Use of Remote Sensing Techniques in Hydrology to Mapping Water (Case study: Alqadarif Area).

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Abstract

This study was conducted at Alqadarif State Area, east of the Sudan latitudes 12° 17′, longitudes 34° 36′ E, which aimed to build a database of the morphometric of 26 properties from a 176 basin, this done through analyzing a digital elevation model (DEM) by using a group of geographical data systems programs, which integrated to result in a large number of morphometric variances and measurements. They are represented in the programs ArcMap 10.4.1 as basic programs and other supportive programs like excel.

The study was done for the purpose to understand its hydrologic significances and consequently understanding the water movement on the surface of the base. The study depended on the data of the digital elevation model accurately 30 m in addition to a group of maps and satellite images. Adoption of Alqadarif State upon automatic agriculture who leads to needing to know a lot about conditions, nature and description runoff water for the rain to know the different characteristics for basins to draw the water map of the State, recognition of cadastral characteristics and formal properties, identify the histological properties and water drainage network characteristics.

Arc gis was installed on a windows 10 computer and loaded the digital elevation model for the experiment site from earth explorer, the DEM file was only used. Work was done by Arc Hydro Tools within the Arc GIS.

Keywords:

Morphometric variances, stream basin, digital elevation, water map, and hydrology.

1. INTRODUCTION

“Hydrology, which treats all phases of the earth's water, is a subject of great importance for people and their environment. Practical applications of hydrology are found in such tasks as the design and operation of hydraulic structures, water supply, wastewater treatment and disposal, irrigation, drainage, hydropower generation, flood control, navigation, erosion, sediment and salinity control, pollution abatement, recreational use of water and fish and wildlife protection. The role of applied hydrology is to help analyze the problems involved in these tasks and to provide guidance for the planning and management of water resources”.

Amnah (2010) showed that the basin of Wadi Yalamlam tends to elongate rather than rotate with a width of 20 km and 80 km length. The elongation rate in the basin is 0.56 and the rotation rate is 0.20. Rain takes a long distance to reach the outlet of the basin and reach weak and dispersed as a result of evaporation and leakage and thus drop the peak of the flood.

Spatio-temporal analysis of rainfall is crucial for water-resource management including water supply, risk management, sustainable agriculture, and hydrological infrastructure. These aspects must be addressed and discussed before promulgating public policies to achieve the best climate-adapted development (Zhou and Lau, 2001., Haylock *et al*, 2006.and Garreaud, 2009).

Over the last decade, remote sensing has come of age as a viable source of observations, particularly in parts of the world where in situ networks are sparse. Many hydrological state variables and fluxes can be estimated through satellite remote sensing. Most satellite remote sensing uses one of two kinds of sensors: passive and active. Passive sensors detect natural radiation that is emitted or reflected by an object, whereas active sensors emit energy to scan objects, and then detect and measure the radiation that is reflected or backscattered from the target. Different sensor types and frequencies in the electromagnetic spectrum can provide different information about water cycle variables (Tapley *et al.*, 2004a).

Precipitation is the primary driver of the land hydrological cycle, hence accurate precipitation records are needed to predict land surface moisturefluxes and state variables. Although precipitation gauge data are available over much of the global land area, the station density and observation quality varies greatly (Huffman *et al.*, 1997). Surface radar offers a (costly) alternative to precipitation gauges; however, its maximum range of observation is limited by the well-known ‘target homogeneity’ problem (Woodhouse, 2001; Tanelli *et al.*, 2004).

There is a trend towards the generation of precipitation fields for a given spatial grid and temporal scale using the optimal combination of rainfall estimates from the multi-sensor and/or multi-satellite observations (Huffman *et al*., 2001; Marzano *et al*., 2004; Tapiador *et al*. 2004; Huffman *et al*., 2007)

2. MATERIALS AND METHODS

The Aster Grem is distributed as geo referenced tagged image file format files and in geographic coordinates. A computer used is Toshiba with the following specifications: Windows 10 education, processor: Intel (R) CPU B950 @ 2.1GHz 2.10 GHz, installed memory (RAM): 4.00 GB, system type: 64-bit operating system’ x64 based processor. Program geographic information systems (GIS) ARC GIS contain several tools that assist in the collection and analysis of data (digital elevation and aerial imagery) together with the generic programming framework, provide basic database design and a set of tools that facilitate the analyses often performed in the water resources area.

Arc gis was installed on a Windows 10 computer and loaded the digital elevation model for the experiment site from Earth Explorer. The uploaded file contains three compressed files in one file (DEM, NUM, README) and after decompression, the DEM file was only used.

The mosaic work was done by Arc Hydro Tools within the Arc GIS Program, the Clip work was done by Arc Hydro Tools within the Arc GIS Program with Gadarif shapefile, the fill work was done by Arc Hydro Tools within the Arc GIS program, the flow direction work was done by Arc Hydro Tools within the Arc GIS program, the flow accumulation work was done by Arc Hydro Tools within the Arc GIS Program, the flow basin work was done by Arc Hydro Tools within the Arc GIS Program. The stream order work was done by Arc Hydro Tools within the Arc GIS program. The merge work was done by Arc Hydro Tools within the Arc GIS Program.

3. RESULTS

3.1 Explained Column 1 in Results Database

The current study, which used the morphometric analysis of 176 basins, and the morphometric analysis, which is based primarily on the preliminary results of the GIS program, showed that the data were placed on a complete database containing columns and rows, Morphometric analysis variables on columns and ID setting for each basin on rows.

3.2 Explained Columns from 2nd to 6th in Results Database

The results of morphometric analysis variables show that the area of the total basin in the database is represented on the second column, whereas, the length of the aquifer basin separated from the adjacent aquifers, the basin circumference was calculated in the GIS program. The perimeter of the total basin in the database is represented in the 3rd column, the total length of the stream is the total number of watercourse lengths per basin calculated in the GIS program represented on the database in the 4th column, high altitude is the highest height in each basin in meter, represented on the database in the 5thcolumn, whereas, lower height represented in the 6th column.

3.3 Explained Columns from 7th to 9th in Results Database

The difference between the highest and lowest elevation of the database is in the 7th column. Drainage basin width is the length of a set of orthogonal lines on the straight line representing the length of the basin, and there is no specific number of these lines, and the width of the basin is calculated and represented in the 8th column. Whereas, the length of the basin is the length of the straight line drawn between the farthest points on the perimeter of the basin and the estuary, the total length of the basins was measured as a tool in comparison to the GIS space and represented in the 9th column.

3.4 Explained Columns from 10th to 17th in Results Database

The river orders in the database are in columns from 10th to 15th, respectively. The number of valleys is the total river order available for each basin from the first to the sixth level, represented on the database in the 16^{th} column. Drainage density is a basic measure of the surface characteristics of the drainage basin and the hydrological analysis, it reflects the efficiency of the discharge or is a measure of the extent of the pelvic floor break and represented on the database in the 17^{th} column.

3.5 Explained Columns from 18^{th} to 24^{th} in Results Database

Basin erosion is related to the climate and geology of the area, the quality of the rocks in the discharge basin and the responses of these rocks to the active erosion processes in the basin, the indexation ratio is in the 18^{th} column. A tissue index describes the topography of the tributaries in the same basin and is represented on the database in the 19^{th} column. The coefficient of the figure describes the regularity of the width of the water basin along its length from the source to the downstream environment and represented on the database in the 24^{th} column.

3.6 Explained Columns 25^{th} and 26^{th} in Results Database

Elongation ratio is the percentage of the length of the basin compared to the shape of the rectangle as the percentage of elongation in rectangular basins while decreasing in a basin of other forms, represented on the database in the 25^{th} column. Fixed water stream survival was calculated and represented on the database in the 26^{th} column.

4. DISCUSSION

The results showed that the sum of stream basin (B45) contains the least length of (2.715 km), whereas the basin (B152) contains the largest length of the sum of the stream (9707.523 km). Also, we found that the density of discharge is in the basin (B54) is the highest density of drainage of the ponds (1.022), whereas the least density of drainage is in the basin (B2) (0.409). It was also found that the textured topography in the basin (B6) (13.46) is the highest, while the basin (B162) gave the lowest one (0.0608).

The main objectives of this study are to draw the water map of the Qadarif state, recognition of cadastral characteristics and formal properties, and identification of water drainage network characteristics and histological properties.

5. CONCLUSIONS

The study conducted in the state of Qadarif showed the importance of using remote sensing techniques in research operations thanks to what this technique achieves in its speed and accuracy associated with these techniques taught in the Department of Agricultural Engineering. The research is the first of its kind in the department. research using remote sensing techniques in the future.

The practical steps have been taken to identify the basins that exist in the state of Qadarif to identify the morphometric and hydrological characteristics and the establishment of the database. The extracted values were mapped and analyzed using GIS to characterize the stream networks and drainage basin systems.

Morphometry is the measurement and mathematical analysis of the configuration of the earth's surface, shape, and dimension of its landforms A widely acknowledged principle of morphometry is that drainage basin morphology reflects various geological and geomorphologic processes over time, as indicated by various morphometric studies. It is well established that the influence of drainage morphometry is very significant in understanding the landform processes, soil physical properties, and erosional characteristics. The analysis of the drainage does not appear to be complete if it lacks the systematic approach towards the development of the drainage basin in the area.

Drainage lines of an area not only explain the existing three-dimensional geometry of the region but also help to narrate its evolutional process. Drainage provides a basic understanding of initial gradient, variation in rock resistance, structural control, geological and geomorphologic history of the drainage basin, or watershed. Evaluation of morphometric parameters requires the analysis of various drainage parameters such as the ordering of the various streams, measurement of basin area and perimeter, length of drainage channels, drainage density (Dd), bifurcation ratio (Rb), stream length ratio (RL), and relief ratio (Rh). Besides, the quantitative analysis of the drainage system is an important aspect of the character of a watershed. It is important in any hydrological investigation like an assessment of groundwater potential, groundwater management, basin management, and environmental assessment.

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