Delineation of flood plain extension

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Abstract

Floodplain delineation is an effective approach in either avoiding of water crisis or making pragmatic decisions in terms of water management strategies. In this study a flood plain extension has been developed in ArcGIS and HE-CRAS models and a comparison has been made within three different scenarios of discharge. The results showed in low and medium discharge scenarios the buffer zone acts as a safety factor zone to adjacent infrastructure either agricultural or residential, but in high discharge condition buffer zone is entirely filled with stream water hence yet more safety regulation should be considered in order to avoid human and resource loss or damage within adjacent areas.

Keywords: Flood plain delineation, Water depth profile, HE-CRAS,

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I.Introduction

Flooding and similar water crisis are common threats to modern cities, hence our infrastructures should be design and operate in a dynamic mode which can easily handle and decrease the negative impact of such events. Floodplains however may happen in any geographical areas and at different locations along river corridors.[1]The remote sensing data has been used for floodplain mapping for tropical wetlands. Analysis of such images has been retrieved an effective algorithm to estimate the extension of flooded areas.[2]Hydrological processes which results in occurrence of flood in lowland river has been already investigated and the surprising result was the usage of buffer zones between farmlands and the riverine environment.[3]A Set of experimental investigations has been done in UK on water table fluctuations in floodplain of Severn, Hampshire in order to understand the interactions between the river, floodplain and the adjacent hillslope.[3]In this study floodplain extension of a riverbed which has path through different land usehas been investigated under three different discharge scenario in HEC-RAS to estimate the efficiency of buffer zone as well as flood extension within the river stream.

II. Materials and Methods

This study consists of four primary steps which are briefly explained below and demonstrated in details later. Firstly, the layers have been constructed in ArcGIS. Second part includes the creation of format of layers and load them from their original location in ArcGIS. Third phase includes the transformation of all created files in Arc GIS into HEC-RAS and run the

program for different scenarios. Finally, the results of flood plain extension has been transferred into ArcGIS to visualize the outputs in the real bed stream domain which has been presented in results part.

Part 1. Layer construction in ArcGIS

Digital topography map (TOPO_DTM) of river stream has been converted into a shape file from a cad-file then has been used as a polyline layer in proceeding steps in ArcMap. (Figure 1.a)

To have a better sense of visualization main file with a 20% transparency has been added as a background layer which is helpful both in visually analysis of flow and flood plain delineation at the end. (Figure 1.b) Raster file which has been created from two previous figures presented in Figure 1.c. Four layers of stream, banks, flow, and cross sections have been developed within Arc catalog.

Figure 1:(a) Contour layers in polyline format, (b) TOPO_DTM layer, (c) Raster file created from river stream.

Part 2. HEC-Geo-RAS

In this part with the help of Ras Geometry, format of all previous layers have been created and they have been loaded from their original location in ArcGIS. Assigning different IDs to all created cross sections as well as land use for different sections of river extension and also buffer zone of the river, all have been developed in this stage. In this study buffer zone considered to be a 50 meters from the talweg point of the main stream. Land use allocation has been presented in Table 1 below within three different zones including buffer, mountainous, and flat land. [4-8](See S.I.1) Different zones creation and allocation of Manning's coefficient presented in figure 2.

Table 1. Zoning areas.

Zone	Land Use type	Land Use Manning coefficient
<u>1</u>	Mountain	0.06
<u>2</u>	Plato (Flat Land)	0.04
<u>3</u>	Stream Buffer Zone	0.035

Figure 2:(a) Creating different zones, (b) Buffer zone construction,(c)Buffer, Mountainous, and flat land zones allocation**Part 3. Bridge designin HECRAS**

As it is shown if Figure 1.c inside the red circle there is a bridge section at the downstream of the river which has been designed in HEC-RAS bridge section and presented in figure 3 and figure 4 below. Bridge specification presented in Table 2. Below.

Design detail presented in Supplementary information section. (See S.I. 2a-e)

Figure 3. Bridge configuration.

Table 2. Bridge Specifications

Width (m)	Dist. from Upstream (m)	High chord Elevation. (m)	Low chord Elevation. (m)	No. of Piers	Upstream XS starting Station.	Pier width (m)
12	9	85	84	6	80	0.9

Figure 4. Bridge cross section.

III. Results

In this part, all the outcomes from HEC-RASHave been recalled back into ArcGIS to delineate the flood plain extension within three different scenarios of river discharges. Three different discharges from low to medium and high have been selected and water depth profile within the stream has been developed for each of them. In discharge of $Q = 50 \text{ m}^3/\text{s}$, there is a small portion of boundary layer which has been sporadically filled with water and there is a lot of discontinuity within the water profile due to low discharge. (Figure 5.a) By increasing discharge to an average condition, $Q = 500 \text{ m}^3/\text{s}$, higher portion of boundary layer has been covered and water depth profile is deeper and more consistent.(Figure 5.b) In the maximum discharge scenario of $Q = 1000 \text{ m}^3/\text{s}$, whole extension of buffer zone has been filled with water.(Figure 5.c)

Figure 5. 2-D Configuration of the

IV. Conclusion

Flood plain delineation is important because it is a useful tool in estimating flood crisis either from extent or cost point of view. It can be also applied in determining erosion and sedimentation pattern of floodways, river streams and channels to calculate a regular dredging program[8, 9]. Protection structure for river and channel are inevitable hence the use of development of flood maps for agricultural, industrial and residential areas adjacent to river buffer zones is needed. As it is obvious in figure 5.a by having low flow rate in seasonal streams there is no concern of flooding but as the flow rate increases the buffer zone would become active and becomes prone to sliding and erosion at the banks of the streams.

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