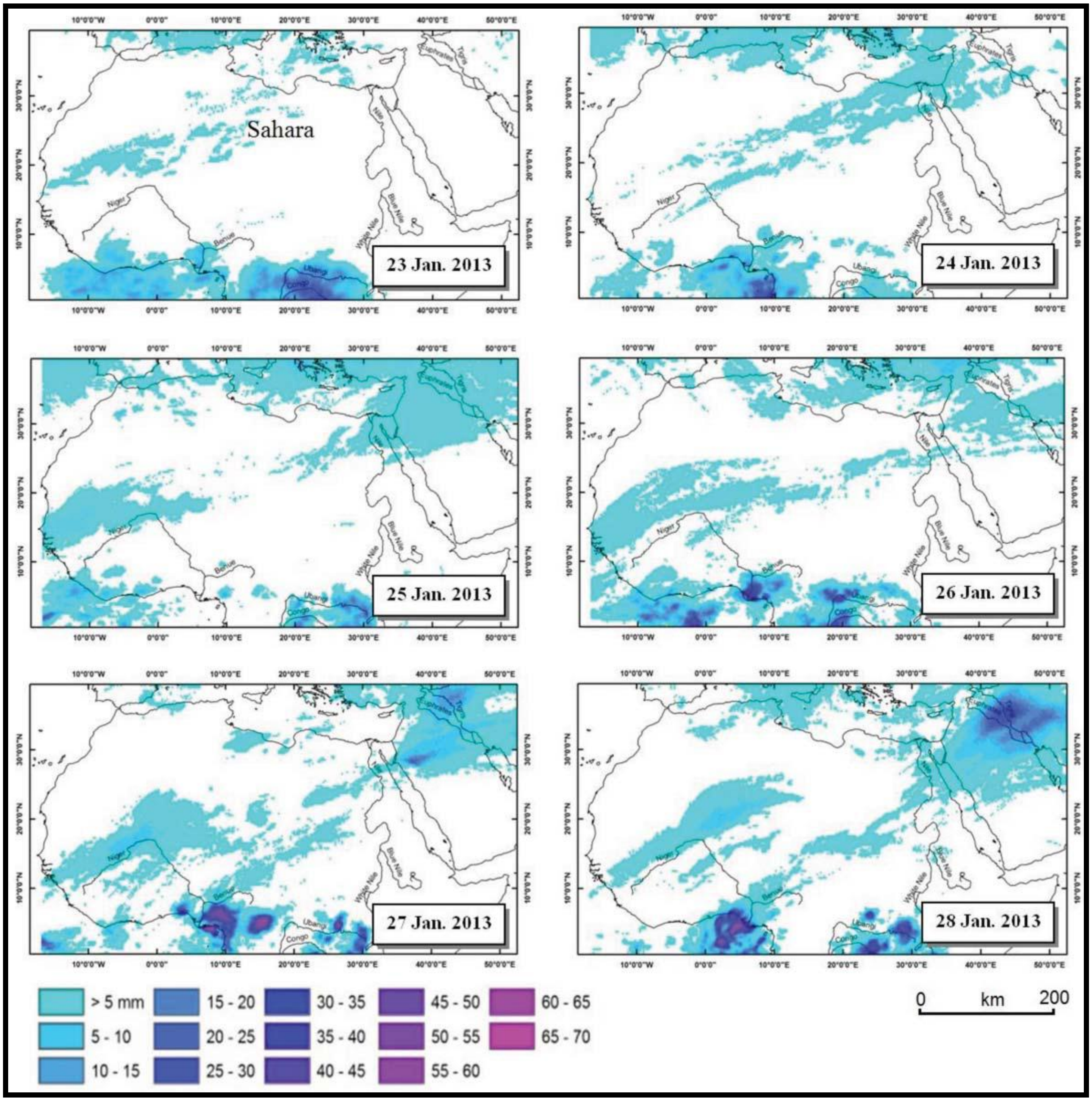


Figure (5-17) Daily development of storms over the Sahara from 23 to 28 January 2013

23 January 2013: A storm was originated from the sup-tropical and tropical (Gulf of Guinea) Western Africa and passed through the Middle desert toward the north eastern Mediterranean. The north western coast of Egypt was influenced by shower rain (>0.5 mm).

24 January: The storm was developed as a branch from the sub-tropical Western Africa, carrying humid air from the sub-tropical Atlantic Ocean. The storm trend was generally SW-NE and

passed through the central Sahara to the Levant, where it is forced by the cold air that plunged southward from southern Europe. It influenced North and Middle Egypt, Northern Sinai Peninsula, Palestine, Jordan, Lebanon, Syria, and Iraq. The storm led to the increase in temperature over Cairo (23°C) and in the Upper Egypt (Aswan 31° C) during the daytime, while it was relatively cold at night (Cairo 12°C and Aswan 15°C).

25-26 January: The same conditions were prevailed with the accumulation of low and medium clouds accompanied with heavy rain over Upper Egypt, South Sinai and the Red Sea.

27 January: The weather was generally warm during the daytime and cold during the night as the maximum and minimum temperatures significantly decreased (Cairo 19°-11° C; Luxor 25°-12°C; Aswan 27°-14°C). Accumulation of low and medium clouds was accompanied with heavy rain over Upper Egypt, South Sinai and the Red Sea.(Moawad ,Ahmed .O ,others 2014)

28-29 January: The general weather condition was unstable as the subtropical jet stream passed through Gulf of Guinea and Central Africa invaded Egypt from SW meanwhile an upper-air cold low pressure has plunged southward from Southern Europe and wandering over NW Egypt and extended up to Upper Egypt and the Sudanese Monsoon (inverted v shape) dominated over the Red Sea. As a result, the maximum and minimum temperatures were suddenly and significantly decreased owing to the cold wind of high speeds (Cairo 16°-7° C; Qena 17°-10° C; Luxor 18°-12°C) and low and medium clouds covered wide areas of Middle, Upper, and Eastern Egypt as well. During the early hours (1:45 am, Cairo local time = 27 January 23:45 pm UTC) of Monday 28th January a rainy thunderstorm battered Qena, Upper Egypt and lasted about two hours later (4:00 am, local time = 2 am UTC) (Figure5-19). The rain was relatively heavy over Upper Egypt, Eastern Desert, Red Sea, and South Sinai and light over the Northern Egypt. The duration of the rain storm was about two hours continual. It is resulted in weak to medium flash floods in South Sinai, Eastern Desert, Qena, and Safaga and El Qusier on the coast of the Red Sea.

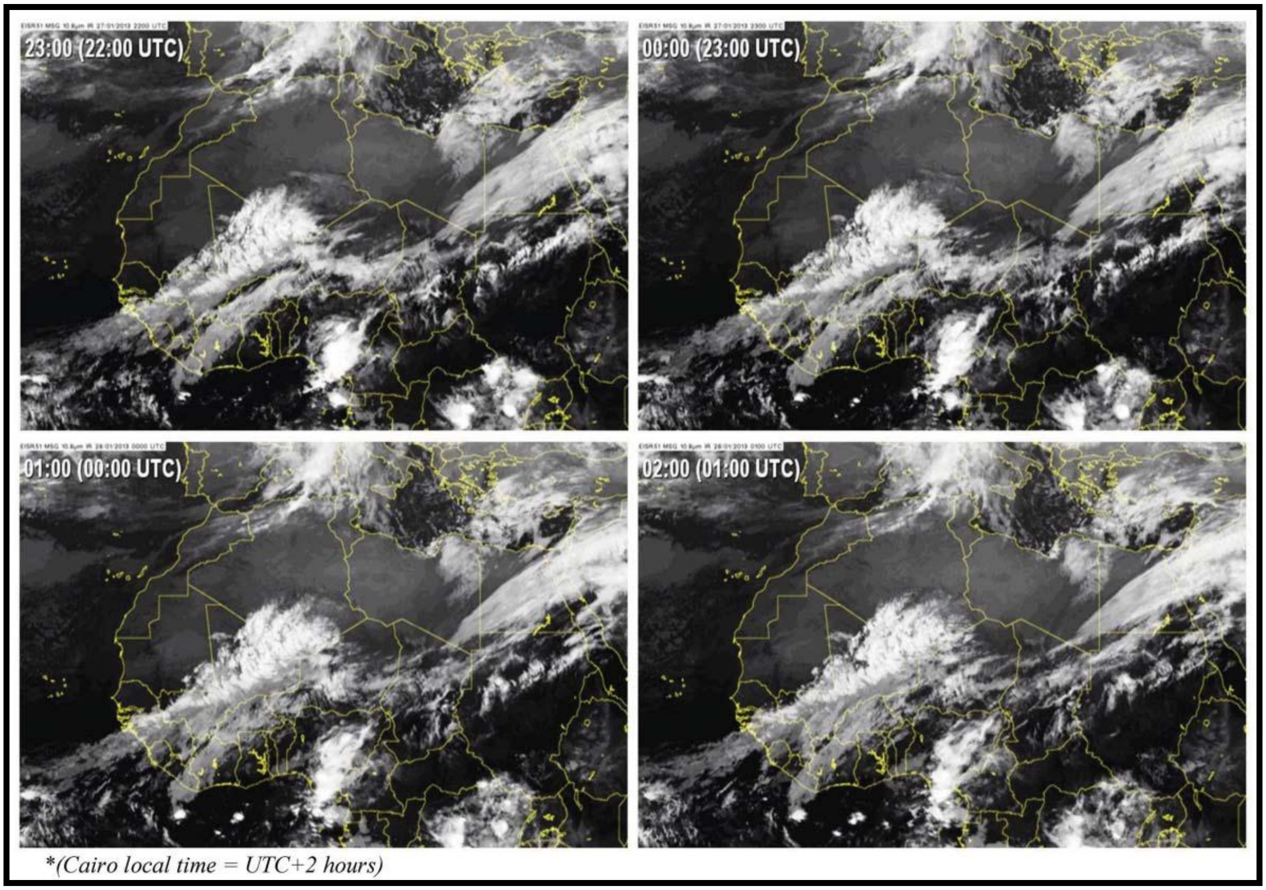


Figure (5-18) Infrared Eumetsat images show 6-hours development of the jet streams over the Sahara from 27 January 2012 (23:00 pm UTC) to 28 January 2013 (02:00 am UTC).

30 January: The storm moved to the northern Saudi Arabia, Jordan, Iraq, Kuwait and north-western Iran.

5.5.2 Rainfall analysis

Cumulative rain map was processed by adding the daily rainfall from 23 to 30 January 2013. Figure (5-18) shows that the maximum rain was about 13.5 [mm] that was mainly concentrated on the north eastern part of Wadi Qena. The total cumulative rain was estimated as 32 $^{-106}$ [mm] and 3.6 $^{-106}$ [mm] for wadis Qena and El Matuli, respectively. Rain volume Qvol for a given cell in the spatial model was then estimated.

Table (5-2) Hydrological estimations

Wadi	**Area [km^2]**	**$\sum Ia$[mm]**	**$\sum Q_{vol}$ [m^3]**	**$\sum Q_{sur}$ [mm]**	**$\sum QT_{vol}$ [m^3]**	**$\sum T_{los}$ [mm]**
Qena	15,700	32×10^6	79.9×10^9	26×10^6	65×10^6	6×10^6
El Matuli	7,600	3.6×10^6	9×10^9	4.7×10^5	1.2×10^6	3.1×10^6
total	23,300	35.6×10^6	88.9×10^9	26.5×10^6	66.2×10^6	9.1×10^6

The total surface runoff ($\sum Qsur$) was estimated as 26×10^6 [mm] and 4.7×10^5 [mm] for wadis Qena and EL Matuli, respectively. Moreover, runoff volume (QT_{vol}) .

The total runoff volumes ($\sum QT_{vol}$) were estimated as 65×10^6 [m3] and 1.2×10^6 [m3] for wadis Qena and EL Matuli, and the total transmission losses ($\sum T_{los}$) were estimated as 6×10^6 [mm] and 3.1×10^6 [mm] in the same order (table 5.2).

5.6 Accuracy assessment

The study relied on the accuracy assessment to reach two goals, the first is the accuracy of the work and the results of analyzes, classifications and their conformity with the reality. The second to know any more accurate classification methods and by comparing them to those using points compared by using GPS.

There are two types of map accuracy assessment: positional and thematic. Positional accuracy deals with the accuracy of the location of map features (Russell G.-2009), and measures how far a spatial feature on a map is from its reference location on the ground (Bolstad, 2005).

The analysis will present the accuracy assessment result for position for each classification type (unsupervised –supervised-object oriented (sub pixel classification))

The errors matrix depending on ground data from global positing system GPS. Producer's accuracy is a reference-based accuracy that is computed by looking at

The predictions produced for a class and determining the percentage of correct Predictions. In other words, if I know that a particular area is hardwood (I've Been out on the ground to check), what is the probability that the digital map Will correctly identify that pixel as water surfaces. May be in conflict between classes as example the cultivated class is overlapping on 25 sample with urban class table (5-3),(5-4),(5-5) this referee to the range of accuracy (procedure accuracy)

Produces accuracy: (∑ Pixels correctly classified)/ ground reference pixels in class.

Overall accuracy = (∑ pixels correctly classified) / (total of pixels).

Table (5-3) Error Matrix for UN supervised classification

	Classified Data				
GPS reference data	**cover type**	**Cultivated**	**urban**	**water surfaces**	**total**
	Cultivated	140	41	22	203
	Urban	25	115	15	156
	Water surfaces	15	4	63	78
	Total accuracy	**180**	**160**	**100**	**437**

Produces accuracy

Cultivated=140/180=.77=77%

Urban=115/160=.884=88%

Water surfaces=63/100=.63=63%

Overall accuracy = (∑ pixels correctly classified) / (total of pixels)

= (140+115+63)/ (437) = (318/437) =72.7%

Table (5-4) Error Matrix for supervised classification

Classified Data					
GPS reference data	**cover type**	**Cultivated**	**urban**	**water surfaces**	**total**
	Cultivated	152	25	11	188
	Urban	18	124	8	150
	Water surfaces	10	11	81	102
	Total accuracy	180	160	100	440

PRODUCER'S ACCURACY:

Cultivated=152/180=.84=84%

Urban=124/160=.775=75.5%

Water surfaces=81/100=.81=81%

Overall accuracy= (152+124+81)/440)

=357/440=81%

Table (5-5) Error Matrix for sub pixel classification

Classified Data					
GPS reference data	**cover type**	**Cultivated**	**urban**	**water surfaces**	**total**
	Cultivated	165	13	8	186
	Urban	10	137	0	147
	Water surfaces	5	10	92	107
	Total accuracy	**180**	**160**	**100**	**440**

PRODUCER'S ACCURACY:

Cultivated=165/180=.91=91%

Urban=137/160=.85=85.6%

Water surfaces=92/100=.92=92%

Overall accuracy= (165+137+92)/440

= (394/440) =89%

According to the previous results and as per the comparison of the accuracy assessment of each classification method. So, the sub pixel classification is the best method that will be applied through this research for image classification.

5.7 Land use change detection

When we look at the change in land use in the study area, the change means that there are two important elements: which item is changed and in which direction this change takes place and compare this direction of the change with other places. I am going to talk about important elements: the construction and cover agriculture. These two elements have changed on yearly basis depending on the developments of the system of living in the study area from the period following the construction of the High dam until now.

From the figure (5-19), one can observe the extent of change between the two regular components regular in the study area, and it seems stable. However, in the year that we are dealing with, the Urban in the Study area reaches 150 kilometers ^{2} while the agricultural area is decreased to reach 553 km due to the increase of the crawl of Urban in the agricultural areas.

In the past, specifically in the period from 1972 until 1984, the agricultural area is increased by 64 km as a result of the construction of the High Dam, the evolution of the cultivated area and regularity of Agriculture in the study area (Ahmed.O 2013).

The second element which is the trends of the change. The study illustrates the direction of those changes and the expansion of urban and agriculture as it appears from the study of evolution in the land use of study area. This represents a serious indication in the study of the dangers of flashfloods. Moreover, the expansions in the mouths of the valleys make them vulnerable to drifting in the face of any flash floods that may come, as happened in previous times where roads collapsed, agricultural land were flooded, and thousands of residents were evacuated (ahmed 2013).

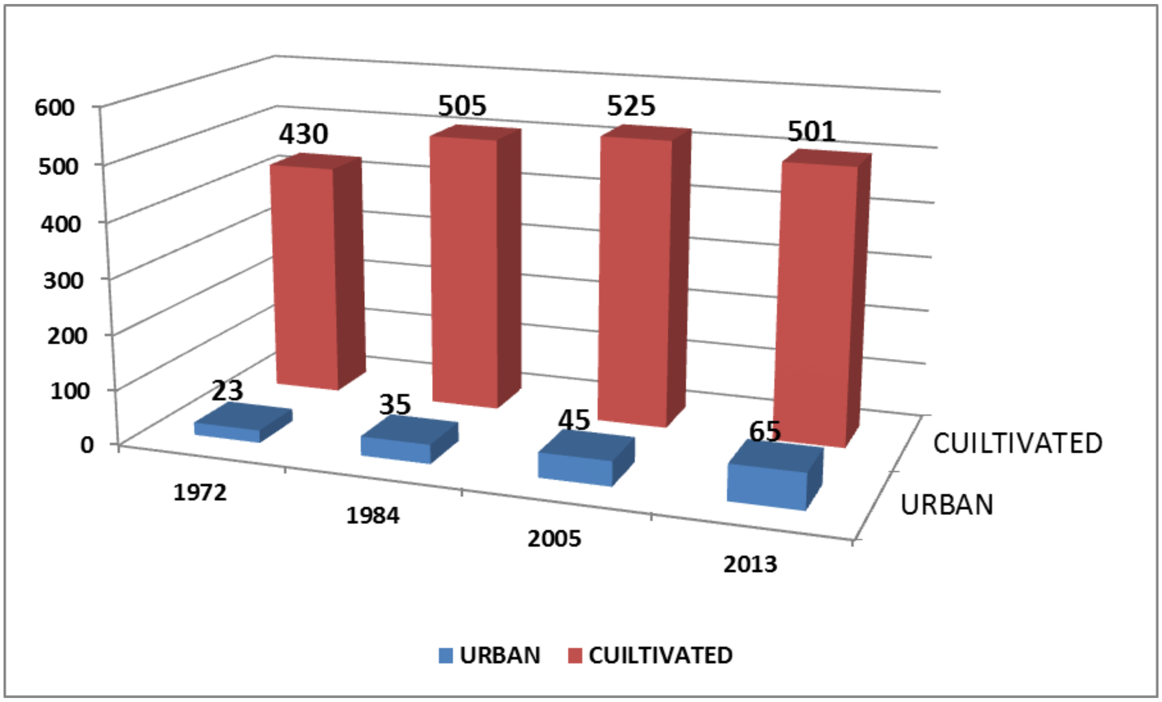


Figure (5-19) land change of study area

Changes can be observed through the following figures for year's 1972-1984- to 2005-2013 figure (5-20).

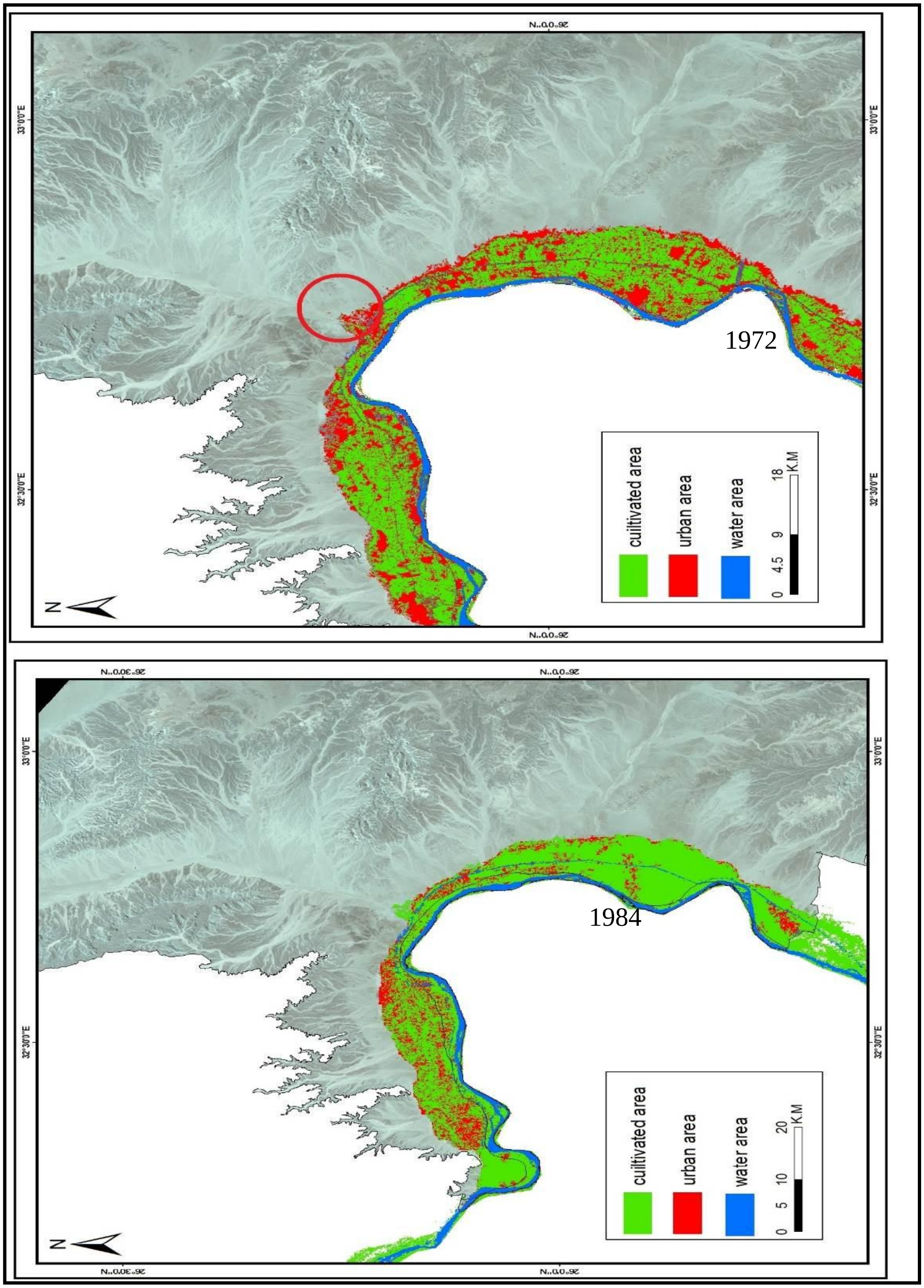


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Figure (5-20) the land use of study area between 1972-1984

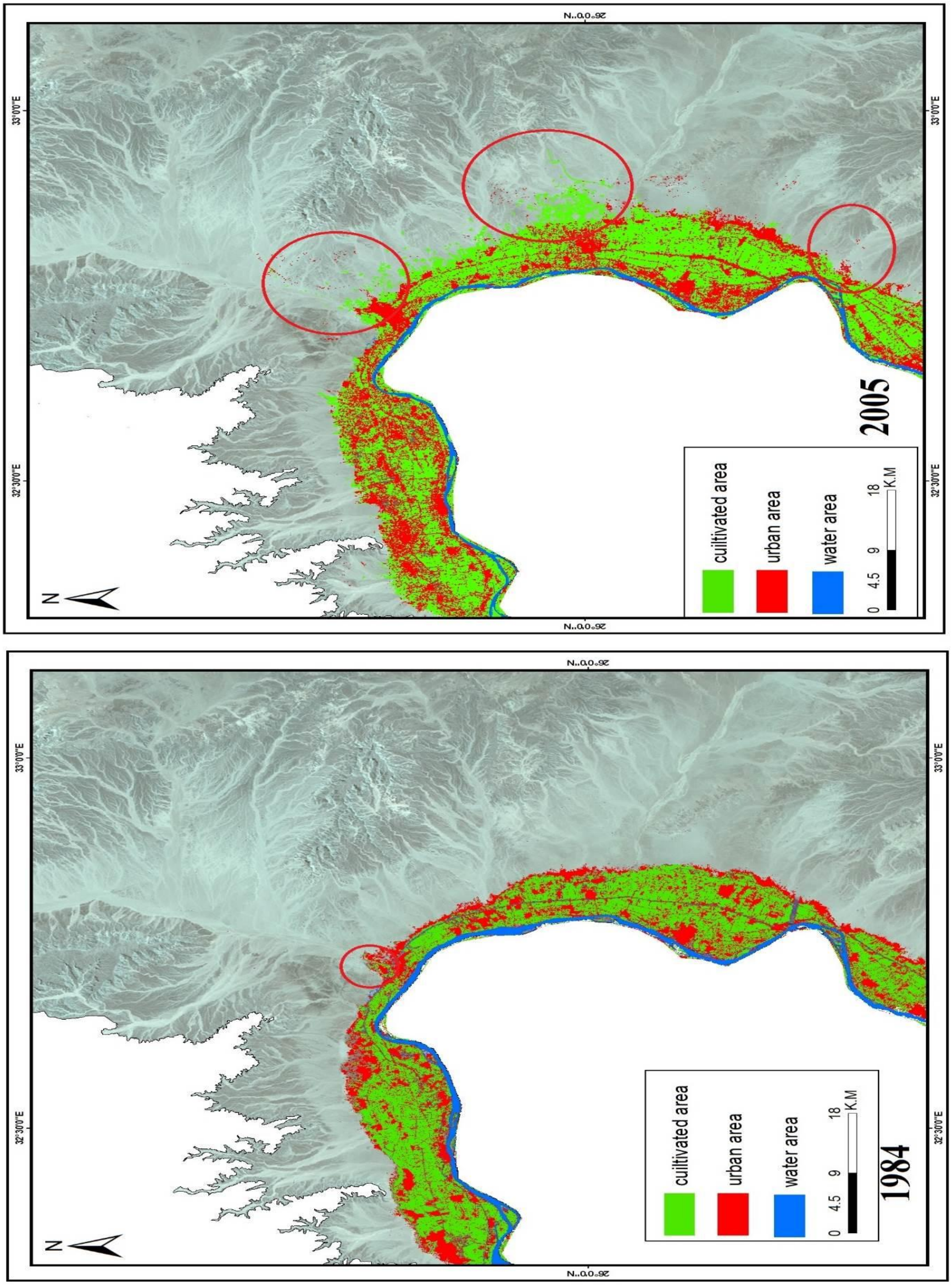

Figure (5-21) the land use of study area between 1984-2005

As these changes can be seen more clearly in the period between 1984 to 2005 in the east in the mouth of the valleys that pour from the east and north-east to the west as shown in Figure (5-21)

It is clear from the study area that the slope affects the intensity of gravity if there are any flash floods and this will increase the strength of the drifting of the flash floods.

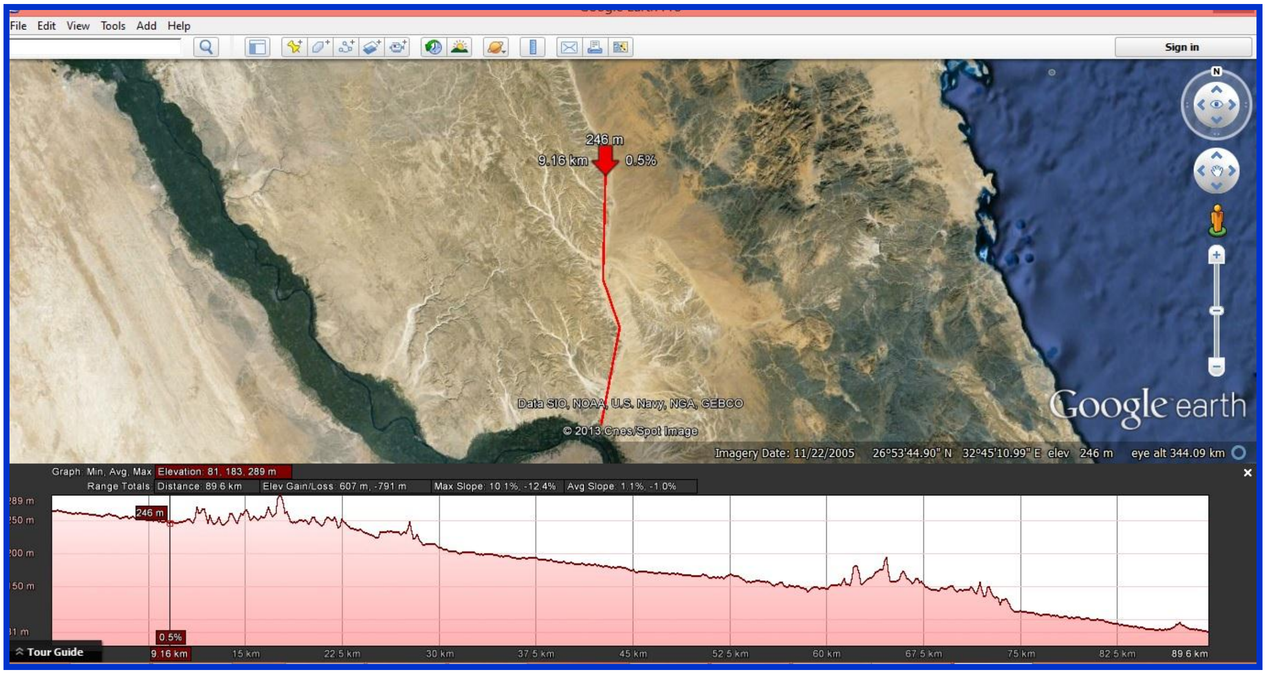

Figure (5-22) land slope of study area for Qena Wadi

Moreover, between 2005 to 2013, one can find an obvious increase in the development of urban human activity more than before, as shown in figure (5-22)

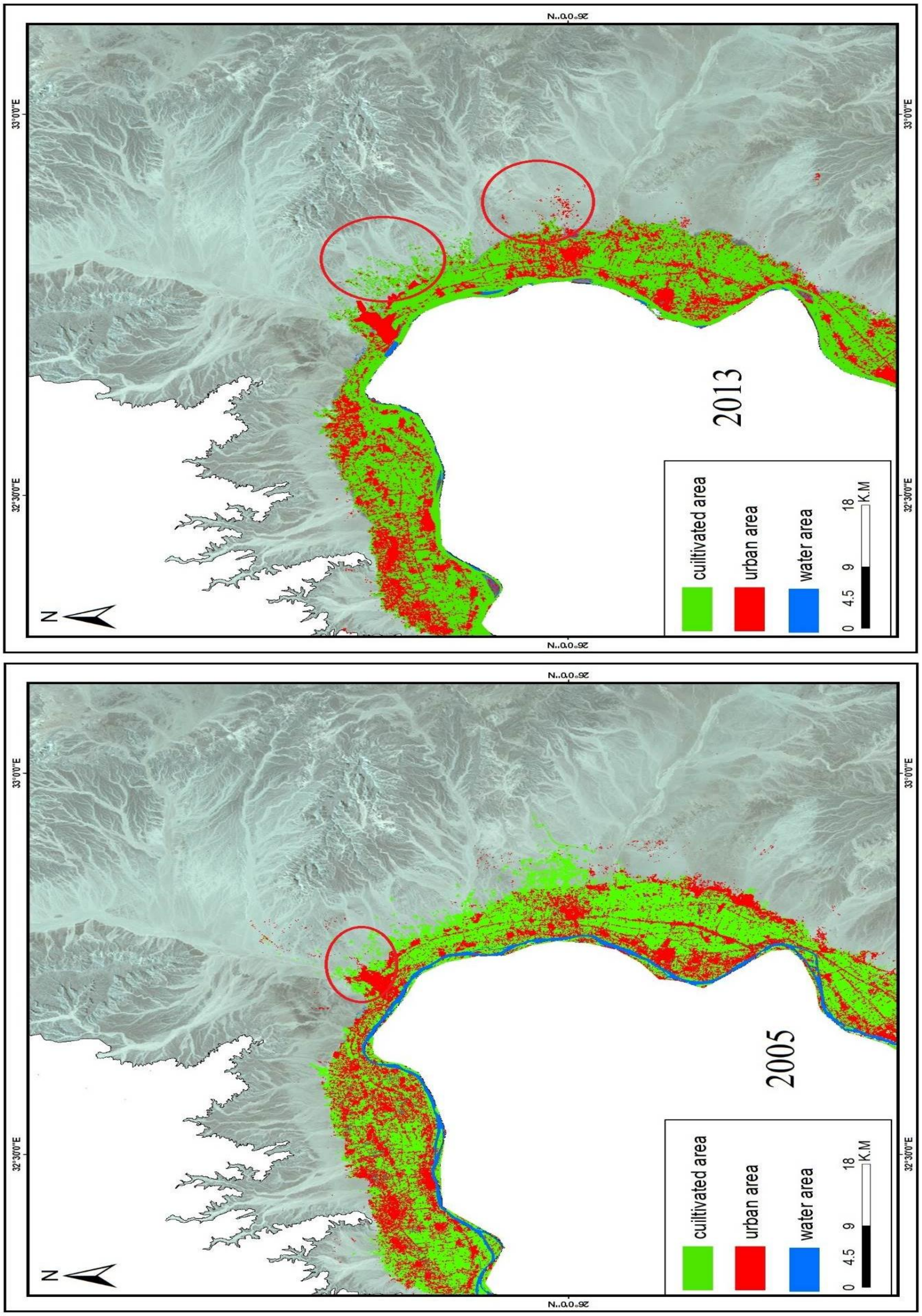

Figure (5-23) the land use of study area between 1972-1984

5.8 Vulnerability Area

Through the above-mentioned elements, the morphometric analysis, the amount of runoff guidance, and the study of changes in land use in the study area will enable getting a clear outline to identify high-risk places and safest places, which can be referred to as places for sustainable development. In figure (5-24), the most dangerous places are shown along with the areas of human activity in the area that are vulnerable to risks. It is clear that the area opposite the mouth of Wadi Qena is an extension of the city of Qena and that the eastern urban expansions are the most dangerous areas prone to damage or disaster. This occurs as a result of the possibility of flash floods in the area opposite the mouth of Wadi Qena

All these factors increase the seriousness of the disasters. There are other important factors that affect the possibility of a catastrophe such as:

- Natural circumstances, trends of the formerly powerful regression degrees in this region, altitude differences between the environment Valley, and similarities between the eastern plateau and output in the mouths of the valleys.

- The other factor is the decision –maker's wrong choice for selecting places of human activity as previously mentioned.

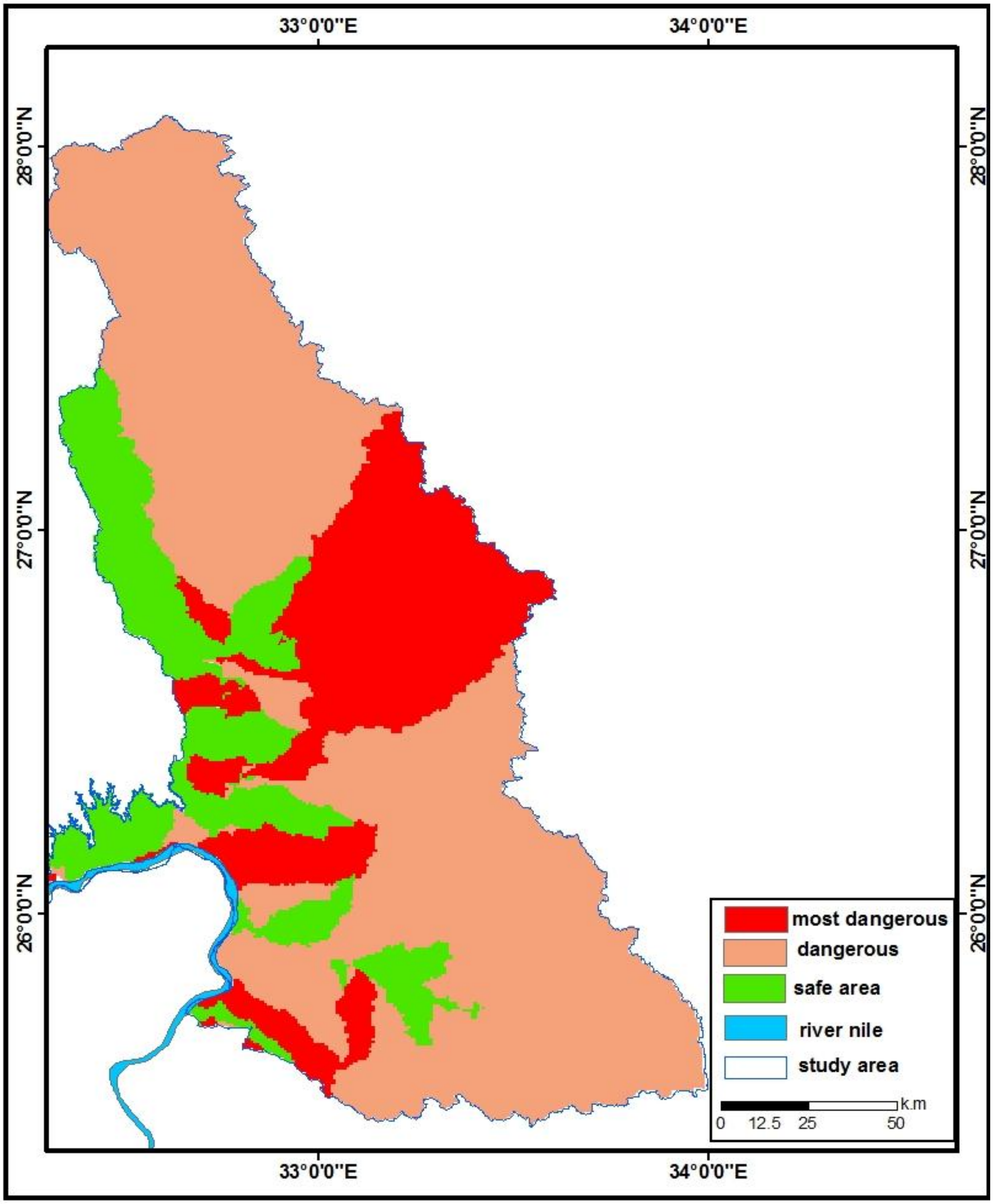

Figure (5-24) vulnerable places in study area

Chapter Six

6.1 Conclusion

This paper presents a thorough image about the flash flood disaster and all the elements that directly impact the degree of risk from morphometric analyzes depending on the Digital Elevation models DEM passing from hydrological modeling and hydrological characteristics of the hydrological network down to determine the estimation flow spate in the model of Soil Conservation Service (SCS), and the analysis of visual space to get to the maps of urban land use and calculate the rates of changes and the increase in human activity and the relationship of each of those previous elements human activity and the severity of the floods. This study resulted in the following:

1 - Morphometric analysis

The transactions morphometric and various analyzes were extracted using the data in the digital elevation models (DEM) has shown various analyzes over roughness area. It is clear from the study morphometric analyzes that the highest rate of circularity reached 0.134, it also hit the maximum of relative relief to the top of 140. That represents a clear roughness sign in the region as it reached the highest degree of value to slope to 60 basins and this is a clear indication of the severity of the decline in the study area basins and a private basin of Qena Valley, which flows directly in the direction of urban cluster in the study area.

2 - hydrological modeling

Through hydrological modeling analyzes in the study area depending on the morphometric transactions and digital elevations in the foundation has resulted in two hydrological systems for two basins: Qena Valley basin has an area of 15,700 km and a basin in Mtolh Valley 7,600 km and both pour in the floodplain of the study area and it has reached maximum drainage density 60, which represents great value for the density of the discharge that has reached the largest number of streams 30515 stream. This shows the extent of the large number of stream and the size of the discharge in the study area and a private basin Valley Qena.

Through soil service conservation service (SCS) the Flash Flood Guidance F.F.G was determined where the estimation amount in December 2010 was 300×10^6 and in January 2013 amounted to 77×10^6 .

3-By working on satellite imagery analyzes, calibration methods were conducted by different classification (supervised classification-supervised classification-object oriented classification) and it turned out that the best are (object oriented classifications) based on tests (accuracy assessment) where the percentage (accuracy assessment) classification of non- observer 72% and the percentage (accuracy assessment) rating of 81 %, while the observer of the degree of the (accuracy assessment) classification (object oriented classifications) 92% and so that has been working on the latter kind of classification methods

Land use map was created for urban areas, places of Agriculture, and Water, the analyzes have shown the evolution of Urban area since 1972 to 2013 the scope of urbanization has increased to 55 km in 1972 and reached 125 km in 2013 half of this area to the east in the direction of the valley streams. Also, agricultural landscapes increased by 425 km in 1972 and to 510 km in 2013 75% to the east in the direction of the mouths of the valleys.

4-- Through those previous elements which clarified analysis the (weighted overlay) that the most dangerous places are the places of human activity in the valleys, especially the mouth of Qena valley, along with Urban places on the edge of the floodplain in the study area, which gathers the most serious relative weights of both the size of the estimation flow spate and over objection human activity, as well as its topography and slope factors that affect the seriousness of the region and represent safer places better direction for sustainable development or an evacuation of the population in the event of floods

6.2 Future Research

This study demonstrates the importance of hydrological modeling in determining the amounts of net runoff, a clear interpretation of the size of the floods and therefore dangerous flood, so the development of these studies meant a greater understanding of the dimensions of risk and the speed of decision-making

* The study shows how fast the arrival of flood since falling until the arrival point downstream, so the development of hydrological modeling in order to be more responsive to flash flood's decision to contribute to the best and fastest event of a disaster.

* Work on the visualization space calibration and test estrous analyzes and classifications of important dimensions that contribute significantly in determining the degree of seriousness of the disaster, through the study of the relationship between them and the places of human activity.

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