MODELING FOR FLOOD MANAGEMENT IN RIVER CHENAB UNDER LANDUSE CHANGE: A CASE STUDY FOR MARALA – KHANKI REACH

By

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CENTRE OF EXCELLENCE IN WATER RESOURCES ENGINEERING

UNIVERSITY OF ENGINEERING AND TECHNOLOGY
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ABSTRACT

Floods have become a common extreme natural phenomenon characterized by a range of external elements such as excessive rainfall and river overflowing. The floods have a catastrophic risk to human populations. Flooding is the most damaging natural hazard in Pakistan. Computer models are used for study of floods and their management. Different models have been developed for the prediction of flood intensity and the aerial extent of the inundation in the basin. Models developed for flood management use both physical and numerical techniques. The continuity and momentum equation are used in the numerical models for the calculation of the flood by using existing hydraulic and physical data. Among a large number of models available, HEC-RAS and LISFLOOD are commonly used models for flood analysis and management. In this study two dimensional LISFLOOD-FP and HEC-RAS models were used for floodplain inundation. In two-dimensional model the Saint-Venant equations are solved by dividing river reach into smaller grid resolutions. The data input includes DEM, boundary condition, channel geometry, floodplain friction, flow data, cross-sections and Roughness values. The flood situations under different land use and channel conditions, as well as the morphological changes were also studied.

In this research the morphological changes in river Chenab (Marala-Khanki) reach i-e the river profiles, distances and changes in banks have been studied. The supervised classification of Landset-8 images was done to identify different land use and their extents in the study reach. The total length of river under this study was 29.7 km, which was further divided into three reaches. The sinuosity index was calculated which shows that there was a significant variation in the channel course of each selected reach. The sinuosity index of reach X1 (10.3km) was calculated as 1.05 which was less than 1.5, it shows that the river had a sinuous path in year 2006. The sinuosity index

was also calculated for years 2011 and 2016 which was 4.1 and 4.5 respectively, as the calculated value was greater than 1.5, it shows that the river had a meandering path. Further the sinuosity index for year 2021, was calculated as 1.09 which shows that the river had a sinuous path. The sinuosity index of section X2 (10.7km) was calculated for years 2006 and 2011, which was calculated as 1.1 and 1.03 respectively. It shows that the river had a sinuous path in years 2006 and 2011. The sinuosity index was calculated in years 2016 and 2021 which was calculated as 9.3 and 12 respectively. The sinuosity index of section X3 (9.9km), which was calculated as 7.2, which shows that the river had a meandering path in year 2021.

LISFLOOD and HEC-RAS models were applied at different discharge conditions such as the maximum and minimum flooding of river which was 15938m^3/s and 350.36m^3/s respectively. The flood frequency analysis of river Chenab was also done by using annual discharge data for 20 years from 1989 to 2018. Different approaches Gumble distribution, Normal distribution, Log- Normal distribution, Log Pearson type-3 distribution was used to select the best fit distribution. The distribution was selected by using easy fit statistical model which shows that Gumble (Extreme Value Type-I) distribution was best fit distribution for the given discharge data.

A high flood was occurred in 2014, daily discharge data for 2014 was used for the flood analysis using LISFLOOD model and HEC-RAS model. The results of LISFLOOD simulation shows that the reach (Marala-Khanki) of river Chenab covers the maximum flood inundation area of 434km^2 at a discharge value of 15938m^3/s and minimum flood inundation area of 175km^2 at a discharge value of. 350.36m^3/s. The results of HEC-RAS simulation shows that the reach (Marala-Khanki) of river Chenab covers the maximum flood inundation area of 473km^2 at a discharge value of 15938m^3/s

and minimum flood inundation area of 197km² at a discharge value of 350.36m³/s. The land use changes in river Chenab (Marala-Khanki) reach for (2007-2021) years was estimated by using the satellite image of Landsat-7 obtained for the month of September of each year from earth explorer (USGS). The results shows that there was an increase of 25% in populated areas and loss of -17% in agricultural areas and flood inundation area under Landcover in the study reach. The future trend shows that the population area increases and there was a decrease in agricultural area from (2022-2034). It was concluded that urban population expansion in flood plain has adverse effect on flooding conditions. As urban land is increasing in riverine area, so population extension should be restricted in flood plain areas.