CHAPTER THREE

STUDY AREA & THE PROBLEM DEFINITION

3.1 Introduction:

The Egyptian eastern desert is having a long coast along the Red sea of more than 1000 km length; also it is one of the largest mining fields in Egypt beside the potential of agriculture and industrial development which gives it a great importance to the economy of the developed country of Egypt. This part of Egypt is sometimes subjected to flash floods events resulting from heavy, short duration and sudden rainfall events, causing heavy damage to man-made features.

3.2 Location:

The Egyptian Eastern desert extends from the Red Sea coast to the Nile valley between Longitude 22º and 30º E; Latitude 31º and 36º N (Figure 3-1), a mountain divider is located parallel to the Red Sea cost which divides flow directions eastward discharging into the red sea and westward discharging towards Nile river.

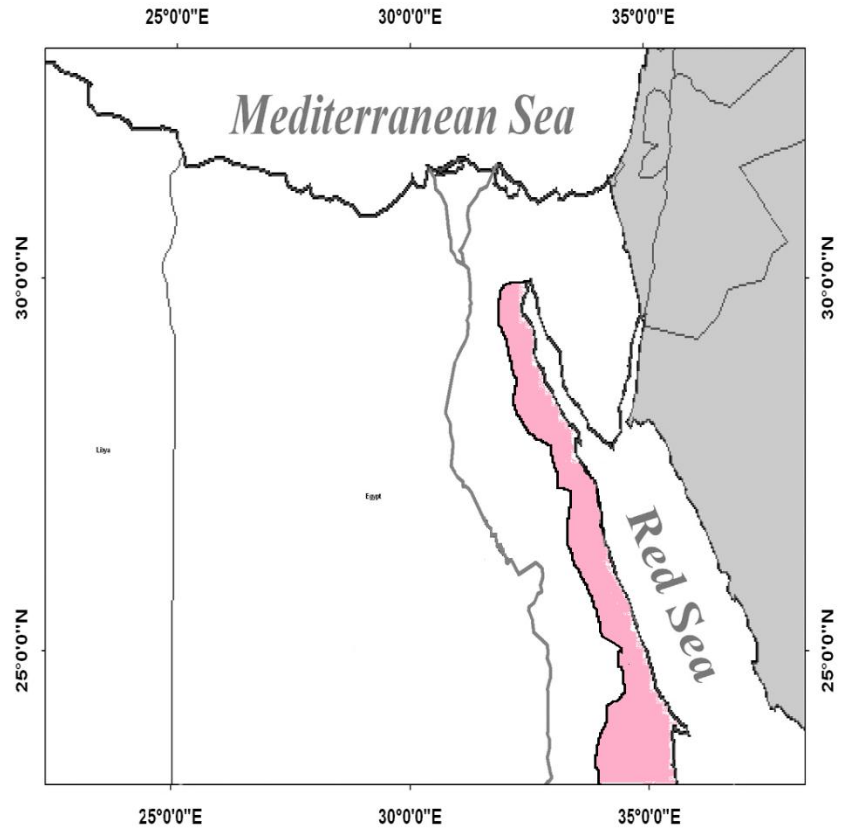

Figure (3.1): Location map of the study area.

It lies within the barren desert range which is distinguished by hot summer and cold winter with the obvious change in the temperature range. Generally, it is distinguished by the scarcity of rain and relative high moisture content. It covers a total area of 223,000 km^2 (22% Egypt area), the study area could be divided into two main geomorphic units (Figure 3.2);

1- The Red Sea Coastal Plain, which extends parallel to the Red Sea Mountains (between contour 0 and 200 asl). It varies in width from few hundreds of meters up to several kilometres and is mostly a gravel desert (with a gentle slope about 5 degree towards the Red Sea). Shallow channels of numerous wadis draining the Red Sea Mountains transect it and deltas of some wadis made of fine alluvial deposits push the coastline into the sea.

2- The Red Sea Mountain is a part of the Arab – Nubian massive shield. The crystalline highlands are formed by the rugged mountainous backbone of the Eastern Desert and form the main catchment area for different basins. It is characterized by good exposures with several peaks protrude delineating the water divide with the many wadis, mostly debouche either eastwards to the Red Sea, where the study area is located, or westwards to Nile river. The area is characterized by many mountains as Gabal El Shaib (2187 m asl). The topographic relief over the wadi floor ranges from 50 to 600 m above sea level. The floors of most wadis are flat and most of them narrow with sharp curvature, water valleys were then dried in drought age, as: Allalaqi - Hammamet - Qena - Assiut - Tarfa - Araba - Hof.

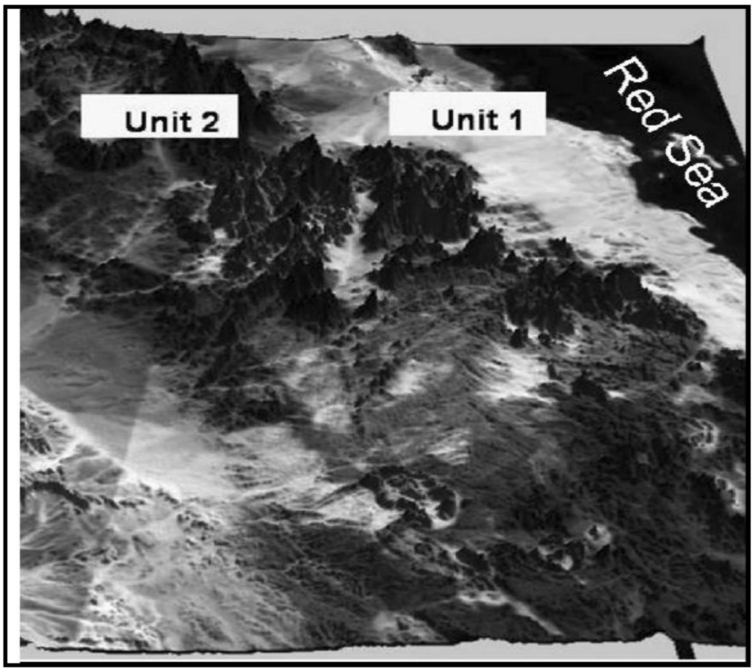

Figure (3.2): Distribution of geomorphic units in the study area.

3.3 Flash flood history :

Between 5000 and 3000 BC the Eastern Desert had areas which would have been very attractive for pasture, with a maximum rainfall of around 150mm. There is one single specimen of Maerua crassifolia known from the Ma'aza's tribal area, together with isolated examples of wild olive, white saksaul, white acacia, Indian mastiche, all of which are thought to be the last remains of the woodlands of the desert environment as it was between c.3000 and 7000BC.It classified into seven categories: 1-coastal forests;2-good pastures with rainfall of more than 150mm;3-pastures with rainfall of 150 mm ;4-seasonal pastures with rainfall of 50-100 mm

;5-area with very poor vegetation and rainfall less than 50mm;6-sub Saharan savanna;7-larger oases, Figure (3.3)

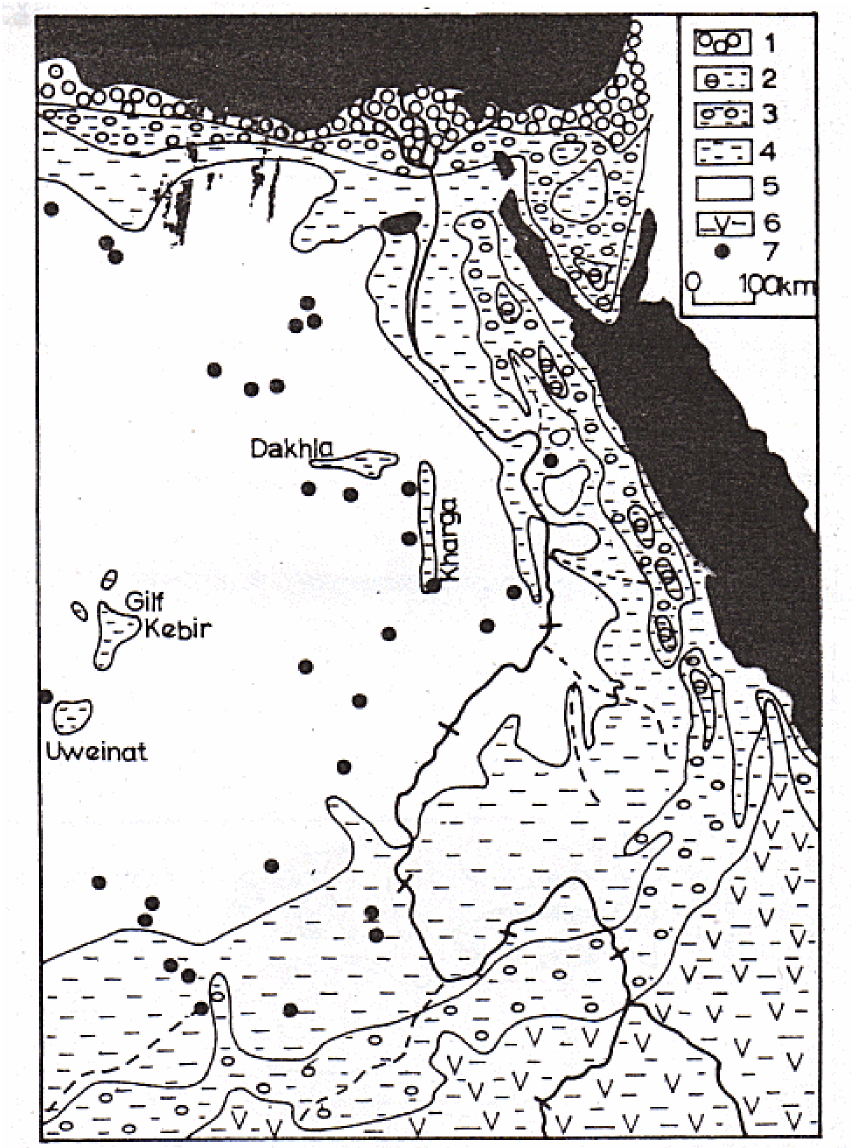

Figure (3.3) Ecological zones in Egypt and the Sudan in the period of 5000-3000 B.C. (Moneim 2005)

Today, the average rainfall received by the Eastern Desert annually ranges between 2.75 and >50mm annually (Moneim 2005). The Eastern Desert receives more rainfall than the Western Desert, which is due largely to the relief of the Eastern Desert, where the Red Sea hills attract orographic rainfall. However, at Quesir on the Red Sea coast where the mean temperature is 28 degrees centigrade, annual rainfall is only around 4mm, whilst at Hurghada on the Red Sea coast it is nearer to 3mm. Occasional rainfall often takes the form of short and quite violent storms which result in large volumes of water racing down the wadis from the Red Sea Mountains to the Nile or to the Red Sea.

Around the 50's, Egypt was subjected to more than 50 flash floods between strong, medium and weak but most of them were disastrous and most were in the Eastern Desert and Sinai as flash floods have been recorded in the years 1969, 1980, 1984, 1985 and 1994. In 1954 a freak storm caused the dry Wadi Qena to fill, and the resulting flooding caused damage in the town of Qena at its Nile end.

In 2010, the heavy rainfall across Egypt has caused floods affecting most of the country. Houses have been swept away and 57 electrical towers have collapsed in cities and villages. Main roads were closed throughout the country and telephone and power lines were cut, Figure (3.4).

Figure (3.4) Heavy rainfall has caused floods across Egypt including Al Arish 2010

3.4 Problem Definition:

Since decades, the mountain areas of Egypt in Sinai Peninsula and Red Sea Governorate were subjected to flash floods. It should be noted that the effects of floods in 1994 that swept the province of Sohag worked to crack houses and the sinking of the streets and destroy many acres of agricultural and displacement of thousands of people due to the lack streams sufficient to maintain the water, as the country was hit by floods again in 96 and 98 but it was less harmful than its predecessor.

The flash floods occurred late 2009 and early 2010 on different Egyptian cities caused losses in both lives and properties. These events triggered the need of flood risk assessment study for the area highly affected by those floods. Sinai and Eastern desert were highly influenced and therefore need a great attention as the mountains of Sinai and Red Sea are places where high risk flash floods may occur and also due to the ambitious development plans of the government to increase/encourage the investment in this region of Egypt.

The area is leaking a plan that may help the people and government identifying the locations that could be subjected to floods and how risky is those locations. With the presence of such information efforts could be directed towards high risky populated area to find solution for protection and/or reallocate the people and properties from these places. It will also help the decision makers when planning for new development locations and/or settlements to avoid high risky locations.

3.5 Scope of the Thesis:

The proposed plan of research main into vest is in predefining the locations where high flood potential is expected with prioritization of these locations. The weighted standardized risk factor obtained from the prioritization can be used during the design of flood protection measurements and/or the calculation of design of peak flows for crossing structure. This may lead to more economic design procedure that can be adopted in drainage design guidelines and manuals. The Research also focuses on producing a well defined procedure for handling risks due to morphological parameters which floods are representative.

CHAPTER FOUR

METHODOLOGY, RESULTS&DISCUSION

4.1 Introduction:

This chapter presents the methodology adopted to generate a weighted risk map for target study area. A Geographic Information System (GIS) was used to calculate the required morphological parameters for all watersheds in the study area using the available Digital Elevation Model (DEM). Main morphological parameters were used to estimate a risk factor representing each of them, and then HEC-HMS was used to study the sensitivity of each morphological parameter of every main catchment in the study area to a pseudo storm applied to all the catchments. New methodology was proposed to combine those risk factors through weights assigned to each of them based on the HEC-HMS sensitivity analysis results.

4.2 Morphological Studies:

The Morphological study aims to study the nature of ground surface, its slopes and elevations for the study area in order to determine morphological parameters of the study area valleys by identifying morphological factors such as longest flow path, area of watersheds, and the other important parameters.

4.2.1 Data collection:

To start the morphological study, it is important to collect available data about land topography of the target area. The Digital Elevation Model (DEM) from NASA Shuttle Radar Topographic Mission (SRTM) has provided digital elevation data with a 90 m resolution where the world map is divided into 72 columns and 60 Rows, figure (4.1). The DEM data about any study area can be downloaded by selecting the cell where the target area is located to download it from web site.

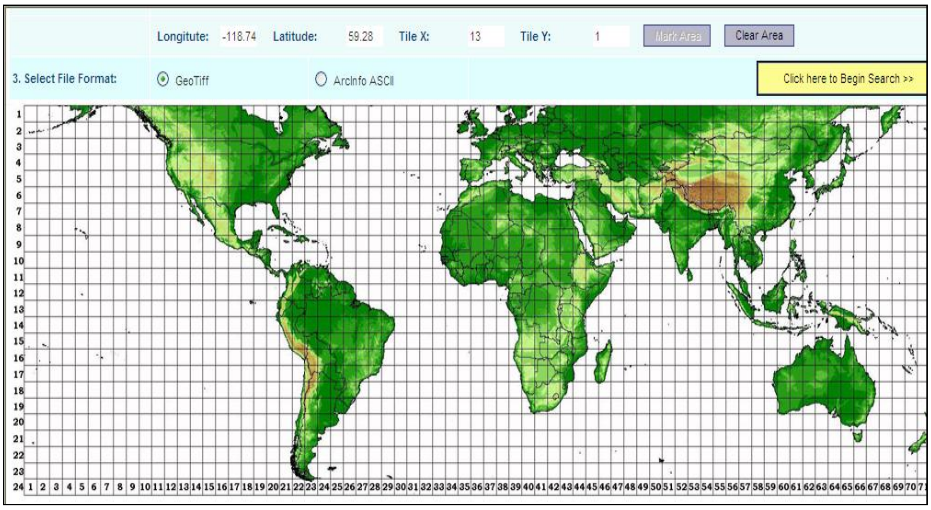

Figure (4.1): The world map at SRTM (website source; http://srtm.csi.cgiar.org)

The Study area, located on the Egyptian Red Sea coast, is marked by 3 cells number [(43_07), (43_08), and (44_08)] (Figures 4.2). The DEM was downloaded and used in the analysis to generate watersheds for the Eastern flowing towards the Red Sea coast and all its morphological for the research.

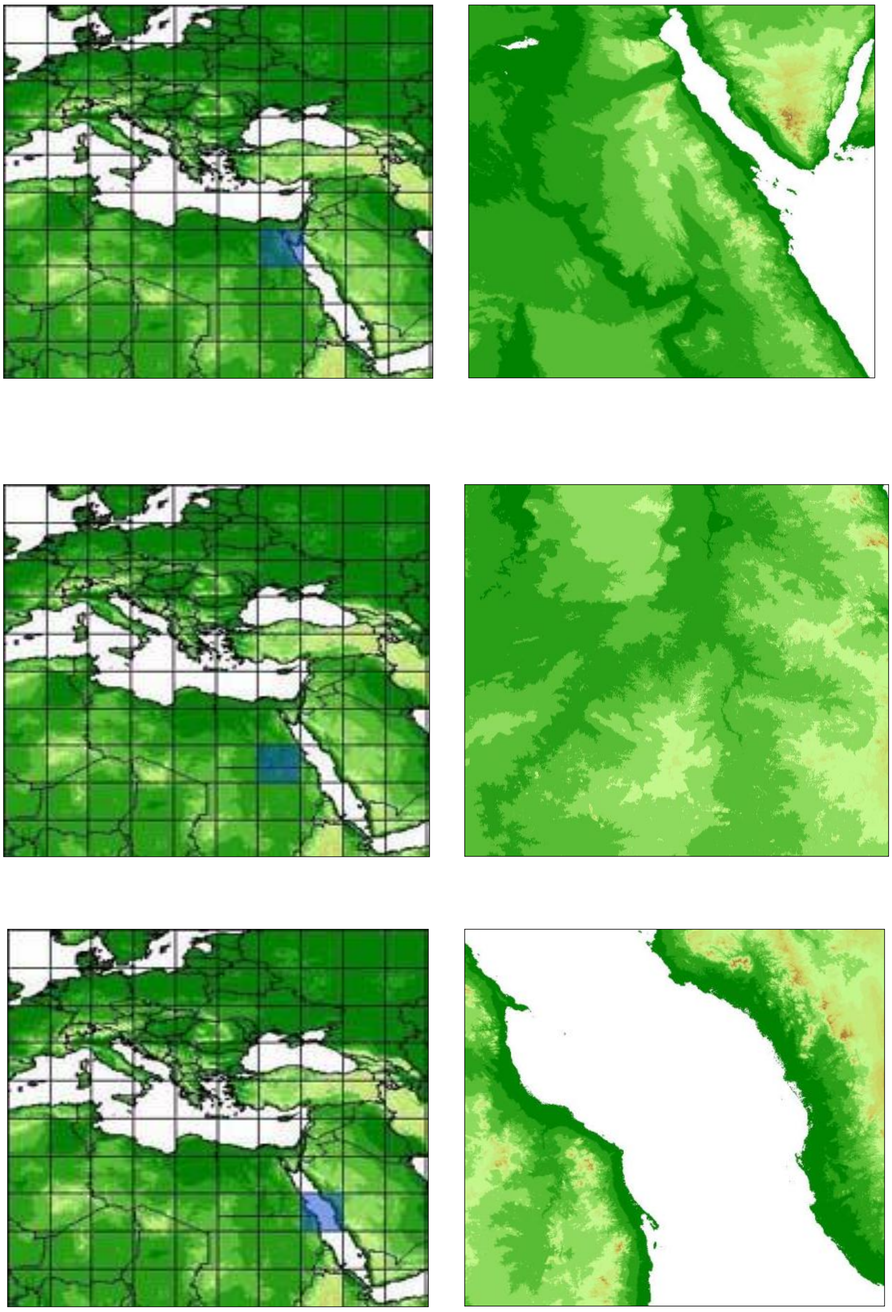

Figure (4.2): SRTM data for the study area (long.22º and 30º E; lat. 31º and 36º N)

4.2.2 Morphological analysis:

Digital maps were used to delineation watersheds flowing into the Red Sea from the Egyptian eastern desert by implementing these maps into Geographic Information System (GIS) database to calculate the most important morphological characteristics. These morphological characteristics are very important to identify flow direction for rainfall on the study area, then further analysis of the resulting flow directions can be used to identify flow accumulation which reflects the main routes of floods in the area.

4.2.2.1 Terrain Preprocessing:

Terrain Preprocessing uses the case study DEM to identify the surface drainage pattern. Once preprocessed, the DEM and its derivatives can be used for efficient watershed delineation and stream network generation. The steps of the terrain preprocessing, described earlier should be performed in sequential order, before Watershed Processing functions can be used as described earlier in chapter 2.

This watershed processing function computes a stream grid contains a value of "1" for all the cells in the input flow accumulation grid that have a value greater than the given threshold value (25 km^2), All other cells in the Stream Grid contain no data. A limited area is created to be processed by first, combine the downloaded rasters files to one raster file, figure (4.3), and then project it using GIS to WGS 1984 UTM Zone 36N projection. And secondly, clip the limited area between the Red Sea coast and Red Sea Mountains, Figure (4.4) and then apply the terrain processing for this limited area as described earlier, figures (4.5) and (4.6).

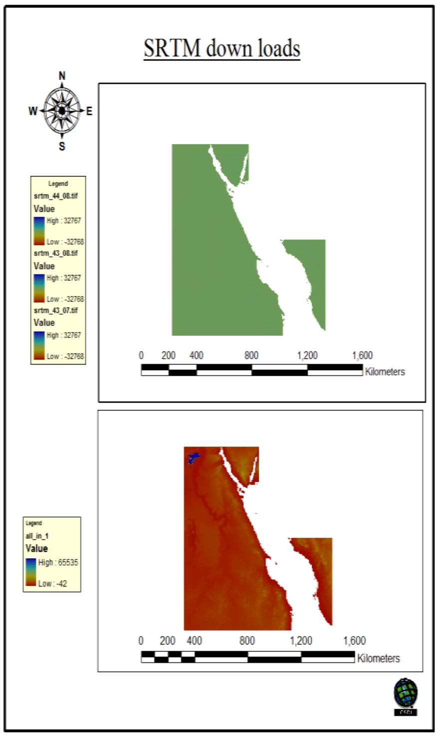

Figure (4.3): Three rasters after mosaic

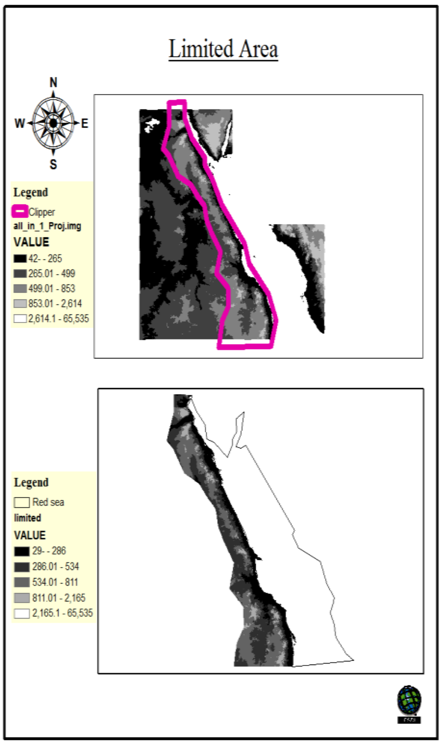

Figure (4.4): The limited area of study

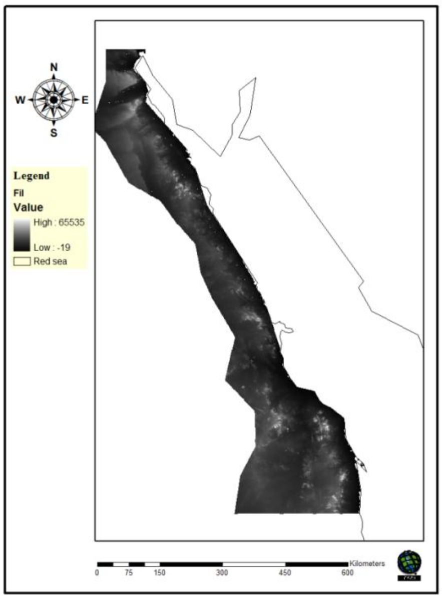

Figure (4.5): DEM for the limited area

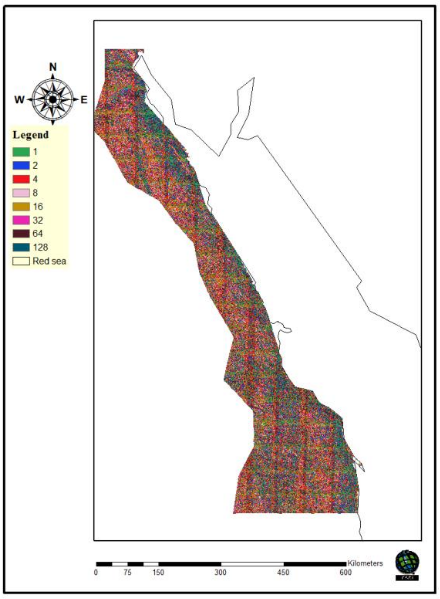

Figure (4.6): Flow direction for the limited area

Next, drainage lines were generated to check streams directions and to be used for delineating the watersheds of the study area based on these directions, figure (4.7).

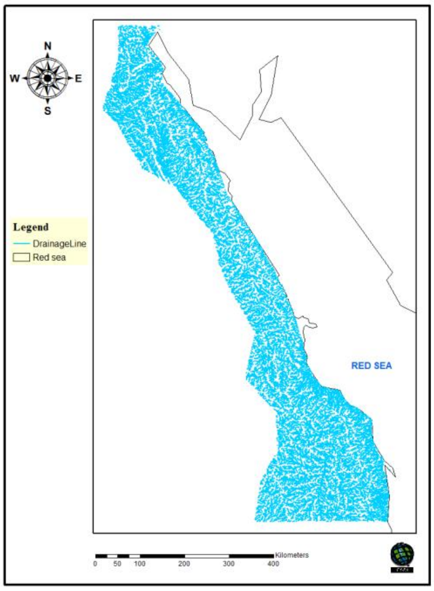

Figure (4.7a): Drainage line for the limited area

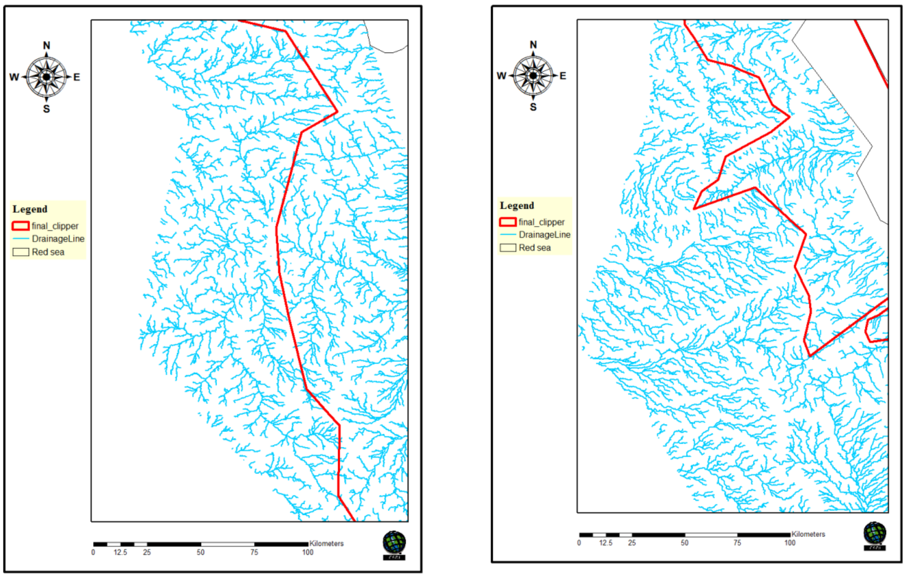

Figure (4.7b): Part of streams discharging to west direction