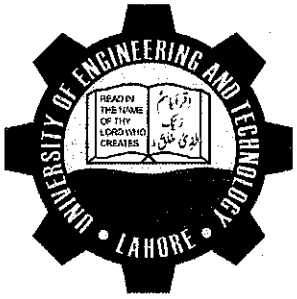
MODELLING FLOODS AND THEIR DAMAGES USING GIS: A CASE STUDY OF SWAT RIVER (MUNDA TO CHARSADDA BRIDGE)



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2017-MS-WRE-01

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2021

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MODELLING FLOODS AND THEIR DAMAGES USING GIS: A CASE STUDY OF SWAT RIVER (MUNDA TO CHARSADDA BRIDGE)

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(2017-MS-WRE-1)

A THESIS

presented to the university of engineering and technology, Lahore

in partial fulfillment of the requirements for the degree of

Master of Science

in

WATER RESOURCES ENGINEERING

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Approval Date: July - 2021

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ABSTRACT

Floods are a major natural disaster worldwide. Flood control plans, risk mitigation programs, and other forms of flood management techniques require a good understanding of the flood risk situation and the possible implications for our community. The accuracy of the flood damage estimates depends on both the modeling of the phenomenon and the risk assessment of human systems exposed by the floods. This research work aimed to simulate floods and to develop a subsequent flood damage assessment model based on inundation depths, velocities, and duration mainly focusing on the impacts on agricultural land crops. The study area lies between coordinates of 34°-03' to 34°-38' latitudes and 71°-28' to 71°-53' longitudes. The soil of the study area is fertile and highly cultivated with several villages. Even the uplands are now irrigated by canals that run along the toe of Mohmand hills. The main source of irrigation for the area is the Swat River. It flows through Kalam valley up to Chakdara for 160 km and then Panjkora River joins at Qalangi. Finally, it flows through the study area (District Charsadda) for the length of about 24 km (River reach of the study area; also named as Khayali river) and outfalls into Kabul river just a few km downstream of Charsadda Bridge. In the past decades, swat valley experienced many disastrous floods e.g., in the years 1973, 1992, 1996, 2005, and 2010, etc. To strengthen efforts for flood damage assessment to crops through modeling and suggestions for mitigation activities, the availability of past flood damage data/information is very important. Even with the high magnitude of the flood, there exist no risk maps for the study area. Primarily, a conventional method was used to assess flood damage which was based on three steps: (1) elements classification

(selection of culture-able field near River), (2) exposure analysis (field exposed to flooding of various magnitude), and (3) damage assessment (for selected crops).

To accomplish the research objectives, various steps were followed including flood frequency analysis, selection of best-fitted results, development of inundation maps against various return periods, and development of 1-D/2-D hydrodynamic models for estimation of flood levels. Flood modeling was carried out using ArcMap and HEC-RAS. The river geometry of the study reach was collected from the hydrology department of Khyber Pakhtunkhwa Irrigation Department coupled with DEM of 1 m grid resolutions. Initially, a simple non-linear equation was developed for historic damages incorporating all the considered parameters. A total of nine (09) years of data of historic flood damages were collected from DC Office Charsadda out of which six (06) years of data were used for developing the nonlinear regression equation and calibration of results. A statistical software named SPSS was used for developing the non-linear equation. For validation purposes, the applicability of the developed equation was checked against historic flood events of 1988, 2006, and 2010 that incurred land crop damages over areas of 14,085 acres, 22,428 acres, and 58,344 acres, respectively. The method for flood damage assessment to agriculture crops differs from that of infrastructure (roads, buildings, etc.) damages by variation of flood impacts from crop to crop. Therefore, the most cultivated crops, one from Rabi and one Kharif season, were taken into consideration in this study i.e., wheat and sugarcane, respectively. The assessment was carried out by defining flood damages to sugarcane and wheat crops by using depth damage function curves considering all the growth stages from sowing to harvesting. In comparison to all others crops, the sugarcane and rice crop was found the most less vulnerable to flood, a detail flood susceptibility analysis for all Kharif Crops planted in the study area are discussed in

result and discussion chapter of the study.as we know that Rabi is dry season and did not experience any flood in the past, however we have analyzed the wheat crop for if scenario, if such kind of flood occur in Rabi then what will be the damages. This research has developed a validated flood damage estimation model and flood zoning maps for the geographical area around Khyali River in the Charsadda district with a coefficient of determination (R^2) of 0.98. Further research may focus on flood damages to residential/non-residential areas with the incorporation of other flood influencing parameters e.g., water salinity and high sediment load etc.