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EFFECTIVENESS OF USE OF DIGITAL ELEVATION MODEL IN THE HYDROLOGICAL ANALYSIS OF THE WATER NETWORK IN SOUTH IRAQ

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Abstract

The Digital Height Model (DEM) is a repository of a variety of surface and hydrological information. In the past decade, automatic water network abstraction from GIS-assisted digital height models has been possible and is now calculated in most studies of water networks for hydrological studies. The study aims to extract the water network for southern Mesopotamia, through analyzing the digital elevation model (DEM), using the geographical information systems programs (Arc GIS 10.6), In this study, an evaluation of the accuracy of the hydrological analysis of the water networks extracted from the digital height models (30 meters) was performed using drainage and drainage extracted from the satellite images of the study area. The study reached the extraction of the water network in the study area and accuracy was acceptable and can be used in subsequent studies, and that the drainage area of the study area, especially in Al-Muthanna Governorate, is characterized by the presence of a water source in the form of groundwater that can be used to meet the needs of the population and contribute to advancing development areas in various Domains.

Key words: GIS, DEM, hydrological analysis, south of Iraq

Introduction

Groundwater is a dynamic and renewable natural resource, especially at the time of drought and the lack of water shares for Iraq after the construction of dams in the areas of water sources of the Tigris and Euphrates rivers, so effective scientific planning of water is very important. A large hydrogeological analysis is required to thoroughly understand the conditions of the groundwater in these. [Hendra, 2013]. In recent decades, the geographic information system (GIS) link and hydrological modeling have become closely linked. Geographic Information Systems provide a representation of the spatial features of the Earth, while hydrological modeling provides a description of the flow of water networks and components on the Earth's surface and underground. The hydrological system is often very complex. In order to have a sound understanding of the hydrological system, a full analysis of all the factors involved must be performed. Therefore, data from different sources is necessary because remote sensing data alone is not sufficient. Where remote sensing data can be used only a little surface information (such as land use, vegetation, surface water bodies, etc.). However, in the field of remote sensing and GIS-based groundwater studies, subsurface information layers are also required (such as groundwater level in different seasons, hydrological characteristics of groundwater layers, etc.). [Shankaraiah, 2017, kundu, 2015].

GIS is an efficient tool for manipulating and storing large volumes of data, integrating spatial and non spatial information in a single system, offering a consistent framework for analyzing the spatial variation, allowing manipulation of geographical information and allowing connection between entities based on geographical proximity. [Guth, 2010]. Integrated GIS and remote sensing technology has modernized the study of natural resources. Remote sensing provides multispectral, multi-temporal, multisensory and multivariate data of the Earth's surface. GIS has emerged as a decision support system with capabilities of efficient data storage and convergent analysis of spatial data from diverse sources. There is a strong synergy between remote sensing and GIS, as

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remote sensing data are a major source of spatial information in GIS analysis and GIS data can be used as ancillary information to support remote sensing data interpolation. The synergism between these two technologies is a major advantage in the use of an integrated approach. [Hasan, 2013].

Materials and Methods

The Study Area

The study area The governorates of Dhi Qar , Maysan and Muthana in the south of Iraq The study area represents a large part of the Middle Euphrates basin region in southern Iraq and is located between latitude (43030’00''E to 48000’00''E) and longitude (29050’00'' N to 32050’00'' N) as Fig. 1.

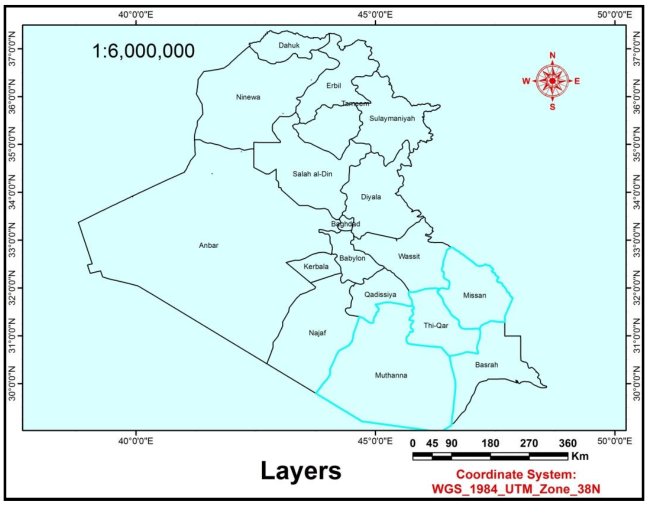

Fig. 1: The study stations.

Study methodology

The image processing was performed in three stages:

1) Digital elevation module (DEM) correction

2) Hydrological analysis

3) Accuracy result.

These applications were performed using ArcGIS 10.6 program

Data and software

The data used for the search are varied and are therefore represented:

1) Digital elevation module (DEM) covers the study area.

2) Arc Map 10.6 program.

3) Base map.

4) shapefile for the study area

The Pearson’s test is moment correlation matrix is a series of scatter graphs that plot the associations between all possible combinations of variables. The first row of the matrix represents the first set of variables or the first column of data, the second row of the matrix represents

Results

Hydrological Analysis

Hydrological analysis involves many processes including filling the basins, determining the maximum flow directions, possible accumulation points, creating a current network, and delineating the basin based on the direction of the flow, by determining the casting points (the lowest point along the watershed boundaries) at the edges and basins and determining the contributing area Above each point. [Saraf, 2004]. Remote sensing and geographic information systems are among the most powerful modern technologies to monitor changes in water networks and changes in the shapes of the earth’s surface and knowledge of hydrological phenomena and determine their dimensions and slopes, through the work of a set of analytical and objective hydrological maps using geographic information systems and represented in rock formation maps and terrain forms and morphometric data (Rises and slopes), [Graham, 2014] slope directions, slope of the water network, drainage patterns, as well as slope stability in the study area where it is through the degree

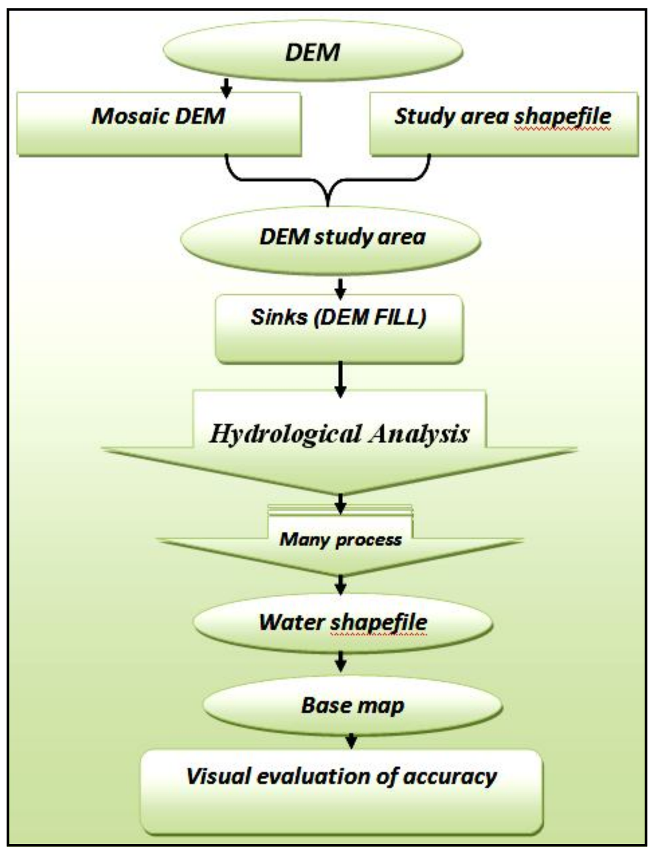

Fig. 2: Methodology adopted for derivation of stream network from DEM based on surface hydrological modeling.

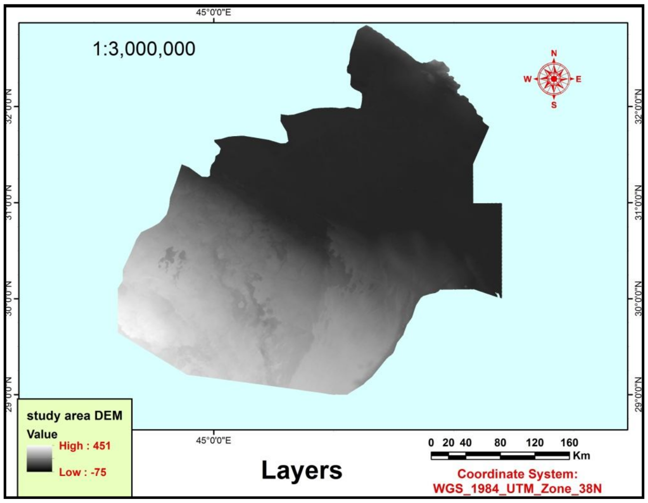

Fig. 3: DEM of study area.

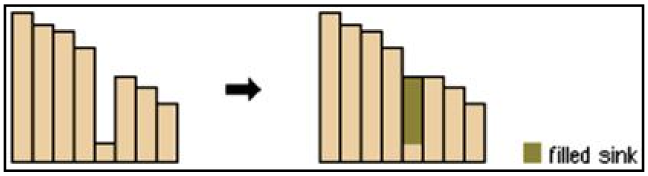

Fig. 4: The filling method [Guth, 2010].

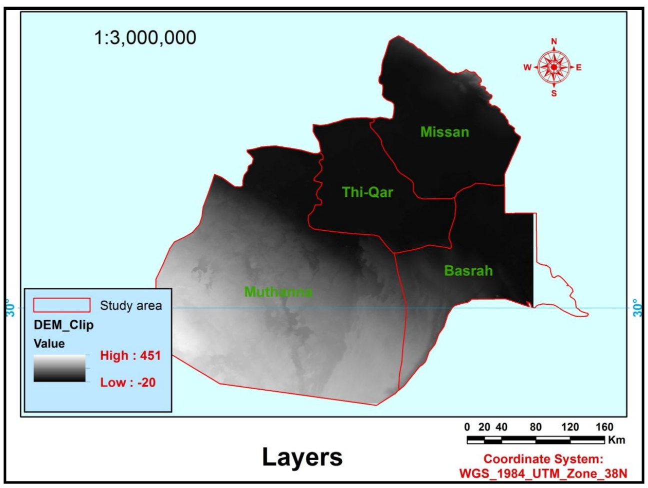

Fig. 5: DEM of study area after fill analysis, Where note that the smaller value of digital elevation module changed before processing from (- 75 to- 20).

of slope and severe changes in it that Hydrology can be determined any region and forms of discrimination and water networks regularly decline used these techniques with research methods in determining hydrological drainage patterns and terrain forms that reflect a clear climate change and rock composition and analysis of hydrological processes. [Hamed, 2011]. The hydrological analysis process that can be extracted from digital elevation models is specialized in the depth and direction of the water and its communication with each other.

Modeling in a Geographic Information System (GIS) with hydrological tools depends on a surface model, a networked DEM model, the quality of which is determined

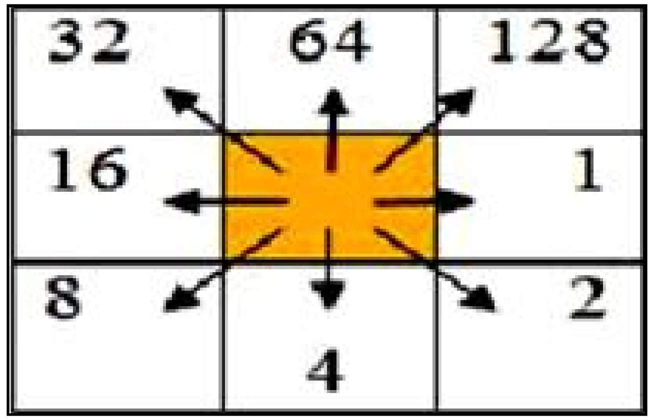

Fig. 6: Flow Direction Generation [Sina, 2014].

by the quality of the analysis. Since the movement of the water is driven primarily by gravity, the slightest pass in DEM indicates the flow path [Chuankun, 2015]. Hydrological analyzes are performed using the digital height model (DEM). In GIS, DEM is defined as a bitmap or vector map with elevation data. In most geomorphological analyzes a bitmap of square pixels is used. Each pixel has a number representing the terrain height at that point [Essam, 2018].

Fill, Sinks

From the toolbar select Spatial Analyst Tools\Hydrology\fill to manipulate the values Abnormal highs or lows, as this command fills abnormal highs and lows Expected in numeric layer data, it is removed and a new layer is created free of that The depressions or elevations are shown in the Fig. 4, thus adding a layer to the list of contents The project is not different from the previous file [Graham, 2014].

Flow Direction

Flow direction indicates the direction of surface flow which is an integer raster value ranges from 1 to 255. In an elevation raster if a cell is lower than its neighboring cells, the direction of the flow will be towards that cell. [Venkatesh, 2012] In some elevation raster's when multiple neighbors have the lowest values then the flow will be defined by filtering out one cell sinks. In some cases if a cell has the same change in 'Z' value in multiple directions the resulted flow direction will be sum of those directions. The flow direction can be determined by finding steepest descent from each cell. [Julio, 2015]. The elevation raster thus generated without sinks has been used to generate the flow direction in the study area using 'Flow direction' option in hydrology analysis function. The output flow direction raster shows eight (8) possible directions of surface. Figure (Hasan, 2013).

From the toolbar choose Spatial Analyst Tools\Hydrology\flow Direction this is to determine the

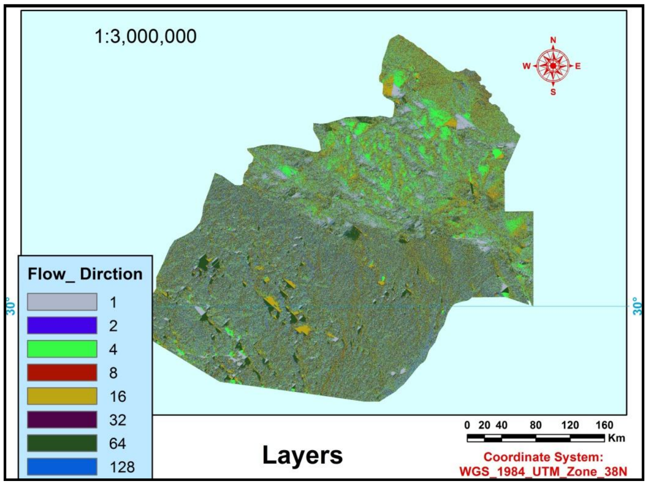

Fig. 7: Flow direction.

direction in which water will flow from one cell to the neighboring cells the result is Fig. 7.

Flow Accumulation

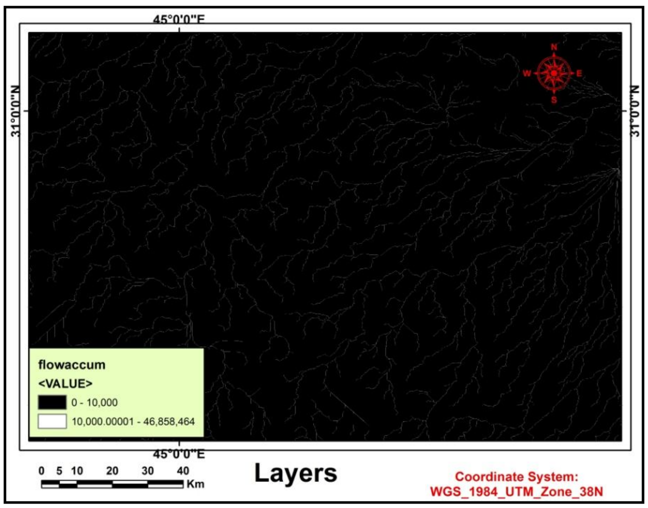

Fig. 8: Flow accumulation after that, the hydrological analysis is completed using the following tools.

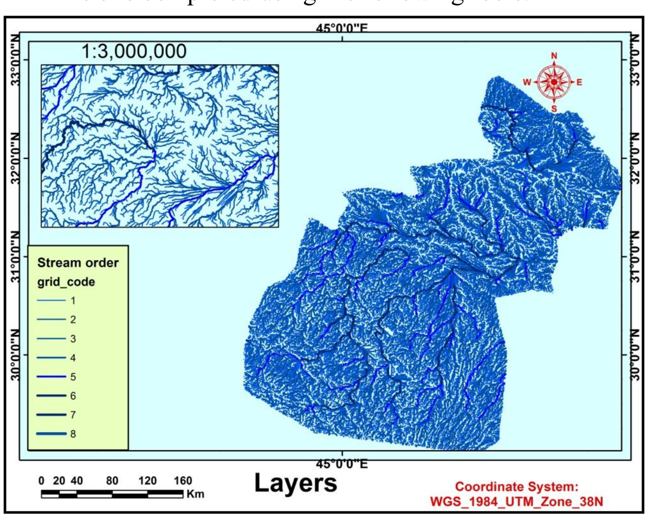

Fig. 9: Water shapefile of study area.

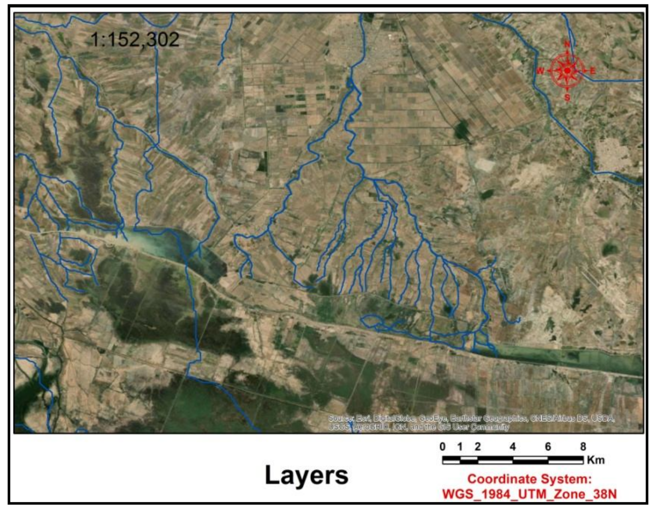

Fig. 10: Matching shapefile on the base imagery map.

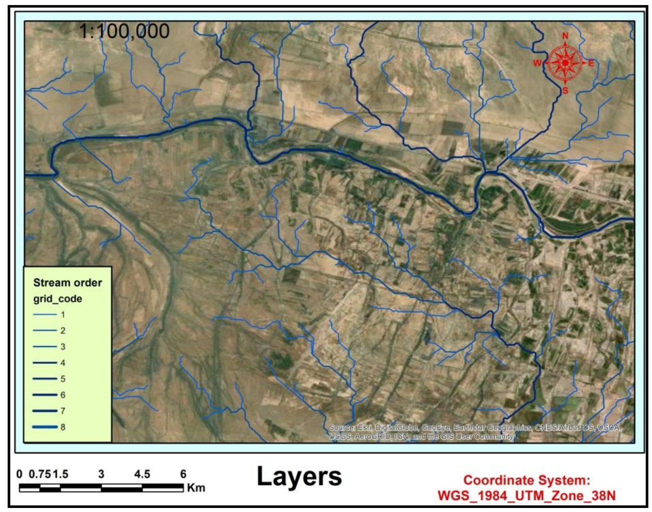

Fig. 11: Matching shapefile on the visual basis (Close look).

Flow accumulation is generated from the error free elevation raster data. The cells of undefined flow directions other than (1 to 8) will only receive flow accumulation. The accumulated flow in the output raster will be calculated based upon the number of cells flowing towards each cell. The high flow areas in the output raster are the areas of concentrated flow which are important to identify possible stream channels similarly, those areas with flow accumulation value zero (low) are the areas of topographically high like ridges. A stream Network can be created by using the results of the high accumulated flow. Similarly, this stream network can be used as input to generate stream order, stream line and stream link. [Sina, 2014]. This function computes the flow accumulation grid that contains the accumulated number of cells upstream of a cell, for each cell in the input grid [Chuankun, 2015]. from Spatial Analyst Tools\Hydrology\Flow Accumulation toolbar for to challenge the main streams in the area of the plot through the aggregate method The flow at each cell by counting the number of cells that the water will pour into a living water, which gives the areas Which contains water (main sewers) numerical value (1) and the rest of the regions take the value (zero) The main sewers are white and the rest of the areas are black. [Xiaoye, 2010] as Fig. 8.

Con

Select from the Spatial Analyst Tools\Conditional\Con toolbar to select the rest Sub-ducts in specific pre-entered spaces (specific cell count) [Venkatesh, 2011].

Stream Link

In all the previous stages, the work was at the cell or tributary level, and the tributaries should be connected Within the same valley, so I choose from the Spatial Analyst Tools\Hydrology\Stream Link toolbar to define Junction contact points between tributaries Link and meeting points of network elements and give each point of contact a unique value [Xiaoye, 2010].

Stream Order

A layer of classification lines Entry into water by grade, where class 1 lines entry into water secondary and flowing lines in entry into water level 2. This is called Category (strahler) [Kun, 2011] the result as in Fig. 9.

To comparing between water shapefile result in Fig. 8 the water shapefile is matching on base imagery map, as Fig. 10 and 11.

Discussion

The extraction and identification of water networks systems is an important step for many geological applications. Determination of detailed water networks requires as high-precision digital height models as possible. This study showed that numerical height models of medium differential accuracy (30 meters) can be used to obtain an acceptable and good analysis of water networks, except for studies in small areas that require high-resolution digital height models (less than 30 meters) that must be used where units are supported High Resolution DEM More details on extraction of low flow (rain water) parts for drainage networks for hydrological applications. The study showed the benefits of using geographic information systems where water networks can be extracted more easily and efficiently than traditional methods. And provide support to decision makers to manage water resources in different regions. The extracted water network was acceptable and well in line with the satellite image

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