REGION 6

Jalaur River Basin:

DREAM Flood Forecasting and Flood Hazard Mapping

TRAINING CENTER FOR APPLIED GEODESY AND PHOTOGRAMMETRY

2015

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List of Abbreviations

ACDP	Acoustic Doppler Current Profiler
AOI	Area of Interest
ARG	Automated Rain Gauge
AWLS	Automated Water Level Sensor
DAC	Data Acquisition Component
DEM	Digital Elevation Model
DOST	Department of Science and Technology
DPC	Data Processing Component
DREAM	Disaster Risk Exposure and Assessment for Mitigation
DTM	Digital Terrain Model
DVC	Data Validation Component
FMC	Flood Modelling Component
GDS	Grid Developer System
HEC-HMS	Hydrologic Engineering Center – Hydrologic Modeling System
LiDAR	Light Detecting and Ranging
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
RIDF	Rainfall Intensity Duration Frequency
SCS	Soil Conservation Service
SRTM	Shuttle Radar Topography Mission
UP-TCAGP	UP Training Center for Applied Geodesy and Photogrammetry

Introduction

Introduction

1.1 About the DREAM Program

The UP Training Center for Applied Geodesy and Photogrammetry (UP TCAGP) conducts a research program entitled "Nationwide Disaster Risk and Exposure Assessment for Mitigation (DREAM) Program" funded by the Department of Science and Technology (DOST) Grants-in-Aid Program. The DREAM Program aims to produce detailed, up-to-date, national elevation dataset for 3D flood and hazard mapping to address disaster risk reduction and mitigation in the country.

The DREAM Program consists of four components that operationalize the various stages of implementation. The Data Acquisition Component (DAC) conducts aerial surveys to collect Light Detecting and Ranging (LiDAR) data and aerial images in major river basins and priority areas. The Data Validation Component (DVC) implements ground surveys to validate acquired LiDAR data, along with bathymetric measurements to gather river discharge data. The Data Processing Component (DPC) processes and compiles all data generated by the DAC and DVC. Finally, the Flood Modeling Component (FMC) utilizes compiled data for flood modeling and simulation.

Overall, the target output is a national elevation dataset suitable for 1:5000 scale mapping, with 50 centimeter horizontal and vertical accuracies. These accuracies are achieved through the use of state-of-the-art airborne Light Detection and Ranging (LiDAR) technology and appended with Synthetic-aperture radar (SAR) in some areas. It collects point cloud data at a rate of 100,000 to 500,000 points per second, and is capable of collecting elevation data at a rate of 300 to 400 square kilometers per day, per sensor.

1.2 Objectives and Target Outputs

The program aims to achieve the following objectives:

a) To acquire a national elevation and resource dataset at sufficient resolution to produce information necessary to support the different phases of disaster management,

b) To operationalize the development of flood hazard models that would produce updated and detailed flood hazard maps for the major river systems in the country,

c) To develop the capacity to process, produce and analyze various proven and potential thematic map layers from the 3D data useful for government agencies,

d) To transfer product development technologies to government agencies with geospatial information requirements, and,

e) To generate the following outputs
1) flood hazard map
2) digital surface model
3) digital terrain model and
4) orthophotograph.

1.3 General Methodological Framework

The methodology to accomplish the program's expected outputs are subdivided into four (4) major components, as shown in Figure 1. Each component is described in detail in the following section.

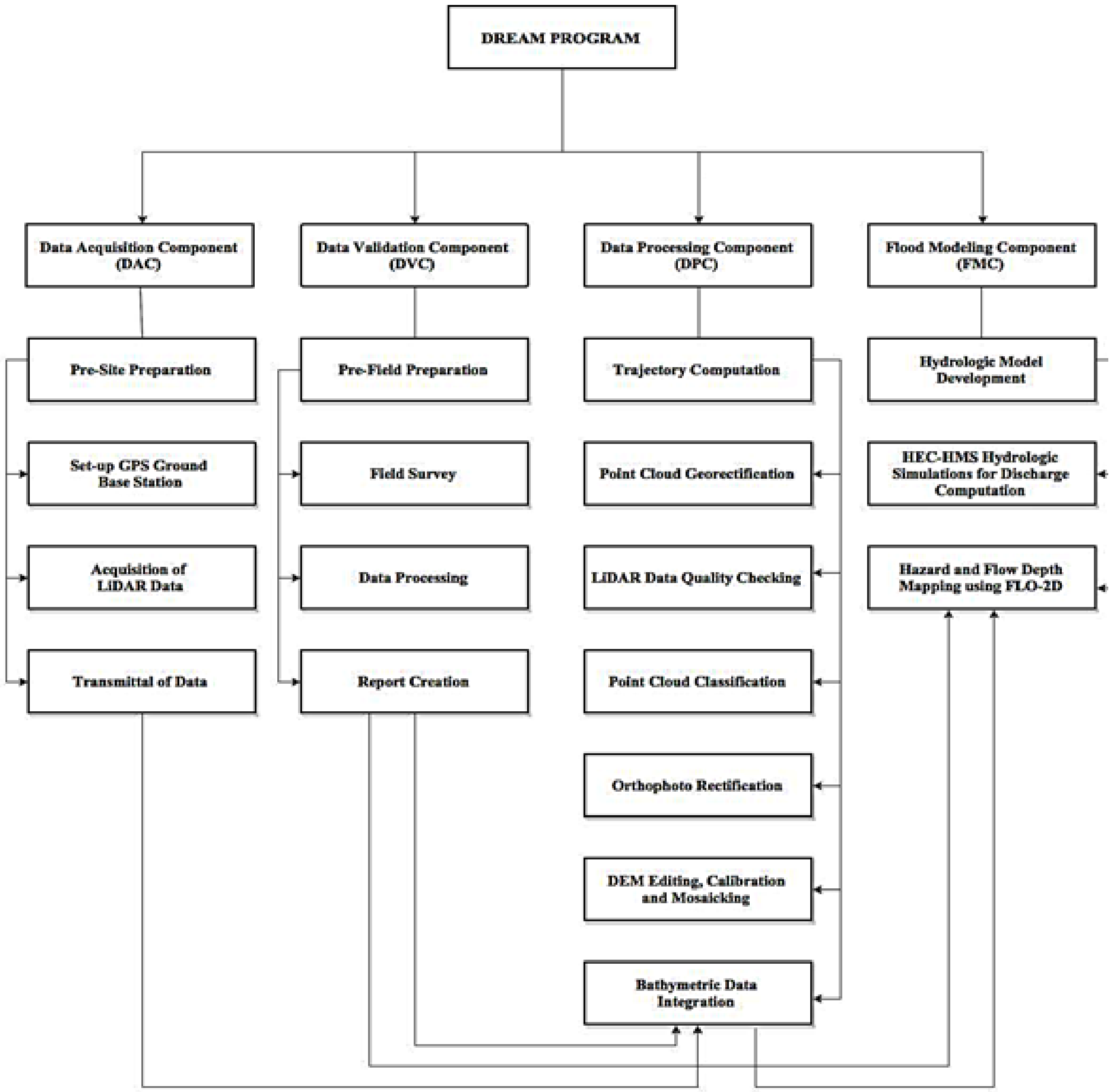


Figure 1. The general methodological framework of the program

1.4 Scope of Work of the Flood Modeling Component

The scope of work of the Flood Modeling Component is listed as the following:

a) To develop the watershed hydrologic model of the Jalaur River Basin;
b) To compute the discharge values quantifying the amount of water entering the floodplain using HEC-HMS;
c) To create flood simulations using hydrologic models of the Jalaur floodplain using FLO-2D GDS Pro; and
d) To prepare the static flood hazard and flow depth maps for the Jalaur river basin.

1.5 Limitations

This research is limited to the usage of the available data, such as the following:

1. Digital Elevation Models (DEM) surveyed by the Data Acquisition Component (DAC) and processed by the Data Processing Component (DPC)
2. Outflow data surveyed by the Data Validation and Bathymetric Component (DVC)
3. Observed Rainfall from ASTI sensors

While the findings of this research could be further used in related-studies, the accuracy of such is dependent on the accuracy of the available data. Also, this research adapts the limitations of the software used: ArcGIS 10.2, HEC-GeoHMS 10.2 extension, WMS 9.1, HEC-HMS 3.5 and FLO-2D GDS Pro.

1.6 Operational Framework

The flow for the operational framework of the Flood Modeling Component is shown in Figure 2.

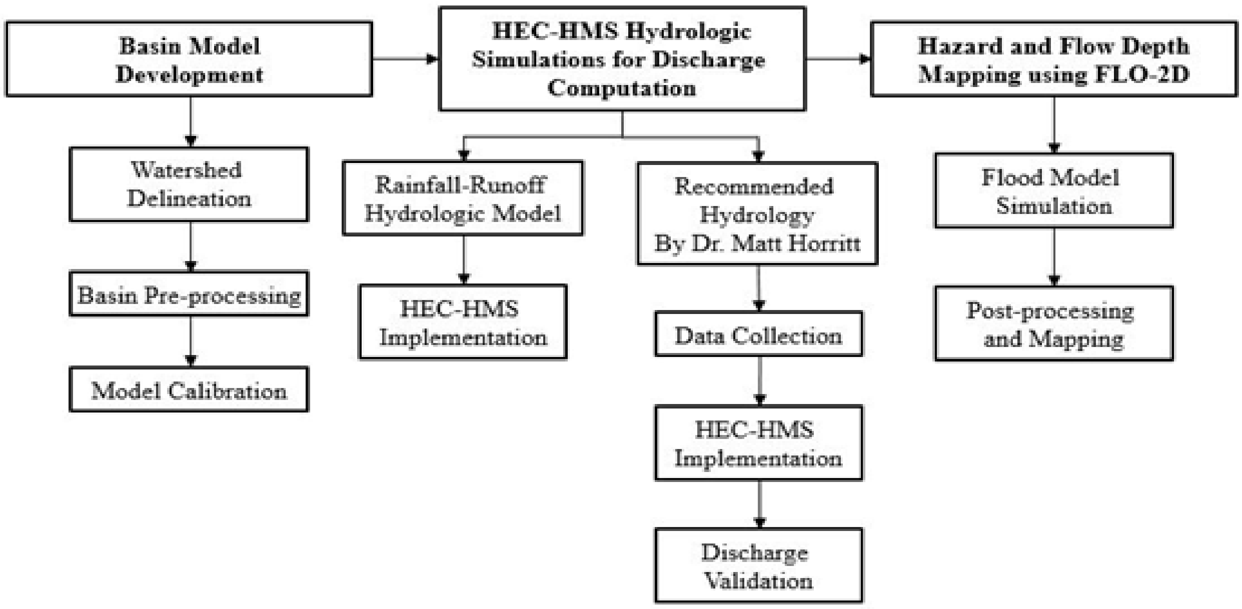


Figure 2. The operational framework and specific work flow of the Flood Modeling Component

The Jalaur River Basin

The Jalaur River Basin

The Jalaur River Basin is located in Region VI. It is the seventeenth largest river basin in the Philippines. It covers an estimated basin area of 1503 square kilometres which includes parts of Iloilo, Capiz, and Antique. Its river, Jalaur River (also known as Jalaud River), is the second largest in the island of Panay. The location of Jalaur River Basin is as shown in Figure 3.

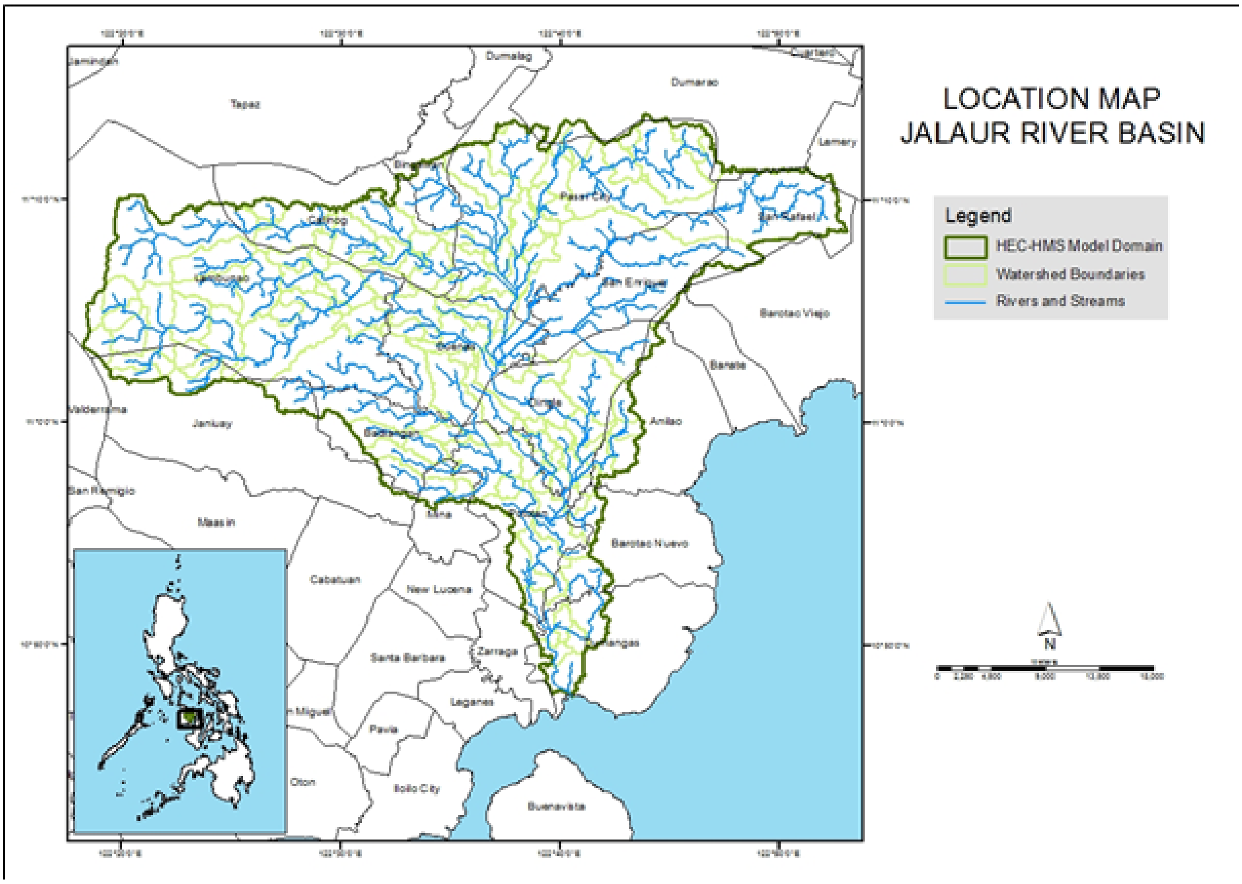


Figure 3. Jalaur River Basin Location Map

It drains the eastern portion of the island and traverses through Passi City and the towns of Leganes, Zarraga, Dumangas, Barotac Nuevo, Pototan, Dingle, Duenas, and Calinog. Jalaur River Basin records the highest annual flow and is the major source of irrigation water for the province of Iloilo. The annual rainfall in the province of Iloilo is 2153.90 millimeters.

The land and soil characteristics are important parameters used in assigning the roughness coefficient for different areas within the river basin. The roughness coefficient, also called Manning's coefficient, represents the variable flow of water in different land covers (i.e. rougher, restricted flow within vegetated areas, smoother flow within channels and fluvial environments).

The shape files of the soil and land cover were taken from the Bureau of Soils, which is under the Department of Environment and Natural Resources Management, and National Mapping and Resource Information Authority (NAMRIA). The soil and land cover of Jalaur River Basin are shown in Figures 4 and 5, respectively.

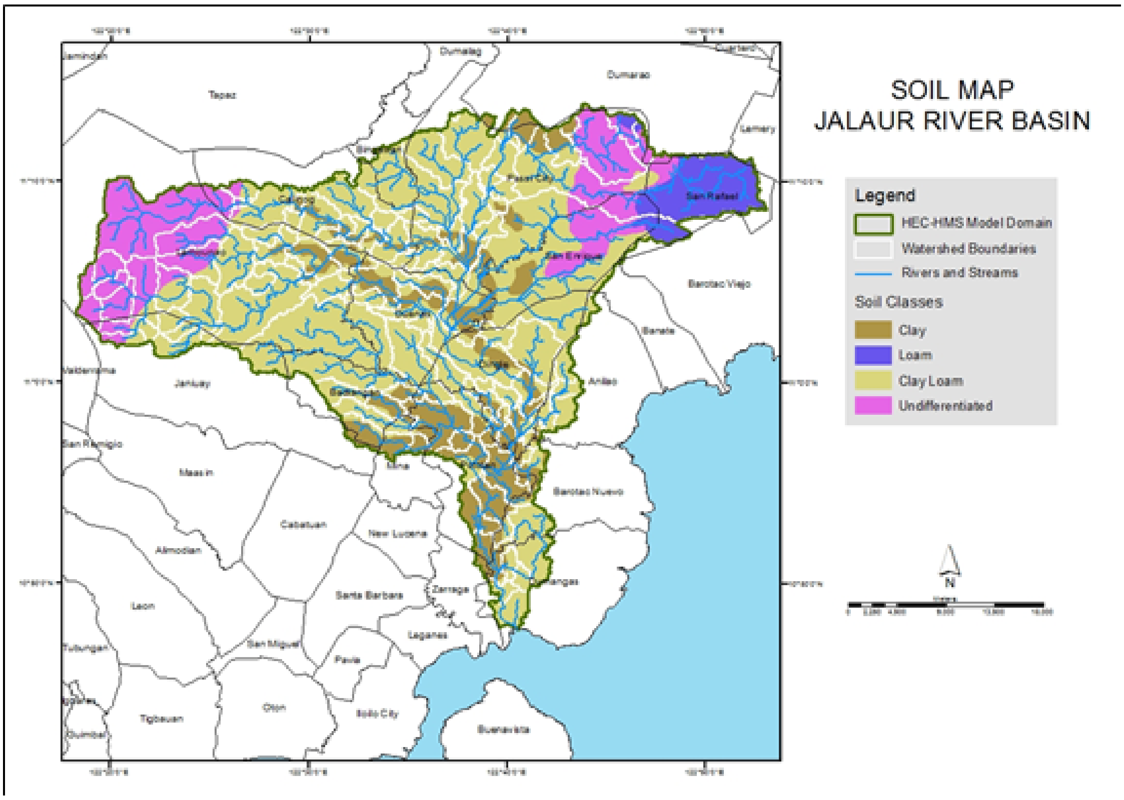


Figure 4. Jalaur River Basin Soil Map

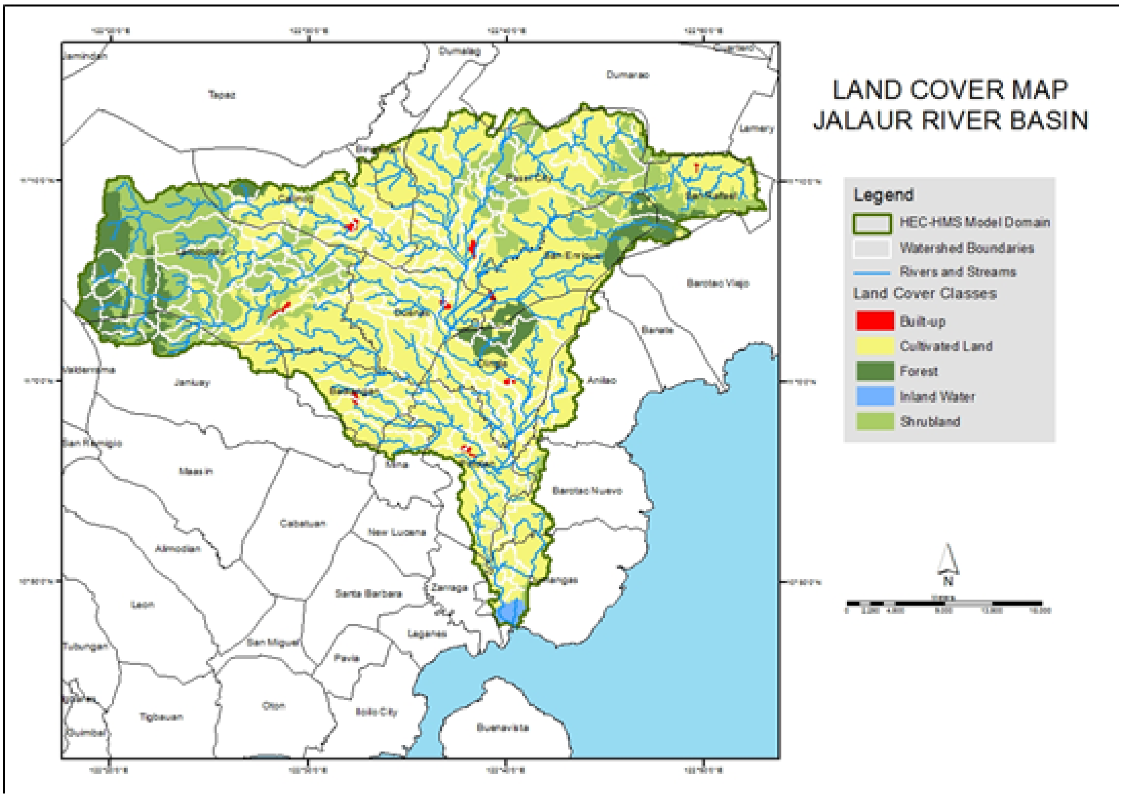


Figure 5. Jalaur River Basin Land Cover Map

Methodology

3.1 Pre-processing and Data Used

Flood modeling involved several data and parameters to achieve realistic simulations and outputs. Figure 6 shows a summary of the data needed to for the research.

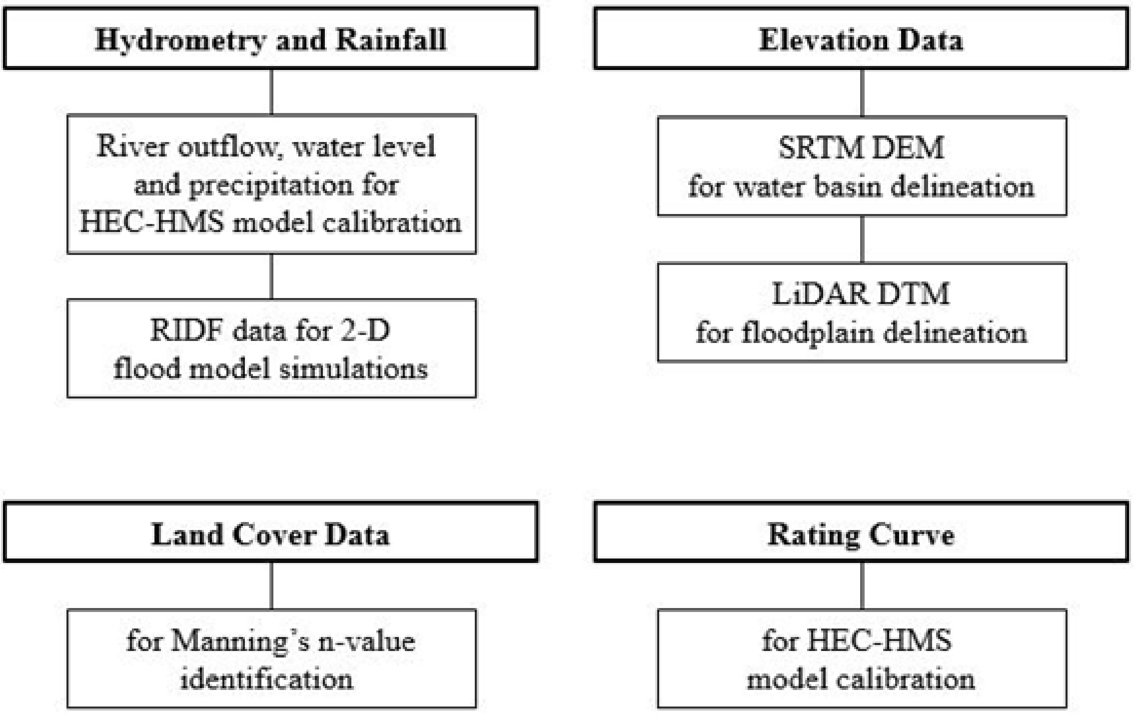


Figure 6. Summary of data needed for the purpose of flood modeling

3.1.1 Elevation Data

3.1.1.1 Hydro Corrected SRTM DEM

With the Shuttle Radar Topography Mission Digital Elevation Model (SRTM DEM) data as an input in determining the extent of the delineated water basin, the model was set-up. The Digital Elevation Model (DEM) is a set of elevation values for a range of points within a designated area. SRTM DEM has a 90 meter spatial mosaic of the entire country. Survey data of cross sections and profile points were integrated to the SRTM DEM for the hydro-correction.

3.1.1.2 LiDAR DEM

LiDAR was used to generate the Digital Elevation Model (DEM) of the different floodplains. DEMs used for flood modeling were already converted to digital terrain models (DTMs) which only show topography, and are thus cleared of land features such as trees and buildings. These terrain features would allow water to flow realistically in the models.

Figure 7 shows an image of the DEM generated through LiDAR.

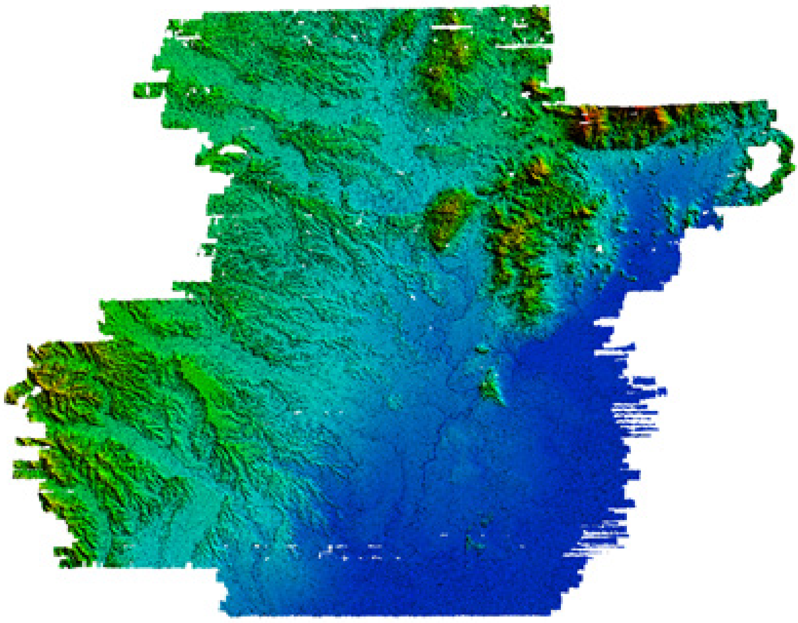


Figure 7. Digital Elevation Model (DEM) of the Jalaur River Basin using Light Detection and Ranging (LiDAR) technology

Elevation points were created from LiDAR DTMs. Since DTMs were provided as 1-meter spatial resolution rasters (while flood models for Jalaur were created using a 10-meter grid), the DTM raster had to be resampled to a raster grid with a 10-meter cell size using ArcGIS.

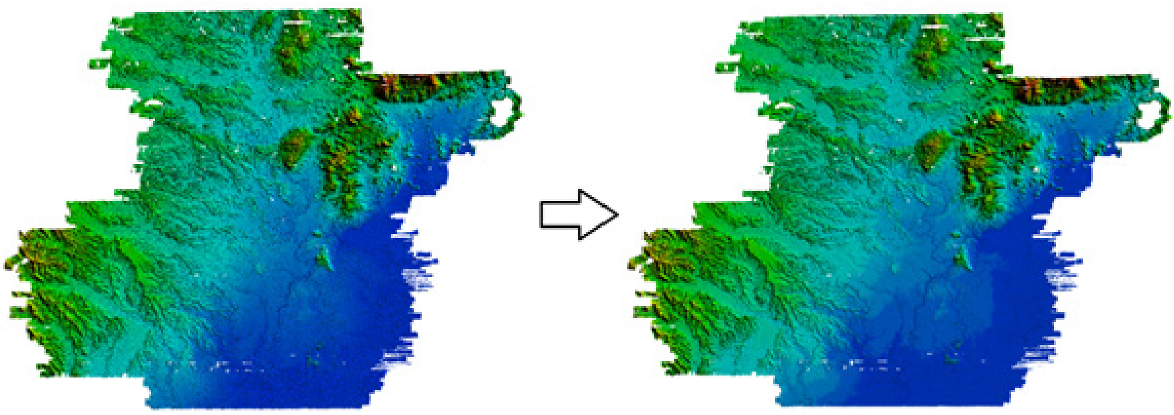


Figure 8. The 1-meter resolution LiDAR data resampled to a 10-meter raster grid in GIS software to ensure that values are properly adjusted.

3.1.2 Land Cover and Soil Type

The land and soil characteristics are important parameters used in assigning the roughness coefficient for different areas within the river basin. The roughness coefficient, also called Manning's coefficient, represents the variable flow of water in different land covers (i.e. rougher, restricted flow within vegetated areas, smoother flow within channels and fluvial environments).

A general approach was done for the Jalaur floodplain. Streams were identified against built-up areas and rice fields. Identification was done visually using stitched Quickbird images from Google Earth. Areas with different land covers are shown on Figure 9. Different Manning n-values are assigned to each grid element coinciding with these main classifications during the modeling phase.

Figure 9. Stitched Quickbird images for the Jalaur floodplain.

3.1.3 Hydrometry and Rainfall Data

3.1.3.1 Hydrometry for different discharge points

3.1.3.1.1 Jalaur Bridge - Passi City, Iloilo

River outflow from the Data Validation Component was used to calibrate the Jalaur HEC-HMS model. This was taken from Jalaur Bridge, Barangay Man-it, Passi City, Iloilo (11°6'34.488"N, 122°38'14.442"E). This was recorded from February 11 to February 18, 2013. Peak discharge is 36.93m3/s at 9:30AM of February 13, 2013 and is shown in Figure 10.

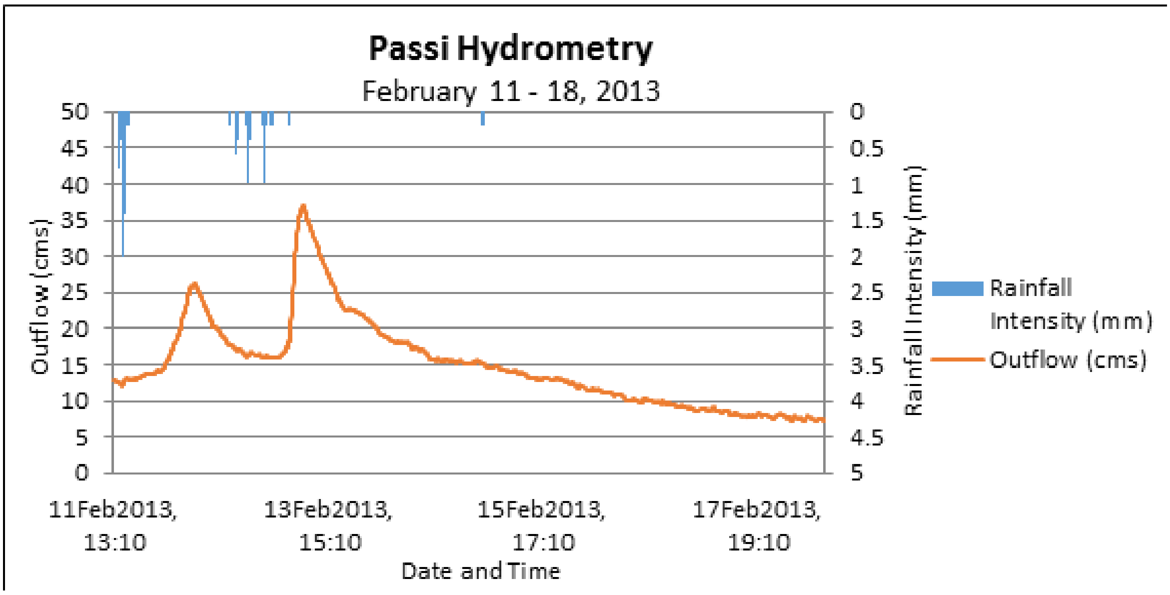


Figure 10. Passi Rainfall and outflow data used for modeling.

3.1.3.1.2 Calinog Bridge, Iloilo

The river outflow was computed using the derived rating curve equation. This was taken from Jalaur Bridge, Barangay Ilaya, Calinog, Iloilo (11°7’10.596”N, 122°32’18.78”E). This was recorded from October 25 to October 26, 2012. Peak discharge is 20.998m3/s at 9:40PM of October 25, 2012 and is shown in Figure 11.

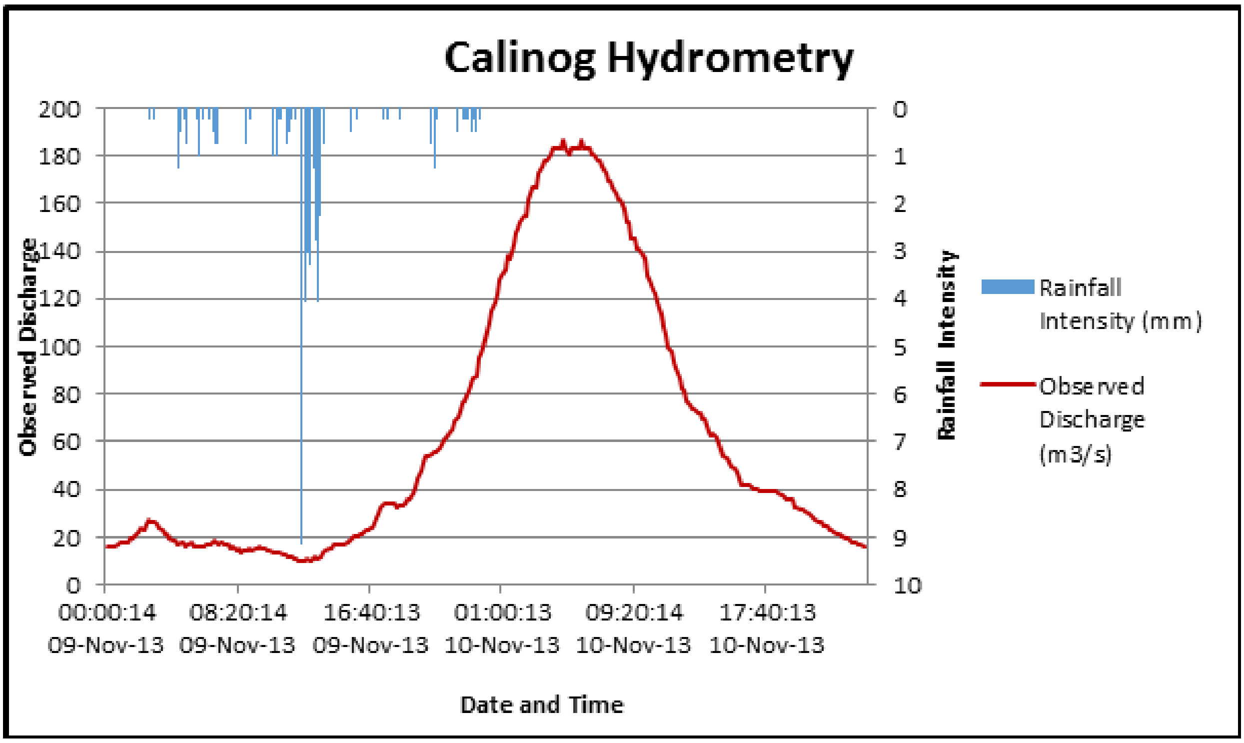


Figure 11. Calinog Rainfall and outflow data used for modeling.

3.1.3.1.3 Jalaur Bridge - Pototan, Iloilo

The river outflow was computed using the derived rating curve equation. This was taken from Jalaur Bridge, Barangay Tuburan, Pototan, Iloilo (10°54'34.311"N, 122°41'9.982"E). This was recorded from October 25 to October 26, 2012. Peak discharge is 73.1m3/s at 6:50AM of October 26, 2012 and is shown in Figure 12.

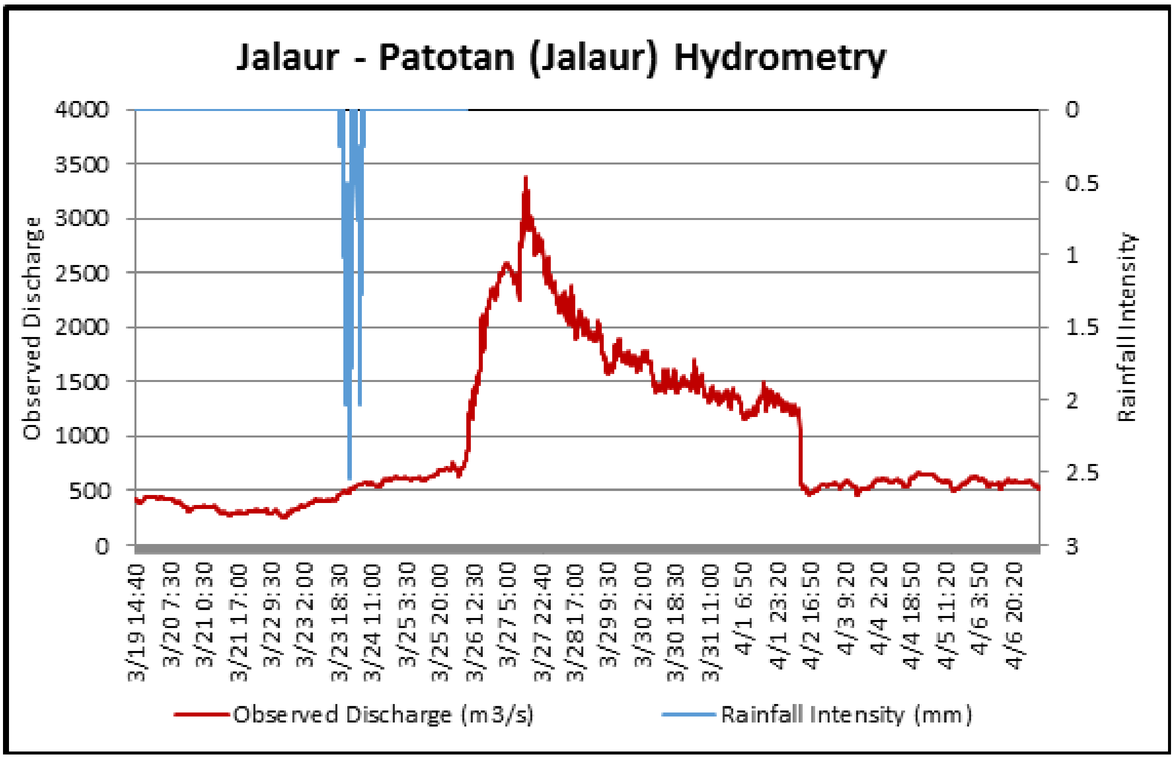


Figure 12. Jalaur- Pototan Rainfall and outflow data used for modeling.

3.1.3.2 Rainfall Intensity Duration Frequency (RIDF)

The Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) computed Rainfall Intensity Duration Frequency (RIDF) values for the Iloilo Rain Gauge. This station was chosen based on its proximity to the Jalaur watershed. The extreme values for this watershed were computed based on a 57-year record.

Five return periods were used, namely, 5-, 10-, 25-, 50-, and 100-year RIDFs. All return periods are 24 hours long and peaks after 12 hours. A map of the different RIDF stations is shown in Figure 13.

Methodology

Figure 13. Thiessen Polygon of Rain Intensity Duration Frequency (RIDF) Stations for the whole Philippines.

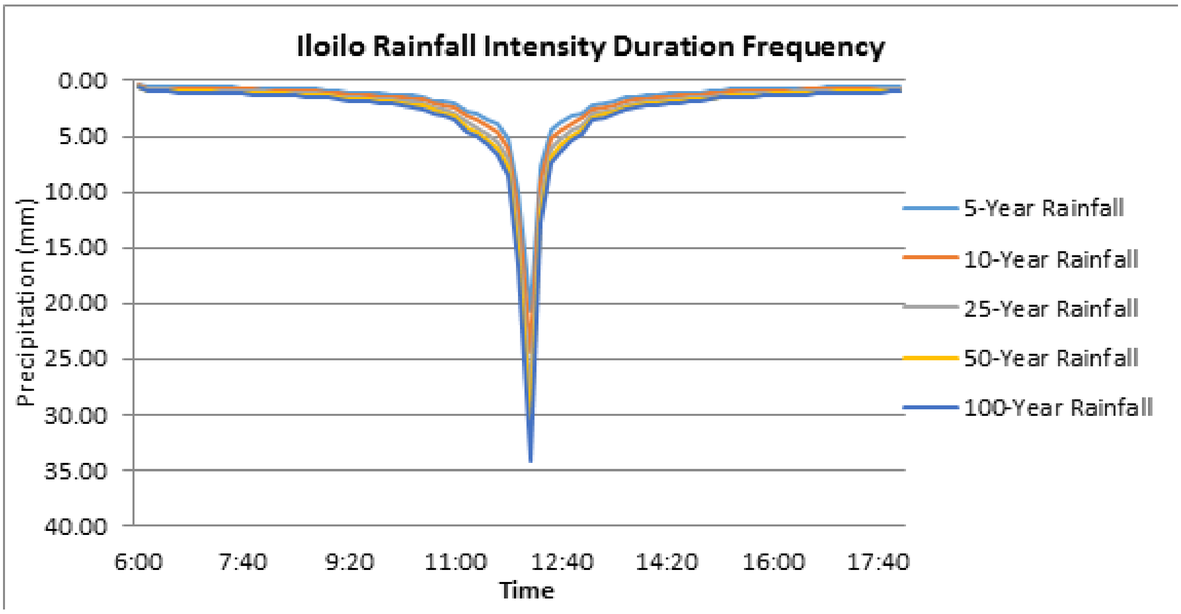


Figure 14. Iloilo Rainfall-Intensity Duration Frequency (RIDF) curves.

The outflow values at the discharge points in the Jalaur river basin were computed for the five return periods, namely, 5-, 10-, 25-, 50-, and 100-year RIDFs.

3.1.4 Rating Curves

Rating curves were provided by DVC. This curve gives the relationship between the observed water levels from the AWLS used and outflow watershed at the said locations.

Rating curves are expressed in the form of Equation 1 with the discharge (Q) as a function of the gauge height (h) readings from AWLS and constants (a and n).

$$Q = a^{nh}$$

Equation 1. Rating Curve

3.1.4.1 Jalaur Bridge – Passi City, Iloilo Rating Curve

A rating curve was developed at Jalaur Bridge, Passi City, Iloilo (11.10958, 122.6373). The rating curve is expressed as $Q = 2E\text{-}46e^{3.16661h}$ as shown in Figure 15.

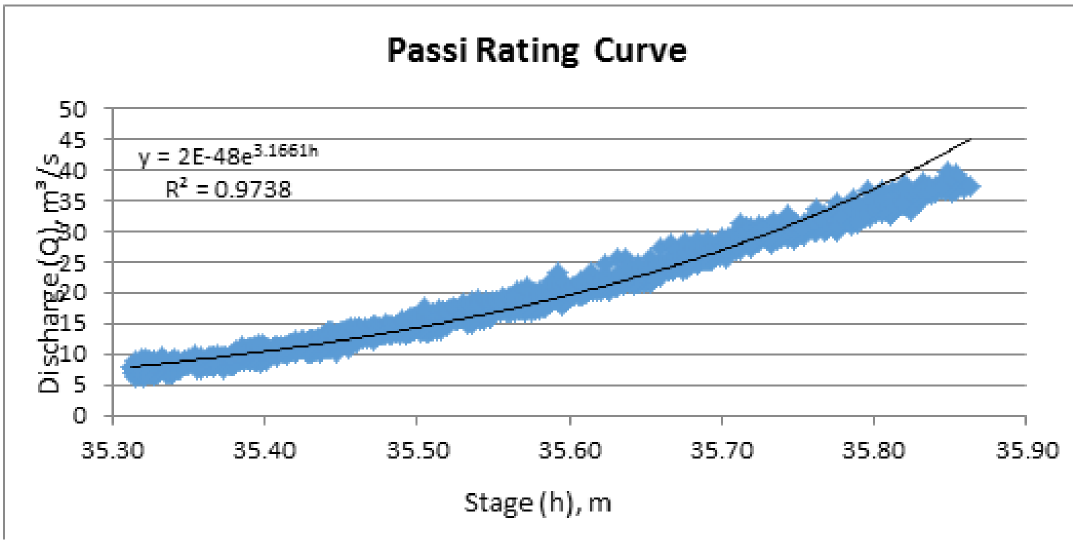


Figure 15. Water level vs. Discharge Curve for Jalaur Bridge – Passi

3.1.4.2 Calinog Bridge, Iloilo Rating Curve

A rating curve was developed at Jalaur Bridge, Calinog, Iloilo (11.11961, 122.5386). The rating curve is expressed as $Q = 1E - 59e^{2.7514h}$ as shown in Figure 16.

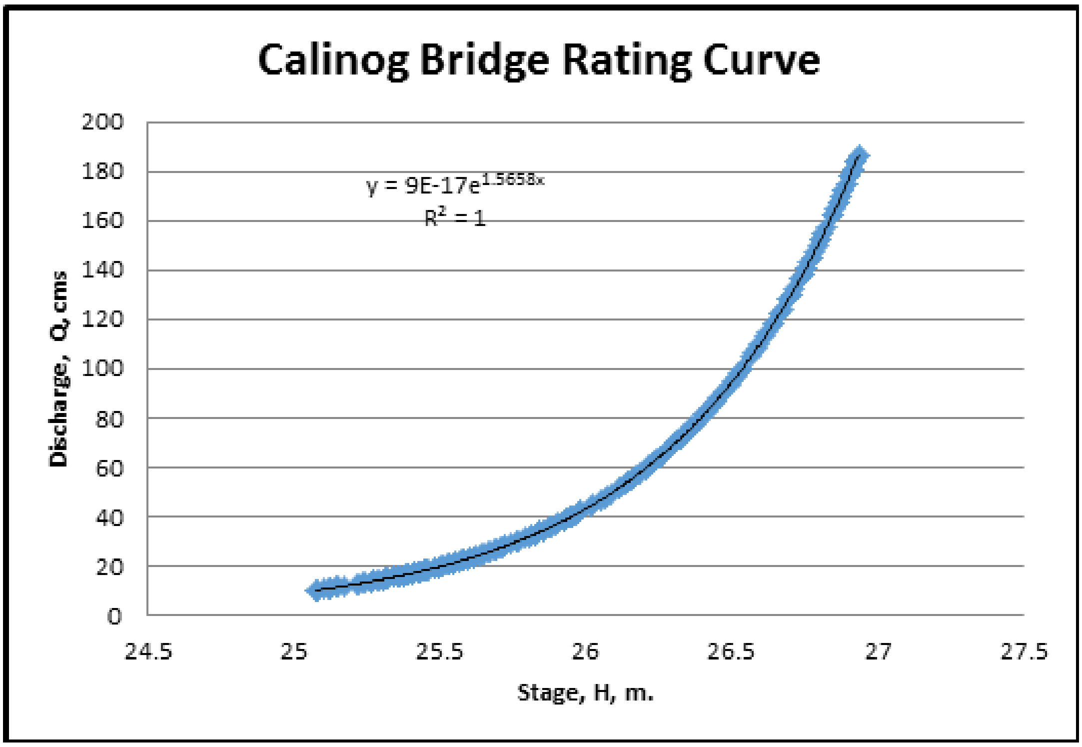


Figure 16. Water level vs. Discharge Curve for Calinog Bridge, Iloilo

3.1.4.3 Jalaur Bridge – Pototan, Iloilo Rating Curve

A rating curve was developed at Jalaur Bridge, Pototan, Iloilo (10.909531, 122.686106). The rating curve is expressed as $Q = 15.06e^{0.1308h}$ as shown in Figure 17.

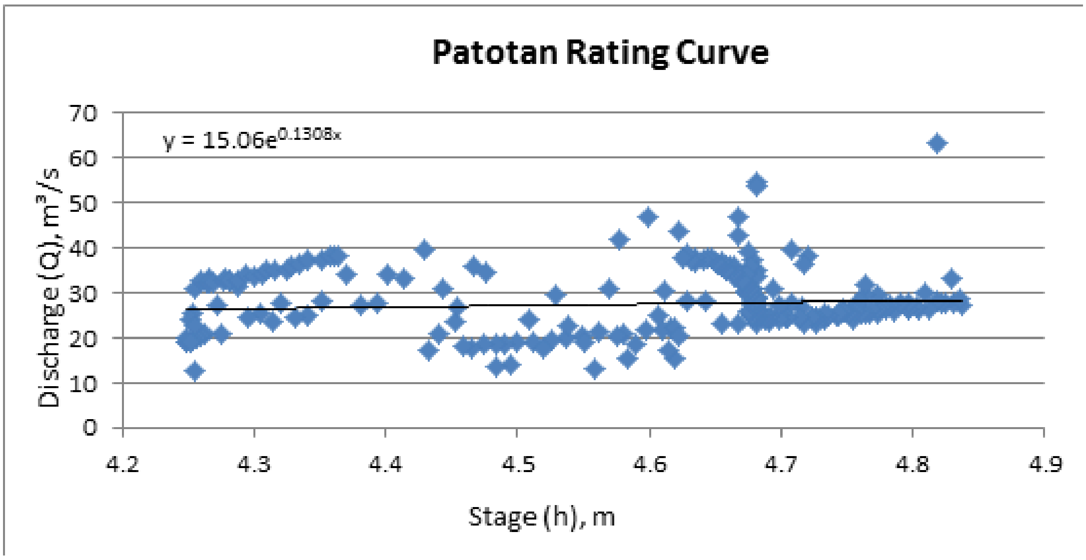


Figure 17. Water level vs. Discharge Curve for Jalaur Bridge, Pototan

3.2 Rainfall-Runoff Hydrologic Model Development

3.2.1 Watershed Delineation and Basin Model Pre-processing

The hydrologic model of Jalaur River Basin was developed using Watershed Modeling System (WMS) version 9.1. The software was developed by Aquaveo, a water resources engineering consulting firm in United States. WMS is a program capable of various watershed computations and hydrologic simulations. The hydrologic model development follows the scheme shown in Figure 18.

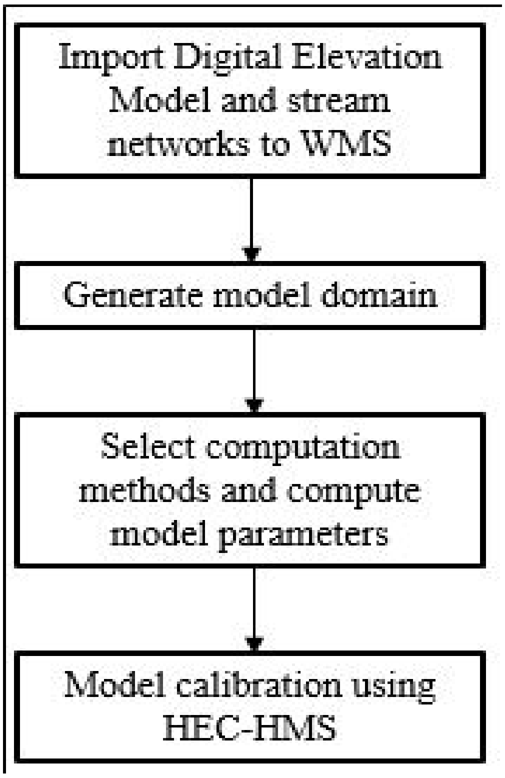


Figure 18. The Rainfall-Runoff Basin Model Development Scheme

Hydro-corrected SRTM DEM was used as the terrain for the basin model. The watershed delineation and its hydrologic elements, namely the subbasins, junctions and reaches, were generated using WMS after importing the elevation data and stream networks.

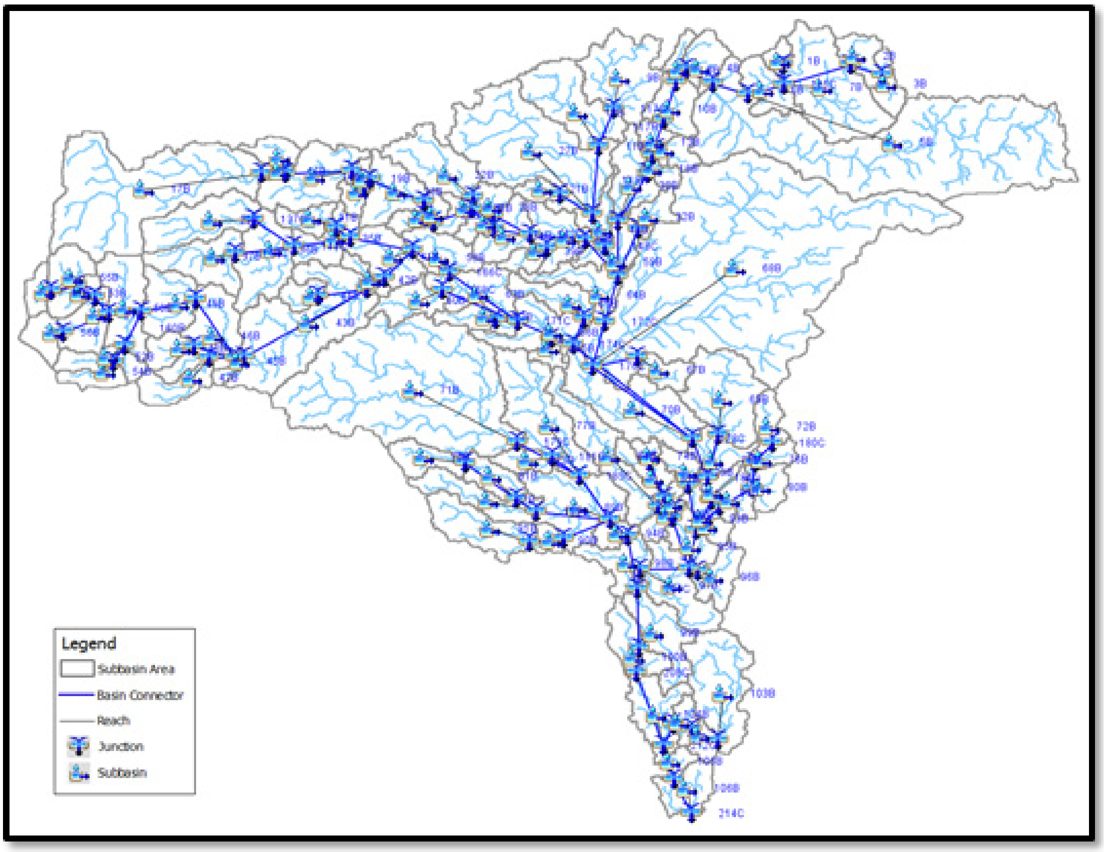


Figure 19. Jalaur HEC-HMS Model domain generated by WMS

The parameters for the subbasins and reaches were computed after the model domain was created. There are several methods available for different calculation types for each subbasin and reach hydrologic elements. The methods used for this study is shown in Table 1. The necessary parameter values are determined by the selected methods. The initial abstraction, curve number, percentage impervious and manning's coefficient of roughness, n, for each subbasin were computed based on the soil type, land cover and land use data. The subbasin time of concentration and storage coefficient were computed based on the analysis of the topography of the basin.

Table 1. Methods used for the different Calculation types for the hydrologic elements

Hydrologic Element	Calculation Type	Method
Subbasin	Loss Rate	SCS Curve Number
	Transform	Clark's unit hydrograph
	Baseflow	Bounded recession
Reach	Routing	Muskingum-Cunge

3.2.2 Basin Model Calibration

The basin model made using WMS was exported to Hydrologic Modeling System (HEC-HMS) version 3.5, a software made by the Hydrologic Engineering Center of the US Army Corps of Engineers, to create the final rainfall-runoff model. The developers described HEC-HMS as a program designed to simulate the hydrologic processes of a dendritic watershed systems. In this study, the rainfall-runoff model was developed to calculate inflow from the watershed to the floodplain.

Precipitation data was taken from three automatic rain gauges (ARGs) installed by the Department of Science and Technology – Advanced Science and Technology Institute (DOST-ASTI). These were the Calinog and Pototan ARGs. The location of the rain gauges is seen in Figure 21.

For the calibration of Passi, the total rain from Calinog rain gauge is 15.6 mm. It peaked to 2.0mm on 11 February 2013, 15:25. For the calibration of Calinog, total rain for this event is 45.72mm measured from the Calinog rain gauge. Peak rain of 5.08mm was recorded on 25 October 2013, 18:00. For the calibration of Pototan, total rain is 28.702mm measured from Pototan rain gauge. It peaked to 11.176mm at 25 October 2013, 19:15.

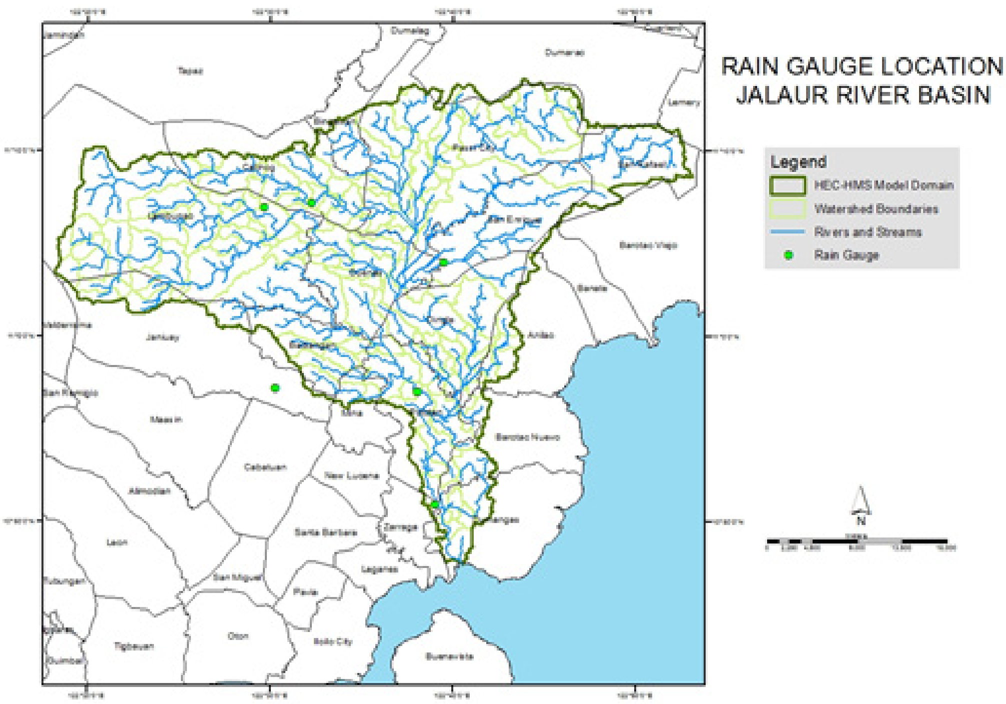


Figure 20 Location of rain gauge used for the calibration of Jalaur HEC-HMS Model.

The outflow hydrograph for the downstream-most discharge point with field data was also encoded to the model as a basis for the calibration. Using the said data, HEC-HMS could perform rainfall-runoff simulation and the resulting outflow hydrograph was compared with the observed hydrograph. The values of the parameters were adjusted and optimized in order for the calculated outflow hydrograph to appear like the observed hydrograph. Acceptable values of the subbasin and reach parameters from the manual and past literatures were considered in the calibration.

After the calibration of the downstream-most discharge point, model calibration of the discharge points along the major tributaries of the main river/s were also performed.

3.3 HEC-HMS Hydrologic Simulations for Discharge Computations using PAGASA RIDF Curves

3.3.1 Discharge Computation using Rainfall-Runoff Hydrologic Model

The calibrated rainfall-Runoff Hydrologic Model for the Jalaur River Basin using WMS and HEC-HMS was used to simulate the flow for for the five return periods, namely, 5-, 10-, 25-, 50-, and 100-year RIDFs. Time-series data of the precipitation data using the Iloilo RIDF curves were encoded to HEC-HMS for the aforementioned return periods, wherein each return period corresponds to a scenario. This process was performed for all discharge points – Jalaur Brige – Passi, Calinog Bridge and Jalaur Bridge – Potation. The output for each simulation was an outflow hydrograph from that result, the total inflow to the floodplain and time difference between the peak outflow and peak precipitation could be determined.

3.3.2 Discharge Computation using Dr. Horritt's Recommended Hydrological Method

The required data to be accumulated for the implementation of Dr. Horrit's method is shown on Figure 26.

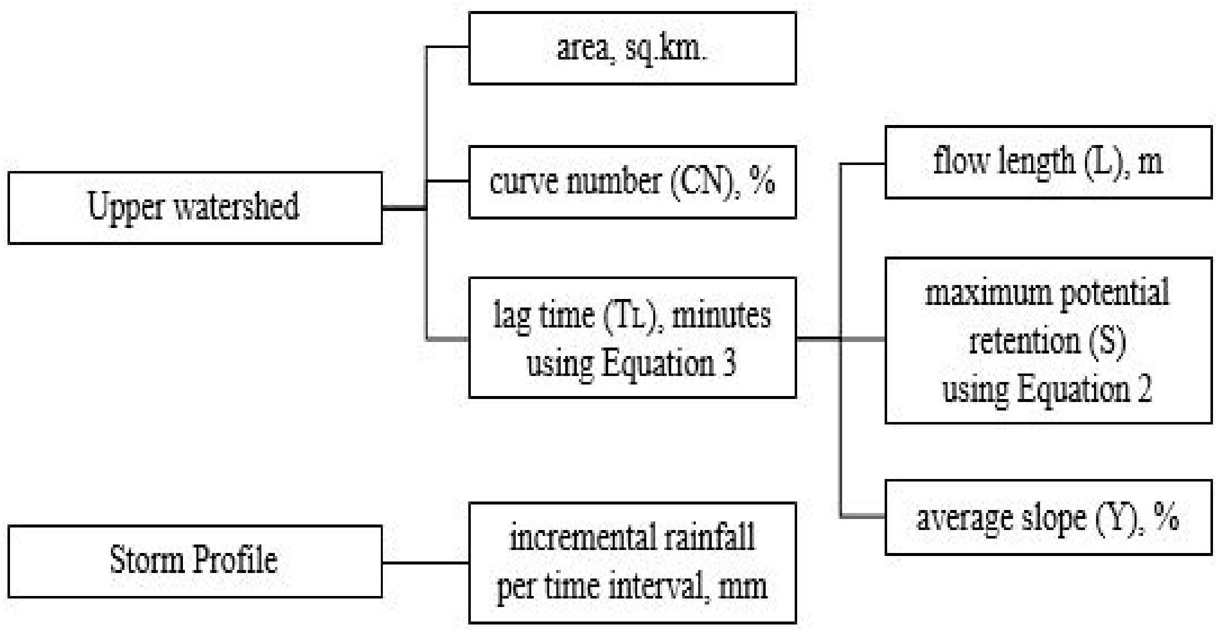


Figure 21. Different data needed as input for HEC-HMS discharge simulation using Dr. Horritt's recommended hydrology method.

Flows from streams were computed using the hydrology method developed by the flood modeling component with Dr. Matt Horritt, a British hydrologist that specializes in flood research. The methodology was based on an approach developed by CH2M Hill and Horritt Consulting for Taiwan which has been successfully validated in a region with meteorology and hydrology similar to the Philippines. It utilizes the SCS curve number and unit hydrograph method to have an accurate approximation of river discharge data from measurable catchment parameters.

3.3.2.1 Determination of Catchment Properties

RADARSAT DTM data for the different areas of the Philippines were compiled with the aid of ArcMap. RADARSAT satellites provide advance geospatial information and these were processed in the forms of shapefiles and layers that are readable and can be analyzed by ArcMap. These shapefiles are digital vectors that store geometric locations.

The watershed flow length is defined as the longest drainage path within the catchment, measured from the top of the watershed to the point of the outlet. With the tools provided by the ArcMap program and the data from RADARSAT DTM, the longest stream was selected and its geometric property, flow length, was then calculated in the program.

The area of the watershed is determined with the longest stream as the guide. The compiled RADARSAT data has a shapefile with defined small catchments based on mean elevation. These parameters were used in determining which catchments, along with the area, belong in the upper watershed.

Figure 22. Delineation upper watershed for Jalaur floodplain discharge computation

The value of the curve number was obtained using the RADARSAT data that contains information of the Philippine national curve number map. An ArcMap tool was used to determine the average curve number of the area bounded by the upper watershed shapefile. The same method was implemented in determining the average slope using RADARSAT with slope data for the whole country.

After determining the curve number (CN), the maximum potential retention (S) was determined by Equation 2.

$$S = \frac{1000}{CN} - 10$$

Equation 2. Determination of maximum potential retention using the average curve number of the catchment

The watershed length (L), average slope (Y) and maximum potential retention (S) are used to estimate the lag time of the upper watershed as illustrated in Equation 3.

$$T_L = \frac{L^{0.8}(S+1)^{0.7}}{560Y^{0.5}}$$

Equation 3. Lag Time Equation Calibrated for Philippine Setting

Finally, the final parameter that will be derived is the storm profile. The synoptic station which covers the majority of the upper watershed was identified. Using the RIDF data, the incremental values of rainfall in millimeter per 0.1 hour was used as the storm profile.

3.3.2.2 HEC-HMS Implementation

With all the parameters available, HEC-HMS was then utilized. Obtained values from the previous section were used as input and a brief simulation would result in the tabulation of discharge results per time interval. The maximum discharge and time-to-peak for the whole simulation as well as the river discharge hydrograph were used for the flood simulation process. The time series results (discharge per time interval) were stored as HYD files for input in FLO-2D GDS Pro.

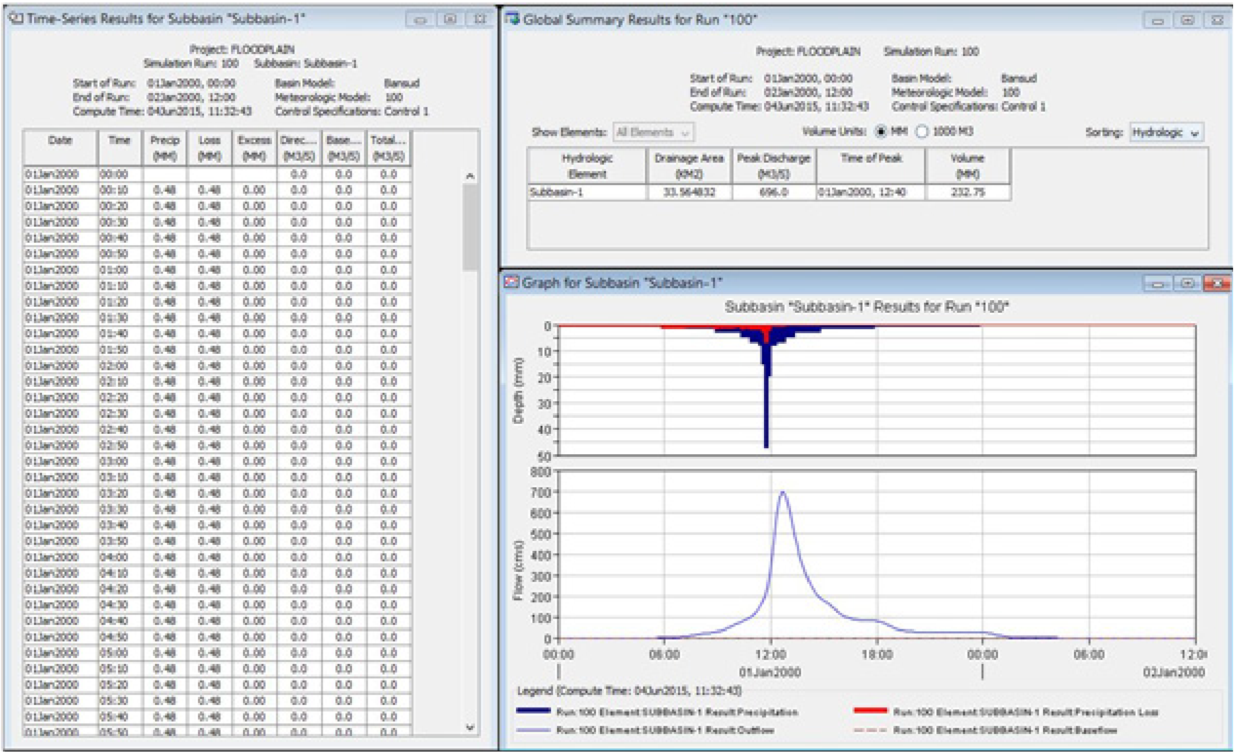


Figure 23. HEC-HMS simulation discharge results using Dr. Horritt's Method

3.3.2.3 Discharge validation against other estimates

As a general rule, the river discharge of a 2-year rain return, QMED, should approximately be equal to the bankful discharge, $Q_{bankful}$, of the river. This assumes that the river is in equilibrium, with its deposition being balanced by erosion. Since the simulations of the river discharge are done for 5-, 25-, and 100-year rainfall return scenarios, a simple ratio for the 2-year and 5-year return was computed with samples from actual discharge data of different rivers. It was found out to have a constant of 0.88. This constant, however, should still be continuously checked and calibrated when necessary.

$$Q_{MED} = 0.88Q_{5yr}$$

Equation 4. Ratio of river discharge of a 5-year rain return to a 2-year rain return scenario from measured discharge data

For the discharge calculation to pass the validation using the bankful method, Equation 5 must be satisfied.

$$50\%\, Q_{bankful} \leq Q_{MED} \leq 150\%\, Q_{bankful}$$

Equation 5. Discharge validation equation using bankful method

The bankful discharge was estimated using channel width (w), channel depth (h), bed slope (S) and Manning's constant (n). Derived from the Manning's Equation, the equation for the bankful discharge is by Equation 6.

$$Q_{bankful} = \frac{(wh)^{\frac{5}{3}} S^{\frac{1}{2}}}{n(w+2h)^{\frac{2}{3}}}$$

Equation 6. Bankful discharge equation using measurable channel parameters

3.4 Hazard and Flow Depth Mapping using FLO-2D

3.4.1 Floodplain Delineation

The boundaries of subbasins within the floodplain were delineated based on elevation values given by the DEM. Each subbasin is marked by ridges dividing catchment areas. These catchments were delineated using a set of ArcMap tools compiled by Al Duncan, a UK Geomatics Specialist, into a single processing model. The tool allows ArcMap to compute for the flow direction and acceleration based on the elevations provided by the DEM.

Running the tool creates features representing large, medium-sized, and small streams, as well as large, medium-sized, and small catchments. For the purpose of this particular model, the large, medium-sized, and small streams were set to have an area threshold of 100,000sqm, 50,000sqm, and 10,000sqm respectively. These thresholds define the values where the algorithm refers to in delineating a trough in the DEM as a stream feature, i.e. a large stream feature should drain a catchment area totalling 100,000 sqm to be considered as such. These values differ from the standard values used (10,000sqm, 1,000 sqm and 100sqm) to limit the detail of the project, as well as the file sizes, allowing the software to process the data faster.

The tool also shows the direction in which the water is going to flow across the catchment area. This information was used as the basis for delineating the floodplain. The entire area of the floodplain was subdivided into several zones in such a way that it that it can be processed properly. This was done by grouping the catchments together, taking special account of the inflows and outflows of water across the entire area. To be able to simulate actual conditions, all the catchments comprising a particular computational domain were set to have outflows that merged towards a single point. The area of each subdivision was limited to 250,000 grids or less to allow for an optimal simulation in FLO-2D GDS Pro. Larger models tend to run longer, while smaller models may not be as accurate as a large one.

3.4.2 Flood Model Generation

The software used to run the simulation is FLO-2D GDS Pro. It is a GIS integrated software tool that creates an integrated river and floodplain model by simulating the flow of the water over a system of square grid elements.

After loading the shapefile of the subcatchment onto FLO-2D, 10 meter by 10 meter grids that encompassed the entire area of interest were created.

The boundary for the area was set by defining the boundary grid elements. This can either be done by defining each element individually, or by drawing a line that traces the boundaries of the subcatchment. The grid elements inside of the defined boundary were considered as the computational area in which the simulation will be run.

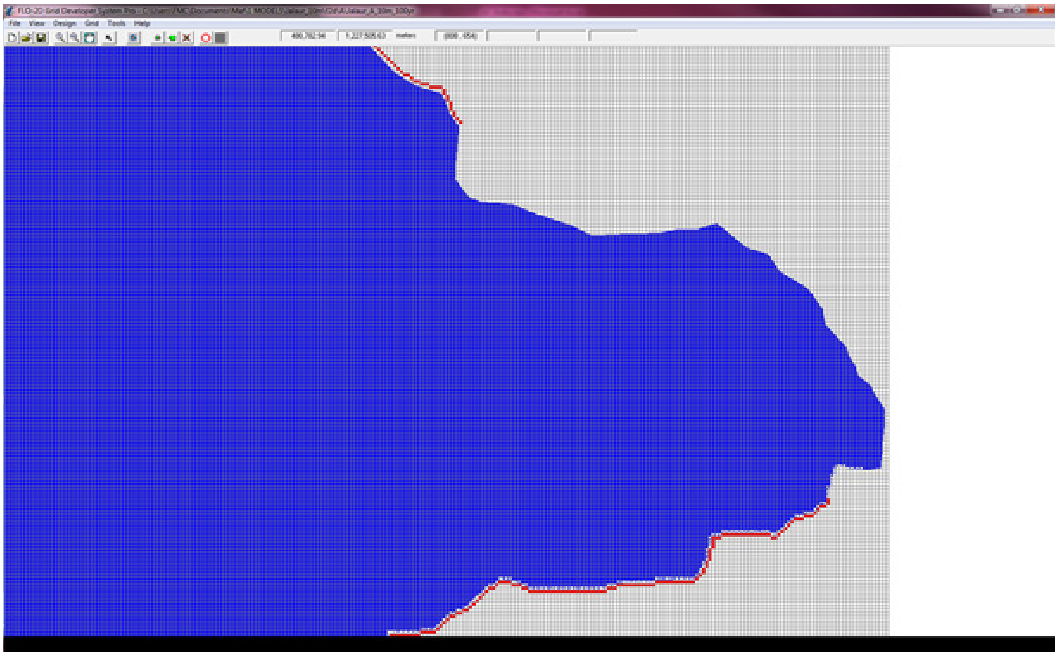


Figure 24. Screenshot showing how boundary grid elements are defined by line

Elevation data was imported in the form of the DEM gathered through LiDAR. These elevation points in PTS format were extrapolated into the model, providing an elevation value for each grid element.

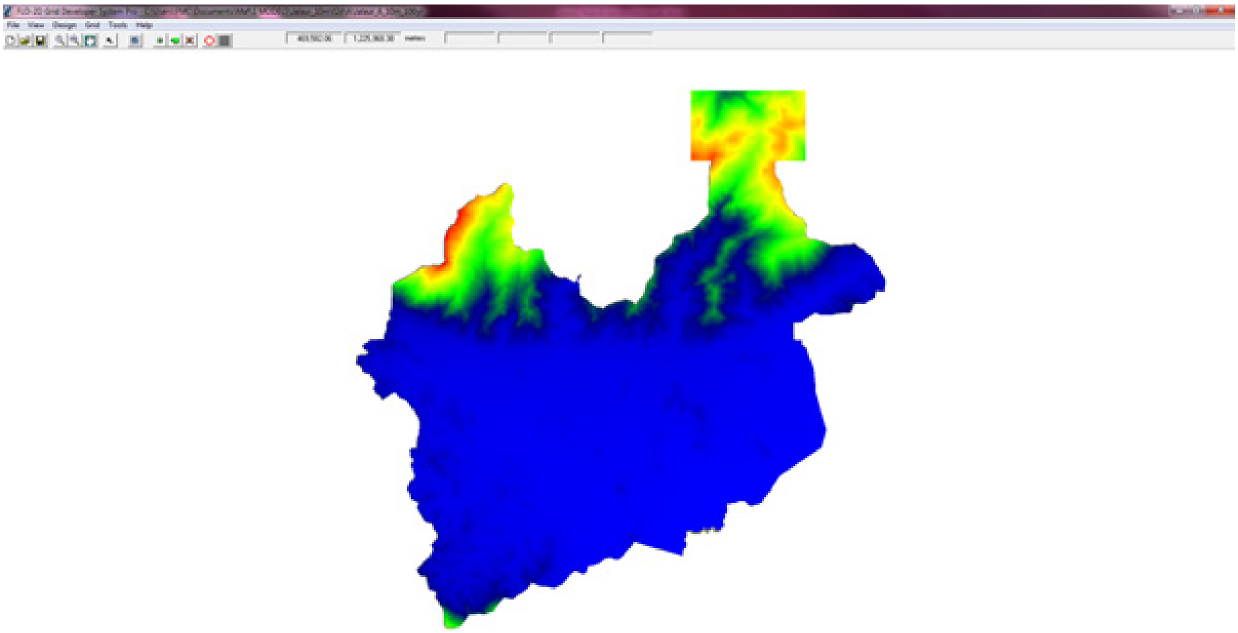


Figure 25. Screenshots of PTS files when loaded into the FLO-2D program

The floodplain is predominantly composed of rice fields, which have a Manning coefficient of 0.15. All the inner grid elements were selected and the Manning coefficient of 0.15 was assigned. To differentiate the streams from the rest of the floodplain, a shapefile containing all the streams and rivers in the area were imported into the software. The shapefile was generated using Al Duncan's catchment tool for ArcMap. The streams were then traced onto their corresponding grid elements.

These grid elements were all selected and assigned a Manning coefficient of 0.03. The DEM and aerial imagery were also used as bases for tracing the streams and rivers.

Figure 26. Aerial Image of Jalaur floodplain

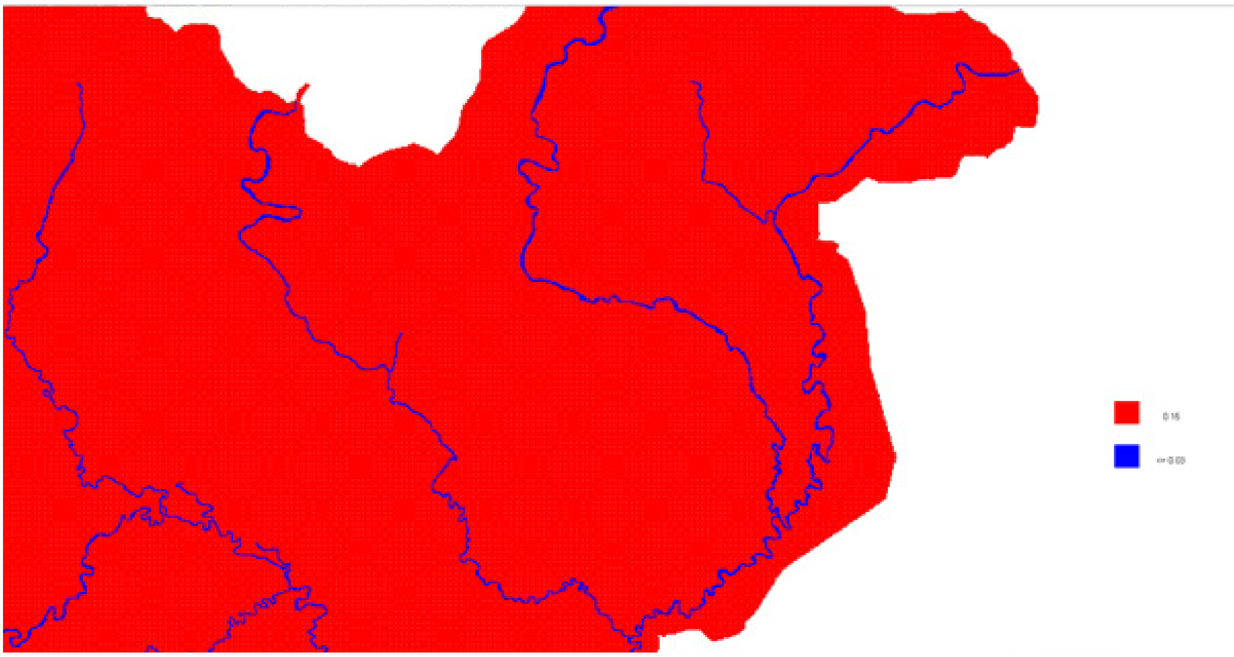


Figure 27. Screenshot of Manning's n-value rendering

After assigning Manning coefficients for each grid, the infiltration parameters were identified. Green-Ampt infiltration method by W. Heber Green and G.S Ampt were used for all the models. The initial saturations applied to the model were 0.99, 0.8, and 0.7 for 100-year, 25-year, and 5-year rain return periods respectively. These initial saturations were used in the computation of the infiltration value.

The Green-Ampt infiltration method by W. Heber Green and G.S Ampt method is based on a simple physical model in which the equation parameter can be related to physical properties of the soil. Physically, Green and Ampt assumed that the soil was saturated behind the wetting front and that one could define some "effective" matric potential at the wetting front (Kirkham, 2005). Basically, the system is assumed to consist of a uniformly wetted near-saturated transmission zone above a sharply defined wetting front of constant pressure head (Diamond & Shanley, 2003).

The next step was to allocate inflow nodes based on the locations of the outlets of the streams from the upper watershed. The inflow values came from the computed discharges that were input as hyd files.

Outflow nodes were allocated for the model. These outflow nodes show the locations where the water received by the watershed is discharged. The water that will remain in the watershed will result to flooding on low lying areas.

For the models to be able to simulate actual conditions, the inflow and outflow of each computational domain should be indicated properly. In situations wherein water flows from one subcatchment to the other, the corresponding models are processed one after the other. The outflow generated by the source subcatchment was used as inflow for the subcatchment area that it flows into.

The standard simulation time used to run each model is the time-to-peak (TP) plus an additional 12 hours. This gives enough time for the water to flow into and out of the model area, illustrating the complete process from entry to exit as shown in the hydrograph. The additional 12 hours allows enough time for the water to drain fully into the next subcatchment. After all the parameters were set, the model was run through FLO-2D GDS Pro.

3.4.3 Flow Depth and Hazard Map Simulation

After running the flood map simulation in FLO-2D GDS Pro, FLO-2D Mapper Pro was used to read the resulting hazard and flow depth maps. The standard input values for reading the simulation results are shown on Figure 24.

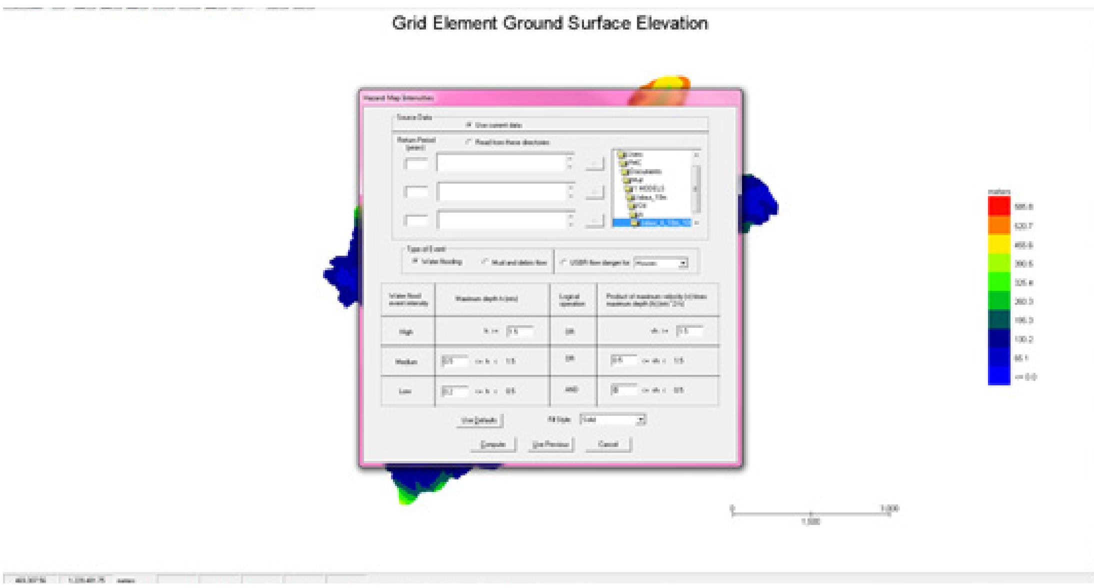


Figure 28. Flo-2D Mapper Pro General Procedure

In order to produce the hazard maps, set input for low maximum depth as 0.2 m, and vh, product of maximum velocity and maximum depth (m^2/s), as greater than or equal to zero. The program will then compute for the flood inundation and will generate shapefiles for the hazard and flow depth scenario.

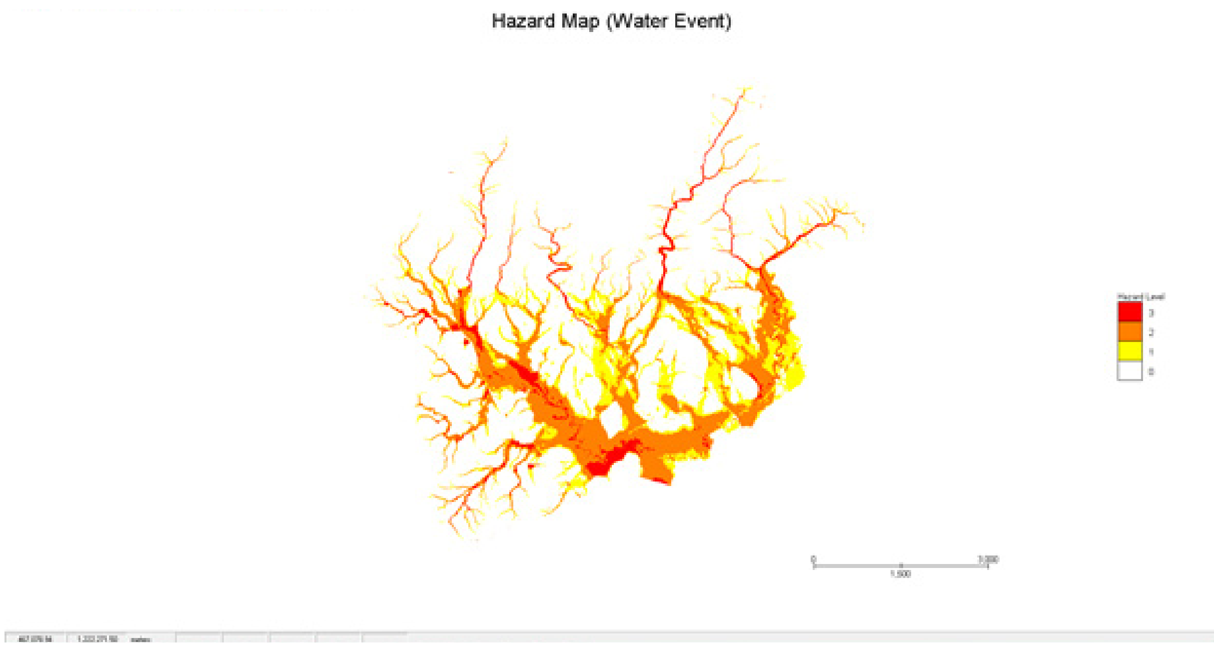


Figure 29. Jalaur Floodplain Generated Hazard Maps using Flo-2D Mapper

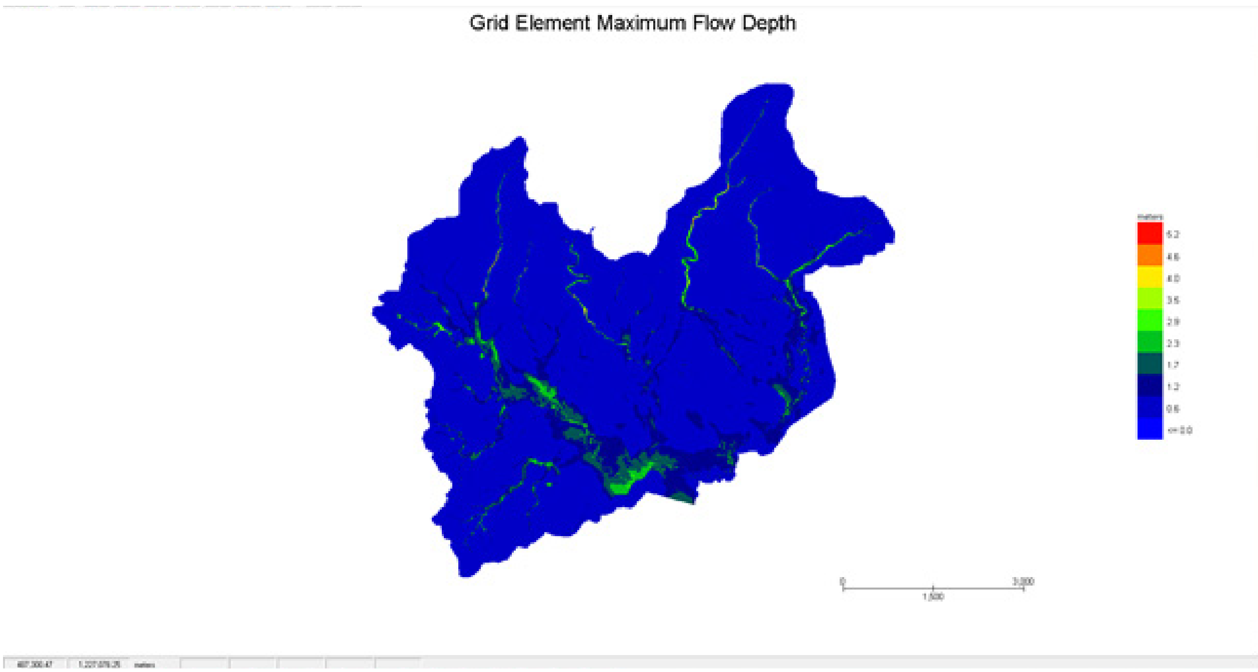
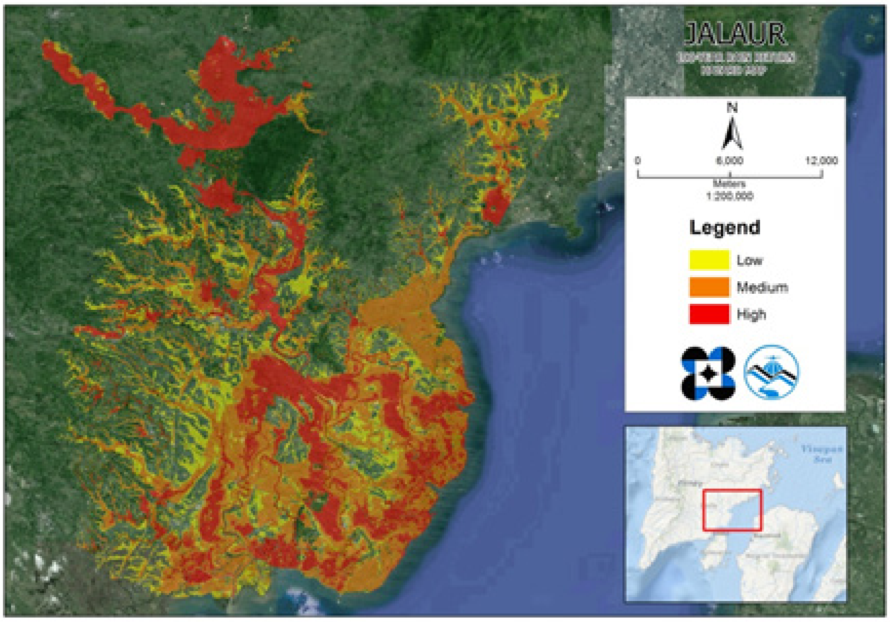


Figure 30. Jalaur floodplain generated flow depth map using Flo-2D Mapper

3.4.4 Hazard Map and Flow Depth Map Creation

The final procedure in creating the maps is to prepare them with the aid of ArcMap. The generated shapefiles from FLO-2D Mapper Pro were opened in ArcMap. The basic layout of a hazard map is shown in Figure 27. The same map elements are also found in a flow depth map.



ELEMENTS:
1. River Basin Name
2. Hazard/Flow Depth Shapefile
3. Provincial Inset
4. Philippine Inset
5. Hi-Res image of the area
6. North Arrow
7. Scale Text and Bar

Figure 31. Basic Layout and Elements of the Hazard Maps

Results and Discussion

4.1 Efficiency of HEC-HMS Rainfall-Runoff Models calibrated based on field survey and gauges data

4.1.1 Jalaur Bridge - Passi City, Iloilo HMS Calibration Results

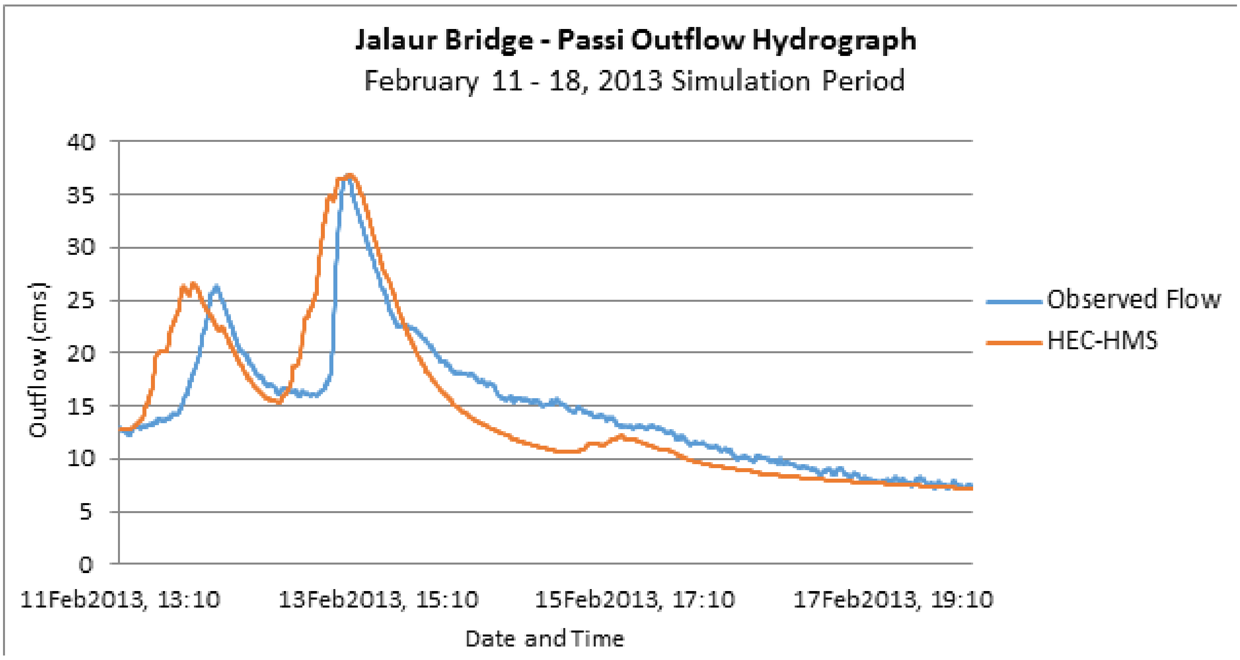


Figure 32. Passi Outflow Hydrograph produced by the HEC-HMS model compared with observed outflow

After calibrating the Jalaur HEC-HMS river basin model, its accuracy was measured against the observed values. Figure 32 shows the comparison between the two discharge data.

The Root Mean Square Error (RMSE) method aggregates the individual differences of these two measurements. It was identified at 0.004.

The Pearson correlation coefficient (r2) assesses the strength of the linear relationship between the observations and the model. This value being close to 1 corresponds to an almost perfect match of the observed discharge and the resulting discharge from the HEC HMS model. Here, it measured 0.491.

The Nash-Sutcliffe (E) method was also used to assess the predictive power of the model. Here the optimal value is 1. The model attained an efficiency coefficient of 0.078.

A positive Percent Bias (PBIAS) indicates a model's propensity towards under-prediction. Negative values indicate bias towards over-prediction. Again, the optimal value is 0. In the model, the PBIAS is -0.398.

The Observation Standard Deviation Ratio, RSR, is an error index. A perfect model attains a value of 0 when the error in the units of the valuable a quantified. The model has an RSR value of 0.12.

4.1.2 Calinog Bridge, Iloilo HMS Calibration Results

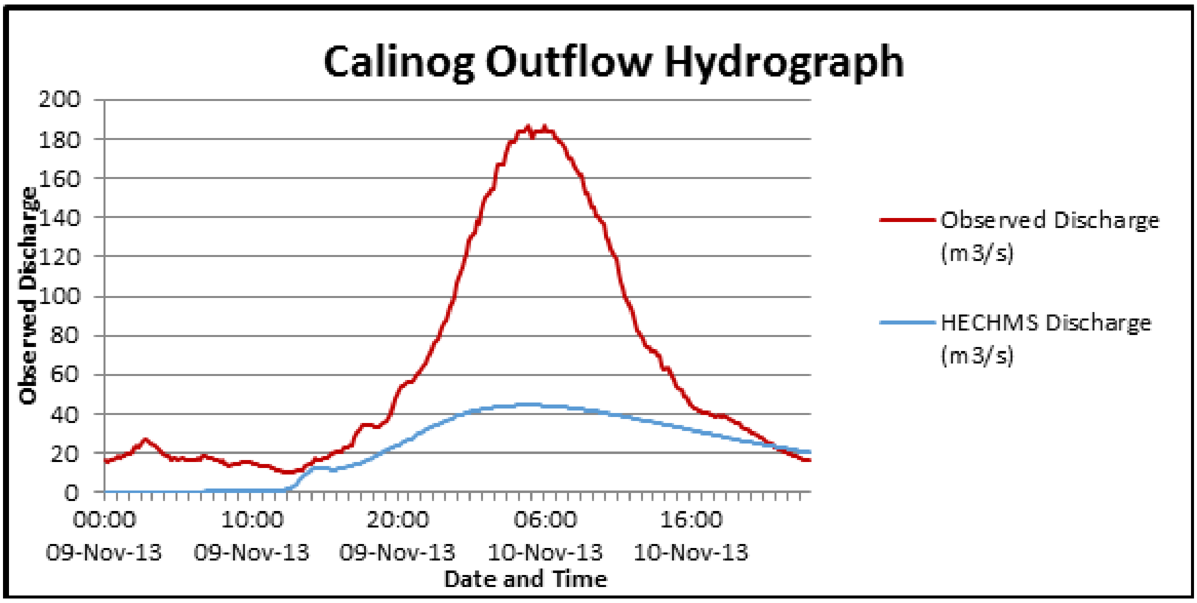


Figure 33. Calinog Outflow Hydrograph produced by the HEC-HMS model compared with observed outflow

The Root Mean Square Error for Calinog model was 0.004. The Pearson correlation coefficient was measured 0.491 while the efficiency coefficient was 0.078 measured using the Nash-Sutcliffe method. The positive percent bias of the model was 10.78 and the observation standard deviation ratio was 23.273.

4.1.3 Jalaur Bridge - Pototan, Iloilo HMS Calibration Results

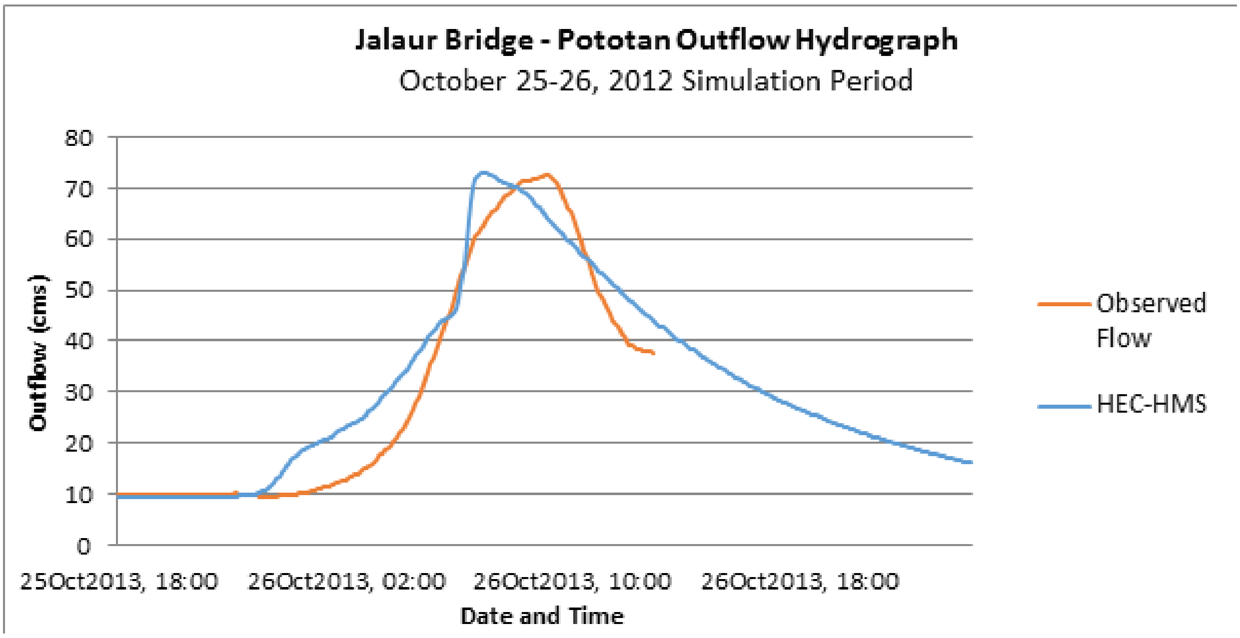


Figure 34. Jalaur Bridge - Pototan Outflow Hydrograph produced by the HEC-HMS model compared with observed outflow

4.2 Calculated Outflow hydrographs and Discharge Values for different Rainfall Return Periods

4.2.1 Hydrograph using the Rainfall-Runoff Model

4.2.1.1 Jalaur Bridge - Passi City, Iloilo

The simulation results reveal significant increase in outflow magnitude as the rainfall intensity increases for a range of durations and return periods. In the 5-year return period graph (Figure 35), the peak outflow is 1308 m3/s. This occurs after 2 hours and 50 minutes after the peak precipitation of 20.63 mm.

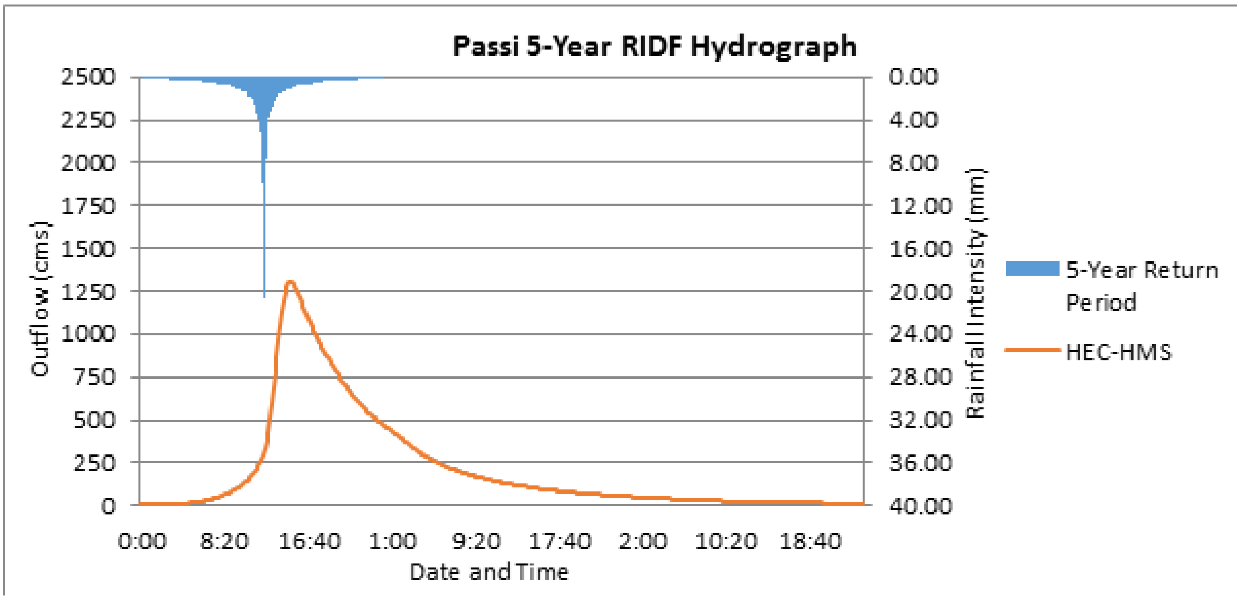


Figure 35. Jalaur Outflow hydrograph generated using the Iloilo 5-Year RIDF in HEC-HMS

In the 10-year return period graph (Figure 36), the peak outflow is 1581 m3/s. This occurs after 2 hours and 50 minutes after the peak precipitation of 24.35 mm.

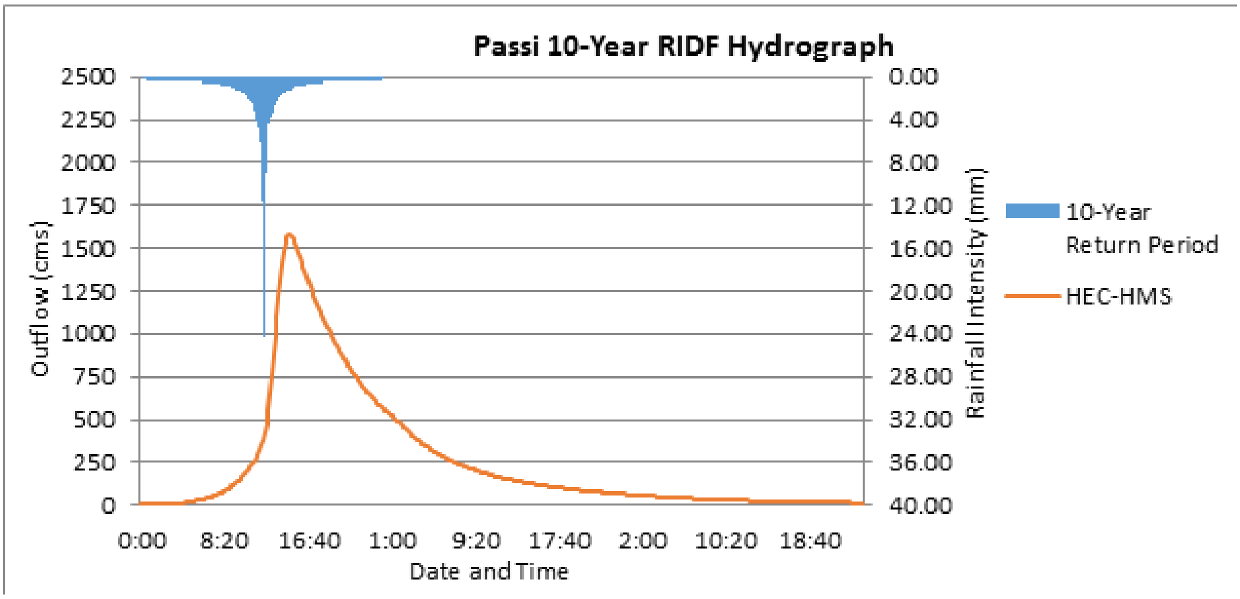


Figure 36. Jalaur Outflow hydrograph generated using the Iloilo 10-Year RIDF in HEC-HMS

In the 25-year return period graph (Figure 37), the peak outflow is 1592.8 m3/s. This occurs after 2 hours and 40 minutes after the peak precipitation of 28.45 mm.

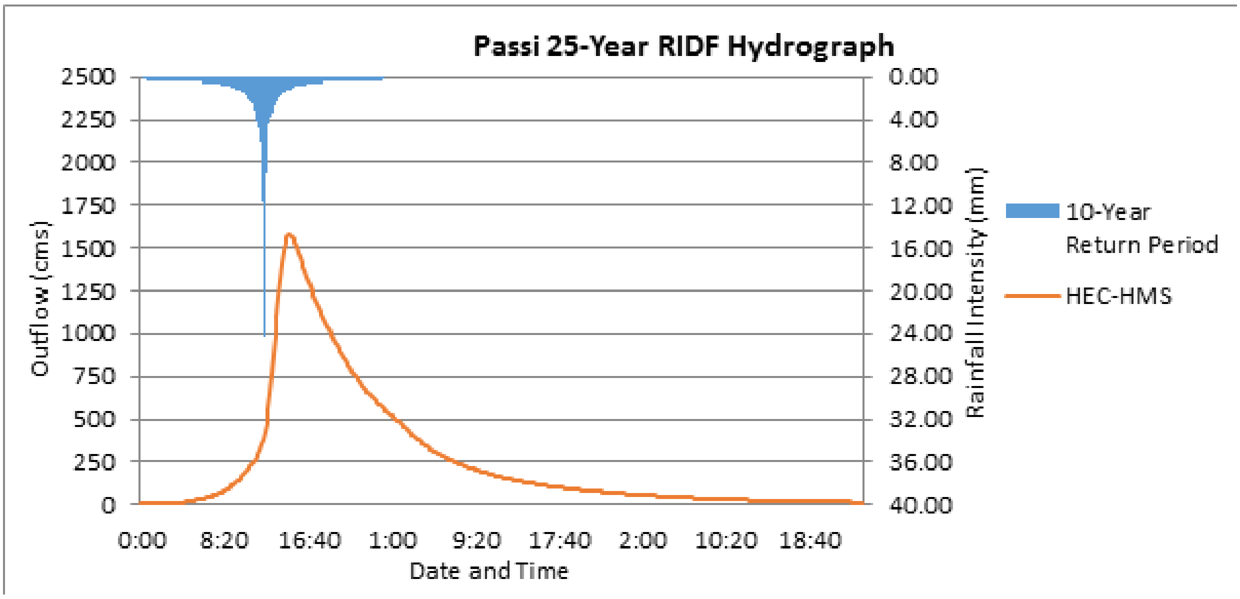


Figure 37. Jalaur Outflow hydrograph generated using the Iloilo 25-Year RIDF in HEC-HMS

In the 50-year return period graph (Figure 38), the peak outflow is 2109.1 m3/s. This occurs after 2 hours and 40 minutes after the peak precipitation of 31.30 mm.

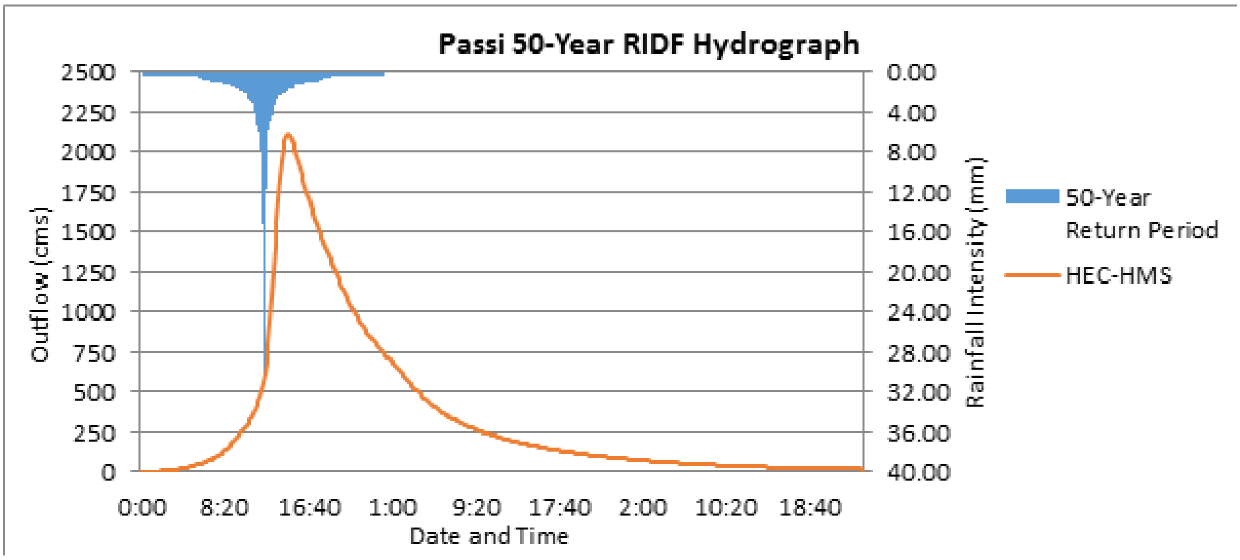


Figure 38. Jalaur Outflow hydrograph generated using the Iloilo 50-Year RIDF in HEC-HMS

In the 100-year return period graph (Figure 39), the peak outflow is 2322 m3/s. This occurs after 2 hours and 40 minutes after the peak precipitation of 34.16 mm.

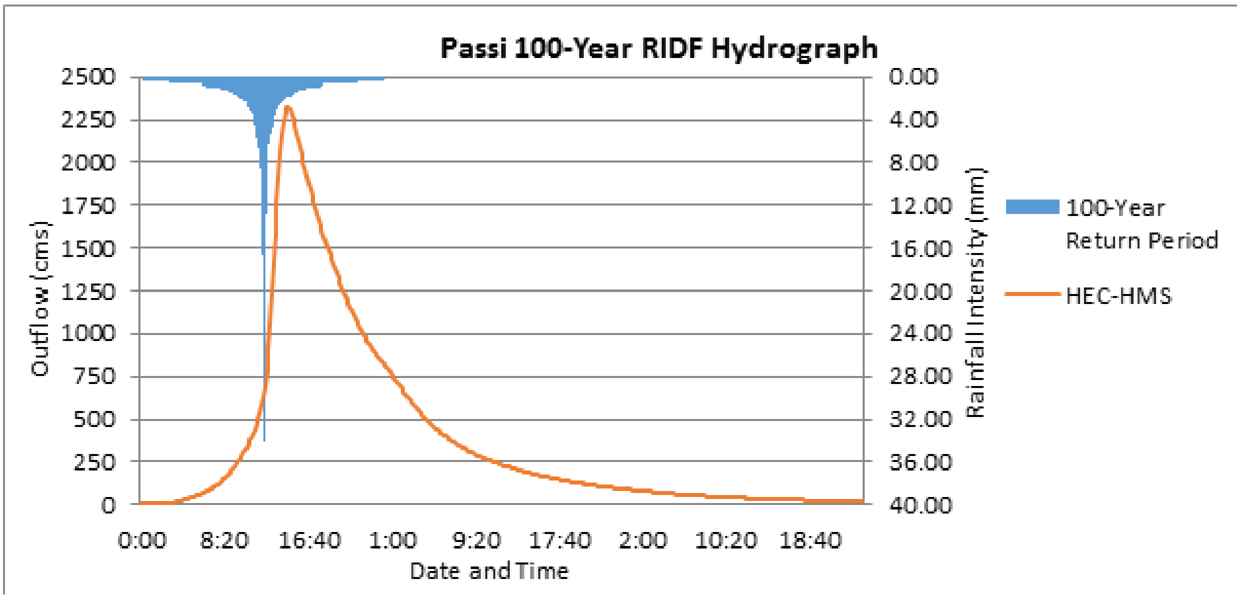


Figure 39. Jalaur Outflow hydrograph generated using the Iloilo 100-Year RIDF in HEC-HMS

A summary of the total precipitation, peak rainfall, peak outflow and time to peak of Passi discharge using the Iloilo Rainfall Intensity-Duration-Frequency curves (RIDF) in five different return periods is shown in Table 2.

Table 2. Summary of Passi outflow using Iloilo Station Rainfall Intensity Duration Frequency (RIDF)

RIDF Period	Total Precipitation (mm)	Peak rainfall (mm)	Peak outflow (cms)	Time to Peak
5-Year	147.56	20.63	1308	2 hours, 50 minutes
10-Year	175.58	24.35	1581	2 hours, 50 minutes
25-Year	207.32	28.45	1892.80	2 hours, 40 minutes
50-Year	229.48	31.30	2109.10	2 hours, 40 minutes
100-Year	251.53	34.16	2322	2 hours, 40 minutes

4.2.1.2 Calinog Bridge, Iloilo

In the 5-year return period graph (Figure 40), the peak outflow is 376 m3/s. This occurs after 2 hours and 30 minutes after the peak precipitation of 20.63 mm.

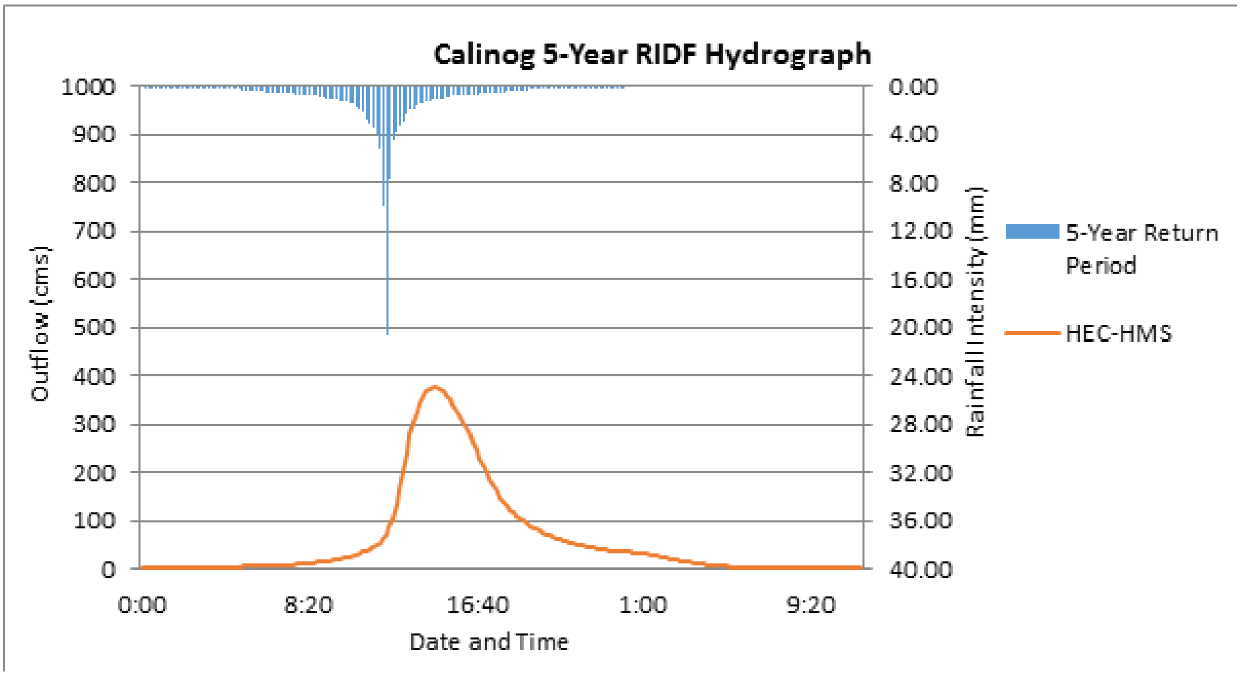


Figure 40. Calinog Outflow hydrograph generated using the Iloilo 5-Year RIDF in HEC-HMS

In the 10-year return period graph (Figure 41), the peak outflow is 482.5 m3/s. This occurs after 2 hours and 20 minutes after the peak precipitation of 24.35 mm.

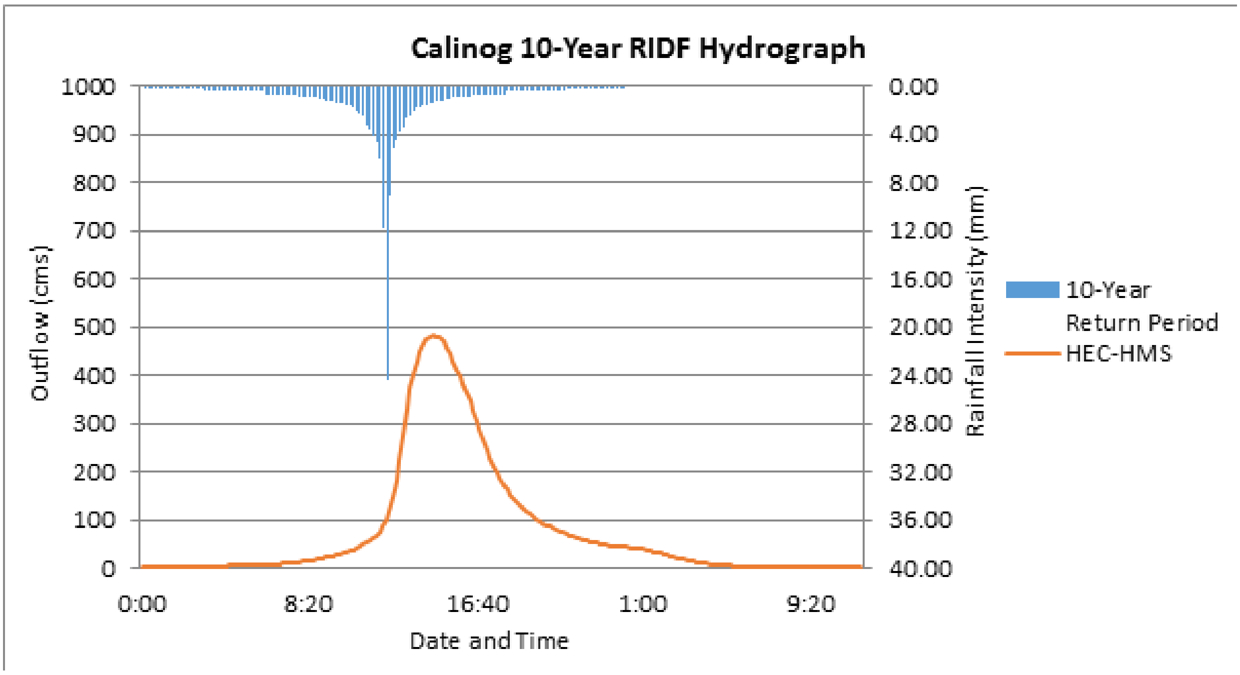


Figure 41. Calinog Outflow hydrograph generated using the Iloilo 10-Year RIDF in HEC-HMS

In the 25-year return period graph (Figure 42), the peak outflow is 607.9 m3/s. This occurs after 2 hours and 20 minutes after the peak precipitation of 28.45 mm.

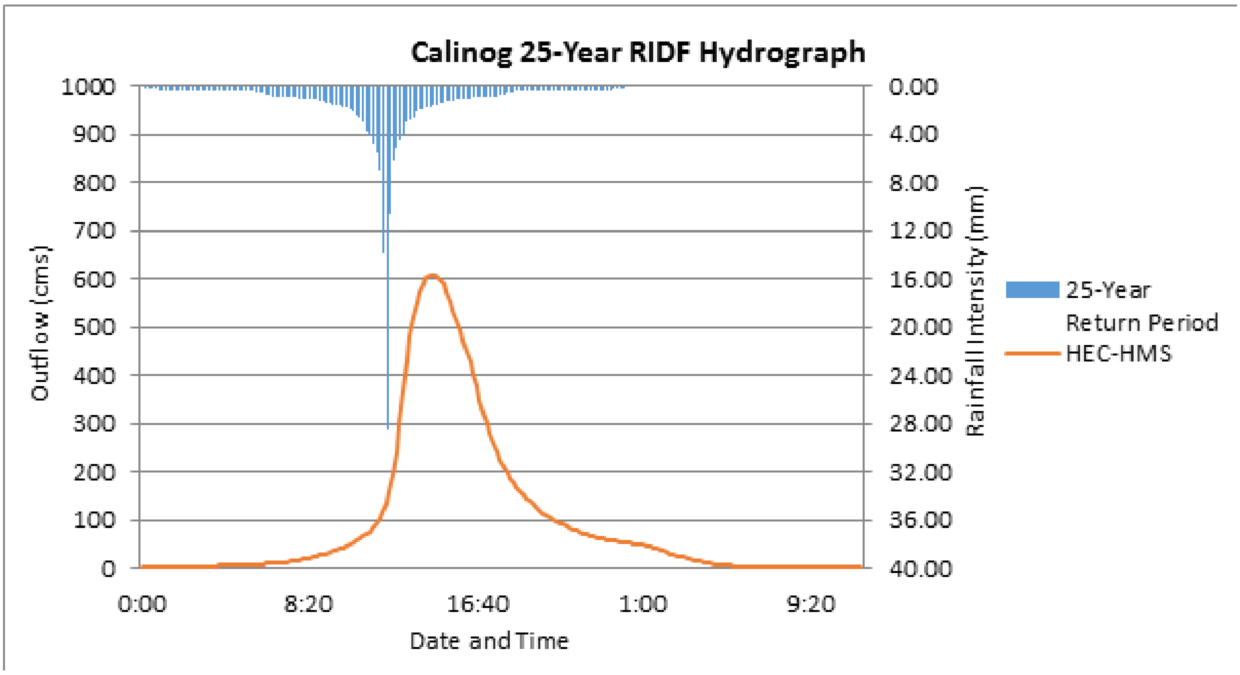


Figure 42. Calinog Outflow hydrograph generated using the Iloilo 25-Year RIDF in HEC-HMS

In the 50-year return period graph (Figure 43), the peak outflow is 698.2 m3/s. This occurs after 2 hours and 20 minutes after the peak precipitation of 31.30 mm.

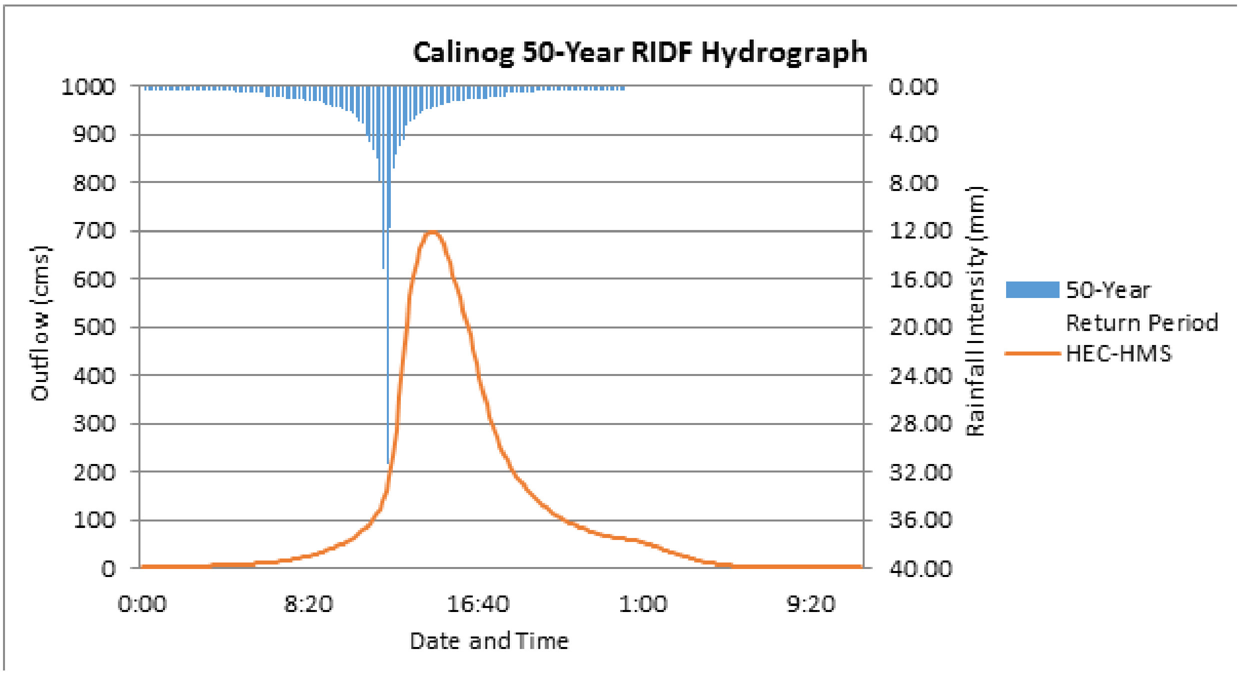


Figure 43. Calinog Outflow hydrograph generated using the Iloilo 50-Year RIDF in HEC-HMS

In the 100-year return period graph (Figure 44), the peak outflow is 788.5. This occurs after 2 hours and 20 minutes after the peak precipitation of 34.16 mm.

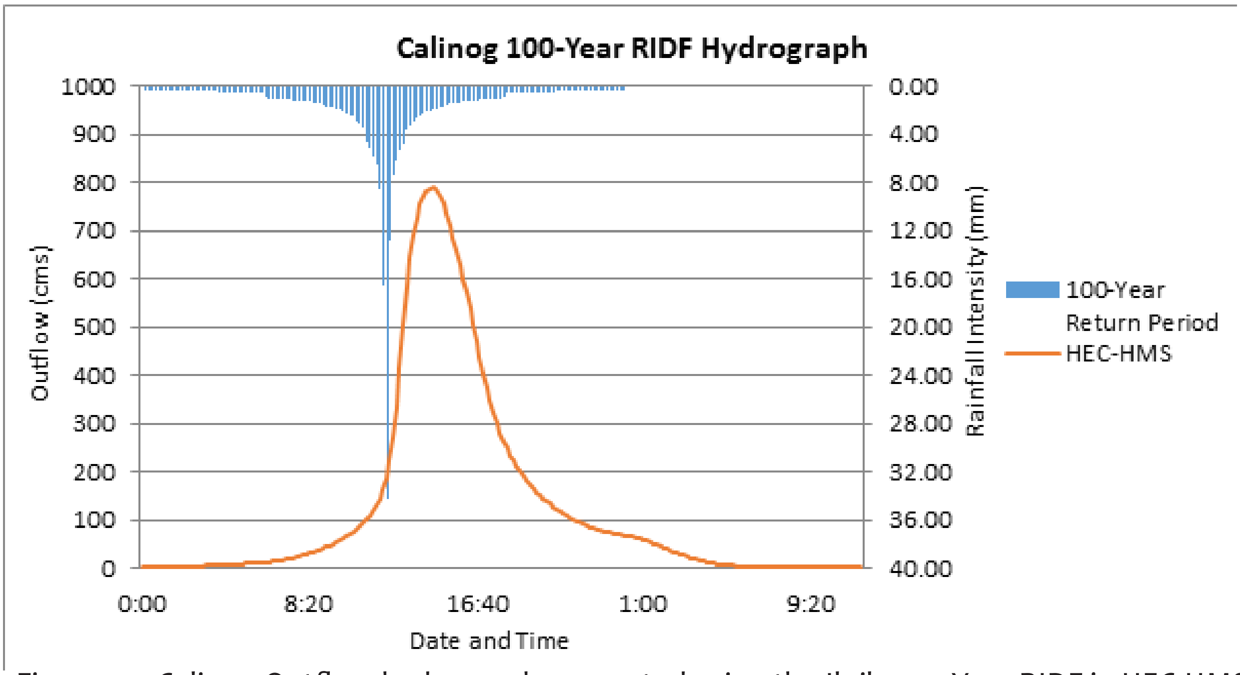


Figure 44. Calinog Outflow hydrograph generated using the Iloilo 100-Year RIDF in HEC-HMS

A summary of the total precipitation, peak rainfall, peak outflow and time to peak of Calinog discharge using the Iloilo Rainfall Intensity-Duration-Frequency curves (RIDF) in five different return periods is shown in Table 3.

Table 3. Summary of Calinog outflow using Iloilo Station Rainfall Intensity Duration Frequency (RIDF)

RIDF Period	Total Precipitation (mm)	Peak rainfall (mm)	Peak outflow (cms)	Time to Peak
5-Year	147.56	20.63	376	2 hours, 30 minutes
10-Year	175.58	24.35	482.5	2 hours, 20 minutes
25-Year	207.32	28.45	607.9	2 hours, 20 minutes
50-Year	229.48	31.30	698.2	2 hours, 20 minutes
100-Year	251.53	34.16	788.5	2 hours, 20 minutes

4.2.1.3 Jalaur Bridge - Pototan, Iloilo

In the 5-year return period graph (Figure 45), the peak outflow is 1776.6 m3/s. This occurs after 2 hours and 30 minutes after the peak precipitation of 20.63 mm.

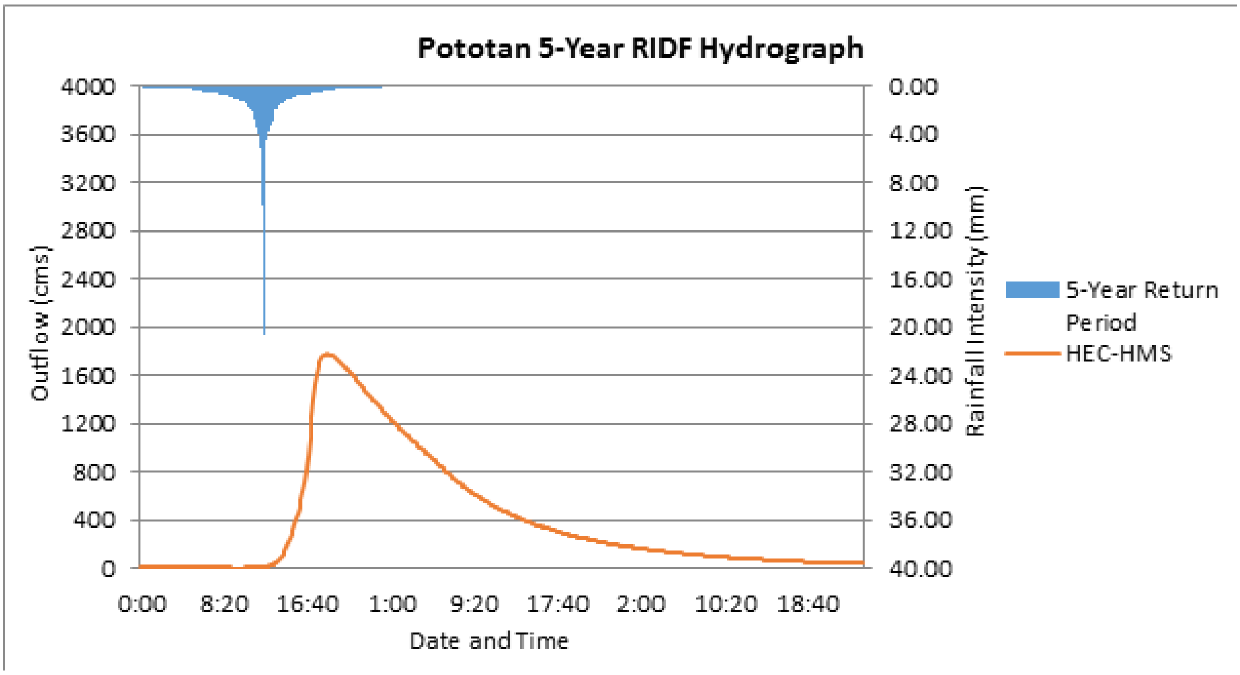


Figure 45. Jalaur - Pototan Outflow hydrograph generated using the Iloilo 5-Year RIDF in HEC-HMS

In the 10-year return period graph (Figure 46), the peak outflow is 2270.9 m3/s. This occurs after 2 hours and 20 minutes after the peak precipitation of 24.35 mm.

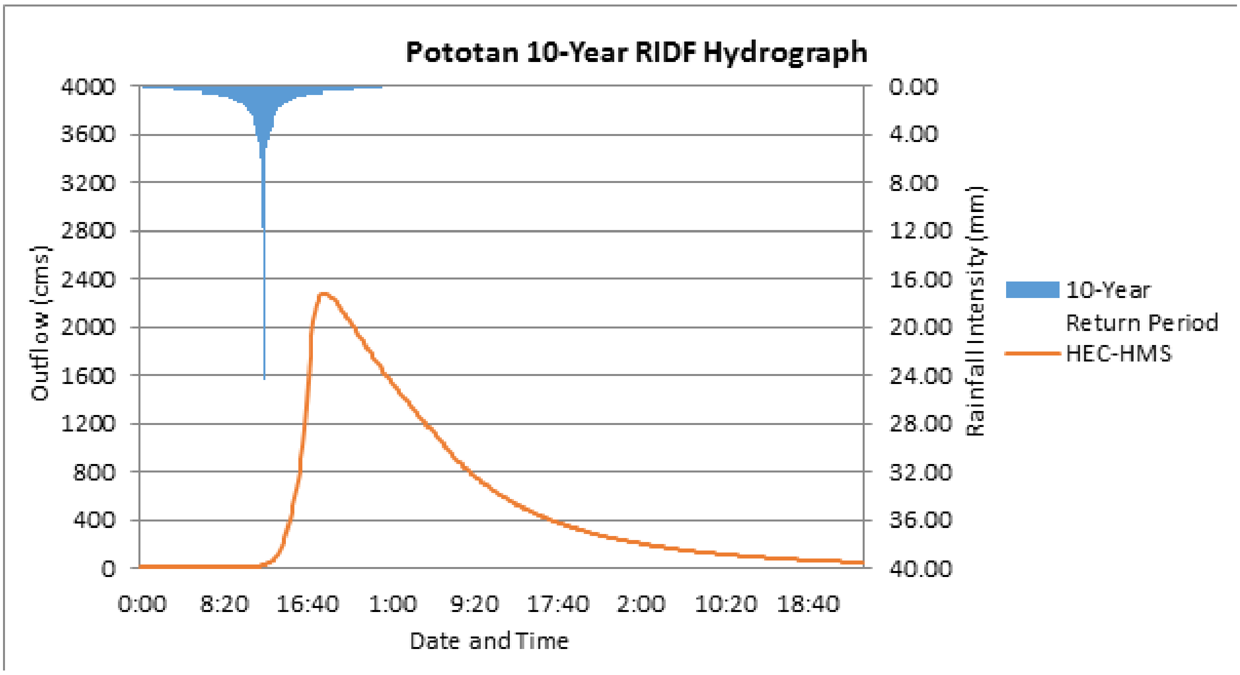


Figure 46. Jalaur - Pototan Outflow hydrograph generated using the Iloilo 10-Year RIDF in HEC-HMS

In the 25-year return period graph (Figure 47), the peak outflow is 2860.4 m3/s. This occurs after 2 hours and 20 minutes after the peak precipitation of 28.45 mm.

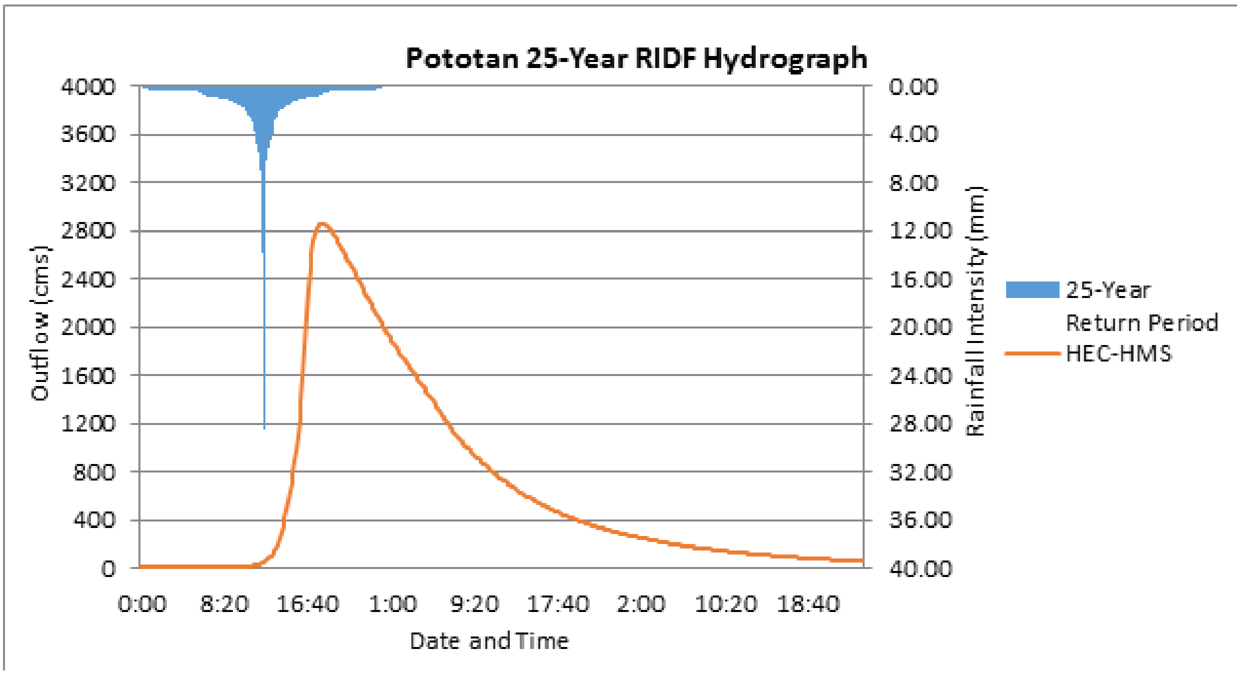


Figure 47. Jalaur - Pototan Outflow hydrograph generated using the Iloilo 25-Year RIDF in HEC-HMS

In the 50-year return period graph (Figure 48), the peak outflow is 3270.6 m3/s. This occurs after 2 hours and 20 minutes after the peak precipitation of 31.30 mm.

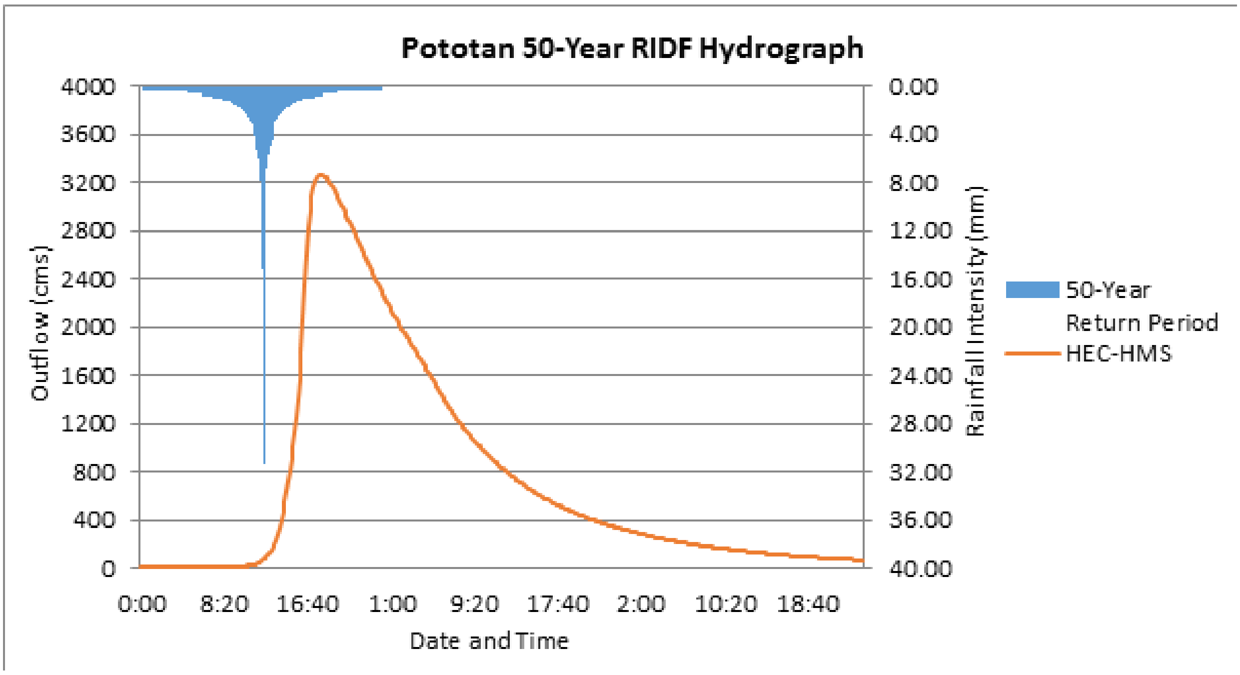


Figure 48. Jalaur - Pototan Outflow hydrograph generated using the Iloilo 50-Year RIDF in HEC-HMS

In the 100-year return period graph (Figure 49), the peak outflow is 3682.5 m3/s. This occurs after 2 hours and 20 minutes after the peak precipitation of 34.16 mm.

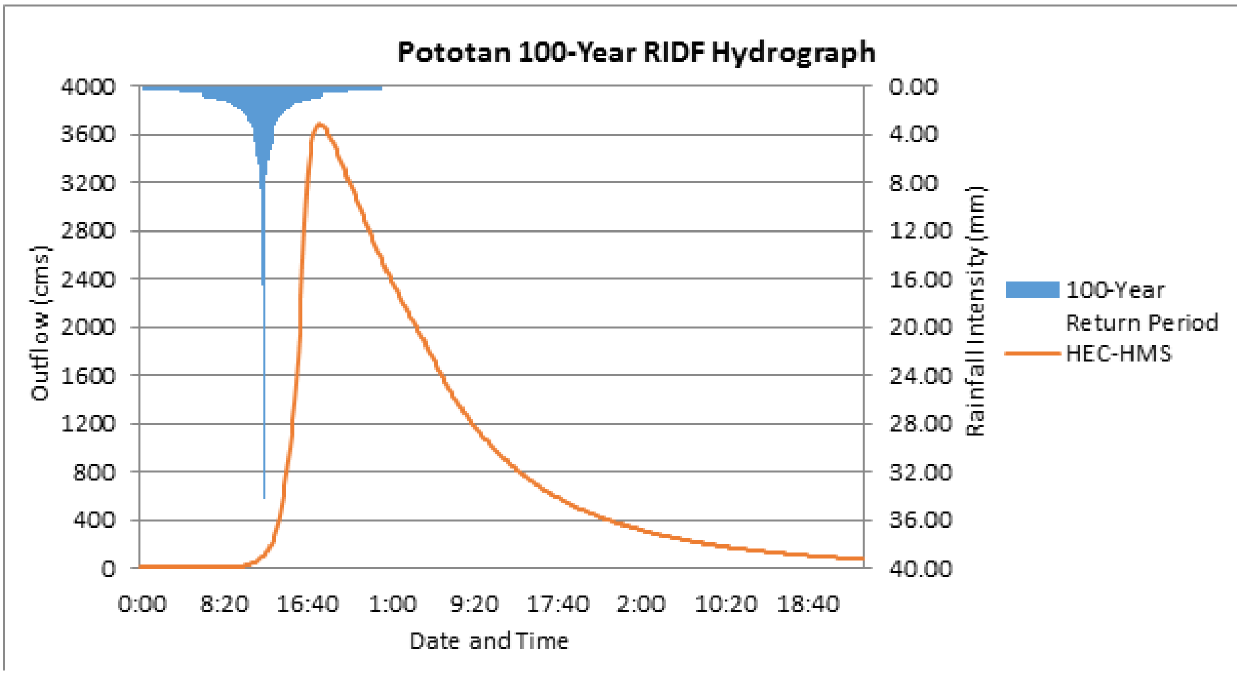


Figure 49. Jalaur - Pototan Outflow hydrograph generated using the Iloilo 100-Year RIDF in HEC-HMS

A summary of the total precipitation, peak rainfall, peak outflow and time to peak of Pototan discharge using the Iloilo Rainfall Intensity-Duration-Frequency curves (RIDF) in five different return periods is shown in Table 4.

Table 4. Summary of Jalaur - Pototan outflow using Iloilo Station Rainfaill Intensity Duration Frequency (RIDF)

RIDF Period	Total Precipitation (mm)	Peak rainfall (mm)	Peak outflow (cms)	Time to Peak
5-Year	147.56	20.63	1776.6	2 hours, 30 minutes
10-Year	175.58	24.35	2279.1	2 hours, 20 minutes
25-Year	207.32	28.45	2860.4	2 hours, 20 minutes
50-Year	229.48	31.30	3270.6	2 hours, 20 minutes
100-Year	251.53	34.16	3682.5	2 hours, 20 minutes

4.2.2 Discharge Data using Dr. Horritt's Recommended Hydrological Method

The river discharge values using Dr. Horritt's recommended hydrological method are shown in Figures 50 to 57.

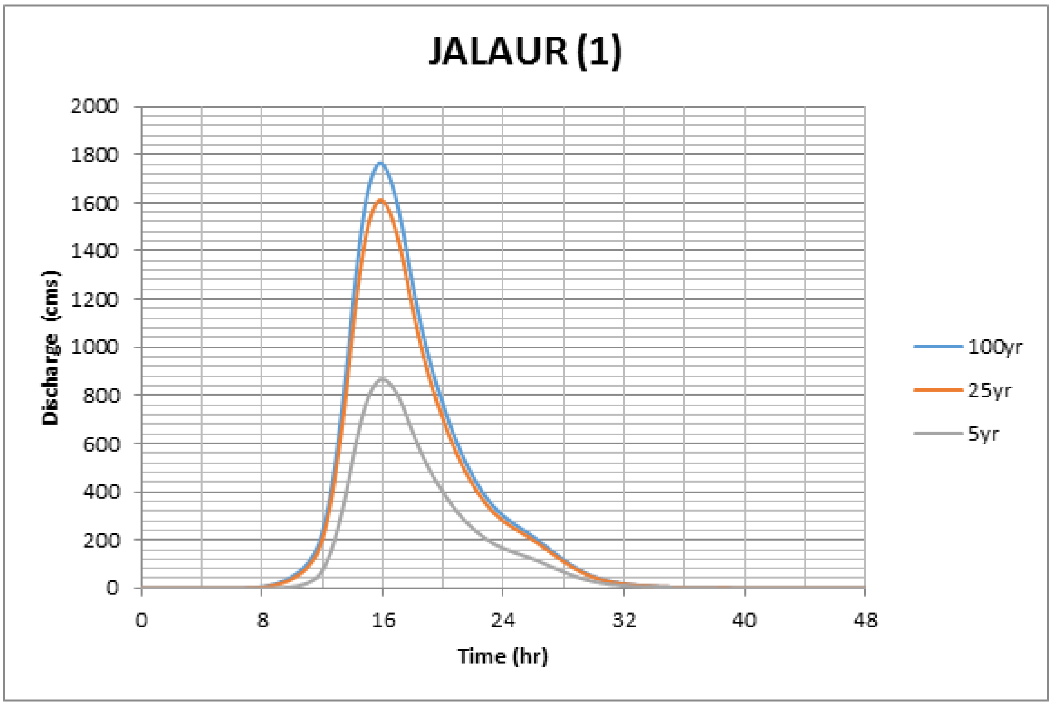


Figure 50. Outflow hydrograph generated for Jalaur (1) using the Iloilo 5-, 25-, 100-Year RIDF in HEC-HMS

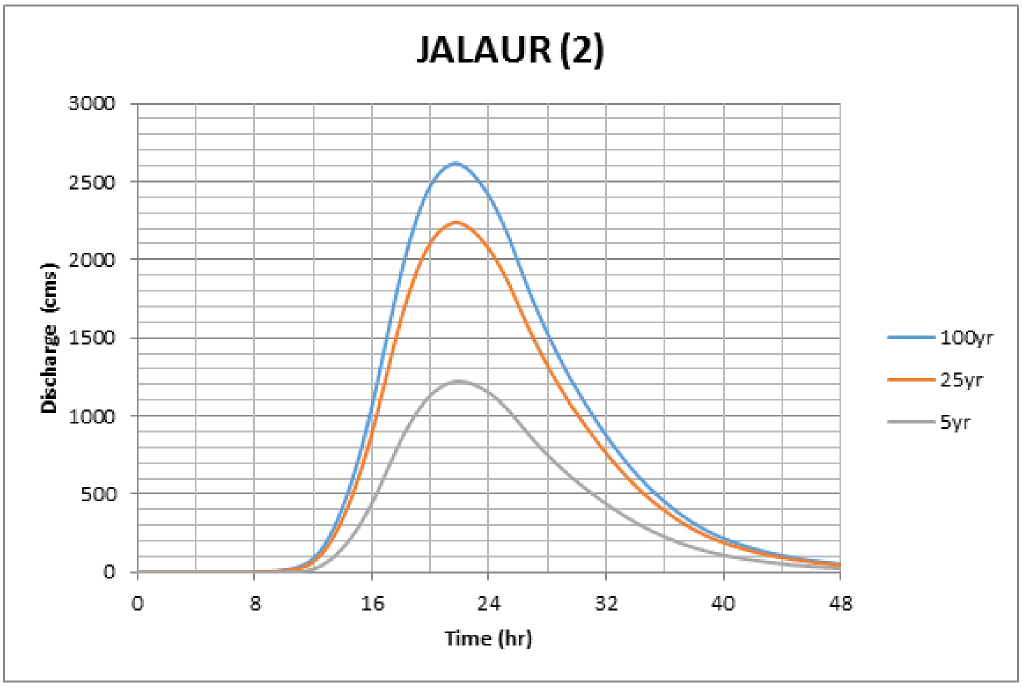


Figure 51. Outflow hydrograph generated for Jalaur (2) using the Iloilo 5-, 25-, 100-Year RIDF in HEC-HMS

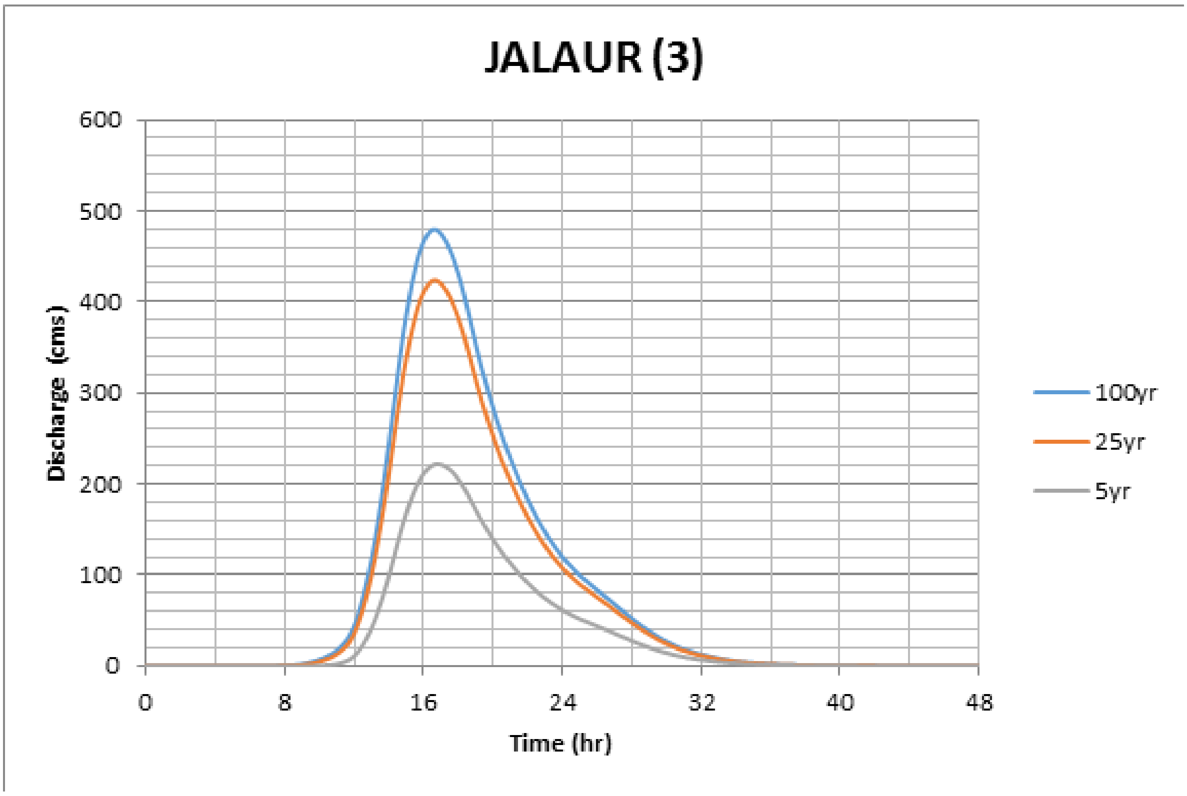


Figure 52. Outflow hydrograph generated for Jalaur (3) using the Iloilo 5-, 25-, 100-Year RIDF in HEC-HMS

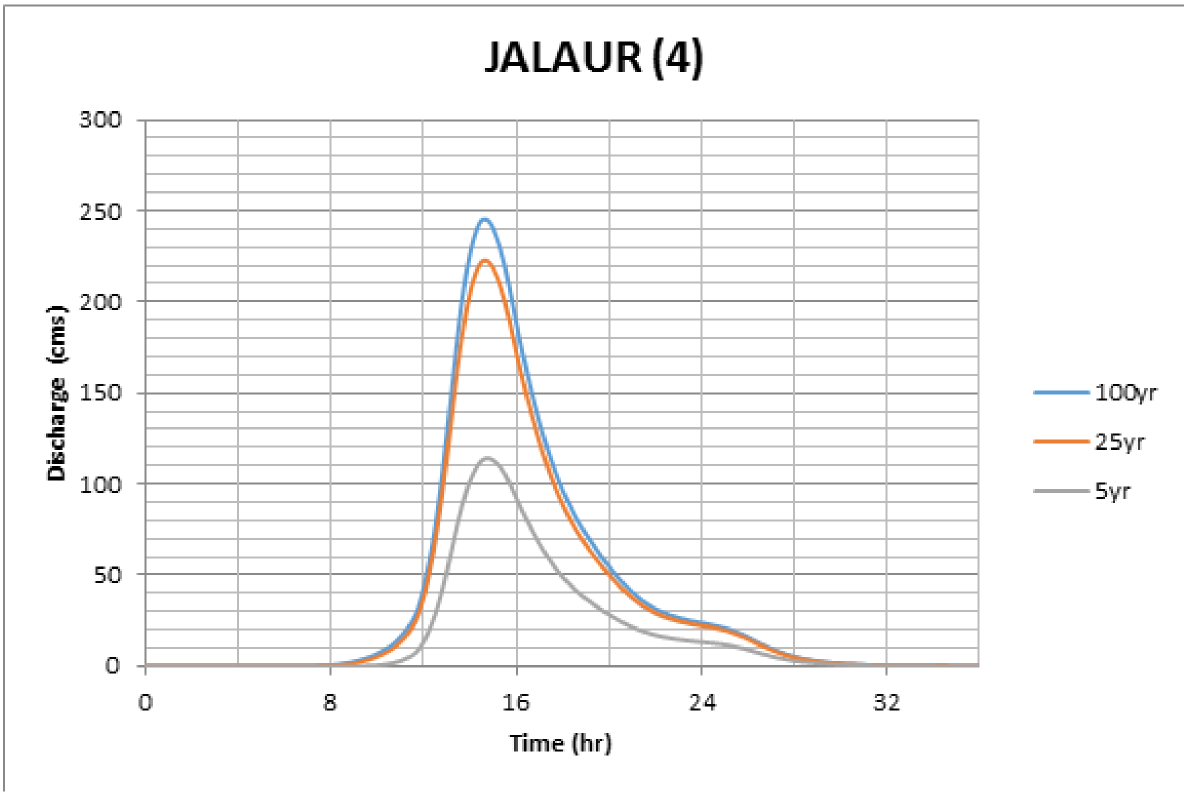


Figure 53. Outflow hydrograph generated for Jalaur (4) using the Iloilo 5-, 25-, 100-Year RIDF in HEC-HMS

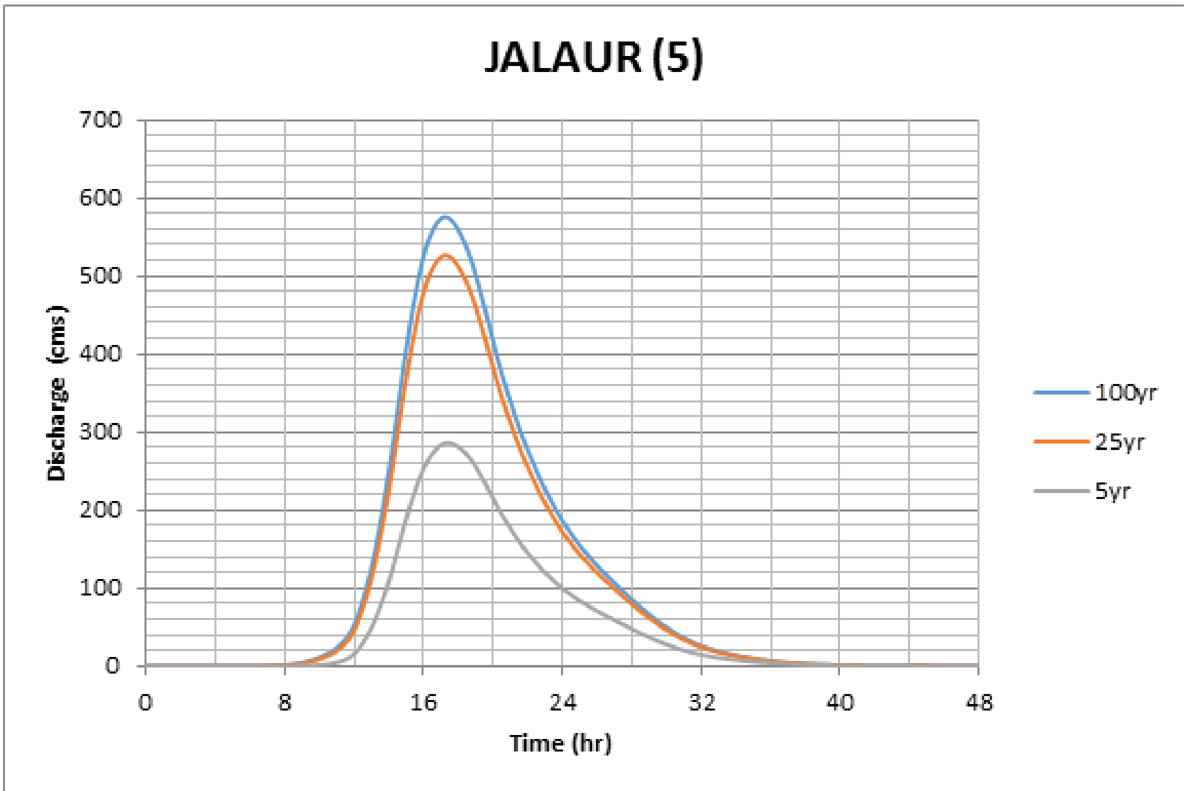


Figure 54. Outflow hydrograph generated for Jalaur (5) using the Iloilo 5-, 25-, 100-Year RIDF in HEC-HMS

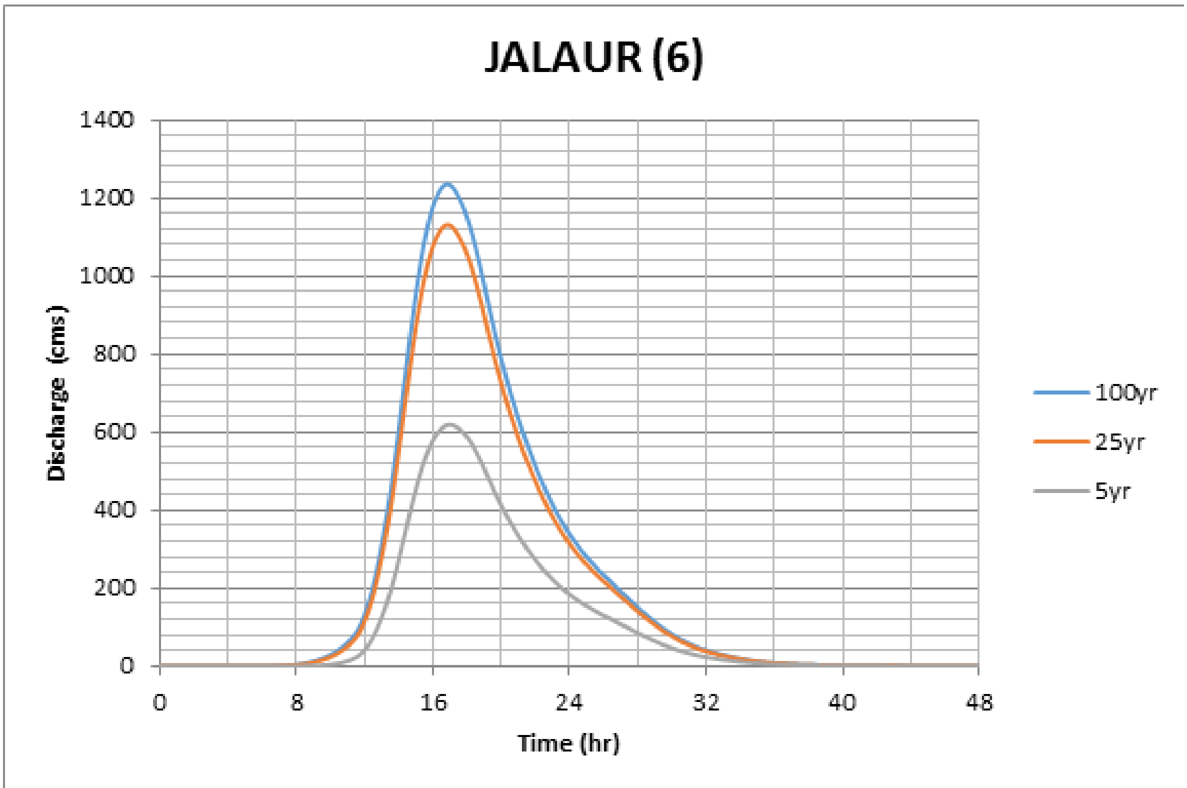


Figure 55. Outflow hydrograph generated for Jalaur (6) using the Iloilo 5-, 25-, 100-Year RIDF in HEC-HMS

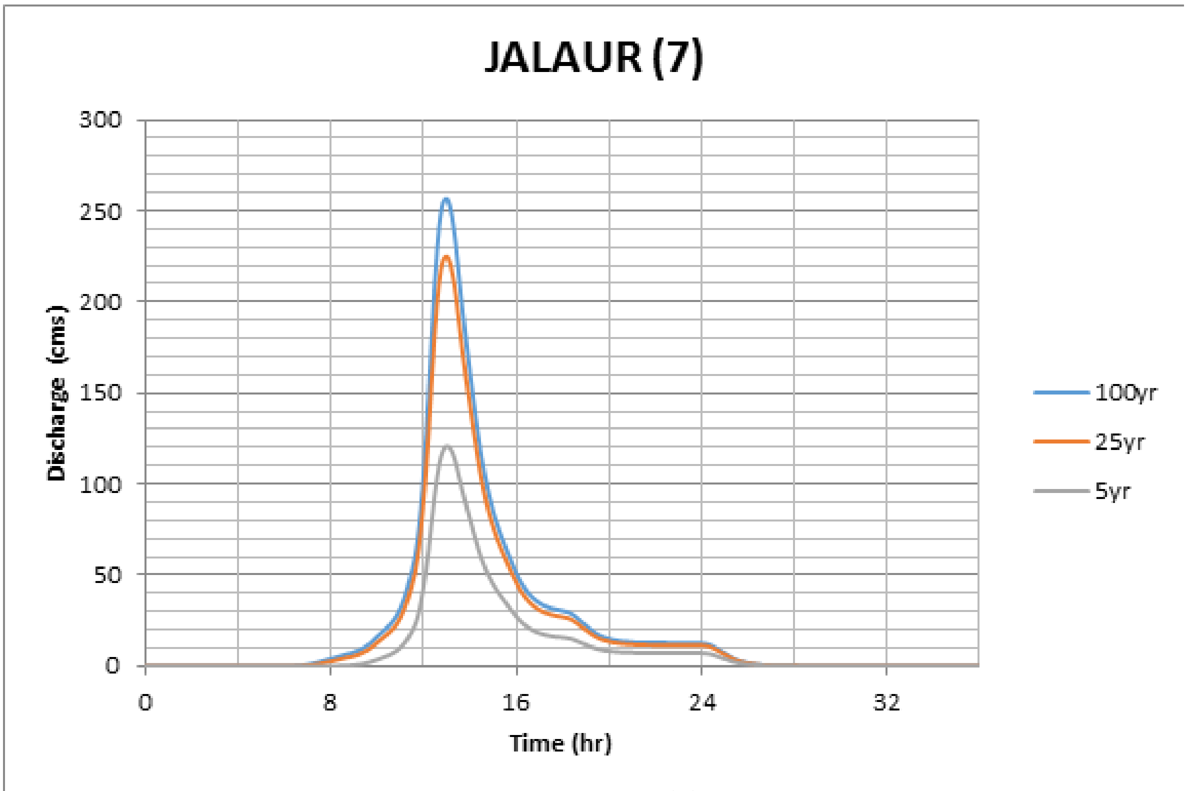


Figure 56. Outflow hydrograph generated for Jalaur (7) using the Iloilo 5-, 25-, 100-Year RIDF in HEC-HMS

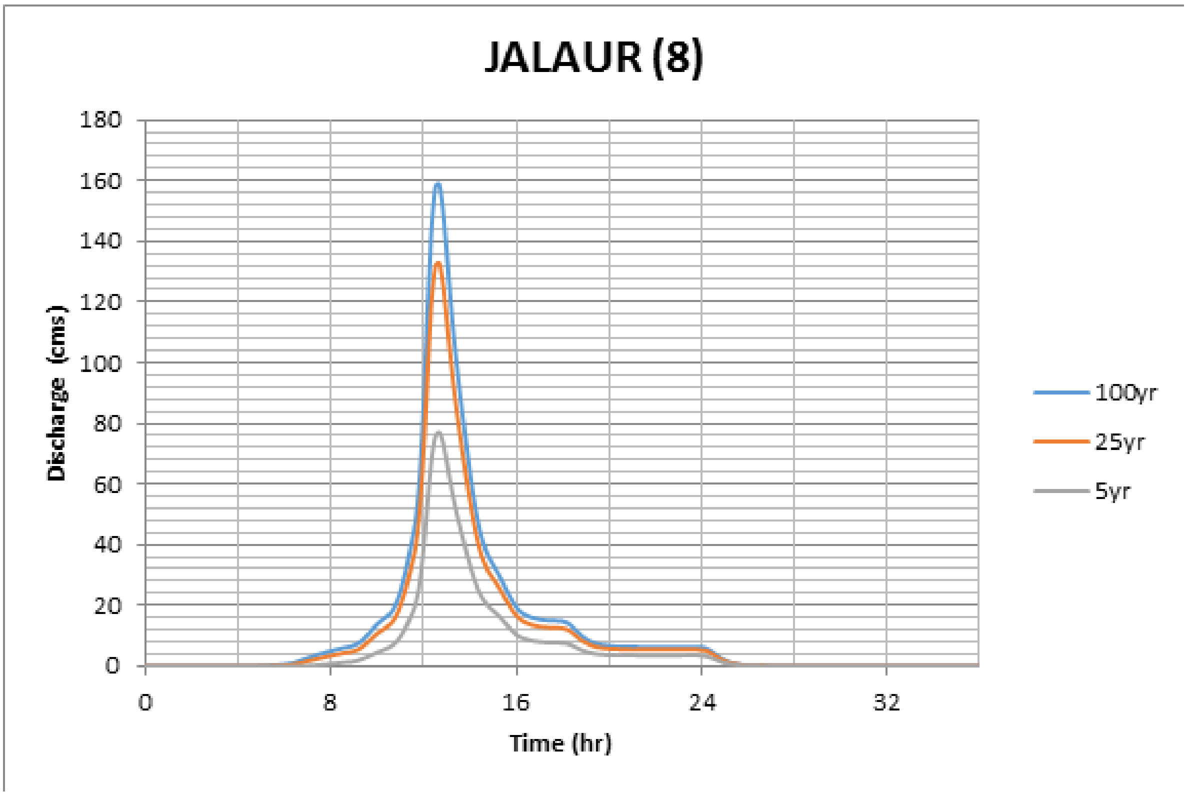


Figure 57. Outflow hydrograph generated for Jalaur (8) using the Iloilo 5-, 25-, 100-Year RIDF in HEC-HMS

Results and Discussion

The peak discharge values are summarized in Tables 5 to 13.

Table 5. Summary of Jalaur river (1) discharge using the recommended hydrological method by Dr. Horritt

RIDF Period	Peak discharge (cms)	Time-to-peak
5-Year	886.8	16 hours
25-Year	1612.0	15 hours, 50 minutes
100-Year	1764.4	15 hours, 50 minutes

Table 6. Summary of Jalaur river (2) discharge using the recommended hydrological method by Dr. Horritt

RIDF Period	Peak discharge (cms)	Time-to-peak
5-Year	1222.9	21 hours, 50 minutes
25-Year	2238.7	21 hours, 40 minutes
100-Year	2616.8	21 hours, 40 minutes

Table 7. Summary of Jalaur river (3) discharge using the recommended hydrological method by Dr. Horritt

RIDF Period	Peak discharge (cms)	Time-to-peak
5-Year	222.0	16 hours, 50 minutes
25-Year	424.0	16 hours, 40 minutes
100-Year	479.7	16 hours, 40 minutes

Table 8. Summary of Jalaur river (4) discharge using the recommended hydrological method by Dr. Horritt

RIDF Period	Peak discharge (cms)	Time-to-peak
5-Year	114.1	14 hours, 50 minutes
25-Year	222.9	14 hours, 40 minutes
100-Year	245.5	14 hours, 40 minutes

Table 9. Summary of Jalaur river (5) discharge using the recommended hydrological method by Dr. Horritt

RIDF Period	Peak discharge (cms)	Time-to-peak
5-Year	222.0	16 hours, 50 minutes
25-Year	424.0	16 hours, 40 minutes
100-Year	479.7	16 hours, 40 minutes

Table 10. Summary of Jalaur river (6) discharge using the recommended hydrological method by Dr. Horritt

RIDF Period	Peak discharge (cms)	Time-to-peak
5-Year	619.2	17 hours
25-Year	1131.5	16 hours, 50 minutes
100-Year	1235.7	16 hours, 50 minutes

Table 11. Summary of Jalaur river (7) discharge using the recommended hydrological method by Dr. Horritt

RIDF Period	Peak discharge (cms)	Time-to-peak
5-Year	120.8	13 hours
25-Year	225.0	13 hours
100-Year	256.7	13 hours

Table 12. Summary of Jalaur river (8) discharge using the recommended hydrological method by Dr. Horritt

RIDF Period	Peak discharge (cms)	Time-to-peak
5-Year	77.1	12 hours, 40 minutes
25-Year	132.9	12 hours, 40 minutes
100-Year	158.9	12 hours, 40 minutes

The comparison of discharge values obtained from HEC-HMS, QMED, and from the bankful discharge method, Qbankful, are shown in Table 13. Using values from the DTM of Jalaur, the bankful discharge for the river was computed.

Table 13. Validation of river discharge estimate using the bankful method

Discharge Point	Qbankful, cms	QMED, cms	Validation
Jalaur (1)	178.59	762.78	Fail
Jalaur (2)	1168.75	1076.15	Pass
Jalaur (3)	176.32	195.36	Pass
Jalaur (4)	128.93	100.41	Pass
Jalaur (5)	190.43	251.68	Pass
Jalaur (6)	425.28	544.90	Pass
Jalaur (7)	122.32	106.30	Pass
Jalaur (8)	74.66	67.85	Pass

Seven out of eight values from the HEC-HMS discharge estimates were able to satisfy the condition for validating the computed discharge using the bankful method. The computed values that passed were used for the particular discharge points that did not have actual discharge data. The actual discharge data were also used for some areas in the floodplain that were modeled. It is recommended, therefore, to use the actual value of the river discharge for higher-accuracy modeling.

4.3 Flood Hazard and Flow Depth Maps

The following images are the hazard and flow depth maps for the 5-, 25-, and 100-year rain return scenarios of the Jalaur river basin.

Flood Hazard Maps and Flow Depth Maps

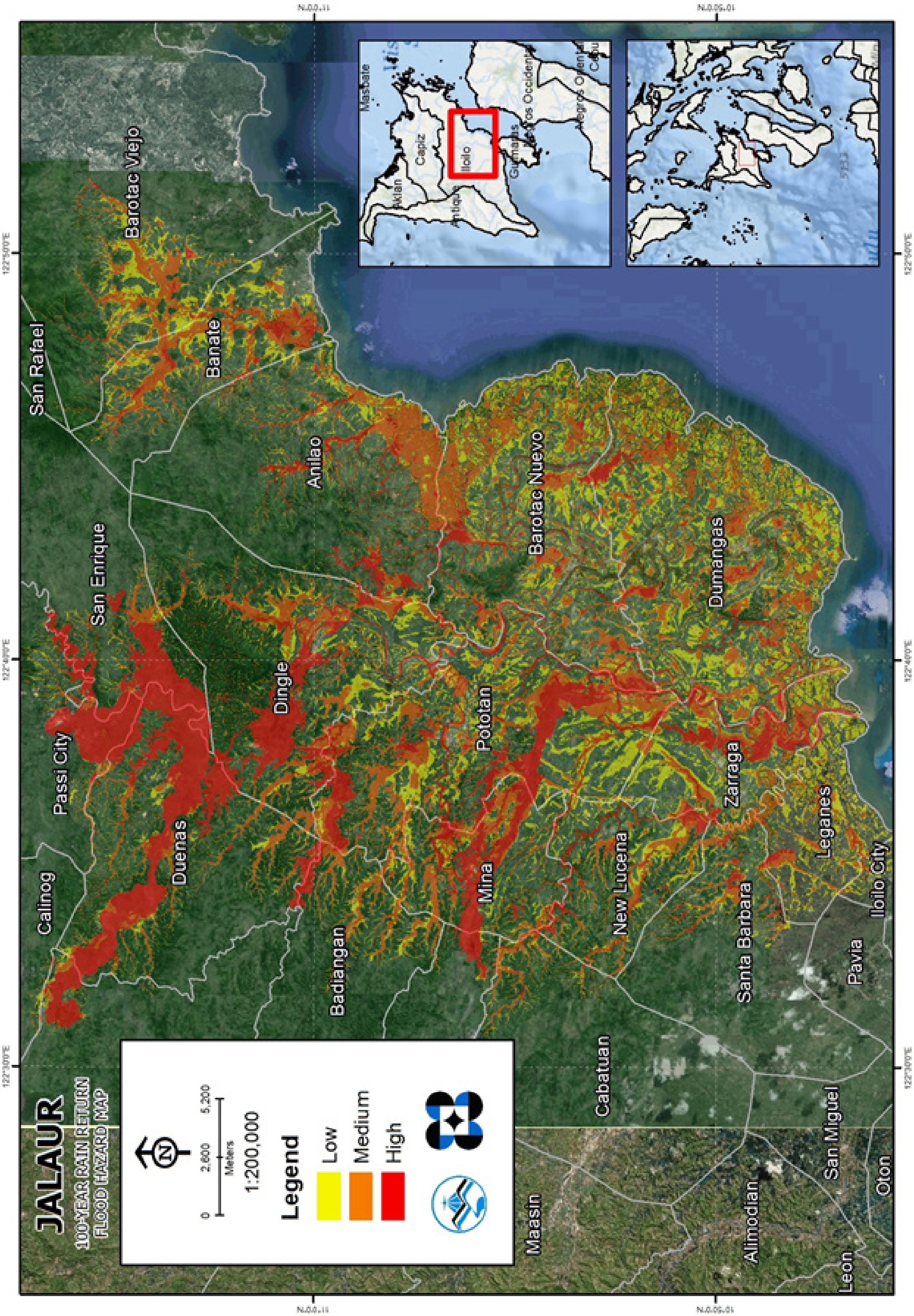


Figure 58. 100-year Flood Hazard Map for Jalaur River Basin

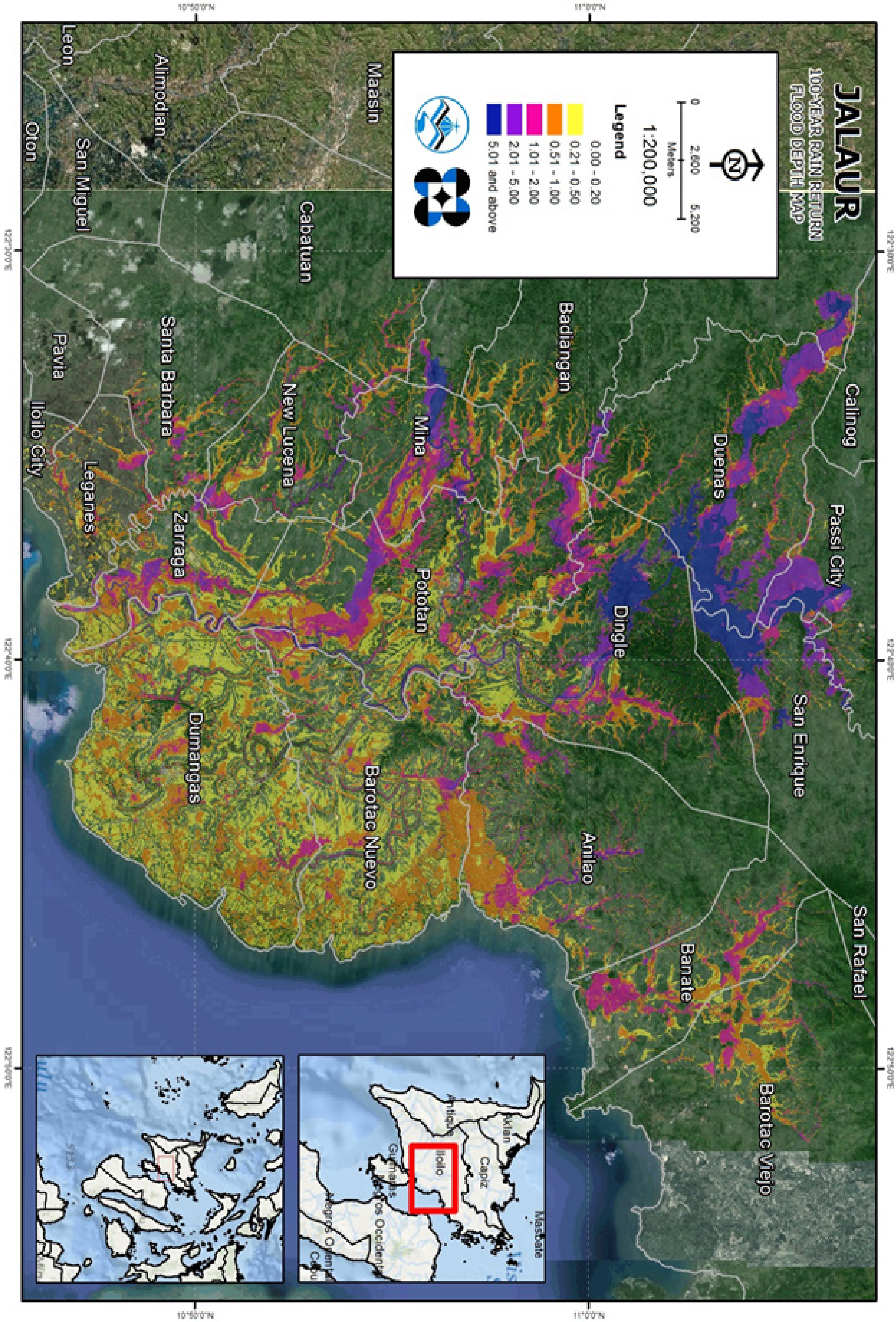


Figure 59. 100-year Flow Depth Map for Jalaur River Basin

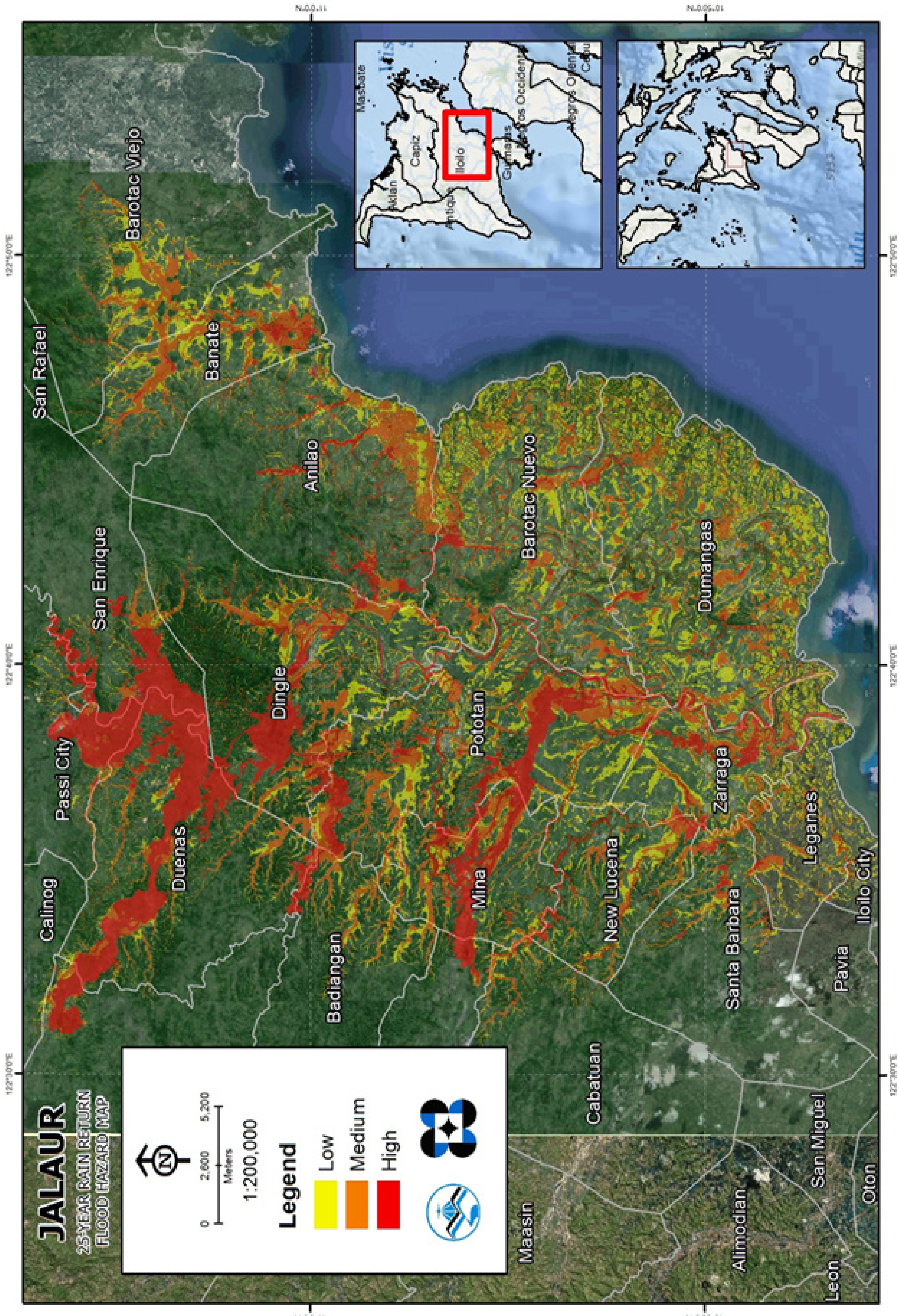


Figure 60. 25-year Flood Hazard Map for Jalaur River Basin

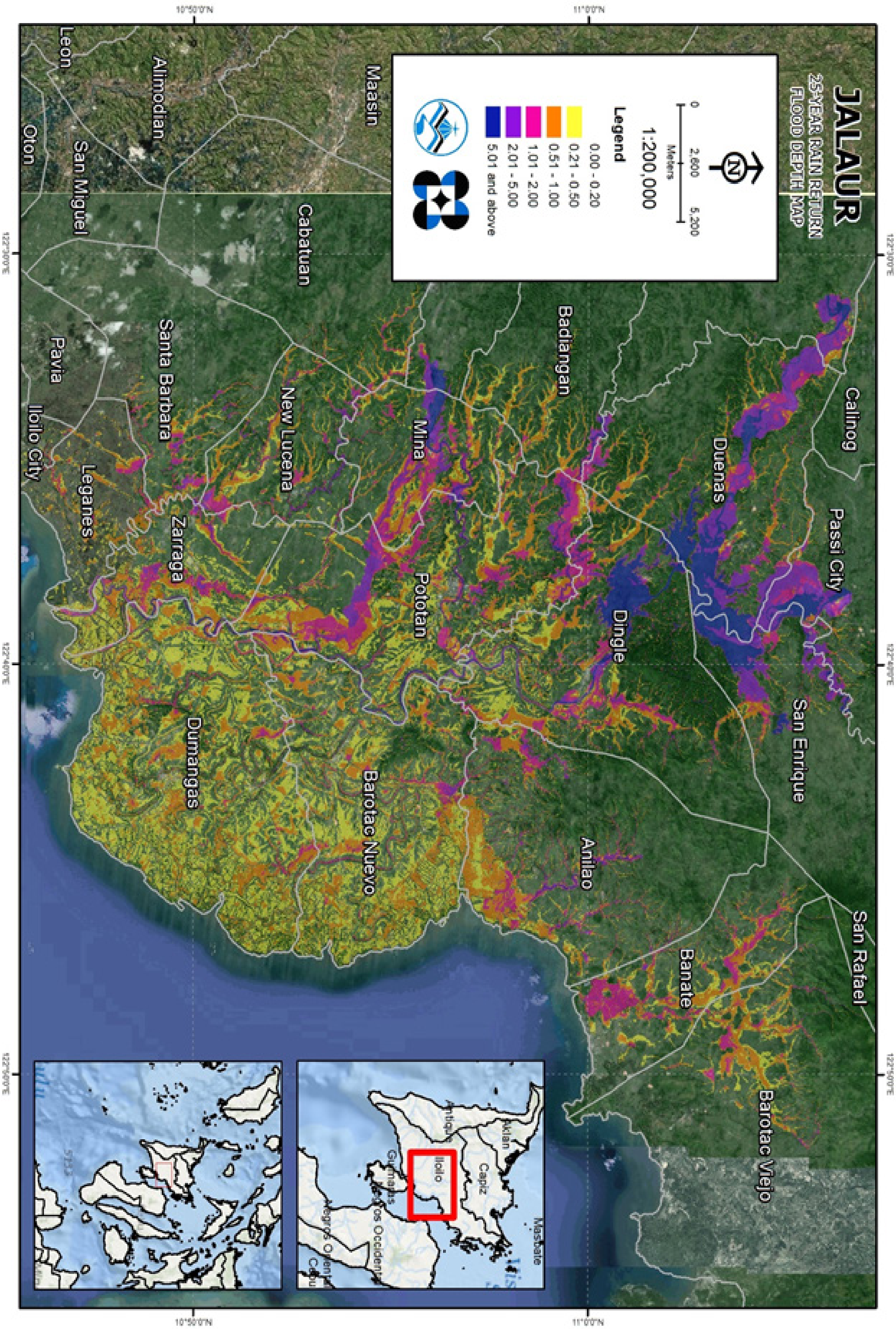


Figure 61. 25-year Flow Depth Map for Jalaur River Basin

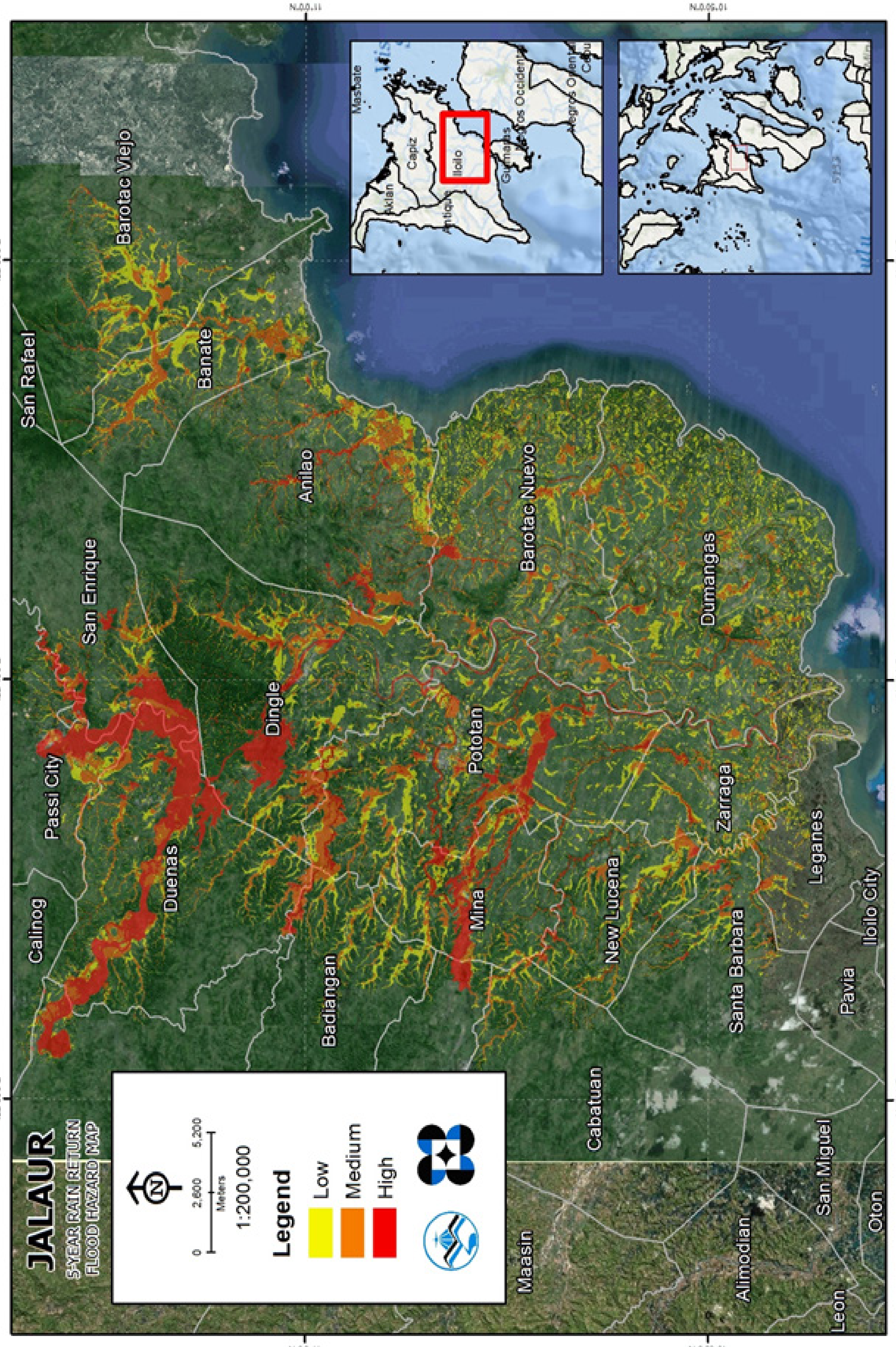


Figure 62. 5-year Flood Hazard Map for Jalaur River Basin

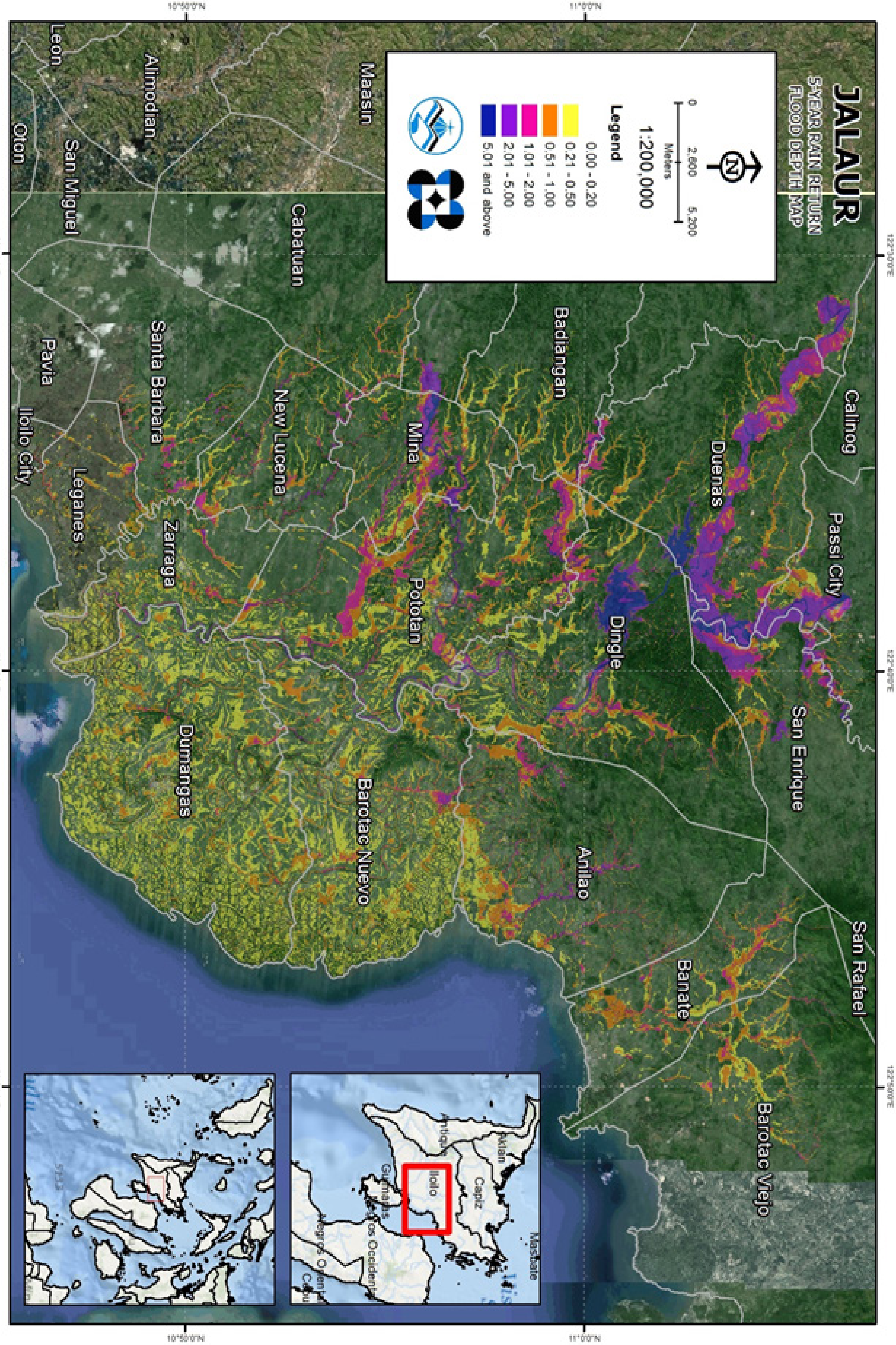


Figure 63. 5-year Flow Depth Map for Jalaur River Basin

Bibliography

- Aquaveo. (2012). Watershed Modeling - HEC HMS Interface. Aquaveo.
- Feldman, A. D. (2000). Hydrologic Modeling System HEC-HMS Technical Reference Manual. Davis, CA: US Army Corps of Engineers - Hydrologic Engineering Center.
- FLO-2D Software, I. Flo-2D Reference Manual. FLO-2D Software, Inc.
- Merwade, V. (2012). Terrain Processing and HMS- Model Development using GeoHMS. Lafayette, Indiana.
- Provincial Profile of the Province of Iloilo, Philippines. (n.d.). Retrieved October 29, 2015, from https://www.scribd.com/doc/33915404/Provincial-Profile-of-the-Province-of-Iloilo-Philippines#scribd
- Santillan, J. (2011). Profile and Cross Section Surveys, Inflow measurement and flood modeling of Surigao River, Surigao City for Flood Hazard Assessment Purposes. Quezon City: Training Center for Applied Geodesy and Photogrammetry (TCAGP).
- Scharffenberg, W. A., & Fleming, M. J. (2010). Hydrologic Modeling System HEC-HMS User's Manual. Davis, California: U.S Army Corps of Engineers - Hydrologic Engineering Center.

Appendix

Appendix A. Passi Model Basin Parameters

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
100B	0.0119	68.103	0	0.76	4.64925	Discharge	0.07624	0.9	Ratio to Peak	0
101B	0.0039	86.687	0	0.54	3.3	Discharge	0.02954	0.9	Ratio to Peak	0
102B	0.00106	95.979	0	0.43	2.62725	Discharge	0.0282	0.9	Ratio to Peak	0
103B	0.00095	96.393	0	2.37	14.4953	Discharge	0.1834	0.9	Ratio to Peak	0
104B	0.0098	72.1625	0	1.062	6.4995	Discharge	0.09567	0.9	Ratio to Peak	0
105B	0.00256	90.85	0	0.54	3.30375	Discharge	0.02898	0.9	Ratio to Peak	0
106B	0.04683	35.167	0	0.822	5.031	Discharge	0.07117	0.9	Ratio to Peak	0
10B	0.00436	89.7345	0	0.24666	3.402	Discharge	0.07007	0.882	Ratio to Peak	0
11B	0.0016	95.979	0	1.428	8.73225	Discharge	0.16315	0.6	Ratio to Peak	0
12B	0.00493	88.55	0	0.148	2.02838	Discharge	0.03036	0.6	Ratio to Peak	0
13B	0.00294	92.8395	0	0.25284	2.37488	Discharge	0.0324	0.882	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
14B	0.0033	88.55	0	0.18133	1.6302	Discharge	0.03943	0.6	Ratio to Peak	0
15B	0.002	95.013	0	0.5437	3.33375	Discharge	0.14518	0.6	Ratio to Peak	0
16B	0.00331	92	0	0.07333	1.01025	Discharge	0.00987	0.6	Ratio to Peak	0
17B	0.00491	88.5845	0	1.164	7.11675	Discharge	0.49291	0.6	Ratio to Peak	0
18B	0.00618	80.5	0	0.13867	1.90238	Discharge	0.02567	0.8953	Ratio to Peak	0
19B	0.00293	89.7	0	0.17248	1.05968	Discharge	0.01649	1	Ratio to Peak	0
1B	0.00528	82.8	0	0.17	1.038	Discharge	0.01811	0.9	Ratio to Peak	0
20B	0.00286	93.0235	0	0.16933	2.32875	Discharge	0.0222	0.9201	Ratio to Peak	0
21B	0.0009	96.6	0	0.20134	2.77313	Discharge	0.02544	1	Ratio to Peak	0
22B	0.00151	96.186	0	0.89844	8.196	Discharge	0.12549	0.6	Ratio to Peak	0
23B	0.00451	89.424	0	0.795	3.25493	Discharge	0.09852	0.6	Ratio to Peak	0
24B	0.0035	87.9405	0	0.232	3.20063	Discharge	0.03223	0.6	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
24B	0.0035	87.9405	0	0.232	3.20063	Discharge	0.03223	0.6	Ratio to Peak	0
25B	0.0039	90.7235	0	0.2	1.83975	Discharge	0.02147	1	Ratio to Peak	0
26B	0.0015	94.4495	0	0.27832	1.74075	Discharge	0.02223	1	Ratio to Peak	0
27B	0.00143	96.3815	0	2.628	16.0808	Discharge	0.38497	1	Ratio to Peak	0
28B	0.0009	96.6	0	0.196	1.80278	Discharge	0.03051	0.6	Ratio to Peak	0
29B	0.00493	88.55	0	0.39382	2.4375	Discharge	0.13598	1	Ratio to Peak	0
2B	0.0018	93.3685	0	0.254	1.55025	Discharge	0.04996	0.9	Ratio to Peak	0
30B	0.00169	93.8055	0	0.945	3.86625	Discharge	0.08822	0.6	Ratio to Peak	0
31B	0.00101	96.1745	0	0.681	4.158	Discharge	0.04344	0.6	Ratio to Peak	0
32B	0.00188	93.15	0	0.15467	2.13188	Discharge	0.03698	0.92254	Ratio to Peak	0
33B	0.00437	85.3645	0	0.24934	2.29628	Discharge	0.02687	0.6	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
34B	0.00217	92.161	0	0.48804	3.06008	Discharge	0.07806	0.91242	Ratio to Peak	0
35B	0.00286	89.9185	0	0.4579	3.1245	Discharge	0.07161	0.90698	Ratio to Peak	0
36B	0.00196	92.8855	0	0.49252	3.04718	Discharge	0.13738	0.6	Ratio to Peak	0
37B	0.0033	88.55	0	0.29	1.77495	Discharge	0.11203	1	Ratio to Peak	0
38B	0.00222	92	0	0.58068	5.36288	Discharge	0.08532	1	Ratio to Peak	0
39B	0.00152	96.163	0	0.26534	2.43915	Discharge	0.02917	0.6	Ratio to Peak	0
3B	0.0028	90.0565	0	0.17	1.0365	Discharge	0.04159	0.9	Ratio to Peak	0
40B	0.00467	89.0905	0	0.82484	7.65675	Discharge	0.04127	1	Ratio to Peak	0
41B	0.00529	82.823	0	0.62508	5.73638	Discharge	0.09773	0.6	Ratio to Peak	0
42B	0.00474	84.3295	0	0.651	2.6652	Discharge	0.02701	0.6	Ratio to Peak	0
43B	0.00181	93.3915	0	1.07296	9.7935	Discharge	0.32319	1	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
44B	0.00468	89.056	0	0.37596	2.0955	Discharge	0.03357	0.6	Ratio to Peak	0
45B	0.0033	88.55	0	0.16856	1.05885	Discharge	0.01494	1	Ratio to Peak	0
46B	0.00378	90.965	0	0.41784	2.61525	Discharge	0.13567	0.6	Ratio to Peak	0
47B	0.00493	88.55	0	0.2737	1.674	Discharge	0.06237	0.9	Ratio to Peak	0
48B	0.00493	88.55	0	0.15041	0.91575	Discharge	0.04066	0.8957	Ratio to Peak	0
49B	0.00493	88.55	0	0.234	2.1465	Discharge	0.10056	1	Ratio to Peak	0
4B	0.01144	68.954	0	0.222	1.362	Discharge	0.05462	0.9	Ratio to Peak	0
50B	0.00493	88.55	0	0.2254	2.10375	Discharge	0.12316	1	Ratio to Peak	0
51B	0.00325	88.688	0	0.192	1.75613	Discharge	0.07362	0.92643	Ratio to Peak	0
52B	0.00315	88.987	0	0.186	1.13303	Discharge	0.05992	0.94414	Ratio to Peak	0
53B	0.00493	88.55	0	0.142	1.30388	Discharge	0.04051	0.6	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
54B	0.00295	89.631	0	0.154	0.93008	Discharge	0.03596	0.891	Ratio to Peak	0
55B	0.0033	88.55	0	0.128	1.177875	Discharge	0.055448	1	Ratio to Peak	0
56B	0.003051	89.3205	0	0.116	1.06425	Discharge	0.045126	1	Ratio to Peak	0
57B	0.002815	90.0335	0	0.1	0.615105	Discharge	0.030849	1	Ratio to Peak	0
58B	0.004372	85.353	0	0.77478	7.099875	Discharge	0.07692	0.93614	Ratio to Peak	0
59B	0.004471	85.031	0	0.496	3.02925	Discharge	0.078413	0.9	Ratio to Peak	0
5B	0.002054	92.5175	0	2.602	15.9255	Discharge	0.89549	0.9	Ratio to Peak	0
60B	0.001848	93.219	0	0.61	3.726	Discharge	0.064932	0.9	Ratio to Peak	0
61B	0.003121	89.056	0	0.692	4.2285	Discharge	0.066963	0.9	Ratio to Peak	0
62B	0.000894	96.6	0	0.414	2.53575	Discharge	0.035409	0.9	Ratio to Peak	0
63B	0.005872	81.2245	0	0.866	5.2965	Discharge	0.11436	0.9	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
64B	0.001156	95.6455	0	0.882	5.391	Discharge	0.077492	0.9	Ratio to Peak	0
65B	0.000894	96.6	0	0.244	1.4895	Discharge	0.020586	0.9	Ratio to Peak	0
66B	0.002895	89.769	0	0.664	4.06725	Discharge	0.11007	0.9	Ratio to Peak	0
67B	0.003352	88.343	0	0.312	1.90725	Discharge	0.044885	0.9	Ratio to Peak	0
68B	0.002576	90.7925	0	2.004	12.25575	Discharge	1.4288	0.9	Ratio to Peak	0
69B	0.003019	89.378	0	0.498	3.0495	Discharge	0.17848	0.9	Ratio to Peak	0
6B	0.003624	87.515	0	0.308	1.87875	Discharge	0.067593	0.9	Ratio to Peak	0
70B	0.002665	90.505	0	1.644	10.065	Discharge	0.21782	0.9	Ratio to Peak	0
71B	0.001004	96.1975	0	1.746	10.6845	Discharge	0.75852	0.9	Ratio to Peak	0
72B	0.00247	91.1375	0	0.27	1.65075	Discharge	0.04098	0.9	Ratio to Peak	0
73B	0.005137	83.1795	0	0.576	3.525	Discharge	0.038303	0.9	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
74B	0.000894	96.6	0	0.234	1.43175	Discharge	0.016225	0.9	Ratio to Peak	0
75B	0.001017	96.1515	0	0.528	3.2295	Discharge	0.060463	0.9	Ratio to Peak	0
76B	0.001638	93.9435	0	0.234	1.43175	Discharge	0.031123	0.9	Ratio to Peak	0
77B	0.001188	95.5305	0	1.03	6.3075	Discharge	0.20032	0.9	Ratio to Peak	0
78B	0.003296	88.5155	0	0.322	1.96575	Discharge	0.060861	0.9	Ratio to Peak	0
79B	0.000894	96.6	0	0.43	2.6265	Discharge	0.029788	0.9	Ratio to Peak	0
7B	0.002143	92.2185	0	0.54	3.3075	Discharge	0.24864	0.9	Ratio to Peak	0
80B	0.001014	96.163	0	0.218	1.33425	Discharge	0.051111	0.9	Ratio to Peak	0
81B	0.005137	83.1795	0	0.698	4.27125	Discharge	0.054851	0.9	Ratio to Peak	0
82B	0.003074	89.2055	0	0.682	4.17525	Discharge	0.043965	0.9	Ratio to Peak	0
63B	0.005872	81.2245	0	0.866	5.2965	Discharge	0.11436	0.9	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
83B	0.005137	83.1795	0	0.252	1.542	Discharge	0.023048	0.9	Ratio to Peak	0
84B	0.001714	93.679	0	1.242	7.60125	Discharge	0.14747	0.9	Ratio to Peak	0
85B	0.001398	94.783	0	0.36	2.2005	Discharge	0.03783	0.9	Ratio to Peak	0
86B	0.003074	89.2055	0	0.266	1.62375	Discharge	0.014293	0.9	Ratio to Peak	0
87B	0.001598	94.0815	0	0.94	5.7465	Discharge	0.093459	0.9	Ratio to Peak	0
88B	0.00661	79.35	0	0.422	2.5785	Discharge	0.028105	0.9	Ratio to Peak	0
89B	0.006027	80.822	0	0.96	5.868	Discharge	0.17364	0.9	Ratio to Peak	0
8B	0.005217	82.961	0	0.322	1.974	Discharge	0.029456	0.9	Ratio to Peak	0
90B	0.00661	79.35	0	0.366	2.24475	Discharge	0.024698	0.9	Ratio to Peak	0
91B	0.005234	82.915	0	0.712	4.35825	Discharge	0.12137	0.9	Ratio to Peak	0
92B	0.002309	91.6665	0	0.222	1.36125	Discharge	0.01872	0.9	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
93B	0.004049	86.25	0	0.708	4.32825	Discharge	0.042713	0.9	Ratio to Peak	0
94B	0.005311	82.708	0	0.574	3.5085	Discharge	0.028511	0.9	Ratio to Peak	0
95B	0.006518	79.58	0	0.868	5.3085	Discharge	0.061532	0.9	Ratio to Peak	0
96B	0.005103	83.2715	0	0.498	3.0525	Discharge	0.063124	0.9	Ratio to Peak	0
97B	0.006802	78.8785	0	1.56	9.5475	Discharge	0.12381	0.9	Ratio to Peak	0
98B	0.003792	87.009	0	0.694	4.24875	Discharge	0.080319	0.9	Ratio to Peak	0
99B	0.007522	77.1535	0	0.924	5.65125	Discharge	0.11223	0.9	Ratio to Peak	0
9B	0.002126	94.714	0	1.341	8.2035	Discharge	0.16797	0.9	Ratio to Peak	0

Appendix B. Passi Model Reach Parameters

Reach Number	Muskingum Cunge Channel Routing						
	Time Step Method	Length (m)	Slope	Manning's n	Shape	Width	Side Slope
109R	Automatic Fixed Interval	4738.056	0.003	0.0017062	Trapezoid	30	45
110R	Automatic Fixed Interval	26551.269	0.0015	0.0025593	Trapezoid	30	45
111R	Automatic Fixed Interval	7994.567	0.0101	0.0025593	Trapezoid	30	45
112R	Automatic Fixed Interval	3626.647	0.0185	0.0017145	Trapezoid	30	45
113R	Automatic Fixed Interval	7713.032	0.0053	0.0025593	Trapezoid	30	45
114R	Automatic Fixed Interval	9964.059	0.0019	0.0017146	Trapezoid	30	45
115R	Automatic Fixed Interval	9612.855	0.0047	0.0017144	Trapezoid	30	45
116R	Automatic Fixed Interval	10050.091	0.0067	0.0025593	Trapezoid	30	45
117R	Automatic Fixed Interval	9909.222	0.0058	0.0017114	Trapezoid	30	45
118R	Automatic Fixed Interval	8450.355	0.0073	0.0017133	Trapezoid	30	45
119R	Automatic Fixed Interval	16897.122	0.0021	0.0017144	Trapezoid	30	45
120R	Automatic Fixed Interval	1638.963	0.0059	0.0016947	Trapezoid	30	45
121R	Automatic Fixed Interval	4272.25	0.003	0.0017145	Trapezoid	30	45
122R	Automatic Fixed Interval	1202.841	0.0039	0.0025593	Trapezoid	30	45
123R	Automatic Fixed Interval	4727.405	0.0066	0.0017121	Trapezoid	30	45
124R	Automatic Fixed Interval	17988.419	0.0082	0.0017062	Trapezoid	30	45
125R	Automatic Fixed Interval	5209.987	0.0121	0.001695	Trapezoid	30	45
126R	Automatic Fixed Interval	12309.822	0.0022	0.0017148	Trapezoid	30	45
127R	Automatic Fixed Interval	12972.598	0.0008	0.0025593	Trapezoid	30	45
128R	Automatic Fixed Interval	2483.424	0.0221	0.0017126	Trapezoid	30	45
129R	Automatic Fixed Interval	8681.725	0.008	0.0016359	Trapezoid	30	45
130R	Automatic Fixed Interval	2539.874	0.0219	0.0017142	Trapezoid	30	45
131R	Automatic Fixed Interval	6781.346	0.0027	0.0017144	Trapezoid	30	45
132R	Automatic Fixed Interval	6917.956	0.0026	0.0025593	Trapezoid	30	45
133R	Automatic Fixed Interval	10038.428	0.0024	0.0025593	Trapezoid	30	45
134R	Automatic Fixed Interval	2277.381	0.0058	0.0017094	Trapezoid	30	45
135R	Automatic Fixed Interval	8098.235	0.0036	0.0025593	Trapezoid	30	45
136R	Automatic Fixed Interval	12943.705	0.0022	0.0025593	Trapezoid	30	45
137R	Automatic Fixed Interval	14593.769	0.0104	0.0025593	Trapezoid	30	45
138R	Automatic Fixed Interval	11961.2	0.0006	0.0017145	Trapezoid	30	45
139R	Automatic Fixed Interval	3776.888	0.0043	0.0025593	Trapezoid	30	45
140R	Automatic Fixed Interval	11012.45	0.0036	0.0016558	Trapezoid	30	45
141R	Automatic Fixed Interval	9332.312	0.0029	0.0017139	Trapezoid	30	45
142R	Automatic Fixed Interval	12266.584	0.0011	0.0017145	Trapezoid	30	45
143R	Automatic Fixed Interval	17132.163	0.0049	0.0017142	Trapezoid	30	45
144R	Automatic Fixed Interval	15269.244	0.0004	0.0017132	Trapezoid	30	45
145R	Automatic Fixed Interval	16410.058	0.0214	0.0017062	Trapezoid	30	45

Reach Number	Muskingum Cunge Channel Routing						
	Time Step Method	Length (m)	Slope	Manning's n	Shape	Width	Side Slope
146R	Automatic Fixed Interval	11068.467	0.0046	0.0025593	Trapezoid	30	45
147R	Automatic Fixed Interval	9136.847	0.0027	0.0025593	Trapezoid	30	45
148R	Automatic Fixed Interval	7395.993	0.0028	0.0025593	Trapezoid	30	45
149R	Automatic Fixed Interval	17932.313	0.0027	0.0017146	Trapezoid	30	45
150R	Automatic Fixed Interval	8662.919	0.0029	0.0025593	Trapezoid	30	45
151R	Automatic Fixed Interval	4632.342	0.0022	0.0017146	Trapezoid	30	45
152R	Automatic Fixed Interval	14659.084	0.0037	0.0016722	Trapezoid	30	45
153R	Automatic Fixed Interval	39202.066	0.0035	0.0016722	Trapezoid	30	45
154R	Automatic Fixed Interval	1849.783	0.0091	0.0016722	Trapezoid	30	45
155R	Automatic Fixed Interval	6816.891	0.0125	0.0011375	Trapezoid	30	45
156R	Automatic Fixed Interval	9937.08	0.0284	0.0011375	Trapezoid	30	45
157R	Automatic Fixed Interval	18932.083	0.0114	0.0019622	Trapezoid	30	45
158R	Automatic Fixed Interval	13842.2	0.0192	0.0017062	Trapezoid	30	45
159R	Automatic Fixed Interval	7886.687	0.029	0.0016929	Trapezoid	30	45
160R	Automatic Fixed Interval	8707.205	0.0163	0.0017062	Trapezoid	30	45
161R	Automatic Fixed Interval	5110.394	0.0346	0.0017062	Trapezoid	30	45
162R	Automatic Fixed Interval	4717.295	0.0383	0.0017062	Trapezoid	30	45
163R	Automatic Fixed Interval	5093.76	0.0935	0.0017062	Trapezoid	30	45
164R	Automatic Fixed Interval	14024.915	0.071	0.0017062	Trapezoid	30	45
165R	Automatic Fixed Interval	6433.638	0.1227	0.0017062	Trapezoid	30	45
166R	Automatic Fixed Interval	21202.676	0.002	0.0017062	Trapezoid	30	45
167R	Automatic Fixed Interval	10491.552	0.0042	0.0017062	Trapezoid	30	45
168R	Automatic Fixed Interval	22077.652	0.0049	0.0017062	Trapezoid	30	45
169R	Automatic Fixed Interval	6201.287	0.0023	0.0017062	Trapezoid	30	45
170R	Automatic Fixed Interval	5611.657	0.0061	0.0017062	Trapezoid	30	45
171R	Automatic Fixed Interval	13593.247	0.0012	0.0017062	Trapezoid	30	45
172R	Automatic Fixed Interval	10994.757	0.0039	0.0017062	Trapezoid	30	45
173R	Automatic Fixed Interval	6089.752	0.0092	0.0017062	Trapezoid	30	45
174R	Automatic Fixed Interval	38818.997	0.0023	0.0017062	Trapezoid	30	45
175R	Automatic Fixed Interval	11967.67	0.0023	0.0017062	Trapezoid	30	45
176R	Automatic Fixed Interval	33724.319	0.0016	0.0017062	Trapezoid	30	45
177R	Automatic Fixed Interval	9921.905	0.0035	0.0017062	Trapezoid	30	45
178R	Automatic Fixed Interval	10624.016	0.004	0.0017062	Trapezoid	30	45
179R	Automatic Fixed Interval	17875.02	0.0028	0.0017062	Trapezoid	30	45
180R	Automatic Fixed Interval	6125.88	0.0092	0.0017062	Trapezoid	30	45
181R	Automatic Fixed Interval	7863.916	0.0035	0.0017062	Trapezoid	30	45
182R	Automatic Fixed Interval	9382.672	0.0034	0.0017062	Trapezoid	30	45

Appendix

Reach Number	Muskingum Cunge Channel Routing						
	Time Step Method	Length (m)	Slope	Manning's n	Shape	Width	Side Slope
183R	Automatic Fixed Interval	16679.64	0.0045	0.0017062	Trapezoid	30	45
184R	Automatic Fixed Interval	6892.166	0.0134	0.0017062	Trapezoid	30	45
185R	Automatic Fixed Interval	12529.607	0.0034	0.0017062	Trapezoid	30	45
186R	Automatic Fixed Interval	5008.874	0.0028	0.0017062	Trapezoid	30	45
187R	Automatic Fixed Interval	10544.56	0.0013	0.0017062	Trapezoid	30	45
188R	Automatic Fixed Interval	9066.739	0.0068	0.0017062	Trapezoid	30	45
189R	Automatic Fixed Interval	5332.492	0.0048	0.0017062	Trapezoid	30	45
190R	Automatic Fixed Interval	3231.549	0.0118	0.0017062	Trapezoid	30	45
191R	Automatic Fixed Interval	7291.762	0.0062	0.0017062	Trapezoid	30	45
192R	Automatic Fixed Interval	3949.681	0.0047	0.0017062	Trapezoid	30	45
193R	Automatic Fixed Interval	7045.156	0.0042	0.0017062	Trapezoid	30	45
194R	Automatic Fixed Interval	2354.332	0.0054	0.0017062	Trapezoid	30	45
195R	Automatic Fixed Interval	20171.876	0.0022	0.0017062	Trapezoid	30	45
196R	Automatic Fixed Interval	12846.652	0.0006	0.0017062	Trapezoid	30	45
197R	Automatic Fixed Interval	7325.884	0.0031	0.0017062	Trapezoid	30	45
198R	Automatic Fixed Interval	17222.837	0.0015	0.0017062	Trapezoid	30	45
199R	Automatic Fixed Interval	8514.862	0.0032	0.0017062	Trapezoid	30	45
200R	Automatic Fixed Interval	2178.674	0.0098	0.0017062	Trapezoid	30	45
201R	Automatic Fixed Interval	10042.832	0.0008	0.0017062	Trapezoid	30	45
202R	Automatic Fixed Interval	17003.527	0.0021	0.0017062	Trapezoid	30	45
203R	Automatic Fixed Interval	12246.491	0.0003	0.0017062	Trapezoid	30	45
204R	Automatic Fixed Interval	2671.311	0.0018	0.0017062	Trapezoid	30	45
205R	Automatic Fixed Interval	8390.862	0.0008	0.0017062	Trapezoid	30	45
206R	Automatic Fixed Interval	16188.994	0.001	0.0017062	Trapezoid	30	45
207R	Automatic Fixed Interval	5774.696	0.0001	0.0017062	Trapezoid	30	45
208R	Automatic Fixed Interval	19693.389	0.0008	0.0017062	Trapezoid	30	45
209R	Automatic Fixed Interval	5643.238	0.0017	0.0017062	Trapezoid	30	45
210R	Automatic Fixed Interval	4366.572	0.0017	0.0017062	Trapezoid	30	45
211R	Automatic Fixed Interval	6494.377	0.0011	0.0017062	Trapezoid	30	45
212R	Automatic Fixed Interval	9857.521	0.0001	0.0017062	Trapezoid	30	45
213R	Automatic Fixed Interval	12048.704	0.0011	0.0017062	Trapezoid	30	45

Appendix C. Calinog Model Basin Parameters

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
100B		49.7448	0	3.8	0.6199	Discharge	0.86972	1	Ratio to Peak	0
101B		63.3192	0	2.7	0.44	Discharge	0.13376	1	Ratio to Peak	0
102B		70.1064	0	2.15	0.3503	Discharge	0.14008	1	Ratio to Peak	0
103B		70.4088	0	11.85	1.9327	Discharge	0.5756	1	Ratio to Peak	0
104B		52.71	0	5.31	0.8666	Discharge	0.11712	1	Ratio to Peak	0
105B		66.36	0	2.7	0.4405	Discharge	0.28674	1	Ratio to Peak	0
106B		25.6872	0	4.11	0.6708	Discharge	0.26012	1	Ratio to Peak	0
10B		65.5452	0	1.85	0.3024	Discharge	0.44321	1	Ratio to Peak	0
11B		70.1064	0	4.76	0.7762	Discharge	0.18164	1	Ratio to Peak	0
12B		64.68	0	1.11	0.1803	Discharge	3.5971	1	Ratio to Peak	0
13B		67.8132	0	1.29	0.2111	Discharge	0.94997	1	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
14B	0.00078	64.68	0	1.36	0.2218	Discharge	0.82345	1	Ratio to Peak	0
15B	0.00011	69.4008	0	2.72	0.4445	Discharge	0.13521	1	Ratio to Peak	0
16B	0.00065	67.2	0	0.55	0.0898	Discharge	0.29936	1	Ratio to Peak	0
17B	0.00077	64.7052	0	3.88	0.6326	Discharge	0.69936	1	Ratio to Peak	0
18B		58.8	0	1.04	0.1691	Discharge	0.07694	1	Ratio to Peak	0
19B	0.00014	65.52	0	0.88	0.1441	Discharge	0.2085	1	Ratio to Peak	0
1B		60.48	0	0.85	0.1384	Discharge	0.06778	1	Ratio to Peak	0
20B	0.00037	67.9476	0	1.27	0.207	Discharge	0.13328	1	Ratio to Peak	0
21B		70.56	0	1.51	0.2465	Discharge	0.08878	1	Ratio to Peak	0
22B		70.2576	0	4.47	0.7285	Discharge	0.14126	1	Ratio to Peak	0
23B	0.00014	65.3184	0	2.65	0.4325	Discharge	0.19434	1	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
24B		64.2348	0	1.74	0.2845	Discharge	0.14759	1	Ratio to Peak	0
25B	0.00013	66.2676	0	1.5	0.2453	Discharge	0.24239	1	Ratio to Peak	0
26B	0.00024	68.9892	0	1.42	0.2321	Discharge	0.1794	1	Ratio to Peak	0
27B		70.4004	0	8.76	1.4294	Discharge	0.84641	1	Ratio to Peak	0
28B		70.56	0	1.47	0.2401	Discharge	0.09762	1	Ratio to Peak	0
29B		64.68	0	1.99	0.325	Discharge	0.31756	1	Ratio to Peak	0
2B		68.1996	0	1.27	0.2067	Discharge	0.16792	1	Ratio to Peak	0
30B		68.5188	0	3.15	0.5143	Discharge	0.30793	1	Ratio to Peak	0
31B		70.2492	0	2.27	0.3696	Discharge	0.1463	1	Ratio to Peak	0
32B		68.04	0	1.16	0.1895	Discharge	0.26295	1	Ratio to Peak	0
33B		62.3532	0	1.87	0.3053	Discharge	0.1921	1	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
34B		67.3176	0	2.49	0.4067	Discharge	0.214	1	Ratio to Peak	0
35B		65.6796	0	2.55	0.4166	Discharge	0.34913	1	Ratio to Peak	0
36B		67.8468	0	2.49	0.406	Discharge	0.17051	1	Ratio to Peak	0
37B		64.68	0	1.45	0.2373	Discharge	0.28418	1	Ratio to Peak	0
38B		67.2	0	2.92	0.4767	Discharge	0.58405	1	Ratio to Peak	0
39B		70.2408	0	1.99	0.3246	Discharge	0.47691	1	Ratio to Peak	0
3B		65.7804	0	0.85	0.1382	Discharge	0.19281	1	Ratio to Peak	0
40B		65.0748	0	4.17	0.6806	Discharge	0.29578	1	Ratio to Peak	0
41B		60.4968	0	3.12	0.5099	Discharge	0.64338	1	Ratio to Peak	0
42B		61.5972	0	2.17	0.3536	Discharge	0.07085	1	Ratio to Peak	0
43B		68.2164	0	5.34	0.8705	Discharge	0.15919	1	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
44B		65.0496	0	1.71	0.2794	Discharge	1.5327	1	Ratio to Peak	0
45B		64.68	0	0.86	0.1407	Discharge	0.12809	1	Ratio to Peak	0
46B		66.444	0	2.14	0.3487	Discharge	0.20602	1	Ratio to Peak	0
47B		64.68	0	1.37	0.2232	Discharge	0.53129	1	Ratio to Peak	0
48B		64.68	0	0.75	0.1221	Discharge	0.64487	1	Ratio to Peak	0
49B		64.68	0	1.17	0.1908	Discharge	0.65152	1	Ratio to Peak	0
4B		50.3664	0	1.11	0.1816	Discharge	0.33958	1	Ratio to Peak	0
50B		64.68	0	1.15	0.187	Discharge	0.46347	1	Ratio to Peak	0
51B		64.7808	0	0.96	0.1561	Discharge	0.36478	1	Ratio to Peak	0
52B		64.9992	0	0.93	0.1519	Discharge	0.54233	1	Ratio to Peak	0
53B		64.68	0	0.71	0.1159	Discharge	0.52201	1	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
54B		65.4696	0	0.77	0.1256	Discharge	0.21286	1	Ratio to Peak	0
55B		64.68	0	0.64	0.1047	Discharge	0.17535	1	Ratio to Peak	0
56B		65.2428	0	0.58	0.0946	Discharge	0.13831	1	Ratio to Peak	0
57B		65.7636	0	0.5	0.0821	Discharge	0.14469	1	Ratio to Peak	0
58B		62.3448	0	3.87	0.6311	Discharge	0.59513	1	Ratio to Peak	0
59B		62.1096	0	2.48	0.4039	Discharge	0.10541	1	Ratio to Peak	0
5B		67.578	0	13.01	2.1234	Discharge	0.10529	1	Ratio to Peak	0
60B		68.0904	0	3.05	0.4968	Discharge	2.3375	1	Ratio to Peak	0
61B		65.0496	0	3.46	0.5638	Discharge	0.18699	1	Ratio to Peak	0
62B		70.56	0	2.07	0.3381	Discharge	0.046824	1	Ratio to Peak	0
63B		59.3292	0	4.33	0.7062	Discharge	0.68847	1	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
64B		69.8628	0	4.41	0.7188	Discharge	0.078201	1	Ratio to Peak	0
65B		70.56	0	1.22	0.1986	Discharge	0.4672	1	Ratio to Peak	0
66B		65.5704	0	3.32	0.5423	Discharge	0.10183	1	Ratio to Peak	0
67B		64.5288	0	1.56	0.2543	Discharge	0.15282	1	Ratio to Peak	0
68B		66.318	0	10.02	1.6341	Discharge	0.12743	1	Ratio to Peak	0
69B		65.2848	0	2.49	0.4066	Discharge	0.37021	1	Ratio to Peak	0
6B		63.924	0	1.54	0.2505	Discharge	0.40461	1	Ratio to Peak	0
70B		66.108	0	8.22	1.342	Discharge	0.12066	1	Ratio to Peak	0
71B		70.266	0	8.73	1.4246	Discharge	0.79655	1	Ratio to Peak	0
72B		66.57	0	1.35	0.2201	Discharge	0.77371	1	Ratio to Peak	0
73B		60.7572	0	2.88	0.47	Discharge	1.8257	1	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
74B		70.56	0	1.17	0.1909	Discharge	0.19572	1	Ratio to Peak	0
75B		70.2324	0	2.64	0.4306	Discharge	0.14398	1	Ratio to Peak	0
76B		68.6196	0	1.17	0.1909	Discharge	0.19721	1	Ratio to Peak	0
77B		69.7788	0	5.15	0.841	Discharge	0.23692	1	Ratio to Peak	0
78B		64.6548	0	1.61	0.2621	Discharge	0.085866	1	Ratio to Peak	0
79B		70.56	0	2.15	0.3502	Discharge	1.1791	1	Ratio to Peak	0
7B		67.3596	0	2.7	0.441	Discharge	0.32055	1	Ratio to Peak	0
80B		70.2408	0	1.09	0.1779	Discharge	4.2467	1	Ratio to Peak	0
81B		60.7572	0	3.49	0.5695	Discharge	0.25902	1	Ratio to Peak	0
82B		65.1588	0	3.41	0.5567	Discharge	0.13969	1	Ratio to Peak	0
83B		60.7572	0	1.26	0.2056	Discharge	0.3323	1	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
84B		68.4264	0	6.21	1.0135	Discharge	0.15365	1	Ratio to Peak	0
85B		69.2328	0	1.8	0.2934	Discharge	0.12173	1	Ratio to Peak	0
86B		65.1588	0	1.33	0.2165	Discharge	0.41837	1	Ratio to Peak	0
87B		68.7204	0	4.7	0.7662	Discharge	0.37186	1	Ratio to Peak	0
88B		57.96	0	2.11	0.3438	Discharge	0.36749	1	Ratio to Peak	0
89B		59.0352	0	4.8	0.7824	Discharge	6.7759	1	Ratio to Peak	0
8B		60.5976	0	1.61	0.2632	Discharge	1.033	1	Ratio to Peak	0
90B		57.96	0	1.83	0.2993	Discharge	0.28862	1	Ratio to Peak	0
91B		60.564	0	3.56	0.5811	Discharge	0.1093	1	Ratio to Peak	0
92B		66.9564	0	1.11	0.1815	Discharge	0.20256	1	Ratio to Peak	0
93B		63	0	3.54	0.5771	Discharge	0.29181	1	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
94B		60.4128	0	2.87	0.4678	Discharge	0.58715	1	Ratio to Peak	0
95B		58.128	0	4.34	0.7078	Discharge	0.3809	1	Ratio to Peak	0
96B		60.8244	0	2.49	0.407	Discharge	0.53223	1	Ratio to Peak	0
97B		57.6156	0	7.8	1.273	Discharge	0.36156	1	Ratio to Peak	0
98B		63.5544	0	3.47	0.5665	Discharge	0.45368	1	Ratio to Peak	0
99B		56.3556	0	4.62	0.7535	Discharge	0.13741	1	Ratio to Peak	0
9B		69.1824	0	6.69	1.0909	Discharge	0.33753	1	Ratio to Peak	0

Appendix D. Calinog Model Reach Parameters

Reach Number	Muskingum Cunge Channel Routing						
	Time Step Method	Length (m)	Slope	Manning's n	Shape	Width	Side Slope
109R	Automatic Fixed Interval	4738.056	0.003	0.05	Trapezoid	30	45
110R	Automatic Fixed Interval	26551.269	0.0015	0.05	Trapezoid	30	45
111R	Automatic Fixed Interval	7994.567	0.0101	0.05	Trapezoid	30	45
112R	Automatic Fixed Interval	3626.647	0.0185	0.05	Trapezoid	30	45
113R	Automatic Fixed Interval	7713.032	0.0053	0.05	Trapezoid	30	45
114R	Automatic Fixed Interval	9964.059	0.0019	0.05	Trapezoid	30	45
115R	Automatic Fixed Interval	9612.855	0.0047	0.05	Trapezoid	30	45
116R	Automatic Fixed Interval	10050.091	0.0067	0.05	Trapezoid	30	45
117R	Automatic Fixed Interval	9909.222	0.0058	0.05	Trapezoid	30	45
118R	Automatic Fixed Interval	8450.355	0.0073	0.05	Trapezoid	30	45
119R	Automatic Fixed Interval	16897.122	0.0021	0.05	Trapezoid	30	45
120R	Automatic Fixed Interval	1638.963	0.0059	0.05	Trapezoid	30	45
121R	Automatic Fixed Interval	4272.25	0.003	0.05	Trapezoid	30	45
122R	Automatic Fixed Interval	1202.841	0.0039	0.0085085	Trapezoid	30	45
123R	Automatic Fixed Interval	4727.405	0.0066	0.000493825	Trapezoid	30	45
124R	Automatic Fixed Interval	17988.419	0.0082	0.0037943	Trapezoid	30	45
125R	Automatic Fixed Interval	5209.987	0.0121	0.0025113	Trapezoid	30	45
126R	Automatic Fixed Interval	12309.822	0.0022	0.05	Trapezoid	30	45
127R	Automatic Fixed Interval	12972.598	0.0008	0.0016007	Trapezoid	30	45
128R	Automatic Fixed Interval	2483.424	0.0221	0.0056765	Trapezoid	30	45
129R	Automatic Fixed Interval	8681.725	0.008	0.05	Trapezoid	30	45
130R	Automatic Fixed Interval	2539.874	0.0219	0.05	Trapezoid	30	45
131R	Automatic Fixed Interval	6781.346	0.0027	0.0024185	Trapezoid	30	45
132R	Automatic Fixed Interval	6917.956	0.0026	0.05	Trapezoid	30	45
133R	Automatic Fixed Interval	10038.428	0.0024	0.05	Trapezoid	30	45
134R	Automatic Fixed Interval	2277.381	0.0058	0.0126565	Trapezoid	30	45
135R	Automatic Fixed Interval	8098.235	0.0036	0.05	Trapezoid	30	45
136R	Automatic Fixed Interval	12943.705	0.0022	0.05	Trapezoid	30	45
137R	Automatic Fixed Interval	14593.769	0.0104	0.05	Trapezoid	30	45
138R	Automatic Fixed Interval	11961.2	0.0006	0.05	Trapezoid	30	45
139R	Automatic Fixed Interval	3776.888	0.0043	0.05	Trapezoid	30	45
140R	Automatic Fixed Interval	11012.45	0.0036	0.05	Trapezoid	30	45
141R	Automatic Fixed Interval	9332.312	0.0029	0.05	Trapezoid	30	45
142R	Automatic Fixed Interval	12266.584	0.0011	0.05	Trapezoid	30	45
143R	Automatic Fixed Interval	17132.163	0.0049	0.05	Trapezoid	30	45
144R	Automatic Fixed Interval	15269.244	0.0004	0.05	Trapezoid	30	45

Reach Number	Muskingum Cunge Channel Routing						
	Time Step Method	Length (m)	Slope	Manning's n	Shape	Width	Side Slope
145R	Automatic Fixed Interval	16410.058	0.0214	0.05	Trapezoid	30	45
146R	Automatic Fixed Interval	11068.467	0.0046	0.05	Trapezoid	30	45
147R	Automatic Fixed Interval	9136.847	0.0027	0.05	Trapezoid	30	45
148R	Automatic Fixed Interval	7395.993	0.0028	0.05	Trapezoid	30	45
149R	Automatic Fixed Interval	17932.313	0.0027	0.05	Trapezoid	30	45
150R	Automatic Fixed Interval	8662.919	0.0029	0.05	Trapezoid	30	45
151R	Automatic Fixed Interval	4632.342	0.0022	0.05	Trapezoid	30	45
152R	Automatic Fixed Interval	14659.084	0.0037	0.05	Trapezoid	30	45
153R	Automatic Fixed Interval	39202.066	0.0035	0.05	Trapezoid	30	45
154R	Automatic Fixed Interval	1849.783	0.0091	0.05	Trapezoid	30	45
155R	Automatic Fixed Interval	6816.891	0.0125	0.05	Trapezoid	30	45
156R	Automatic Fixed Interval	9937.08	0.0284	0.05	Trapezoid	30	45
157R	Automatic Fixed Interval	18932.083	0.0114	0.05	Trapezoid	30	45
158R	Automatic Fixed Interval	13842.2	0.0192	0.05	Trapezoid	30	45
159R	Automatic Fixed Interval	7886.687	0.029	0.05	Trapezoid	30	45
160R	Automatic Fixed Interval	8707.205	0.0163	0.05	Trapezoid	30	45
161R	Automatic Fixed Interval	5110.394	0.0346	0.05	Trapezoid	30	45
162R	Automatic Fixed Interval	4717.295	0.0383	0.05	Trapezoid	30	45
163R	Automatic Fixed Interval	5093.76	0.0935	0.05	Trapezoid	30	45
164R	Automatic Fixed Interval	14024.915	0.071	0.05	Trapezoid	30	45
165R	Automatic Fixed Interval	6433.638	0.1227	0.05	Trapezoid	30	45
166R	Automatic Fixed Interval	21202.676	0.002	0.05	Trapezoid	30	45
167R	Automatic Fixed Interval	10491.552	0.0042	0.05	Trapezoid	30	45
168R	Automatic Fixed Interval	22077.652	0.0049	0.05	Trapezoid	30	45
169R	Automatic Fixed Interval	6201.287	0.0023	0.05	Trapezoid	30	45
170R	Automatic Fixed Interval	5611.657	0.0061	0.05	Trapezoid	30	45
171R	Automatic Fixed Interval	13593.247	0.0012	0.05	Trapezoid	30	45
172R	Automatic Fixed Interval	10994.757	0.0039	0.05	Trapezoid	30	45
173R	Automatic Fixed Interval	6089.752	0.0092	0.05	Trapezoid	30	45
174R	Automatic Fixed Interval	38818.997	0.0023	0.05	Trapezoid	30	45
175R	Automatic Fixed Interval	11967.67	0.0023	0.05	Trapezoid	30	45
176R	Automatic Fixed Interval	33724.319	0.0016	0.05	Trapezoid	30	45
177R	Automatic Fixed Interval	9921.905	0.0035	0.05	Trapezoid	30	45
178R	Automatic Fixed Interval	10624.016	0.004	0.05	Trapezoid	30	45
179R	Automatic Fixed Interval	17875.02	0.0028	0.05	Trapezoid	30	45
180R	Automatic Fixed Interval	6125.88	0.0092	0.05	Trapezoid	30	45
181R	Automatic Fixed Interval	7863.916	0.0035	0.05	Trapezoid	30	45
182R	Automatic Fixed Interval	9382.672	0.0034	0.05	Trapezoid	30	45

Reach Number	Muskingum Cunge Channel Routing						
	Time Step Method	Length (m)	Slope	Manning's n	Shape	Width	Side Slope
183R	Automatic Fixed Interval	16679.64	0.0045	0.05	Trapezoid	30	45
184R	Automatic Fixed Interval	6892.166	0.0134	0.05	Trapezoid	30	45
185R	Automatic Fixed Interval	12529.607	0.0034	0.05	Trapezoid	30	45
186R	Automatic Fixed Interval	5008.874	0.0028	0.05	Trapezoid	30	45
187R	Automatic Fixed Interval	10544.56	0.0013	0.05	Trapezoid	30	45
188R	Automatic Fixed Interval	9066.739	0.0068	0.05	Trapezoid	30	45
189R	Automatic Fixed Interval	5332.492	0.0048	0.05	Trapezoid	30	45
190R	Automatic Fixed Interval	3231.549	0.0118	0.05	Trapezoid	30	45
191R	Automatic Fixed Interval	7291.762	0.0062	0.05	Trapezoid	30	45
192R	Automatic Fixed Interval	3949.681	0.0047	0.05	Trapezoid	30	45
193R	Automatic Fixed Interval	7045.156	0.0042	0.05	Trapezoid	30	45
194R	Automatic Fixed Interval	2354.332	0.0054	0.05	Trapezoid	30	45
195R	Automatic Fixed Interval	20171.876	0.0022	0.05	Trapezoid	30	45
196R	Automatic Fixed Interval	12846.652	0.0006	0.05	Trapezoid	30	45
197R	Automatic Fixed Interval	7325.884	0.0031	0.05	Trapezoid	30	45
198R	Automatic Fixed Interval	17222.837	0.0015	0.05	Trapezoid	30	45
199R	Automatic Fixed Interval	8514.862	0.0032	0.05	Trapezoid	30	45
200R	Automatic Fixed Interval	2178.674	0.0098	0.05	Trapezoid	30	45
201R	Automatic Fixed Interval	10042.832	0.0008	0.05	Trapezoid	30	45
202R	Automatic Fixed Interval	17003.527	0.0021	0.05	Trapezoid	30	45
203R	Automatic Fixed Interval	12246.491	0.0003	0.05	Trapezoid	30	45
204R	Automatic Fixed Interval	2671.311	0.0018	0.05	Trapezoid	30	45
205R	Automatic Fixed Interval	8390.862	0.0008	0.05	Trapezoid	30	45
206R	Automatic Fixed Interval	16188.994	0.001	0.05	Trapezoid	30	45
207R	Automatic Fixed Interval	5774.696	0.0001	0.05	Trapezoid	30	45
208R	Automatic Fixed Interval	19693.389	0.0008	0.05	Trapezoid	30	45
209R	Automatic Fixed Interval	5643.238	0.0017	0.05	Trapezoid	30	45
210R	Automatic Fixed Interval	4366.572	0.0017	0.05	Trapezoid	30	45
211R	Automatic Fixed Interval	6494.377	0.0011	0.05	Trapezoid	30	45
212R	Automatic Fixed Interval	9857.521	0.0001	0.05	Trapezoid	30	45
213R	Automatic Fixed Interval	12048.704	0.0011	0.05	Trapezoid	30	45

Appendix E. Pototan Model Basin Parameters

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
100B		59.5161	0	5.7	6.199	Discharge	0.16423	0.05	Ratio to Peak	0
101B		75.7569	0	4.05	4.4	Discharge	0.02526	0.05	Ratio to Peak	0
102B		83.8773	0	3.225	3.503	Discharge	0.02645	0.05	Ratio to Peak	0
103B		84.2391	0	17.775	19.327	Discharge	0.10869	0.05	Ratio to Peak	0
104B		63.0638	0	7.965	8.666	Discharge	0.02212	0.05	Ratio to Peak	0
105B		79.395	0	4.05	4.405	Discharge	0.05414	0.05	Ratio to Peak	0
106B		30.7329	0	6.165	6.708	Discharge	0.04912	0.05	Ratio to Peak	0
10B	14.303	78.4202	0	2.775	3.024	Discharge	0.08369	0.05	Ratio to Peak	0
11B	10.067	83.8773	0	7.14	7.762	Discharge	0.0343	0.05	Ratio to Peak	0
12B	15.174	77.385	0	1.665	1.803	Discharge	0.67925	0.05	Ratio to Peak	0
13B	12.126	81.1337	0	1.935	2.111	Discharge	0.17938	0.05	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
14B	15.174	77.385	0	2.04	2.218	Discharge	0.15549	0.05	Ratio to Peak	0
15B	10.686	83.0331	0	4.08	4.445	Discharge	0.02553	0.05	Ratio to Peak	0
16B	12.7	80.4	0	0.825	0.898	Discharge	0.05653	0.05	Ratio to Peak	0
17B	15.148	77.4152	0	5.82	6.326	Discharge	0.13206	0.05	Ratio to Peak	0
18B	21.771	70.35	0	1.56	1.691	Discharge	0.01453	0.05	Ratio to Peak	0
19B	14.328	78.39	0	1.32	1.441	Discharge	0.03937	0.05	Ratio to Peak	0
1B	19.756	72.36	0	1.275	1.384	Discharge	0.0128	0.05	Ratio to Peak	0
20B	12.001	81.2945	0	1.905	2.07	Discharge	0.02517	0.05	Ratio to Peak	0
21B	9.6762	84.42	0	2.265	2.465	Discharge	0.01676	0.05	Ratio to Peak	0
22B	9.9365	84.0582	0	6.705	7.285	Discharge	0.02667	0.05	Ratio to Peak	0
23B	14.529	78.1488	0	3.975	4.325	Discharge	0.0367	0.05	Ratio to Peak	0

Appendix

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
24B	15.631	76.8524	0	2.61	2.845	Discharge	0.02787	0.05	Ratio to Peak	0
25B	13.593	79.2845	0	2.25	2.453	Discharge	0.04577	0.05	Ratio to Peak	0
26B	11.053	82.5407	0	2.13	2.321	Discharge	0.03388	0.05	Ratio to Peak	0
27B	9.8133	84.2291	0	13.14	14.294	Discharge	0.15983	0.05	Ratio to Peak	0
28B	9.6762	84.42	0	2.205	2.401	Discharge	0.01843	0.05	Ratio to Peak	0
29B	15.174	77.385	0	2.985	3.25	Discharge	0.05996	0.05	Ratio to Peak	0
2B	11.769	81.596	0	1.905	2.067	Discharge	0.03171	0.05	Ratio to Peak	0
30B	11.478	81.9779	0	4.725	5.143	Discharge	0.05815	0.05	Ratio to Peak	0
31B	9.9438	84.0482	0	3.405	3.696	Discharge	0.02763	0.05	Ratio to Peak	0
32B	11.916	81.405	0	1.74	1.895	Discharge	0.04965	0.05	Ratio to Peak	0
33B	17.636	74.6012	0	2.805	3.053	Discharge	0.03627	0.05	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
34B	12.589	80.5407	0	3.735	4.067	Discharge	0.04041	0.05	Ratio to Peak	0
35B	14.17	78.581	0	3.825	4.166	Discharge	0.06593	0.05	Ratio to Peak	0
36B	12.095	81.1739	0	3.735	4.06	Discharge	0.0322	0.05	Ratio to Peak	0
37B	15.174	77.385	0	2.175	2.373	Discharge	0.05366	0.05	Ratio to Peak	0
38B	12.7	80.4	0	4.38	4.767	Discharge	0.11029	0.05	Ratio to Peak	0
39B	9.951	84.0381	0	2.985	3.246	Discharge	0.09006	0.05	Ratio to Peak	0
3B	14.07	78.7016	0	1.275	1.382	Discharge	0.03641	0.05	Ratio to Peak	0
40B	14.774	77.8574	0	6.255	6.806	Discharge	0.05585	0.05	Ratio to Peak	0
41B	19.736	72.3801	0	4.68	5.099	Discharge	0.12149	0.05	Ratio to Peak	0
42B	18.476	73.6967	0	3.255	3.536	Discharge	0.01338	0.05	Ratio to Peak	0
43B	11.754	81.6161	0	8.01	8.705	Discharge	0.03006	0.05	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
44B	14.799	77.8272	0	2.565	2.794	Discharge	0.28942	0.05	Ratio to Peak	0
45B	15.174	77.385	0	1.29	1.407	Discharge	0.02419	0.05	Ratio to Peak	0
46B	13.423	79.4955	0	3.21	3.487	Discharge	0.0389	0.05	Ratio to Peak	0
47B	15.174	77.385	0	2.055	2.232	Discharge	0.10032	0.05	Ratio to Peak	0
48B	15.174	77.385	0	1.125	1.221	Discharge	0.12177	0.05	Ratio to Peak	0
49B	15.174	77.385	0	1.755	1.908	Discharge	0.12303	0.05	Ratio to Peak	0
4B	33.923	60.2598	0	1.665	1.816	Discharge	0.06412	0.05	Ratio to Peak	0
50B	15.174	77.385	0	1.725	1.87	Discharge	0.08752	0.05	Ratio to Peak	0
51B	15.071	77.5056	0	1.44	1.561	Discharge	0.06888	0.05	Ratio to Peak	0
52B	14.85	77.7669	0	1.395	1.519	Discharge	0.10241	0.05	Ratio to Peak	0
53B	15.174	77.385	0	1.065	1.159	Discharge	0.09857	0.05	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
54B	14.378	78.3297	0	1.155	1.256	Discharge	0.04019	0.05	Ratio to Peak	0
55B	15.174	77.385	0	0.96	1.047	Discharge	0.033112	0.05	Ratio to Peak	0
56B	14.605	78.05835	0	0.87	0.946	Discharge	0.026118	0.05	Ratio to Peak	0
57B	14.087	78.68145	0	0.75	0.821	Discharge	0.027321	0.05	Ratio to Peak	0
58B	17.645	74.5911	0	5.805	6.311	Discharge	0.11238	0.05	Ratio to Peak	0
59B	17.904	74.3097	0	3.72	4.039	Discharge	0.019904	0.05	Ratio to Peak	0
5B	12.345	80.85225	0	19.515	21.234	Discharge	0.019882	0.05	Ratio to Peak	0
60B	11.87	81.4653	0	4.575	4.968	Discharge	0.4414	0.05	Ratio to Peak	0
61B	14.799	77.8272	0	5.19	5.638	Discharge	0.035309	0.05	Ratio to Peak	0
62B	9.6762	84.42	0	3.105	3.381	Discharge	0.008842	0.05	Ratio to Peak	0
63B	21.124	70.98315	0	6.495	7.062	Discharge	0.130005	0.05	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
64B	10.28	83.58585	0	6.615	7.188	Discharge	0.014767	0.05	Ratio to Peak	0
65B	9.6762	84.42	0	1.83	1.986	Discharge	0.088222	0.05	Ratio to Peak	0
66B	14.278	78.4503	0	4.98	5.423	Discharge	0.019228	0.05	Ratio to Peak	0
67B	15.329	77.2041	0	2.34	2.543	Discharge	0.028858	0.05	Ratio to Peak	0
68B	13.545	79.34475	0	15.03	16.341	Discharge	0.024062	0.05	Ratio to Peak	0
69B	14.563	78.1086	0	3.735	4.066	Discharge	0.069906	0.05	Ratio to Peak	0
6B	15.954	76.4805	0	2.31	2.505	Discharge	0.076402	0.05	Ratio to Peak	0
70B	13.749	79.0935	0	12.33	13.42	Discharge	0.022785	0.05	Ratio to Peak	0
71B	9.9292	84.06825	0	13.095	14.246	Discharge	0.15041	0.05	Ratio to Peak	0
72B	13.301	79.64625	0	2.025	2.201	Discharge	0.1461	0.05	Ratio to Peak	0
73B	19.434	72.69165	0	4.32	4.7	Discharge	0.34474	0.05	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
74B	9.6762	84.42	0	1.755	1.909	Discharge	0.036958	0.05	Ratio to Peak	0
75B	9.9583	84.02805	0	3.96	4.306	Discharge	0.027187	0.05	Ratio to Peak	0
76B	11.386	82.09845	0	1.755	1.909	Discharge	0.037239	0.05	Ratio to Peak	0
77B	10.353	83.48535	0	7.725	8.41	Discharge	0.044738	0.05	Ratio to Peak	0
78B	15.2	77.35485	0	2.415	2.621	Discharge	0.016214	0.05	Ratio to Peak	0
79B	9.6762	84.42	0	3.225	3.502	Discharge	0.22266	0.05	Ratio to Peak	0
7B	12.55	80.59095	0	4.05	4.41	Discharge	0.060529	0.05	Ratio to Peak	0
80B	9.951	84.0381	0	1.635	1.779	Discharge	0.80191	0.05	Ratio to Peak	0
81B	19.434	72.69165	0	5.235	5.695	Discharge	0.04891	0.05	Ratio to Peak	0
82B	14.689	77.95785	0	5.115	5.567	Discharge	0.026378	0.05	Ratio to Peak	0
83B	19.434	72.69165	0	1.89	2.056	Discharge	0.062749	0.05	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
84B	11.562	81.8673	0	9.315	10.135	Discharge	0.029013	0.05	Ratio to Peak	0
85B	10.836	82.8321	0	2.7	2.934	Discharge	0.022986	0.05	Ratio to Peak	0
86B	14.689	77.95785	0	1.995	2.165	Discharge	0.079001	0.05	Ratio to Peak	0
87B	11.295	82.21905	0	7.05	7.662	Discharge	0.070218	0.05	Ratio to Peak	0
88B	22.823	69.345	0	3.165	3.438	Discharge	0.069394	0.05	Ratio to Peak	0
89B	21.482	70.6314	0	7.2	7.824	Discharge	1.2795	0.05	Ratio to Peak	0
8B	19.619	72.5007	0	2.415	2.632	Discharge	0.19506	0.05	Ratio to Peak	0
90B	22.823	69.345	0	2.745	2.993	Discharge	0.054501	0.05	Ratio to Peak	0
91B	19.658	72.4605	0	5.34	5.811	Discharge	0.020639	0.05	Ratio to Peak	0
92B	12.931	80.10855	0	1.665	1.815	Discharge	0.038249	0.05	Ratio to Peak	0
93B	16.933	75.375	0	5.31	5.771	Discharge	0.055102	0.05	Ratio to Peak	0

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (M3/S)	Recession Constant	Threshold Type	Ratio to Peak
94B	19.834	72.2796	0	4.305	4.678	Discharge	0.11087	0.05	Ratio to Peak	0
95B	22.61	69.546	0	6.51	7.078	Discharge	0.071926	0.05	Ratio to Peak	0
96B	19.356	72.77205	0	3.735	4.07	Discharge	0.1005	0.05	Ratio to Peak	0
97B	23.263	68.93295	0	11.7	12.73	Discharge	0.068273	0.05	Ratio to Peak	0
98B	16.342	76.0383	0	5.205	5.665	Discharge	0.085668	0.05	Ratio to Peak	0
99B		67.42545	0	6.93	7.535	Discharge	0.025947	0.05	Ratio to Peak	0
9B	10.88	82.7718	0	10.035	10.909	Discharge	0.063736	0.05	Ratio to Peak	0

Appendix F. Pototan Model Reach Parameters

Reach Number	Muskingum Cunge Channel Routing						
	Time Step Method	Length (m)	Slope	Manning's n	Shape	Width	Side Slope
109R	Automatic Fixed Interval	4738.056	0.003	0.0025	Trapezoid	30	45
110R	Automatic Fixed Interval	26551.269	0.0015	0.0025	Trapezoid	30	45
111R	Automatic Fixed Interval	7994.567	0.0101	0.0025	Trapezoid	30	45
112R	Automatic Fixed Interval	3626.647	0.0185	0.0025	Trapezoid	30	45
113R	Automatic Fixed Interval	7713.032	0.0053	0.0025	Trapezoid	30	45
114R	Automatic Fixed Interval	9964.059	0.0019	0.0025	Trapezoid	30	45
115R	Automatic Fixed Interval	9612.855	0.0047	0.0025	Trapezoid	30	45
116R	Automatic Fixed Interval	10050.091	0.0067	0.0025	Trapezoid	30	45
117R	Automatic Fixed Interval	9909.222	0.0058	0.0025	Trapezoid	30	45
118R	Automatic Fixed Interval	8450.355	0.0073	0.0025	Trapezoid	30	45
119R	Automatic Fixed Interval	16897.122	0.0021	0.0025	Trapezoid	30	45
120R	Automatic Fixed Interval	1638.963	0.0059	0.0025	Trapezoid	30	45
121R	Automatic Fixed Interval	4272.25	0.003	0.0025	Trapezoid	30	45
122R	Automatic Fixed Interval	1202.841	0.0039	0.0025	Trapezoid	30	45
123R	Automatic Fixed Interval	4727.405	0.0066	0.0025	Trapezoid	30	45
124R	Automatic Fixed Interval	17988.419	0.0082	0.0025	Trapezoid	30	45
125R	Automatic Fixed Interval	5209.987	0.0121	0.0025	Trapezoid	30	45
126R	Automatic Fixed Interval	12309.822	0.0022	0.0025	Trapezoid	30	45
127R	Automatic Fixed Interval	12972.598	0.0008	0.0025	Trapezoid	30	45
128R	Automatic Fixed Interval	2483.424	0.0221	0.0025	Trapezoid	30	45
129R	Automatic Fixed Interval	8681.725	0.008	0.0025	Trapezoid	30	45
130R	Automatic Fixed Interval	2539.874	0.0219	0.0025	Trapezoid	30	45
131R	Automatic Fixed Interval	6781.346	0.0027	0.0025	Trapezoid	30	45
132R	Automatic Fixed Interval	6917.956	0.0026	0.0025	Trapezoid	30	45
133R	Automatic Fixed Interval	10038.428	0.0024	0.0025	Trapezoid	30	45
134R	Automatic Fixed Interval	2277.381	0.0058	0.0025	Trapezoid	30	45
135R	Automatic Fixed Interval	8098.235	0.0036	0.0025	Trapezoid	30	45
136R	Automatic Fixed Interval	12943.705	0.0022	0.0025	Trapezoid	30	45
137R	Automatic Fixed Interval	14593.769	0.0104	0.0025	Trapezoid	30	45
138R	Automatic Fixed Interval	11961.2	0.0006	0.0025	Trapezoid	30	45
139R	Automatic Fixed Interval	3776.888	0.0043	0.0025	Trapezoid	30	45
140R	Automatic Fixed Interval	11012.45	0.0036	0.0025	Trapezoid	30	45
141R	Automatic Fixed Interval	9332.312	0.0029	0.0025	Trapezoid	30	45
142R	Automatic Fixed Interval	12266.584	0.0011	0.0025	Trapezoid	30	45
143R	Automatic Fixed Interval	17132.163	0.0049	0.0025	Trapezoid	30	45
144R	Automatic Fixed Interval	15269.244	0.0004	0.0025	Trapezoid	30	45

Reach Number	Muskingum Cunge Channel Routing						
	Time Step Method	Length (m)	Slope	Manning's n	Shape	Width	Side Slope
145R	Automatic Fixed Interval	16410.058	0.0214	0.0025	Trapezoid	30	45
146R	Automatic Fixed Interval	11068.467	0.0046	0.0025	Trapezoid	30	45
147R	Automatic Fixed Interval	9136.847	0.0027	0.0025	Trapezoid	30	45
148R	Automatic Fixed Interval	7395.993	0.0028	0.0025	Trapezoid	30	45
149R	Automatic Fixed Interval	17932.313	0.0027	0.0025	Trapezoid	30	45
150R	Automatic Fixed Interval	8662.919	0.0029	0.0025	Trapezoid	30	45
151R	Automatic Fixed Interval	4632.342	0.0022	0.0025	Trapezoid	30	45
152R	Automatic Fixed Interval	14659.084	0.0037	0.0025	Trapezoid	30	45
153R	Automatic Fixed Interval	39202.066	0.0035	0.0025	Trapezoid	30	45
154R	Automatic Fixed Interval	1849.783	0.0091	0.0025	Trapezoid	30	45
155R	Automatic Fixed Interval	6816.891	0.0125	0.0025	Trapezoid	30	45
156R	Automatic Fixed Interval	9937.08	0.0284	0.0025	Trapezoid	30	45
157R	Automatic Fixed Interval	18932.083	0.0114	0.0025	Trapezoid	30	45
158R	Automatic Fixed Interval	13842.2	0.0192	0.0025	Trapezoid	30	45
159R	Automatic Fixed Interval	7886.687	0.029	0.0025	Trapezoid	30	45
160R	Automatic Fixed Interval	8707.205	0.0163	0.0025	Trapezoid	30	45
161R	Automatic Fixed Interval	5110.394	0.0346	0.0025	Trapezoid	30	45
162R	Automatic Fixed Interval	4717.295	0.0383	0.0025	Trapezoid	30	45
163R	Automatic Fixed Interval	5093.76	0.0935	0.0025	Trapezoid	30	45
164R	Automatic Fixed Interval	14024.915	0.071	0.0025	Trapezoid	30	45
165R	Automatic Fixed Interval	6433.638	0.1227	0.0025	Trapezoid	30	45
166R	Automatic Fixed Interval	21202.676	0.002	0.0025	Trapezoid	30	45
167R	Automatic Fixed Interval	10491.552	0.0042	0.0025	Trapezoid	30	45
168R	Automatic Fixed Interval	22077.652	0.0049	0.0025	Trapezoid	30	45
169R	Automatic Fixed Interval	6201.287	0.0023	0.0025	Trapezoid	30	45
170R	Automatic Fixed Interval	5611.657	0.0061	0.0025	Trapezoid	30	45
171R	Automatic Fixed Interval	13593.247	0.0012	0.0025	Trapezoid	30	45
172R	Automatic Fixed Interval	10994.757	0.0039	0.0025	Trapezoid	30	45
173R	Automatic Fixed Interval	6089.752	0.0092	0.0025	Trapezoid	30	45
174R	Automatic Fixed Interval	38818.997	0.0023	0.0025	Trapezoid	30	45
175R	Automatic Fixed Interval	11967.67	0.0023	0.0025	Trapezoid	30	45
176R	Automatic Fixed Interval	33724.319	0.0016	0.0025	Trapezoid	30	45
177R	Automatic Fixed Interval	9921.905	0.0035	0.0025	Trapezoid	30	45
178R	Automatic Fixed Interval	10624.016	0.004	0.0025	Trapezoid	30	45
179R	Automatic Fixed Interval	17875.02	0.0028	0.0025	Trapezoid	30	45
180R	Automatic Fixed Interval	6125.88	0.0092	0.0025	Trapezoid	30	45
181R	Automatic Fixed Interval	7863.916	0.0035	0.0025	Trapezoid	30	45

Reach Number	Muskingum Cunge Channel Routing						
	Time Step Method	Length (m)	Slope	Manning's n	Shape	Width	Side Slope
182R	Automatic Fixed Interval	9382.672	0.0034	0.0025	Trapezoid	30	45
183R	Automatic Fixed Interval	16679.64	0.0045	0.0025	Trapezoid	30	45
184R	Automatic Fixed Interval	6892.166	0.0134	0.0025	Trapezoid	30	45
185R	Automatic Fixed Interval	12529.607	0.0034	0.0025	Trapezoid	30	45
186R	Automatic Fixed Interval	5008.874	0.0028	0.0025474	Trapezoid	30	45
187R	Automatic Fixed Interval	10544.56	0.0013	0.0025	Trapezoid	30	45
188R	Automatic Fixed Interval	9066.739	0.0068	0.0025	Trapezoid	30	45
189R	Automatic Fixed Interval	5332.492	0.0048	0.0025	Trapezoid	30	45
190R	Automatic Fixed Interval	3231.549	0.0118	0.0025	Trapezoid	30	45
191R	Automatic Fixed Interval	7291.762	0.0062	0.0025473	Trapezoid	30	45
192R	Automatic Fixed Interval	3949.681	0.0047	0.0025	Trapezoid	30	45
193R	Automatic Fixed Interval	7045.156	0.0042	0.0025	Trapezoid	30	45
194R	Automatic Fixed Interval	2354.332	0.0054	0.0025	Trapezoid	30	45
195R	Automatic Fixed Interval	20171.876	0.0022	0.0025	Trapezoid	30	45
196R	Automatic Fixed Interval	12846.652	0.0006	0.0024625	Trapezoid	30	45
197R	Automatic Fixed Interval	7325.884	0.0031	0.0025343	Trapezoid	30	45
198R	Automatic Fixed Interval	17222.837	0.0015	0.0025	Trapezoid	30	45
199R	Automatic Fixed Interval	8514.862	0.0032	0.0025	Trapezoid	30	45
200R	Automatic Fixed Interval	2178.674	0.0098	0.005642	Trapezoid	30	45
201R	Automatic Fixed Interval	10042.832	0.0008	0.0025454	Trapezoid	30	45
202R	Automatic Fixed Interval	17003.527	0.0021	0.0025449	Trapezoid	30	45
203R	Automatic Fixed Interval	12246.491	0.0003	0.0025466	Trapezoid	30	45
204R	Automatic Fixed Interval	2671.311	0.0018	0.0025454	Trapezoid	30	45
205R	Automatic Fixed Interval	8390.862	0.0008	0.00255	Trapezoid	30	45
206R	Automatic Fixed Interval	16188.994	0.001	0.01	Trapezoid	30	45
207R	Automatic Fixed Interval	5774.696	0.0001	0.01	Trapezoid	30	45
208R	Automatic Fixed Interval	19693.389	0.0008	0.01	Trapezoid	30	45
209R	Automatic Fixed Interval	5643.238	0.0017	0.01	Trapezoid	30	45
210R	Automatic Fixed Interval	4366.572	0.0017	0.01	Trapezoid	30	45
211R	Automatic Fixed Interval	6494.377	0.0011	0.01	Trapezoid	30	45
212R	Automatic Fixed Interval	9857.521	0.0001	0.01	Trapezoid	30	45
213R	Automatic Fixed Interval	12048.704	0.0011	0.01	Trapezoid	30	45

Appendix G. Jalaur (1) HEC-HMS Discharge Results

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
0	0	0	0	6.333333333	0.1	0.1	0
0.166666667	0	0	0	6.5	0.2	0.1	0
0.333333333	0	0	0	6.666666667	0.4	0.2	0
0.5	0	0	0	6.833333333	0.6	0.4	0
0.666666667	0	0	0	7	1	0.6	0
0.833333333	0	0	0	7.166666667	1.4	0.9	0
1	0	0	0	7.333333333	2	1.3	0
1.166666667	0	0	0	7.5	2.7	1.8	0
1.333333333	0	0	0	7.666666667	3.6	2.5	0
1.5	0	0	0	7.833333333	4.8	3.3	0
1.666666667	0	0	0	8	6.1	4.4	0.1
1.833333333	0	0	0	8.166666667	7.8	5.6	0.2
2	0	0	0	8.333333333	9.7	7.1	0.2
2.166666667	0	0	0	8.5	11.9	8.8	0.4
2.333333333	0	0	0	8.666666667	14.4	10.8	0.5
2.5	0	0	0	8.833333333	17.2	13	0.8
2.666666667	0	0	0	9	20.3	15.6	1.1
2.833333333	0	0	0	9.166666667	23.9	18.4	1.5
3	0	0	0	9.333333333	27.9	21.7	2
3.166666667	0	0	0	9.5	32.4	25.5	2.7
3.333333333	0	0	0	9.666666667	37.3	29.6	3.6
3.5	0	0	0	9.833333333	42.8	34.3	4.6
3.666666667	0	0	0	10	48.9	39.5	5.9
3.833333333	0	0	0	10.16666667	55.5	45.2	7.5
4	0	0	0	10.33333333	62.8	51.5	9.3
4.166666667	0	0	0	10.5	70.9	58.6	11.6
4.333333333	0	0	0	10.66666667	80	66.6	14.3
4.5	0	0	0	10.83333333	90.3	75.7	17.5
4.666666667	0	0	0	11	102.2	86.3	21.5
4.833333333	0	0	0	11.16666667	115.8	98.4	26.3
5	0	0	0	11.33333333	131.4	112.4	32
5.166666667	0	0	0	11.5	149.4	128.6	38.9
5.333333333	0	0	0	11.66666667	170.6	147.7	47.4
5.5	0	0	0	11.83333333	199.3	173.7	59.6
5.666666667	0	0	0	12	233.4	204.7	74.6
5.833333333	0	0	0	12.16666667	276	243.3	93.7
6	0	0	0	12.33333333	325.7	288.6	116.6

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
6.166666667	0.1	0	0	12.5	381.9	339.7	142.8
				11.83333333	133.7	85.8	38.8
				12	155.9	101.7	47.7
				12.16666667	179.8	118.8	57.3
12.66666667	444.7	396.9	172.5	19.33333333	894.4	822.5	465.3
12.83333333	513.7	459.9	205.5	19.5	859.8	790.8	447.9
13	590.9	530.3	242.7	19.66666667	826.2	759.9	430.9
13.16666667	673.6	605.8	283.1	19.83333333	793.3	729.7	414.2
13.33333333	765.6	689.9	328.3	20	761.3	700.3	398
13.5	862.5	778.6	376.5	20.16666667	730.6	672.1	382.4
13.66666667	964.7	872.1	427.7	20.33333333	700.7	644.7	367.3
13.83333333	1069.8	968.4	480.9	20.5	671.4	617.8	352.4
14	1172.6	1062.6	533.5	20.66666667	643	591.8	338.1
14.16666667	1270.9	1152.9	584.4	20.83333333	616.7	567.7	324.8
14.33333333	1364	1238.5	633.1	21	591.7	544.9	312.2
14.5	1447.3	1315.3	677.5	21.16666667	567.6	522.9	300
14.66666667	1523.6	1385.7	718.6	21.33333333	544.3	501.5	288.3
14.83333333	1587.9	1445.3	754.2	21.5	522	481.2	277.1
15	1643	1496.4	785.4	21.66666667	501	462	266.6
15.16666667	1686.3	1537	811	21.83333333	481	443.7	256.5
15.33333333	1719	1567.8	831.3	22	461.6	426	246.7
15.5	1742.9	1590.6	847.3	22.16666667	443	409.1	237.4
15.66666667	1758.2	1605.4	858.9	22.33333333	425.8	393.4	228.8
15.83333333	1764.4	1612	865.9	22.5	409.6	378.6	220.6
16	1758.2	1607.2	866.8	22.66666667	394	364.4	212.8
16.16666667	1744.1	1595.2	863.6	22.83333333	379.1	350.8	205.4
16.33333333	1723.2	1576.9	856.8	23	365.2	338.1	198.4
16.5	1696.7	1553.4	846.9	23.16666667	352.3	326.4	191.9
16.66666667	1664.5	1524.7	834	23.33333333	340.3	315.4	185.9
16.83333333	1627	1491	818.3	23.5	329	305.1	180.2
17	1584.1	1452.4	799.5	23.66666667	318.4	295.5	174.9
17.16666667	1535.8	1408.6	777.8	23.83333333	308.9	286.8	170.2
17.33333333	1483.3	1361	753.6	24	300	278.7	165.7
17.5	1425.8	1308.8	726.7	24.16666667	291.6	271.1	161.5
17.66666667	1366.5	1254.9	698.5	24.33333333	283.6	263.8	157.5
17.83333333	1309.1	1202.5	670.9	24.5	276	256.8	153.6
18	1252.8	1151.1	643.6	24.66666667	268.8	250.2	150
18.16666667	1199.8	1102.7	617.7	24.83333333	261.7	243.8	146.4
18.33333333	1149.9	1057	593.1	25	254.8	237.4	142.8

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
18.5	1101.8	1012.9	569.3	25.16666667	247.9	231.1	139.2
18.66666667	1055.9	970.8	546.5	25.33333333	241.1	224.9	135.7
18.83333333	1011.8	930.4	524.5	25.5	234.2	218.5	132
19	970.2	892.2	503.5	25.66666667	227.2	212	128.3
19.16666667	930.7	856	483.7	25.83333333	219.9	205.3	124.4
17.5	1425.8	1308.8	726.7				
17.66666667	2118.7	1542.1	891.4				
17.83333333	2215.6	1613.9	934.2				
26	212.5	198.4	120.4	32.66666667	13.9	13	8
26.16666667	204.9	191.4	116.2	32.83333333	12.9	12.1	7.5
26.33333333	197.1	184.2	111.9	33	11.9	11.2	6.9
26.5	189.1	176.7	107.5	33.16666667	11	10.4	6.4
26.66666667	181	169.2	103	33.33333333	10.2	9.6	5.9
26.83333333	172.9	161.7	98.5	33.5	9.5	8.9	5.5
27	164.9	154.1	93.9	33.66666667	8.8	8.2	5.1
27.16666667	156.8	146.6	89.4	33.83333333	8.1	7.6	4.7
27.33333333	148.8	139.1	84.9	34	7.5	7	4.4
27.5	140.8	131.7	80.4	34.16666667	6.9	6.5	4
27.66666667	133	124.4	76	34.33333333	6.4	6	3.7
27.83333333	125.3	117.2	71.6	34.5	5.9	5.6	3.5
28	117.7	110.1	67.3	34.66666667	5.5	5.1	3.2
28.16666667	110.4	103.3	63.1	34.83333333	5.1	4.8	3
28.33333333	103.3	96.6	59.1	35	4.7	4.4	2.7
28.5	96.4	90.2	55.2	35.16666667	4.3	4.1	2.5
28.66666667	89.8	84.1	51.5	35.33333333	4	3.7	2.3
28.83333333	83.5	78.2	47.9	35.5	3.7	3.5	2.2
29	77.5	72.5	44.4	35.66666667	3.4	3.2	2
29.16666667	71.7	67.1	41.2	35.83333333	3.1	2.9	1.8
29.33333333	66.3	62.1	38.1	36	2.9	2.7	1.7
29.5	61.2	57.3	35.2	36.16666667	2.7	2.5	1.6
29.66666667	56.4	52.8	32.5	36.33333333	2.5	2.3	1.4
29.83333333	52.1	48.8	30	36.5	2.3	2.1	1.3
30	48	45	27.7	36.66666667	2.1	2	1.2
30.16666667	44.3	41.5	25.5	36.83333333	1.9	1.8	1.1
30.33333333	40.8	38.2	23.6	37	1.8	1.7	1
30.5	37.6	35.3	21.8	37.16666667	1.6	1.6	1
30.66666667	34.8	32.6	20.1	37.33333333	1.5	1.4	0.9
30.83333333	32.2	30.2	18.6	37.5	1.4	1.3	0.8

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
31	29.8	28	17.3	37.66666667	1.3	1.2	0.8
31.16666667	27.6	25.9	16	37.83333333	1.2	1.1	0.7
31.33333333	25.6	24	14.8	38	1.1	1	0.6
31.5	23.7	22.2	13.7	38.16666667	1	0.9	0.6
31.66666667	22	20.6	12.7	38.33333333	0.9	0.9	0.5
31.83333333	20.3	19.1	11.8	38.5	0.8	0.8	0.5
32	18.8	17.7	10.9	38.66666667	0.8	0.7	0.4
32.16666667	17.5	16.4	10.1	38.83333333	0.7	0.7	0.4
32.33333333	16.2	15.2	9.4	39	0.6	0.6	0.4
32.5	15	14	8.7	39.16666667	0.6	0.5	0.3
39.33333333	0.5	0.5	0.3	45.66666667	0	0	0
39.5	0.5	0.4	0.3	45.83333333	0	0	0
39.66666667	0.4	0.4	0.2	46	0	0	0
39.83333333	0.4	0.3	0.2	46.16666667	0	0	0
40	0.3	0.3	0.2	46.33333333	0	0	0
40.16666667	0.3	0.3	0.2	46.5	0	0	0
40.33333333	0.2	0.2	0.1	46.66666667	0	0	0
40.5	0.2	0.2	0.1	46.83333333	0	0	0
40.66666667	0.2	0.2	0.1	47	0	0	0
40.83333333	0.1	0.1	0.1	47.16666667	0	0	0
41	0.1	0.1	0.1	47.33333333	0	0	0
41.16666667	0.1	0.1	0.1	47.5	0	0	0
41.33333333	0.1	0.1	0	47.66666667	0	0	0
41.5	0.1	0	0	47.83333333	0	0	0
41.66666667	0	0	0	48	0	0	0
41.83333333	0	0	0				
42	0	0	0				
42.16666667	0	0	0				
42.33333333	0	0	0				
42.5	0	0	0				
42.66666667	0	0	0				
42.83333333	0	0	0				
43	0	0	0				
43.16666667	0	0	0				
43.33333333	0	0	0				
43.5	0	0	0				

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
43.66666667	0	0	0				
43.83333333	0	0	0				
44	0	0	0				
44.16666667	0	0	0				
44.33333333	0	0	0				
44.5	0	0	0				
44.66666667	0	0	0				
44.83333333	0	0	0				
45	0	0	0				
45.16666667	0	0	0				
45.33333333	0	0	0				
45.5	0	0	0				
45.66666667	0	0	0				
45.83333333	0	0	0				
46	0	0	0				
46.16666667	0	0	0				
46.33333333	0	0	0				
46.5	0	0	0				
46.66666667	0	0	0				
46.83333333	0	0	0				
47	0	0	0				
47.16666667	0	0	0				
47.33333333	0	0	0				
47.5	0	0	0				
47.66666667	0	0	0				
47.83333333	0	0	0				
48	0	0	0				

Appendix H. Jalaur (2) HEC-HMS Discharge Results

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
0	0	0	0	6.333333333	0.1	0.1	0
0.166666667	0	0	0	6.5	0.2	0.1	0
0.333333333	0	0	0	6.666666667	0.4	0.2	0
0.5	0	0	0	6.833333333	0.6	0.4	0
0.666666667	0	0	0	7	1	0.6	0
0.833333333	0	0	0	7.166666667	1.4	0.9	0
1	0	0	0	7.333333333	2	1.3	0
1.166666667	0	0	0	7.5	2.7	1.8	0
1.333333333	0	0	0	7.666666667	3.6	2.5	0
1.5	0	0	0	7.833333333	4.8	3.3	0
1.666666667	0	0	0	8	6.1	4.4	0.1
1.833333333	0	0	0	8.166666667	7.8	5.6	0.2
2	0	0	0	8.333333333	9.7	7.1	0.2
2.166666667	0	0	0	8.5	11.9	8.8	0.4
2.333333333	0	0	0	8.666666667	14.4	10.8	0.5
2.5	0	0	0	8.833333333	17.2	13	0.8
2.666666667	0	0	0	9	20.3	15.6	1.1
2.833333333	0	0	0	9.166666667	23.9	18.4	1.5
3	0	0	0	9.333333333	27.9	21.7	2
3.166666667	0	0	0	9.5	32.4	25.5	2.7
3.333333333	0	0	0	9.666666667	37.3	29.6	3.6
3.5	0	0	0	9.833333333	42.8	34.3	4.6
3.666666667	0	0	0	10	48.9	39.5	5.9
3.833333333	0	0	0	10.16666667	55.5	45.2	7.5
4	0	0	0	10.33333333	62.8	51.5	9.3
4.166666667	0	0	0	10.5	70.9	58.6	11.6
4.333333333	0	0	0	10.66666667	80	66.6	14.3
4.5	0	0	0	10.83333333	90.3	75.7	17.5
4.666666667	0	0	0	11	102.2	86.3	21.5
4.833333333	0	0	0	11.16666667	115.8	98.4	26.3
5	0	0	0	11.33333333	131.4	112.4	32
5.166666667	0	0	0	11.5	149.4	128.6	38.9
5.333333333	0	0	0	11.66666667	170.6	147.7	47.4
5.5	0	0	0	11.83333333	199.3	173.7	59.6
5.666666667	0	0	0	12	233.4	204.7	74.6
5.833333333	0	0	0	12.16666667	276	243.3	93.7
6	0	0	0	12.33333333	325.7	288.6	116.6
6.166666667	0	0	0	12.5	381.9	339.7	142.8

				11.83333333	133.7	85.8	38.8
				12	155.9	101.7	47.7
				12.16666667	179.8	118.8	57.3
12.66666667	160.4	126.9	48.7	19.33333333	2336	1987.9	1059.8
12.83333333	185.8	148	58.7	19.5	2375.1	2022.1	1080.2
13	213.1	170.8	69.8	19.66666667	2411.9	2054.3	1099.6
13.16666667	242.1	195	81.6	19.83333333	2446.1	2084.4	1117.8
13.33333333	272.8	220.7	94.2	20	2474.9	2109.8	1133.5
13.5	305.4	248	107.7	20.16666667	2499.8	2131.9	1147.4
13.66666667	341	277.9	122.7	20.33333333	2522.5	2152.1	1160.2
13.83333333	378.7	309.6	138.6	20.5	2542.9	2170.3	1171.9
14	418	342.7	155.4	20.66666667	2561.2	2186.7	1182.6
14.16666667	459	377.3	172.9	20.83333333	2576.9	2200.8	1192.1
14.33333333	501.7	413.4	191.4	21	2589.1	2212.1	1200
14.5	547.5	452.1	211.3	21.16666667	2599.1	2221.4	1206.8
14.66666667	596.3	493.5	232.7	21.33333333	2607.1	2229	1212.8
14.83333333	647.1	536.5	255.1	21.5	2613.1	2234.8	1217.7
15	699.4	580.9	278.3	21.66666667	2616.8	2238.7	1221.5
15.16666667	753.6	626.9	302.5	21.83333333	2615.1	2237.9	1222.9
15.33333333	810	674.9	327.8	22	2609.9	2234.2	1222.5
15.5	870.9	726.7	355.3	22.16666667	2602.7	2228.7	1221.1
15.66666667	934.2	780.7	384	22.33333333	2593.6	2221.7	1218.8
15.83333333	999.1	836	413.6	22.5	2582.8	2213.1	1215.6
16	1065.3	892.5	444	22.66666667	2569.9	2202.6	1211.4
16.16666667	1132.9	950.3	475.2	22.83333333	2554.6	2190.2	1206.1
16.33333333	1203.2	1010.4	507.8	23	2537.7	2176.4	1199.9
16.5	1275.7	1072.5	541.6	23.16666667	2519.3	2161.3	1193
16.66666667	1349.1	1135.4	576	23.33333333	2499.5	2144.9	1185.4
16.83333333	1423	1198.7	610.9	23.5	2478.4	2127.4	1177.1
17	1497.1	1262.3	646	23.66666667	2455.4	2108.3	1167.9
17.16666667	1570.3	1325.3	680.9	23.83333333	2431	2088	1158
17.33333333	1641.4	1386.4	715	24	2405.3	2066.6	1147.5
17.5	1711.3	1446.6	748.7	24.16666667	2378.4	2044	1136.3
17.66666667	1780.5	1506.3	782.2	24.33333333	2350.1	2020.4	1124.4
17.83333333	1848.7	1565.1	815.4	24.5	2319.9	1995	1111.6
18	1915.3	1622.6	847.9	24.66666667	2287.4	1967.8	1097.7
18.16666667	1977.5	1676.4	878.6	24.83333333	2253.5	1939.2	1083
18.33333333	2036.2	1727.2	907.8	25	2218.6	1909.7	1067.8
18.5	2093.1	1776.5	936.2	25.16666667	2182.5	1879.3	1052
18.66666667	2148.1	1824.2	963.7	25.33333333	2145.4	1848	1035.6
18.83333333	2201	1870.1	990.4	25.5	2105.9	1814.6	1018.1

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
19	2250.5	1913.2	1015.5	25.66666667	2065.3	1780.2	999.8
19.16666667	2294.7	1951.8	1038.3	25.83333333	2023.9	1745.1	981.2
26	1982	1709.5	962.2	32.66666667	789.1	687.4	395.7
26.16666667	1939.9	1673.8	943	32.83333333	768.4	669.4	385.4
26.33333333	1898.6	1638.7	924.2	33	748	651.7	375.4
26.5	1858.2	1604.4	905.6	33.16666667	727.9	634.3	365.4
26.66666667	1818.1	1570.2	887.1	33.33333333	708.1	617.1	355.6
26.83333333	1778.2	1536.2	868.6	33.5	688.6	600.2	346
27	1738.5	1502.4	850.2	33.66666667	670.1	584.1	336.8
27.16666667	1699.7	1469.3	832.1	33.83333333	652.2	568.6	327.8
27.33333333	1663.5	1438.4	815.2	34	634.7	553.3	319.1
27.5	1628.3	1408.4	798.7	34.16666667	617.5	538.3	310.5
27.66666667	1593.6	1378.7	782.4	34.33333333	600.6	523.7	302.1
27.83333333	1559.3	1349.4	766.3	34.5	584.1	509.3	293.8
28	1525.4	1320.5	750.3	34.66666667	567.9	495.2	285.7
28.16666667	1492.6	1292.4	734.8	34.83333333	552	481.4	277.8
28.33333333	1460.6	1265	719.7	35	536.5	467.9	270
28.5	1428.9	1237.9	704.7	35.16666667	521.2	454.6	262.4
28.66666667	1397.7	1211.2	689.9	35.33333333	506.3	441.6	254.9
28.83333333	1366.8	1184.8	675.2	35.5	492	429.1	247.7
29	1336.4	1158.7	660.7	35.66666667	478	416.9	240.6
29.16666667	1307	1133.5	646.7	35.83333333	464.4	405	233.8
29.33333333	1278.2	1108.8	632.9	36	451	393.3	227.1
29.5	1249.6	1084.3	619.2	36.16666667	437.9	381.9	220.5
29.66666667	1221.4	1060	605.7	36.33333333	425	370.7	214
29.83333333	1193.6	1036.1	592.4	36.5	412.5	359.8	207.7
30	1166.8	1013.1	579.5	36.66666667	400.2	349	201.5
30.16666667	1140.9	990.9	567	36.83333333	388.1	338.5	195.4
30.33333333	1115.4	968.9	554.6	37	376.4	328.3	189.5
30.5	1090.1	947.2	542.4	37.16666667	364.9	318.2	183.7
30.66666667	1065.1	925.6	530.4	37.33333333	354	308.7	178.2
30.83333333	1040.3	904.3	518.4	37.5	343.4	299.5	172.9
31	1015.8	883.2	506.5	37.66666667	333.1	290.5	167.7
31.16666667	991.6	862.3	494.7	37.83333333	323.1	281.8	162.6
31.33333333	967.5	841.6	483	38	313.4	273.3	157.7

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
31.5	943.8	821.1	471.4	38.16666667	303.9	265	153
31.66666667	920.4	800.8	460	38.33333333	294.8	257.1	148.4
31.83333333	897.6	781.1	448.9	38.5	285.9	249.3	143.9
32	875.2	761.9	437.9	38.66666667	277.2	241.8	139.5
32.16666667	853.2	742.8	427.2	38.83333333	268.8	234.4	135.3
32.33333333	831.6	724.1	416.5	39	260.7	227.3	131.2
32.5	810.2	705.6	406	39.16666667	253.1	220.7	127.4
39.33333333	245.7	214.3	123.7	45.66666667	79.6	69.4	40.1
39.5	238.6	208.1	120.1	45.83333333	77.3	67.4	38.9
39.66666667	231.7	202	116.6	46	75	65.4	37.7
39.83333333	225	196.2	113.2	46.16666667	72.8	63.4	36.6
40	218.4	190.4	109.9	46.33333333	70.6	61.6	35.5
40.16666667	212	184.9	106.7	46.5	68.6	59.8	34.5
40.33333333	205.8	179.5	103.6	46.66666667	66.6	58.1	33.5
40.5	199.8	174.2	100.5	46.83333333	64.7	56.4	32.5
40.66666667	193.9	169.1	97.6	47	62.8	54.8	31.6
40.83333333	188.2	164.1	94.7	47.16666667	61	53.2	30.7
41	182.8	159.4	92	47.33333333	59.3	51.7	29.8
41.16666667	177.5	154.8	89.3	47.5	57.6	50.2	28.9
41.33333333	172.4	150.4	86.8	47.66666667	55.9	48.7	28.1
41.5	167.5	146	84.3	47.83333333	54.3	47.3	27.3
41.66666667	162.6	141.8	81.8	48	52.7	46	26.5
41.83333333	157.9	137.7	79.5				
42	153.3	133.7	77.2				
42.16666667	148.9	129.8	74.9				
42.33333333	144.5	126	72.7				
42.5	140.2	122.3	70.6				
42.66666667	136.1	118.7	68.5				
42.83333333	132.1	115.2	66.5				
43	128.3	111.9	64.6				
44	107.4	93.6	54				
44.16666667	104.2	90.9	52.4				
44.33333333	101.1	88.2	50.9				
44.5	98.1	85.5	49.4				
44.66666667	95.2	83	47.9				

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
44.83333333	92.4	80.6	46.5				
45	89.7	78.2	45.1				
45.16666667	87.1	75.9	43.8				
45.33333333	84.5	73.7	42.5				
45.5	82.1	71.5	41.3				
45.66666667	0	0	0				
45.83333333	0	0	0				
46	0	0	0				
46.16666667	0	0	0				
46.33333333	0	0	0				
46.5	0	0	0				
46.66666667	0	0	0				
46.83333333	0	0	0				
47	0	0	0				
47.16666667	0	0	0				
47.33333333	0	0	0				
47.5	0	0	0				
47.66666667	0	0	0				
47.83333333	0	0	0				
48	0	0	0				

Appendix I. Jalaur (3) HEC-HMS Discharge Results

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
0	0	0	0	6.333333333	0	0	0
0.166666667	0	0	0	6.5	0	0	0
0.333333333	0	0	0	6.666666667	0	0	0
0.5	0	0	0	6.833333333	0	0	0
0.666666667	0	0	0	7	0.1	0	0
0.833333333	0	0	0	7.166666667	0.1	0	0
1	0	0	0	7.333333333	0.1	0.1	0
1.166666667	0	0	0	7.5	0.2	0.1	0
1.333333333	0	0	0	7.666666667	0.3	0.2	0
1.5	0	0	0	7.833333333	0.4	0.2	0
1.666666667	0	0	0	8	0.6	0.3	0
1.833333333	0	0	0	8.166666667	0.8	0.4	0
2	0	0	0	8.333333333	1	0.6	0
2.166666667	0	0	0	8.5	1.2	0.7	0
2.333333333	0	0	0	8.666666667	1.6	0.9	0
2.5	0	0	0	8.833333333	1.9	1.2	0
2.666666667	0	0	0	9	2.4	1.5	0
2.833333333	0	0	0	9.166666667	2.9	1.9	0.1
3	0	0	0	9.333333333	3.5	2.3	0.1
3.166666667	0	0	0	9.5	4.3	2.8	0.1
3.333333333	0	0	0	9.666666667	5.1	3.4	0.2
3.5	0	0	0	9.833333333	6	4.2	0.3
3.666666667	0	0	0	10	7.1	5	0.4
3.833333333	0	0	0	10.16666667	8.3	5.9	0.6
4	0	0	0	10.33333333	9.7	7	0.8
4.166666667	0	0	0	10.5	11.3	8.2	1.1
4.333333333	0	0	0	10.66666667	13	9.6	1.4
4.5	0	0	0	10.83333333	15	11.3	1.8
4.666666667	0	0	0	11	17.4	13.2	2.4
4.833333333	0	0	0	11.16666667	20.1	15.5	3.1
5	0	0	0	11.33333333	23.3	18.1	3.9
5.166666667	0	0	0	11.5	27	21.2	5
5.333333333	0	0	0	11.66666667	31.3	24.9	6.4
5.5	0	0	0	11.83333333	37.4	30.1	8.5
5.666666667	0	0	0	12	44.6	36.3	11.2
5.833333333	0	0	0	12.16666667	53.1	43.7	14.5
6	0	0	0	12.33333333	63.5	52.8	18.7

6.166666667	0	0	0	12.5	75.2	62.9	23.5
				11.83333333	133.7	85.8	38.8
				12	155.9	101.7	47.7
				12.16666667	179.8	118.8	57.3
12.66666667	88.3	74.4	29	19.33333333	328	292	159.9
12.83333333	102.8	87.1	35.2	19.5	316.3	281.6	154.4
13	118.5	100.9	42	19.66666667	304.8	271.4	149.1
13.16666667	136.1	116.4	49.8	19.83333333	293.9	261.7	144
13.33333333	155.1	133.1	58.3	20	283.3	252.3	139
13.5	175.5	151.1	67.4	20.16666667	273	243.2	134.2
13.66666667	197.6	170.6	77.5	20.33333333	263.3	234.6	129.6
13.83333333	220.7	191.1	88.2	20.5	253.8	226.2	125.2
14	245.1	212.6	99.6	20.66666667	244.9	218.3	120.9
14.16666667	270.3	234.9	111.5	20.83333333	236.4	210.7	116.9
14.33333333	295.5	257.4	123.5	21	228.1	203.3	112.9
14.5	319.7	278.9	135.2	21.16666667	219.9	196.1	109
14.66666667	343.2	299.8	146.7	21.33333333	211.9	189	105.2
14.83333333	365.5	319.7	157.7	21.5	204.2	182.2	101.5
15	385.8	337.9	168	21.66666667	196.8	175.6	98
15.16666667	404.8	354.9	177.6	21.83333333	189.7	169.3	94.6
15.33333333	421.4	369.9	186.3	22	182.7	163.2	91.3
15.5	435.9	383	194	22.16666667	176	157.3	88.2
15.66666667	448.7	394.6	201	22.33333333	169.5	151.5	85.1
15.83333333	458.5	403.5	206.6	22.5	163.6	146.3	82.2
16	466.3	410.7	211.3	22.66666667	157.9	141.2	79.5
16.16666667	472.5	416.5	215.3	22.83333333	152.3	136.3	76.9
16.33333333	476.8	420.7	218.3	23	147	131.6	74.4
16.5	479.6	423.4	220.7	23.16666667	141.9	127.1	71.9
16.66666667	479.9	424	221.8	23.33333333	137.1	122.9	69.6
16.83333333	478.1	422.6	222	23.5	132.6	118.9	67.5
17	475	420.1	221.5	23.66666667	128.2	115	65.4
17.16666667	470.4	416.3	220.2	23.83333333	124.1	111.4	63.4
17.33333333	464.6	411.4	218.3	24	120	107.8	61.5
17.5	457.7	405.6	215.9	24.16666667	116.2	104.4	59.7
17.66666667	449.6	398.6	212.9	24.33333333	112.6	101.3	58
17.83333333	440.6	390.8	209.3	24.5	109.2	98.2	56.3
18	430.4	381.9	205.1	24.66666667	105.9	95.3	54.8
18.16666667	419.1	372.1	200.4	24.83333333	102.7	92.5	53.2
18.33333333	407.1	361.6	195.3	25	99.7	89.8	51.8
18.5	394	350.1	189.6	25.16666667	96.8	87.3	50.4

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
18.66666667	380.4	338.1	183.6	25.33333333	94.1	84.9	49.1
18.83333333	366.7	326.1	177.5	25.5	91.4	82.5	47.7
19	353.5	314.4	171.5	25.66666667	88.7	80.1	46.4
19.16666667	340.4	302.9	165.5	25.83333333	86.1	77.8	45.1
26	83.5	75.5	43.9	32.66666667	9.8	8.9	5.3
26.16666667	81	73.2	42.6	32.83333333	9.1	8.3	4.9
26.33333333	78.4	70.9	41.3	33	8.5	7.7	4.6
26.5	75.8	68.5	40	33.16666667	7.9	7.2	4.3
26.66666667	73.1	66.2	38.6	33.33333333	7.3	6.7	4
26.83333333	70.5	63.8	37.3	33.5	6.8	6.2	3.7
27	67.9	61.4	35.9	33.66666667	6.3	5.7	3.4
27.16666667	65.2	59.1	34.5	33.83333333	5.8	5.3	3.2
27.33333333	62.6	56.7	33.2	34	5.4	4.9	3
27.5	60	54.3	31.8	34.16666667	5	4.6	2.8
27.66666667	57.4	52	30.5	34.33333333	4.7	4.3	2.6
27.83333333	54.8	49.7	29.1	34.5	4.4	4	2.4
28	52.3	47.4	27.8	34.66666667	4.1	3.7	2.2
28.16666667	49.8	45.2	26.5	34.83333333	3.8	3.5	2.1
28.33333333	47.4	43	25.2	35	3.6	3.3	2
28.5	45	40.8	24	35.16666667	3.3	3	1.8
28.66666667	42.7	38.7	22.8	35.33333333	3.1	2.8	1.7
28.83333333	40.5	36.7	21.6	35.5	2.9	2.7	1.6
29	38.4	34.8	20.4	35.66666667	2.7	2.5	1.5
29.16666667	36.3	32.9	19.3	35.83333333	2.5	2.3	1.4
29.33333333	34.3	31.1	18.3	36	2.4	2.2	1.3
29.5	32.3	29.3	17.2	36.16666667	2.2	2	1.2
29.66666667	30.5	27.7	16.3	36.33333333	2.1	1.9	1.1
29.83333333	28.7	26.1	15.3	36.5	1.9	1.8	1.1
30	27	24.5	14.4	36.66666667	1.8	1.7	1
30.16666667	25.4	23.1	13.6	36.83333333	1.7	1.5	0.9
30.33333333	23.9	21.7	12.7	37	1.6	1.4	0.9
30.5	22.4	20.4	12	37.16666667	1.5	1.3	0.8
30.66666667	21.1	19.1	11.2	37.33333333	1.4	1.3	0.8
30.83333333	19.8	18	10.6	37.5	1.3	1.2	0.7
31	18.6	16.9	9.9	37.66666667	1.2	1.1	0.7

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
31.16666667	17.5	15.8	9.3	37.83333333	1.1	1	0.6
31.33333333	16.4	14.9	8.8	38	1	1	0.6
31.5	15.4	14	8.2	38.16666667	1	0.9	0.5
31.66666667	14.5	13.1	7.7	38.33333333	0.9	0.8	0.5
31.83333333	13.6	12.3	7.3	38.5	0.8	0.8	0.5
32	12.7	11.6	6.8	38.66666667	0.8	0.7	0.4
32.16666667	11.9	10.8	6.4	38.83333333	0.7	0.7	0.4
32.33333333	11.2	10.1	6	39	0.7	0.6	0.4
32.5	10.5	9.5	5.6	39.16666667	0.6	0.6	0.3
39.33333333	0.6	0.5	0.3	45.66666667	0	0	0
39.5	0.5	0.5	0.3	45.83333333	0	0	0
39.66666667	0.5	0.5	0.3	46	0	0	0
39.83333333	0.5	0.4	0.3	46.16666667	0	0	0
40	0.4	0.4	0.2	46.33333333	0	0	0
40.16666667	0.4	0.4	0.2	46.5	0	0	0
40.33333333	0.4	0.4	0.2	46.66666667	0	0	0
40.5	0.4	0.3	0.2	46.83333333	0	0	0
40.66666667	0.3	0.3	0.2	47	0	0	0
40.83333333	0.3	0.3	0.2	47.16666667	0	0	0
41	0.3	0.3	0.2	47.33333333	0	0	0
41.16666667	0.3	0.2	0.1	47.5	0	0	0
41.33333333	0.2	0.2	0.1	47.66666667	0	0	0
41.5	0.2	0.2	0.1	47.83333333	0	0	0
41.66666667	0.2	0.2	0.1	48	0	0	0
41.83333333	0.2	0.2	0.1				
42	0.2	0.2	0.1				
42.16666667	0.2	0.1	0.1				
42.33333333	0.1	0.1	0.1				
42.5	0.1	0.1	0.1				
42.66666667	0.1	0.1	0.1				
42.83333333	0.1	0.1	0.1				
43	0.1	0.1	0.1				
43.16666667	0.1	0.1	0				
43.33333333	0.1	0.1	0				
43.5	0.1	0.1	0				
43.66666667	0.1	0.1	0				

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
43.83333333	0	0	0				
44	0	0	0				
44.16666667	0	0	0				
44.33333333	0	0	0				
44.5	0	0	0				
44.66666667	0	0	0				
44.83333333	0	0	0				
45	0	0	0				
45.16666667	0	0	0				
45.33333333	0	0	0				
45.5	0	0	0				
45.66666667	0	0	0				
45.83333333	0	0	0				
46	0	0	0				
46.16666667	0	0	0				
46.33333333	0	0	0				
46.5	0	0	0				
46.66666667	0	0	0				
46.83333333	0	0	0				
47	0	0	0				
47.16666667	0	0	0				
47.33333333	0	0	0				
47.5	0	0	0				
47.66666667	0	0	0				
47.83333333	0	0	0				
48	0	0	0				

Appendix J. Jalaur (4) HEC-HMS Discharge Results

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
0	0	0	0	6.333333333	0	0	0
0.166666667	0	0	0	6.5	0	0	0
0.333333333	0	0	0	6.666666667	0	0	0
0.5	0	0	0	6.833333333	0	0	0
0.666666667	0	0	0	7	0	0	0
0.833333333	0	0	0	7.166666667	0.1	0	0
1	0	0	0	7.333333333	0.1	0.1	0
1.166666667	0	0	0	7.5	0.2	0.1	0
1.333333333	0	0	0	7.666666667	0.3	0.2	0
1.5	0	0	0	7.833333333	0.4	0.2	0
1.666666667	0	0	0	8	0.6	0.3	0
1.833333333	0	0	0	8.166666667	0.8	0.5	0
2	0	0	0	8.333333333	1	0.6	0
2.166666667	0	0	0	8.5	1.3	0.9	0
2.333333333	0	0	0	8.666666667	1.6	1.1	0
2.5	0	0	0	8.833333333	2	1.4	0
2.666666667	0	0	0	9	2.5	1.7	0
2.833333333	0	0	0	9.166666667	3	2.1	0
3	0	0	0	9.333333333	3.6	2.6	0.1
3.166666667	0	0	0	9.5	4.2	3.2	0.1
3.333333333	0	0	0	9.666666667	5	3.8	0.2
3.5	0	0	0	9.833333333	5.8	4.5	0.3
3.666666667	0	0	0	10	6.8	5.3	0.5
3.833333333	0	0	0	10.16666667	7.9	6.2	0.7
4	0	0	0	10.33333333	9.1	7.3	0.9
4.166666667	0	0	0	10.5	10.5	8.5	1.3
4.333333333	0	0	0	10.66666667	12	9.9	1.7
4.5	0	0	0	10.83333333	13.9	11.5	2.2
4.666666667	0	0	0	11	16	13.4	2.8
4.833333333	0	0	0	11.16666667	18.4	15.6	3.7
5	0	0	0	11.33333333	21.3	18.2	4.7
5.166666667	0	0	0	11.5	24.7	21.2	5.9
5.333333333	0	0	0	11.66666667	28.9	25	7.5
5.5	0	0	0	11.83333333	34.9	30.4	10
5.666666667	0	0	0	12	42.7	37.4	13.3
5.833333333	0	0	0	12.16666667	52.5	46.3	17.5
6	0	0	0	12.33333333	64.1	56.8	22.7

6.166666667	0	0	0	12.5	77.2	68.7	28.6
				11.83333333	133.7	85.8	38.8
				12	155.9	101.7	47.7
				12.16666667	179.8	118.8	57.3
12.66666667	92.2	82.3	35.5	19.33333333	66.4	60.9	34
12.83333333	109.1	97.6	43.4	19.5	63.4	58.1	32.5
13	127.5	114.4	52.1	19.66666667	60.4	55.5	31.1
13.16666667	147.3	132.4	61.6	19.83333333	57.6	52.9	29.7
13.33333333	166.8	150.2	71.1	20	54.9	50.4	28.4
13.5	185.3	167	80.2	20.16666667	52.2	48	27.1
13.66666667	201.4	181.7	88.4	20.33333333	49.7	45.7	25.9
13.83333333	215.2	194.5	95.6	20.5	47.3	43.5	24.7
14	226.6	205	101.7	20.66666667	45	41.4	23.6
14.16666667	235	212.8	106.5	20.83333333	42.8	39.4	22.5
14.33333333	241	218.4	110.2	21	40.8	37.6	21.5
14.5	244.7	221.9	112.8	21.16666667	38.9	35.9	20.6
14.66666667	245.5	222.9	114	21.33333333	37.1	34.3	19.7
14.83333333	243.8	221.5	114.1	21.5	35.5	32.8	19
15	240.1	218.4	113.1	21.66666667	34	31.5	18.2
15.16666667	234.8	213.8	111.4	21.83333333	32.7	30.3	17.6
15.33333333	228.2	207.9	109	22	31.5	29.2	17
15.5	219.9	200.5	105.7	22.16666667	30.5	28.2	16.5
15.66666667	210.2	191.9	101.7	22.33333333	29.5	27.4	16.1
15.83333333	199.5	182.3	97.1	22.5	28.7	26.7	15.7
16	188.8	172.6	92.4	22.66666667	27.9	26	15.3
16.16666667	178.3	163.2	87.8	22.83333333	27.3	25.4	15
16.33333333	168.6	154.4	83.4	23	26.6	24.8	14.7
16.5	159.3	146	79.1	23.16666667	26.1	24.3	14.4
16.66666667	150.3	137.8	74.9	23.33333333	25.5	23.8	14.1
16.83333333	141.8	130.1	70.9	23.5	25	23.3	13.9
17	134	122.9	67.2	23.66666667	24.6	22.9	13.7
17.16666667	126.7	116.2	63.7	23.83333333	24.2	22.6	13.5
17.33333333	119.8	109.9	60.4	24	23.8	22.2	13.3
17.5	113.4	104	57.3	24.16666667	23.4	21.8	13.1
17.66666667	107.4	98.6	54.3	24.33333333	23	21.5	12.9
17.83333333	101.9	93.5	51.6	24.5	22.5	21.1	12.7
18	96.7	88.7	49.1	24.66666667	22.1	20.6	12.4
18.16666667	92.1	84.5	46.8	24.83333333	21.5	20.1	12.2
18.33333333	87.7	80.4	44.6	25	21	19.6	11.9

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
18.5	83.5	76.6	42.5	25.16666667	20.3	19	11.5
18.66666667	79.7	73.1	40.6	25.33333333	19.6	18.3	11.1
18.83333333	76.1	69.8	38.8	25.5	18.8	17.6	10.6
19	72.7	66.7	37.1	25.66666667	17.9	16.7	10.1
19.16666667	69.5	63.7	35.6	25.83333333	16.9	15.8	9.6
26	15.9	14.9	9	32.66666667	0.3	0.2	0.1
26.16666667	14.8	13.9	8.4	32.83333333	0.2	0.2	0.1
26.33333333	13.8	12.9	7.8	33	0.2	0.2	0.1
26.5	12.7	11.9	7.2	33.16666667	0.2	0.2	0.1
26.66666667	11.7	11	6.6	33.33333333	0.2	0.2	0.1
26.83333333	10.7	10	6.1	33.5	0.1	0.1	0.1
27	9.7	9.1	5.5	33.66666667	0.1	0.1	0.1
27.16666667	8.8	8.3	5	33.83333333	0.1	0.1	0.1
27.33333333	8	7.5	4.5	34	0.1	0.1	0.1
27.5	7.2	6.7	4.1	34.16666667	0.1	0.1	0.1
27.66666667	6.4	6	3.7	34.33333333	0.1	0.1	0
27.83333333	5.8	5.4	3.3	34.5	0.1	0.1	0
28	5.2	4.9	2.9	34.66666667	0.1	0.1	0
28.16666667	4.7	4.4	2.7	34.83333333	0	0	0
28.33333333	4.2	3.9	2.4	35	0	0	0
28.5	3.8	3.6	2.2	35.66666667	0	0	0
28.66666667	3.4	3.2	1.9	35.83333333	0	0	0
28.83333333	3.1	2.9	1.8	36	0	0	0
29	2.8	2.6	1.6				
29.16666667	2.5	2.3	1.4				
29.33333333	2.2	2.1	1.3				
29.5	2	1.9	1.2				
29.66666667	1.8	1.7	1				
29.83333333	1.6	1.5	0.9				
30	1.5	1.4	0.8				
30.16666667	1.3	1.2	0.8				
30.33333333	1.2	1.1	0.7				
30.5	1.1	1	0.6				
30.66666667	1	0.9	0.5				
30.83333333	0.9	0.8	0.5				
31	0.8	0.7	0.4				

DIRECT FLOW (cms)							
Time (hr)	**100-yr**	**25-yr**	**5-year**	**Time (hr)**	**100-yr**	**25-yr**	**5-year**
31.16666667	0.7	0.6	0.4				
31.33333333	0.6	0.6	0.4				
31.5	0.6	0.5	0.3				
31.66666667	0.5	0.5	0.3				
31.83333333	0.5	0.4	0.3				
32	0.4	0.4	0.2				
32.16666667	0.4	0.3	0.2				
32.33333333	0.3	0.3	0.2				
32.5	0.3	0.3	0.2				

Appendix K. Jalaur (5) HEC-HMS Discharge Results

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
0	0	0	0	6.333333333	0	0	0
0.166666667	0	0	0	6.5	0.1	0	0
0.333333333	0	0	0	6.666666667	0.1	0.1	0
0.5	0	0	0	6.833333333	0.2	0.1	0
0.666666667	0	0	0	7	0.3	0.2	0
0.833333333	0	0	0	7.166666667	0.4	0.2	0
1	0	0	0	7.333333333	0.5	0.3	0
1.166666667	0	0	0	7.5	0.6	0.5	0
1.333333333	0	0	0	7.666666667	0.8	0.6	0
1.5	0	0	0	7.833333333	1.1	0.8	0
1.666666667	0	0	0	8	1.4	1	0
1.833333333	0	0	0	8.166666667	1.7	1.3	0.1
2	0	0	0	8.333333333	2.1	1.6	0.1
2.166666667	0	0	0	8.5	2.6	1.9	0.1
2.333333333	0	0	0	8.666666667	3.1	2.3	0.2
2.5	0	0	0	8.833333333	3.7	2.8	0.2
2.666666667	0	0	0	9	4.4	3.4	0.3
2.833333333	0	0	0	9.166666667	5.2	4	0.4
3	0	0	0	9.333333333	6.1	4.8	0.5
3.166666667	0	0	0	9.5	7.1	5.6	0.7
3.333333333	0	0	0	9.666666667	8.3	6.6	0.8
3.5	0	0	0	9.833333333	9.6	7.7	1.1
3.666666667	0	0	0	10	11	8.9	1.4
3.833333333	0	0	0	10.16666667	12.6	10.2	1.7
4	0	0	0	10.33333333	14.4	11.7	2.1
4.166666667	0	0	0	10.5	16.3	13.4	2.6
4.333333333	0	0	0	10.66666667	18.5	15.3	3.2
4.5	0	0	0	10.83333333	20.9	17.4	3.9
4.666666667	0	0	0	11	23.7	19.8	4.7
4.833333333	0	0	0	11.16666667	26.9	22.6	5.7
5	0	0	0	11.33333333	30.4	25.8	6.9
5.166666667	0	0	0	11.5	34.5	29.5	8.4
5.333333333	0	0	0	11.66666667	39.4	33.8	10.2
5.5	0	0	0	11.83333333	45.9	39.6	12.8
5.666666667	0	0	0	12	53.5	46.4	16
5.833333333	0	0	0	12.16666667	62	54.1	19.6
6	0	0	0	12.33333333	72.6	63.7	24.3

6.166666667	0	0	0	12.5	84.6	74.6	29.7
				11.83333333	133.7	85.8	38.8
				12	155.9	101.7	47.7
				12.16666667	179.8	118.8	57.3
12.66666667	97.5	86.4	35.7	19.33333333	474.4	435.6	242.9
12.83333333	112.1	99.6	42.4	19.5	459.9	422.3	236
13	127.8	114	49.8	19.66666667	445.1	408.8	228.8
13.16666667	144.6	129.3	57.8	19.83333333	430.4	395.4	221.7
13.33333333	163.3	146.4	66.8	20	416.1	382.3	214.7
13.5	183.3	164.5	76.4	20.16666667	401.8	369.3	207.7
13.66666667	204.2	183.7	86.6	20.33333333	388.1	356.8	200.9
13.83333333	227.2	204.7	97.9	20.5	375.2	344.9	194.5
14	251.2	226.7	109.8	20.66666667	362.6	333.4	188.2
14.16666667	276	249.4	122.2	20.83333333	350.4	322.2	182.1
14.33333333	302.2	273.4	135.4	21	338.7	311.5	176.2
14.5	329	297.9	149	21.16666667	327.2	301	170.5
14.66666667	355.8	322.5	162.7	21.33333333	316.2	290.9	165
14.83333333	381.7	346.4	176.1	21.5	305.7	281.3	159.7
15	406.8	369.5	189.2	21.66666667	295.5	271.9	154.5
15.16666667	431.1	391.8	202	21.83333333	285.7	262.9	149.6
15.33333333	453.5	412.5	213.9	22	276.4	254.5	144.9
15.5	474.1	431.5	225	22.16666667	267.5	246.3	140.4
15.66666667	493.5	449.4	235.5	22.33333333	258.8	238.3	136
15.83333333	510.4	465.1	244.9	22.5	250.2	230.5	131.7
16	525.3	478.9	253.2	22.66666667	242	222.9	127.6
16.16666667	538.6	491.3	260.8	22.83333333	234	215.6	123.6
16.33333333	549.2	501.3	267.1	23	226.5	208.7	119.8
16.5	557.7	509.3	272.4	23.16666667	219.1	202	116.1
16.66666667	564.7	515.9	276.9	23.33333333	212	195.5	112.6
16.83333333	569.9	520.9	280.4	23.5	205.1	189.2	109.1
17	573.5	524.3	283.2	23.66666667	198.4	183.1	105.8
17.16666667	575.7	526.5	285.2	23.83333333	192	177.3	102.6
17.33333333	575.4	526.5	286	24	186.1	171.8	99.6
17.5	573.1	524.6	285.7	24.16666667	180.4	166.6	96.7
17.66666667	569.6	521.5	284.8	24.33333333	174.9	161.6	94
17.83333333	564.7	517.2	283.1	24.5	169.5	156.7	91.3
18	558.7	511.9	280.8	24.66666667	164.3	152	88.7
18.16666667	551.6	505.6	278	24.83333333	159.3	147.4	86.1
18.33333333	543.5	498.2	274.6	25	154.5	143	83.7
18.5	534.3	490	270.6	25.16666667	149.9	138.9	81.4
18.66666667	524.3	480.9	266.1	25.33333333	145.5	134.8	79.2

Appendix

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
18.83333333	513.1	470.8	261.1	25.5	141.1	130.8	76.9
19	500.9	459.7	255.4	25.66666667	136.8	126.9	74.8
19.16666667	488.1	448	249.4	25.83333333	132.7	123.1	72.7
26	128.8	119.5	70.6	32.66666667	21.1	19.6	11.8
26.16666667	124.9	116	68.6	32.83333333	20	18.6	11.2
26.33333333	121.2	112.5	66.7	33	19	17.7	10.6
26.5	117.4	109	64.7	33.16666667	18	16.8	10.1
26.66666667	113.6	105.6	62.7	33.33333333	17.1	15.9	9.6
26.83333333	109.9	102.2	60.8	33.5	16.2	15.1	9.1
27	106.3	98.8	58.9	33.66666667	15.4	14.3	8.6
27.16666667	102.8	95.6	57	33.83333333	14.5	13.6	8.2
27.33333333	99.2	92.3	55.1	34	13.8	12.8	7.7
27.5	95.7	89	53.2	34.16666667	13	12.1	7.3
27.66666667	92.2	85.8	51.3	34.33333333	12.3	11.5	6.9
27.83333333	88.7	82.6	49.4	34.5	11.6	10.8	6.5
28	85.3	79.4	47.5	34.66666667	11	10.2	6.2
28.16666667	82	76.3	45.7	34.83333333	10.3	9.6	5.8
28.33333333	78.7	73.3	43.9	35	9.7	9.1	5.5
28.5	75.5	70.3	42.1	35.16666667	9.2	8.6	5.2
28.66666667	72.3	67.3	40.4	35.33333333	8.6	8	4.9
28.83333333	69.2	64.4	38.7	35.5	8.1	7.5	4.6
29	66.1	61.6	37	35.66666667	7.6	7.1	4.3
29.16666667	63.2	58.9	35.3	35.83333333	7.1	6.6	4
29.33333333	60.3	56.2	33.7	36	6.6	6.2	3.8
29.5	57.5	53.5	32.2	36.16666667	6.2	5.8	3.5
29.66666667	54.7	51	30.6	36.33333333	5.8	5.4	3.3
29.83333333	52.1	48.5	29.2	36.5	5.4	5	3.1
30	49.5	46.2	27.8	36.66666667	5	4.7	2.9
30.16666667	47.1	43.9	26.4	36.83333333	4.6	4.3	2.7
30.33333333	44.7	41.7	25.1	37	4.3	4	2.5
30.5	42.4	39.5	23.8	37.16666667	4	3.8	2.3
30.66666667	40.2	37.5	22.5	37.33333333	3.8	3.5	2.2
30.83333333	38.1	35.5	21.3	37.5	3.5	3.3	2
31	36.1	33.6	20.2	37.66666667	3.3	3.1	1.9
31.16666667	34.2	31.8	19.1	37.83333333	3.1	2.9	1.8

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
31.33333333	32.3	30.1	18.1	38	2.9	2.7	1.7
31.5	30.6	28.5	17.1	38.16666667	2.7	2.5	1.6
31.66666667	29	27	16.2	38.33333333	2.6	2.4	1.5
31.83333333	27.4	25.5	15.4	38.5	2.4	2.2	1.4
32	26	24.2	14.6	38.66666667	2.3	2.1	1.3
32.16666667	24.7	23	13.8	38.83333333	2.1	2	1.2
32.33333333	23.4	21.8	13.1	39	2	1.9	1.2
32.5	22.2	20.7	12.4	39.16666667	1.9	1.8	1.1
39.33333333	1.8	1.6	1	45.66666667	0.1	0.1	0.1
39.5	1.6	1.5	1	45.83333333	0.1	0.1	0.1
39.66666667	1.5	1.5	0.9	46	0.1	0.1	0.1
39.83333333	1.5	1.4	0.8	46.16666667	0.1	0.1	0.1
40	1.4	1.3	0.8	46.33333333	0.1	0.1	0
40.16666667	1.3	1.2	0.7	46.5	0.1	0.1	0
40.33333333	1.2	1.1	0.7	46.66666667	0.1	0.1	0
40.5	1.1	1.1	0.7	46.83333333	0.1	0	0
40.66666667	1.1	1	0.6	47	0	0	0
40.83333333	1	0.9	0.6	47.16666667	0	0	0
41	0.9	0.9	0.5	47.33333333	0	0	0
41.16666667	0.9	0.8	0.5	47.5	0	0	0
41.33333333	0.8	0.8	0.5	47.66666667	0	0	0
41.5	0.8	0.7	0.4	47.83333333	0	0	0
41.66666667	0.7	0.7	0.4	48	0	0	0
41.83333333	0.7	0.6	0.4				
42	0.6	0.6	0.4				
42.16666667	0.6	0.5	0.3				
42.33333333	0.5	0.5	0.3				
42.5	0.5	0.5	0.3				
42.66666667	0.5	0.4	0.3				
42.83333333	0.4	0.4	0.3				
43	0.4	0.4	0.2				
43.16666667	0.4	0.4	0.2				
43.33333333	0.4	0.3	0.2				
43.5	0.3	0.3	0.2				
43.66666667	0.3	0.3	0.2				
43.83333333	0.3	0.3	0.2				

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
44	0.3	0.3	0.2				
44.16666667	0.3	0.2	0.2				
44.33333333	0.2	0.2	0.1				
44.5	0.2	0.2	0.1				
44.66666667	0.2	0.2	0.1				
44.83333333	0.2	0.2	0.1				
45	0.2	0.2	0.1				
45.16666667	0.2	0.2	0.1				
45.33333333	0.1	0.1	0.1				
45.5	0.1	0.1	0.1				
45.66666667	0	0	0				
45.83333333	0	0	0				
46	0	0	0				
46.16666667	0	0	0				
46.33333333	0	0	0				
46.5	0	0	0				
46.66666667	0	0	0				
46.83333333	0	0	0				
47	0	0	0				
47.16666667	0	0	0				
47.33333333	0	0	0				
47.5	0	0	0				
47.66666667	0	0	0				
47.83333333	0	0	0				
48	0	0	0				

Appendix L. Jalaur (6) HEC-HMS Discharge Results

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
0	0	0	0	6.333333333	0.2	0.1	0
0.166666667	0	0	0	6.5	0.3	0.1	0
0.333333333	0	0	0	6.666666667	0.4	0.2	0
0.5	0	0	0	6.833333333	0.6	0.4	0
0.666666667	0	0	0	7	0.8	0.5	0
0.833333333	0	0	0	7.166666667	1.1	0.8	0
1	0	0	0	7.333333333	1.5	1	0
1.166666667	0	0	0	7.5	2	1.4	0
1.333333333	0	0	0	7.666666667	2.5	1.8	0.1
1.5	0	0	0	7.833333333	3.2	2.3	0.1
1.666666667	0	0	0	8	4	3	0.1
1.833333333	0	0	0	8.166666667	5	3.7	0.2
2	0	0	0	8.333333333	6.1	4.6	0.3
2.166666667	0	0	0	8.5	7.3	5.6	0.4
2.333333333	0	0	0	8.666666667	8.8	6.7	0.5
2.5	0	0	0	8.833333333	10.4	8.1	0.7
2.666666667	0	0	0	9	12.3	9.6	0.9
2.833333333	0	0	0	9.166666667	14.4	11.3	1.2
3	0	0	0	9.333333333	16.7	13.2	1.6
3.166666667	0	0	0	9.5	19.4	15.4	2
3.333333333	0	0	0	9.666666667	22.3	17.9	2.6
3.5	0	0	0	9.833333333	25.6	20.7	3.3
3.666666667	0	0	0	10	29.2	23.8	4.1
3.833333333	0	0	0	10.16666667	33.1	27.1	5
4	0	0	0	10.33333333	37.4	30.9	6.1
4.166666667	0	0	0	10.5	42.2	35	7.4
4.333333333	0	0	0	10.66666667	47.5	39.7	9
4.5	0	0	0	10.83333333	53.4	44.8	10.8
4.666666667	0	0	0	11	60.2	50.8	13
4.833333333	0	0	0	11.16666667	67.8	57.6	15.7
5	0	0	0	11.33333333	76.5	65.3	18.8
5.166666667	0	0	0	11.5	86.4	74.2	22.5
5.333333333	0	0	0	11.66666667	98.1	84.7	27.1
5.5	0	0	0	11.83333333	113.7	98.8	33.6
5.666666667	0	0	0	12	131.8	115.2	41.5
5.833333333	0	0	0	12.16666667	152.6	134.1	50.8

6	0.1	0	0	12.33333333	178.2	157.4	62.4
6.166666667	0.1	0	0	12.5	206.8	183.4	75.7
				11.83333333	133.7	85.8	38.8
				12	155.9	101.7	47.7
				12.16666667	179.8	118.8	57.3
12.66666667	238.2	212	90.5	19.33333333	910.8	837.6	473.4
12.83333333	273.1	243.8	107.1	19.5	878.2	807.8	457.2
13	310.6	278.1	125.2	19.66666667	846.1	778.4	441.3
13.16666667	351.8	315.7	145.2	19.83333333	816.4	751.2	426.4
13.33333333	396.7	356.7	167.2	20	787.7	724.9	411.9
13.5	444	400.1	190.7	20.16666667	759.8	699.2	397.8
13.66666667	495.6	447.3	216.4	20.33333333	733	674.7	384.3
13.83333333	550.3	497.4	243.9	20.5	707	650.8	371.1
14	606.7	549.1	272.5	20.66666667	681.9	627.8	358.4
14.16666667	666.3	603.8	302.8	20.83333333	658.1	605.9	346.2
14.33333333	727.1	659.6	334.1	21	634.9	584.6	334.4
14.5	787.6	715.2	365.5	21.16666667	612.8	564.4	323.2
14.66666667	845.5	768.5	395.9	21.33333333	591.9	545.2	312.5
14.83333333	901.6	820.2	425.5	21.5	571.6	526.5	302.1
15	955	869.3	453.9	21.66666667	551.6	508.2	292
15.16666667	1003.3	914	480.1	21.83333333	532.2	490.4	282.1
15.33333333	1048.3	955.6	504.6	22	513.2	473.1	272.4
15.5	1088.7	993	527	22.16666667	495.3	456.7	263.3
15.66666667	1123.4	1025.3	546.6	22.33333333	478.2	440.9	254.6
15.83333333	1154	1053.8	564.2	22.5	461.4	425.6	246.1
16	1178.9	1077.1	578.9	22.66666667	445.2	410.8	237.9
16.16666667	1198.1	1095.2	590.9	22.83333333	429.5	396.4	229.9
16.33333333	1213.6	1109.8	600.9	23	414.4	382.7	222.3
16.5	1224.6	1120.4	608.7	23.16666667	400.5	369.9	215.2
16.66666667	1231.9	1127.6	614.5	23.33333333	387.2	357.8	208.5
16.83333333	1235.7	1131.5	618.5	23.5	374.4	346.1	202
17	1232.8	1129.3	619.2	23.66666667	362	334.8	195.8
17.16666667	1225.8	1123.4	617.6	23.83333333	350.1	323.9	189.8
17.33333333	1216.1	1114.9	614.6	24	338.9	313.6	184.1
17.5	1203.1	1103.3	609.7	24.16666667	328.3	303.9	178.7
17.66666667	1187.6	1089.4	603.5	24.33333333	318	294.6	173.5
17.83333333	1169.6	1073.2	595.9	24.5	308.1	285.5	168.5
18	1148.8	1054.5	586.8	24.66666667	298.5	276.7	163.6
18.16666667	1126	1033.8	576.6	24.83333333	289.1	268.2	158.8

DIRECT FLOW (cms)							
Time (hr)	**100-yr**	**25-yr**	**5-year**	**Time (hr)**	**100-yr**	**25-yr**	**5-year**
18.33333333	1100.6	1010.7	564.9	25	280.4	260.2	154.3
18.5	1072.6	985.3	551.8	25.16666667	272.1	252.5	150.1
18.66666667	1043	958.3	537.8	25.33333333	264	245.1	145.9
18.83333333	1011.2	929.4	522.5	25.5	256.1	237.9	141.8
19	977.8	898.8	506.3	25.66666667	248.4	230.8	137.8
19.16666667	943.8	867.8	489.7	25.83333333	240.9	224	134
26	233.8	217.4	130.2	32.66666667	32.4	30.2	18.4
26.16666667	226.7	210.9	126.5	32.83333333	30.5	28.5	17.4
26.33333333	219.7	204.4	122.7	33	28.7	26.8	16.4
26.5	212.6	197.9	118.9	33.16666667	27	25.2	15.4
26.66666667	205.5	191.3	115.1	33.33333333	25.4	23.7	14.5
26.83333333	198.5	184.8	111.3	33.5	23.8	22.3	13.6
27	191.5	178.4	107.6	33.66666667	22.4	20.9	12.8
27.16666667	184.6	172	103.8	33.83333333	20.9	19.6	12
27.33333333	177.7	165.6	100	34	19.6	18.3	11.2
27.5	170.7	159.1	96.2	34.16666667	18.3	17.1	10.5
27.66666667	163.8	152.8	92.4	34.33333333	17	15.9	9.8
27.83333333	157.1	146.5	88.7	34.5	15.8	14.8	9.1
28	150.5	140.4	85	34.66666667	14.7	13.8	8.5
28.16666667	144	134.3	81.4	34.83333333	13.7	12.8	7.9
28.33333333	137.6	128.3	77.8	35	12.7	11.9	7.3
28.5	131.2	122.4	74.3	35.16666667	11.7	11	6.8
28.66666667	125.1	116.7	70.8	35.33333333	10.9	10.2	6.3
28.83333333	119.1	111.1	67.4	35.5	10.2	9.6	5.9
29	113.2	105.7	64.2	35.66666667	9.5	8.9	5.5
29.16666667	107.6	100.4	61	35.83333333	8.9	8.3	5.2
29.33333333	102.1	95.3	57.9	36	8.3	7.8	4.8
29.5	96.7	90.3	54.8	36.16666667	7.8	7.3	4.5
29.66666667	91.6	85.5	52	36.33333333	7.3	6.8	4.2
29.83333333	86.7	81	49.2	36.5	6.8	6.4	4
30	82	76.6	46.5	36.66666667	6.4	6	3.7
30.16666667	77.5	72.3	44	36.83333333	6	5.6	3.5
30.33333333	73.2	68.3	41.5	37	5.6	5.3	3.3
30.5	69	64.4	39.1	37.16666667	5.3	4.9	3.1
30.66666667	65.1	60.8	36.9	37.33333333	4.9	4.6	2.9
30.83333333	61.4	57.3	34.8	37.5	4.6	4.3	2.7

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
31	57.9	54.1	32.8	37.66666667	4.3	4	2.5
31.16666667	54.7	51	31	37.83333333	4	3.8	2.4
31.33333333	51.6	48.1	29.2	38	3.8	3.6	2.2
31.5	48.7	45.4	27.6	38.16666667	3.5	3.3	2.1
31.66666667	46	42.9	26.1	38.33333333	3.3	3.1	1.9
31.83333333	43.4	40.5	24.6	38.5	3.1	2.9	1.8
32	41	38.3	23.3	38.66666667	2.9	2.7	1.7
32.16666667	38.7	36.1	22	38.83333333	2.7	2.6	1.6
32.33333333	36.5	34.1	20.7	39	2.6	2.4	1.5
32.5	34.4	32.1	19.5	39.16666667	2.4	2.2	1.4
39.33333333	2.2	2.1	1.3	45.66666667	0.1	0.1	0
39.5	2.1	2	1.2	45.83333333	0.1	0	0
39.66666667	1.9	1.8	1.1	46	0	0	0
39.83333333	1.8	1.7	1.1	46.16666667	0	0	0
40	1.7	1.6	1	46.33333333	0	0	0
40.16666667	1.6	1.5	0.9	46.5	0	0	0
40.33333333	1.5	1.4	0.9	46.66666667	0	0	0
40.5	1.4	1.3	0.8	46.83333333	0	0	0
40.66666667	1.3	1.2	0.8	47	0	0	0
40.83333333	1.2	1.1	0.7	47.16666667	0	0	0
41	1.1	1	0.7	47.33333333	0	0	0
41.16666667	1	1	0.6	47.5	0	0	0
41.33333333	1	0.9	0.6	47.66666667	0	0	0
41.5	0.9	0.9	0.5	47.83333333	0	0	0
41.66666667	0.8	0.8	0.5	48	0	0	0
41.83333333	0.8	0.7	0.5				
42	0.7	0.7	0.4				
42.16666667	0.7	0.6	0.4				
42.33333333	0.6	0.6	0.4				
42.5	0.6	0.6	0.4				
42.66666667	0.6	0.5	0.3				
42.83333333	0.5	0.5	0.3				
43	0.5	0.4	0.3				
43.16666667	0.4	0.4	0.3				
43.33333333	0.4	0.4	0.2				

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
43.5	0.4	0.3	0.2				
43.66666667	0.3	0.3	0.2				
43.83333333	0.3	0.3	0.2				
44	0.3	0.3	0.2				
44.16666667	0.2	0.2	0.1				
44.33333333	0.2	0.2	0.1				
44.5	0.2	0.2	0.1				
44.66666667	0.2	0.2	0.1				
44.83333333	0.1	0.1	0.1				
45	0.1	0.1	0.1				
45.16666667	0.1	0.1	0.1				
45.33333333	0.1	0.1	0.1				
45.5	0.1	0.1	0				
45.66666667	0	0	0				
45.83333333	0	0	0				
46	0	0	0				
46.16666667	0	0	0				
46.33333333	0	0	0				
46.5	0	0	0				
46.66666667	0	0	0				
46.83333333	0	0	0				
47	0	0	0				
47.16666667	0	0	0				
47.33333333	0	0	0				
47.5	0	0	0				
47.66666667	0	0	0				
47.83333333	0	0	0				
48	0	0	0				

Appendix M. Jalaur (7) HEC-HMS Discharge Results

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
0	0	0	0	6.666666667	0.3	0.1	0
0.166666667	0	0	0	6.833333333	0.6	0.2	0
0.333333333	0	0	0	7	0.9	0.4	0
0.5	0	0	0	7.166666667	1.3	0.7	0
0.666666667	0	0	0	7.333333333	1.8	1	0
0.833333333	0	0	0	7.5	2.3	1.3	0
1	0	0	0	7.666666667	2.9	1.8	0
1.166666667	0	0	0	7.833333333	3.5	2.2	0
1.333333333	0	0	0	8	4.1	2.7	0
1.5	0	0	0	8.166666667	4.7	3.2	0.1
1.666666667	0	0	0	8.333333333	5.3	3.7	0.1
1.833333333	0	0	0	8.5	5.9	4.2	0.2
2	0	0	0	8.666666667	6.5	4.7	0.3
2.166666667	0	0	0	8.833333333	7	5.1	0.5
2.333333333	0	0	0	9	7.7	5.7	0.7
2.5	0	0	0	9.166666667	8.4	6.3	0.9
2.666666667	0	0	0	9.333333333	9.4	7.2	1.2
2.833333333	0	0	0	9.5	10.8	8.3	1.7
3	0	0	0	9.666666667	12.4	9.7	2.2
3.166666667	0	0	0	9.833333333	14.3	11.3	2.9
3.333333333	0	0	0	10	16.3	13.1	3.6
3.5	0	0	0	10.16666667	18.3	14.8	4.4
3.666666667	0	0	0	10.33333333	20.2	16.5	5.2
3.833333333	0	0	0	10.5	22.3	18.4	6.1
4	0	0	0	10.66666667	24.7	20.5	7.2
4.166666667	0	0	0	10.83333333	27.7	23.1	8.5
4.333333333	0	0	0	11	31.9	26.7	10.3
4.5	0	0	0	11.16666667	37.4	31.6	12.6
4.666666667	0	0	0	11.33333333	44.4	37.6	15.6
4.833333333	0	0	0	11.5	53	45.1	19.3
5	0	0	0	11.66666667	63.6	54.3	24
5.166666667	0	0	0	11.83333333	80.8	69.3	31.9
5.333333333	0	0	0	12	105.7	91.1	43.6
5.5	0	0	0	12.16666667	138.3	119.8	59.2
5.666666667	0	0	0	12.33333333	177.9	154.6	78.4
5.833333333	0	0	0	12.5	215.1	187.3	96.8
6	0	0	0	12.33333333	178.2	157.4	62.4

6.166666667	0	0	0	12.5	206.8	183.4	75.7
6.333333333	0.1	0	0	11.83333333	133.7	85.8	38.8
6.5	0.2	0	0	12	155.9	101.7	47.7
				12.16666667	179.8	118.8	57.3
12.66666667	241.1	210.5	110.4	19.33333333	18.9	16.9	10.2
12.83333333	254.4	222.6	118.2	19.5	17.5	15.7	9.5
13	256.7	225	120.8	19.66666667	16.5	14.8	9
13.16666667	250.1	219.5	119	19.83333333	15.7	14.1	8.6
13.33333333	236.8	208.2	113.8	20	15	13.6	8.3
13.5	217.2	191.3	105.5	20.16666667	14.5	13.1	8.1
13.66666667	196.8	173.7	96.6	20.33333333	14.1	12.8	7.9
13.83333333	178.3	157.7	88.4	20.5	13.8	12.5	7.7
14	160.9	142.6	80.5	20.66666667	13.6	12.3	7.6
14.16666667	144.5	128.2	72.9	20.83333333	13.4	12.1	7.5
14.33333333	128.9	114.7	65.6	21	13.2	12	7.5
14.5	114.9	102.4	59	21.16666667	13.1	11.9	7.4
14.66666667	103	92	53.4	21.33333333	13	11.8	7.4
14.83333333	93.2	83.3	48.7	21.5	13	11.8	7.3
15	84.9	76.1	44.8	21.66666667	12.9	11.7	7.3
15.16666667	78.1	70	41.5	21.83333333	12.9	11.7	7.3
15.33333333	72.1	64.8	38.5	22	12.8	11.6	7.3
15.5	66.5	59.8	35.6	22.16666667	12.8	11.6	7.3
15.66666667	61.1	54.9	32.7	22.33333333	12.8	11.6	7.3
15.83333333	55.9	50.2	29.9	22.5	12.8	11.6	7.3
16	51.1	45.8	27.3	22.66666667	12.7	11.6	7.3
16.16666667	46.9	42	25	22.83333333	12.7	11.6	7.3
16.33333333	43.4	38.8	23	23	12.7	11.6	7.3
16.5	40.4	36	21.3	23.16666667	12.7	11.6	7.3
16.66666667	38.1	33.9	20	23.33333333	12.7	11.6	7.3
16.83333333	36.2	32.2	18.9	23.5	12.7	11.6	7.3
17	34.7	30.9	18.1	23.66666667	12.7	11.6	7.3
17.16666667	33.5	29.8	17.5	23.83333333	12.7	11.6	7.3
17.33333333	32.6	28.9	16.9	24	12.6	11.5	7.2
17.5	31.8	28.3	16.5	24.16666667	12.4	11.3	7.1
17.66666667	31.3	27.8	16.2	24.33333333	11.9	10.8	6.8
17.83333333	30.9	27.4	16	24.5	11	10	6.3
18	30.5	27	15.8	24.66666667	9.8	8.9	5.6
18.16666667	29.9	26.5	15.5	24.83333333	8.5	7.7	4.8
18.33333333	29.1	25.8	15.1	25	7.1	6.5	4.1

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
18.5	27.8	24.6	14.5	25.16666667	5.8	5.3	3.3
18.66666667	26.1	23.2	13.6	25.33333333	4.6	4.2	2.6
18.83333333	24.2	21.5	12.7	25.5	3.6	3.3	2.1
19	22.3	19.9	11.8	25.66666667	2.8	2.6	1.6
19.16666667	20.5	18.3	10.9	25.83333333	2.2	2	1.3
26	1.8	1.6	1	32.66666667	0	0	0
26.16666667	1.4	1.3	0.8	32.83333333	0	0	0
26.33333333	1.1	1	0.6	33	0	0	0
26.5	0.9	0.8	0.5	33.16666667	0	0	0
26.66666667	0.7	0.6	0.4	33.33333333	0	0	0
26.83333333	0.5	0.5	0.3	33.5	0	0	0
27	0.4	0.4	0.2	33.66666667	0	0	0
27.16666667	0.3	0.3	0.2	33.83333333	0	0	0
27.33333333	0.3	0.2	0.1	34	0	0	0
27.5	0.2	0.2	0.1	34.16666667	0	0	0
27.66666667	0.2	0.1	0.1	34.33333333	0	0	0
27.83333333	0.1	0.1	0.1	34.5	0	0	0
28	0.1	0.1	0.1	34.66666667	0	0	0
28.16666667	0.1	0.1	0	34.83333333	0	0	0
28.33333333	0	0	0	35	0	0	0
28.5	0	0	0	35.16666667	0	0	0
28.66666667	0	0	0	35.33333333	0	0	0
28.83333333	0	0	0	35.5	0	0	0
29	0	0	0	35.66666667	0	0	0
29.16666667	0	0	0	35.83333333	0	0	0
29.33333333	0	0	0	36	0	0	0
29.5	0	0	0				
29.66666667	0	0	0				
29.83333333	0	0	0				
30	0	0	0				
30.16666667	0	0	0				
30.33333333	0	0	0				
30.5	0	0	0				
30.66666667	0	0	0				
30.83333333	0	0	0				

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
31	0	0	0				
31.16666667	0	0	0				
31.33333333	0	0	0				
31.5	0	0	0				
31.66666667	0	0	0				
31.83333333	0	0	0				
32	0	0	0				
32.16666667	0	0	0				
32.33333333	0	0	0				
32.5	0	0	0				

Appendix N. Jalaur (8) HEC-HMS Discharge Results

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
0	0	0	0	6.666666667	1.8	1	0
0.166666667	0	0	0	6.833333333	2.3	1.3	0
0.333333333	0	0	0	7	2.7	1.7	0.1
0.5	0	0	0	7.166666667	3.1	2	0.2
0.666666667	0	0	0	7.333333333	3.6	2.3	0.3
0.833333333	0	0	0	7.5	4	2.6	0.4
1	0	0	0	7.666666667	4.3	2.9	0.5
1.166666667	0	0	0	7.833333333	4.7	3.2	0.6
1.333333333	0	0	0	8	5	3.5	0.8
1.5	0	0	0	8.166666667	5.4	3.8	0.9
1.666666667	0	0	0	8.333333333	5.7	4	1
1.833333333	0	0	0	8.5	6	4.3	1.2
2	0	0	0	8.666666667	6.2	4.5	1.3
2.166666667	0	0	0	8.833333333	6.5	4.7	1.4
2.333333333	0	0	0	9	6.9	5	1.6
2.5	0	0	0	9.166666667	7.5	5.5	1.9
2.666666667	0	0	0	9.333333333	8.4	6.3	2.3
2.833333333	0	0	0	9.5	9.7	7.3	2.8
3	0	0	0	9.666666667	11.1	8.5	3.4
3.166666667	0	0	0	9.833333333	12.6	9.7	4
3.333333333	0	0	0	10	13.9	10.8	4.6
3.5	0	0	0	10.16666667	15	11.7	5.1
3.666666667	0	0	0	10.33333333	15.9	12.5	5.6
3.833333333	0	0	0	10.5	17	13.5	6.2
4	0	0	0	10.66666667	18.6	14.8	7
4.166666667	0	0	0	10.83333333	21.2	17	8.1
4.333333333	0	0	0	11	24.8	20	9.8
4.5	0	0	0	11.16666667	29.5	23.9	11.9
4.666666667	0	0	0	11.33333333	35.3	28.6	14.4
4.833333333	0.1	0	0	11.5	41.8	34	17.4
5	0.1	0	0	11.66666667	49.3	40.3	21.1
5.166666667	0.2	0	0	11.83333333	63.2	51.9	27.8
5.333333333	0.3	0	0	12	85.5	70.7	38.9
5.5	0.3	0.1	0	12.16666667	116.2	96.4	54.1
5.666666667	0.4	0.1	0	12.33333333	143.8	119.7	68
5.833333333	0.5	0.2	0	12.5	157.8	131.7	75.7

6	0.6	0.3	0	12.33333333	178.2	157.4	62.4
6.166666667	0.8	0.4	0	12.5	206.8	183.4	75.7
6.333333333	1	0.5	0	11.83333333	133.7	85.8	38.8
6.5	1.4	0.8	0	12	155.9	101.7	47.7
				12.16666667	179.8	118.8	57.3
12.66666667	158.9	132.9	77.1	19.33333333	7.7	6.6	4.2
12.83333333	150.4	126.1	73.8	19.5	7.3	6.3	4
13	135.5	113.8	67.1	19.66666667	7.1	6.1	3.9
13.16666667	119.4	100.5	59.7	19.83333333	6.9	5.9	3.8
13.33333333	106	89.4	53.4	20	6.7	5.8	3.7
13.5	94.5	79.9	48	20.16666667	6.6	5.7	3.7
13.66666667	83.8	71	42.9	20.33333333	6.5	5.7	3.6
13.83333333	73.4	62.3	38	20.5	6.5	5.6	3.6
14	63.6	54.2	33.2	20.66666667	6.4	5.6	3.6
14.16666667	55.1	47	29	20.83333333	6.4	5.6	3.6
14.33333333	48.1	41.2	25.6	21	6.4	5.5	3.6
14.5	42.6	36.5	22.9	21.16666667	6.4	5.5	3.6
14.66666667	38.5	33.1	20.9	21.33333333	6.3	5.5	3.5
14.83333333	35.6	30.6	19.4	21.5	6.3	5.5	3.5
15	33.3	28.7	18.3	21.66666667	6.3	5.5	3.5
15.16666667	31.2	26.9	17.2	21.83333333	6.3	5.5	3.5
15.33333333	28.9	24.9	15.9	22	6.3	5.5	3.5
15.5	26.3	22.6	14.4	22.16666667	6.3	5.5	3.5
15.66666667	23.7	20.4	12.9	22.33333333	6.3	5.5	3.5
15.83333333	21.4	18.3	11.6	22.5	6.3	5.5	3.5
16	19.5	16.7	10.4	22.66666667	6.3	5.5	3.5
16.16666667	18.1	15.5	9.6	22.83333333	6.3	5.5	3.5
16.33333333	17.2	14.6	9.1	23	6.3	5.5	3.5
16.5	16.5	14	8.7	23.16666667	6.3	5.5	3.6
16.66666667	16	13.6	8.4	23.33333333	6.3	5.5	3.6
16.83333333	15.7	13.3	8.2	23.5	6.3	5.5	3.6
17	15.4	13	8	23.66666667	6.3	5.5	3.6
17.16666667	15.2	12.9	7.9	23.83333333	6.3	5.5	3.6
17.33333333	15.1	12.8	7.8	24	6.3	5.4	3.5
17.5	15	12.7	7.8	24.16666667	6	5.2	3.3
17.66666667	15	12.6	7.7	24.33333333	5.4	4.7	3
17.83333333	14.9	12.6	7.7	24.5	4.5	3.9	2.5
18	14.8	12.5	7.6	24.66666667	3.6	3.1	2
18.16666667	14.4	12.2	7.5	24.83333333	2.7	2.4	1.5
18.33333333	13.6	11.5	7.1	25	2	1.7	1.1

Appendix

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
18.5	12.4	10.5	6.5	25.16666667	1.4	1.2	0.8
18.66666667	11.2	9.5	5.9	25.33333333	1	0.9	0.6
18.83333333	10	8.5	5.3	25.5	0.8	0.7	0.4
19	9	7.7	4.8	25.66666667	0.5	0.5	0.3
19.16666667	8.2	7.1	4.5	25.83333333	0.4	0.3	0.2
26	0.3	0.2	0.2	32.66666667	0	0	0
26.16666667	0.2	0.2	0.1	32.83333333	0	0	0
26.33333333	0.1	0.1	0.1	33	0	0	0
26.5	0.1	0.1	0.1	33.16666667	0	0	0
26.66666667	0.1	0.1	0	33.33333333	0	0	0
26.83333333	0.1	0	0	33.5	0	0	0
27	0	0	0	33.66666667	0	0	0
27.16666667	0	0	0	33.83333333	0	0	0
27.33333333	0	0	0	34	0	0	0
27.5	0	0	0	34.16666667	0	0	0
27.66666667	0	0	0	34.33333333	0	0	0
27.83333333	0	0	0	34.5	0	0	0
28	0	0	0	34.66666667	0	0	0
28.16666667	0	0	0	34.83333333	0	0	0
28.33333333	0	0	0	35	0	0	0
28.5	0	0	0	35.16666667	0	0	0
28.66666667	0	0	0	35.33333333	0	0	0
28.83333333	0	0	0	35.5	0	0	0
29	0	0	0	35.66666667	0	0	0
29.16666667	0	0	0	35.83333333	0	0	0
29.33333333	0	0	0	36	0	0	0
29.5	0	0	0				
29.66666667	0	0	0				
29.83333333	0	0	0				
30	0	0	0				
30.16666667	0	0	0				
30.33333333	0	0	0				
30.5	0	0	0				
30.66666667	0	0	0				
30.83333333	0	0	0				

DIRECT FLOW (cms)							
Time (hr)	100-yr	25-yr	5-year	Time (hr)	100-yr	25-yr	5-year
31	0	0	0				
31.16666667	0	0	0				
31.33333333	0	0	0				
31.5	0	0	0				
31.66666667	0	0	0				
31.83333333	0	0	0				
32	0	0	0				
32.16666667	0	0	0				
32.33333333	0	0	0				
32.5	0	0	0				

DREAM

Disaster RIsk and Exposure Assessment for Mitigation