THESIS

DEVELOPMENT OF COAXIAL CURVES FOR FLOOD DAMAGE ANALYSIS

BY

MUHAMMAD RIZWAN

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ABSTRACT

Chenab River is one of the largest rivers of the Indus basin. The river basin measures 67,515 sq. km. The river forms at the confluence of the two streams called "Bhaga" and "Chandra" join at a place called Tandi in Jammu and Kashmir State (India). Chenab is joined near the border by two major tributaries, the Munwar Tawi and Jammu Tawi both draining some 2,800 sq. km of land on both sides of the two rivers. Chenab enters Pakistan just upstream of rim station Marala (32°- 40/ N and 76°-29/ E). The total catchment area upstream of Marala is nearly 28,000 sq. km. The distance from Marala Barrage to confluence point with Indus river at Mithankot is 598 km. Downstream of Marala the river width varies from 700 m to 1400 m whereas the flood plain is about ten times as wide as the river. Between Marala and Khanki number of small tributaries like Halsi, Bhimber, Palku and Aik, cover drainage area of 3,437 sq. km, contribute into Chenab River. The average slope is about 0.33 m/km between this area (i.e. Marala to Khanki).(Awan, 2003). Marala, Khanki, Qadiraabad, Trimmu and Panjnand are barrages / headworks on Chenab River.

Marala to Qadirabad reach experiences serious problems of flooding. The floods in the joining nullahs are often sudden and have sharp peaks and hence cause extensive damage and life loss. Economic damages resulting from annual flooding is a major burden on the country. Floods have wreaked havoc over the years, threatening country's vital agricultural and communication infrastructure, with damages worth US $ 29 billion recorded for the historical floods since country's independence in 1947.

Floods in Chenab result from heavy rainfall in the upper drainage basin, which falls under the most active monsoon belt. The snow melt contributions on the average

40% of the total flow in July when the peak melt rates are attained. Hence it synchronizes with the early monsoon in July, but not with the peak values occurring in August and September.

The flood frequency analysis technique involves using observed annual peak flow discharge data to calculate statistical information such as mean values, standard deviations, skewness, and recurrence intervals. Frequency analysis was done by Excel sheets and discharges for different return periods were estimated by using the three distributions i.e. Log-Pearson Type III, Log Normal and Gumble distribution.

For return period of 200 year designed discharges were 10,72,312; 11,24,241 and 11,27,041 cusecs using Log Pearson Type III, Log Normal and Gumbel's distribution respectively. Distributions were checked for the fitness of good distribution using the DFW software. Results of three distributions were compared by using the method of moments and method of maximum likelihood. Both the methods showed that Log Pearson type-III distribution adequately described the given data, where as other distributions did not described the data.

Geographic Information System (GIS) has been used extensively to model surface water, particularly floods and associated damages. River cross sections were extracted from SRTM DEM of 90 meters resolution by Arc GIS software. DEM cross sections were verified with surveyed cross sections at few points and noted that DEM cross sections or geometry require correction. The DEM was adjusted after calculating RMSE by adding selected factor 14.6 ft.

HEC-RAS software was used for the steady flow simulation at flood values of 3 lac, 6 lac, 9 lac, 10 lac and 11 lac cusecs to generate depth discharge relationship. For calibration purpose, flood of 1992 was selected having discharge of 9,48,530

cusecs and flow water depth 8.81m at head Qadirabad. Few parameters i-e manning's coefficient, slope and levees elevations were adjusted for the calibration.

Total area under flood from Marala barrage to Qadirabad barrage at flood of 3,00,000 cusecs nearly 500 square kilometers was inundated, whereas 830 square kilometers were inundated by a flood of 11,00,000 cusecs. Five classes were made each of 2 meter, for flood values of 11 lac, 9 lac, 6 lac and 3lac cusecs. Maximum area was inundated by first class 0 to 2 meter water depth that is more than half of the total area under flood.

Populated areas were digitized in Google Earth and areas were estimated using Arc GIS. 27 villages were under flood by flood magnitude of 3,00,000 cusecs, 86 villages were inundated by flood of 6,00,000 cusecs, 127 villages were under flood by flood of 9,00,000 cusecs and 140 villages were submerged by flood of 11,00,000 cusecs from Marala to Qadirabad reach. Agricultural area under flood was estimated by using the satellite image and an employing Remote sensing technique that is supervised classification, nearly 90,000 acres of agricultural land were submerged by flood of 11,00,000 cusecs.

Coaxial curve was developed between four parameters, discharge, water depth, area under flood and economic damages. Economic damages were estimated by finding out the agricultural and populated area under flood. Marala to Qadirabad reach suffered 6 billion, 21 billion, 29 billion and 34 billion rupees damages due to floods of 3 lac, 6 lac, 9 lac and 11 lac cusecs respectively.