The Use of GIS in Hydrological Studies: Applications in Part of Seyhan River Basin

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1. Introduction

The application of geographical information systems (GIS) in hydrological studies offers considerable potential. In hydrological studies, GIS can be used in preparing the watershed description, which may include representation of stream layout from digital elevation model (DEM), describing soils, land cover, land use, locating point gauges, interpolating point climatic data, impact of water utilization.

In this study some examples of GIS applications in hydrological studies in part of Seyhan River Basin were given and results were discussed.

2. Study Area

Study area is a subwatershed called Korkun in the Seyhan River Basin, located in South of Turkey as shown in Figure 1. It consists of approximately 1440 Km^2; the maximum altitude is 3756 meters on sea level, the minimum 200 meters.

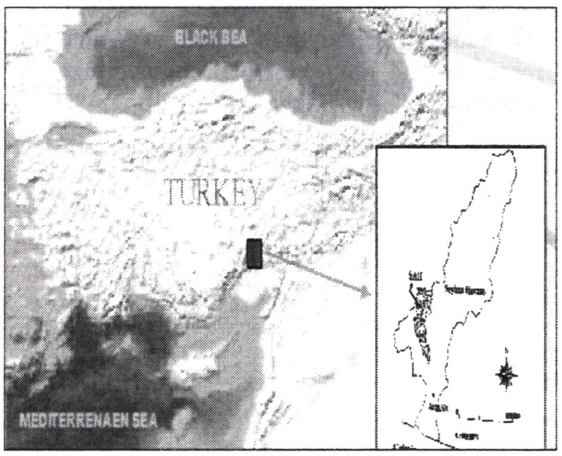

Fig 1. Study Area

Boundary and drainage network of Korkun Subwatershed can be seen in Figure 2.

Fig. 2 Korkun Sub-watershed

3. GIS Applications

A few of the many applications of the GIS in hydrology was applied to subwatershed called Korkun in Seyhan River Basin. These applications are surface water, DEM, land surface, hydrologic data, water utilization. ILWIS was used for all applications.

4. Surface Water

Surface water system is the most complex of all the phases of the hydrologic cycle, because it interacts with atmospheric water, soil water, and groundwater, and because the flow environment is complicated, depending on characteristics of land surface and stream system. Fortunately, this is the area where GIS helps the most because of the detailed description of land surface features which can be presented easily in GIS by using Digital Elevation Model (DEM).

5. Digital Elevation Model (DEM)

DEM can be use for derivation of drainage networks and the quantitative description of the geomorphic characteristics of basins.

Figure 3. Shows drainage networks derived from DEM for Korkun Subwatershed.

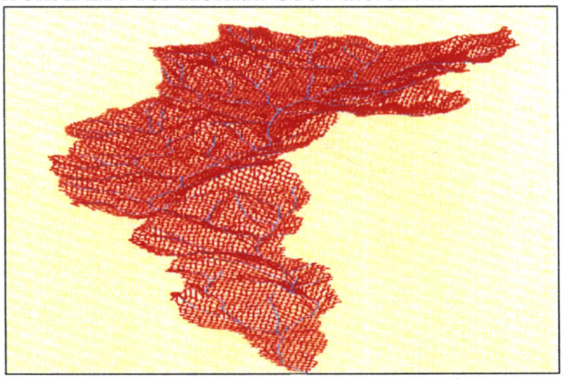

Fig. 3. DEM and Drainage Network of Korkun Subwatershed

4. Land Surface

Land surface of the study area can be described which may include soil groups, land cover, land use, cities and roads by using GIS. Examples were shown in Figure 4. and Figure 5.

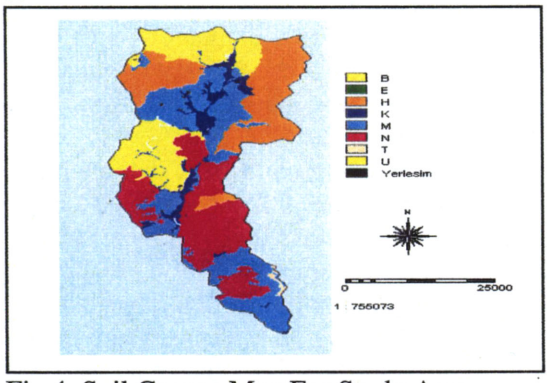

Fig.4. Soil Groups Map For Study Area

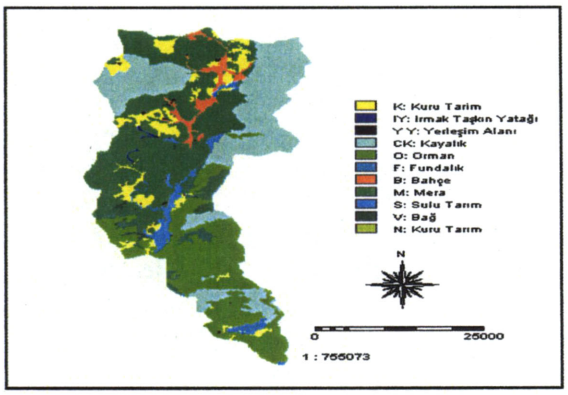

Fig. 5. Land Use Map For Study Area

6. Hydrologic Data

Hydrology is concerned with study of motion of the earth's waters through the hydrologic cycle, and the transport of sediment and pollutants in the water as it flows. In hydrology, GIS is focused on representing the watershed characteristics by means of locationally reference data describing parameters of hydrologic cycle and related processes (Ward 1995). In hydrological studies, location of rain gauges can be mapped by GIS and analyzed spatial and temporal variability of rainfall.

Figure 6. Shows Rain gauges locations for study area.

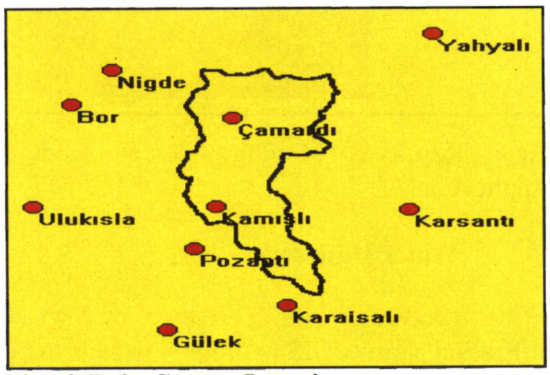

Fig. 6. Rain Gauges Locations

The grid methods are used in GIS for spatial calculations. Grids are generated and the number of points containing each grid is counted, while nearest neighbor method is used to derive distance nearest neighbors. These kind of spatial calculations are made easy with GIS (Garbrecht, 1999).

In this study, Interpolation methods which are nearest point (Thiessen), Moving Average, Trend Surface, Moving Surface and Kriging in ILWIS can be use for converting point rainfall to area rainfall. Result maps of application nearest point method and moving average method can be seen in Figure 7.and Figure 8 respectively.

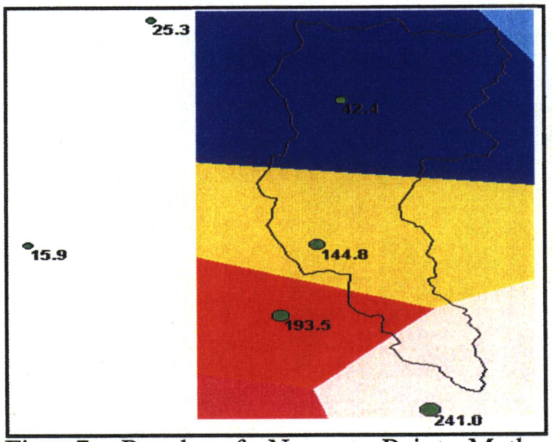

Fig. 7. Result of Nearest Point Method Application

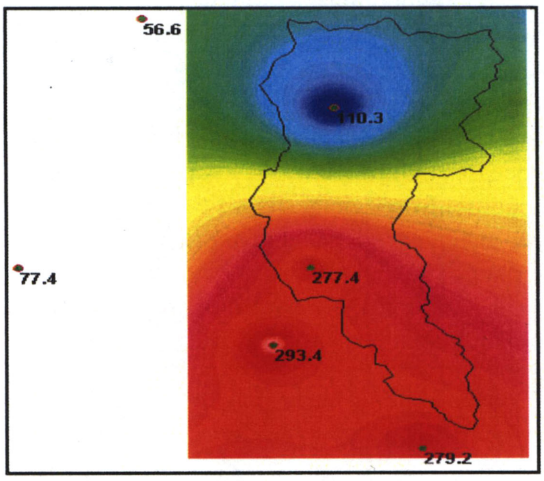

Fig.8. Result of Moving Average Method Application

Water Utilization

Modeling the effects of water utilization permits GIS hydrology models to be useful as a basis for planning decisions on water facilities.

Including reservoirs in the computation is more complicated because a reservoir is fairly complicated system by itself, and its outflow depends on the manner in which the reservoir control works are operated.

GIS can be used to quantify changes in water volume of reservoirs. When a dam constructed in study areas as shown in Figure 9, an area upstream will be flooded up to a certain water level. To determine the exact area to be flooded neighbourhood operation was used. Figure 8 shows that the area, which will be flooded after creating the dam and area of water body, can be calculated.

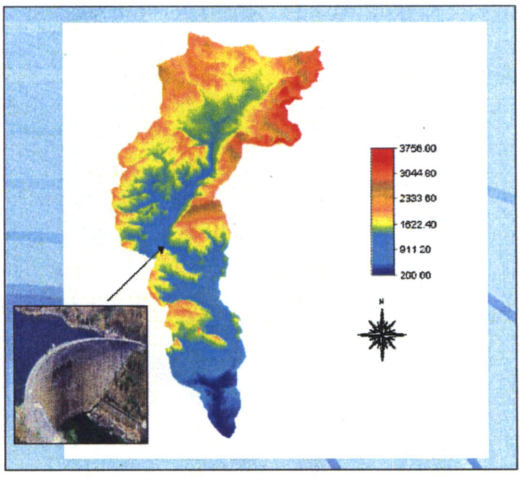

Fig.7. Location of Dam in Study Area

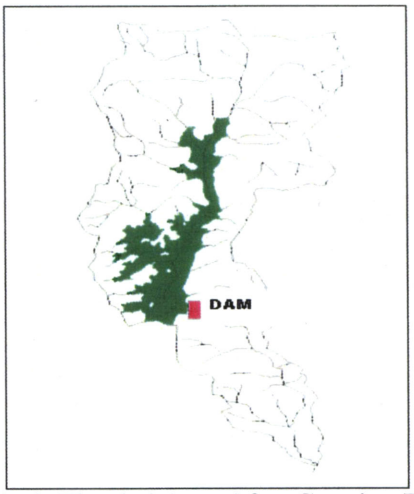

Fig.9. Flooded Area After Creating Dam

7. Conclusions

In this study available data was used for describing the land surface especially DEM data for land surface terrain, which has made it practical for the first time to delineate Korkun Subwatershed in a few minutes in an automated way to compute hydrologic properties of study area. But, data availability and quality for computations are very important in GIS.

Interpolation of climatic data with GIS such as temperature and precipitation data is very useful calculations for hydrologic studies.

The integration of hydrologic processes, especially integration of surface and groundwater flow, the impact of water utilization facilities water quality studies, and global climate change issues may be studied with GIS successfully.

Hydrologic models can be generated more accurately and database development for these models have to be considered.

8. References

Garbrecht.J., Martz, L.W. 1999., Digital Elevation Model Issues In Water Resources Modeling. 19t^{h} ESRI International User Conference, Environmental Research Institute, San Diego, California, July 26-30,1999.

ITC 1998 The Integrated Land and Water Information System (ILWIS) Int. Inst. for Aerospace Survey and Earth Sciences, Enschede, The Netherland.

Ward, A., D. Elliot, J.,W. 1995: Environmental Hydrology, CRC Press, Inc.