Available online at www.elixirpublishers.com (Elixir International Journal)

Agriculture

Elixir Agriculture 84 (2015) 33677-33680

ISSN: 2229-712X

Application of Geographic Information System (GIS) and Digital Elevation Models (DEM) for Estimation Hydraulic Parameters of the Republic of Iraq

Abdulghafour Ibrahim[1], Alaa Salih Ati[2] and Amel Radhi Jubair[3]

[1]Department of Desertification control, College of Agriculture, University of Baghdad-Iraq.

[2]Department of Soil Science, College of Agriculture, University of Baghdad-Iraq.

[3]Department of Soil Science, College of Agriculture, Green University of Al Qasim-Iraq.

ARTICLE INFO

Article history:

Received: 14 May 2015;

Received in revised form:

2 July 2015;

Accepted: 7 July 2015;

Keywords

DEM, Basin,

Stream order,

Flow direction,

Flow accumulation.

ABSTRACT

Digital Elevation Model (DEM) is used with Arc-Hydro tool of Arc-GIS to described flow direction, flow accumulation, streams orders and basins in the republic of Iraq. The Republic of Iraq is in southwest Asia between latitudes 29° 5' and 37° 22' N and longitudes 38° 45' and 48° 45' E; it forms the eastern frontier of the Arab countries. Turkey to the north, Iran to the east, Jordan, Syria and the Kingdom of Saudi to the west, and the Arabian Gulf, Kuwait and the Kingdom of Saudi Arabia to the south, border it (see Figure 1). Its unique environmental, biological and social features, which are unlike anywhere else in the Arabian Peninsula, characterize the country. It has a total area of 438 317 km^2. The results referred to there are five stream orders and two main basins in the study area.

Introduction

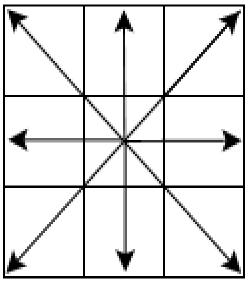
In order to perform distributed or even lumped rainfall - runoff modeling a multitude of information is needed. Part of the necessary model input can now be provided through processing and analysis of a Digital Elevation Model (DEM) in combination with information extracted from other remotely sensed images of a selected model area.

Digital elevation models (DEM) are extensively used in hydrological analysis to obtain the direction of flow on a topographical surface. Knowing the direction of flow helps in determining channel networks, and in obtaining the distributed specific catchments, which are important attributes in a DEM based analysis, and the digital elevation model (DEM) has been successfully utilised in digital hydrology for decades. A number of related algorithms have been developed, e.g., pit extraction, flow path trace, and basin division. Flow mode is the basic principle for depicting the hydrological elements. However, tremendous research has been put forward for a raster-based DEM because of its simple data structure and its easy, practical algorithms (Suzanne and Charles, 2006).

Many studies in hydrological science use digital elevation models for describing the catchment topography and obtaining topographical attributes. A network of flow channels, which the DEM can produce easily. Is the most widely used product of DEM in hydrological studies. In addition to that, the DEM provide the basic data for calculating the upslope area, specific catchment, and slope driven parameters in flow routing and sediment and contaminant movements (Moore et al., 1991 and Tarboton et al., 1991).

In recent years, digital elevation models (DEM) have been widely used as input data for defining the flow directions in distributed hydrological models for discharge simulation due to their high efficiency in representing the spatial variability of the earth's surface (Beasely et al. 1980and Fortin et al. 2001).

Importance of water is increasing due to the high population growth and global warming in the World. Iraq is an agricultural country and the demand has been growing for more agricultural production to ensure food security. To calculate a drainage network or watersheds, a grid must exist that is coded for the direction in which each cell in a surface drains. Flow direction is important in hydrologic modeling because in order to determine where a landscape drains, it is necessary to determine the direction of flow for each cell in the landscape. This is accomplished with the Calculate Flow Direction menu choice. For every cell in the surface grid, the Arc GIS grid processor finds the direction of steepest downward descent. Flow direction is a focal function. For every 3-x-3 cell neighborhood, the grid processor stops at the center cell and determines which neighboring cell is lowest. Depending on the direction of flow, the output grid will have a cell value at the center cell, as determined by this matrix:



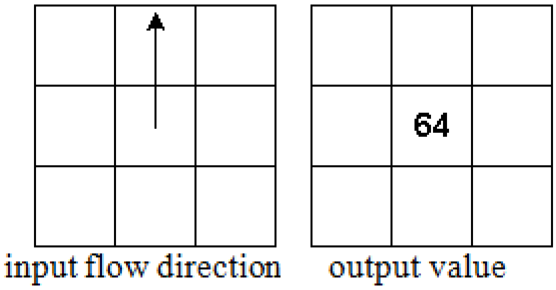
32	64	128
16		1
8	4	2

If a cell flows northward, then in the output grid, the cell in its location will have a value of 64, if the direction of flow for a cell is due north, then in the output grid, that cell's value will be 64. These numbers do not have any absolute, relative, or ratio meaning, they are just used as numeric place holders for nominal direction data values (since grid values are always numeric).Flow Direction is a choice on the Hydro menu. It should only be performed on grids that are known to be free of sinks

http://courses.washington.edu/gis250/lessons/hydrology/index.html # coded.

Tele:

E-mail addresses: salih_alaa@yahoo.com



The main purpose of this study was to assess how well a hydrodynamic model could be used to simulate flood events on a large, remote, data sparse tropical floodplain using the DEM and remote sensing imagery.

Material and Methods

Description of the Study Area/ Location and area

The study area (Fig.1) called The Republic of Iraq is in southwest Asia between latitudes 29° 5' and 37° 22' N and longitudes 38° 45' and 48° 45' E; it forms the eastern frontier of the Arab countries. Turkey to the north, Iran to the east, Jordan, Syria and the Kingdom of Saudi to the west, and the Arabian Gulf, Kuwait and the Kingdom of Saudi Arabia to the south, border it (see Figure 1). Its unique environmental, biological and social features, which are unlike anywhere else in the Arabian Peninsula, characterize the country. It has a total area of 438 317 km^2.

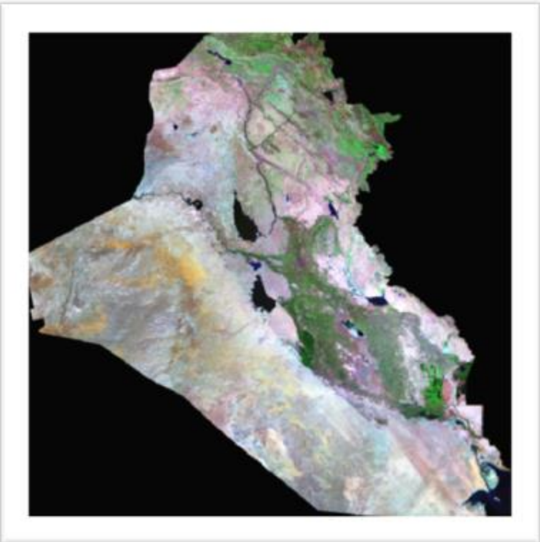


Figure 1. Study area

Physiography

Iraq can be divided into the following five physiographic zones (FAO/UNESCO/WMO, 1962). Zagros Mountain Region: consists of high mountain ranges and valleys. The mountains are 1 000 to about 4 000 metres high consisting of mostly limestone ridges. There are different kinds of lime stones varying from very hard dolomite limestone to soft chalk. In places shale is inter-bedded with limestone. The various layers of limestone are folded. The mountain ridges have scarp like faces on the south-western sides but gentler slopes on the northeast. In a small area in the north-eastern part there is a thrust zone in which older geological formations are resting on top of the younger. The mountains have steep slopes but the valleys are nearly level to gently sloping or undulating. Three fluvial terraces are found in valleys. Foothills Region: Comprises hills at the foot of the Zagros Mountains, 500 to 1 000 metres high. It consists of beds of gravel, conglomerate and sandstones. The gravel and conglomerate layers alternate with thin layers of reddish loam and clay. In some places these red loam and clay layers are at the top and are severely eroded, forming bad land and gullied land. It is an area of rolling hilly landscape with low parallel hill ridges and extensive valleys and plains. There are three distinct terraces in the valleys indicating various cycles of erosion during the Pleistocene. The vegetation consisting mostly of grasses flourishes during winter and spring giving the whole region a green look. In summer the vegetation dries up and the climate is hot and dry. The hills are generally rounded and have thin soil. The level areas of valleys commonly consist of three different terraces. The lowest terrace usually being most extensive is most important with good soil.

Jazeera Region: includes the remnant of an old inland sea in which mainly gypsum was deposited. It is a steppe and desert plateau. The area is relatively flat broken by some hills and low mountain ridges which are an extension of the mountain ridges to the east. The mountain ridges go in an east west direction; in between there are level to undulating and at places rolling terrain. Gypsum is the main rock but in the east and north limestone and sandstones occur. Large areas have lime and gypsum crusts exposed at the surface. The natural vegetation is of desert type in the south west and steppe in the north east. This region has been traditionally a grazing area but recently some parts in the north have been broken and ploughed to grow wheat and barley.

Desert Region: consists of various kinds of limestone which was deposited on the old shelf (the stable land area). This region is 200 to about 600 metres above sea level. The north-western part is the highest and there is a general slope from west to east. The vegetation is of Iran-Turanian type in the northern part and of Sahara-Sindian type in the south. The whole of the northern desert and the northern part of the southern desert are rock plains developed on limestone or limestone crust (an old soil horizon). A small part in the south is a sandy desert with sandy and gravely surface as well as sand ridges or high but stable dunes up to 35 metres high. The eastern strip has gypsum crust. Wind erosion is important as high winds are very common. A layer of gravels or pebbles called desert pavement is commonly present on the surface protecting the soil from being blown away. Water erosion is also important and large parts of the desert have been affected by it during the Pleistocene and the Holocene. In some places deep gullies or wadis have been shaped by water erosion in a true desert with rainfall of about 70 mm and these wadis have some sparse vegetation. In the northern part, the rainfall is up to 150 mm and there is some vegetation especially in wadis.

Mesopotamian Plain Region: is a geological depression filled with river sediments which cover the central and southern parts of Iraq. It is a plain of the Tigris and Euphrates rivers. In the Bible it is referred to as “Shinar”. Later on it was called “Babylonia and As-Sawad”. In the Holy Quran, there is a reference to the city of “Baable,” the capital of the state at the time.

The northern part extending between Samarra and Deltwa consists of three distinct river terraces which are about 5 to 15 metres higher than the present river level. These old river terraces thus form high plains which are never flooded by the river. The lowest of these terraces is the most important for irrigated agriculture. It extends on both sides of Adhaim River.

In central Iraq, the plains are nearly level. Large parts of it were flooded almost every year during spring and new soil material was deposited till 1956 when the first flood control project was completed. Deposition of material by the rivers is in a levee basin pattern giving a distinct meso relief in the nearly level landscape. In addition, the old irrigation canals have deposited irrigation silt to form narrow high strips along them.

In the southern parts the plain can be divided into delta plain, the marsh region and the estuary region. In the delta plain starting south of Kut and Hilla, the rivers split up into many branches. The land is flat, the natural drainage is poor and the ground water level is high. South of the Delta is a marsh region starting from Amra and Nasiriya. The ground water is at or near the surface and a large proportion of the area is covered by marshes which expand after river floods during winter and spring and contracts in late summer. The marshes are covered by reeds. Near the coast is the estuary region where sedimentation is in the form of extensive saline, estuary flats traversed by estuary channels. Along the river there are narrow strips of high well-drained land which are famous for date orchards (Figure2) (Omer, 2011).

Figure 2. Map of Physiographic Units of Iraq

Remote sensed dataset

All the remote sensing process and geographic information systems Carried out at the college of agriculture – University of Baghdad- desertification control, the Digital Elevation Model (DEM) was used to investigate Hydraulic Parameters changes of the Republic of Iraq (Fig 3) by t he following steps:

- Convert raster extension from tiff to grid type.
- Fills skins in a surface raster to remove small imperfections in the data.
- Flow direction: creates a raster of flow from each cell to its steepest down slop neighbor.
- Flow Accumulation: creates a raster of accumulated flow to each cell.
- Stream order: assigns a numeric order to segments of a raster representing branches of a linear network.
- Great Basin raster delineating all drainage basins.

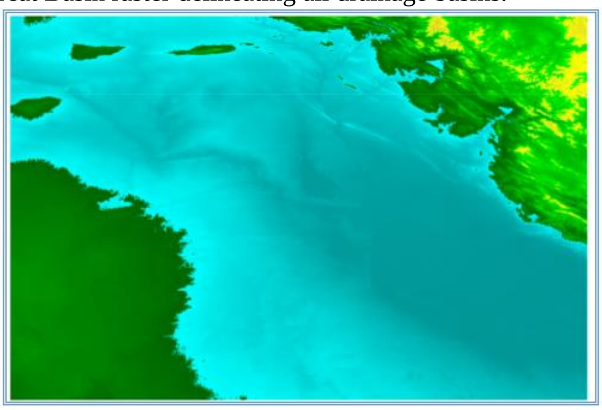


Figure 3. Digital Elevation Model (DEM) for the Republic of Iraqi

Results and discussion

Fill sinks

The results referred to found sinks in study area Figure 4, Sinks are areas of internal drainage, that is, areas that do not drain out anywhere. So must start with a surface that has no Anomalous data (sinks) (Figure5).

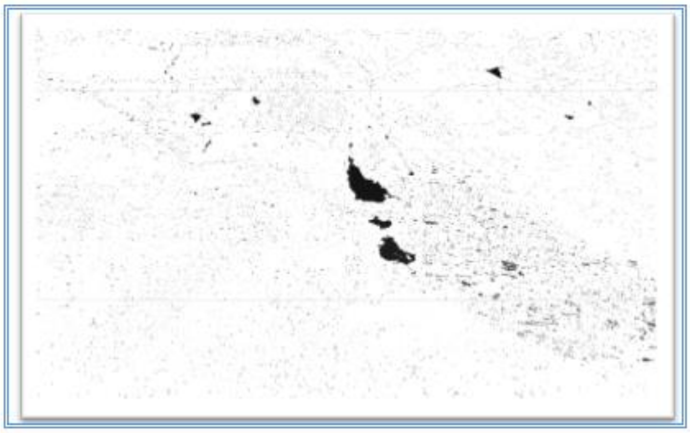


Figure 4. Sinks in study area

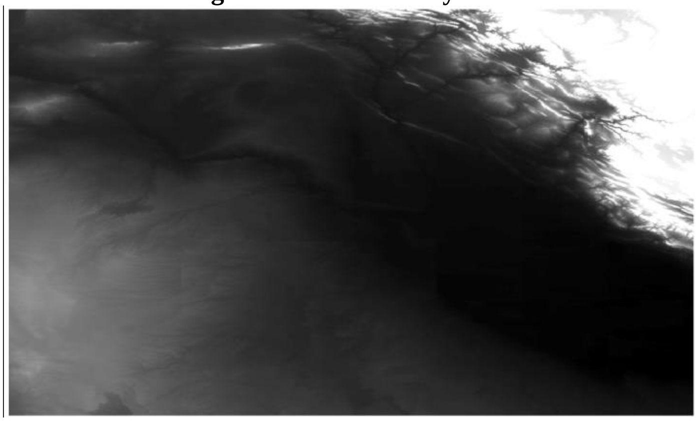


Figure 5 .Fill sinks in a surface raster

Flow direction

To determine where a landscape drains, flow direction does this process; Figure 6 showed determine the direction of flow for each cell in the landscape in study area.

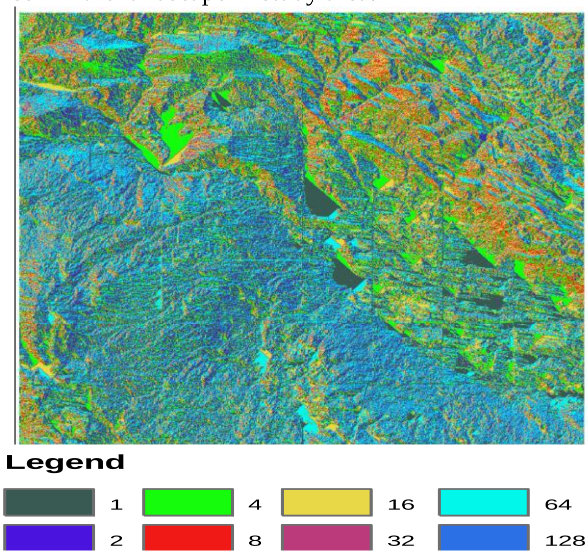


Figure 6. Flow direction

Flow accumulation

Figure 7 showed Flow accumulations which used to generate a drainage network, based on the direction of flow of each cell. The white color referred to high flow cells, while the black referred to low flow cells.

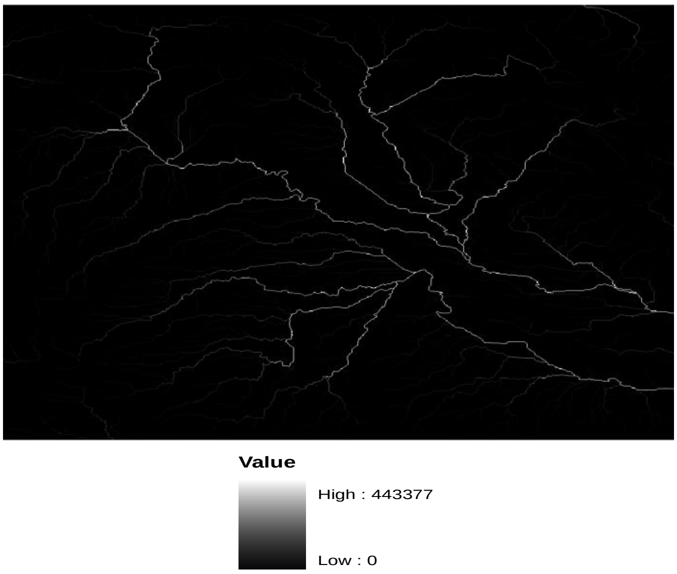


Figure 7. Flow Accumulation

The streams were increased by using conditional evaluation on each of the input cells of an input flow accumulation raster Figure 8.

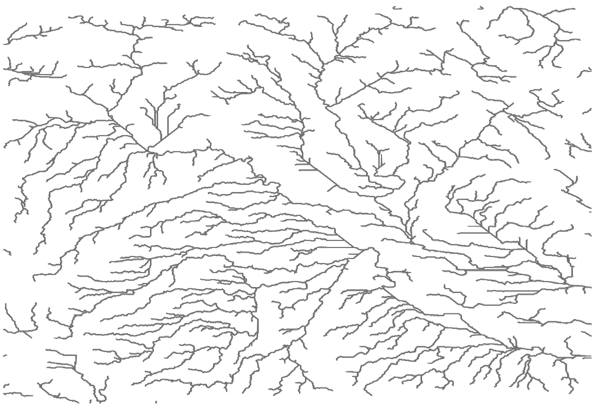


Figure 8. Flow Accumulation conditional raster

Stream order

The results referred to there are five stream orders, the order 1 (red color) greater than other stream orders, while the order 4(green color) smaller than others Figure 9.

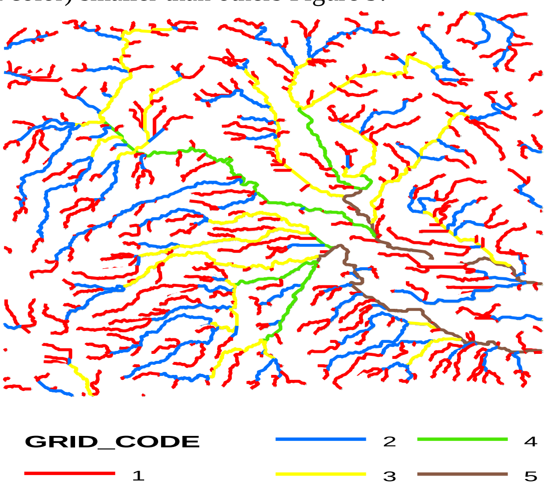


Figure 9. Stream order

Basins

The results referred to there are two main basins in the study area, the red color basin greater, while the blue color basin smaller. Others basins referred to parts of basins out the study area (Figure 10). Figure 11 referred to basins in The Republic of Iraq in Iraq with streams order.

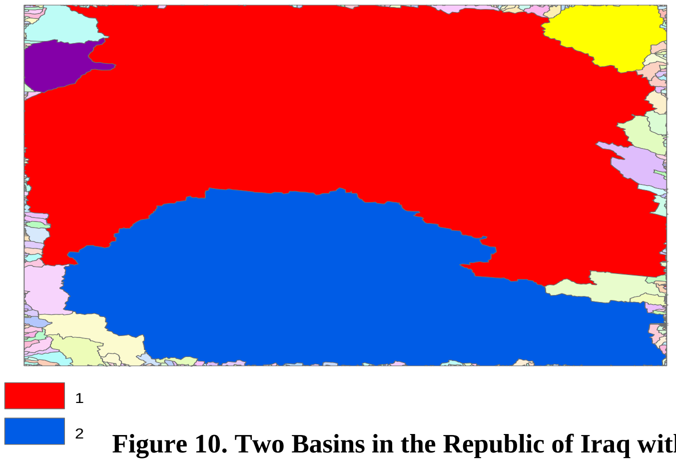


Figure 10. Two Basins in the Republic of Iraq with parts of other basins

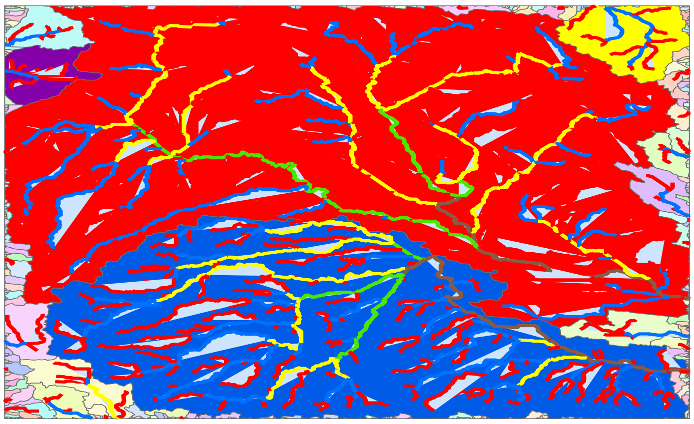


Figure 11. Basins in the Republic of Iraq with stream order

Conclusion

There are two main basins in The Republic of Iraq and all basins in the edge of the figure referred to parts of basins out the study area, there are five stream orders in the study area.

References

Beasely, D. B., L. F. Huggins and E. J. Monke. 1980. ANSWERS: A model for watershed planning. *Transactions of the American Society of Agricultural Engineers*, 23(4), 938-944.

FAO/UNESCO/WMO. 1962. A study of agro-climatology in semi-arid and arid zones of the Near East. Inter-agency project on agro-climatology. By C.C. Wallen, WMO Meteorologist and G. Perrin de Brichambaut, FAO Agronomist.

Fortin, J. P., R. Turcotte, S. Massicotte, R. Moussa, J. Fitzback, and J. P. Villeneuve,. 2001. A distributed watershed model compatible with remote sensing and GIS Data, I: Description of model. *Journal of Hydrologic Engineering*, 6(2), 91-99. [doi:10.1061/(ASCE)1084-0699(2001)6:2(91)]

http://courses.washington.edu/gis250/lessons/hydrology/index.html # coded.

Moore, I., R. Garyson, and A. R. Ladson. 1991. Digital terrain modeling: A review f hydrological, geomophological, and biological applications. Hydrological Processes 5:3-30.

Omer, T. M. 2011. Country Pasture/Forage Resource Profiles. http://www.fao.org/ ag/agp/ AGPC/doc/ Counprof/Iraq/Iraq.html

Suzanne P. Wechsler and Charles N. Kroll. 2006. Photogrammetric Engineering & Remote Sensing Vol. 72, No. 9, September, pp. 1081–1090.

Tarboton. D., R. Bras and L. Rodigueziturbe. 1991. On the Extraction of Channel Networks from Digital Elevation Data Hydrological Processes 5: 81-100.