Submission ID (*according to EasyChair number*)

ANALYTICAL HYDROLOGICAL MODELLING FOR WADI AL HASA CATCHMENT AREA - JORDAN

Taleb Odeh[1], Alsharifa Hind Mohammad[2], Sura Al-Harahsheh[3], Faten Alslaty[4]

1 The Hashemite University - Arid Lands Academy, Zarqa, Jordan
taleb_odeh@yahoo.com

2 The University of Jordan - Water, Energy and Environment Center, Amman, Jordan
s.jasem@ju.edu.j

3 Al al-Bayt University - Water, Environment and Arid Regions Research Center, Al-Mafraq, Jordan
sura@aabu.edu.jo

4 The Hashemite University - Faculaty of Natural Resources & Environment , Zarqa, Jordan
fatenm@hu.edu.jo

KEY WORDS

GIS, Flash floods, Geomorphological units, Drainage network

ABSTRACT

Wadi Al Hasa catchment is prone to flash flooding by heavy precipitation during the winter season. The geomorphological settings of this catchment is extremely heterogeneous as a result of different underline geological structures of the Dead Sea basin. The geomorphological heterogeneities control the drainage networks density and directions and hence control the spatial distribution of flash flooding strength and direction over the catchment too. Therefore, understanding the geomorpholgical setting of the catchemnt has a special importance in order to understand flash flooding. Automated generation of drainage networks from digital elevation models (DEMs) is a powerful analytical function in geographic information systems (GIS). Remote sensing methods offer a vast array of DEMs with different resolutions to choose from. Therefore, an integrated approach that combines remote sensing and GIS could be used to generate an analytical hydrological and investigate the influence of geomorphology on the hydrological cycle. We found that the overlay method in GIS could be an analytical tool for groundwater recharge estimation and geo-visualization.

1. INTRODUCTION, FIRST HEADINGS

Arid and semi arid areas face globally the greatest pressure to deliver and mange water recourses (Trondalen 2009). Water resources in the Dead Sea basin, which is an arid to semi arid region, are limited to groundwater and rainfall that falls on the mountainous area which cause flash floods during the winter season (Dayan & Morin 2006). The spatial distribution of the flash flooding is controlled mainly by the geomorphological setting of the flash flood catchment area (Vivoni et al. 2008).

Drainage networks respond rapidly to the geomorphological settings. Wadi Al Hasa catchment area locates at the eastern side of the Dead Sea (Fig. 1). It has an area of about 2520 Km2 of a high relief topography as a result of the complicated underline structures. The high relief topography generated complicated geomorphological units therefore the objectives of this research are as follows:
1) Geomorphological evaluation for Al Hasa catchment area.

2) Analytical hydrological modelling for the study area in order to investigate the flash flood intensity and probability.

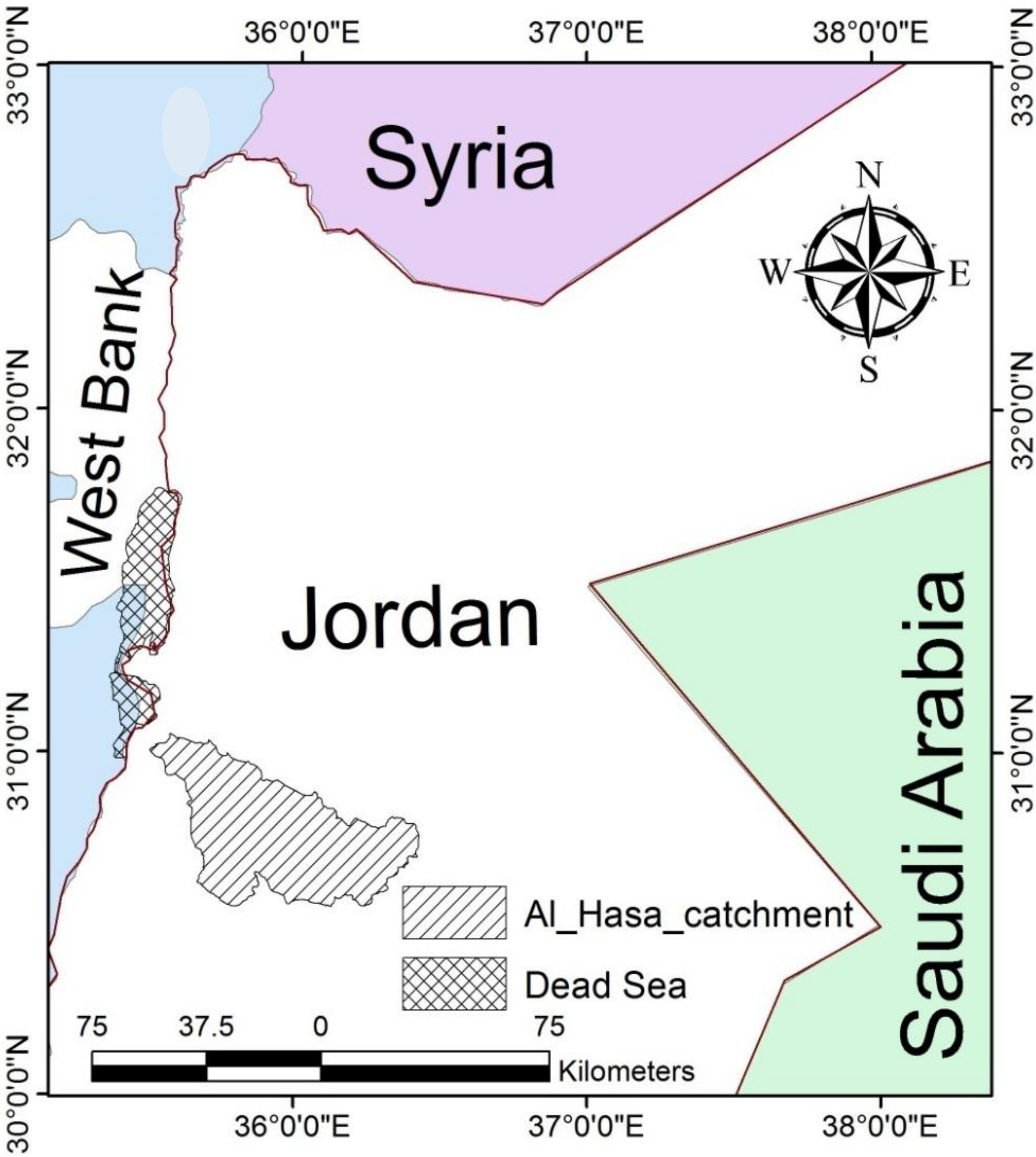


Figure 1: Location of the study area (south east of the Dead Sea).

3) Correlate the location of hydrological unites with geomorphological unites and determine the relationship between them.

2. MATERIALS AND METHODS

A Geographic Information System (GIS) is a useful tool for the analyses of spatial and temporal parameters that any analytical hydrological modelling request (Saintot et al. 1999). Drainage networks which is a basic part in any hydrological modelling are generated by the geomorphological units changes (Shahzad and Gloaguen 2009). The automated generation of drainage networks from Digital Elevation Models (DEMs) is a powerful analytical function in GIS. ArcGIS 10.3 is the most useful and common for GIS in order to generate drainage network and overlaying method that is a must in any analytical hydrological modelling. Therefore, we use hydrology tool tools box in ArcGIS 10.3 software in order to extract the drainage network while use the spatial analyst extension to overlay the different layers that our analytical model needs including rainfall layer, runoff layer and evaporation layer (Fig. 2).

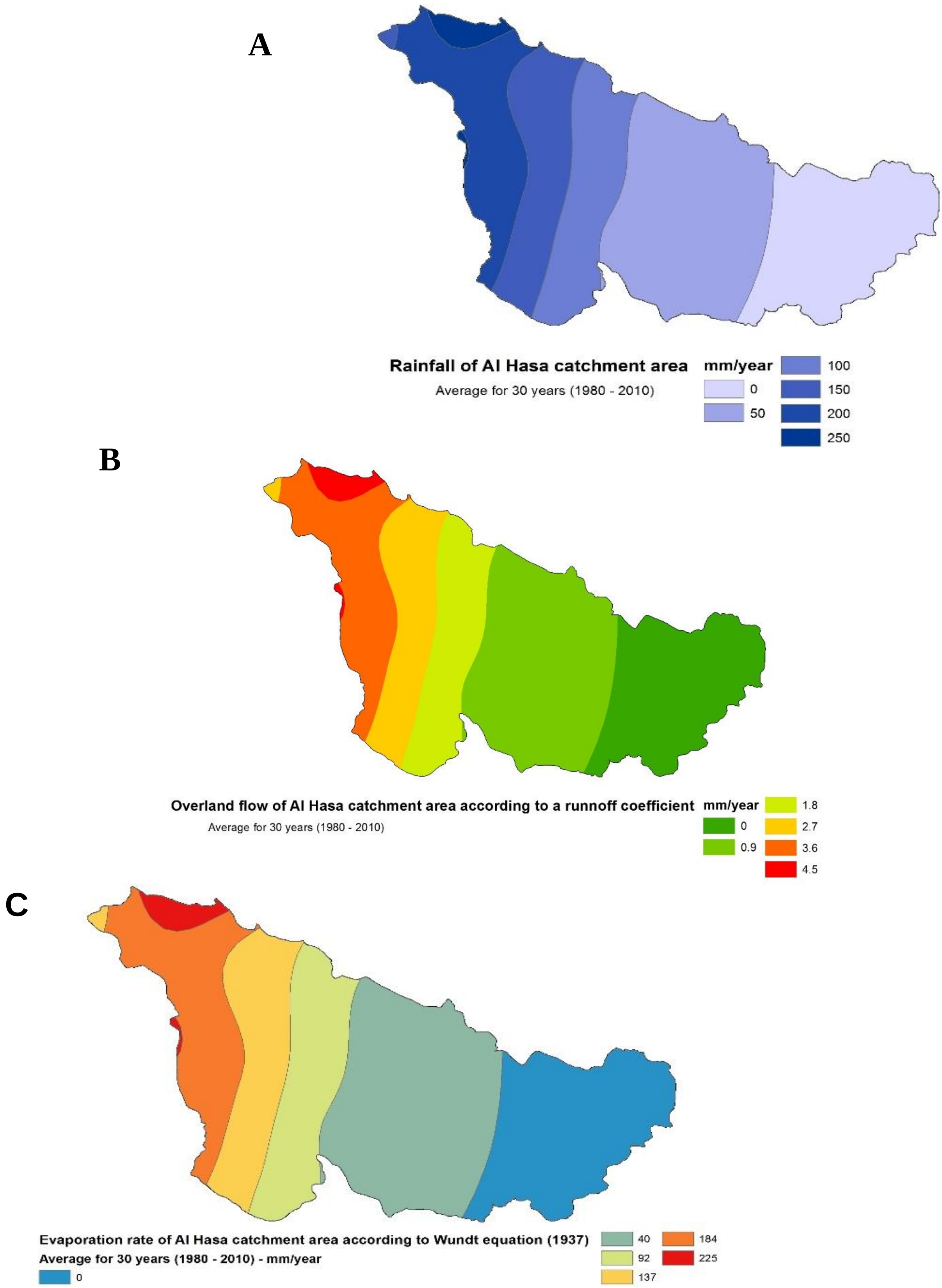
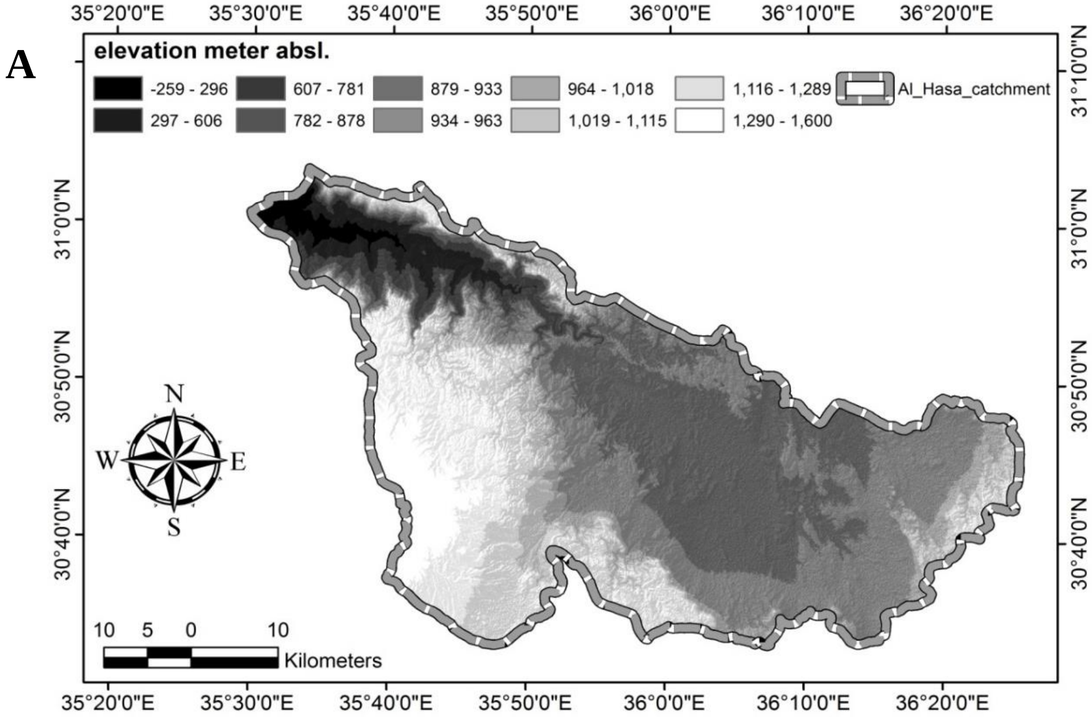


Fig. 2: The layers that we used to generate our analytical model. A) is the rainfall pattern that generated by interpolate the rainfall values by ArcGIS 10.3. B) is the overland follow for each rainfall pattern according to the runoff coefficient. C) is evaporation that were estimated according to wundt equation.

2. RESULTS

Interrelationships between topography and near-surface structure are often recognizable (Wilson and Dominic 1998). Topography can be parsed automatically by manipulating land surface heights within elevations arrayed in DEMs. From a functionality perspective, GIS techniques can efficiently achieve that process through a variety of data visualization approaches, patterns, and spatial analyses (Wang and Yin 1998). Figure 3 shows the DEM that drainage network intensity is increase in the north west



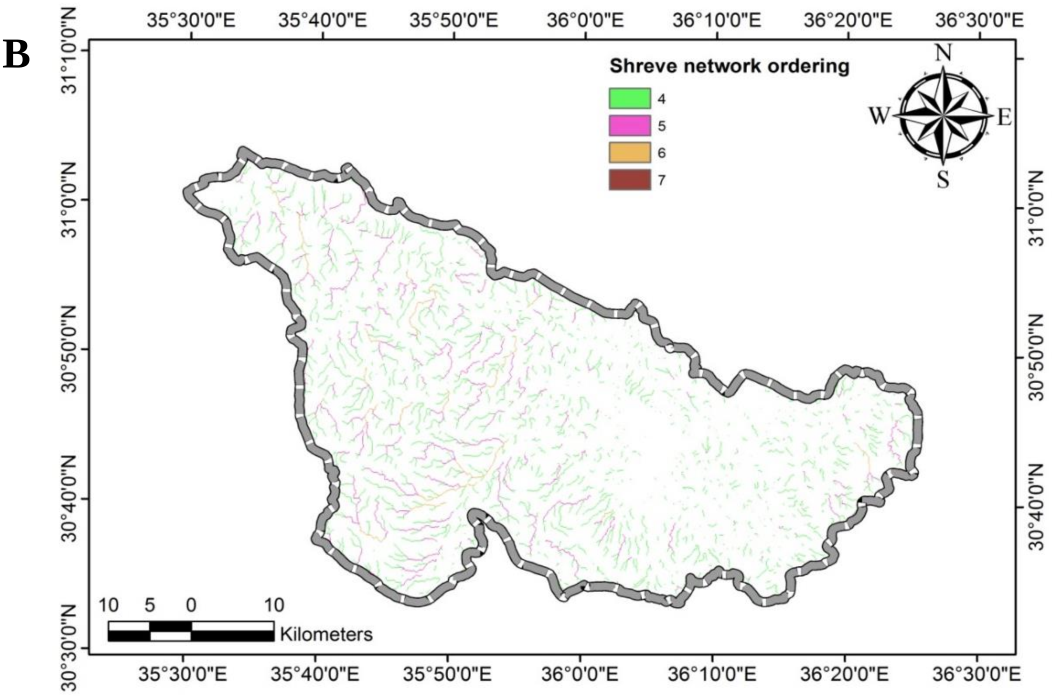


Fig. 3: The DEM of the study area (A) and the extracted drainage network (B).

of the study area while it is decreased in the south west. However, the high relief of the study area could be subdivided into 6 geomorphological units as is shown in figure 4. We correlated these

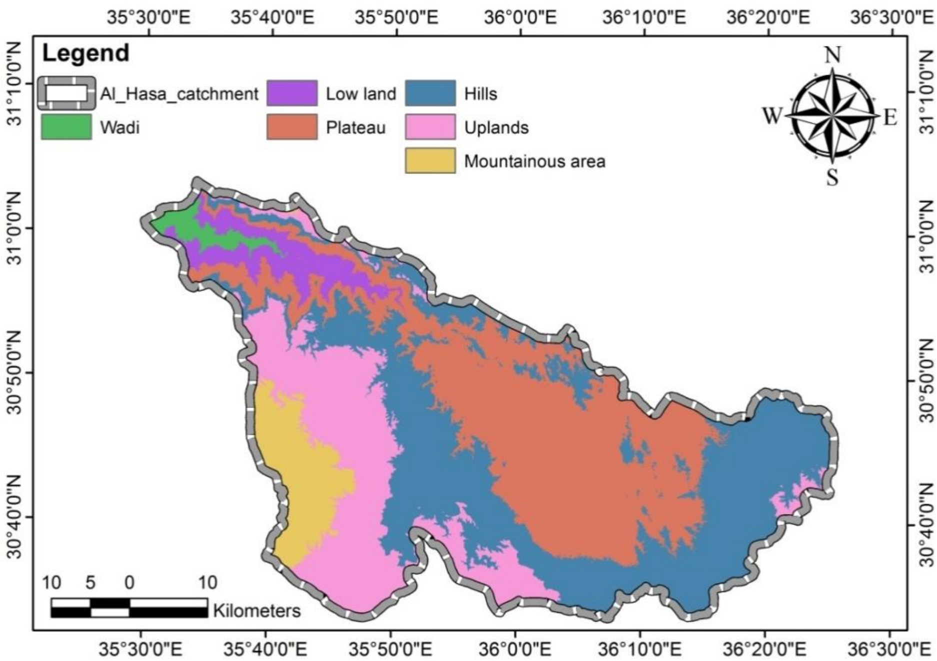


Fig. 4: the geomorphological units in the study area.

geomorphological units with the infiltration or groundwater recharge units that is shown in figure 5.

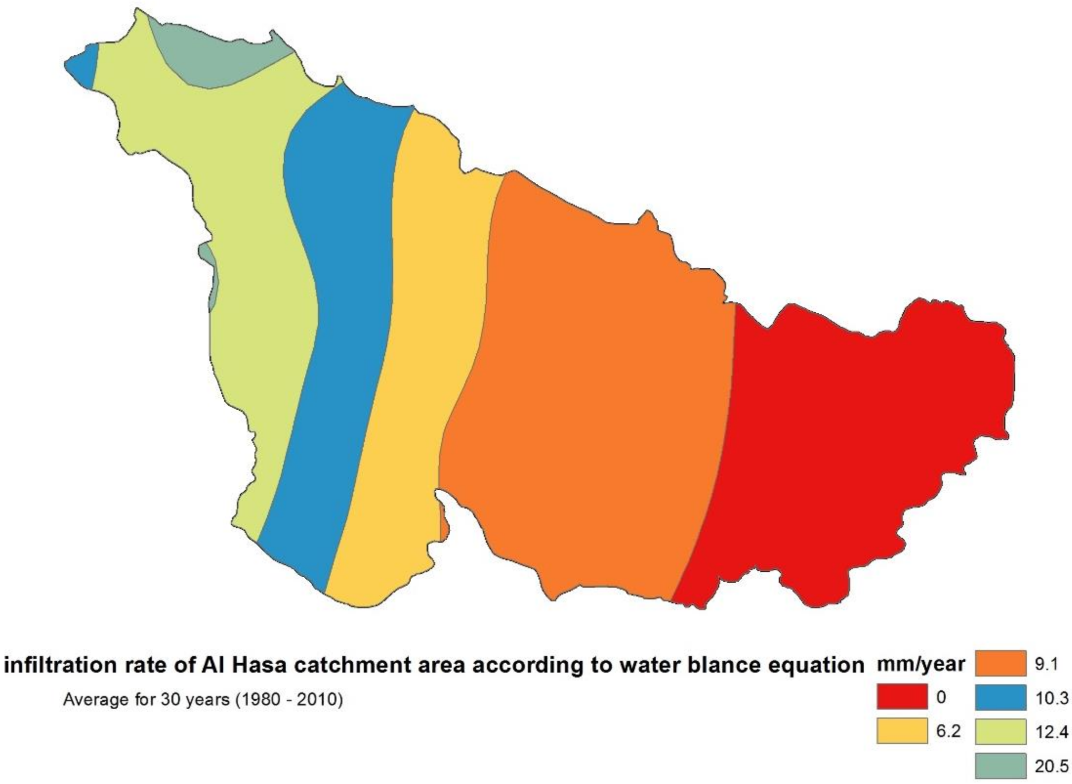


Fig. 5: The groundwater recharge zones that were estimated according to water balance equation and by overlaying method in GIS.

We found hat the highest amount of recharge is located with the mountainous area because it receives the highest amount of rainfall the originally and mostly comes from the Mediterranean sea. An exception is in the east of the study area where the study area become out of the Mediterranean climate zone and more effected by the desert conditions. In the plateau area there is a high amount of groundwater recharge as a result of low amount of overland flow. In the north west of the study area the drainage network is increase therefore overland flow in form of flash flood is increased and the groundwater recharge is decreased.

4. CONCLUSIONS

The geomorphological units play a major role in the spatial distribution of flash floods according to control the Drainage density. Topography control the amount and the spatial distribution of groundwater recharge according to control the rainfall pattern spatial distribution.

ACKNOWLEDGEMENT

We are thankful for the Hashemite University in Jordan for supporting this research.

REFERENCES

Dayan U & Morin E (2006). Flash flood-producing rainstorms over the Dead Sea: a review. *Geol Soc Am Spec* Pap 401:53–62.

Trondalen J (2009). Climate changes, water security and possible remedies for the Middle East. U*nited Nation Educational, Scientific and Cultural Organization publication* 75352, France, p 8.

Saintot A, Angelier J & Chorowicz J (1999). Mechanical significance of structural patterns identified by remote sensing studies: a multiscale analysis of tectonic structures in Crimea. *Tectonophysics* 32:187–218.

Shahzad F & Gloaguen R (2009). Understanding tectonics from digital elevation model, part 1: drainage network preparation and stream profile analysis. *Comput Geosci* 37:250–260.

Vivoni R, Benedetto F, Grimaldi S & Eltahir E (2008). Hypsometric control on surface and subsurface runoff. *Water Resour Res* 44:12502–12512.

Wang X & Yin Z (1998). A comparison of drainage networks derived from digital elevation models at two scales. *J Hydrol* 210:221–241.

Wilson T & Dominic J (1998). Fractal interrelationships between topography and structure. *Earth Surf Proc Land* 23:509–525.