4th International Conference on Water Resources and Arid Environments (ICWRAE 4): 811-814
5-8 December 2010, Riyadh, Saudi Arabia

The Use of GIS and Remote Sensing for Hydrologic Evaluation of Wadi Al-Karak Basin: Building Gis Database System

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Abstract: Remotley sensed data and related hydrolgical (spatial and attributes) data were used in this study in order to build a GIS database system which is the most essential for data modeling, analysis and evaluation in GIS environment. Wadi Al-Karak basin is one of the most important basin in Jordan. It represents the transitional area between the humid-semiarid areas in the west into drought areas in the east as well as the central city is located within this basin. The study area (Wadi Al-karak Basin) is located at the south-western part of Jordan. It comprises an area of 190.7 km2. GIS database system for the basin has been established including many GIS layers such as drainage pattern, structural feature, residential areas, road network and digital elevation model (DEM). An evaluatetion of rainfall distribution map as well as the other climatic measurements also have been made. Further, the groundwater resources in the study area has been studied and evaluated. Accordingly, the promising areas for further and future investment have been determined.

Key words: Remote sensing • GIS • Hydrology • GIS database system and digital elevation model (DEM).

INTRODUCTION

The Hashemite Kingdom of Jordan is located between latitudes 29°11' and 33° 22' North and longitudes 34°19' and 39°18' east and covers an area of about 90000 km^2. Water resources in Jordan become the main crises resources because of the location of Jordan in the arid zones and of the drought years. Due to the limitation of surface water resources in Jordan, groundwater considers the main water resources in Jordan. Generally, the total amount of water recharge into the groundwater basins from the excess rainfall is estimated to be about 275 million cubic meters (MCM) m^3 /year [1]. Wadi Al karak Basin is located at the southern part of and covers an area of about 190 km^2, it is consider important basin in Jordan because this basin contains the transitional areas between high lands in the east and low lands in the west. This is not only reflected in the climatologically changes from wet to dry but also in different land use vegetation Application patterns and also in large changes of habitat. On the other side, the eastern hilly areas are relatively densely populated, the west of the basin almost without population. In order to manage relation geodata base in Wadi Al-Karak Basin in sustainable and wisely way, geographic information system (GIS) and Remote Sensing (RS) and other tools are essential and valuable. Based on the study results, According to the high, rainfall distribution, land use map and aquifer parameters, three promising areas can be distinguished in the study area.

MATERIALS AND METHODS

All data available related to geological, hydrogeological, hydrological and other related environmental data documented in technical reports, papers, journals or other references has been collected and stored as GIS database. Moreover, all available data were checked and evaluated by statistical handling (correlation coefficients, type of distribution. Missing data were replaced based on the similarity and the correlation coefficients between data [2].

As GIS database, all relevant data was tabulated (attributes) and was used to create the shape files using ARCGIS software, where contour lines map, geological map, drainage boundary, roads and residential areas and topographic map was digitized and converted into shape files (themes).

Hydrogeology: The rain fall precipitation in Wadi Al-Karak basin differs according to time and place and to clarify the characteristics of rain rates for the basin of wadi Karak, rain data has been analysed for five stations

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Table 1: Spatial hydrological characteristics of Wadi Al-Karak basin

Station	Lowest precipitation / mm	Highest rate of precipitation / mm	Average annual precipitation / mm	Standard deviation	coefficient of variation %
Karak	130/1995	619/1979	324	135	41
Rakhine	84/1992	743/1991	277	133	48
Albesas	110/1999	698/1991	280	137	48
Al Mazar	136/1972	512/1987	290	101	35
Farm Ghore	13/1986	153/1987	77	28	36
Avarage range	119/1995	487/1991	248	80	32

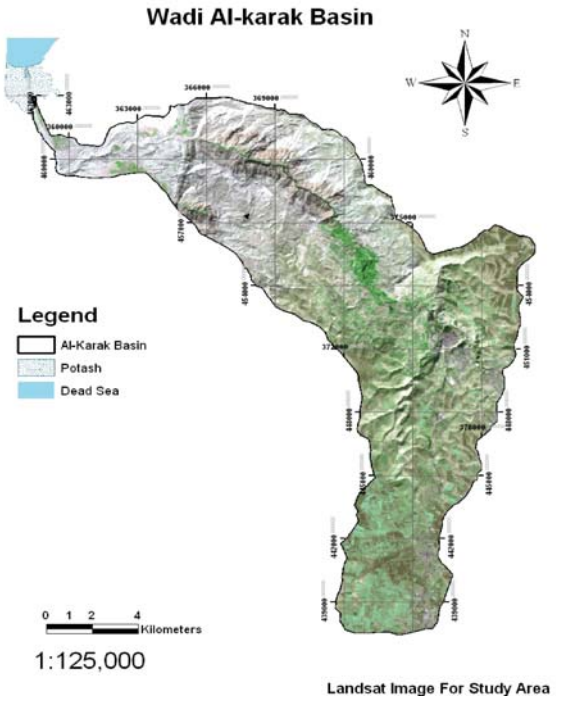

Fig. 1: The satellite image of the Wadi Al-Karak basin in standarde false color composite (7,4 & 2 in RGB).

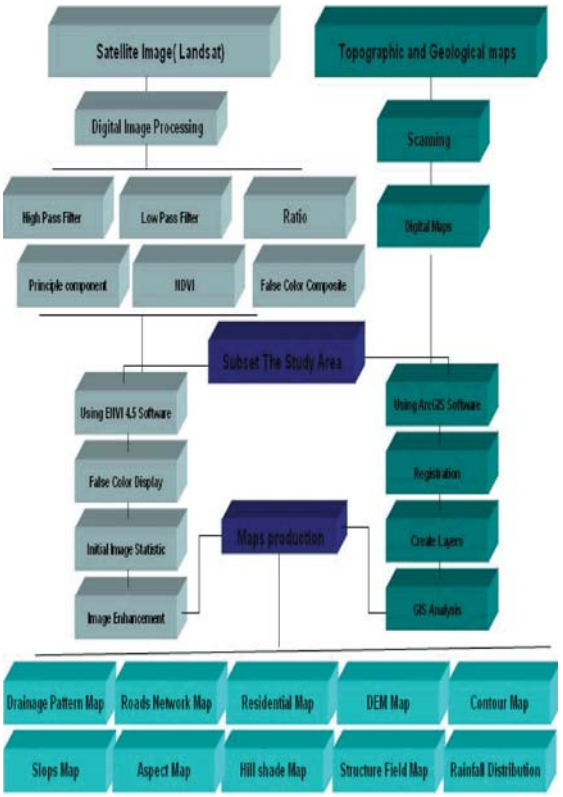

Fig. 2: Methodology diagram for the study area

of the Ministry of Water and Irrigation / Jordan Valley Authority, namely: Karak, the Rakhine and Albesas, the southern Mazar and the Gore farm, divided into all parts of the basin. The hydrological characteristics of Wadi Al-Karak basin can be illustrated in the below Table 1.

Springs are important sources of water in Wadi Al-Karak basin, whether for domestic or agricultural exploitation and these springs are generated from the different classes of water, a total of 46 water springs in Wadi Al-Karak basin were stored in the GIS database system, that in addition to all available data from Central Water Authority of the Ministry of Water and Irrigation and Natural Water Authority were also stored in the GIS database system which incloud; precipitation rate of rain, runoff, evaporation, Infiltration, flow-based (base flow) and gusty flow (flood).

Gis Analysis: Data entry can be very time consuming, but it is the most important task of the GIS process [3]. The amount of geographic data that has been gathered is huge and includes volumes of satellite imagery collected from space, in addition to all available and published by Central Water Authority of the Ministry of Water and Irrigation and Natural Water Authority. Therefore, storing and producing the GIS database system for Wadi Al-Karak basin for such enormous amount of data in GIS environment is supporting and has allowed the automated mapping and facilities analysing and managing the data. In ArcGIS program a layout for or Wadi Al-Karak basin DEM was geneated in order to drap the satellite image, the geological map and the topographic map of Wadi Al-Karak Basin area over it.

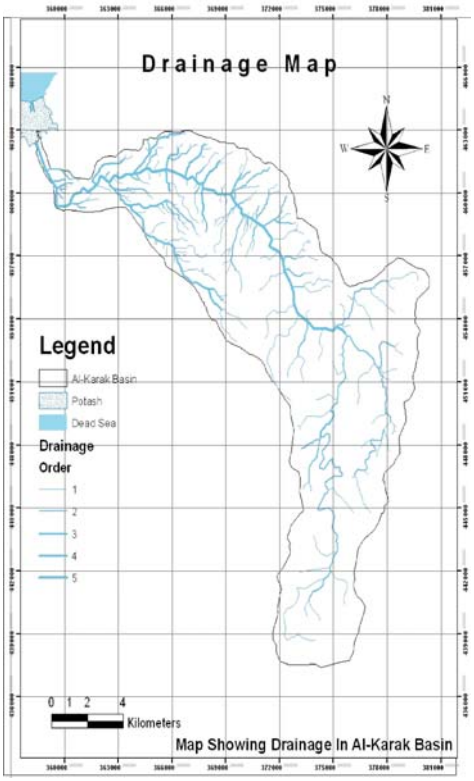

Fig. 3: Drainage pattern map.

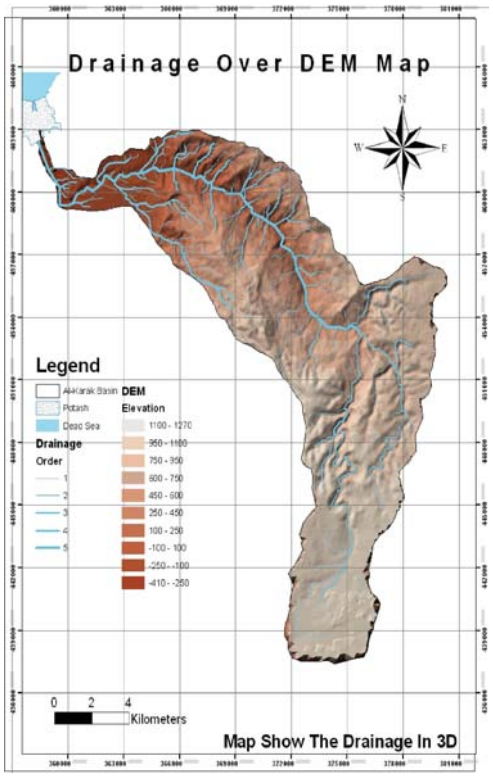

Fig. 5: Drainage Draped Over DEM

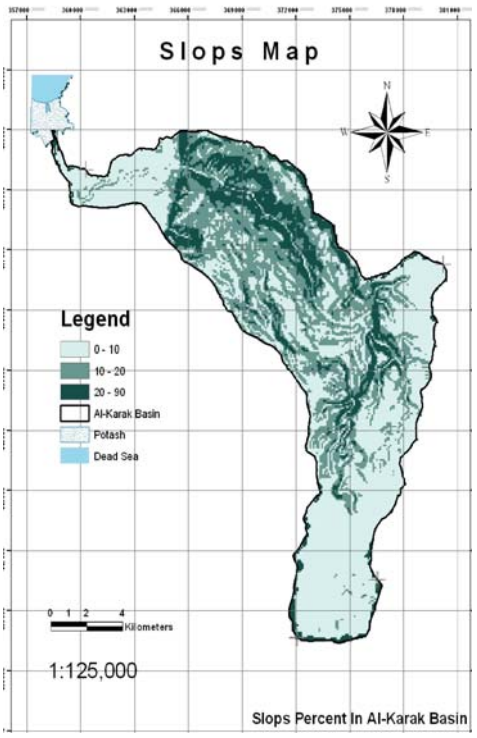

Fig. 4: Slope map.

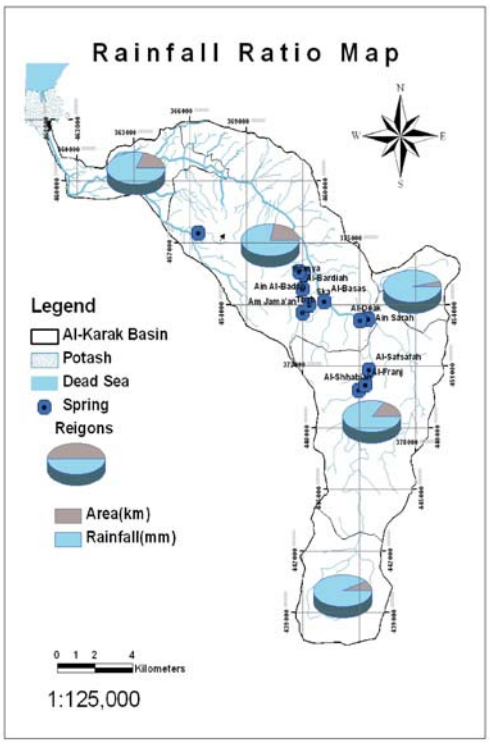

Fig. 6: Rainfall Distribution

RESULTS AND DISSCUSION

Data analysis is the process of interpreting data. This may range from simple exploratory data analysis, which involves simply looking at the data and describing what you see to complex analysis such as modeling.

Spatial analysis of GIS starts with the basic operation of visualization (exploratory data analyses). Visualization critically important function in GIS: the human ability to recognize spatial relationships on maps, images and other graphical displays (on screen) or hardcopy (maps) output. Geoscientists are accustomed to looking at maps and from patterns they have the ability to postulate geological structure. A GIS is a powerful tool and can provide better information to support many types of difficult decision-making. With the rapid advancement taking place in computer hardware and GIS software, more complex models are being developed. These models help researchers and planers to simplify complex systems and to develop theories to better understand the processes at work. Present analytical function and conventional cartographic modeling techniques in GIS are based on Boolean logic, which completely assumes that objects in a spatial database and their attributes can be uniquely defined [4].

The layout is the procedure to view the output maps from the GIS in hard or soft copy. The hydro geological elements in Wadi Al-Karak Basin area and all attributes were stored as GIS database. This can be used to execute calculation, statistics and analysis for a better management and for further investment in Wadi Al-Karak basin. The following figures are examples of what can be produced of GIS layers or GIS maps from the GIS database system for Wadi Al-Karak basin.

CONCLUSIONS

Water resources in Jordan become the main crises resources because of the location of Jordan in the arid zones and of the drought years. Due to the limitation of surface water resources in Jordan, groundwater considers the main water resources in Jordan. Generally, the total amount of water recharge into the groundwater basins from the excess rainfall is estimated to be about 275 million cubic meters (MCM) m^3 /year.

Geographic information System (GIS) and Remote Sensing (RS) were used to produce GIS database for Wadi Al-Karak Basin. Relational geo-database for wadi Al Karak basin has been produced in which hydro-geological elements, drainage pattern map, slope map, DEM model and Rainfall Distribution map in addition to many maps that can be produced for any reason at any time from the GIS database system.

The rainfall distribution maps over and above all the other produced maps of wadi Al Karak basin were produced for evaluating purposes.

ACKNOWLDEGEMENT

The authers would like to acknowldege the King Saud University. Acknowldege go also for Prince Sultan center for water and desert and environment.

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