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Determining of flood zones using HEC-GeoRAS software in GIS environment (Case study: Qarasoo, Kermanshah, Iran)

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ABSTRACT

Iran because of its particular climate and in respect of being flood prone is seventh country in the world and sustains lots of damages every year. Reducing of crisis impacts requires integrating of various data including topography, roads, buildings and urban facilities. In this order GIS along with hydraulic models are key tools that provide suitable response and analysis and also possibilities for determining flood zones and safe places. In this paper, first all of required information layers were designed using GIS and secondary programs such as HEC-GeoRAS and ArcHydro and after creating spatial database of parameters including river route, cross-sections, longitude slope of river, banks and discharge amount imported them into the hydraulic model of HEC_RAS. After running the model the obtained results including flood zone, depth of water flow were sent again to the GIS environment and in shape of a information layer placed upon a land use map and by 3D simulation of the region different land use condition in flood occurrence time were determined. Since the result of this research further determining zone, water depth, different land use condition could also determine safe places using different functions in GIS environment. Furthermore since the results obtained from hydraulic model run are including flood prone zone and also the flow depth at each region we could provide an accurate estimation of damage due to flood with different return periods.

Key words : *Flood, Flood Zone, HEC-GeoRAS, ArcHydro, HEC-RAS*

Introduction

Increasing process of life and economic damages due to flowing of flood in recent decades in the world obliged water engineers and other experts to find a solution for control and management of this natural phenomenon. One of the fundamental steps in management of floodplains, flood control, estimation of flood damages and determining of flood insurance right is determining of floodplain boundaries that this purpose can not to be served without hydraulic and hydrologic analysis. But, deficiency of these models is their disability to link data related to GIS properties of water surface profile with their physical location on the earth. Using GIS in order to simplify estimation of watershed hydrologic parameters attracted much attention within recent years. It's because of this fact that hydrologic models in-

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clude spatial geomorphic variables. GIS technology is suitable option for management of massive and complex data. Preventing of flood occurrence risks, organizing and management of flood in rivers and eventually renovation of rivers require detection and determination of flood zones.

Group of the United States experts in 2007 using hydrologic and geomorphologic properties studied risks of engineering operation using HEC-GeoRAS and HEC-RAS. For start of investigation they divided the region into six study zones. According to side erosion of the bank and bed of the river and sedimentation during flood occurrence time they provided desirable criteria for similar regions.

In another study that was carried out in Alberta located in the united States application of GIS in flood simulation has been evaluated. GIS application showed successful results in comparison with traditional methods.

Materials and Methods

Under study basin is a part of the Qarasoo river watershed. The study area located between 34 degrees and 0 minute and 22 seconds to 34 degrees and 55 minutes and 10 seconds of latitude and 46 degrees and 22 minutes and 12 seconds of longitude.

HEC-RAS Hydraulic Model

HEC-RAS is a software package consisting of a series of hydraulic analysis programs. This system is capable for calculations of sediment transportation and some other hydraulic designs. This model is able to analyses river network and single and multi branches systems. The steady state flow analysis model is capable to analyze sub critical, super critical flows and combination of them.

HEC-Geo RAS

HEC-GeoRAS is a lateral program for use along with ArcGIS. This program is a program in GIS context.

HEC-SSP

HEC - SSP software is Windows edition of HEC - FFA software, a very powerful application in context of statistical fit of sediment amount. The software recommended by the U.S. Water Resources Council and the coefficient of the log Pearson type III distribution is used for flood control and exceptional (Outliers) is performed. Due to these flood shappened on the floods return period are considered.

Results

Basin physiography of the first stage using Arcgis Software Arc Hydro which can be installed as a side software, is calculated. After entering the correct DEM and DEM of watershed run off flow direction for each cell is then determined (Fig. 2).

Then the area where run off is collected in those points specified as cumulative. In fact this stage determines that each point is what point of concentration point need to be considered. Then, stream flows segmented as unit area or upstream cells number.

Using data available of region hydrometrics flood peak is obtained. In this order the statistical peak flow and daily discharge of these stations were collected since establishment date. It should be noted that the maximum daily discharge belongs to the date of the maximum instantaneous discharge occurrence. Because some stations in one or more statistics years have no data for the maximum instanta-

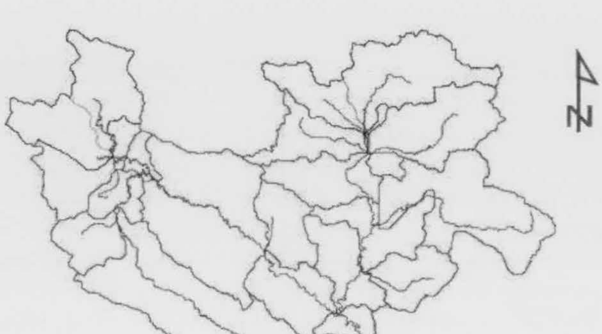

Fig. 1. Qarasoo Watershed

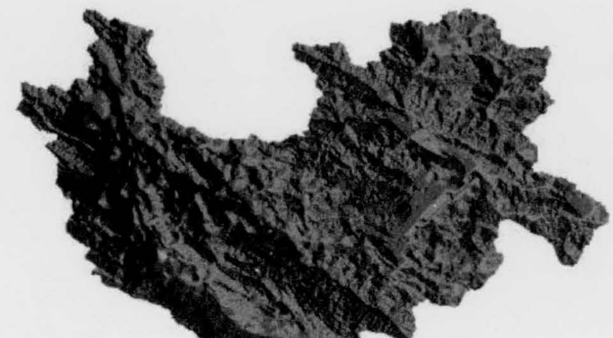

Fig. 2. Determining runoff flow direction for each cell

neous flow rate then, in order to estimate of the maximum flow rate for these stations HEC-SSP were used.

After theflood hydrograph computed with different return periods, with physiographic data of streams using HEC - RAS the flow for discharges with different return periods were modeled. At this stage, after importing the cross sections of streams and rivers, flood plains and the Manning roughness coefficient was defined in each section. Then, because there is not enough information about the flow condition and the flow boundary condition the flow modeled in steady state. Thus,with respect to the uniform slope of the river bottom, water surface slope, and the slope of the energy line was assumed same and the flow modeled as subcritical.

Using HEC-GeoRAS software

In order to obtain flow lines, banks, stream flows and river cross sections we used HEC-GeoRAS. In this software that could be used in the GIS environment there is possibility to create cross sections with desire length and number. Thus, with perpendicular cross sections on the river on the region DEM, cross sections created in the Arc GIS environment and transferred to the HEC-RAS environment.

In the next step, the flow pathlineson both side of the main reach (flood plains) are plotted. The next

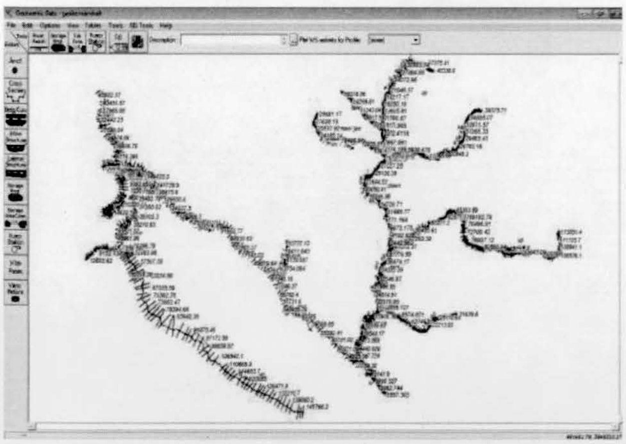

Fig. 3. Streamflows model that created by HEC-GeoRAS and used by HEC-RAS

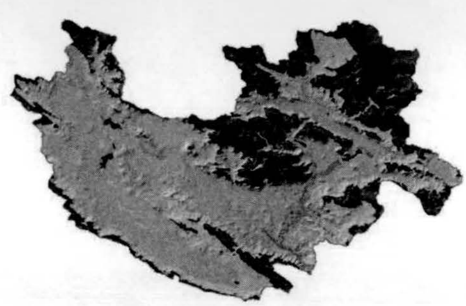

Fig. 4. Water surface profile during 1 year return period

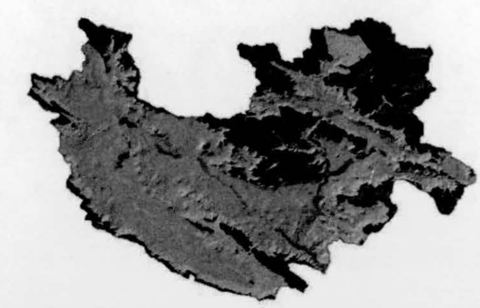

Fig. 5. Water surface profile during 10 years return period

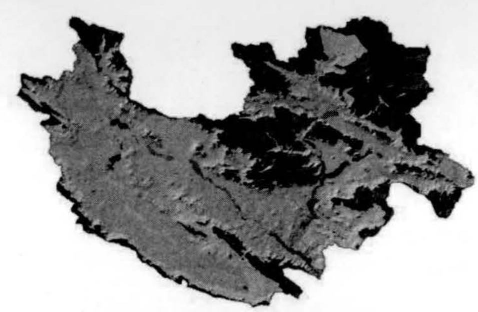

Fig. 6. Water surface profile during 50 years return period

Table 1. Flood peak of stations for different return periods

Station name	Return Period (Year)								
	2	5	10	25	50	100	200	500	1000
Pol kohneh	126.18	268.57	431.89	765.19	1149.85	1702.99	2495.6	4086.3	5892.77
Hojat Abad	84.14	146.93	214.83	347.13	494.6	701.73	993.14	1568.3	2215.96
Khers Abad	46	82.46	111.15	152.05	185.63	221.72	260.47	316	361.42
Doab Merg	48.63	108.42	164.24	254.91	338	435.12	547.73	723.04	877.81

step is to draw lines in the cross sections. In drawing these lines according to topographic maps should be paid attention that more length of these lines be in the plains and less in the valleys. In drawing these lines we should be careful about sections that have almost same height in sides and reasonable height difference with the river to display on large scale. For this case this is the best way to draw curves that can be aligned with the flow passage between the parties drew the same height. Cross section lines should be drawn from left to right and cut flow passage lines in the sides. The next point is the lines should not intersect each other. Fig. 3.

The land use map will be added to the model to calculate the Manning roughness coefficient based on it. This step is optional and can be deleted and the Manningroughness coefficient values could be imported manually in HEC-RAS model. Now, the geometric model of the basin stream flows for using by HEC-RAS is ready and the output on HEC-GeoRAS environment read by HEC-RAS model.

In HEC-RAS software after importing geometric file sent from GIS, flow data was defined to desir-

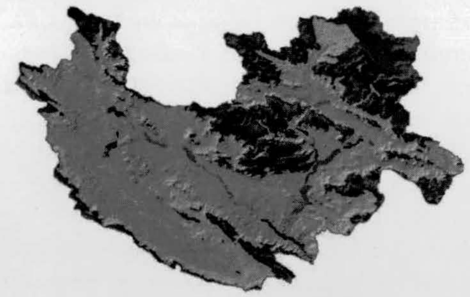

Fig. 7. Water surface profile during 100 years return period

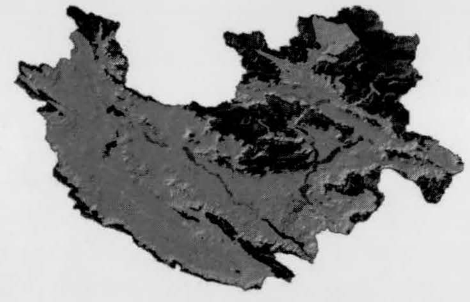

Fig. 8. Water surface profile during 200 years return period

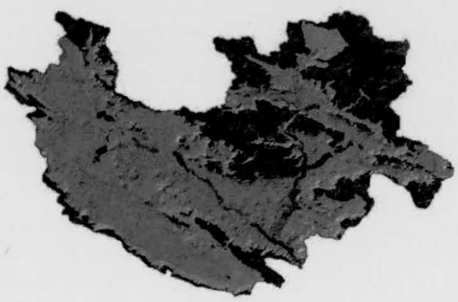

Fig. 9. Water surface profile during 500 years return period

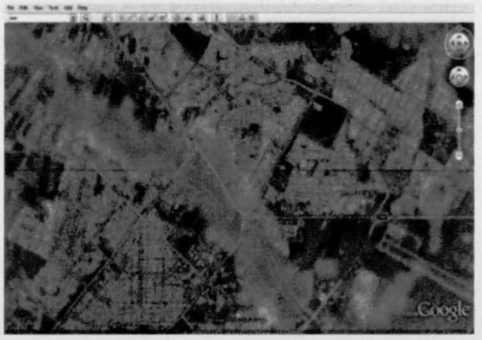

Fig. 10. Water surface profile during 1 year return period

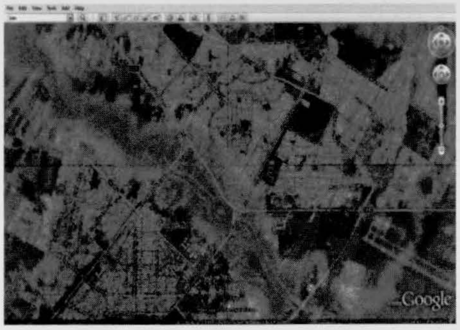

Fig. 11. Water surface profile during 10 years return period

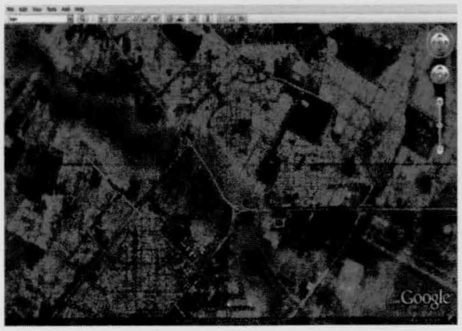

Fig. 12. Water surface return period during 50 years return period

able profiles and the project was calculated by Run option. Finally, calculated file send to GIS for editing and better display.

For showing water surface profiles with urban areas and facilities we had to link between GIS and Google Earth and determined flood risk zones. For example we displayed Kermanshah city during different return periods in large scale.

Conclusion

Determining of flood region let us increase our in-

Fig. 13. Water surface profile during 100 years return period

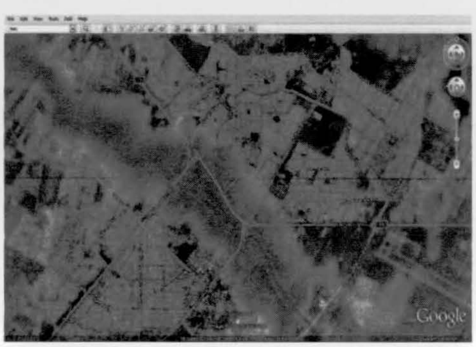

Fig. 14. Water surface profile during 200 years return period

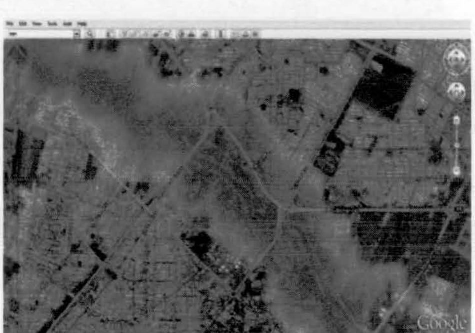

Fig. 15. Water surface profile during 500 years return period

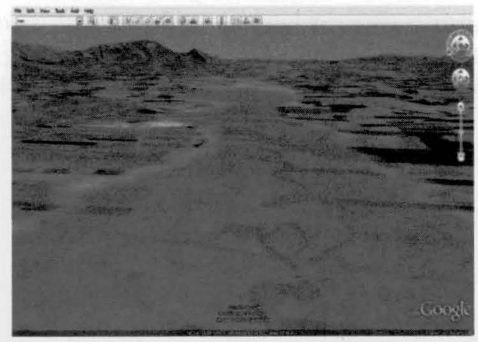

Fig. 16. Water surface near Faraman village with return period of 500 years

Fig. 17. Water surface profile on LabeaabBridge with return period of 500 years

formation about flood zoning to take better decisions in risk times. Zoning maps could be useful for alarm systems and rescue operations. These maps according to each region risk be distinguished with different colors. Also, if ordinary people can have such maps to in a short time after receiving the warning signs reach to areas with a lower risk.

The results of this study indicate that despite many difficulties and obstacles to use of new technologies in the field of water resources management including flood management, preparation and use of such techniques is possible and need to develop information in the country. Among the applications of these results that can be noted are as follows.

Control structures design, Determining flood insurance amount, digital basin precipitation, precipitation maps digitized by Arc Hydro data model for watersheds can be used for hydrological and hydraulic studies of dams.

Having information maps including the flow depth in the GIS environment and this environment capabilities in operating spatial analysis will result in possibility to determine safe places, determining suitable paths for help and rescue operations and finally damage estimation. Flood zoning maps make more accuracy in insurance right payment where cases that risk of flood damage are so small, pay less insurance right to them.

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