Chapter 1

1.1Introduction

Floods are one of the most dangerous natural phenomena that negatively affect human life. They can destroy infrastructures and parts of cities and villages, and more dangerous, may kill many people. Flood is composed by water rafting which is very large and considerably above normal levels. Geographic Information Systems (GIS) and remote sensing play an active role in monitoring and reducing natural disasters.

A GIS is a computer-based system that allows for the collection, maintenance, storage, analysis and output and distribution of spatial data and information. These systems are collecting data for management and processing for analysis and simulations – finally results are displayed and the output may help for planning and decision making, in particular for emergency responses, Remote Sensing is a major source of geographical data.

1.2 Problem Statement

In Sudan, the people face flood hazards, especially in Alsalha-algeaa region, in which every year people are suffering from this problem. The Study Area is exposed annually to floods no maps are helping to reduce the damage of floods . and There is no research going on to solve this problem.

1.3 Research Importance

This study will promote GIS technologies as an early warning system to deliver the necessary precautions for Omdurman (Alsalha), to avoid or minimize losses and making contributions to the preservation of life, property and the continuation of life.

1.4 Research Hypothesis

Using GIS technology for data collection, storage, and analysis to increase and improve the accuracy of the information which would lead to flood forecasting and emergency responses.

1.5 Objectives

The main objective of this research is to study the potential of GIS and the role it can play in thedeveloped GIS based system for the management of flood disasters in terms of mapping, representation, processing, statistical and spatial analysis,showing the abilities and the function of using GIS in general and in floods hazard specifically, Develop a multilayer geo- database for the study area to design an early warning system for floods of Alsalha–algeaa, and Applying tools of GIS tools analysis to determine flood risks , and Provide authorities and decision makers with flood hazard thematic maps and reports , and Increase the awareness ofthe publics for the hazards of floods and its danger.

1.6 Research Scope

The implementation of this project is planned for the city of Omdurman Alsalha-algeaa, the project data will be collected by the GIS technologies and using GIS tools - mapping analysis will deliver recommendations for emergency responses.

1.7 Research Methodology

In this study, the descriptive and analytical method was used to use the information. The methodology was developed using spatial data, processing and application of spatial, statistical and data analysis techniques suitable for generating objective maps and reports on flood risks. Using spatial analysis to determine the level of study area, Affected and the assembly point of the affected area, and use network analysis to determine the shortest path from civil defense to the assembly point. In addition to identifying the nearest route from the assembly point to the nearest hospital.

1.8 Organization of the Thesis

There are Five chapters in this thesis; it is organized as follows**:**

1. Chapter**:**2 contain a literature review about floods causes and effects and GIS technology as well as summarizes related work, which are papers with regard to this thesis
2. Chapter**:**3 describe the case study and design geo-database used in data collection and analysis for spatial and statistical analysis.

3. Chapter**:**4 contain implementation and determine the affected areas of floods. Using Simulation models on the computer would enable decision makers to show the results and feasibility and how to use analysis and result.
4. Chapter**:**5 provide conclusions and recommendations for future works with discussion.

Chapter Two

Theoretical Background And Literature Review

2.1 **Natural disaster**

Disaster is an accident caused by the forces of nature, or by human action, resulting in loss of life and destruction of property, and has a severe impact on the national economy and social life.one example is flood.

2.1.1 **Definition of floods**

Floods are defined as extremely high flows or levels flood water of rivers, lakes, ponds, reservoirs and any other water bodies, whereby water inundates outside of the water bodies area.

Flooding also occurs when the sea level rises extremely or above coastal lands due to tidal sea and sea surges. In many regions and countries floods are the most damaging phenomena that effect to the social and economiclife of the population

2.1.2 **Causes of Flooding**

In general, many reasons increase flooding in many parts of the world such as: Climatologically events ,Changes in land use and increasing population, Land subsidence, Tsunami and Dam & Levee Failures.

2.1.3 **The characteristics and related hazards**

The dangers of floodwaters are associated with a number of different characteristics of the flood: Depth of water ,Duration , Velocity , Sediment load and Rate of rise , and Frequency of occurrence

2.1.4 **Effects of Floods**

The effect of a flood can be catastrophic, All these things can happen:

Broken roads and railway lines, Demolished houses and displaced thousands of people and made them homeless, Spoilage of farms and agricultural crops, The electricity and gas supplies are cut off and Diseases , and Disruption of means of transportation ,People and animals are killed , Electrical items like computers and TV can be damaged and Bridges break and Lose luggage

2.1.5 **Benefits of Floods**

The floods have many losses andonly few benefits :River floods feed groundwater reservoirs , and Fill the land with water, which makes fertile land suitable for agriculture and this helps to flourish agricultural activity in the world.

(a) (b)

(c)

(d) (e)

Figure (2.1) Effects of Floods (a, b, c, d ,e)

2.1.6 **Sudan floods**

In the Sudan, as mostother countrieswhich have been hit by floods many times, from time to time and in different amounts, some of them were heavy floods.The most recent heavy floods were in August 2013 which hit Khartoum, the capital.These floods caused massive destruction in infrastructure and destroyed most of the houses and made many families homeless.

The destruction caused by these floods requires assistance, from some of countrieswhom delivered shelters, food and some other basic needs of the affected families.

In July 2016 floods have destroyed 1,160 houses and damaged another 1,320 homes. The UN Office for the Coordination of Humanitarian Affairs (OCHA) reported in a bulletin last week. Around 15,000 people have been affected.

The floods occurred in Singa, the capital of Sennar State. In response, Civil Defense and Sudanese Red Crescent Society (SRCS) have unblocked drainage networks, relocated affected people and distributed sandbags to protect from flooding, (by Richard Davies in Africa news).

In 2016 for example in general Sudan was hit by major floods causing the collapse many housesof either totally or partially.

Torrential rains caused major damage to the lives and property, killing 76 people in 13 states, collapsing more than 300 homes in all, andeffecting more than 1,000 others in Kassala, North Darfur and the island, and also caused severe damage to a group of villages, and flooded the water for about 6 thousand acres, as a result of successive rainfall, as well as torrential flows from the plateau of western Sinnar.

Table (2.1) of disaster damage, rain and floods in the Sudan 18 July 2016 Source: operational mechanism to prevent the effects of the floods and torrential rains of 2016.

Table (2.2) of disaster damage

Unit	**No**	**Item**
The total collapse of housing	541	House
Partial collapse of housing	698	House
The number of deaths	Over 100	People
The number of casualties of	302	People
The cultivated areas lost	1011573	Acres

2.1.7 **Floods in the Alsalha-algeaa Area**

On Aug 3, 2014the total number of homes that was collapsed completely 876 houses, while 720 houses were partially collapsed, along with 16 drowning deaths due to the power of the water rush. In addition that the area is in a state of suffering and lacks a lot of needs, including tents, radiators and blankets beside bed nets, as well as eating and drinking problems related due to lack of bread.

And it resulted in the destruction of a number of bakeries along with the lack of household utensils that disappeared amid the rubble of houses. Thus the emergency room have taken upon themself to provide small meals for the affected, but it could not meet the needs of all, calling organizations together to overcome this disaster Especially organizations and associationsworking in the medical field in anticipation of diseases, that may result from such disasters (Khartoum electronic media center)

(a) (b)

(c) (d)

Figure (2.3)

Figure (2.2), (a,b) Effected Area in Case Study Alsalha-algeaa,2014
(c,d) Alsoog- alarabe, Tunnel of Omdurman- The Great Alftihab, 2018

2.2 **Geographical Information Systems (GIS)**

GIS is defined as a system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing, and disseminating information about areas of the earth [1]

GIS is defined as follows

An integrated spatial database management system using database technology and spatial databasesor A computer-based system comprising one or more databases together with a set of tools for collecting (capturing) ,storing, checking, editing, retrieving, integrating, manipulating, transforming, analyzing and displaying geographical referenced dataother defined **,** A powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes.

2.2.1 **ArcGIS Definition**

ArcGIS is a geographic information system (GIS)software for working with maps and geographic information. It is used for creating and using maps, compiling geographic data, analyzing mapped information, sharing and discovering geographic information, using maps and geographicinformation in a range of applications, and managing geographic information in a data base.

The software provides an infrastructure for making maps and geographic information available throughout an organization, across a community, and openly on the Web.

2.2.1.2 **ArcGIS includes the following Windows desktop software**

Arc Reader, which allows one to view and query maps created with the other ArcGIS products; ArcGIS for Desktop, which is licensed a follows

2.2.1.3 **Functionality levels**

ArcGIS for Desktop Basic (formerly known as ArcView), which allows one to view spatial data, create layered maps, and perform basic spatial analysis;

And ,ArcGIS for Desktop Standard (formerly known as Arc Editor), which in addition to the functionality of ArcView, includes more advanced tools for manipulation of shape files and geo databases; and ArcGIS for Desktop Advanced (formerly known as Arc Info), which includes capabilities for data manipulation, editing, and analysis.

There are also server-based ArcGIS products, as well as ArcGIS products for PDAs. Extensions can be purchased separately to increase the functionality of ArcGIS

2.2.2 **Geography**

Geography is broadly concerned with understanding the world and man‘s place in it. Geography has a long tradition in spatial analysis. The discipline of geography provides techniques for conducting spatial analysis and a spatial perspective on research [2].

2.2.3 **Cartography**

Cartography is concerned with the display of spatial information. Currently the main source of input data for GIS is maps. Cartography provides a long tradition in the design of maps which is an important form of output from GIS. Computer cartography (also called ‗digital cartography‘, ‗automated cartography‘)

provides methods for digital representation and manipulation of cartographic features and methods of visualization.

2.2.4 **Benefits of GIS**

Automating map making and updating, and Providing a unified database, and Linking location and descriptive attributes of feature(s) ,and Manipulating & analyzing Geographic Information in ways that are not possible manually and Higher accuracy, higher costs

2.2.5 **GIS Advantage over Maps**

2.2.5.1 **Data Storage**

Spatial data stored in digital format in a GIS allows for rapid access for traditional as well as innovative purposes, The nature of maps creates difficulties when used as sources for digital data, and Most GIS take no account of differences between datasets derived from maps at different scales.

2.2.5.2 **Data Indexes**

This function can be performed much better by GIS due to the ability to provide multiple and efficient cross-referencing and searching.

2.2.5.3 **Data Analysis Tool**

GIS is a powerful tool for map analysis, and Traditional impediments to the accurate and rapid measurement of area or to map overlay no longer exist.

2.2.5.4 **Data Display Tools**

Electronic display offers significant advantages over the paper map , Ability to browse across an area without interruption by map sheet boundaries, and Ability to zoom and change scale freely, and Potential for the animation of time dependent data, and Display in three dimensions‖ (perspective views),with in real-time , Rotation of viewing angle, and Potential for continuous scales of intensity and the use of color and shading , then Independent of the constraints of the printing process, ability to change colorsas required for interpretation.

2.2.5.5 **GIS Data Models**

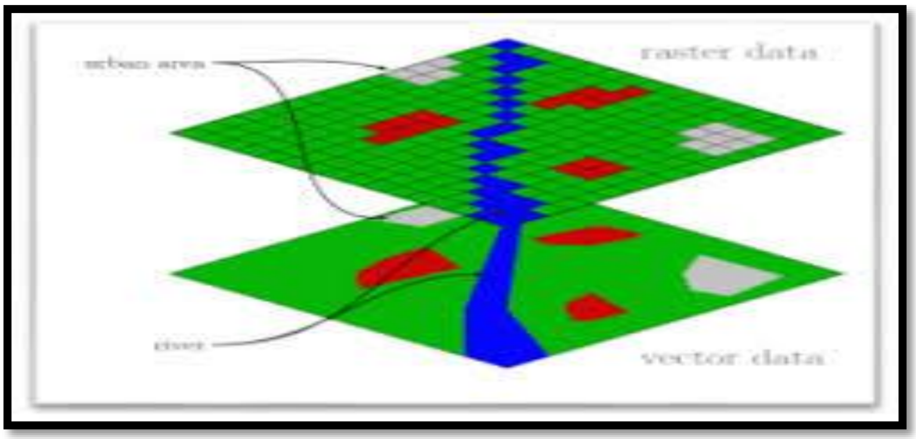


Figure (2.4)The GISlayers Models

2.2.6 **Vector-based**

The geographic features are points, lines and polygons (areas), the features are discrete. In the vector format, the river is represented by an actual line with geographic coordinates, while the trees can either be represented as an area that surrounds the tree stand, or as individual points representing trees. Storing the geographic coordinates for these features provides great flexibility for use in a GIS.

2.2.6.1 **Raster-based**

The geographic features are represented as a matrix/grid of values. The values equally spaced across a surface. The raster representation of the real world objects is limited by the size of the grid cells. Therefore, the river is coded as a series of grids with the letter B, while the trees are codes as a series of grid cells with the letter G.

2.2.6.2 Raster Representation of Data

Raster data is an abstraction of the real world where spatial data is expressed as a matrix of cells or pixels, with spatial position implicit in the ordering of the pixels. Each cell within this matrix contains location coordinates as well as an attribute value. With the raster data model, spatial data is not continuous but divided into discrete units. This makes raster data particularly suitable for certain types of spatial operation, for example overlays or area calculations[3].

2.2.6.3 Three Views of GIS

Many have characterized GIS as one of the most powerful of all information technologies, because it focuses on integrating knowledge from multiple sources and creates a crosscutting environment for collaboration. In addition, GIS is attractive to most people who encounter it because it is both intuitive and cognitive. It combines a powerful visualization environment with a strong analytic and modeling framework that is rooted in the science of geography. This combination has resulted in a technology that is science-based, trusted, and easily communicated across cultures, social classes, languages, and disciplines. To support this vision, GIS combines three fundamental aspects or views [4].

2.2.6.4The Geo-database View

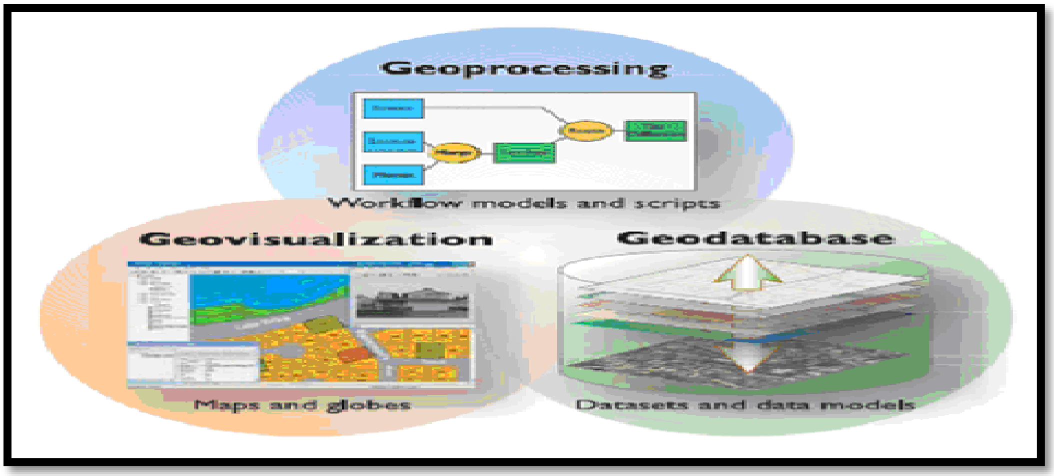
A GIS manages geographic information. One way to think of a GIS is as a spatial database containing datasets that represent geographic information in terms of a generic GIS data model— features, raster, attributes, topologies, networks, and so forth. GIS datasets are like map layers; they are geographically referenced so that the overlay onto the earth's surface. In many cases, the features (points, lines, and polygons) share spatial relationships with one another. For example, adjacent features share a common boundary. Many linear features connect at their endpoints. Many point locations fall along linear features (e.g., address locations along roads) [4].

2.2.6.5 **The Map View**

A GIS is a set of intelligent maps and other views that show features and feature relationships on the Earth's surface. Various map views of the underlying geographic information can be constructed and used as "windows into the geographic database" to support queries, analyses, and editing of geographic information. Each GIS has a series of two-dimensional (2D) and three-dimensional (3D) map applications.That provides rich tools for working with geographic information through these views [4].

2.2.6.6 **The Geo-processing view**

A GIS is a set of information transformation tools that derive new information from existing datasets. These geo-processing functions take information from existing datasets, apply analytic functions, and write results into new derived datasets. Geoprocessing involves the ability to string together a series of operations so that users can perform spatial analysis and automate data processing all by assembling an ordered sequence of operations.



Figure(2.5)three views of GIS

2.2.7 Kinds of GIS Analysis

There are many kinds of GIS analysis such as measurements, layer statistics, queries, proximity analysis, filtering the raster data, buffering vector data, map overlay, transformation and reclassification.

2.2.7.1Spatial Data Analysis

Spatial analysis is a term widely used in the Geographical Information Systems (GIS) and Geographical Information *Science*. A definition of spatial analysis is that it represents a collection of techniques and models that explicitly use the spatial referencing associated with each data value or object that is specified within the system under study. Spatial analysis methods need to make assumptions about or draw on data describing the spatial relationships or spatial interactions between cases. The results of any spatial analysis are not the same under re-arrangements of the spatial distribution of values or reconfiguration of the spatial structure of the system under investigation [5].

2.3 **Remote Sensing**

This emerging technique which records images from space and the air is a major source of geographical data. Remote sensing includes techniques for data acquisition and processing anywhere on the globe at low cost. and consistent update potential. The main advantage of it is that interpreted data from a remote sensing system can be merged with other data layers in a GIS

2.4 **Photogrammetry**

Using aerial photographs and techniques for making accurate measurements from them, photogrammetry is the source of most data on topography (ground surface elevations) used for input to GIS [3].

2.5 **Global Positioning System (GPS)**

Is a satellite navigation system that provides location and time information in all weather conditions anywhere on or near the Earth where there is an unobstructed line of sight for four or more GPS satellites. The system provides important capabilities for military, civil and commercial users worldwide. The US government has created the system, maintains it and has made it free for anyone with a GPS receiver

2.6 **Surveying**

Surveying is concerned with the measurement of locations of objects on the Earth's surface, particularly property boundaries. Surveying provides high quality data on positions of land boundaries, buildings, etc.

2.7 Related Works

- Flood Hazard and Risk Assessment in Chamoli District, Uttarakhand Using Satellite Remote Sensing and GIS Techniques

Floods are a major environmental problem in India and have devastating effects on life and property. The problem with this paper is that there are no maps that determine the risks of flooding and the absence of maps that assess risks at the landscape level. India is characterized by spectacular landscapes and floods have a negative impact.TheChamoli District, Uttarakhand, India covering total geographical area of 8030 km2. The study area lies between 30-31° N latitude and 79-80° E longitude,

The methodology and the techniques usedare the visual interpretation techniques for the preparation of the plant maps. A series of multiple temporal data for flooding was used to prepare the digital evaluation model. Geographic information systems were used in spatial analysis.

The result of the researchers was the creation of a map that illustrated the areas affected by the floods. The areas were classified as very high, high, medium, low and very low. This classification contributes to reducing and reducing losses and contributes to minimizing the impact of floods. There are comparable areas in the Himalaya.

- Applicationof RS & GIS in Flood Management A case Study of Mongalkote Blocks , Burdwan, West Bengal

Floods occur as a result of geophysical events that create an unexpected threat to human life, which negatively affects people and their well-being. Mongalkote Blocklies between 23°30′51″N to 23°40′37″N

Latitude 87°53′28″E to 88°49′12″E longitude. It extends over 364.90 sqkmarea and has a population, according to thecensus of 2001of 233,944 persons with the density of 641/sq km.

The study areahas been mainly affected by two rivers Ajoy&KunurRiver. Due to flooding in thearea by Ajoy and KunurRiver water spillsover and the other causes are narrow riverchannel, over sedimentation of channel, lowrun-off, heavy rainfall and very lowelevation of this area.

The problem ,Mongalkote Block suffer floods and the absence of structural measures for flooding, management, control and prediction and the absence of appropriate illustrations of maps in real-time torrents.

The methodology and techniques used by the researchers in this paper are remote sensing and their ability to provide data in real time. Here GIS technology support mapping of submerged areas and assessing damage by integrating meteorological data, topographic data and land use data. Satellite data was used before and during after the disaster

The results of the researchers in this paper are maps of the floods used in real time and also maps of flood forecasting, which helps in the structural measures of floods and management and control and thus can be mitigated by floods, preparedness and response speed

- GIS Database on Hydro-GeomorphologicDisaster in Portugal

Natural disasters are one of the most widespread phenomena in the world, and in Portugal there are many floods and landslides, where economic losses are not included and need to be reconsidered

The problem in this paper is the absence of a geographic geomorphological database system, that monitors water disasters, identifies the type of disaster, the number of casualties and the others.

The methodology for data collection and storage using an online multiuser database, a development was made on a LAMP platform, comprised of an Apache Webserver, a MySQL database engine and using the PHP programming language built on a Linux Server, tocollect data from mainstream newspapers and distributethem to most sites to cover the country and read these newspapers to analyze and convert data to digital data.

The results of the researchers are the creation of a database that enables disaster monitoring, type, analysis, prediction and dissemination, The records of damage were also identified and the number of injured, missing and displaced persons was determined by floods or water disasters.

Chapter Three

Design Geo-database

The Study Area

3. Descriptionof Study Area

The study covers a selected part of the Alsalha-algeaa and areas around.

3.1 Location

Alsalha is located in the state of Khartoum in the south of the city of Abosyed Omdurman the southern countryside. It lies between [15°32‘0", 15°31‘0"] latitude N , and [32°25‘0", 32°26‘0"] longitude E, and in the East we find the Islamic University of Omdurman and in the North-West Mount Touraieh and the new airport in addition to the bridge dabasin,Figure [3.1].

Its total area is estimated at 3.28 km2 and the Built Area is estimated at 2.13 km2.

Table (3.1) Area coordinates

Point	Easting	Northing
A	437918	1718740
B	438337	1715309
C	437163	1717263
D	439477	1717342

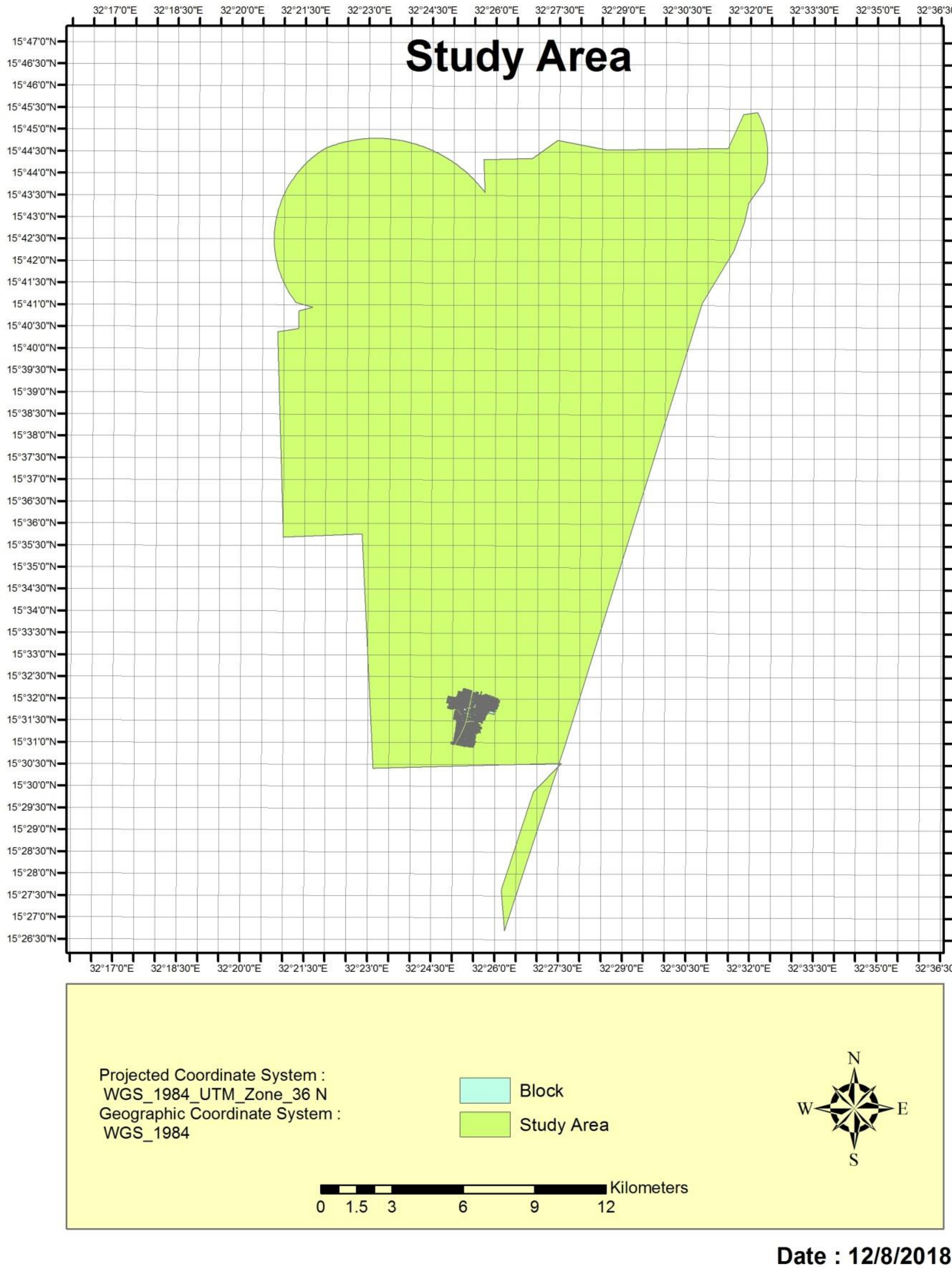


Figure (3.1) Study Area

3.2 **Ecology**

The Study Area features a hot arid climate, with only the autumn months seeing noticeable precipitation. The city averages a little over 155 millimeters (6.1 in) of precipitation per year

3.2.1 **Climate**

The climate of the study area is semi-desert almost every months of the year except for the months of July and August, where rainfall occurs.TheOmdurman Alsalha-algeaaregion is considered one of the hottest cities in the world, with a temperature exceeding 53 ° C (127 ° F). The average annual temperature is 37 ° C (99 ° C) ° F) with six months of the yearand at least an average monthly temperature of 38 ° C (100 ° F). It is noted that the temperature drops significantly during the night to reach about 15 ° C (59 ° F).

3.2.2**Topography**

The study area topography is a plain surface gently sloping towards the White Nil and River Niles, generally elevated between 400 to 380 m above mean sea level the area is regarded as semi-arid zone. The drainage system is dominated by the lower most reaches of the White Nile, River Nile and local systems of ephemeral streams (e.g. Wadis and Khors) Figure (3.2)

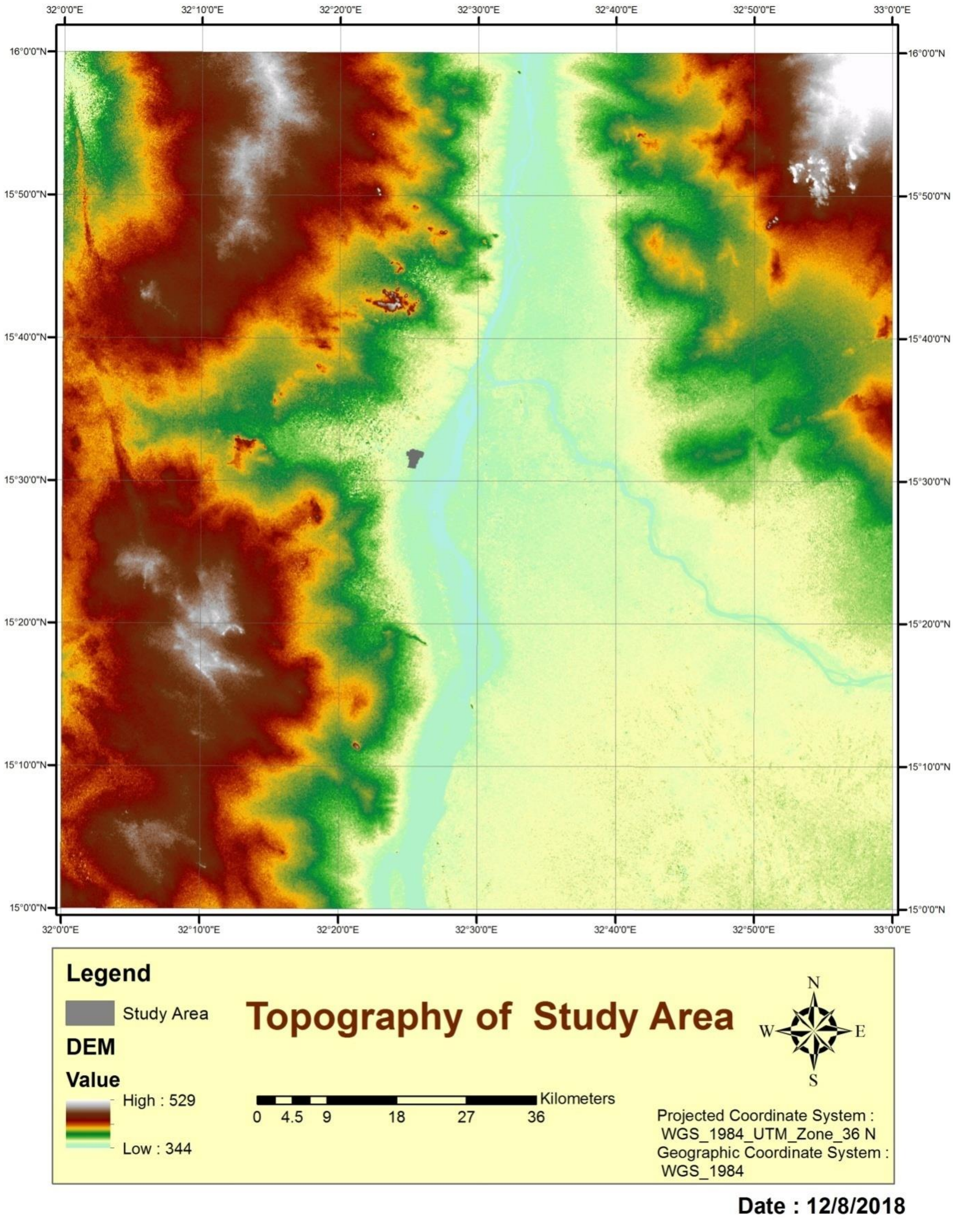


Figure (3.2)Topography of study Area

3.2.3 **Old Channels and Wadies**

The area of Alsalha-algeaa is characterized by the existence ofWadi or Khor on the western side, which extends East to reach the Nile River, called the region of (Toti), the khoris a long and narrow depression formed as a result of erosion, a natural drainage of rain .

3.2.4 **Soil**

In terms of geological composition, they are divided into three main sections: sedimentary formations, basic rocks and sandstone formations.Each of which has its characteristics which distinguish it from other structures. Sedimentary formations are the most common form in this region.

3.2.5 **Contours**

Work was done to see the nature of the earth and the terrain, in the steep north and southward the lowest slope Figure (3.3).

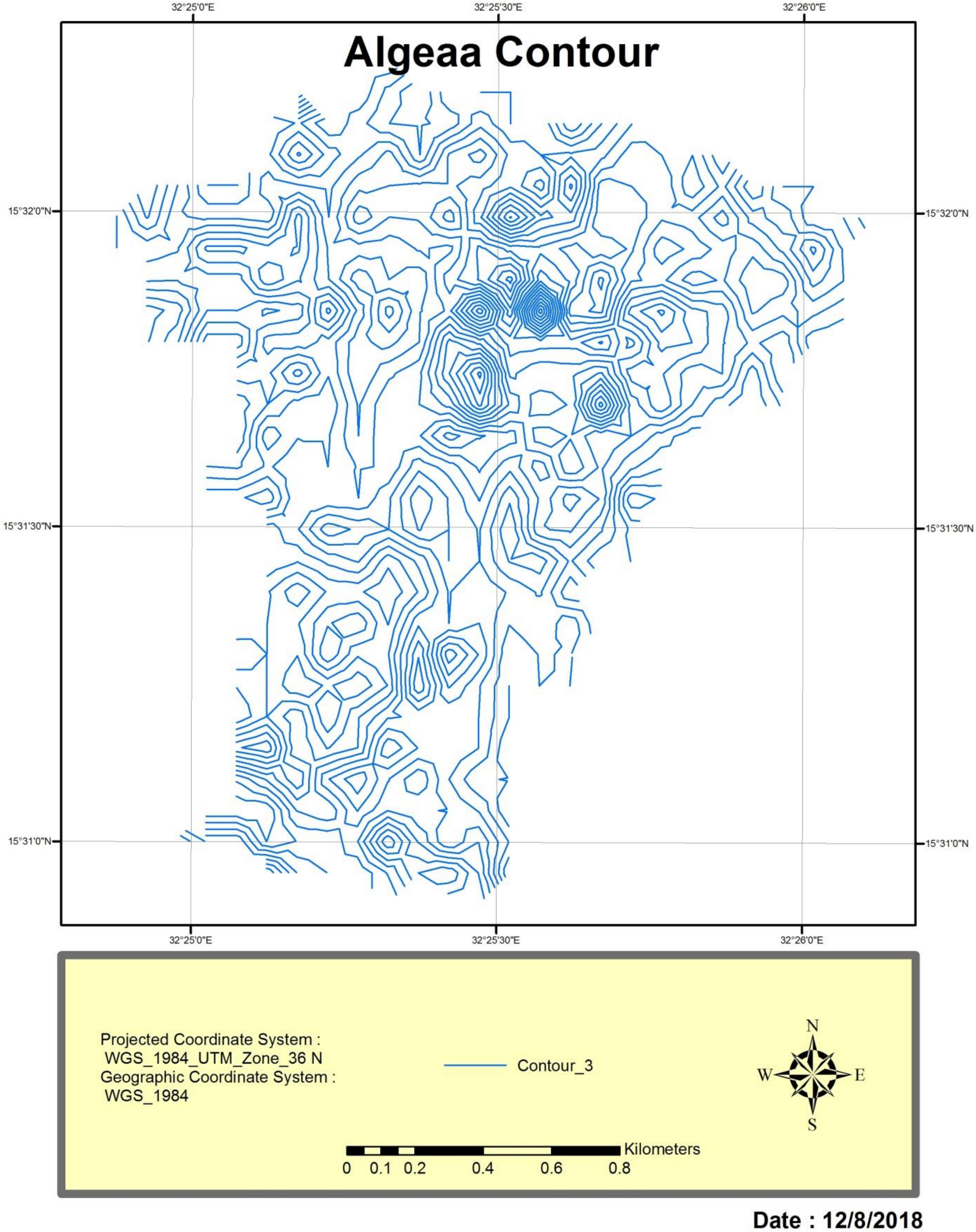


Figure (3.3) Algeaa Contours Line

3.2.6 **Aspect**

Most of the region is heading east by 32%, followed by the southward slope of 27% and the north and west by 20%, calculated according to count pixel, see Figure (3.4).

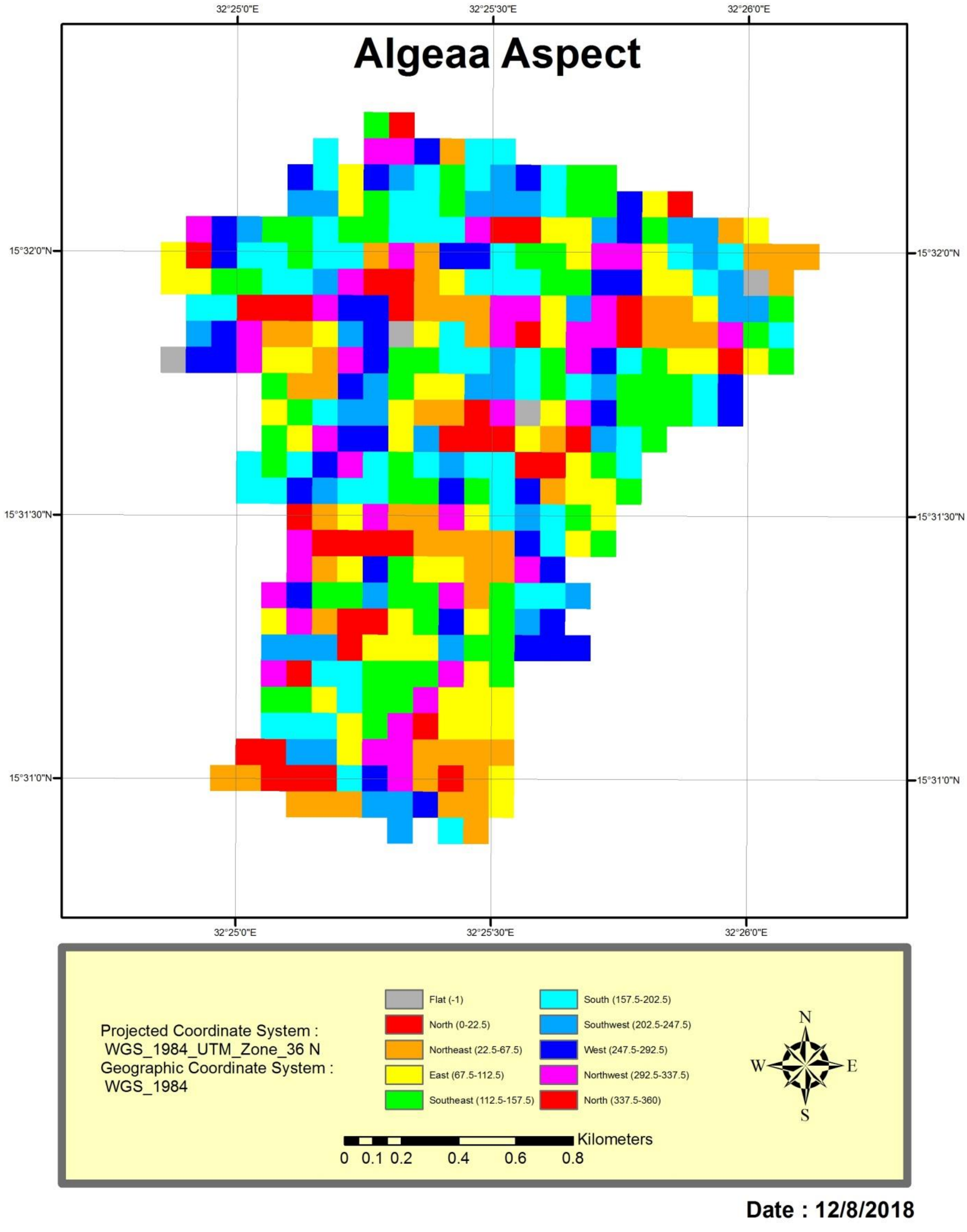


Figure (3.4) Algeaa Aspect

3.3 Data Collection

A field visit to the area was conducted, characterized as low-built and densely populated, andgathering coordinate and data using GPS navigator Figure (3.5)and Figure(3.6) and The map of buildings and roads has been obtained from the Khartoum State Survey Corporation (KSSC) with accuracy of about 2m Figure (3.7) then Digital Elevation Model (DEM):Space Shuttle Radar Topography Mission (SRTM) with 30 meter spatial resolution was used to determine the topographic characteristics of the study area, and Data obtained from the Nile Meteorological Authority Figure(3.8).

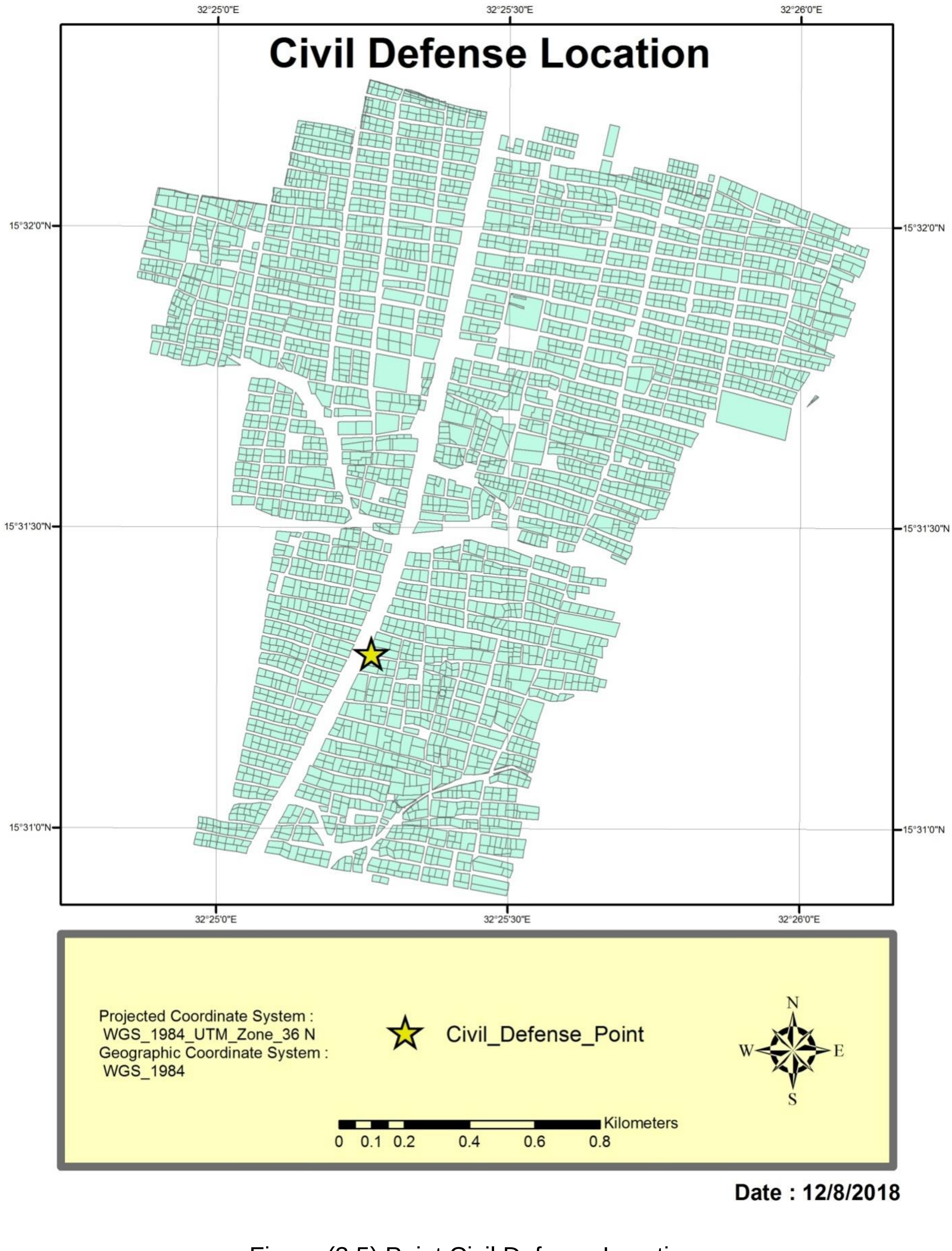


Figure (3.5) Point Civil Defense Location

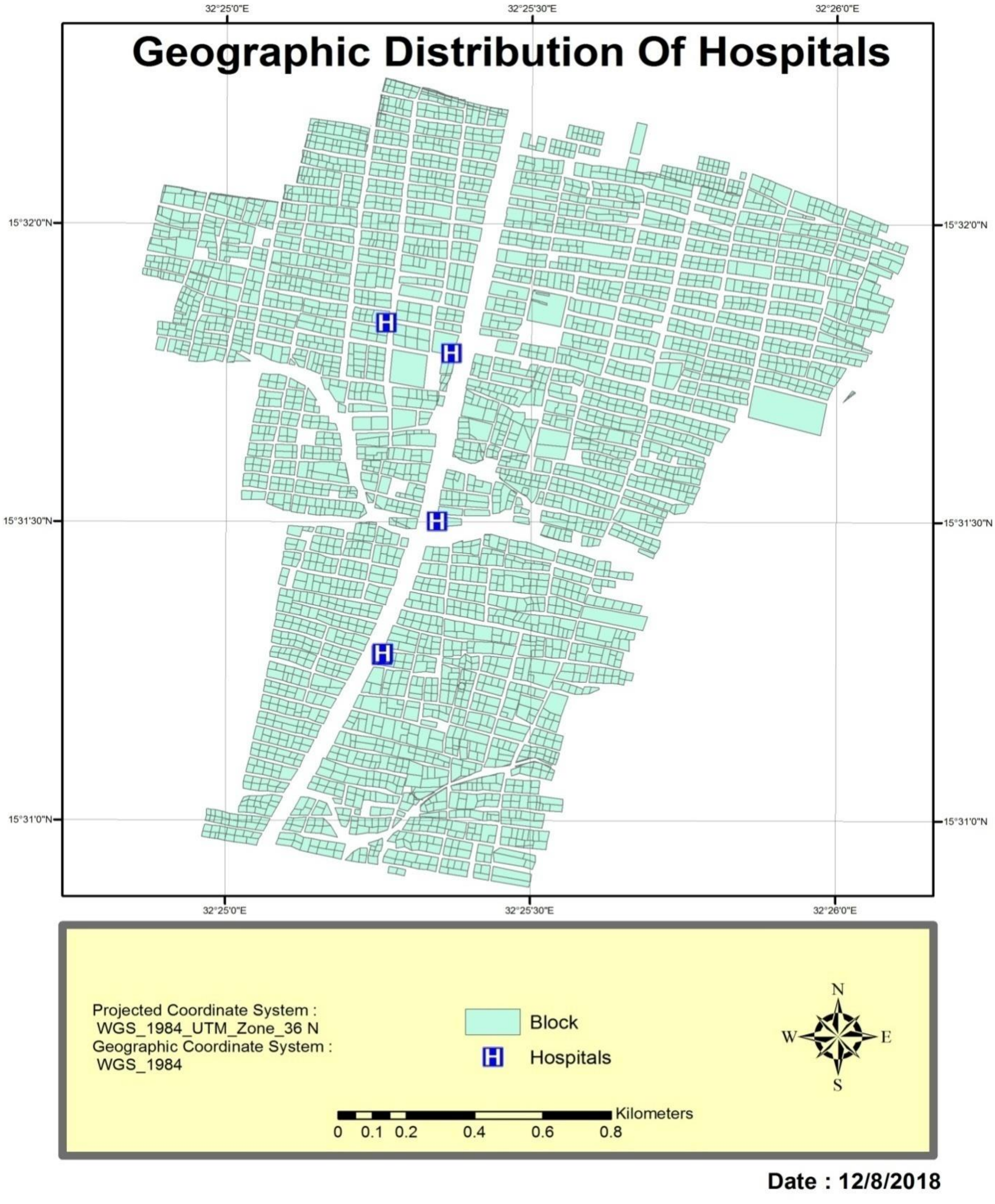


Figure (3.6) Distribution of Hospital

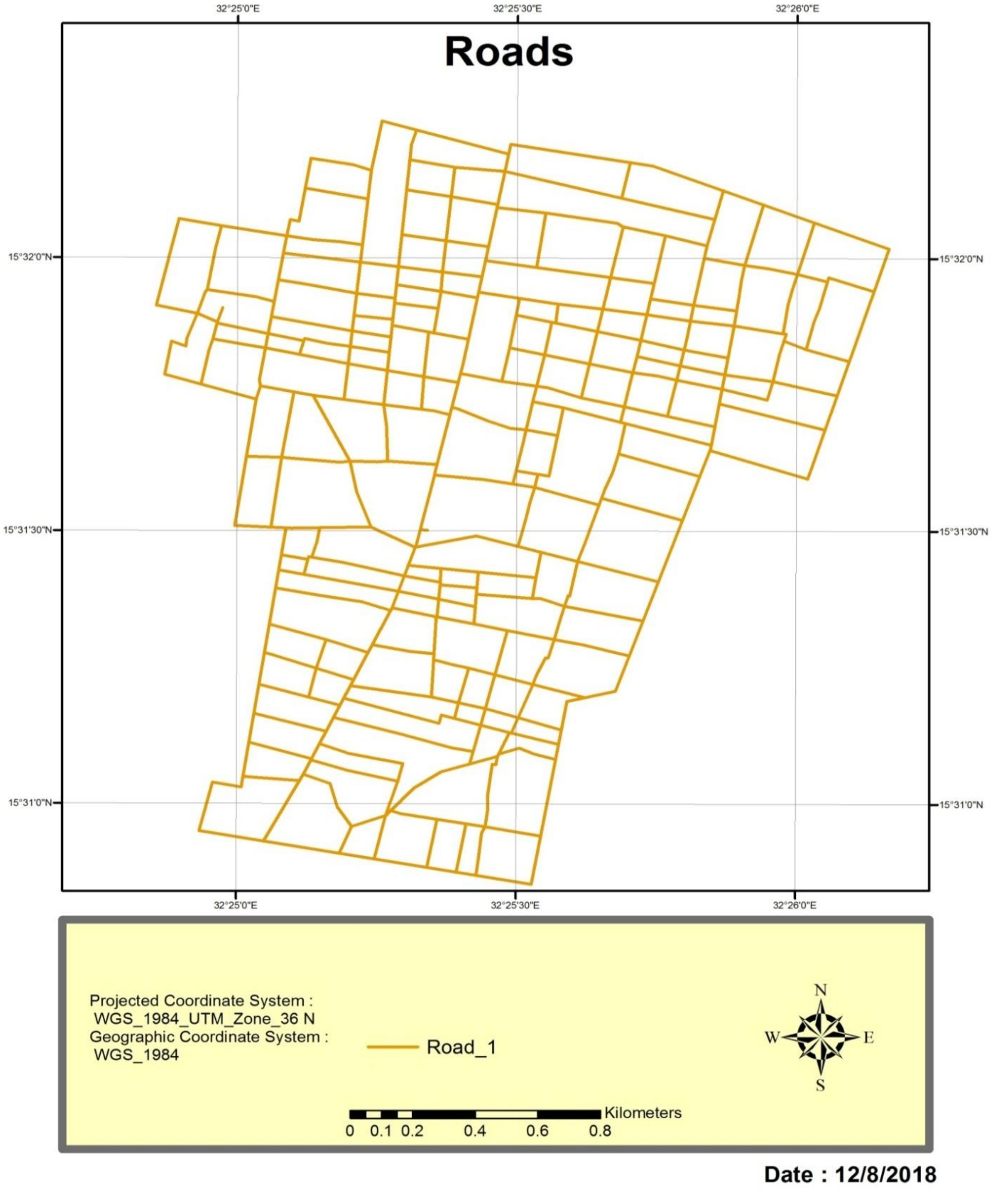


Figure (3.7) Roads

MINISTRY OF ENVIROMENT, FORESTRY
AND PHYSICAL DEVELOPMENT
METEOROLOGICAL AUTHORITY
WEATHER – CLIMATE DATA

Station: - KHARTOUM

2012 2013 2014 2015 2016 2017

ELEMENT Month	Total Rainfall (Mm)	Total Rainfall (Mm)	Total Rainfall (Mm)	Total Rainfall (Mm)	Total Rainfall (Mm)	Total Rainfall (Mm)
January	0.0	0.0	0.0	0.0	0.0	0.0
February	0.0	0.0	0.0	0.0	0.0	0.0
March	0.0	0.0	0.2	0.0	0.0	0.0
April	0.0	0.0	TR	0.0	0.0	0.0
May	0.0	TR	4.6	0.0	0.0	1.4
June	TR	0.0	0.6	TR	0.2	12.0
July	20.9	14.4	73.6	0.4	14.2	24.0
August	57.7	69.0	52.3	28.9	52.6	75.9
September	TR	3.2	29.4	13.9	12.2	0.0
October	8.0	0.2	5.7	29.3	TR	
November	TR	0.0	0.0	0.0	0.0	
December	0.0	0.0	0.0	0.0	0.0	
Total/annual	86.6	86.8	165.8	72.5	79.2	113.3

Note :- TR = Trace

Figure (3.8) Weather Climate Data

3.4 **Methodology**

After the selection of the study area, the coordination of the coordinate systemunitsand the network of roads,were established by steps Converting numbered data into a layer within the ARC GIS program, finding the levels for the study area, finding the level of natural Nile, work of the topology of the road network

And ,The work on topology of the Road Network to find and correct errors, according to the following rules:The line is not redundant or incomplete; two lines do not match one point. And do not intersect a line, and are looking for intersection errors and The geo-database has been created to store spatial data.

,Other spatial data such as hospital location,civil defense point location, the road network, buildinglayer, are all stored in the geodatabase are used to conduct the spatial analysis and The digital evaluation model of the study area and contains the clip ,(Toolboxes → Data Management → Raster → Raster Processing → Clip),(Toolboxes → Data Management Tools → Features → Feature to Point) and ,The levelswere extracted from the DEM, (Toolboxes→ Spatial Analyst Tools → Extraction → Extract Values to Point) and To identify the affected areas which are below the Nile level during the floods, we follow the following steps of selection by attribute, the affected areas (below the Nile level) were identified from (Attribute → Table →Summarize), and To show the affected and unaffected areas and to calculate the areas and buildings affected by(Attribute → Calculate →Geometry → Area), and After the treatments performed in the previous steps, many statistical and spatial analyses were conducted on the processed data.

GatheringPointSpatial analysis was used to determine the level of the Study Area;from the meteorological level, the affected areas were calculated,then the

Gathering point for the affected areas, thegathering point have been determined (the intermediate point between the affected areas only).
Toolbox→ Spatial Statistics Tools →Measuring Geographic Distribution → Mean Center. The nearest safe area was selected in the unaffected part to be the required gathering point, Toolbox → Analysis Tools → Proximity → Near.

ClosestPathTo determine the closest path from thecivil defense to thegathering point, from the Network Analysis tab, choose(New Route) , after specifying the points (gathering point and civil defense) and pressing £ Solve.
Closest Path to the NearestHospitalDetermine the closest path from the gathering point to the nearest hospital, through the (New Closest Facility) from the bar (NetworkAnalysis) because there are more than one hospital. Where the hospital layer is added to the facilities by
Arc Toolbox → Network Analysis Tool → Analysis → Add Location
The gathering point is selected from the Create Location Tool, then choose £Solve from spatial analysis tab.

Flood Hazard Map It is one of the simulation models on the computer to identifythe affected at the height of the Nile level to 386m. Then a new layer for the affected areaswas created and there after the transfer the affected buildings in the new layer followed.

3.4.1 **Prediction for 2019**

Defining the civil defense point of 2019

The civil defense is one of the most important organs that specialize in the management of all preventive and precautionary factors and activities of the rescue and rescue operations through the intervention and rapid handling in an integrated manner with any emergency circumstances and reduce any negative effects of the disaster or mitigate them. The presence of civil defense is important in all areas to reduce the percentage of losses resulting from any disaster and avoiding the serious damage resulting from it.

With the help of Microsoft Excel software using thefunction of forecasting aMathematical prediction has been done to estimate the flood in 2019 through the information ofthe meteorological agency of the previous seven years (2012-2018).

3.4.2 **Model of Geo-database**

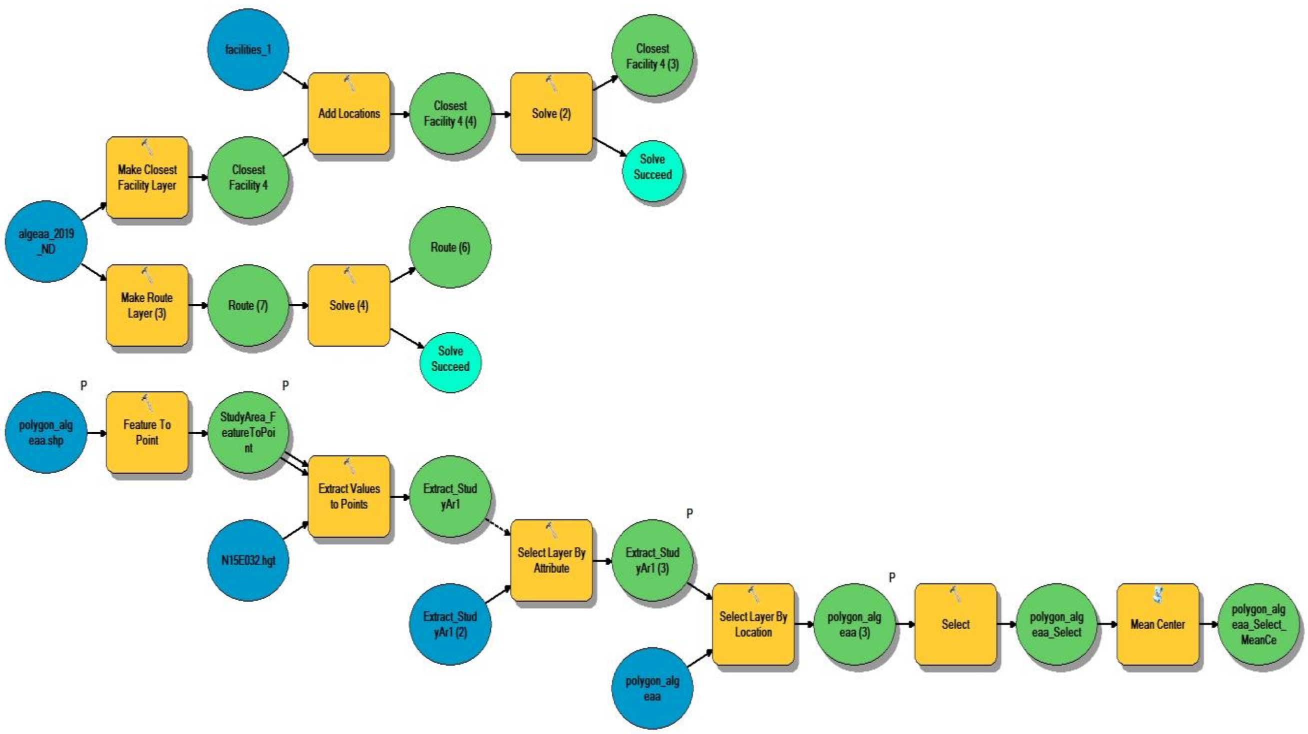


Figure (3.9) Model of Geo-database

Chapter Four

Result And Discussion

4. Result

4.1 The gathering point 2014

reduce lives as much as possible, a safe gathering point is chosen to transport the affected persons according to their necessary medical treatment of the residential areas using the evacuation (the transfer of persons or Property from a danger zone or area at risk to safe places, the gathering point or the accommodation areas) Figure (4.1).

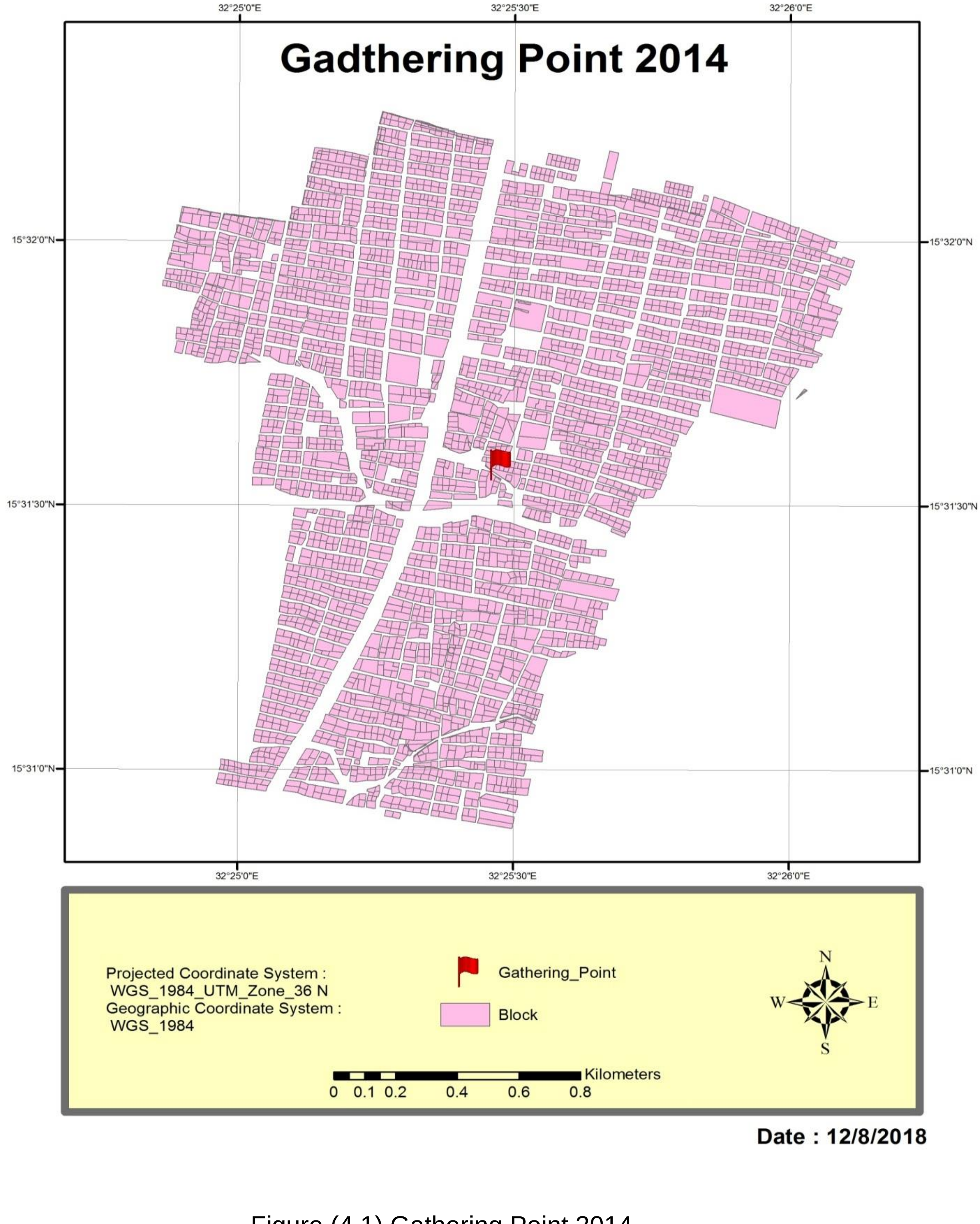


Figure (4.1) Gathering Point 2014

4.2 **Closest path from Civil Defense to the gathering point 2014**

One of the main points in saving lives and property is to reach the gathering point with the shortest route and the lowest possible time. Therefore, amap was produced showing the shortest route from the point of defense to the gathering point, Figure (4.2).

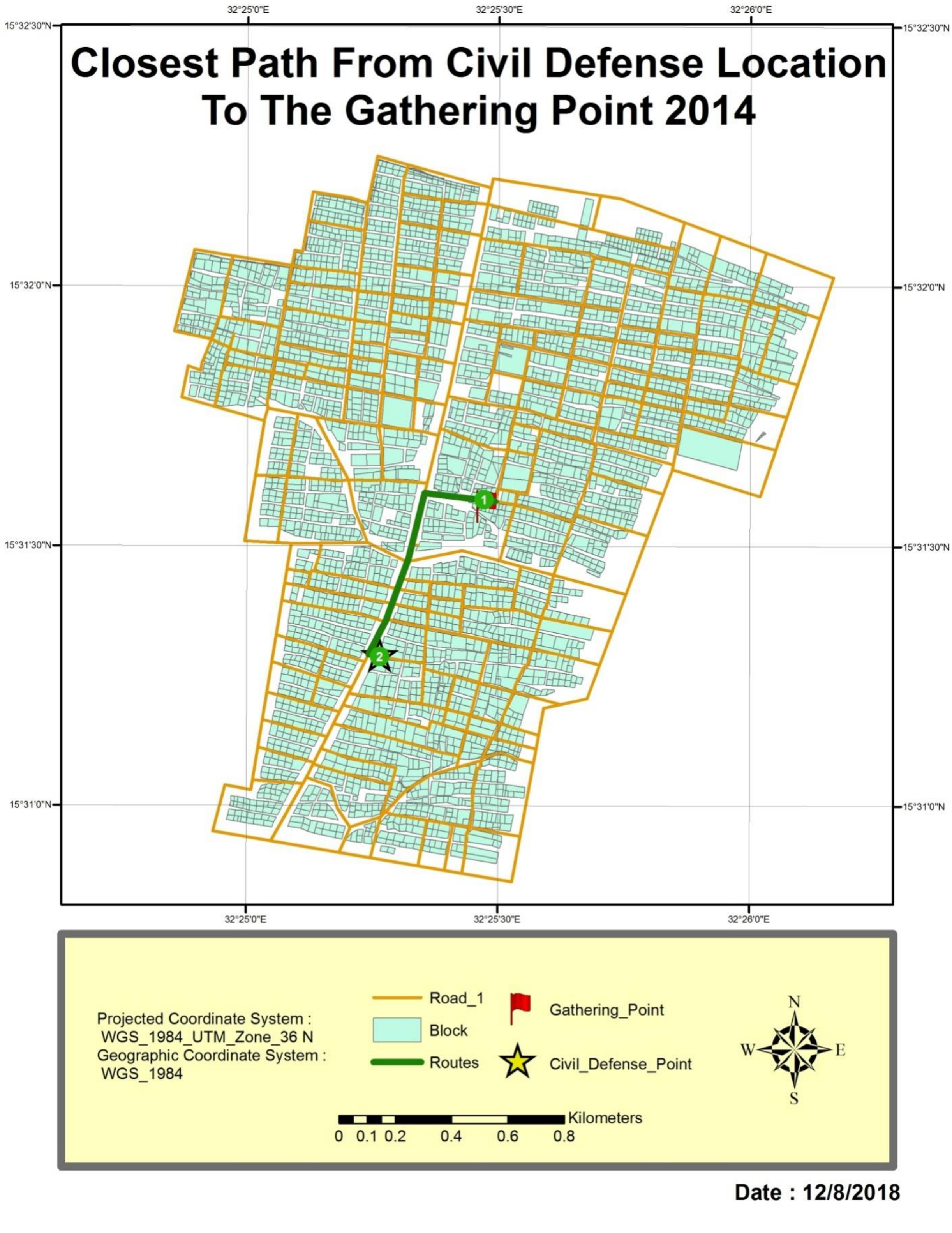


Figure (4.2) Closest Path from Civil Defense Location to the Gathering Point 2014

4.3 **Closest Path from the Gathering to the Nearest Hospitals in 2014**

To analyze the damages caused by the flood as much as possible and the response time needed for ambulance services, the nearest hospital was identified for the gathering point and the shortest path to reach it, Figure (4.3)

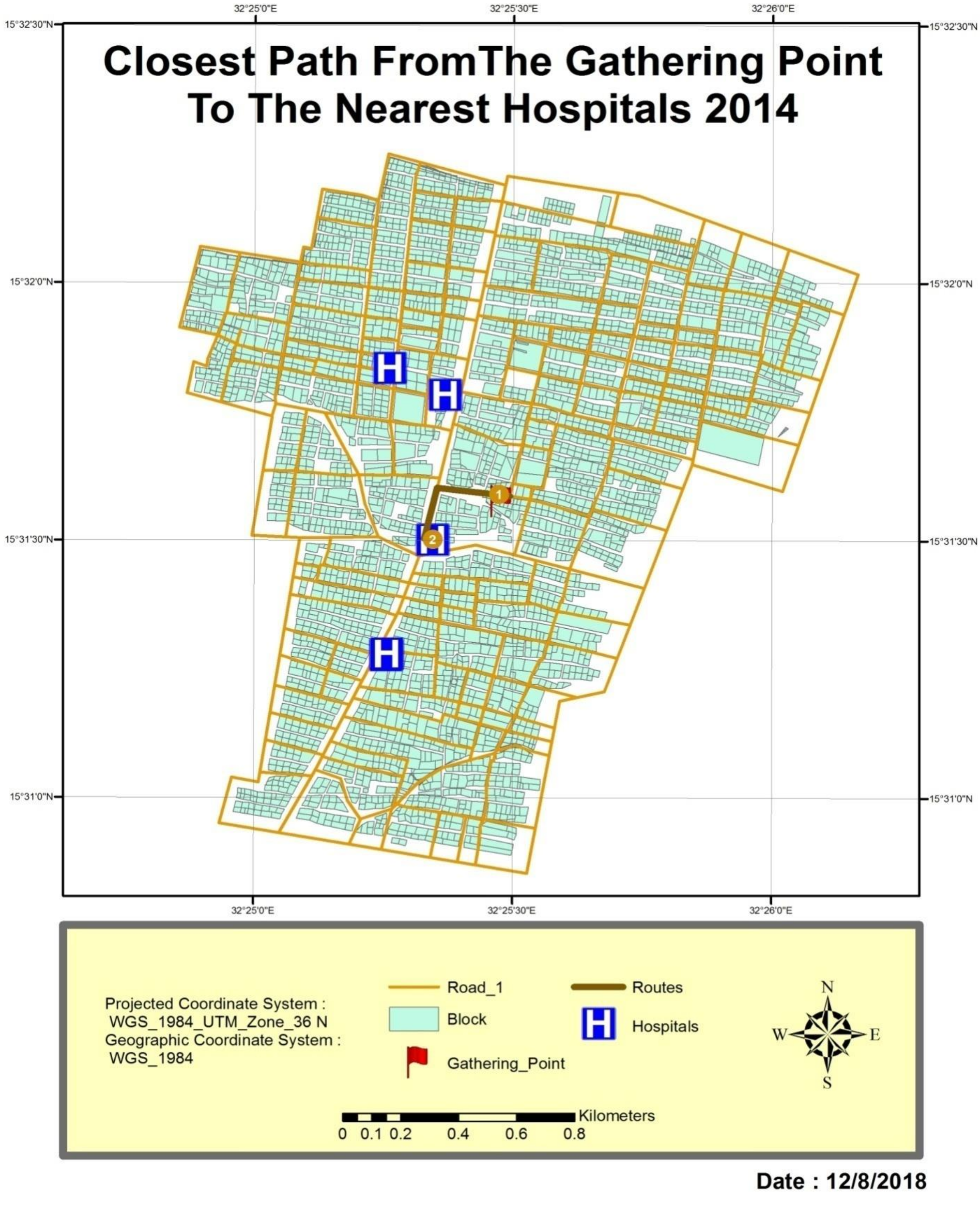


Figure (4.3)Closest Path from the Gathering Point to the Nearest Hospitals 2014

4.4 **Flood Hazard Map2014**

The goal of the hazard level map is to try to determine the affected areas based on descriptive and spatial data., The result distance the access to damaged and non-damaged areas, Figure (4.4), and we got the number of affected homes =892 & The area of the affected houses=838.415 m2, and the total number of houses =3877.

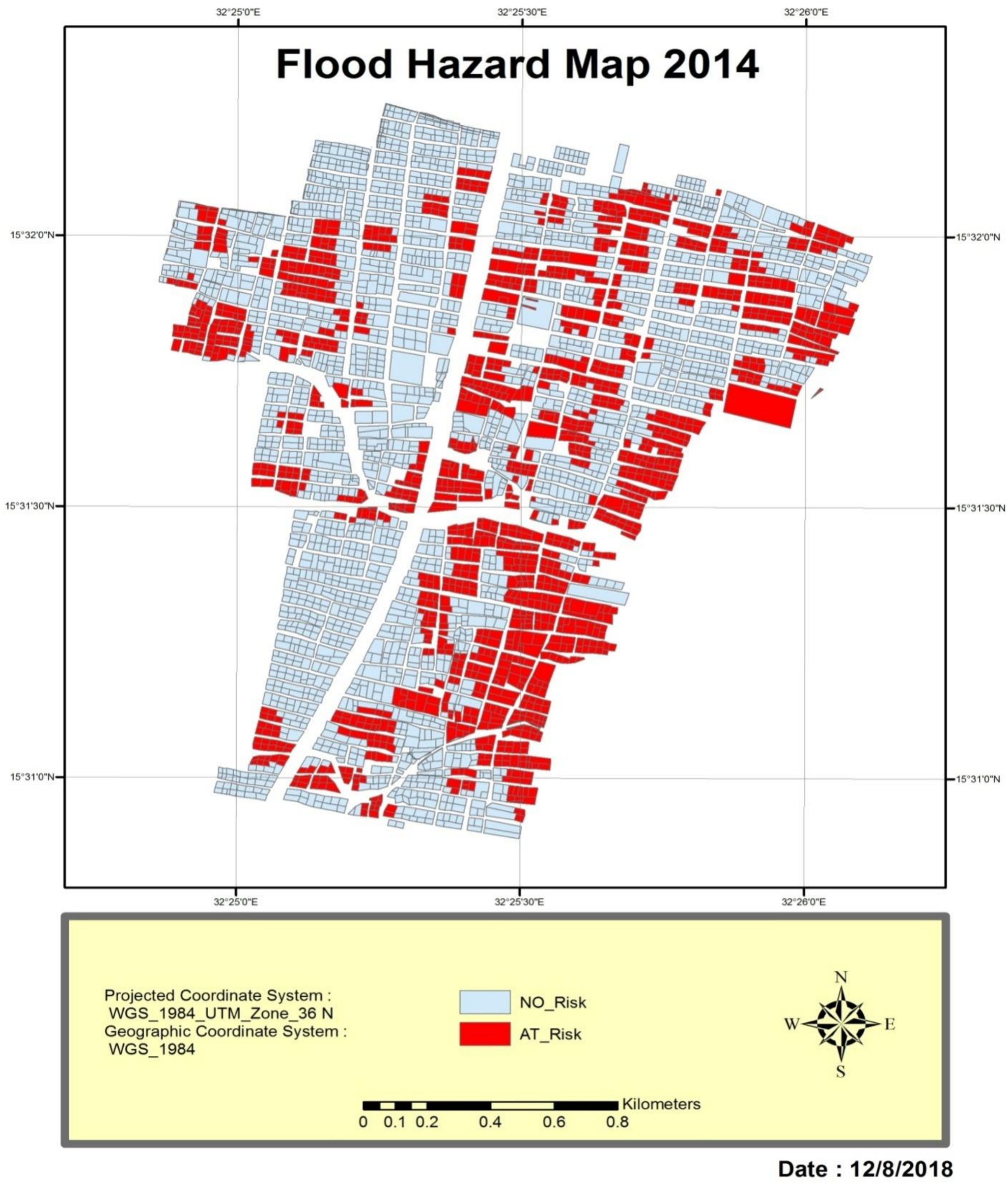


Figure (4.4) Flood Hazard Map 2014

4.5 **Predicted flood2019**

Using the information of the meteorological agency for the previous seven yearsand using the prediction function of the Excel program and it result was that the expected rainfall rate for 2019 is = **90.08** millimeters,seeFigure (4.5).

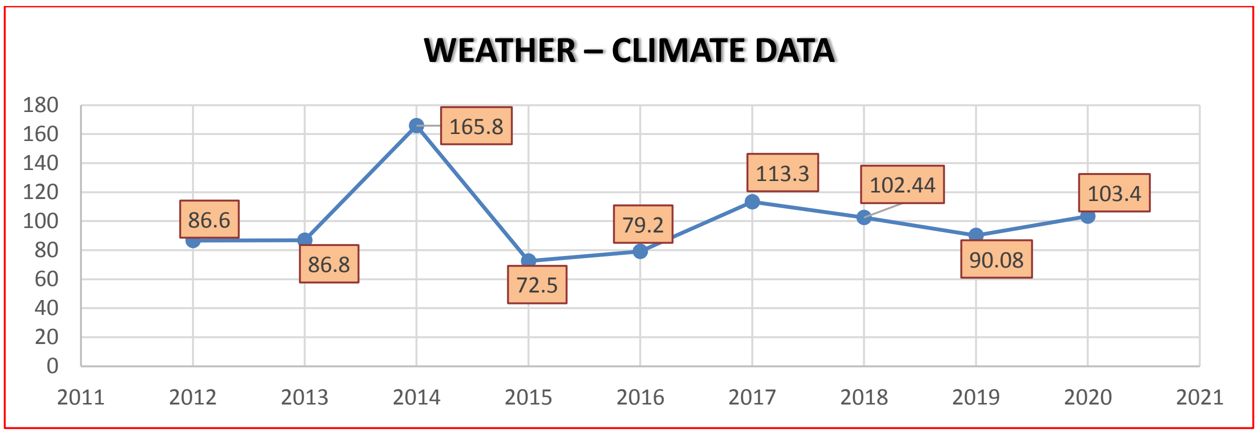


Figure (4.5)Weather Predictions 2019

4.6 **The gathering point 2019**

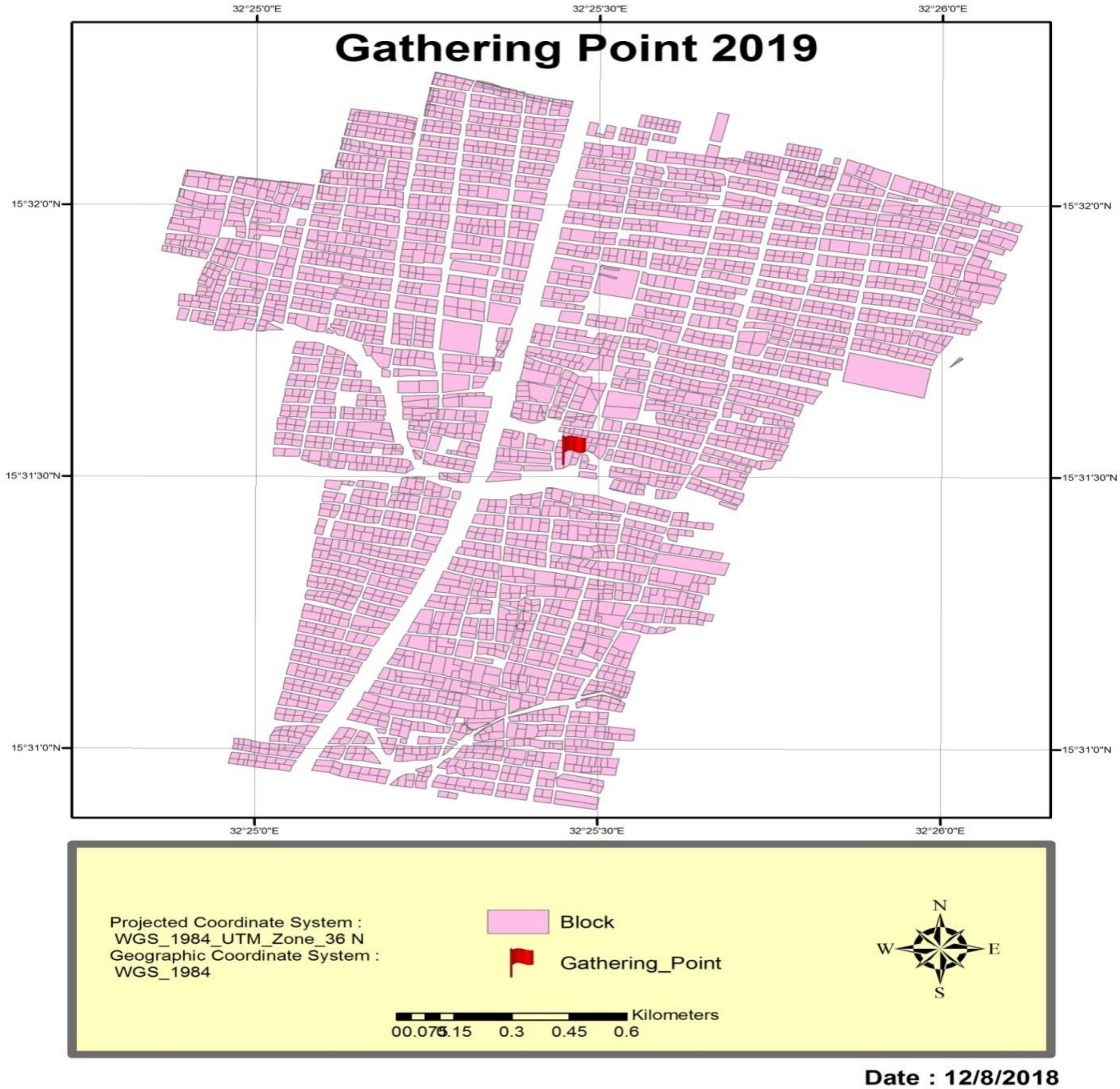


Figure (4.6) The Gathering Point for the Affected Areas **2019**

4.7 **Closest Pathfrom Civil Defense to the Gathering point 2019**

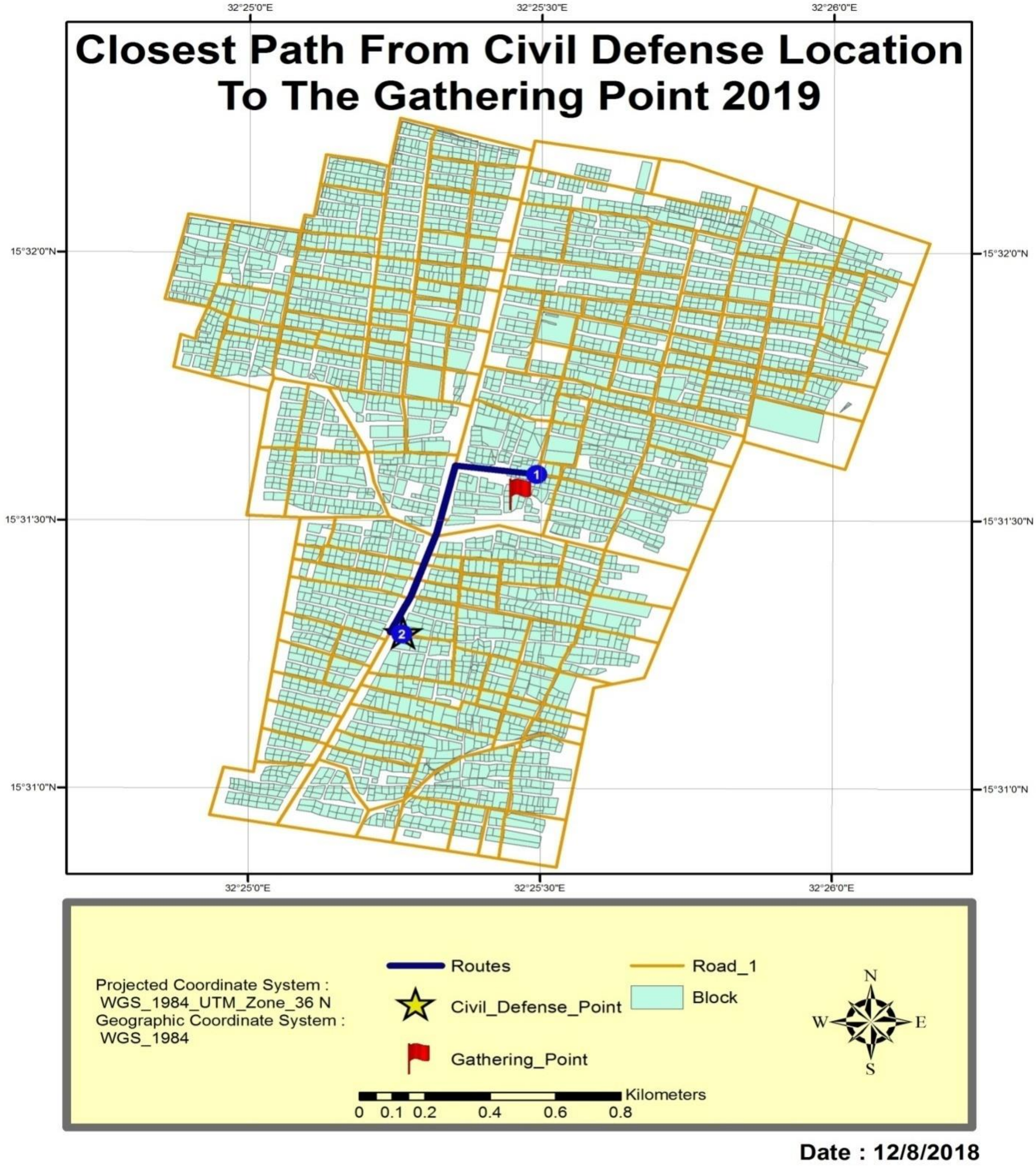


Figure (4.7)Closest Path from Civil Defense Location to the Gathering Point 2019

4.8 Closest Path from the Gathering to the Nearest Hospitals 2019

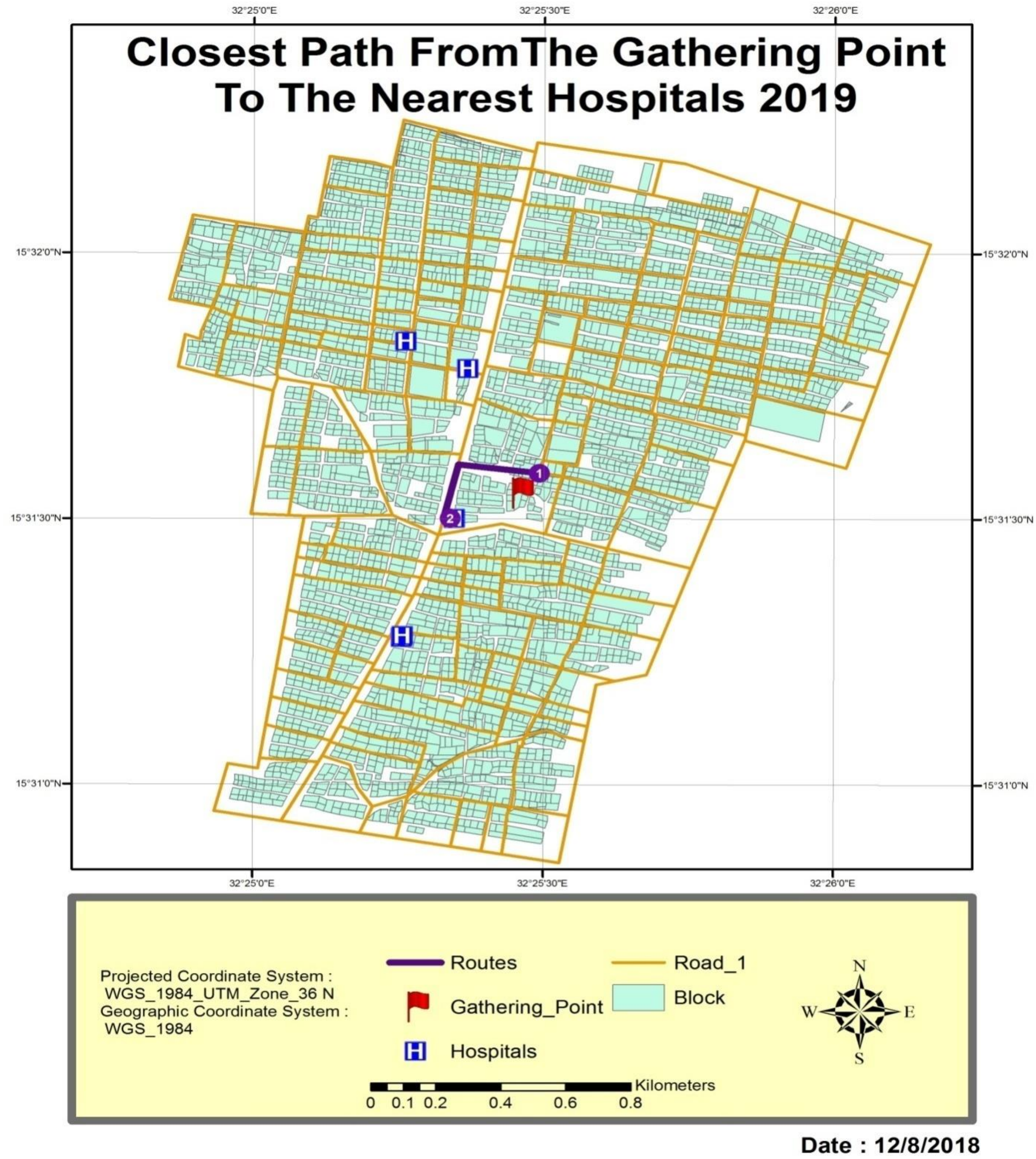


Figure (4.8)Closest Path from the Gathering Point to the Nearest Hospitals 2019

4.9 **Flood Hazard Map 2019**

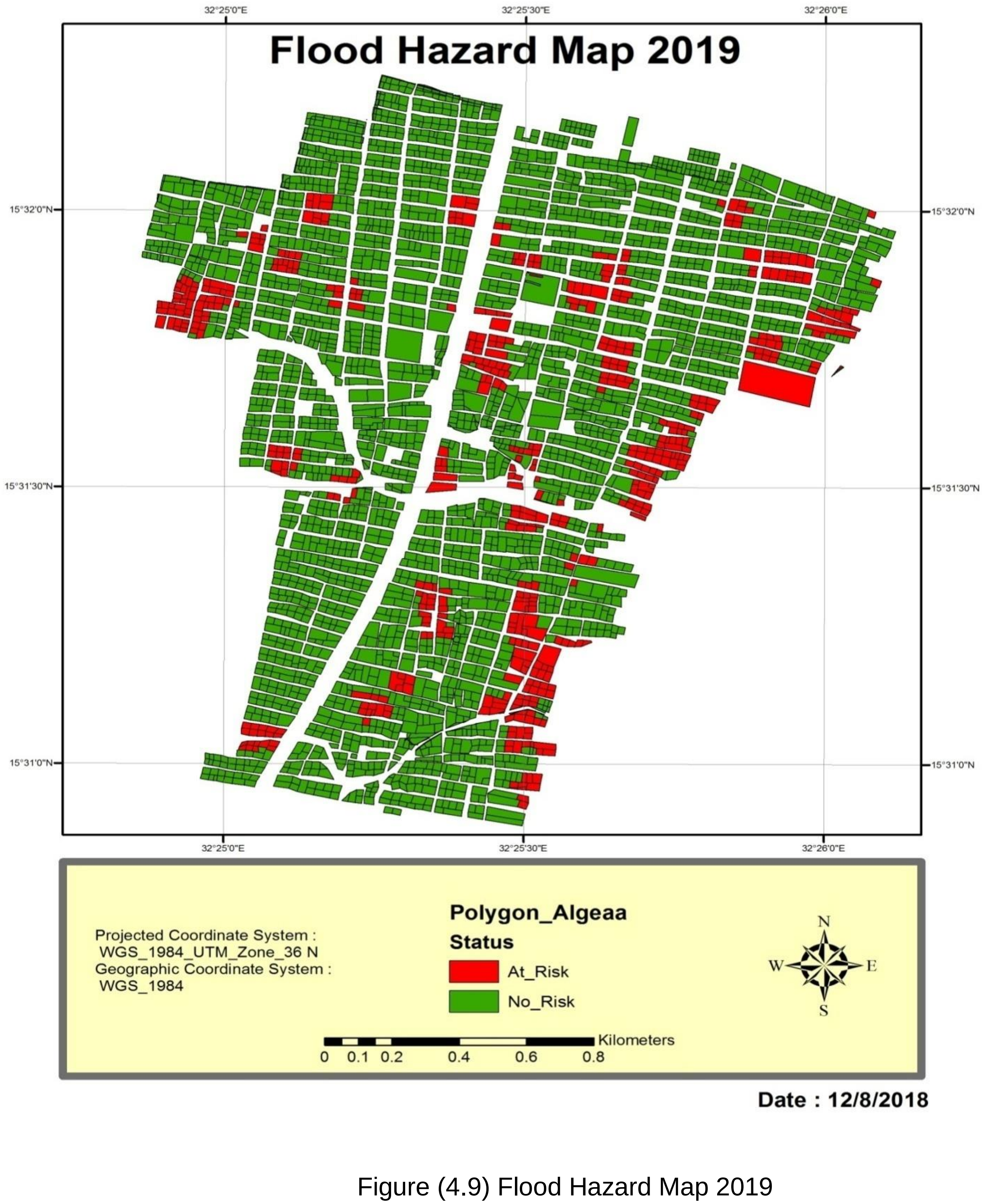


Figure (4.9) Flood Hazard Map 2019

Chapter Five

Conclusions and Recommendations

5.1 Conclusions

This study focused on the application of GIS in flood management and mitigation, especially in theAlsalh-algeaa area .The study concluded the following:

Through the flood hazard map of 2019 we conclude that a decision can be made to minimize as much as possible the flood damage expected to occur in 2019 by evacuating the population from areas expected to be exposed to flood risk or to make landings before the time of precipitation or other solutions ,and The use of the geospatial information environment reduces the time and effort in dealing with the floods at the time of its occurrence. In addition to the fact that geographic information systems enable the construction of representative models of the disaster scene, they are enabling the competent authorities to implement several scenarios and alternatives and applying them to the computer first and then study the most appropriate alternative on ground, and GIS is a suitable method for flood analysis and extensive use of these techniques contributes significantly to the creation of a long-term database that helps mitigate flood and relief affected, Provide authorities and decision makers with the created risk maps then Increase the awareness of the public for the risk of floods and its danger

5.2 Recommendation

Develop new methods of mapping and monitoring of flooded areas and predicting possible extensions of the flood. Moreover an employment of geographic information systems is proposed to find solutions to mitigate flood risks , and Protecting thewadis and their streams from encroachments on them to use them as residences, estates and farms, and it may cause flood water reserves, flooding of valleys,for the last years, with the work of soil nature studies and mechanical properties, Construction and provision of rainwater drainage systems for citiesaccording to engineering and technical standards, The importance of cooperation with relevant and competent authorities in order to collect and monitor information on climatic conditions and the use of modern technologies such as satellites and GIS and early warning systems and train and qualify specialists in flood risk management and how to deal with them, then Taking into account the protection of cities from the dangers of floods when studying the future urbanization of cities and communities, and giving low areas and locations within cities the importance of rain and flood drainage

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https://www.ouarsenis.com/vb/showthread, 23/9/2018.2:47PM.

Appendix

```
# -*- coding: utf-8 -*-
# ---------------------------------------------------------------------------
# python.py
# Created on: 2018-09-16 01:22:49.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: python
<StudyArea_FeatureToPoint><polygon_algeaa_shp><polygon_algeaa__3_><Extr
act_StudyAr1__3_>
# Description:
# ---------------------------------------------------------------------------

# Set the necessary product code
# import arcinfo


# Importarcpy module
importarcpy

# Check out any necessary licenses
Arcpy.CheckOutExtension("spatial")
arcpy.CheckOutExtension("Network")

# Script arguments
StudyArea_FeatureToPoint = arcpy.GetParameterAsText(0)
if StudyArea_FeatureToPoint == '#' or not StudyArea_FeatureToPoint:
    StudyArea_FeatureToPoint =
"C:\\Users\\meinas\\Documents\\ArcGIS\\Default.gdb\\StudyArea_FeatureToPoint
" # provide a default value if unspecified

polygon_algeaa_shp = arcpy.GetParameterAsText(1)
ifpolygon_algeaa_shp == '#' or not polygon_algeaa_shp:
polygon_algeaa_shp = "D:\\2019\\shapefile\\polygon_algeaa.shp" # provide a
default value if unspecified

polygon_algeaa__3_ = arcpy.GetParameterAsText(2)
if polygon_algeaa__3_ == '#' or not polygon_algeaa__3_:
    polygon_algeaa__3_ = "polygon_algeaa" # provide a default value if
unspecified
```

```
Extract_StudyAr1__3_ = arcpy.GetParameterAsText(3)
if Extract_StudyAr1__3_ == '#' or not Extract_StudyAr1__3_:
   Extract_StudyAr1__3_ = "Extract_StudyAr1" # provide a default value if
unspecified

# Local variables:
Extract_StudyAr1 = StudyArea_FeatureToPoint
N15E032_hgt = "D:\\floods_2\\DEM\\N15E032.hgt"
Extract_StudyAr1__2_ = "Extract_StudyAr1"
Polygon_algeaa_Select = polygon_algeaa__3_
polygon_algeaa_Select_MeanCe = polygon_algeaa_Select
polygon_algeaa = "polygon_algeaa"
algeaa_2019_ND = "algeaa_2019_ND"
facilities_1 = "facilities_1"
algeaa_2019_ND__2_ = "algeaa_2019_ND"
Closest_Facility_4 = "Closest Facility 4"
Closest_Facility_4__4_ = "Closest Facility 4"
Route__2_ = "Route"
Route__7_ = "Route"

# Process: Feature To Point
arcpy.FeatureToPoint_management(polygon_algeaa_shp,
StudyArea_FeatureToPoint, "CENTROID")

# Process: Extract Values to Points
arcpy.gp.ExtractValuesToPoints_sa(StudyArea_FeatureToPoint, N15E032_hgt,
Extract_StudyAr1, "NONE", "VALUE_ONLY")

# Process: Select Layer By Attribute
tempEnvironment0 = arcpy.env.extent
arcpy.env.extent =
"C:\\Users\\meinas\\Documents\\ArcGIS\\Default.gdb\\Extract_StudyAr1"
arcpy.SelectLayerByAttribute_management(Extract_StudyAr1__2_,
"NEW_SELECTION", "RASTERVALU <382")
arcpy.env.extent = tempEnvironment0

# Process: Select Layer By Location
arcpy.SelectLayerByLocation_management(polygon_algeaa, "INTERSECT",
Extract_StudyAr1__3_, "", "NEW_SELECTION", "NOT_INVERT")
```

```
# Process: Select
arcpy.Select_analysis(polygon_algeaa__3_, polygon_algeaa_Select, "")

# Process: Mean Center
arcpy.MeanCenter_stats(polygon_algeaa_Select, polygon_algeaa_Select_MeanCe,
"", "", "")

# Process: Make Closest Facility Layer
arcpy.MakeClosestFacilityLayer_na(algeaa_2019_ND, "Closest Facility 4",
"Length", "TRAVEL_TO", "", "1", "", "ALLOW_UTURNS", "",
"NO_HIERARCHY", "", "TRUE_LINES_WITH_MEASURES", "",
"NOT_USED")

# Process: Add Locations
arcpy.AddLocations_na(Closest_Facility_4, "Facilities", facilities_1, "Name Name
#", "5000 Meters", "", "Road_1 SHAPE;facilities_1
SHAPE;algeaa_2019_ND_Junctions NONE", "MATCH_TO_CLOSEST",
"APPEND", "NO_SNAP", "5 Meters", "INCLUDE", "Road_1 #;facilities_1
#;algeaa_2019_ND_Junctions #")

# Process: Solve (2)
arcpy.Solve_na(Closest_Facility_4__4_, "SKIP", "CONTINUE", "5 Meters")

# Process: Make Route Layer (2)
arcpy.MakeRouteLayer_na(algeaa_2019_ND__2_, "Route", "Length",
"USE_INPUT_ORDER", "PRESERVE_BOTH", "NO_TIMEWINDOWS", "",
"ALLOW_UTURNS", "", "NO_HIERARCHY", "",
"TRUE_LINES_WITH_MEASURES", "")

# Process: Solve (3)
arcpy.Solve_na(Route__2_, "SKIP", "TERMINATE", "5 Meters")

# Process: Make Route Layer (3)
arcpy.MakeRouteLayer_na(algeaa_2019_ND, "Route", "Length",
"USE_INPUT_ORDER", "PRESERVE_BOTH", "NO_TIMEWINDOWS", "",
"ALLOW_UTURNS", "", "NO_HIERARCHY", "",
"TRUE_LINES_WITH_MEASURES", "")
# Process: Solve (4)
arcpy.Solve_na(Route__7_, "SKIP", "TERMINATE", "5 Meters")
```