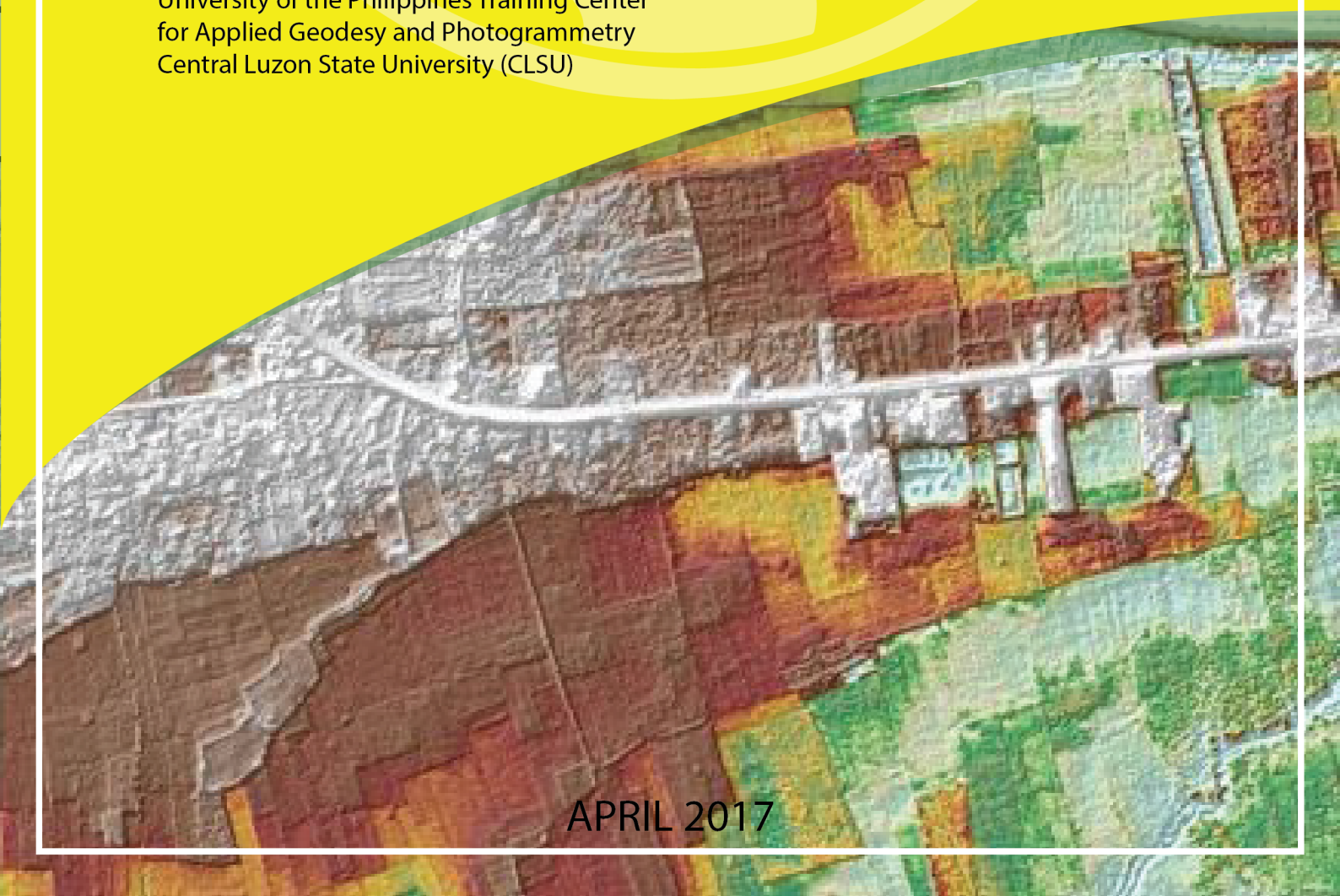
Hazard Mapping of the Philippines Using LIDAR (Phil-LIDAR 1)

LiDAR Surveys and Flood Mapping of Dagupan River

University of the Philippines Training Center
for Applied Geodesy and Photogrammetry
Central Luzon State University (CLSU)



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LIST OF ACRONYMS AND ABBREVIATIONS

AAC	Asian Aerospace Corporation
Ab	abutment
ALTM	Airborne LiDAR Terrain Mapper
ARG	automatic rain gauge
ATQ	Antique
AWLS	Automated Water Level Sensor
BA	Bridge Approach
BM	benchmark
CAD	Computer-Aided Design
CN	Curve Number
CLSU	Central Luzon State University
CSRS	Chief Science Research Specialist
DAC	Data Acquisition Component
DEM	Digital Elevation Model
DENR	Department of Environment and Natural Resources
DOST	Department of Science and Technology
DPPC	Data Pre-Processing Component
DREAM	Disaster Risk and Exposure Assessment for Mitigation [Program]
DRRM	Disaster Risk Reduction and Management
DSM	Digital Surface Model
DTM	Digital Terrain Model
DVBC	Data Validation and Bathymetry Component
FMC	Flood Modeling Component
FOV	Field of View
GiA	Grants-in-Aid
GCP	Ground Control Point
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HEC-HMS	Hydrologic Engineering Center - Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center - River Analysis System
HC	High Chord
IDW	Inverse Distance Weighted [interpolation method]
IMU	Inertial Measurement Unit
kts	knots
LAS	LiDAR Data Exchange File format
LC	Low Chord
LGU	local government unit
LiDAR	Light Detection and Ranging
LMS	LiDAR Mapping Suite
m AGL	meters Above Ground Level
MMS	Mobile Mapping Suite
MSL	mean sea level
NAMRIA	National Mapping and Resource Information Authority
NSTC	Northern Subtropical Convergence
PAF	Philippine Air Force
PAGASA	Philippine Atmospheric Geophysical and Astronomical Services Administration
PDOP	Positional Dilution of Precision
PPK	Post-Processed Kinematic [technique]
PRF	Pulse Repetition Frequency
PTM	Philippine Transverse Mercator
QC	Quality Check
QT	Quick Terrain [Modeler]
RA	Research Associate
RIDF	Rainfall-Intensity-Duration-Frequency
RMSE	Root Mean Square Error
SAR	Synthetic Aperture Radar
SCS	Soil Conservation Service
SRTM	Shuttle Radar Topography Mission
SRS	Science Research Specialist
SSG	Special Service Group
TBC	Thermal Barrier Coatings
UP-TCAGP	University of the Philippines – Training Center for Applied Geodesy and Photogrammetry
UTM	Universal Transverse Mercator
WGS	World Geodetic System

CHAPTER 1: OVERVIEW OF THE PROGRAM AND DAGUPAN RIVER

Enrico C. Paringit, Dr. Eng., Dr. Annie Melinda Paz-Alberto, and Kathrina M. Mapanao

1.1 Background of the Phil-LiDAR 1 Program

The University of the Philippines Training Center for Applied Geodesy and Photogrammetry (UP-TCAGP) launched a research program in 2014 entitled "Nationwide Hazard Mapping using LiDAR" or Phil-LiDAR 1, supported by the Department of Science and Technology (DOST) Grants-in-Aid (GiA) Program. The program was primarily aimed at acquiring a national elevation and resource dataset at sufficient resolution to produce information necessary to support the different phases of disaster management. Particularly, it targeted 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.

Also, the program was aimed at producing an up-to-date and detailed national elevation dataset suitable for 1:5,000 scale mapping, with 50 cm and 20 cm horizontal and vertical accuracies, respectively. These accuracies were achieved through the use of the state-of-the-art Light Detection and Ranging (LiDAR) airborne technology procured by the project through DOST. The methods described in this report are thoroughly described in a separate publication entitled "Flood Mapping of Rivers in the Philippines Using Airborne LiDAR: Methods (Paringit, et. al., 2017) available separately.

The implementing partner university for the Phil-LiDAR 1 Program is the Central Luzon State University (CLSU). CLSU is in charge of processing LiDAR data and conducting data validation reconnaissance, cross section, bathymetric survey, validation, river flow measurements, flood height and extent data gathering, flood modeling, and flood map generation for the 8 river basins in the Central Luzon Region. The university is located in Munoz City in the province of Nueva Ecija.

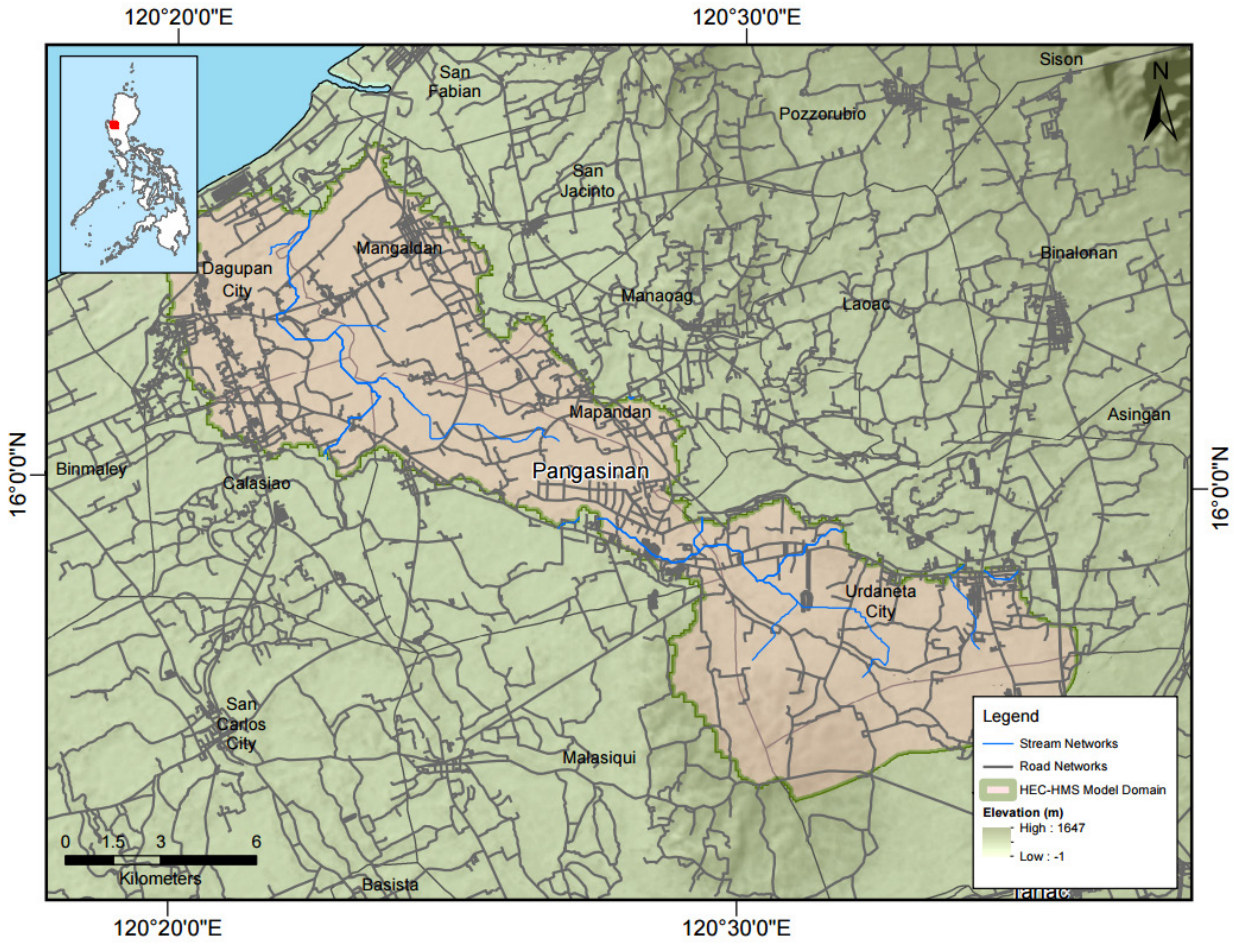

Figure 1. Map of Dagupan River Basin (in brown)

Dagupan (also known as Sinocalan) river basin is located in the island of Luzon and it covers the province of Pangasinan whose fountain head is at Mt. Ampucao, Itogon Benguet. Dagupan River is also known as Toboy Tacnien or Sinocalan River. It has a total catchment area of 711.81 sq. km. and it is connected with the Agno River. The Dagupan River system runs through the towns of Urdaneta, Sta Barbara, Calasiao and Dagupan before draining into the Lingayen Gulf. The Dagupan River Basin covers most of the Cities of Dagupan and Urdaneta, Municipalities of Calasiao, Santa Barbara, Mangaldan, and Mapandan, and a small portion of the Municipalities of Malasiqui and Villasis, all of which are in Pangasinan. The DENR River Basin Control Office identified the basin to have a drainage area of 897 km2 and an estimated annual runoff of 1,002 million cubic meter (MCM) (RBCO, 2015).

The Dagupan River Watershed falls under Climatic Type 1 of the Corona's classification system having two distinct seasons: rainy from June to November and dry for the rest of the year (DENR, 2013). The Dagupan River Basin is characterized by three (3) geologic formations, namely: Klondyke formations, Quaternary deposits and Zigzag formations.

Dagupan Watershed covers 14 municipalities with 214 barangays. There were about 612,705 people who are living within the watershed. Dagupan City is the most thickly populated municipality within the watershed.

Out of the 37,326.40 hectares alienable or disposable total land area of the watershed, 22,784.62 hectares or 61.04 % was devoted to agriculture. In this regard, majority of the population derived their income from the production of rice and vegetable gardening/cultivation (DENR, 2013). Aquaculture products such as bangus and Malaga were also produced in San Fabian, Dagupan City and Bolinao. The fish sufficiency level of the province is 122%.

A total of 567.53 hectares are highly susceptible to biodiversity-loss in Dagupan River Watershed. In the municipality of Binalonan, only barangay Moreno is highly susceptible to biodiversity-loss particularly in San Manuel (ERDB, 2013).

The river basin's main stem, the Dagupan River, passes along Dagupan City, Municipalities of Calasiao and Santa Barbara, and passes a small portion of Urdaneta City. The delineated basin and river name is "Dagupan River" but the Provincial Disaster Risk and Reduction Management Office (PDRRMO) of Pangasinan indicated that its actual local name is "Sinocalan River". According to the 2015 national census of NSO, a total of 116,588 people residing within the immediate vicinity of the river which is distributed among twenty-nine (29) barangays in Urdaneta City, Municipalities of Santa Barbara, Calasiao, and Dagupan City, in Pangasinan. Most of the economy and livelihood in Pangasinan is involved in aquaculture and marine activities. Pangisinan is a major producer of salt in the Philippines, and has an extensive resource of fishponds. Besides the previously mentioned, the province also undertakes in agricultural production such as rice, mangoes, corn, sugar cane, and the like (Source: http://pangasinan.gov.ph/). Last October 2016, super typhoon Lawin, internationally known as Haima, made landfall in Pangasinan province and was placed under storm signal number 2 by the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAG-ASA). Lawin was expected to bring flashfloods and landslides in the affected regions. (Source: http://www.rappler.com/nation/special-coverage/weather-alert/149647-20161019-super-typhoon-lawin-pagasa-forecast-2pm).

CHAPTER 2: LIDAR DATA ACQUISITION OF THE DAGUPAN FLOODPLAIN

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The methods applied in this Chapter were based on the DREAM methods manual (Sarmiento, et al., 2014) and further enhanced and updated in Paringit, et al. (2017).

2.1 Flight Plans

Plans were made to acquire LiDAR data within the delineated priority area for Dagupan (Sinocalan) floodplain in Pangasinan. These missions were planned for 17 lines that run for at most four and a half (4.5) hours including take-off, landing, and turning time. The flight planning parameters for the LiDAR system are found in Table 1 and Table 2. Figure 1 shows the flight plan for Dagupan (Sinocalan) floodplain survey.

Table 1. Flight planning parameters for Aquarius LiDAR system

Block Name	Flying Height (m AGL)	Overlap (%)	Field of View (θ)	Pulse Repetition Frequency (PRF) (kHz)	Scan Frequency (Hz)	Average Speed (kts)	Average Turn Time (Minutes)
PAMV	600	25,40	36	50	50	120	5
TRCV	600	40	36	50	50	120	5

Table 2. Flight planning parameters for Gemini LiDAR system

Block Name	Flying Height (m AGL)	Overlap (%)	Field of View (θ)	Pulse Repetition Frequency (PRF) (kHz)	Scan Frequency (Hz)	Average Speed (kts)	Average Turn Time (Minutes)
BLK15S	1000	30	40	100	50	120	5
PAMS8	1000	40	40	100	50	120	5
TRCV	1000	40	40	100	50	120	5

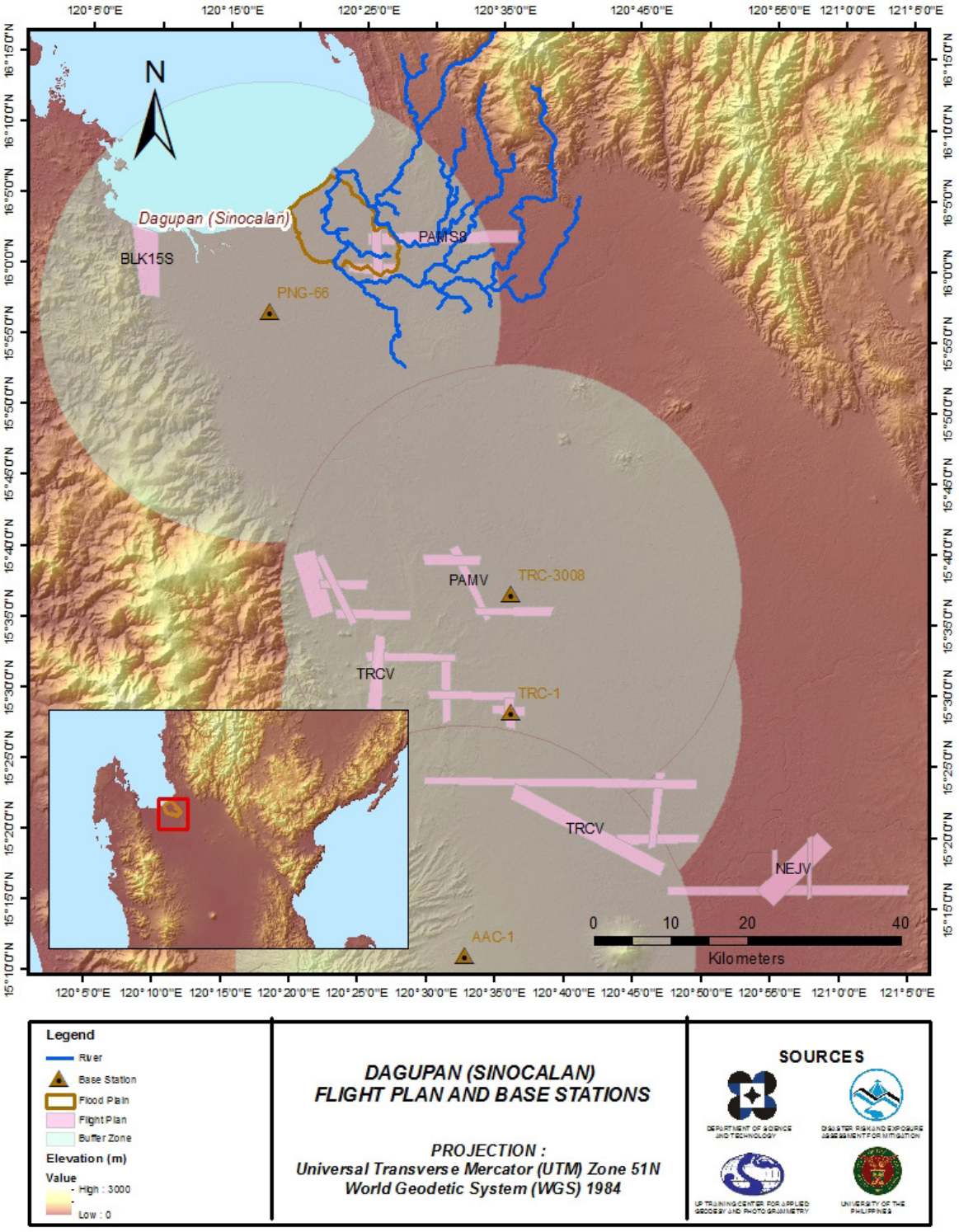

Figure 2. Flight plan and base stations used for Dagupan (Sinocalan) floodplain.

2.2 Ground Base Stations

The project team was able to recover three (3) NAMRIA horizontal ground control points: TRC-1 which is of first (1st) order accuracy, PNG-66 which is of second (2nd) order accuracy and TRC-3008 which is of third (3rd) order accuracy. The team also established one (1) ground control point, AAC-1. The certification for the NAMRIA reference points are found in Annex-B while the baseline processing reports for the established control points are found in Annex-C. These were used as base stations during flight operations for the entire duration of the survey (May 15 – May 25, 2014, December 4-13, 2014. Base stations were observed using dual frequency GPS receivers, TRIMBLE SPS 882 and SPS 985. Flight plans and location of base stations used during the aerial LiDAR acquisition in Dagupan (Sinocalan) floodplain are shown in Figure 1.

Table 3 to Table 6 show the details about the following NAMRIA control stations and established points, while Table 7 shows the list of all ground control points occupied during the acquisition with the corresponding dates of utilization.

Table 3. Details of the recovered NAMRIA horizontal control point TRC-1 used as base station for the LiDAR acquisition.

Station Name	TRC-1	
Order of Accuracy	1st	
Relative Error (horizontal positioning)	1 in 100,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude	15° 28’ 44.13765”
	Longitude	120° 35’ 52.67202”
	Ellipsoidal Height	446.89100 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting	456859.89 meters
	Northing	1711833.357 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude	15° 28’ 38.48550” North
	Longitude	120° 35’ 57.49329” East
	Ellipsoidal Height	86.90220 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting	242278.30 meters
	Northing	1712636.20 meters

Table 4. Details of the recovered NAMRIA horizontal control point PNG-66 used as base station for the LiDAR acquisition.

Station Name	PNG-66	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude	15° 56’ 47.31803”
	Longitude	120° 17’ 57.03550”
	Ellipsoidal Height	1.57500 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting	424968.98 meters
	Northing	1763650.683 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude	15° 56’ 41.53646” North
	Longitude	120° 18’ 1.81867” East
	Ellipsoidal Height	48.46800 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting	210862.35 meters
	Northing	1764780.62 meters

Table 5. Details of the recovered NAMRIA horizontal control point TRC-3008 used as base station for the LiDAR acquisition.

Station Name	TRC-3008	
Order of Accuracy	3rd	
Relative Error (horizontal positioning)	1 in 25,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude	15° 37’ 1.26155”
	Longitude	120° 35’ 46.75495”
	Ellipsoidal Height	28.39700 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting	456712.374 meters
	Northing	1727112.619 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude	15° 36’ 55.57785” North
	Longitude	120° 35’ 51.56455” East
	Ellipsoidal Height	67.99500 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting	242273.84 meters
	Northing	1727923.03 meters

Table 6. Details of the recovered NAMRIA horizontal control point AAC-1 used as base station for the LiDAR acquisition.

Station Name	AAC-1	
Order of Accuracy	1st	
Relative Error (horizontal positioning)	1 in 100,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude	15° 11’ 27.61685” North
	Longitude	120° 32’ 43.37833” East
	Ellipsoidal Height	154.260 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude	15° 11’ 22.22626” North
	Longitude	120° 32’ 48.22418” East
	Ellipsoidal Height	194.988 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting	236272.483 meters
	Northing	1680836.256 meters

Table 7. Ground control points used during LiDAR data acquisition.

Date Surveyed	Flight Number	Mission Name	Ground Control Points
23-May-2014	7266GC	2BLK15S143A	PNG-66 and TRC-3008
24-May-2014	7268GC	2PAMS8144A	PNG-66 and TRC-3008
06-Dec-2014	2278A	3PAMV340A	AAC-01
10-Dec-2014	2294A	3TRCV344A	AAC-01
11-Dec-2014	7670GC	2TRCV345A	TRC-1 and AAC-1

2.3 Flight Missions

Thirteen (13) missions under DREAM program covered around one hundred seventy-six (176) square kilometers (Table 8) within Dagupan (Sinocalan) floodplain. Five (5) missions under Phil-LiDAR program were conducted to complete the LiDAR data acquisition in Dagupan (Sinocalan) floodplain, for a total of nineteen hours (19) of flying time for RP-C9122 and RP-C9322. The missions were acquired using the Aquarius and Gemini LiDAR system. Table 9 shows the total area of actual coverage and the corresponding flying hours per mission, while Table 10 presents the actual parameters used during the LiDAR data acquisition.

Table 8. Flight missions under DREAM program which covers Dagupan (Sinocalan) floodplain.

Flight Number	**Mission Name**	**Area Surveyed within the Floodplain (km^2)**
97G	2AGN6P021A	NA
98G	2AGN6O021B	1.73
99G	2AGN6N022A	6.40
100G	2AGN6M023A	2.61
102G	2AGN6L023B	NA
124P	1A5P035B	0.19
125G	2AGN5N035B	40.32
127P	1A5M036A	56.68
128G	2AGN5O036B	20.25
130P	1A5L037B	24.74
158P	1A6O050A	NA
175G	2AGN5OQ059B	23.05
176P	1A5KS059A	0.49
TOTAL		176.46

Table 9. Flight missions for LiDAR data acquisition in Dagupan (Sinocalan) floodplain.

Date Surveyed	Flight Number	Flight Plan Area (km2)	Surveyed Area (km2)	Area Surveyed within the Floodplain (km2)	Area Surveyed Outside the Floodplain (km2)	No. of Images (Frames)	Flying Hours	
							Hr.	Min
May 23, 2014	7266GC	88.9	105.72	10.44	100.2	NA	3	47
May 24, 2014	7268GC	150.02	148.14	NA	148.14	NA	3	46
Dec 6, 2014	2278A	63.01	60.63	NA	60.63	NA	3	59
Dec 10, 2014	2294A	62.39	37.05	NA	37.05	NA	3	11
Dec 11, 2014	7670GC	44.71	57.98	NA	57.98	NA	4	17
TOTAL		409.03	409.52	10.44	404	NA	19	0

Table 10. Actual parameters used during LiDAR data acquisition

Flight Number	Flying Height (m AGL)	Overlap (%)	FOV (θ)	PRF (khz)	Scan Frequency (Hz)	Average Speed (kts)	Average Turn Time (Minutes)
7266GC	1000	30	40	100	50	120	5
7268GC	1000	40	40	100	50	120	5
2278A	600	40,25	36	50	50	120	5
2294A	600	40	36	50	50	120	5
7670GC	1000	40	40	100	50	120	5

2.4 Survey Coverage

Dagupan (Sinocalan) floodplain is located in the province of Pangasinan. The list of municipalities and cities surveyed, with at least one (1) square kilometer coverage, is shown in Table 11. The actual coverage of the LiDAR acquisition for Dagupan (Sinocalan) Floodplain is presented in Figure 2.

Table 11. List of municipalities and cities surveyed during Dagupan (Sinocalan) floodplain LiDAR survey.

Province	Municipality/City	Area of Municipality/ City (km^2)	Total Area Surveyed (km^2)	Percentage of Area Surveyed
Pangasinan	Labrador	92.63	29.74	32.10%
	Mapandan	21.35	6.26	29.34%
	Laoac	40.70	7.50	18.43%
	Santa Barbara	64.71	9.10	14.06%
	Manaoag	42.42	4.54	10.70%
	Binalonan	78.54	6.18	7.87%
	Mangaldan	43.42	2.50	5.76%
	Lingayen	68.74	1.69	2.47%
	Asingan	65.93	1.22	1.85%
	Bugallon	158.15	2.41	1.52%
Nueva Ecija	Gapan City	163.45	34.21	20.93%
	San Isidro	44.49	8.76	19.68%
	San Antonio	169.06	32.80	19.40%
	Cabiao	110.18	4.83	4.38%
	San Leonardo	51.79	1.48	2.86%
	Jaen	93.66	1.36	1.45%
Tarlac	Santa Ignacia	145.32	30.03	20.66%
	Paniqui	108.69	18.94	17.42%
	Gerona	128.21	19.03	14.84%
	Mayantoc	244.09	31.72	13%
	Concepcion	234.56	26.92	11.48%
	Camiling	130.78	13.66	10.45%
	Tarlac City	241.67	22.64	9.37%
	Pura	28.52	2.59	9.07%
	La Paz	122.26	8.01	6.55%
	San Clemente	69.75	4.32	6.19%
	Capas	467.83	16.80	3.59%
	San Jose	626.98	21.79	3.48%
	Victoria	107.37	3.18	2.96%
Total		3965.25	374.21	9.44%

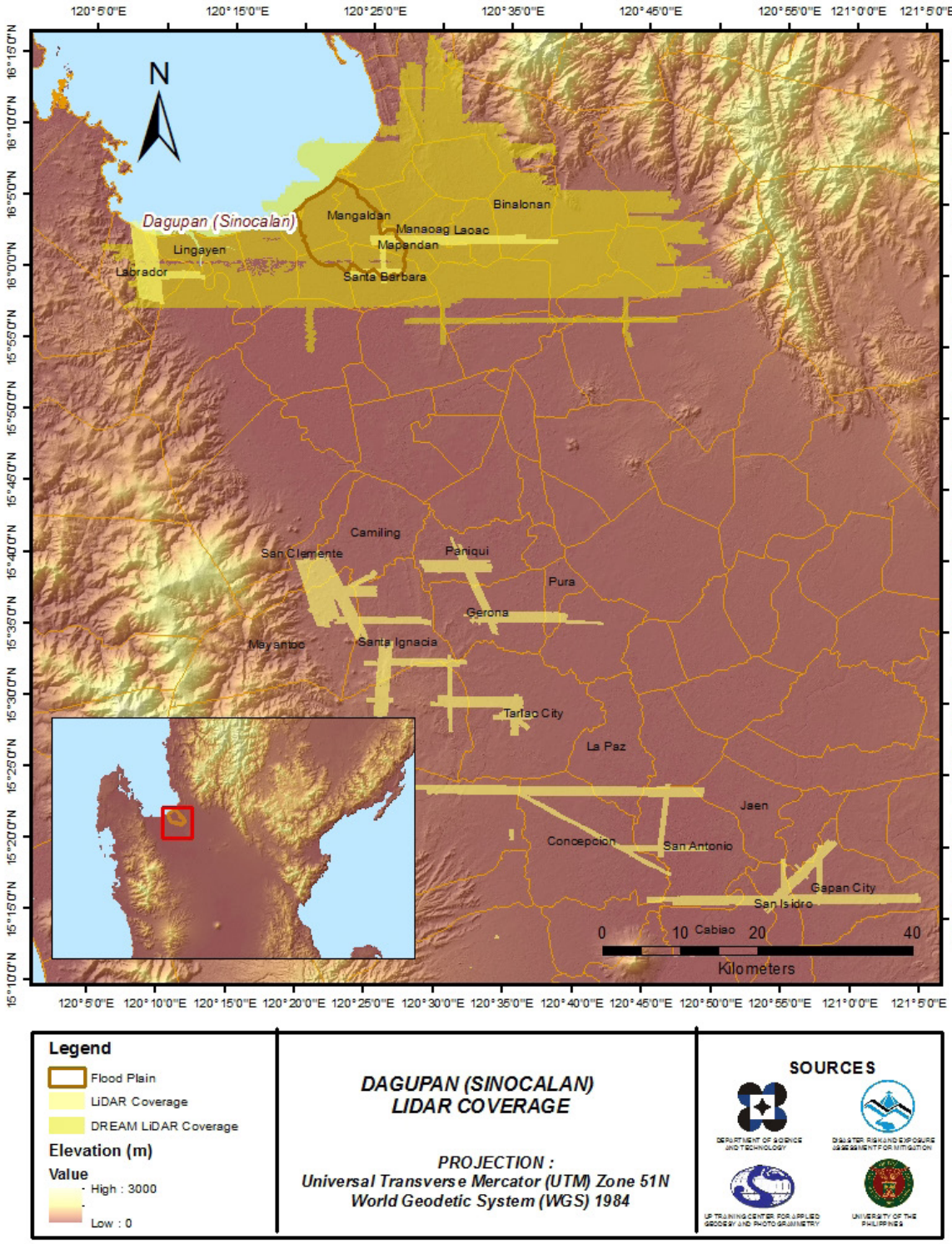

Figure 3. Actual LiDAR survey coverage for Dagupan (Sinocalan) floodplain.

CHAPTER 3: LIDAR DATA PROCESSING OF THE DAGUPAN FLOODPLAIN

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The methods applied in this Chapter were based on the DREAM methods manual (Ang, et al., 2014) and further enhanced and updated in Paringit, et al. (2017)

3.1 Overview of the LiDAR Data Pre-Processing

The data transmitted by the Data Acquisition Component are checked for completeness based on the list of raw files required to proceed with the pre-processing of the LiDAR data. Upon acceptance of the LiDAR field data, georeferencing of the flight trajectory is done in order to obtain the exact location of the LiDAR sensor when the laser was shot. Point cloud georectification is performed to incorporate correct position and orientation for each point acquired. The georectified LiDAR point clouds are subject for quality checking to ensure that the required accuracies of the program, which are the minimum point density, vertical and horizontal accuracies, are met. The point clouds are then classified into various classes before generating Digital Elevation Models such as Digital Terrain Model and Digital Surface Model.

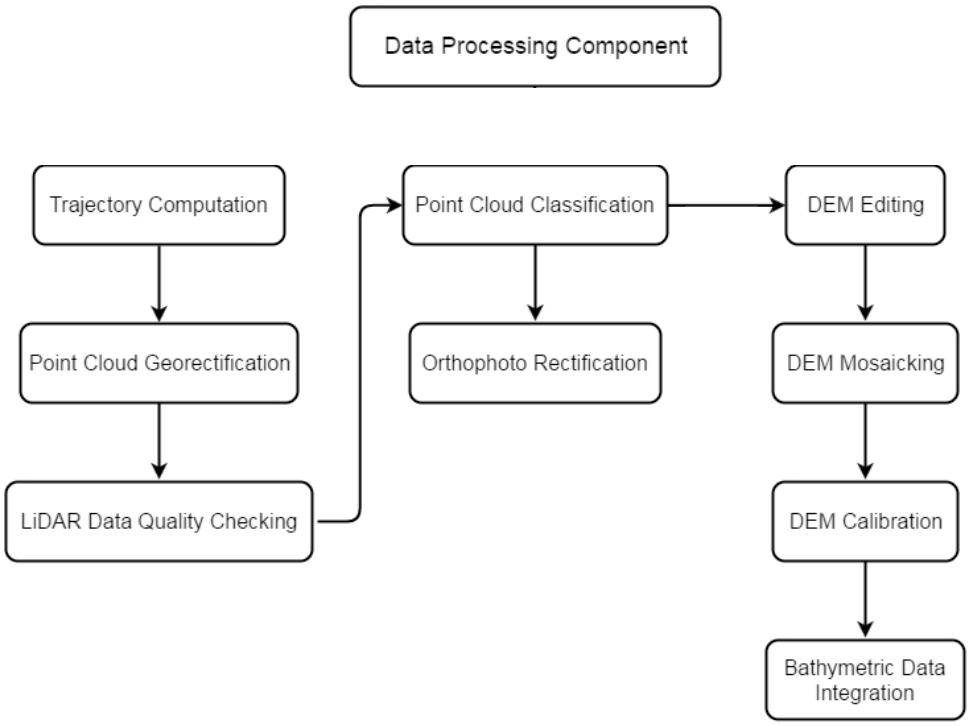

Figure 4. Schematic Diagram for Data Pre-Processing Component

Using the elevation of points gathered in the field, the LiDAR-derived digital models are calibrated. Portions of the river that are barely penetrated by the LiDAR system are replaced by the actual river geometry measured from the field by the Data Validation and Bathymetry Component. LiDAR acquired temporally are then mosaicked to completely cover the target river systems in the Philippines. Orthorectification of images acquired simultaneously with the LiDAR data is done through the help of the georectified point clouds and the metadata containing the time the image was captured.

These processes are summarized in the flowchart shown in Figure 4.

3.2 Transmittal of Acquired LiDAR Data

Data transfer sheets for all the LiDAR missions for Dagupan floodplain can be found in Annex 5. Data Transfer Sheets. Missions flown during the first survey conducted on January 2013 used the Airborne LiDAR Terrain Mapper (ALTM™ Optech Inc.) Gemini and Pegasus system while the second survey conducted on May 2014 used Gemini and Aquarius system over Clark, Pampanga and Agno, Pangasinan. The Data Acquisition Component (DAC) transferred a total of 205.64 Gigabytes of Range data, 3.13 Gigabytes of POS data, 171.38 Megabytes of GPS base station data, and 395.54 Gigabytes of raw image data to the data server on January 21, 2013 for the first survey and May 23, 2014 for the second survey. The Data Pre-processing Component (DPPC) verified the completeness of the transferred data. The whole dataset for Dagupan was fully transferred on February 12, 2015, as indicated on the Data Transfer Sheets for Dagupan floodplain.

3.3 Trajectory Computation

The Smoothed Performance Metrics of the computed trajectory for flight 2294A, one of the Dagupan flights, which is the North, East, and Down position RMSE values are shown in Figure 4. The x-axis corresponds to the time of flight, which is measured by the number of seconds from the midnight of the start of the GPS week, which on that week fell on December 10, 2014 00:00AM. The y-axis is the RMSE value for that particular position.

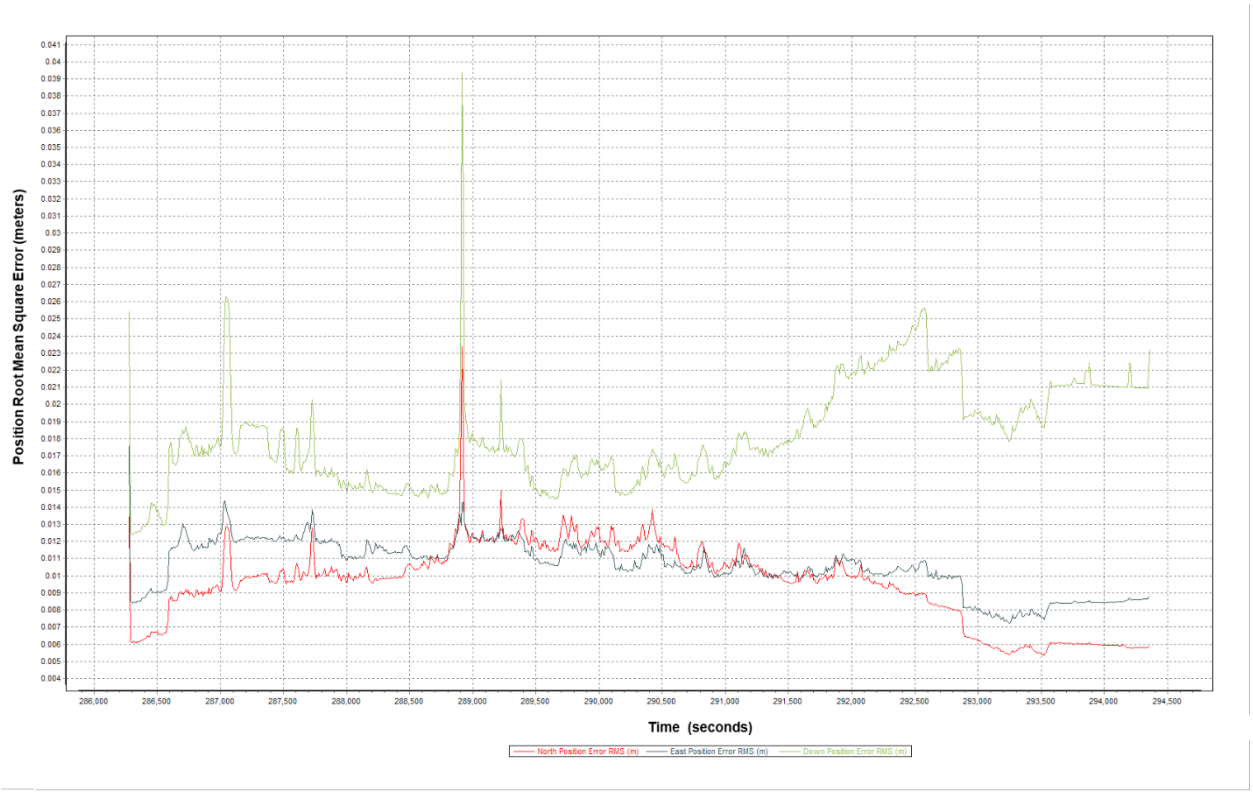

Figure 5. Smoothed Performance Metrics of a Dagupan Flight 2294A.

The time of flight was from 286000 seconds to 294500 seconds, which corresponds to morning of December 10, 2014. The initial spike that is seen on the data corresponds to the time that the aircraft was getting into position to start the acquisition, and the POS system starts computing for the position and orientation of the aircraft. Redundant measurements from the POS system quickly minimized the RMSE value of the positions. The periodic increase in RMSE values from an otherwise smoothly curving RMSE values correspond to the turn-around period of the aircraft, when the aircraft makes a turn to start a new flight line. Figure 4 shows that the North position RMSE peaks at 2.30 centimeters, the East position RMSE peaks at 1.40 centimeters, and the Down position RMSE peaks at 3.90 centimeters, which are within the prescribed accuracies described in the methodology.

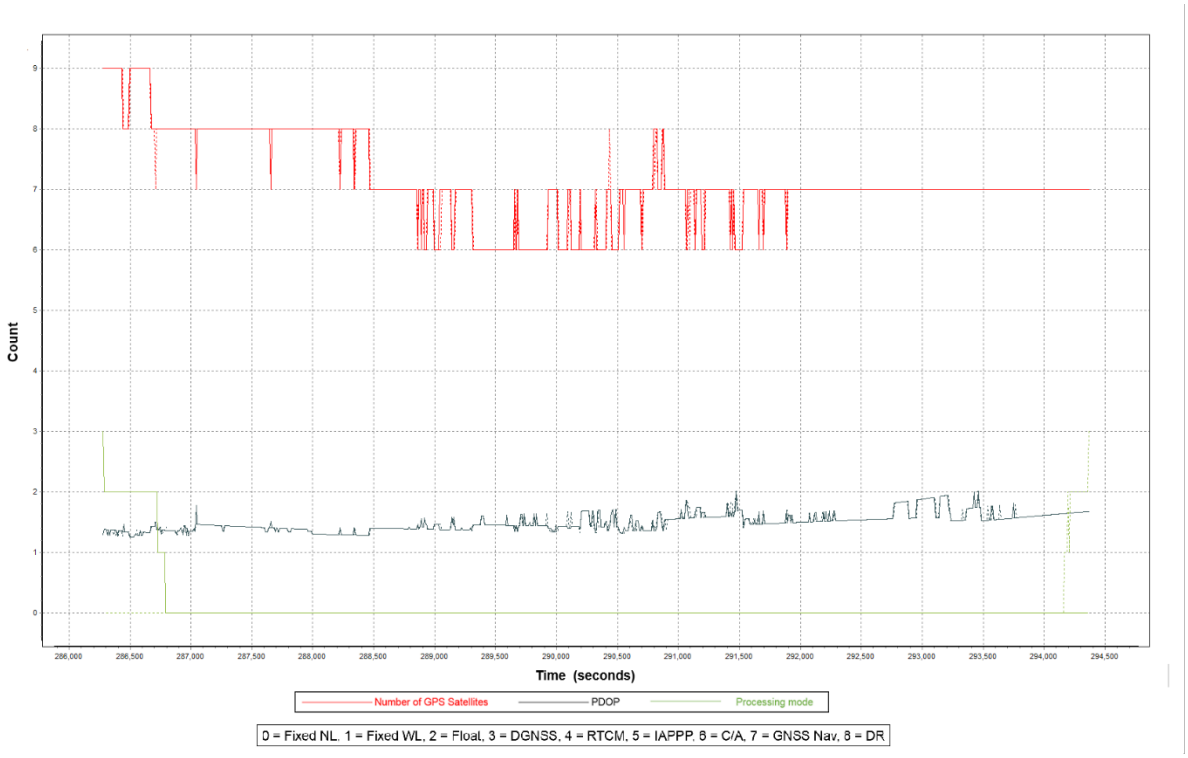

Figure 6. Solution Status Parameters of Dagupan Flight 2294A.

The Solution Status parameters of flight 2294A, one of the Dagupan flights, which indicate the number of GPS satellites, Positional Dilution of Precision (PDOP), and the GPS processing mode used, are shown in Figure 5. The graphs indicate that the number of satellites during the acquisition did not go down to 6. Most of the time, the number of satellites tracked was between 6 and 9. The PDOP value also did not go above the value of 3, which indicates optimal GPS geometry. The processing mode remained at 0 for majority of the survey with some peaks up to 1 attributed to the turns performed by the aircraft. The value of 0 corresponds to a Fixed, Narrow-Lane mode, which is the optimum carrier-cycle integer ambiguity resolution technique available for POSPAC MMS. All of the parameters adhered to the accuracy requirements for optimal trajectory solutions, as indicated in the methodology. The computed best estimated trajectory for all Dagupan flights is shown in Figure 6.

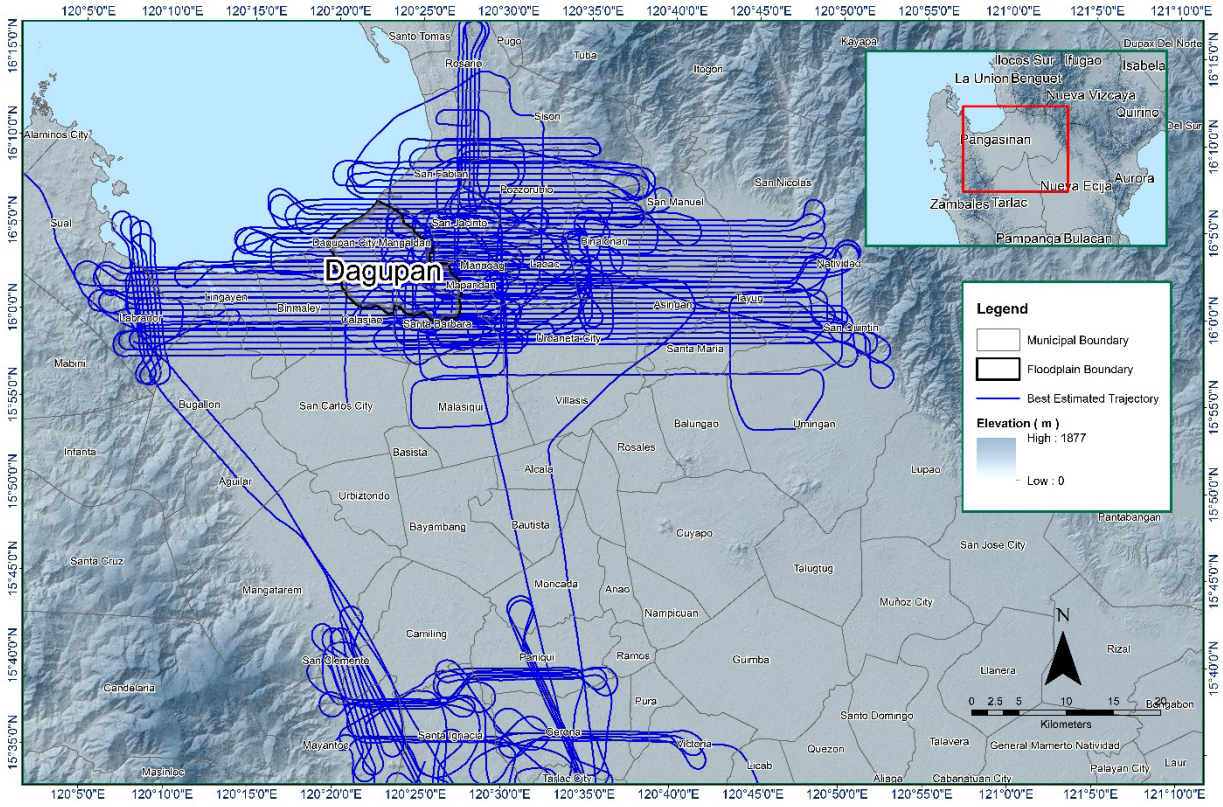

Figure 7. Best estimated trajectory for Dagupan floodplain.

3.4 LiDAR Point Cloud Computation

The produced LAS data contains 157 flight lines, with each flight line containing one channel, since the Aquarius system contain one channel only. The summary of the self-calibration results obtained from LiDAR processing in LiDAR Mapping Suite (LMS) software for all flights over Dagupan floodplain are given in Table 12.

Table 12. Self-Calibration Results values for Dagupan flights.

Parameter	Acceptable Value	Computed Value
Boresight Correction stdev	(<0.001degrees)	0.000448
IMU Attitude Correction Roll and Pitch Corrections stdev	(<0.001degrees)	0.000812
GPS Position Z-correction stdev	(<0.01meters)	0.0268

The optimum accuracy is obtained for all Dagupan flights based on the computed standard deviations of the corrections of the orientation parameters. Standard deviation values for individual blocks are available in the Annex 8. Mission Summary Reports.

3.5 LiDAR Data Quality Checking

The boundary of the processed LiDAR data is shown in Figure 7. The map shows gaps in the LiDAR coverage that are attributed to cloud coverage.

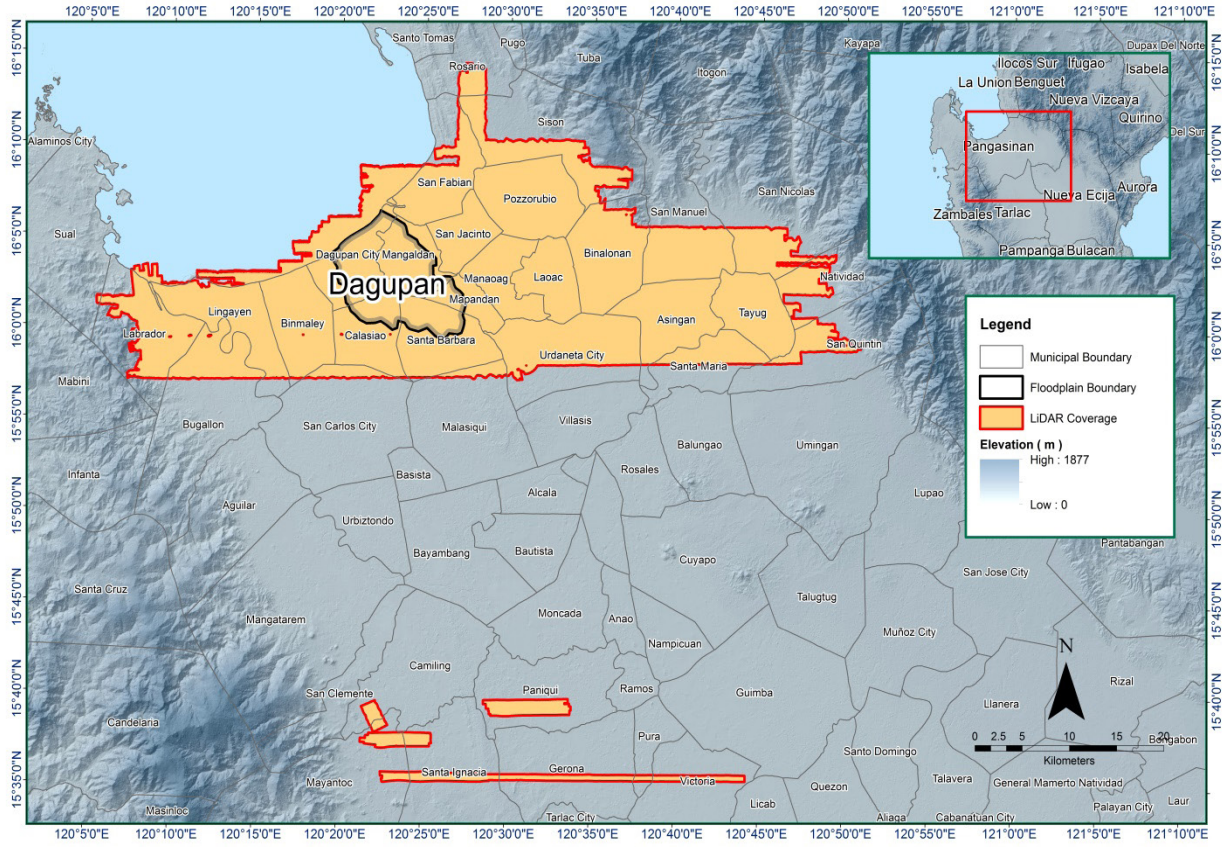

Figure 8. Boundary of the processed LiDAR data on top of a SAR Elevation Data over Dagupan Floodplain.

The total area covered by the Dagupan missions is 1511.58 sq.km that is comprised of eighteen (18) flight acquisitions grouped and merged into seventeen (17) blocks as shown in Table 13.

Table 13. List of LiDAR blocks for Dagupan floodplain.

LiDAR Blocks	Flight Numbers	Area (sq. km)
Agno_Blk10I_additional	7670GC 2294A 2278A	38.50
Agno_Blk10H_additional	2278A	17.43
Agno_Blk5H_reflight	7266G	31.57
Agno_Blk6I_reflight	7268GC	26.71
Agno_Blk5H_reflight2	7268GC	6.53
Agno_Blk5O	175G 128G	111.17
Agno_Blk5N	125G	106.98
Agno_Blk5M	127P	159.11
Agno_Blk5L	130P	102.95
Agno_Blk5K	176P	177.19
Agno_Blk5P	124P	157.81
Agno_Blk6O	98G	165.62
Agno_Blk6N	99G 100G	29.41
Agno_Blk6M	99G 100G 102G	161.65
Agno_Blk5P_additional	128G	21.42
Agno_Blk6P	97G	148.59
Agno_Blk6Q	158P	48.94
	TOTAL	**1511.58 sq.km**

The overlap data for the merged LiDAR blocks, showing the number of channels that pass through a particular location is shown in Figure 8. Since the Gemini and Aquarius systems both employ one channel, we would expect an average value of 1 (blue) for areas where there is limited overlap, and a value of 2 (yellow) or more (red) for areas with three or more overlapping flight lines. While for the Pegasus system which employs two channels, we would expect an average value of 2 (blue) for areas where there is limited overlap and a value of 3 (yellow) or more (red) for areas with three or more overlapping flight lines.

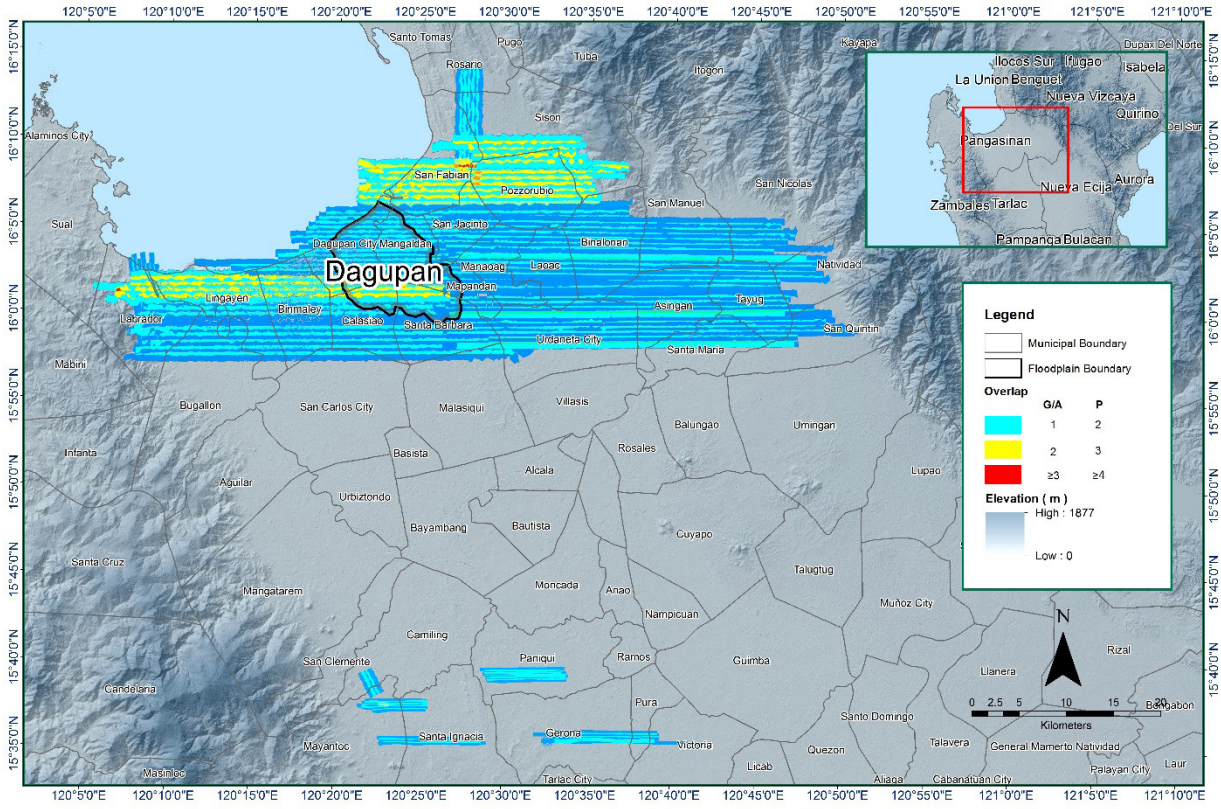

Figure 9. Image of data overlap for Dagupan floodplain.

The overlap statistics per block for the Dagupan floodplain can be found in Annex 8. Mission Summary Reports. It should be noted that one pixel corresponds to 25.0 square meters on the ground. For this area, the minimum and maximum percent overlaps are 34.44% and 87.47% respectively, which passed the 25% requirement.

The pulse density map for the merged LiDAR data, with the red parts showing the portions of the data that satisfy the 2 points per square meter criterion is shown in Figure 9. It was determined that all LiDAR data for Dagupan floodplain satisfy the point density requirement, and the average density for the entire survey area is 3.05 points per square meter.

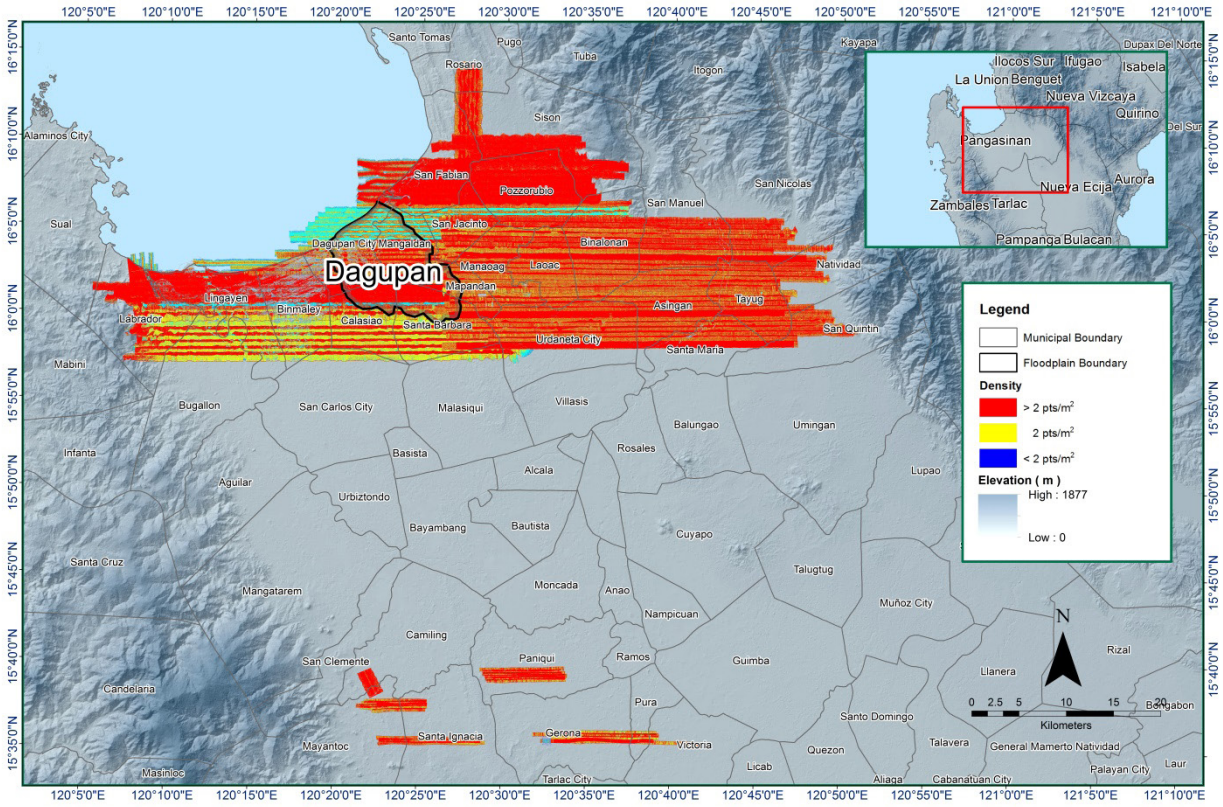

Figure 10. Pulse density map of merged LiDAR data for Dagupan floodplain.

The elevation difference between overlaps of adjacent flight lines is shown in Figure 10. The default color range is from blue to red, where bright blue areas correspond to portions where elevations of a previous flight line, identified by its acquisition time, are higher by more than 0.20m relative to elevations of its adjacent flight line. Bright red areas indicate portions where elevations of a previous flight line are lower by more than 0.20m relative to elevations of its adjacent flight line. Areas with bright red or bright blue need to be investigated further using Quick Terrain Modeler software.

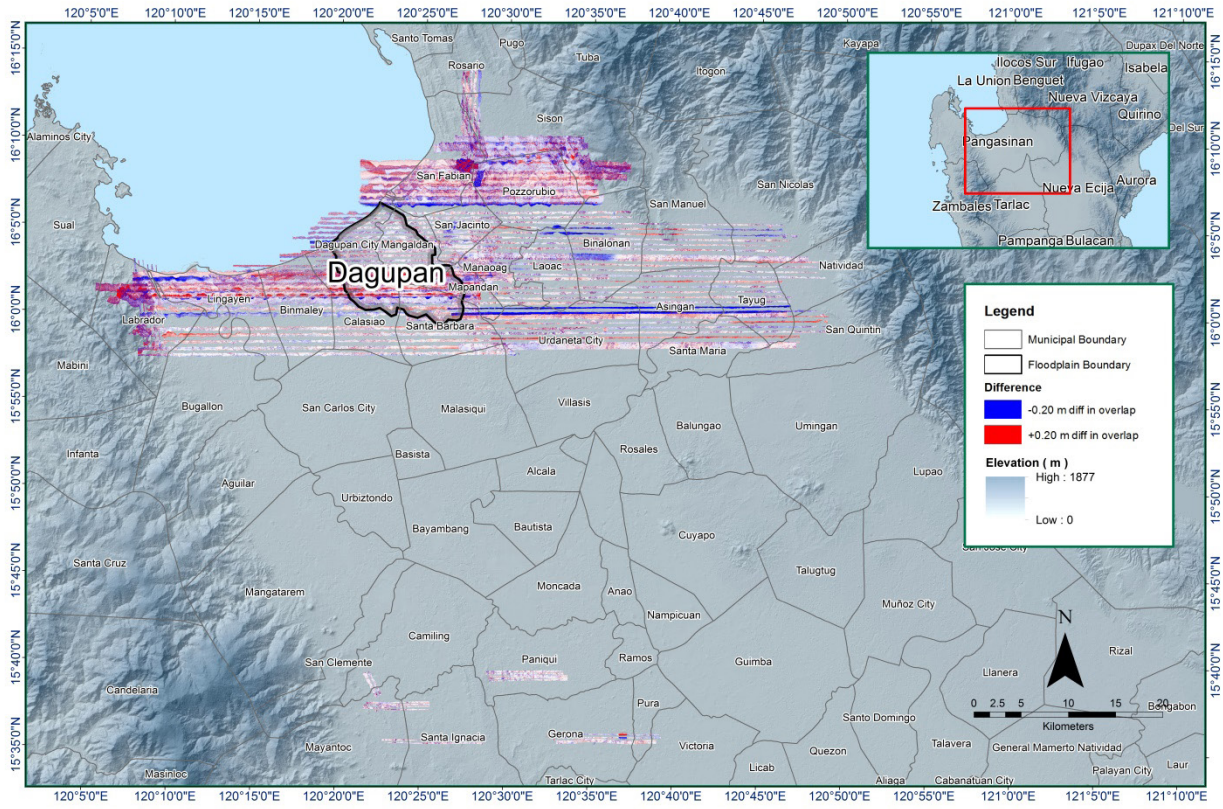

Figure 11. Elevation difference map between flight lines for Dagupan floodplain.

A screen capture of the processed LAS data from a Dagupan flight 2294A loaded in QT Modeler is shown in Figure 11. The upper left image shows the elevations of the points from two overlapping flight strips traversed by the profile, illustrated by a dashed blue green line. The x-axis corresponds to the length of the profile. It is evident that there are differences in elevation, but the differences do not exceed the 20-centimeter mark. This profiling was repeated until the quality of the LiDAR data becomes satisfactory. No reprocessing was done for this LiDAR dataset.

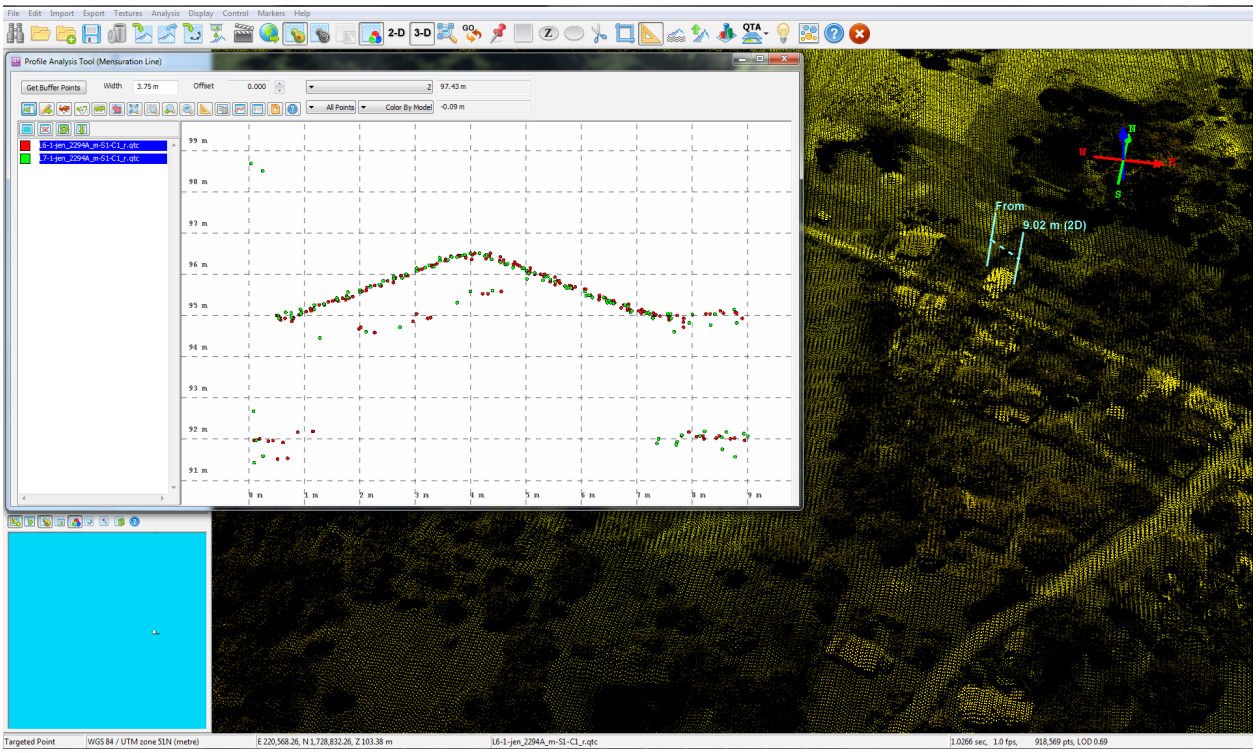

Figure 12. Quality checking for a Dagupan flight 2294A using the Profile Tool of QT Modeler.

3.6 LiDAR Point Cloud Classification and Rasterization

Table 14. Dagupan classification results in TerraScan.

Pertinent Class	Total Number of Points
Ground	1,216,646,941
Low Vegetation	1,147,698,927
Medium Vegetation	1,189,386,420
High Vegetation	600,042,460
Building	113,259,199

The tile system that TerraScan employed for the LiDAR data and the final classification image for a block in Dagupan floodplain is shown in Figure 12. A total of 2,541 1km by 1km tiles were produced. The number of points classified to the pertinent categories is illustrated in Table 14. The point cloud has a maximum and minimum height of 612.46 meters and 17.59 meters respectively.

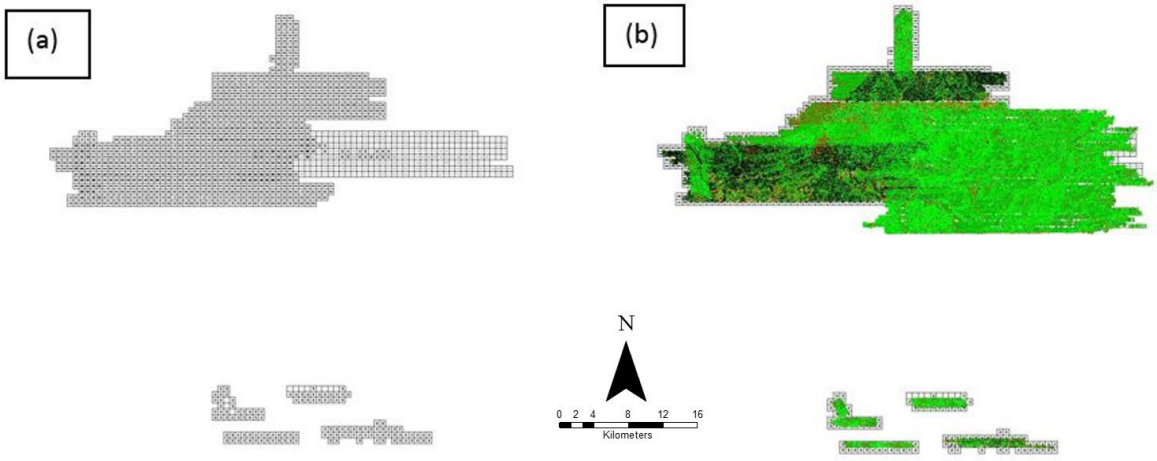

Figure 13. Tiles for Dagupan floodplain (a) and classification results (b) in TerraScan.

An isometric view of an area before and after running the classification routines is shown in Figure 13. The ground points are in orange, the vegetation is in different shades of green, and the buildings are in cyan. It can be seen that residential structures adjacent or even below canopy are classified correctly, due to the density of the LiDAR data.

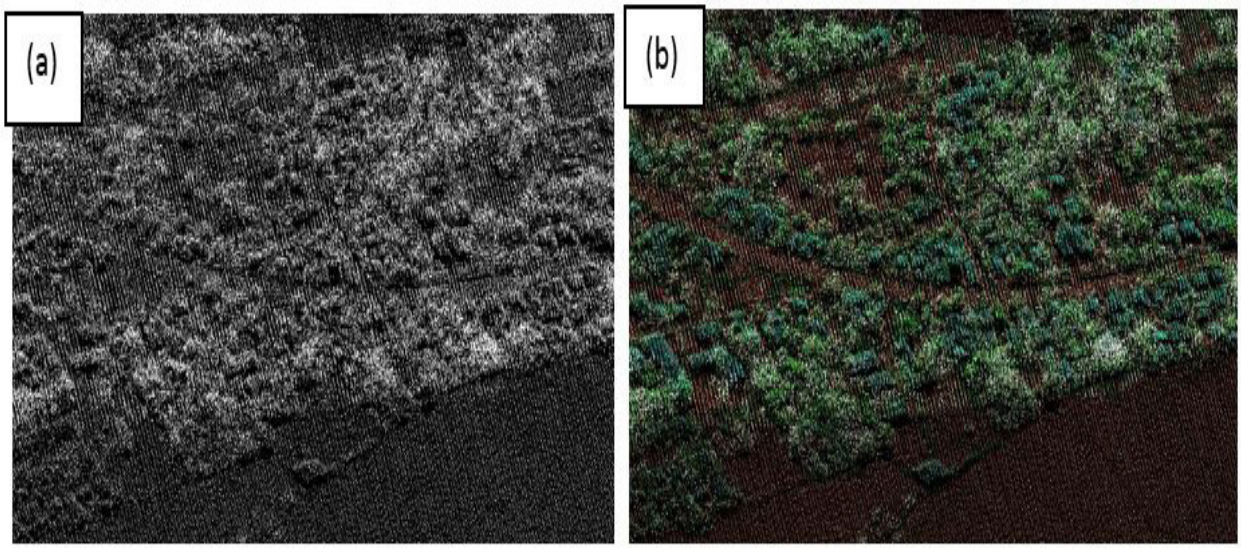

Figure 14. Point cloud before (a) and after (b) classification.

The production of last return (V_ASCII) and the secondary (T_ ASCII) DTM, first (S_ ASCII) and last (D_ ASCII) return DSM of the area in top view display are shown in Figure 14. It shows that DTMs are the representation of the bare earth while on the DSMs, all features are present such as buildings and vegetation.

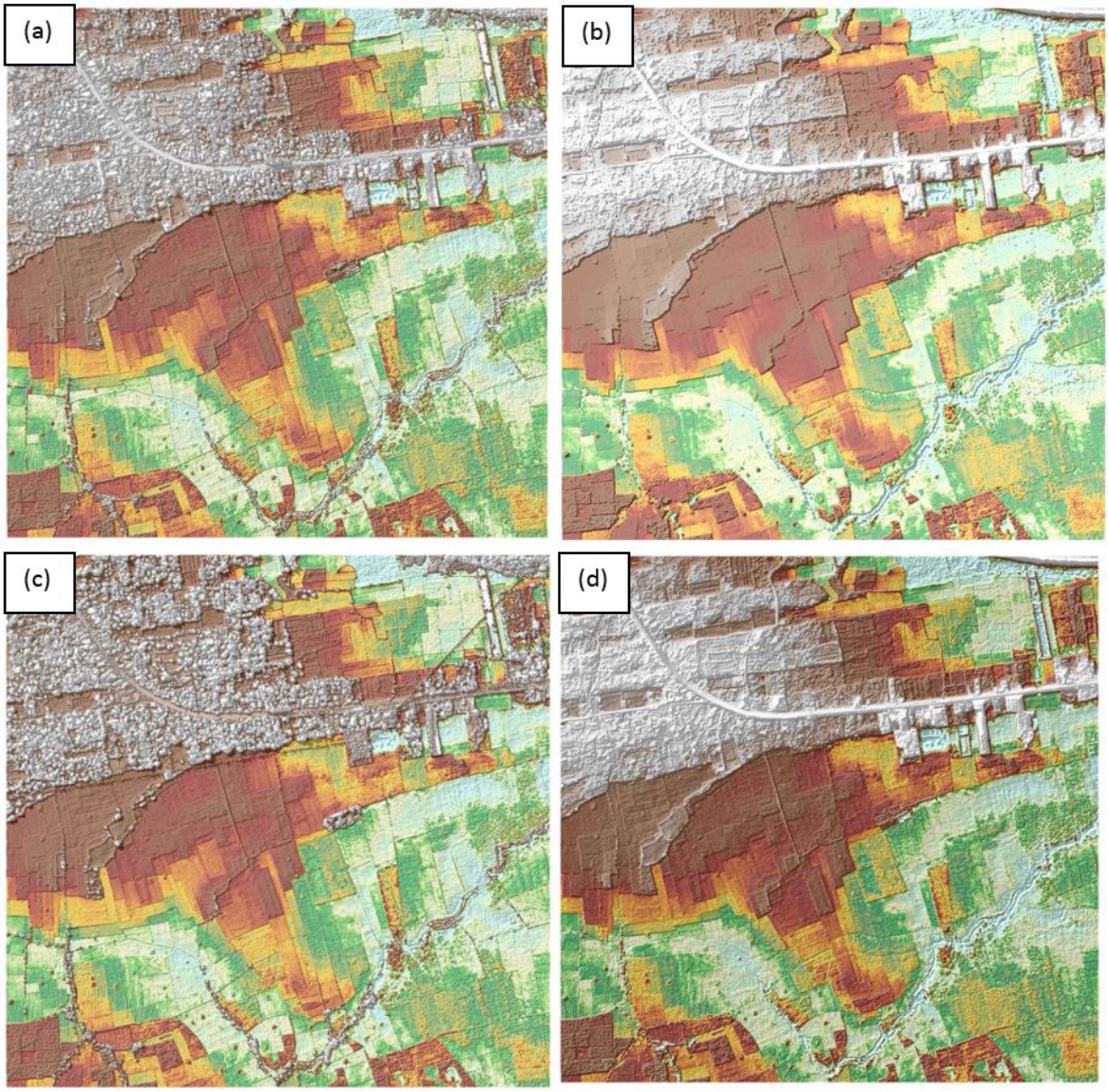

Figure 15. The production of last return DSM (a) and DTM (b), first return DSM (c) and secondary DTM (d) in some portion of Dagupan floodplain.

3.7 LiDAR Image Processing and Orthophotograph Rectification

The 1,615 1km by 1km tiles area covered by Dagupan floodplain is shown in Figure 15. After tie point selection to fix photo misalignments, color points were added to smoothen out visual inconsistencies along the seamlines where photos overlap. The Dagupan floodplain has a total of 915.59 sq.km orthophotogaph coverage comprised of 5467 images. A zoomed in version of sample orthophotographs named in reference to its tile number is shown Figure 16.

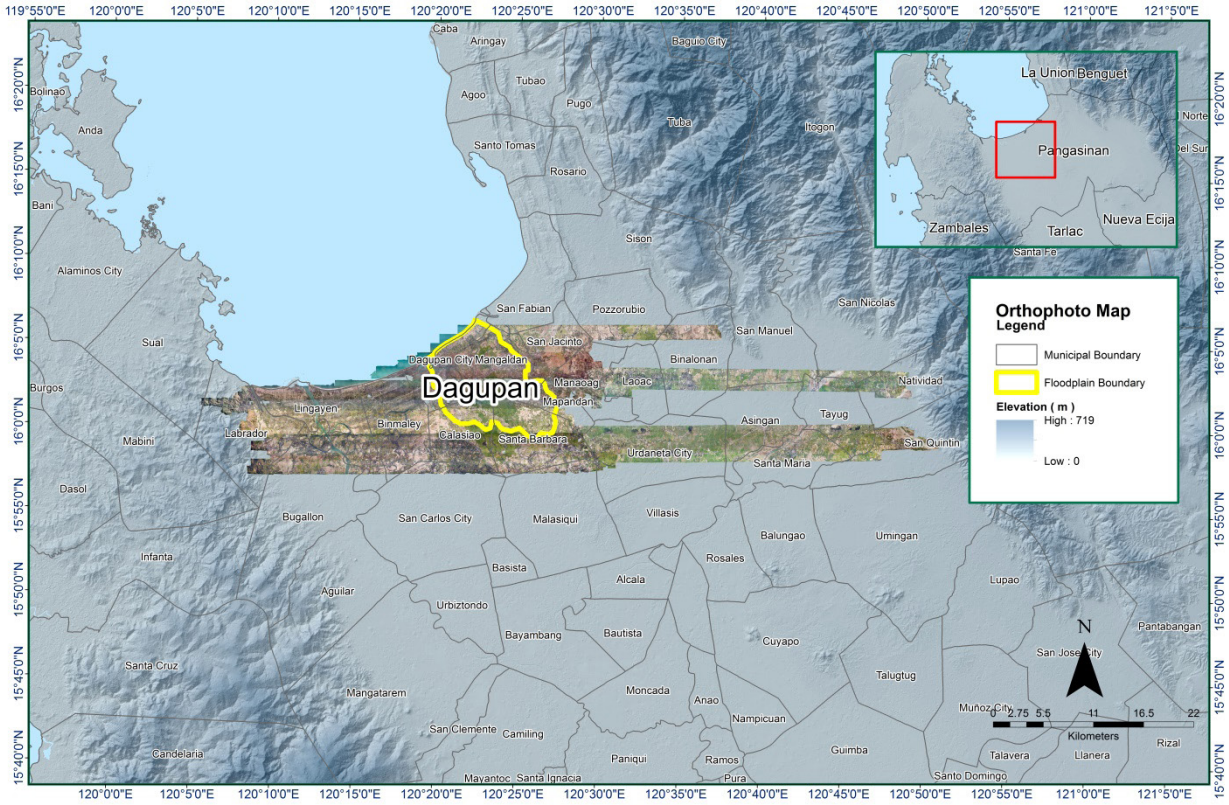

Figure 16. Dagupan floodplain with available orthophotographs.

Figure 17. Sample orthophotograph tiles for Dagupan floodplain.

3.8 DEM Editing and Hydro-Correction

Seventeen (17) mission blocks were processed for Dagupan flood plain. These blocks are composed of Agno blocks with a total area of 1,511.58 square kilometers. Table 15 shows the name and corresponding area of each block in square kilometers.

Table 15. LiDAR blocks with its corresponding area.

LiDAR Blocks	Area (sq. km)
Agno_Blk10I_additional	38.5
Agno_Blk10H_additional	17.43
Agno_Blk5H_reflight	31.57
Agno_Blk6I_reflight	26.71
Agno_Blk5H_reflight2	6.53
Agno_Blk5O	111.17
Agno_Blk5N	106.98
Agno_Blk5M	159.11
Agno_Blk5L	102.95
Agno_Blk5K	177.19
Agno_Blk5P	157.81
Agno_Blk6O	165.62
Agno_Blk6N	29.41
Agno_Blk6M	161.65
Agno_Blk5P_additional	21.42
Agno_Blk6P	148.59
Agno_Blk6Q	48.94
TOTAL	1511.58 sq. km

Portions of DTM before and after manual editing are shown in Figure 17. The bridge (Figure 17a) is considered to be an impedance to the flow of water along a waterway and has to be removed (Figure 17b) in order to hydrologically correct the river. Another common subject for editing is when a waterway is obstructed by built-up and thick vegetation (Figure 17c) and have to be cleared (Figure 17d). Retrieval of data gaps resulting from loading V-ASCII tiles (Figure 17e) is done during manual editing, as well (Figure 17f).

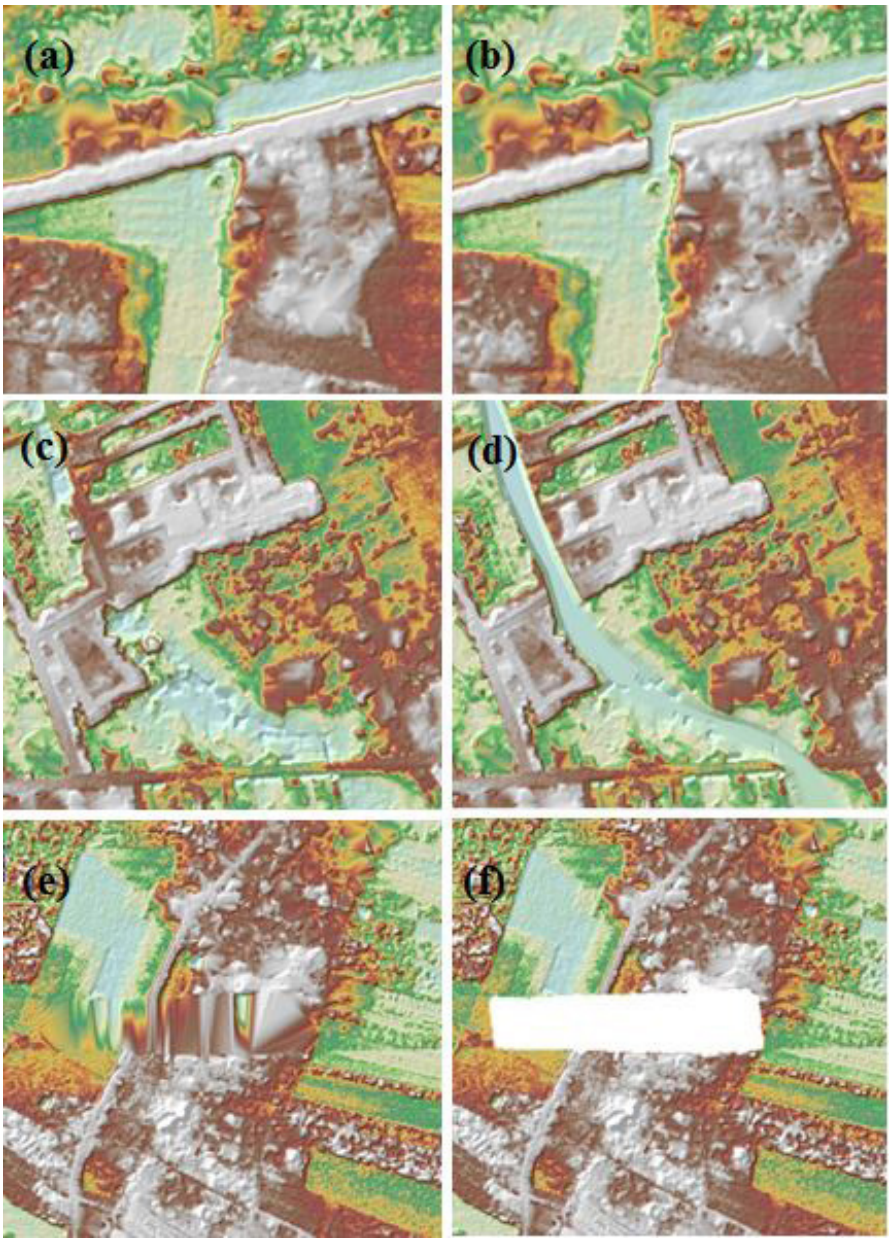

Figure 18. Portions in the DTM of Dagupan floodplain – a bridge before (a) and after (b) manual editing; a waterway before (c) and after (d) data retrieval; and a data gap before (e) and after (f) manual editing.

3.9 Mosaicking of Blocks

The blocks covering Dagupan floodplain were mosaicked with reference to the blocks covering the Agno-Pampanga floodplain, which is included in the original 18 major floodplains targeted under DREAM Program. The reference block used is Agno_Blk6A because the mission blocks that covered Dagupan floodplain are Agno mission blocks.

Mosaicked LiDAR DTM for Dagupan floodplain is shown in Figure 18. It can be seen that the entire Dagupan floodplain is 100% covered by LiDAR data.

Table 16. Shift Values of each LiDAR Block of Dagupan floodplain.

Mission Blocks	Shift Values (meters)		
	x	y	z
Agno_Blk10I_additional (lowermost)	-2.55	0.00	-0.59
Agno_Blk10I_additional (leftmost)	-1.70	-1.00	-0.81
Agno_Blk10I_additional (upper-leftmost)	-58.00	29.00	-0.85
Agno_Blk10I_additional (rightmost)	-1.00	-1.50	-0.49
Agno_Blk10H_additional	-2.00	-1.00	0.41
Agno_Blk5H_reflight	0.00	0.00	-1.08
Agno_Blk6I_reflight	0.00	0.00	-0.19
Agno_Blk5H_reflight2	0.00	0.00	-0.04
Agno_Blk5O	-0.56	0.11	-0.09
Agno_Blk5N	0.37	0.09	-0.09
Agno_Blk5M	0.05	0.12	-0.24
Agno_Blk5L	0.00	0.00	0.21
Agno_Blk5K	0.00	0.00	0.21
Agno_Blk5P	0.00	0.00	-0.39
Agno_Blk6O	0.00	0.00	-0.97
Agno_Blk6N	0.00	0.00	-0.97
Agno_Blk6M	0.00	0.00	-0.97
Agno_Blk5P_additional	0.30	-0.83	-0.29
Agno_Blk6P	0.00	0.00	-0.93
Agno_Blk6Q	-0.4	14.31	0.31

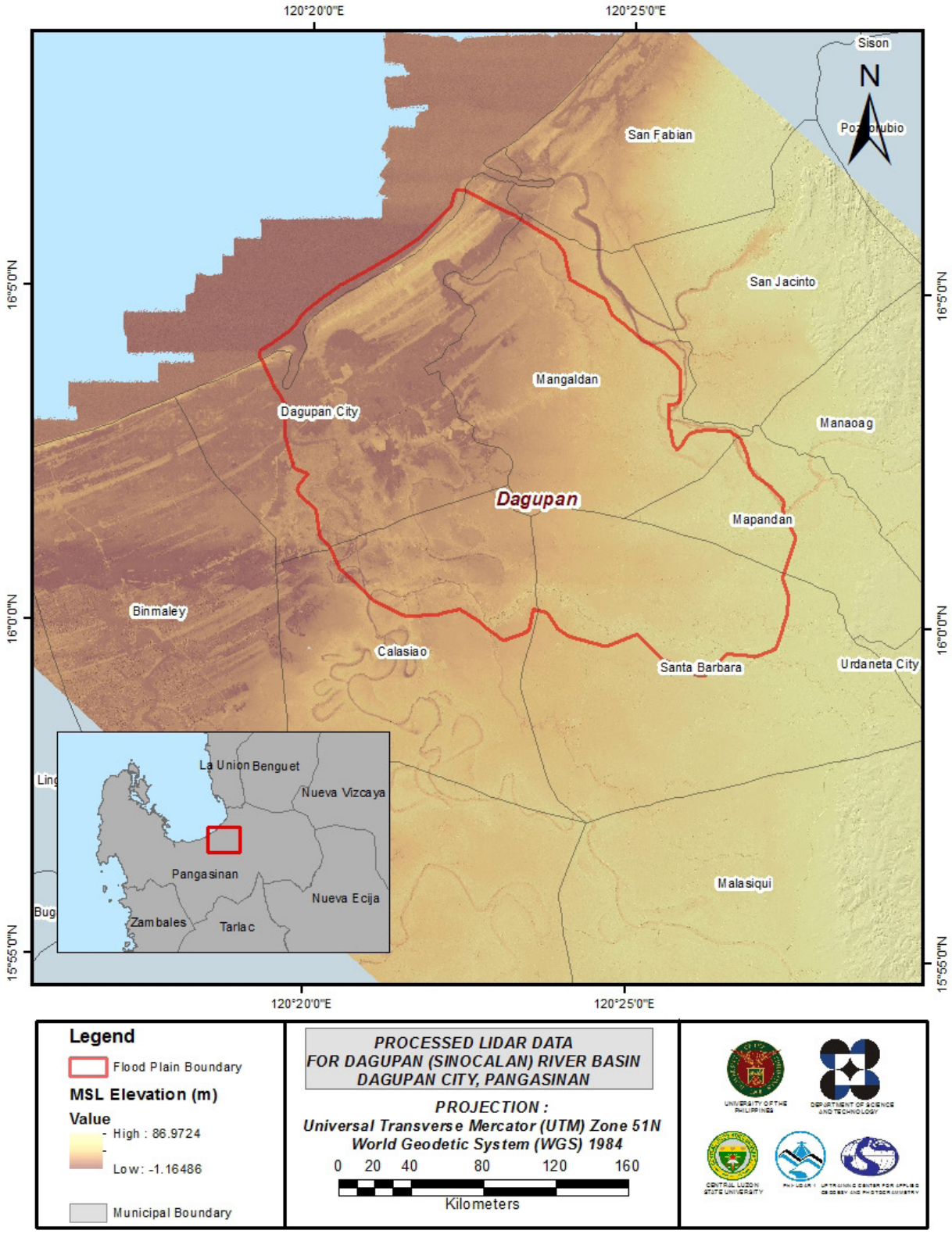

Figure 19. Map of Processed LiDAR Data for Dagupan Flood Plain.

3.10 Calibration and Validation of Mosaicked LiDAR DEM

The extent of the validation survey done by the Data Validation and Bathymetry Component (DVBC) in Dagupan to collect points with which the LiDAR dataset is validated is shown in Figure 19. Dagupan LiDAR data was calibrated using the validation survey points provided for Agno floodplain to be consistent with how the blocks were mosaicked. A total of 7,140 survey points for Agno calibration were considered for calibration of Dagupan LiDAR data. Random selection of 80% of the survey points, resulting to 5712 points, were used for calibration.

A good correlation between the uncalibrated mosaicked LiDAR elevation values and the ground survey elevation values is shown in Figure 20. Statistical values were computed from extracted LiDAR values using the selected points to assess the quality of data and obtain the value for vertical adjustment. The computed height difference between the LiDAR DTM and calibration elevation values is 3.41 meters with a standard deviation of 0.08 meter. Calibration of Dagupan LiDAR data was done by subtracting the height difference value, 3.41 meters, to Dagupan mosaicked LiDAR data. Table 17 shows the statistical values of the compared elevation values between LiDAR data and calibration data.

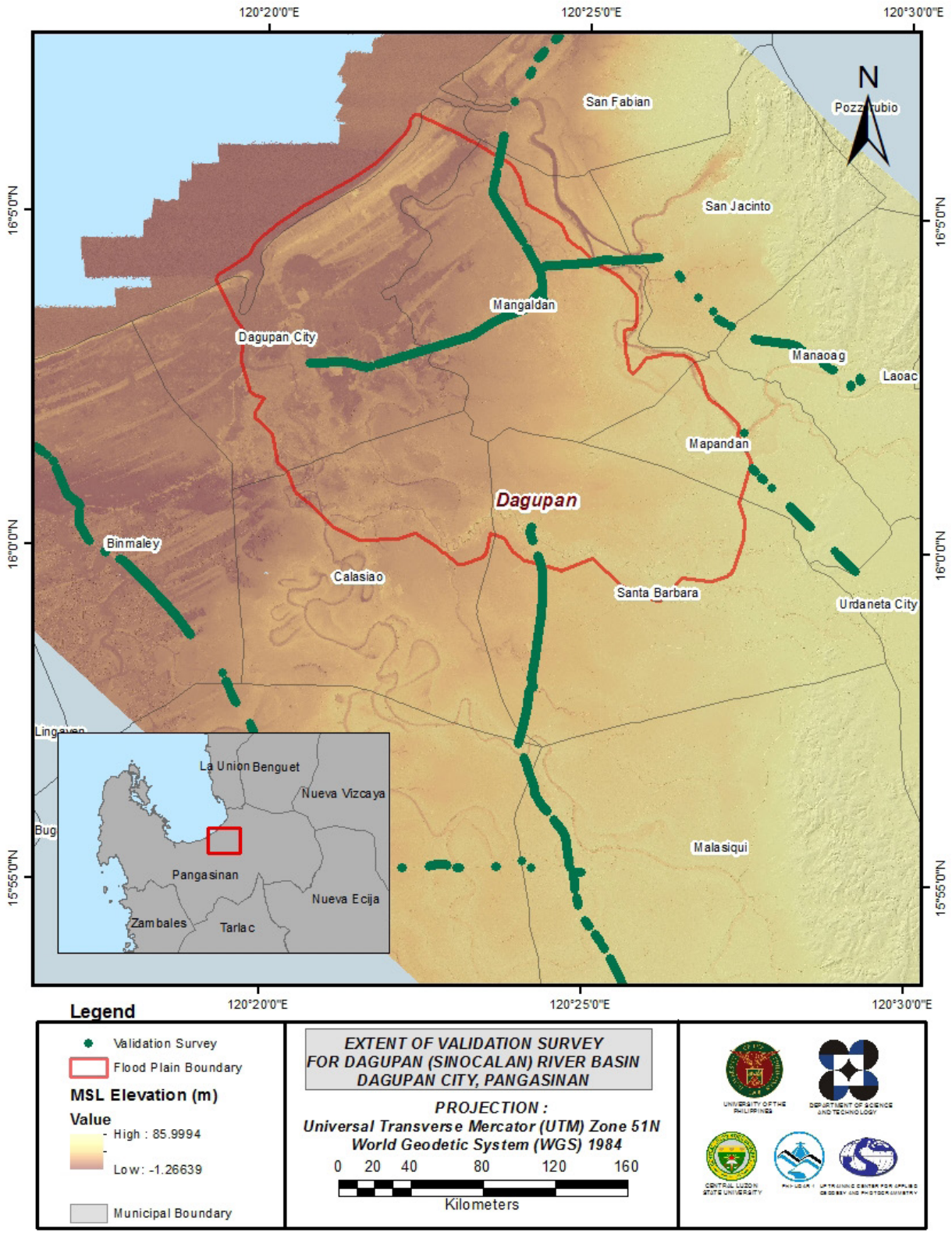

Figure 20. Map of Dagupan Flood Plain with validation survey points in green.

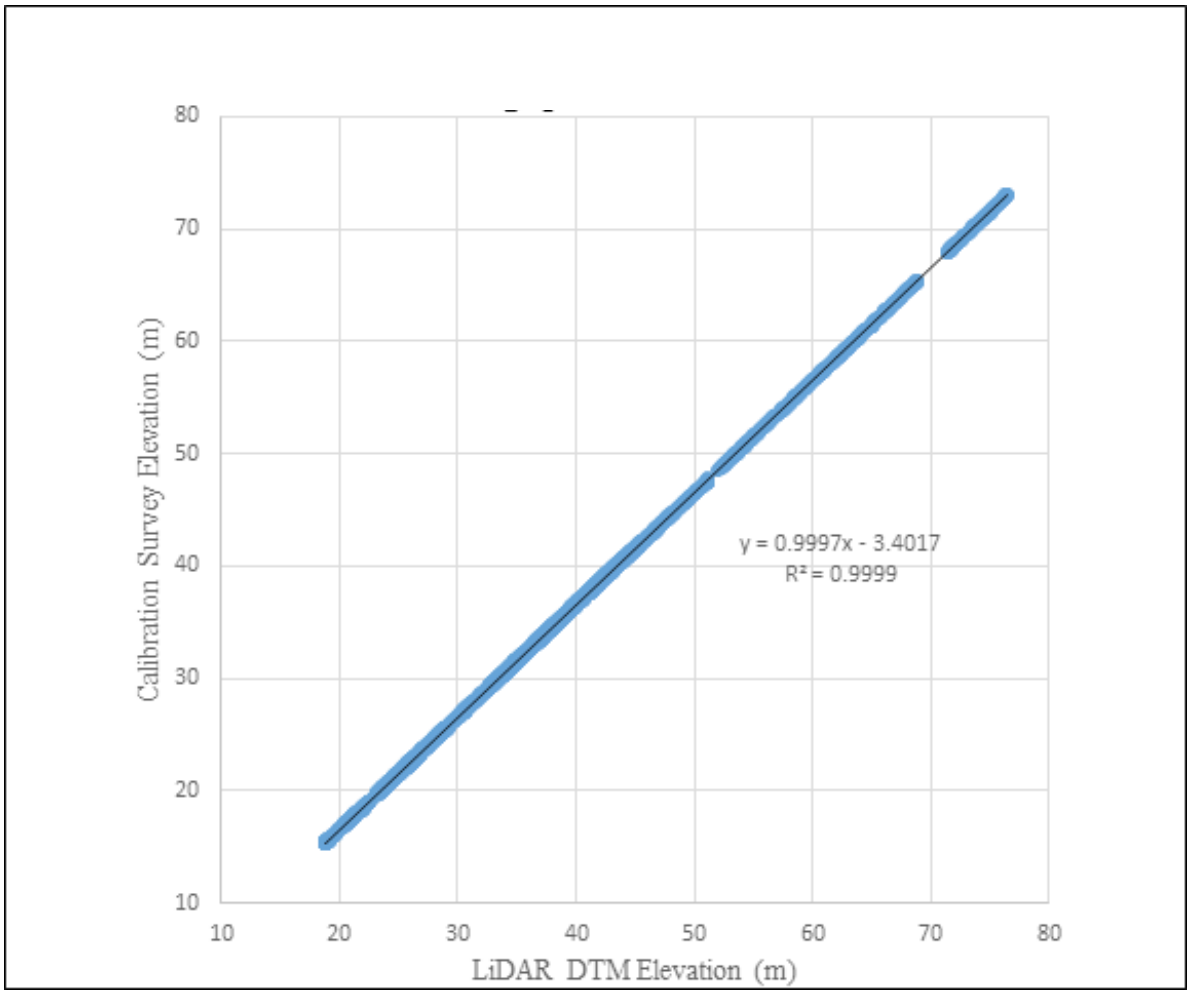

Figure 21. Correlation plot between calibration survey points and LiDAR data.

Table 17. Calibration Statistical Measures.

Calibration Statistical Measures	Value (meters)
Height Difference	3.41
Standard Deviation	0.08
Average	-3.41
Minimum	-3.57
Maximum	-3.25

For validation, the validation survey data for Dagupan that was forwarded after the calibration of Dagupan LiDAR data was used. Randomly selected 20% of the 2,326 total survey points, resulting to 458 points, were used for the validation of calibrated Dagupan DTM. A good correlation between the calibrated mosaicked LiDAR elevation values and the ground survey elevation, which reflects the quality of the LiDAR DTM is shown in Figure 21. The computed RMSE between the calibrated LiDAR DTM and validation elevation values is 0.14 meters with a standard deviation of 0.11 meters, as shown in Table 18.

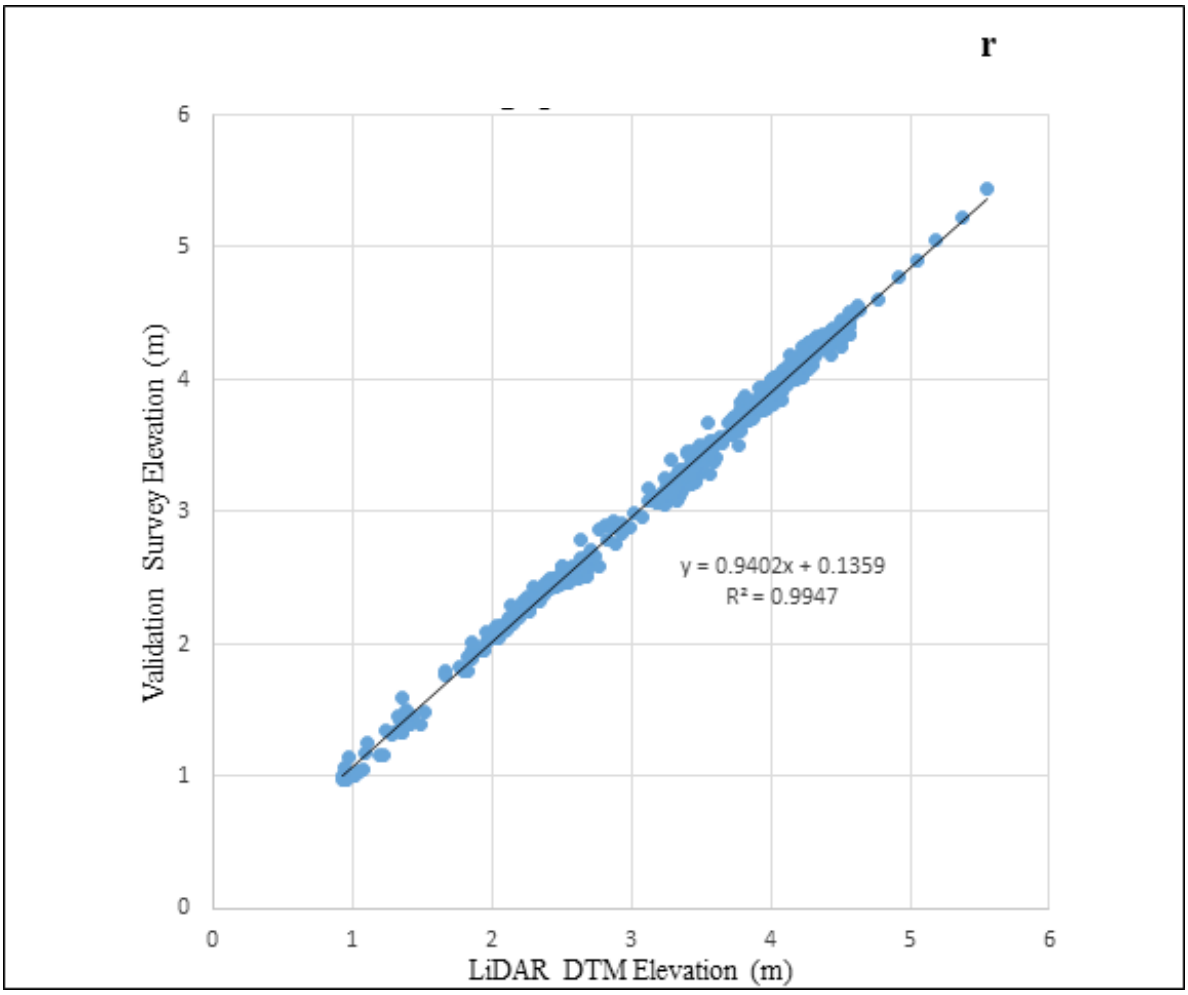

Figure 22. Correlation plot between validation survey points and LiDAR data.

Table 18. Validation Statistical Measures.

Validation Statistical Measures	Value (meters)
RMSE	0.11
Standard Deviation	0.09
Average	-0.06
Minimum	-0.28
Maximum	0.24

3.11 Integration of Bathymetric Data into the LiDAR Digital Terrain Model

For bathy integration, only centerline data was available for Dagupan with 29,636 bathymetric survey points. The resulting raster surface produced was done by Kernel interpolation with barriers method. After burning the bathymetric data to the calibrated DTM, assessment of the interpolated surface is represented by the computed RMSE value of 0.86 meters. The extent of the bathymetric survey done by the Data Validation and Bathymetry Component (DVBC) in Dagupan integrated with the processed LiDAR DEM is shown in Figure 22.

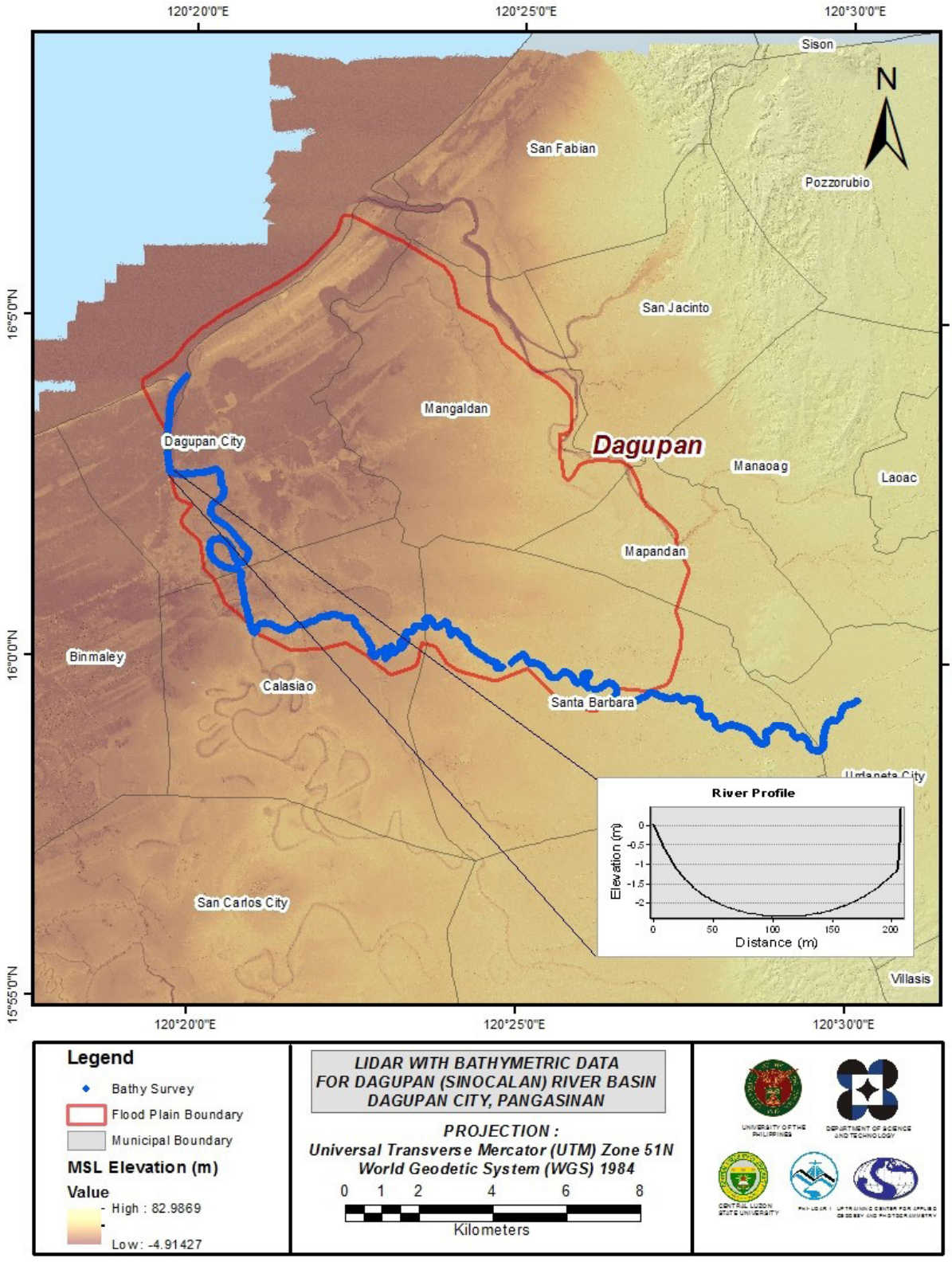

Figure 23. Map of Dagupan Flood Plain with bathymetric survey points shown in blue.

3.12 Feature Extraction

The features salient in flood hazard exposure analysis include buildings, road networks, bridges and water bodies within the floodplain area with 200 m buffer zone. Mosaicked LiDAR DEM with 1 m resolution was used to delineate footprints of building features, which consist of residential buildings, government offices, medical facilities, religious institutions, and commercial establishments, among others. Road networks comprise of main thoroughfares such as highways and municipal and barangay roads essential for routing of disaster response efforts. These features are represented by a network of road centerlines.

3.12.1 Quality Checking of Digitized Features' Boundary

Dagupan floodplain, including its 200 m buffer, has a total area of 120.13 sq km. For this area, a total of 5.0 sq km, corresponding to a total of 4861 building features, are considered for QC. Figure 23 shows the QC blocks for Dagupan floodplain.

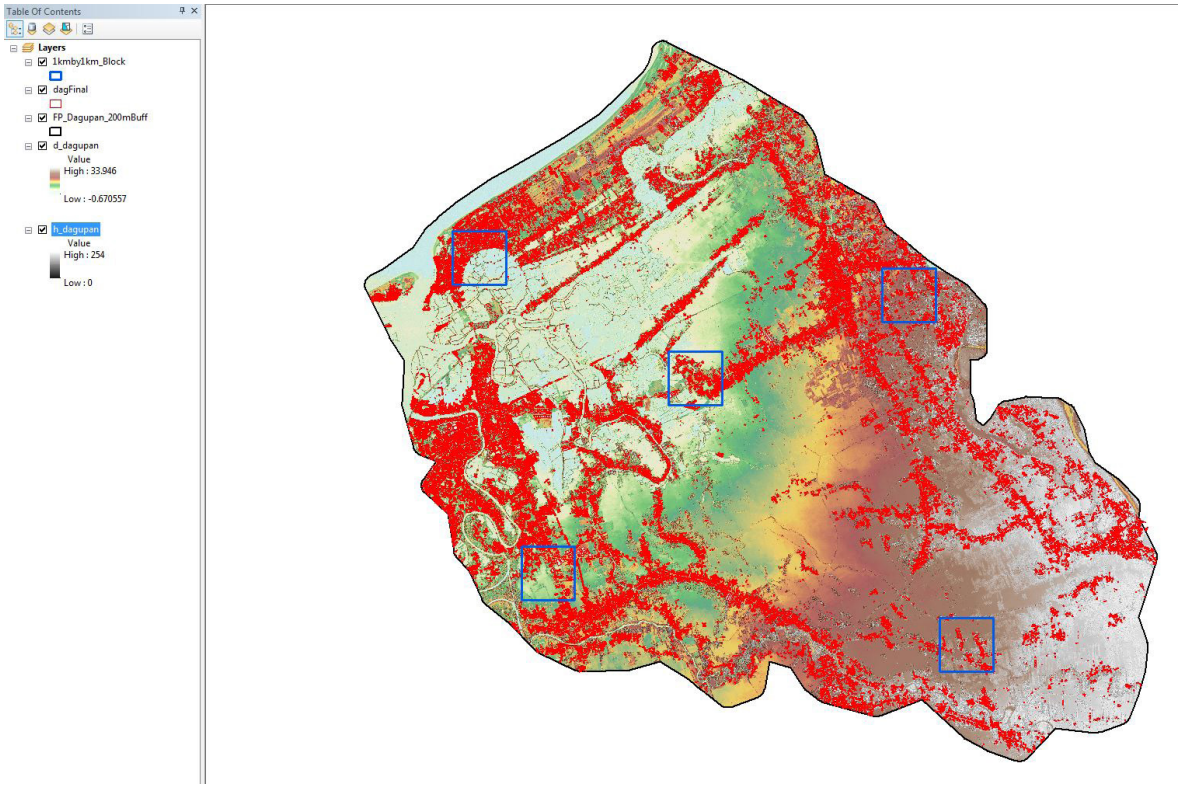

Figure 24. QC blocks for Dagupan building features.

Quality checking of Dagupan building features resulted in the ratings shown in Table 19.

Table 19. Quality Checking Ratings for Dagupan Building Features.

FLOODPLAIN	COMPLETENESS	CORRECTNESS	QUALITY	REMARKS
Dagupan	99.13	100	87.43	PASSED

3.12.2 Height Extraction

Height extraction was done for 73,840 building features in Dagupan (Sinocalan) floodplain. Of these building features, 1,956 was filtered out after height extraction, resulting to 71,884 buildings with height attributes. The lowest building height is at 2.00 m, while the highest building is at 13.22 m.

3.12.3 Feature Attribution

For improved accuracy in building footprints attribution, all the necessary data such as name and type were gathered, verified and field validated with the use of video-tagging device or geo tagged video capturing tool.

Table 20 summarizes the number of building features per type. On the other hand, Table 21 shows the total length of each road type, while Table 22 shows the number of water features extracted per type.

Table 20. Building Features Extracted for Dagupan Floodplain.

Facility Type	No. of Features
Residential	69,522
School	938
Market	71
Agricultural/Agro-Industrial Facilities	90
Medical Institutions	96
Barangay Hall	58
Military Institution	1
Sports Center/Gymnasium/Covered Court	52
Telecommunication Facilities	8
Transport Terminal	20
Warehouse	92
Power Plant/Substation	16
NGO/CSO Offices	6
Police Station	21
Water Supply/Sewerage	8
Religious Institutions	134
Bank	46
Factory	32
Gas Station	54
Fire Station	4
Other Government Offices	81
Other Commercial Establishments	534
Total	71,884

Table 21. Total Length of Extracted Roads for Dagupan Floodplain.

Floodplain	Road Network Length (km)					Total
	Barangay Road	City/Municipal Road	Provincial Road	National Road	Others	
Dagupan	322.78	37.88	61.14	524.05	0.00	**421.80**

Table 22. Number of Extracted Water Bodies for Dagupan Floodplain.

Floodplain	Water Body Type					Total
	Rivers/Streams	Lakes/Ponds	Sea	Dam	Fish Pen	
Dagupan	13	867	0	0	0	**880.00**

A total of 114 bridges and culverts over small channels that are part of the river network were also extracted for the floodplain.

3.12.4 Final Quality Checking of Extracted Features

All extracted ground features were completely given the required attributes. All these output features comprise the flood hazard exposure database for the floodplain. This completes the feature extraction phase of the project.

Figure 24 shows the Digital Surface Model (DSM) of Dagupan floodplain overlaid with its ground features.

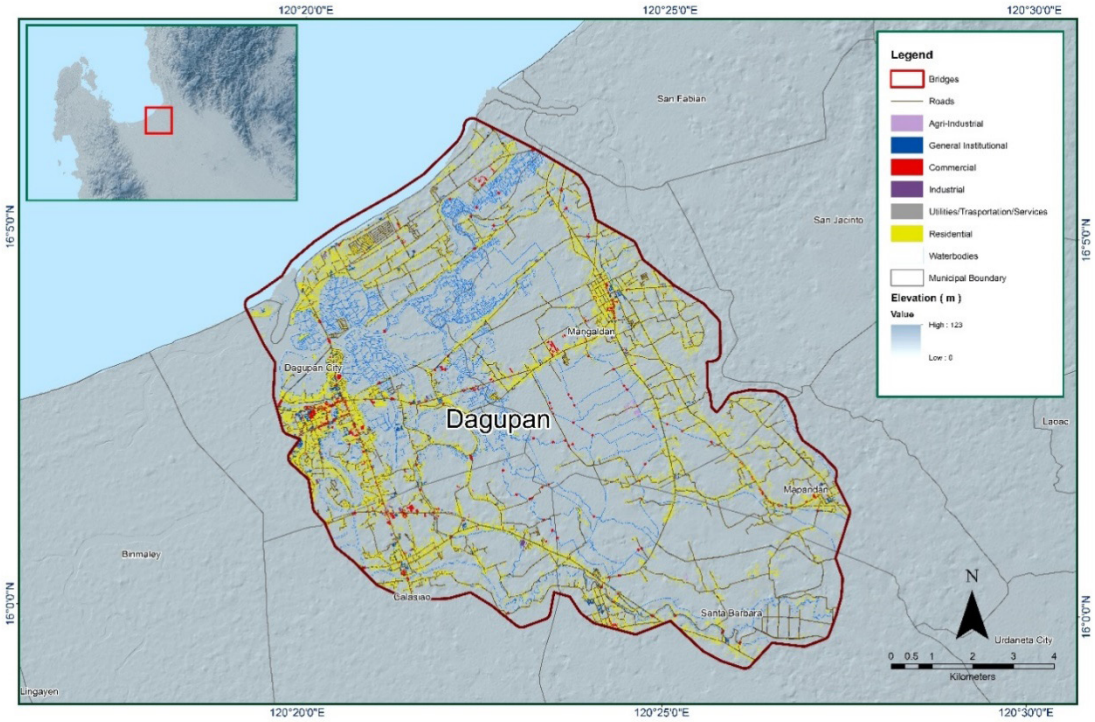

Figure 25. Extracted features for Dagupan floodplain.

CHAPTER 4: LIDAR VALIDATION SURVEY AND MEASUREMENTS OF THE DAGUPAN RIVER BASIN

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The methods applied in this Chapter were based on the DREAM methods manual (Balicanta, et al., 2014) and further enhanced and updated in Paringit, et al. (2017).

4.1 Summary of Activities

The Data Validation and Bathymetry Component (DVBC) conducted a field survey in the Dagupan (also known as Sinocalan) River on September 8 – 22, 2015 with the following scope of work: reconnaissance; control survey for the establishment of a control point; cross-section, bridge as-built of Maramba Bridge in Brgy. Dalongue, Municipality of Santa Barbara and in Caligo Bridge in Brgy. Catablan, Urdaneta City; validation points data acquisition of about 162.06 km for the whole province of Pangasinan; and bathymetric survey from Brgy. San Jose, Urdaneta City, Pangasinan down to Brgy. Bonuan Gueset, Dagupan City, Pangasinan with an estimated length of 36.6 km using GNSS PPK survey technique.

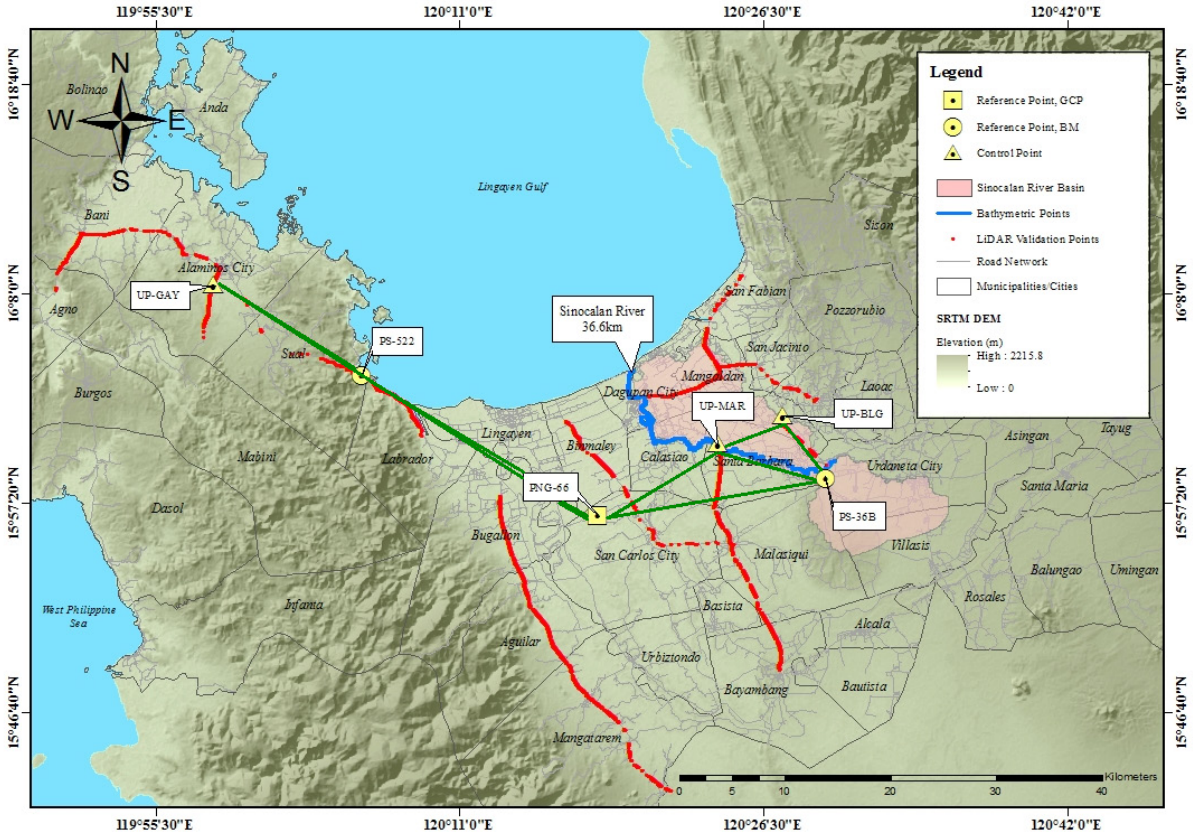


Figure 26. Sinocalan River Survey Extent

4.2 Control Survey

The GNSS network used for Sinocalan River Basin is composed of three (3) loops established on September 10, 16, and 19, 2015 occupying the following reference points: PNG-66, second-order GCP, located in San Carlos City, PS-36B, first-order BM, located in Urdaneta City, and PS-522, first-order BM, located in the Municipality of Sual, Pangasinan.

Three control points were established along the approach of the bridges namely; UP-BLG is a located at the left side, facing upstream, of the approach of Baloling bridge, Brgy. Poblacion, Municipality of Mapandan; UP-GAY located at the left side, facing downstream, of the approach of Gayaga bridge, Brgy. Amandiego, Alaminos City; UP-MAR located at the right side, facing downstream, of the approach of Maramba bridge. Maramba Bridge is built in Brgy. Dalongue, Municipality of Santa Barbara, all in the Province of Pangasinan.

The summary of the reference and control points and its location is summarized in Table C-1 while the GNSS network established is illustrated in Figure C-2.

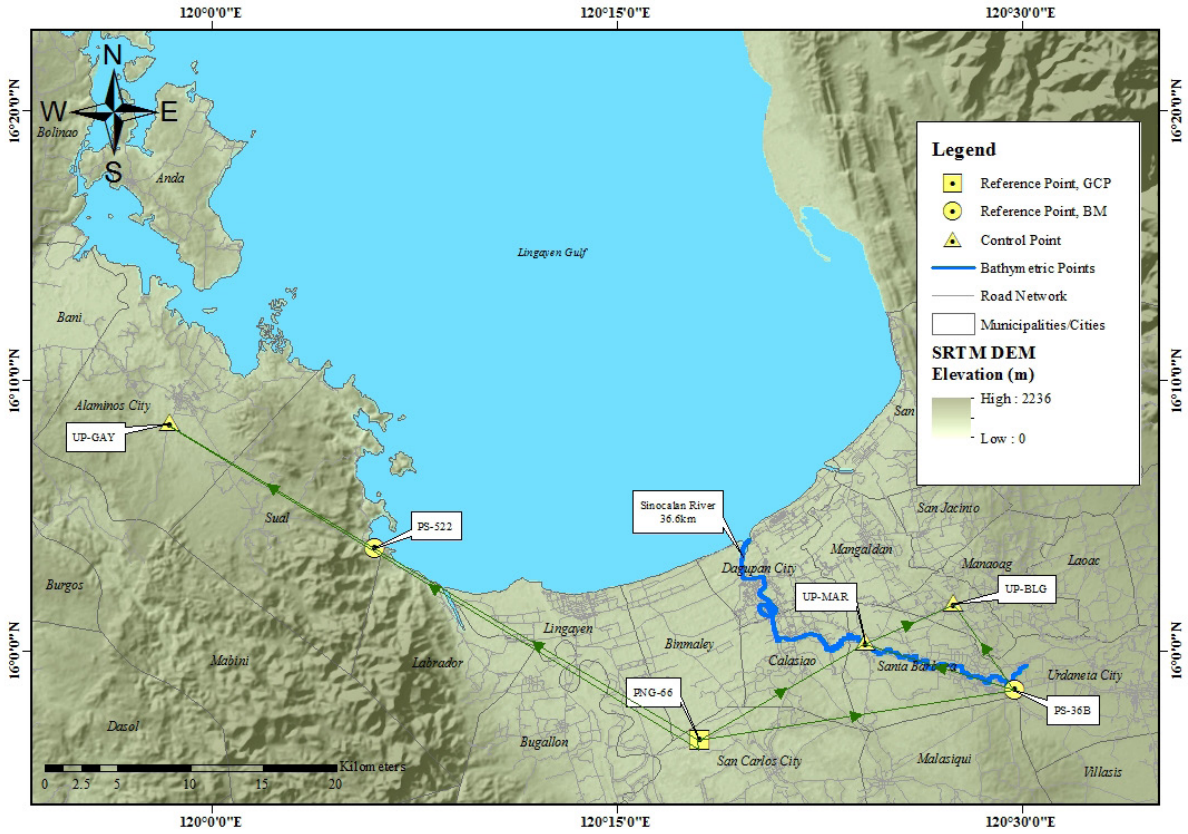


Figure 27. GNSS Network of Sinocalan River Field Survey

Table C-1 List of references and control points used in Pangasinan fieldwork from September 8 - 22, 2015 (Source: NAMRIA, UP-TCAGP)

Control Point Name	Order of Accuracy	Geographic Coordinates (WGS 84)				
		Latitude	Longitude	Ellipsoid Height, (m)	Elevation in MSL (m)	Date Established
PNG-66	2nd Order, GCP	15°56'41.53646"	120°18'01.81867"	45.135	-	2007
PS-36B	1st Order, BM	-	-	60.309	18.639	1991
PS-522	1st Order, BM	-	-	44.330	1.812	2007
UP-BLG	UP Established	-	-	-	-	Sept. 15, 2015
UP-GAY	UP Established	-	-	-	-	Sept. 17, 2015
UP-MAR	UP Established	-	-	-	-	Sept. 17, 2015

The GNSS set ups made in the location of the reference and control points are exhibited in Figure C-3 to Figure C-8.

Figure 28. GNSS base receiver setup, Trimble® SPS 852 at PNG-66 in Calamboyan Elementary School, San Carlos City, Pangasinan

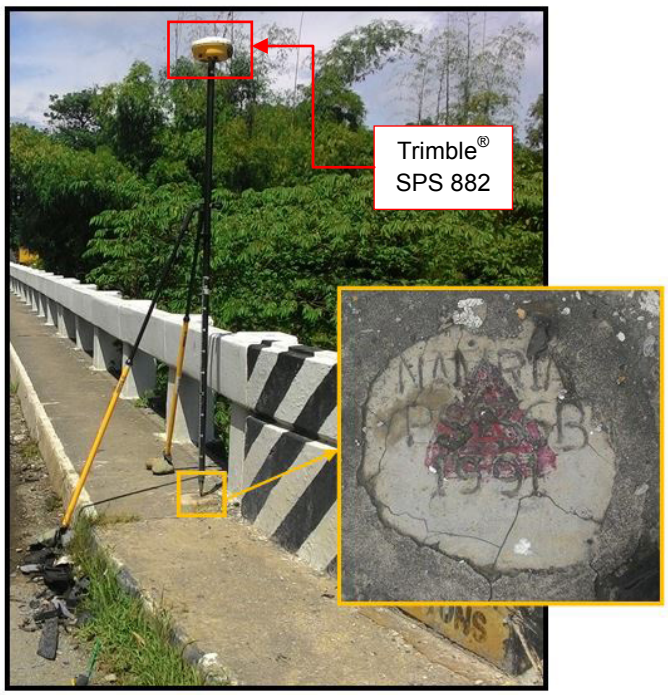


Figure 29. GNSS receiver setup, Trimble® SPS 882at PS-36B in Villamil Bridge, Urdaneta City, Pangasinan

Figure 30. GNSS receiver occupation, Trimble® SPS 882 at PS-522 in Quartel Bridge, Municipality of Sual, Pangasinan

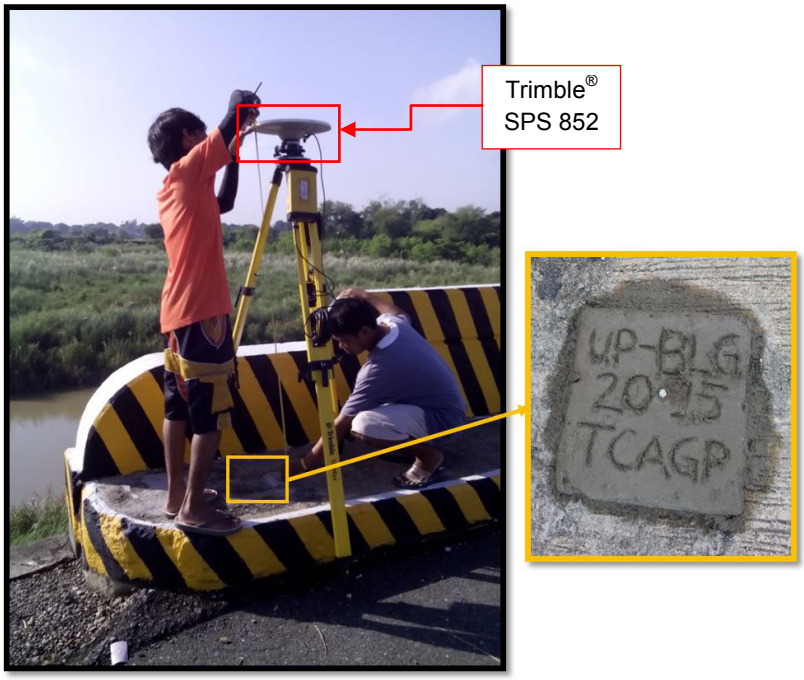


Figure 31. GNSS base receiver setup, Trimble® SPS 852 at UP-BLG in Baloling Bridge, Municipality of Mapandan, Pangasinan

Figure 32. GNSS base receiver setup, Trimble® SPS 852 at UP-GAY in Gayaga Bridge, Alaminos City, Pangasinan

Figure 33. GNSS base receiver setup, Trimble® SPS 852 at UP-MAR in Maramba Bridge, Municipality of Santa Barbara, Pangasinan

4.3 Baseline Processing

GNSS Baselines were processed simultaneously in TBC by observing that all baselines have fixed solutions with horizontal and vertical precisions within +/- 20 cm and +/- 10 cm requirement, respectively. In cases where one or more baselines did not meet all of these criteria, masking is performed. Masking is done by removing/masking portions of these baseline data using the same processing software. It is repeatedly processed until all baseline requirements are met. If the reiteration yields out of the required accuracy, resurvey is initiated. Baseline processing result of control points in Sinocalan River Basin is summarized in Table C-2 generated by TBC software.

Table C-2. Baseline Processing Report for Sinocalan River static survey

Observation	Date of Observation	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
PNG-66 --- PS-36B	Sept. 10, 2015	Fixed	0.004	0.032	80°34'24"	21076.72	15.257
PNG-66 --- PS-36B	Sept. 19, 2015	Fixed	0.004	0.023	80°34'24"	21076.73	15.178
PNG-66 --- UP-MAR	Sept. 19, 2015	Fixed	0.005	0.033	58°24'17"	12839.72	6.668
PNG-66 --- UP-BLG	Sept. 19, 2015	Fixed	0.005	0.03	60°45'33"	19259.28	10.98
PNG-66 --- PS-522	Sept. 16, 2015	Fixed	0.005	0.022	301°25'35"	25130.95	-0.832
UP-MAR --- PS-36B	Sept. 19, 2015	Fixed	0.004	0.029	108°24'33"	10385.5	8.6
PS-36B --- UP-BLG	Sept. 10, 2015	Fixed	0.004	0.025	326°15'14"	7167.08	-4.244
PS-522 --- UP-GAY	Sept. 16, 2015	Fixed	0.004	0.026	302°25'36"	15998.92	6.786
PNG-66 --- UP-GAY	Sept. 16, 2015	Fixed	0.004	0.028	301°50'14"	41128.23	5.941

As shown in Table C-2, a total of nine (9) baselines were processed with reference point PNG-66 held fixed for coordinate values; and PS-36B and PS-522 fixed for elevation values. All of them passed the required accuracy.

4.4 Network Adjustment

After the baseline processing procedure, network adjustment is performed using TBC. Looking at the Adjusted Grid Coordinates table of the TBC generated Network Adjustment Report, it is observed that the square root of the sum of the squares of x and y must be less than 20cm and z less than 10cm in equation from:

$$\sqrt{(x_e)^2 + (y_e)^2} < 20cm \text{ and } z_e < 10cm$$

Where:

xe is the Easting Error,
ye is the Northing Error, and
ze is the Elevation Error

The six (6) control points, PNG-66, PS-36B, PS-522, UP-BLG, UP-GAY, and UP-MAR were occupied and observed simultaneously to form a GNSS loop. Coordinates of PNG-66 and elevation values of PS-36B and PS-522 were held fixed during the processing of the control points as presented in Table C-3. Through these reference points, the coordinates and elevation of the unknown control points were computed.

Table C-3. Control Point Constraints

Point ID	Type	East σ (Meter)	North σ (Meter)	Height σ (Meter)	Elevation σ (Meter)
PNG-66	Local	Fixed	Fixed		
PS-36B	Grid				Fixed
PS-522	Grid				Fixed
Fixed = 0.000001(Meter)					

The list of adjusted grid coordinates, i.e. Northing, Easting, Elevation and computed standard errors of the control points in the network is indicated in Table C-4. All fixed control points have no values for grid and elevation values.

Table C-4. Adjusted Grid Coordinates

Point ID	Easting (Meter)	Easting Error (Meter)	Northing (Meter)	Northing Error (Meter)	Elevation (Meter)	Elevation Error (Meter)	Constraint
PNG-66	211006.342	?	1764708.591	?	2.268	0.050	LL
PS-36B	231853.134	0.008	1767892.575	0.007	18.639	?	e
PS-522	189718.885	0.012	1778099.180	0.009	1.812	?	e
UP-BLG	227941.936	0.011	1773902.67	0.010	14.378	0.083	
UP-GAY	176325.127	0.011	1786874.424	0.009	9.759	0.082	
UP-MAR	222035.735	0.011	1771296.986	0.009	9.726	0.092	

With the mentioned equation, for horizontal and for the vertical; the computation for the accuracy are as follows:

PNG-66

horizontal accuracy	=	Fixed
vertical accuracy	=	5 cm < 10 cm

PS-36B

horizontal accuracy	=	$\sqrt{((0.8)^2 + (0.7)^2)}$
	=	$\sqrt{(0.64 + 0.49)}$
	=	1.06 cm < 20 cm
vertical accuracy	=	Fixed

PS-522

horizontal accuracy	=	$\sqrt{((1.2)^2 + (0.9)^2)}$
	=	$\sqrt{(1.44 + 0.81)}$
	=	1.50cm < 20 cm
vertical accuracy	=	Fixed

UP-BLG

horizontal accuracy	=	$\sqrt{((1.1)^2 + (1.0)^2)}$
	=	$\sqrt{((1.21 + 1)}$
	=	1.49 cm < 20 cm
vertical accuracy	=	8.3 cm < 10 cm

UP-GAY

horizontal accuracy	=	$\sqrt{((1.1)^2 + (0.9)^2)}$
	=	$\sqrt{(1.21 + 0.81)}$
	=	1.42 cm < 20 cm
vertical accuracy	=	8.2 cm < 10 cm

UP-MAR

horizontal accuracy	=	$\sqrt{((1.1)^2 + (0.9)^2)}$
	=	$\sqrt{(1.21 + 0.81)}$
	=	1.42 cm < 20 cm
vertical accuracy	=	8.2 cm < 10 cm

Following the given formula, the horizontal and vertical accuracy result of the two occupied control points are within the required accuracy of the project.

Table C-5 Adjusted Geodetic Coordinates

Point ID	Latitude	Longitude	Height (Meter)	Height Error (Meter)	Constraint
PNG-66	N15°56'41.53646"	E120°18'01.81867"	45.135	0.050	LL
PS-36B	N15°58'33.52429"	E120°29'41.05846"	60.309	?	e
PS-522	N16°03'47.48583"	E120°06'00.32645"	44.330	?	e
UP-BLG	N16°01'47.38965"	E120°27'27.12781"	56.071	0.083	
UP-GAY	N16°08'26.44413"	E119°58'25.80151"	51.092	0.082	
UP-MAR	N16°00'20.29399"	E120°24'09.66719"	51.750	0.092	

The corresponding geodetic coordinates of the observed points are within the required accuracy as shown in Table C-5. Based on the result of the computation, the accuracy condition is satisfied; hence, the required accuracy for the program was met.

The summary of reference and control points used is indicated in Table C-6.

Table C-6. Reference and control points used and its location (Source: NAMRIA, UP-TCAGP)

Control Point	Order of Accuracy	Geographic Coordinates (WGS 84)			UTM ZONE 51 N		
		Latitude	Longitude	Ellipsoidal Height (m)	Northing (m)	Easting (m)	BM Ortho (m)
PNG-66	2nd Order, GCP	15°56'41.53646"	120°18'01.81867"	45.135	1764708.591	211006.342	2.268
PS-36B	1st Order, BM	15°58'33.52429"	120°29'41.05846"	60.309	1767892.575	231853.134	18.639
PS-522	1st Order, BM	16°03'47.48583"	120°06'00.32645"	44.330	1778099.180	189718.885	1.812
UP-BLG	UP Established	16°01'47.38965"	120°27'27.12781"	56.071	1773902.67	227941.936	14.378
UP-GAY	UP Established	16°08'26.44413"	119°58'25.80151"	51.092	1786874.424	176325.127	9.759
UP-MAR	UP Established	16°00'20.29399"	120°24'09.66719"	51.750	1771296.986	222035.735	9.726

4.5 Cross-section and Bridge As-Built survey and Water Level Marking

Cross-section and as-built surveys were conducted in Maramba Bridge in Brgy. Dalongue, Municipality of Santa Barbara on September 17, 2015 and in Caligo Bridge in Brgy. Catablan, Urdaneta City on September 11, 2015 using Trimble® SPS 882 GNSS in PPK survey technique as shown in Figure C-9.

Figure 34. (A) As-built surveys in Maramba Bridge, Municipality of Santa Barbara and (B) in Caligo Bridge, Urdaneta City

The cross-sectional line for Maramba Bridge is about 63 m with twenty-one (21) cross-sectional points, while the cross-sectional line for Caligo Bridge is about 94 m with ninety-five (95) cross-sectional points using the control points UP-MAR, and PS-36B, respectively, as the GNSS base stations. The cross-section diagram, planimetric maps, and bridge data forms are shown in Figure C-10 to Figure C-15, respectively.

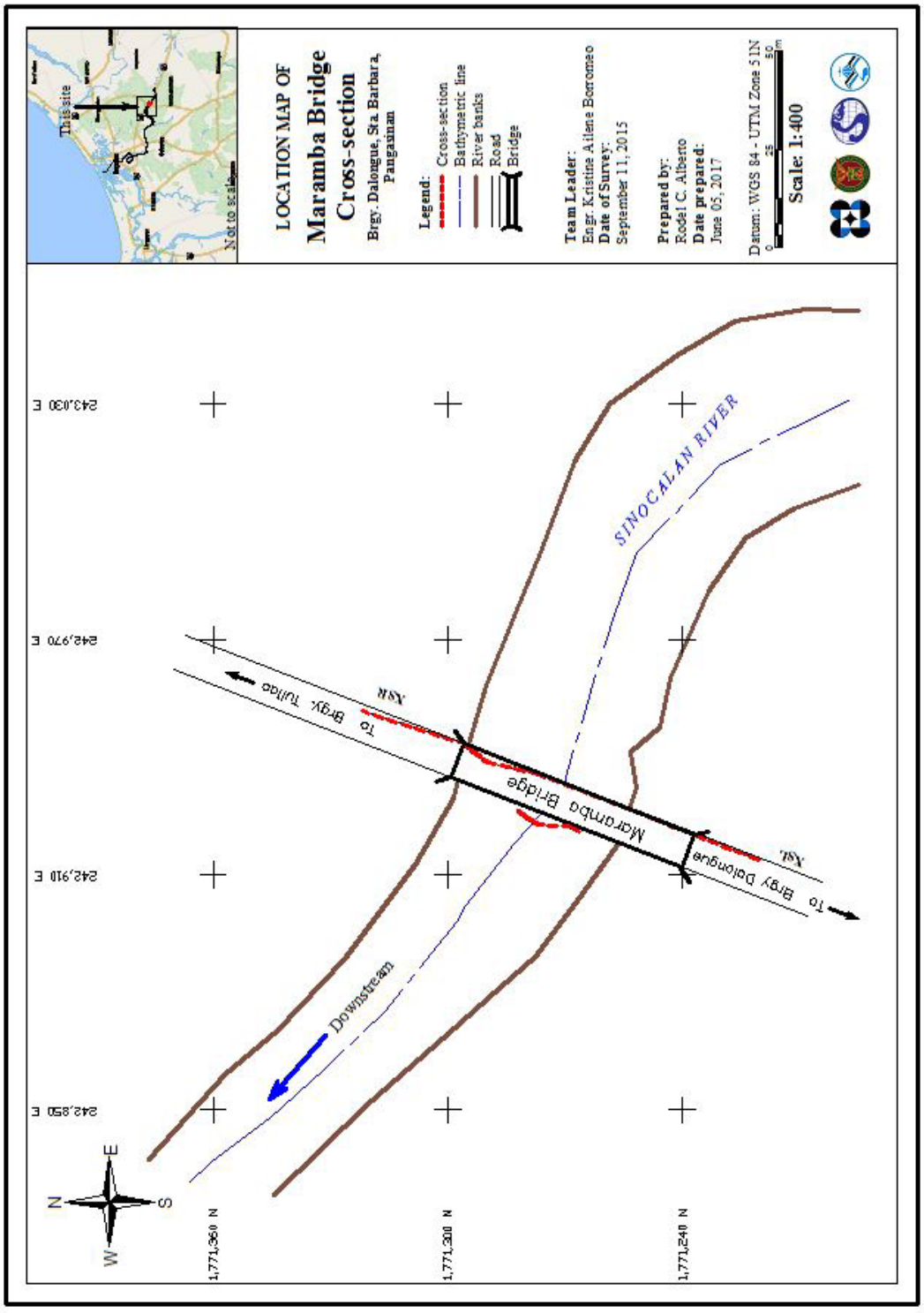


Figure 35. Maramba bridge cross-section planimetric map

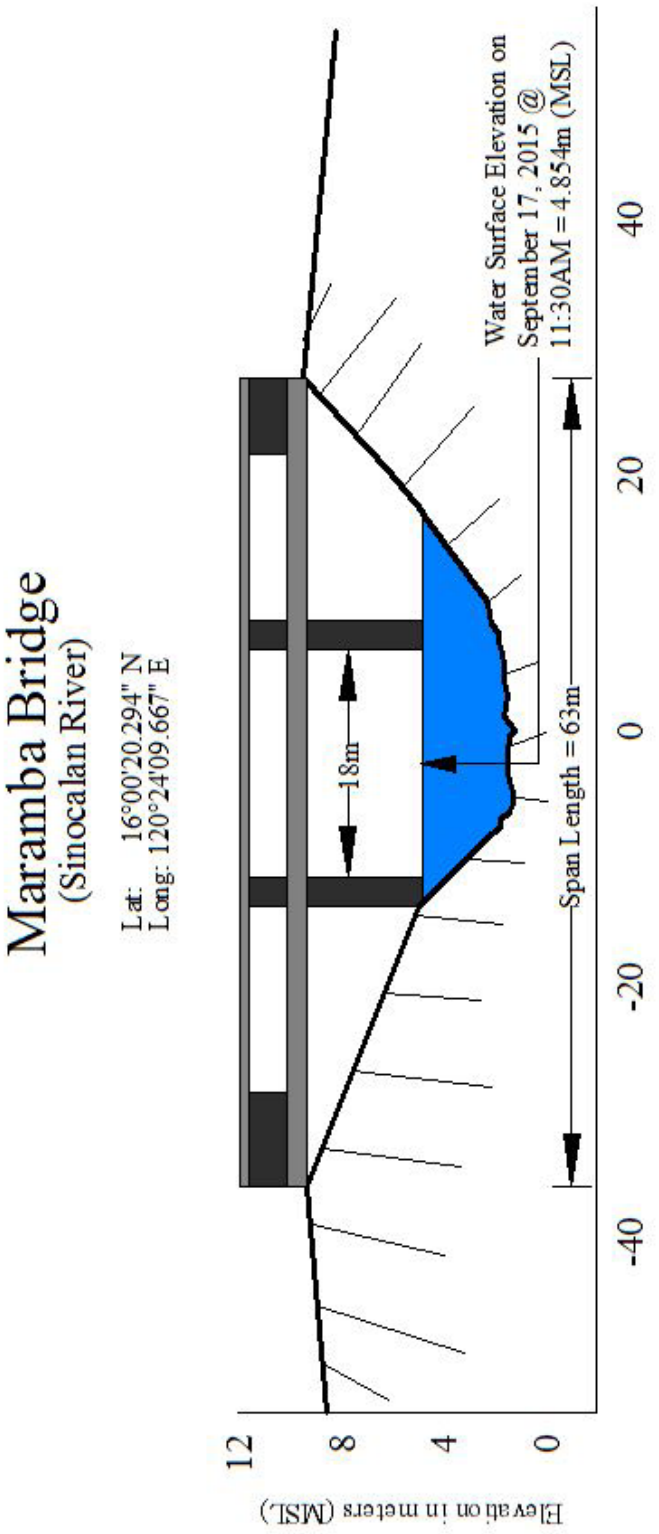


Figure 36. Maramba Bridge cross section diagram

Bridge Data Form

Bridge Name: Maramba Bridge **Date:** September 11, 2015

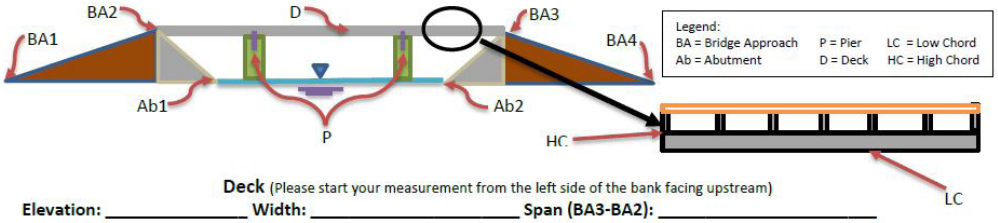
River Name: Sinocalan River **Time:** 11:30 AM

Location (Brgy, City,Region): Brgy. Dalongue, Municipality of Santa Barbara

Survey Team: Abrio, Alberto, Borromeo, Salvador

Flow condition: low normal high **Weather Condition:** fair rainy

Latitude: 16d00'20.29378" **Longitude:** 120d24'09.66679"



Deck (Please start your measurement from the left side of the bank facing upstream)

Elevation: _____ **Width:** _____ **Span (BA3-BA2):** _____

	Station	High Chord Elevation	Low Chord Elevation
1			
2			
3			
4			
5			

Bridge Approach (Please start your measurement from the left side of the bank facing upstream)

	Station(Distance from BA1)	Elevation		Station(Distance from BA1)	Elevation
BA1	0	8.53m	BA3	81.1m	9.48m
BA2	17.8m	9.32m	BA4	108.22m	8.19m

Abutment: Is the abutment sloping? Yes No; If yes, fill in the following information:

	Station (Distance from BA1)	Elevation
Ab1		
Ab2		

Pier (Please start your measurement from the left side of the bank facing upstream)

Shape: _____ Number of Piers: _____ Height of column footing: _____

	Station (Distance from BA1)	Elevation	Pier Width
Pier 1	40.80m	9.78m	
Pier 2	60.90m	9.76m	

NOTE: Use the center of the pier as reference to its station

DREAM
Disaster Risk and Exposure Assessment for Mitigation

Figure 37. Maramba Bridge Data Form

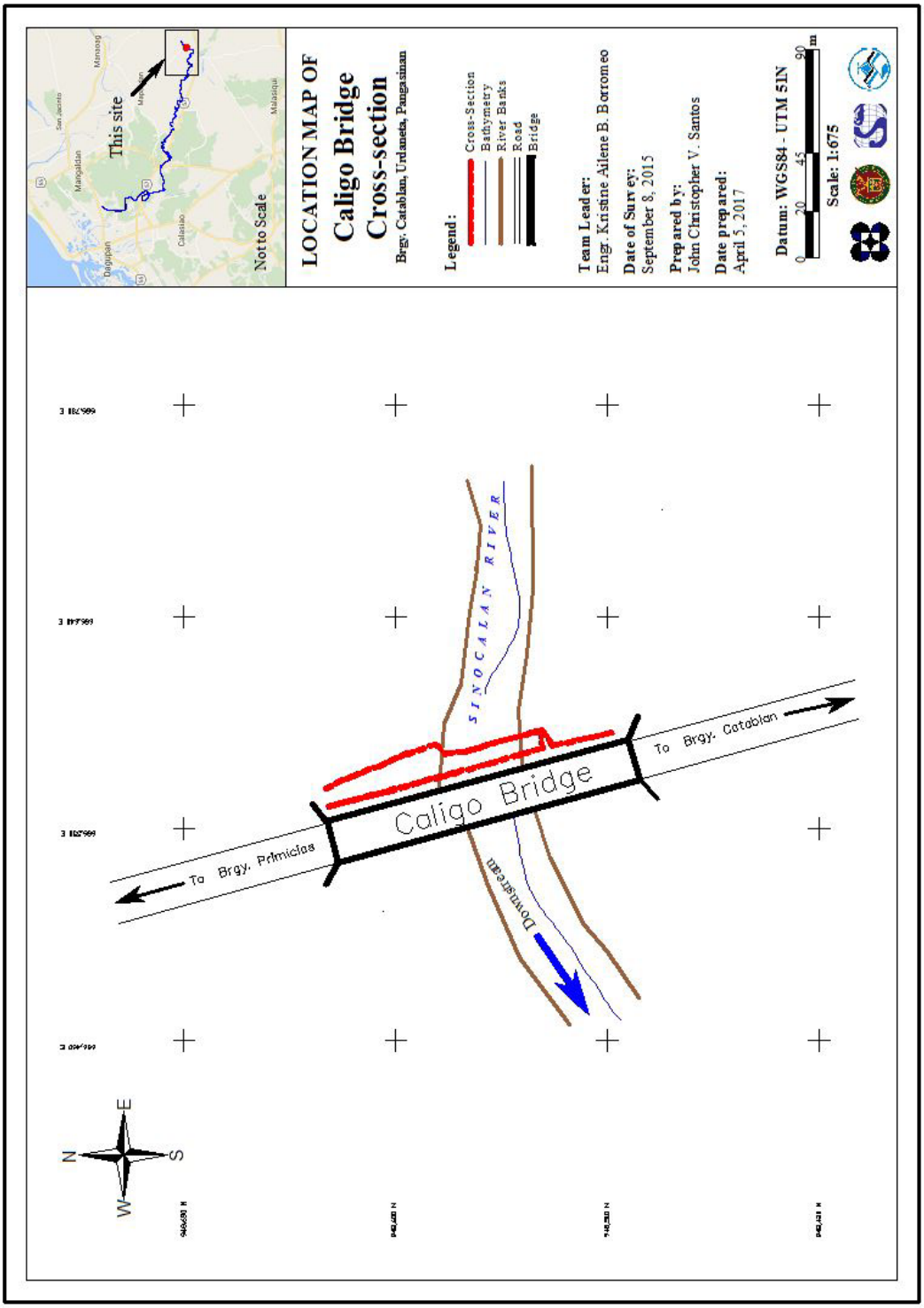


Figure 38. Caligo bridge cross-section planimetric map

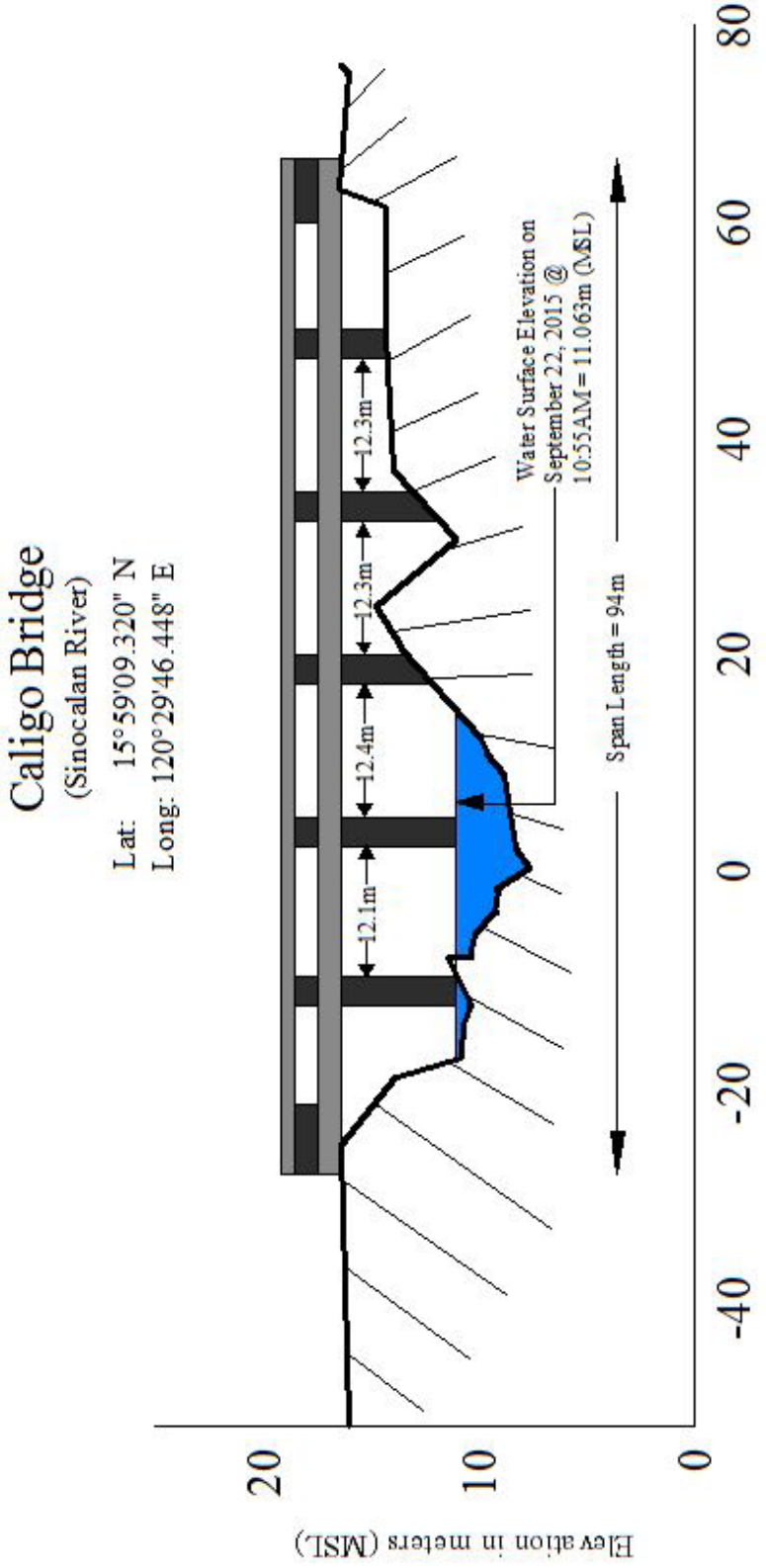


Figure 39. Caligo Bridge cross section diagram

Bridge Data Form

Bridge Name: Caligo Bridge **Date:** September 17, 2015

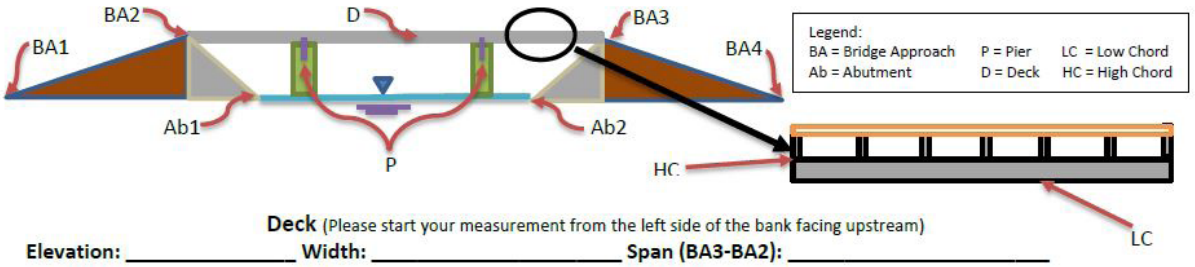
River Name: Sinocalan River **Time:** 12:40 PM

Location (Brgy, City,Region): Brgy. Catablan, Urdaneta City

Survey Team: Abrio, Alberto, Borromeo, Salvador

Flow condition: low normal high **Weather Condition:** fair rainy

Latitude: 15d59'09.31995" **Longitude:** 120d29'46.44828"



Deck (Please start your measurement from the left side of the bank facing upstream)

Elevation: _____ **Width:** _____ **Span (BA3-BA2):** _____

	Station	High Chord Elevation	Low Chord Elevation
1			
2			
3			
4			

Bridge Approach (Please start your measurement from the left side of the bank facing upstream)

	Station(Distance from BA1)	Elevation		Station(Distance from BA1)	Elevation
BA1	0	15.981m	BA3	114.64m	16.440m
BA2	25.96m	16.339m	BA4	126.0841m	16.332

Abutment: Is the abutment sloping? Yes No; If yes, fill in the following information:

	Station (Distance from BA1)	Elevation
Ab1	30.22m	15.385
Ab2		

Pier (Please start your measurement from the left side of the bank facing upstream)

Shape: _____ Number of Piers: _____ Height of column footing: _____

	Station (Distance from BA1)	Elevation	Pier Width
Pier 1	40.41m	16.557m	
Pier 2	55.19m	16.495m	
Pier 3	70.31m	16.496m	
Pier 4	85.33m	16.480m	
Pier 5	100.39m	16.522m	

NOTE: Use the center of the pier as reference to its station

DREAM
Disaster Risk and Exposure Assessment for Mitigation

Figure 40. Caligo Bridge Data Form

Water surface elevation of Caligo River was determined using Trimble® SPS 882 in PPK mode survey on September 22, 2015 at 10:55 AM with a value of 11.063 m in MSL. This was translated onto marking the bridge's pier as shown in Figure C-16. The marking shall serve as reference for flow data gathering and depth gauge deployment by the partner HEI, Central Luzon State University, who is responsible for Sinocalan River.

Figure 41. Water level marking on the post of Caligo Bridge

4.6 Validation Points Acquisition Survey

Validation Points Acquisition Survey was conducted on September 11, 12, 13, 14, 16, and 18, 2015 using a survey-grade GNSS rover receiver, Trimble® SPS 882, mounted on a pole which was attached in front of the vehicle as shown in Figure C-17. It was secured with a nylon rope to ensure that it was horizontally and vertically balanced. The antenna height of 2.53 m was measured from the ground up to the bottom of notch of the GNSS Rover receiver. The survey was conducted using PPK technique on a continuous topo mode.

On September 11, 2015, gathering of ground validation points started from the Municipality of Santa Barbara traversing major roads going to the Municipality of Malasiqui. The next day, September 12, 2015, the team was divided into two groups, Group 1 started from Urdaneta City going to the Municipality of Mangaldan, while Group 2 started from the Municipality of San Fabian up to the Municipality of Santa Barbara. On September 13, 2015, Group 1 validated roads from San Carlos City going to the Municipality of Binmaley, then continued from Dagupan City up to the Municipality of San Fabian. Group 2 started from the Municipality of Bayambang going to the Municipality of Malasiqui, and continued the extent up to the Municipality of Santa Barbara. Then on September 14, 2015, the team validated the areas in Alaminos City going to the Municipalities of Mabini and Bani. The remaining validation extent was surveyed on September 16 and 18, 2015. A total of 15,327 points were gathered with approximate length of 162.06 km using PNG-66, UP-MAR, UP-GAY, and UP-BLG as GNSS base stations for the entire extent of validation points acquisition survey, as illustrated in the map in Figure C-18.

Figure 42. (A) Setup of Trimble® SPS 882 attached to a vehicle and (B) Setting up of GNSS base station at PNG-66

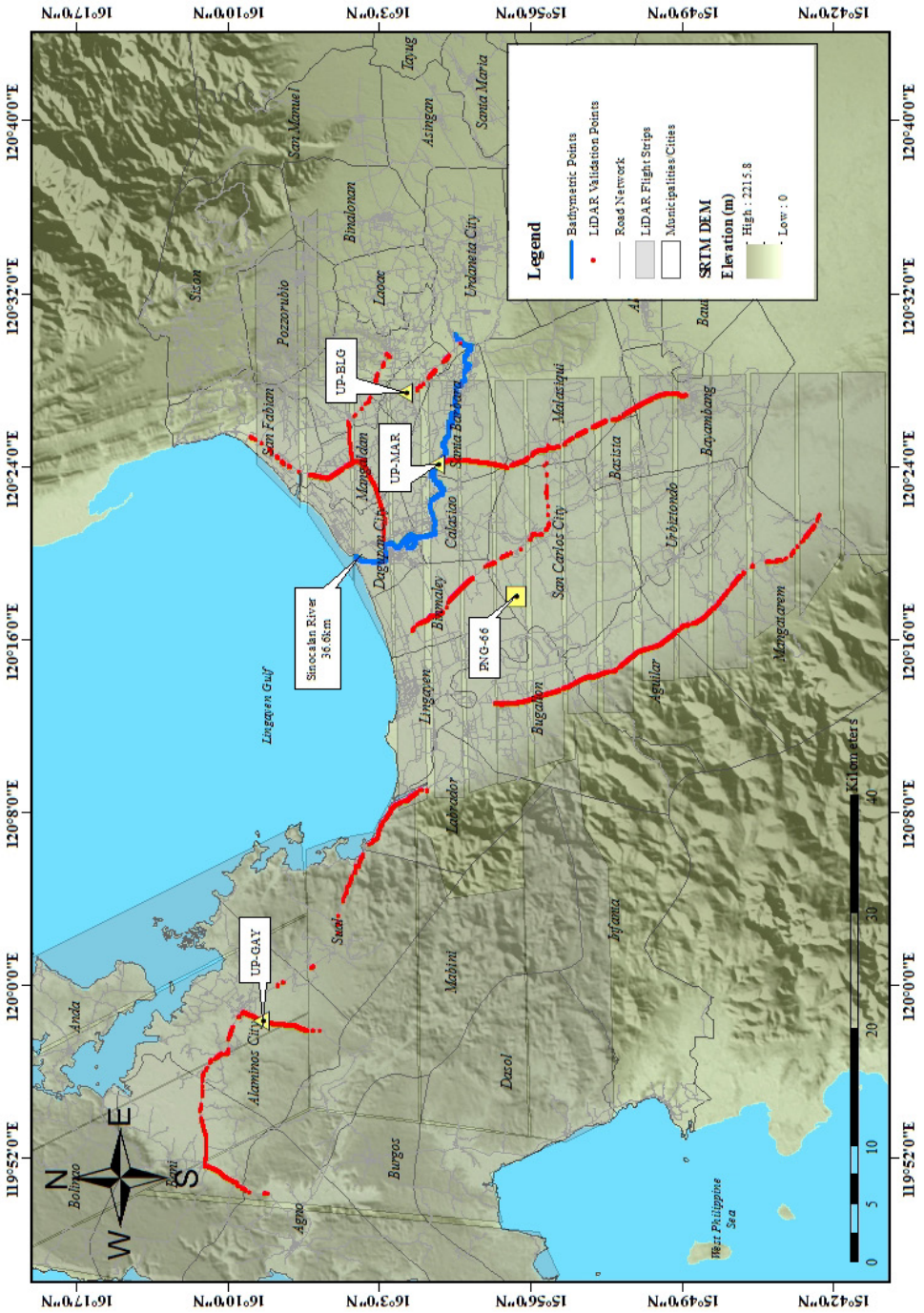


Figure 43. Validation Points Acquisition Survey along Pangasinan Province

4.7 River Bathymetric Survey

Bathymetric survey was executed on September 11, 12, and, 18, 2015 using an Ohmex™ single beam echo sounder and Trimble® SPS 882 in GNSS PPK survey technique in continuous topo mode as illustrated in Figure C-19. The survey started in the downstream part of the river in Brgy. Lomboy, Dagupan City with coordinates 16°03›08.83322»N, 120°19›37.69171»E, and ended at the upstream of the river with coordinates 15°59›27.71057»N, 120°30›09.53431»E in Brgy. San Jose, Urdaneta City. The control UP-MAR was used as GNSS base station all throughout the entire survey.

Figure 44. Bathymetric Survey equipment setup on a rescue boat borrowed from PDRRMC of Pangasinan along Sinocalan River

The bathymetric survey for Sinocalan River gathered a total of 30,618 points covering 36.6 km of the river traversing Brgy. San Jose, Urdaneta City, Pangasinan downstream to Brgy. Bonuan Gueset, Dagupan City, Pangasinan. A CAD drawing was also produced to illustrate the riverbed profile of Sinocalan River. As shown in Figure C-21, Figure C-22, and Figure C-23, the highest and lowest elevation has a 0.971-m above MSL difference for Sinocalan River. The highest elevation observed was 8.442 m above MSL located at the upstream part of Sinocalan river; while the lowest was –7.471 m below MSL located in the downstream portion of the river.

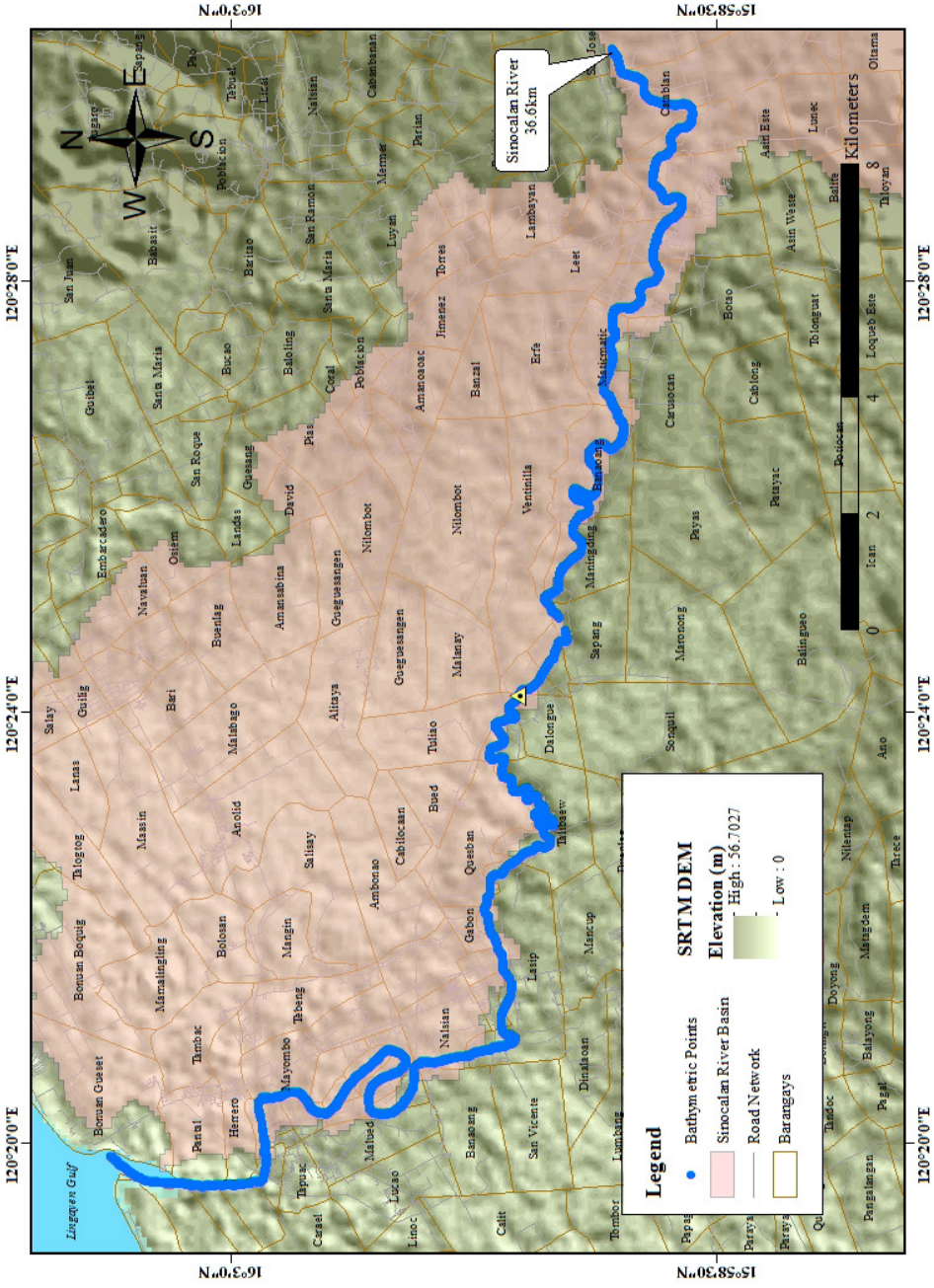


Figure 45. Bathymetric points gathered from Sinocalan River

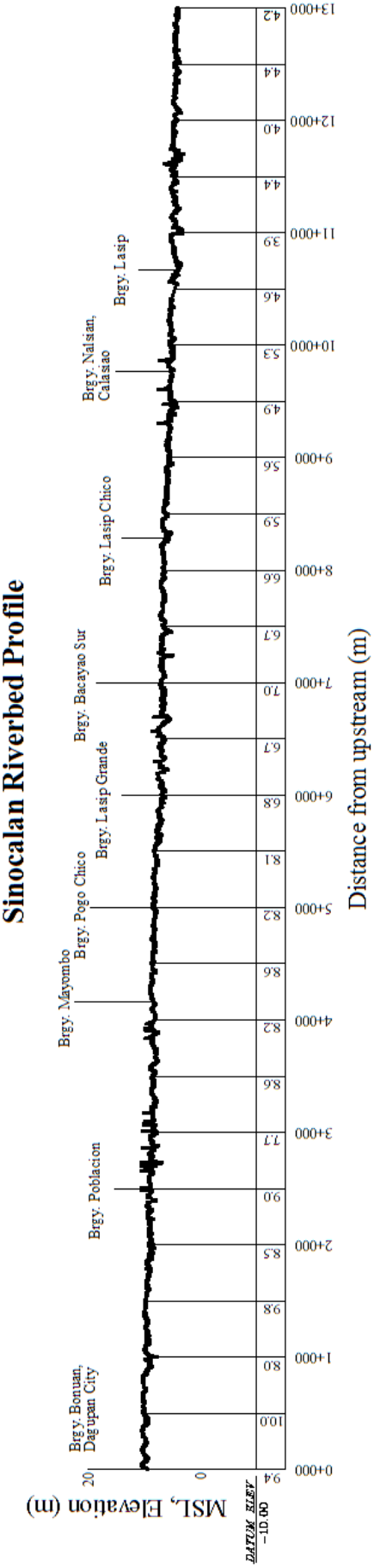


Figure 46. Sinocalan Riverbed Profile from Brgy. Bonuan, Dagupan City down to Brgy. Lasip, Municipality of Calasiao

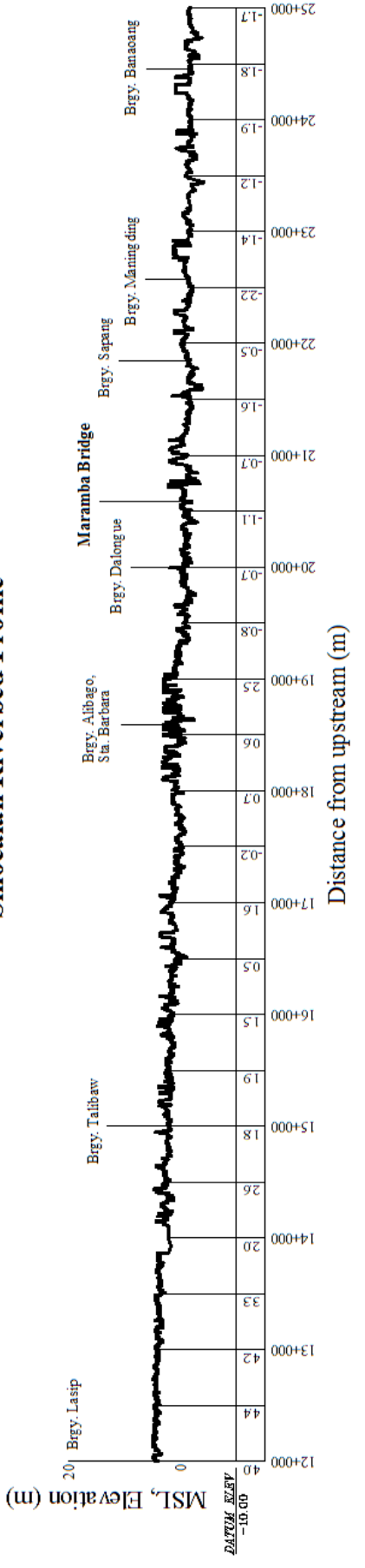


Figure 47. Continuation of Sinocalan Riverbed Profile from Brgy. Lasip, Municipality of Calasiao down to Brgy. Banaoang, Municipality of Santa Barbara

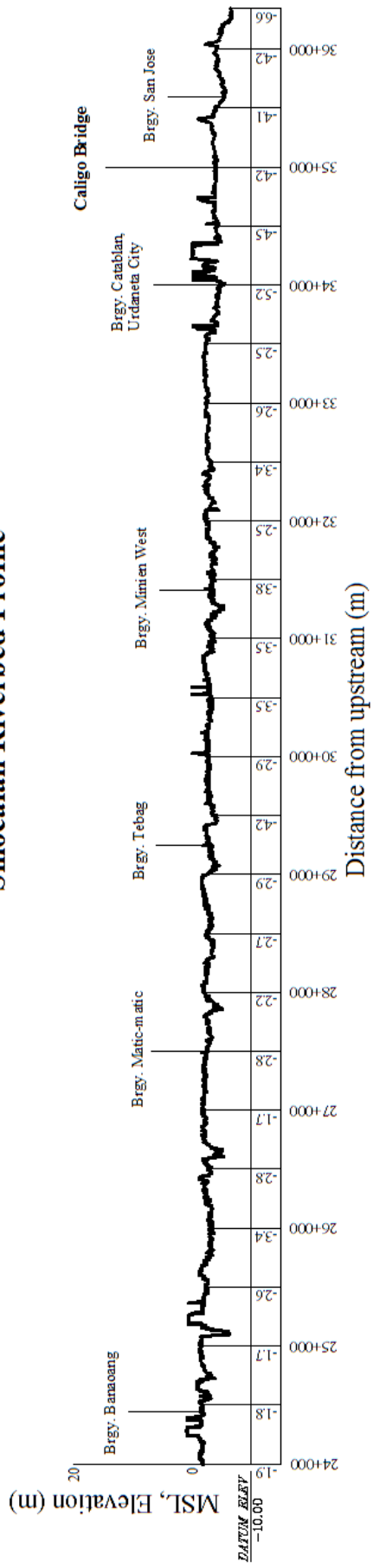


Figure 48. Continuation of Sinocalan Riverbed Profile from Brgy. Banaoang, Municipality of Santa Barbara down to Brgy. San Jose, Urdaneta City

CHAPTER 5: FLOOD MODELING AND MAPPING

Dr. Alfredo Mahar Lagmay, Christopher Uichanco, Sylvia Sueno, Marc Moises, Hale Ines, Miguel del Rosario, Kenneth Punay, Neil Tingin, Girlie David, Mariel Monteclaro, Eleazar Raneses, Jr. and Jose T. Gavino

The methods applied in this Chapter were based on the DREAM methods manual (Lagmay, et al., 2014) and further enhanced and updated in Paringit, et al. (2017)

5.1 Data Used for Hydrologic Modeling

5.1.1 Hydrometry and Rating Curves

Components and data that affect the hydrologic cycle of Dagupan River Basin were monitored, collected, and analyzed. These include the rainfall, water level, and flow in a certain period of time.

5.1.2 Precipitation

Precipitation data was taken from two automatic rain gauges (ARGs) installed by theDepartment of Science and Technology – Advanced Science and Technology Institute(DOST-ASTI) at the Laoac and San Roque (located in San Manuel) ARGs in Pangasinan. The location of the rain gauges is seen in Figure 49.

The total precipitation for this event in San Roque rain gauge was 67.82 mm. It peaked to 9.40 mm on 14 September 2015 at 18:30. The lag time between the peak rainfall and discharge is 10 hours. For Laoac rain gauge, total precipitation for this event was 27.2 mm. It has a peak rainfall of 11.8 mm on 14 September 2015 at 17:30. The lag time between the peak rainfall and discharge is 11 hours.

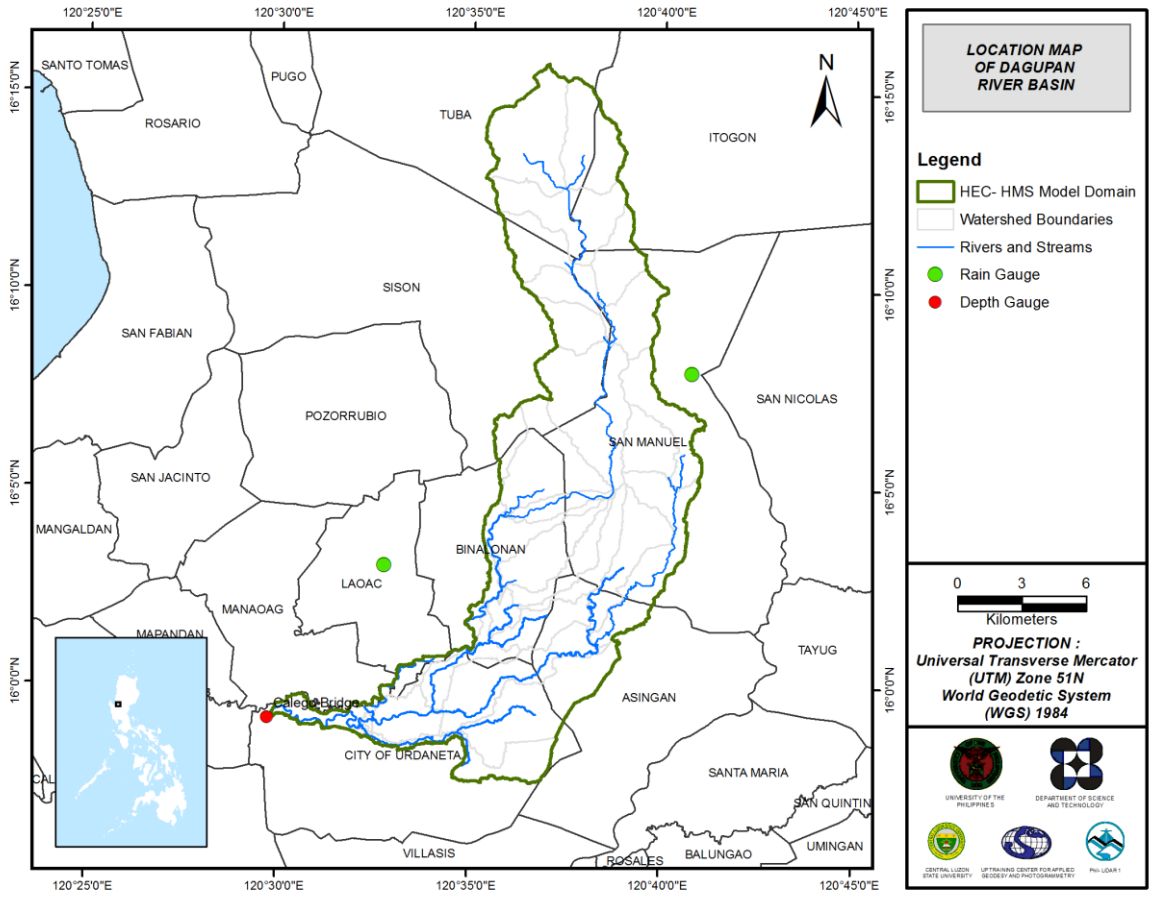


Figure 49. The location map of Dagupan HEC-HMS model used for calibration.

5.1.3 Rating Curves and River Outflow

A rating curve was developed at Calego Bridge, Urdaneta, Pangasinan (15°59'10.28"N, 120°29'46.22"E). It gives the relationship between the observed water levels at Calego Bridge and outflow of the watershed at this location.

For Calego Bridge, the rating curve is expressed as Q = 0.0005e1.0699h as shown in Figure 51.

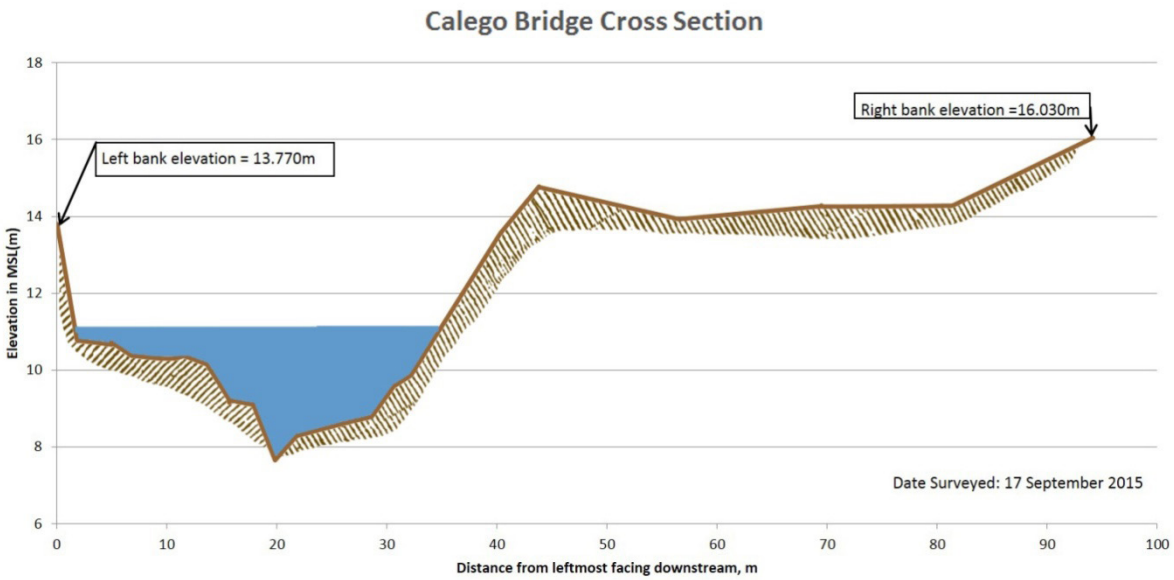


Figure 50. Cross-section plot of Caligo Bridge

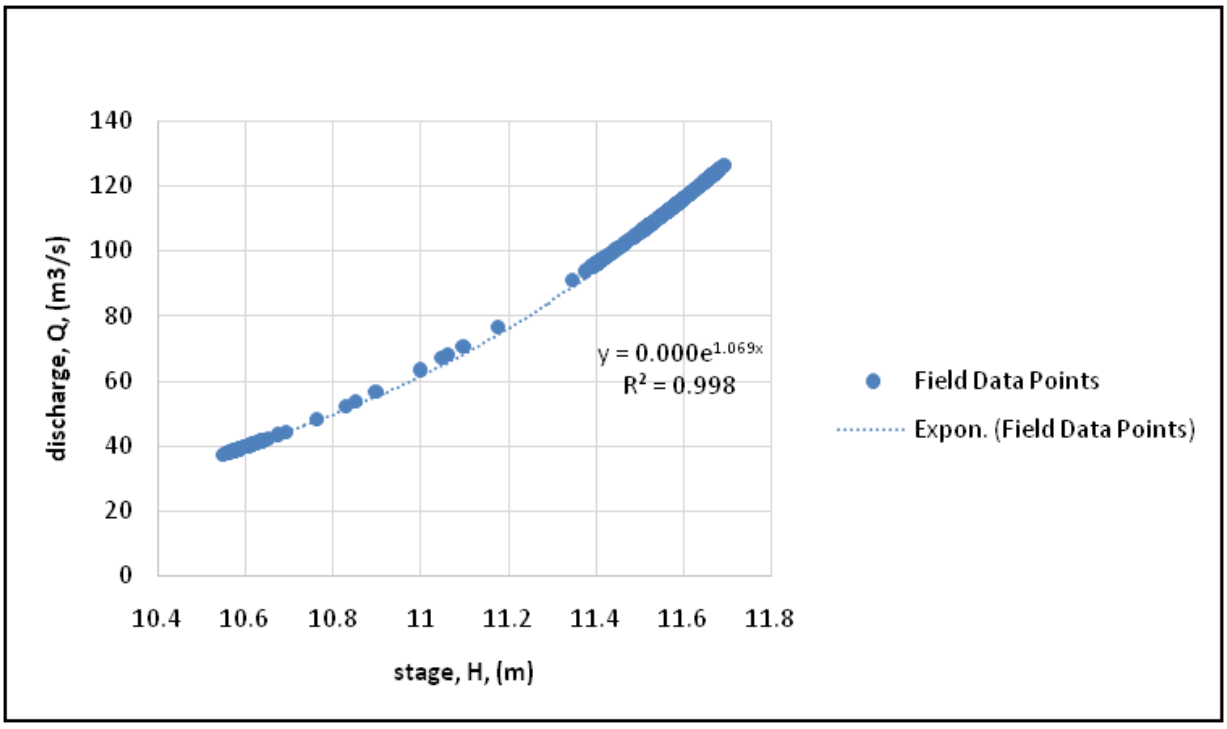


Figure 51. Rating Curve at Calego Bridge, Urdaneta, Pangasinan

This rating curve equation was used to compute the river outflow at Calego Bridge for the calibration of the HEC-HMS model shown in Figure 51. Peak discharge is 126.35 cms at 00:10, September 16, 2015.

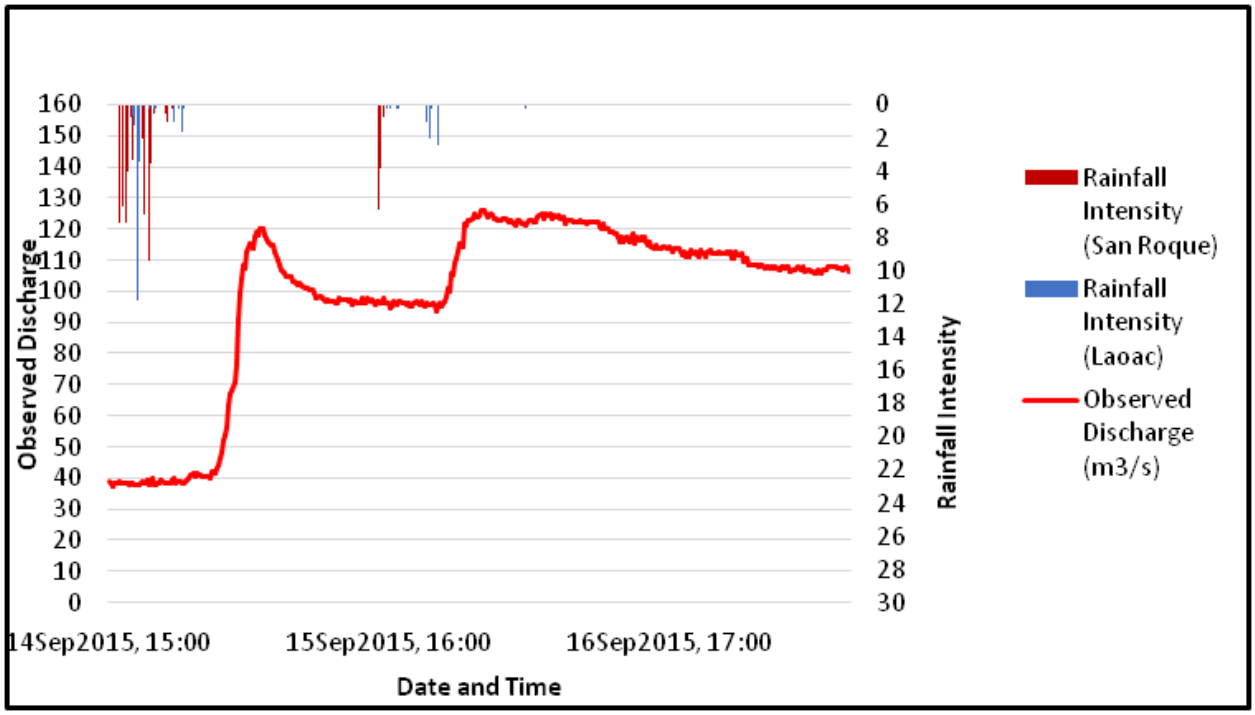


Figure 52. Rainfall and outflow data at Dagupan used for modeling

5.2 RIDF Station

The Philippines Atmospheric Geophysical and Astronomical Services Administration (PAGASA) computed Rainfall Intensity Duration Frequency (RIDF) values for the Dagupan Rain Gauge. The RIDF rainfall amount for 24 hours was converted to a synthetic storm by interpolating and re-arranging the value in such a way certain peak value will be attained at a certain time. This station chosen based on its proximity to the Dagupan watershed. The extreme values for this watershed were computed based on a 26-year record

Table 1. RIDF values for Dagupan Rain Gauge computed by PAGASA

COMPUTED EXTREME VALUES (in mm) OF PRECIPITATION									
T (yrs)	10 mins	20 mins	30 mins	1 hr	2 hrs	3 hrs	6 hrs	12 hrs	24 hrs
2	23.9	34.3	42.3	55.4	77.6	93	121.2	148.3	175.8
5	33.9	47.4	58.8	77.3	109.1	131.3	170.8	209	246.7
10	40.5	56.1	69.7	91.9	129.9	156.6	203.6	249.2	293.6
15	44.3	61	75.9	100.1	141.6	170.9	222.1	271.9	320
20	46.9	64.4	80.2	105.8	149.8	180.9	235.1	287.8	338.6
25	48.9	67.1	83.5	110.2	156.2	188.7	245.1	300	352.9
50	55.1	75.2	93.8	123.8	175.7	212.4	275.8	337.7	396.8
100	61.2	83.3	103.9	137.3	195	236	306.3	375.1	440.5

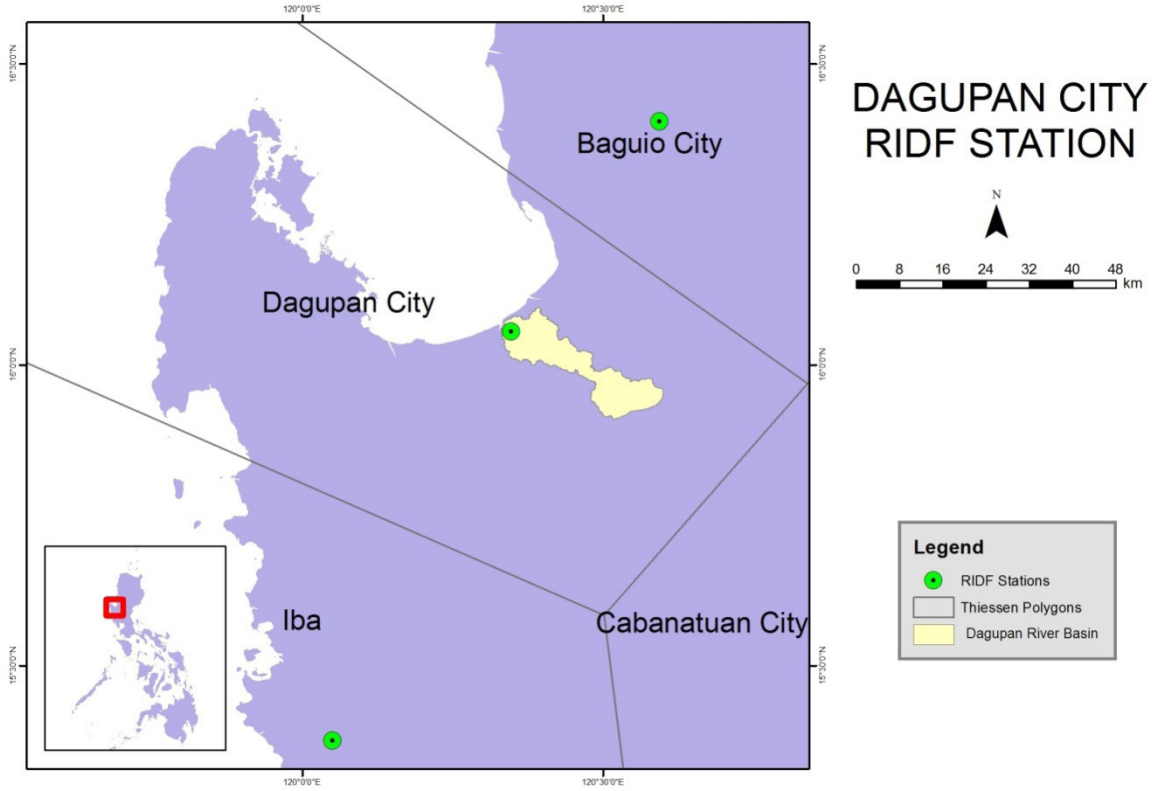


Figure 53. Dagupan RIDF location relative to Dagupan River Basin

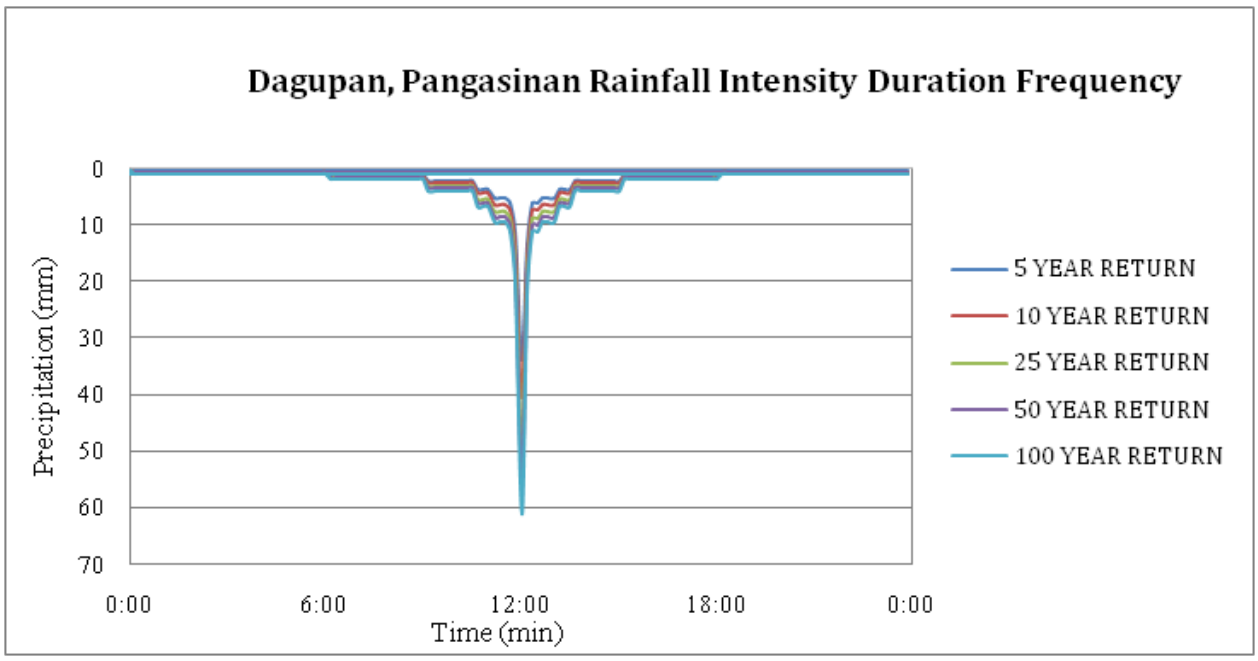


Figure 54. Synthetic storm generated for a 24-hr period rainfall for various return periods

5.3 HMS Model

The soil shapefile was taken on 2004 from the Bureau of Soils; this is under the Department of Environment and Natural Resources Management. The land cover shape file is from the National Mapping and Resource

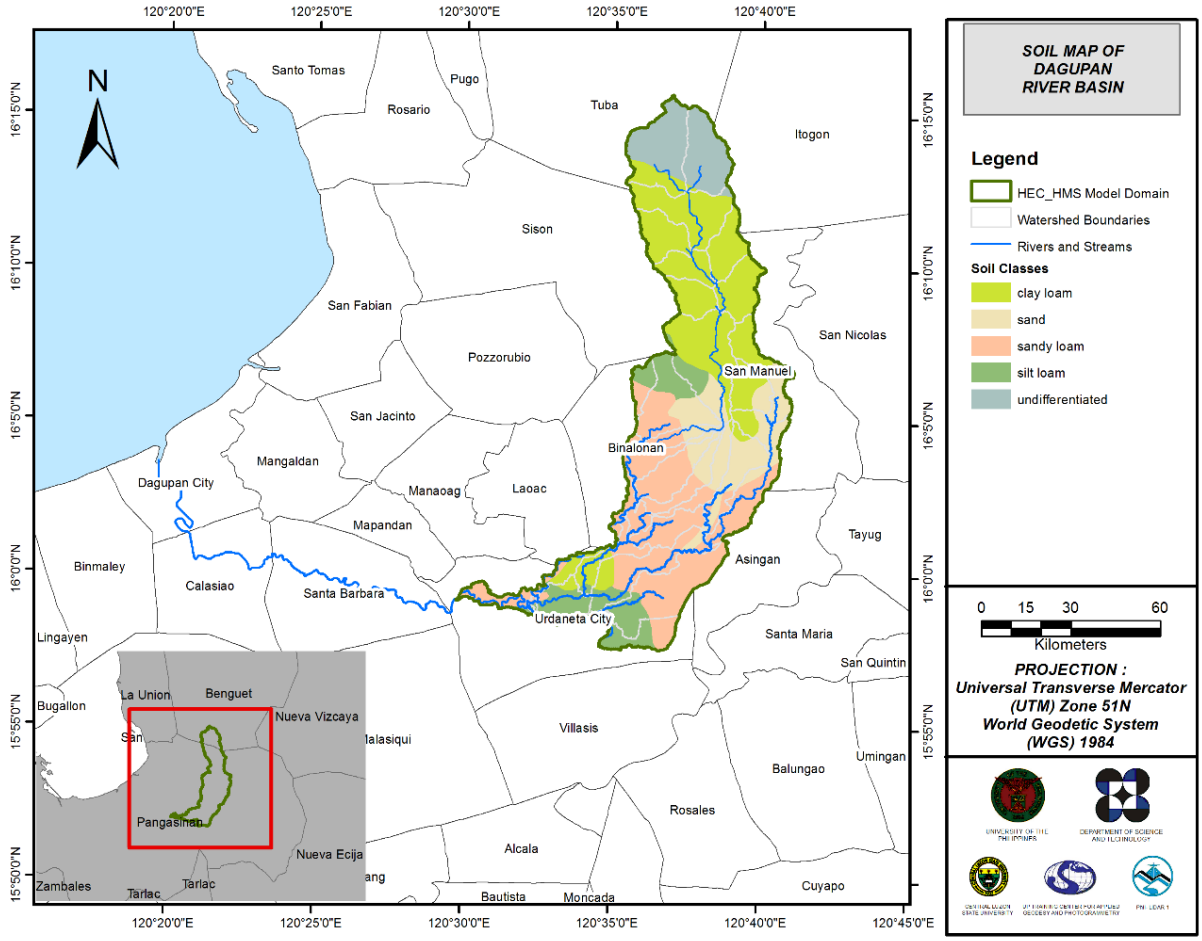


Figure 55. Soil Map of Dagupan River Basin

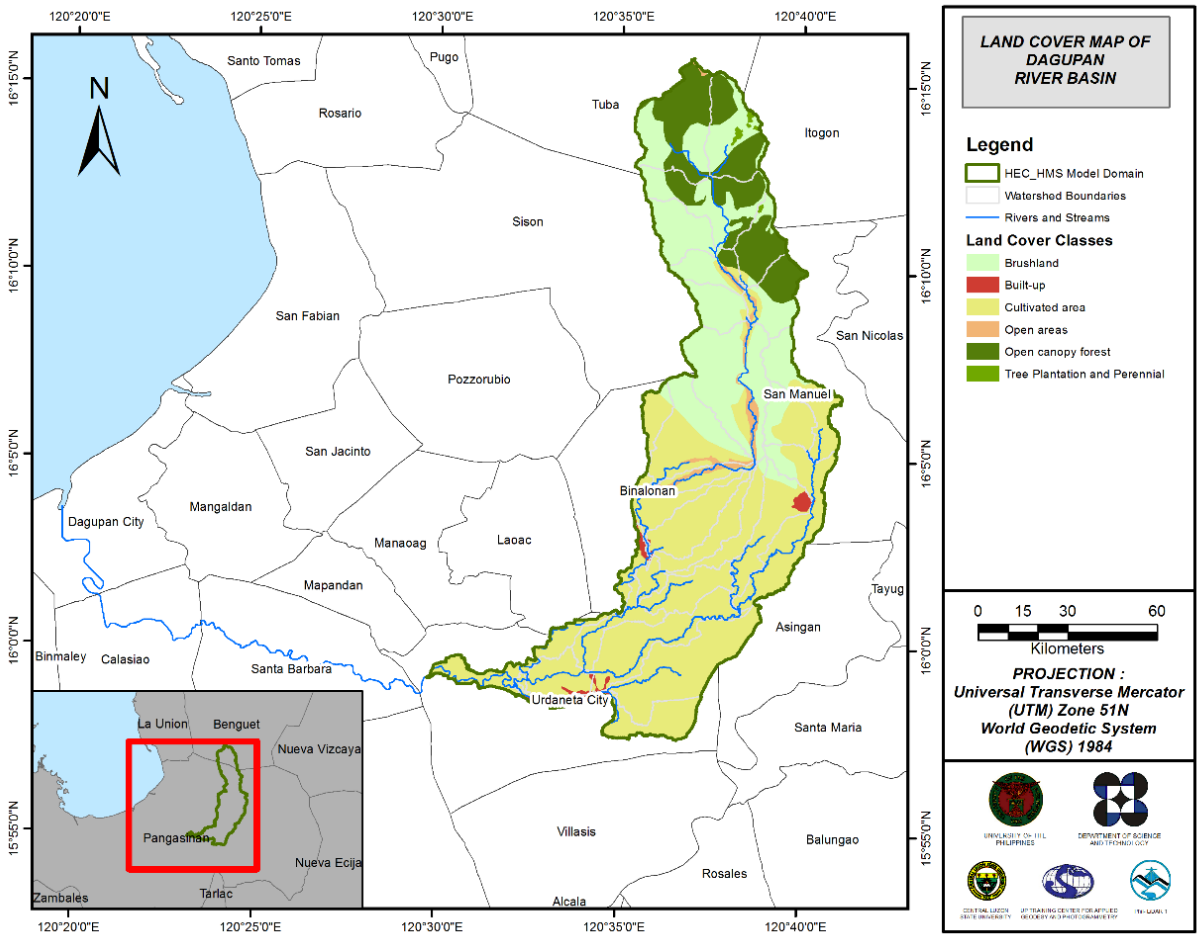


Figure 56. Land Cover Map of Dagupan River Basin

For Dagupan, five soil classes were identified. These are clay loam, sand, sandy loam, silt loam and undifferentiated soil. Moreover, six land cover classes were identified. These are brushland, built-up, cultivated area, open areas, open canopy forest and tree plantation and perennial.

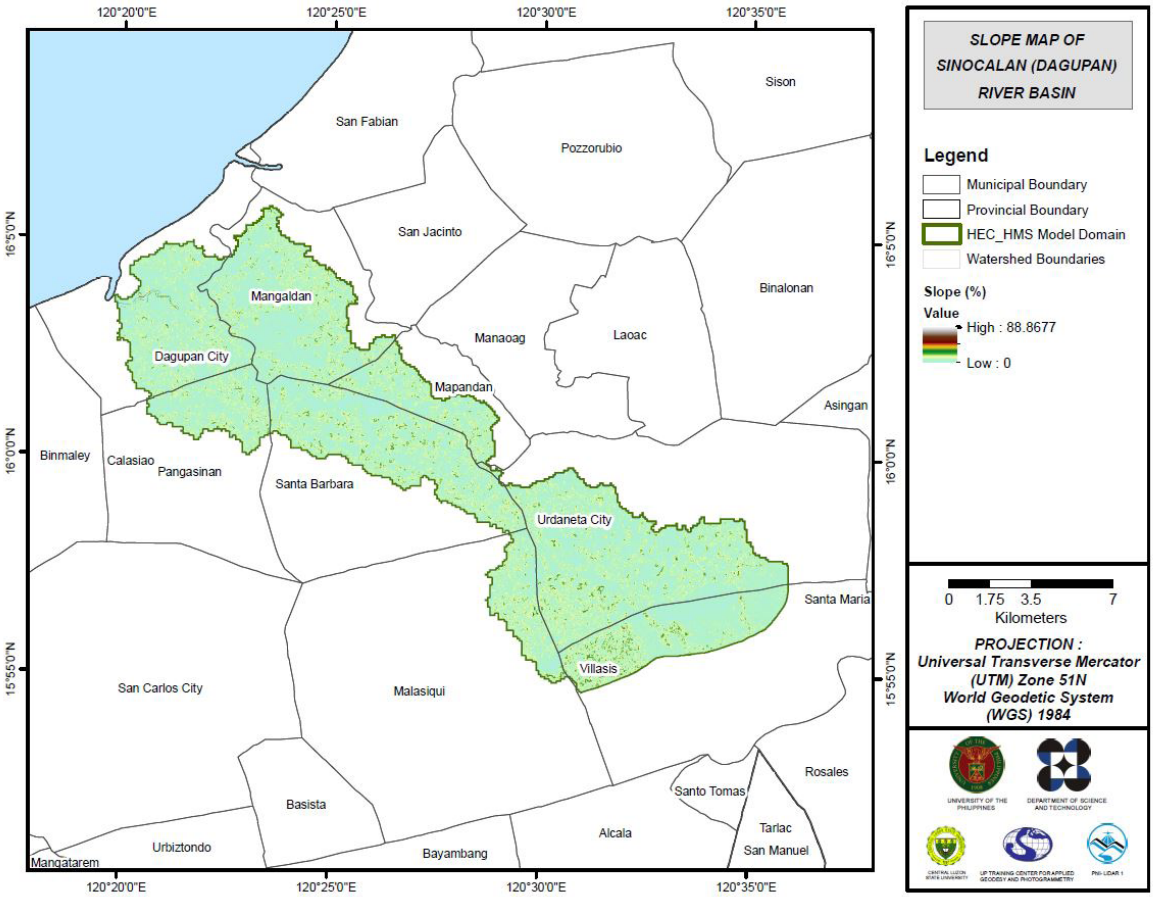


Figure 57. Slope Map of Dagupan River Basin

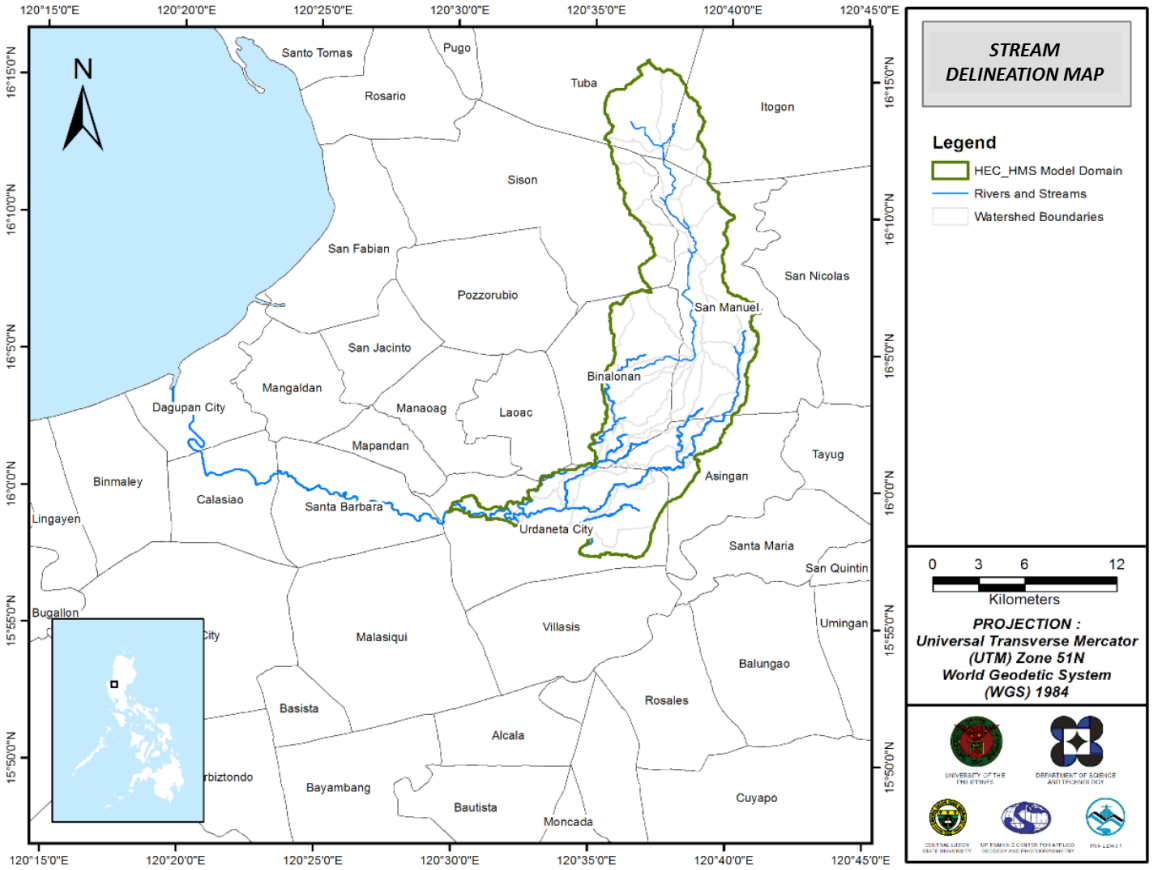


Figure 58. Stream Delineation Map of Dagupan River Basin

Using the SAR-based DEM, the Dagupan basin was delineated and further subdivided into subbasin. The Dagupan basin model consists of 29 sub basins, 14 reaches, and 14 junctions as shown in Figure 59. Finally, it was calibrated using depth gauge installed in Calego Bridge.

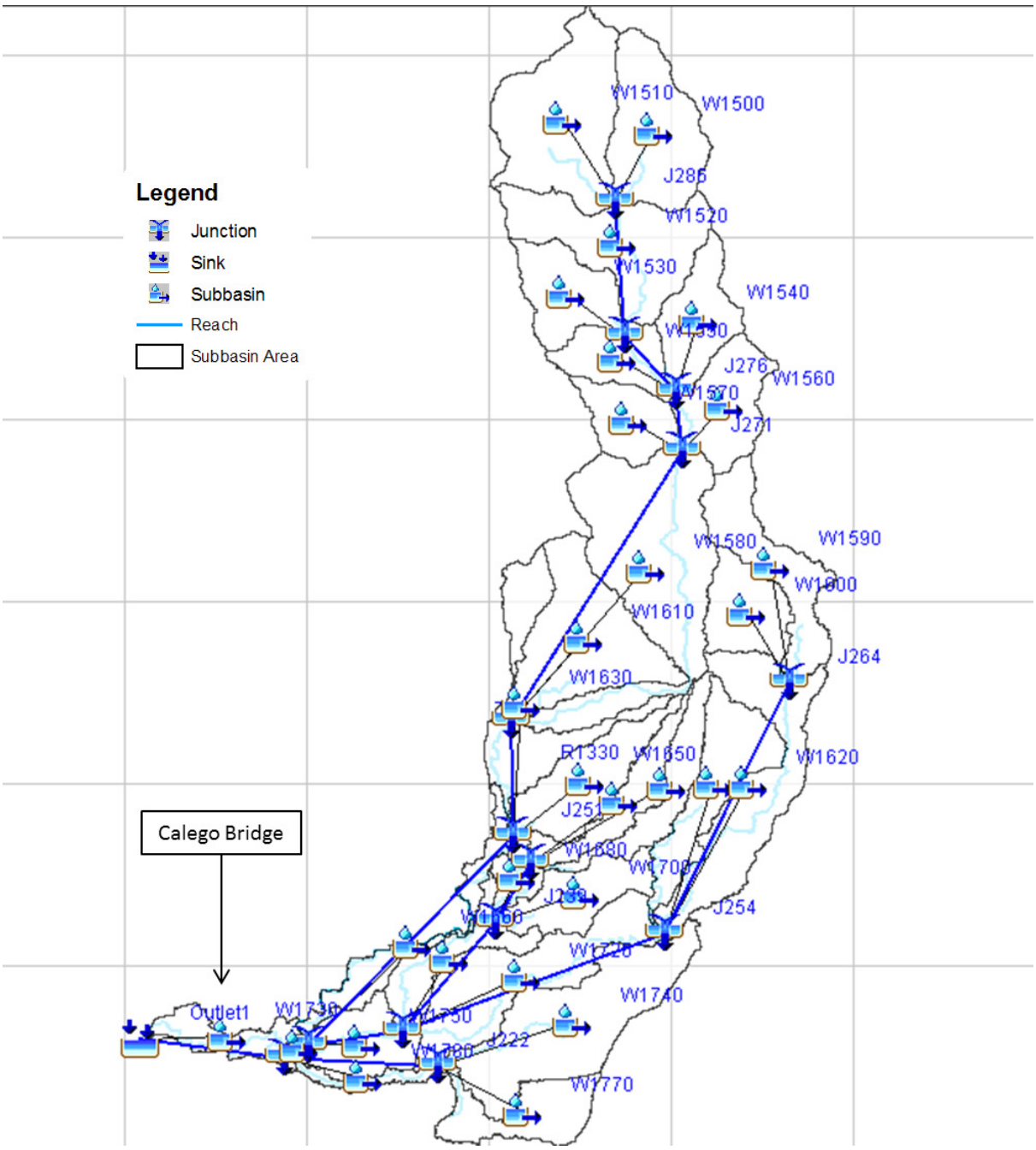


Figure 59. The Calego river basin model generated using HEC-HMS

5.4 Cross-section Data

Riverbed cross-sections of the watershed are crucial in the HEC-RAS model setup. The cross-section data for the HEC-RAS model was derived using the LiDAR DEM data. It was defined using the Arc GeoRAS tool and was post-processed in ArcMap.

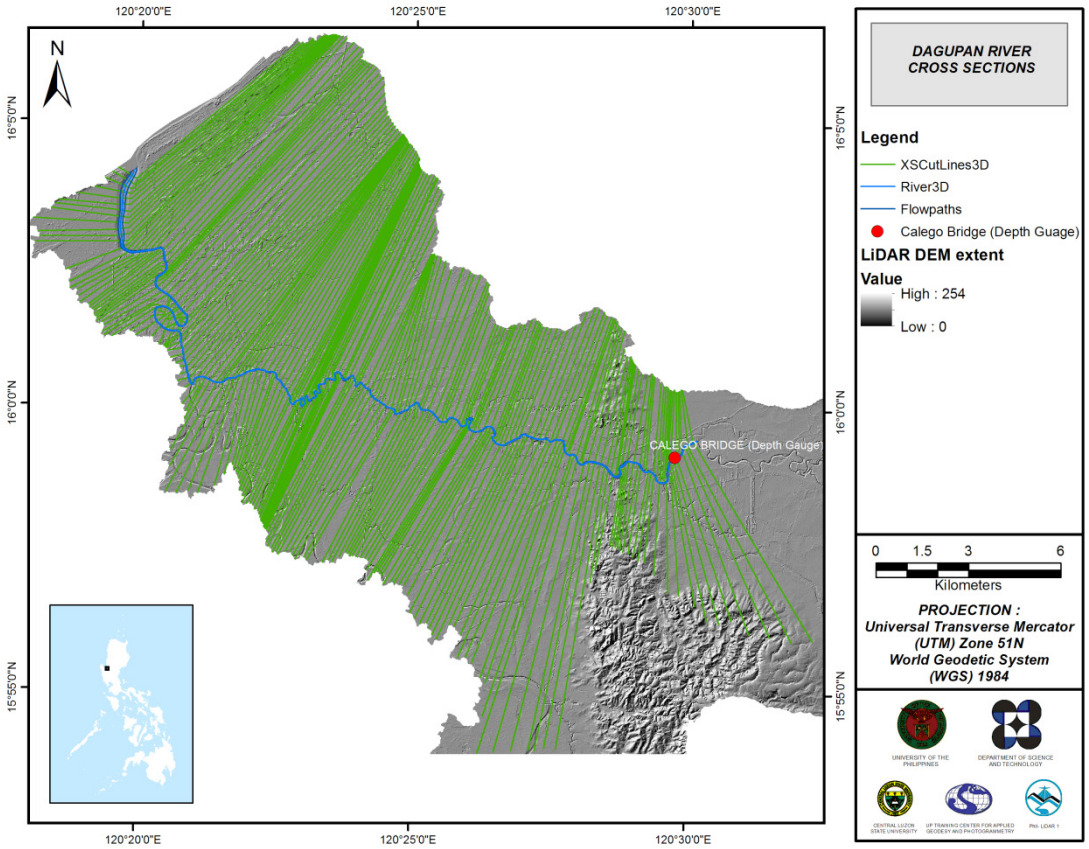


Figure 60. River cross-section of Dagupan River generated through Arcmap HEC GeoRAS tool

5.5 Flo 2D Model

The automated modelling process allows for the creation of a model with boundaries that are almost exactly coincidental with that of the catchment area. As such, they have approximately the same land area and location. The entire area is divided into square grid elements, 10 meter by 10 meter in size. Each element is assigned a unique grid element number which serves as its identifier, then attributed with the parameters required for modelling such as x-and y-coordinate of centroid, names of adjacent grid elements, Manning coefficient of roughness, infiltration, and elevation value. The elements are arranged spatially to form the model, allowing the software to simulate the flow of water across the grid elements and in eight directions (north, south, east, west, northeast, northwest, southeast, southwest).

Based on the elevation and flow direction, it is seen that the water will generally flow from the south of the model to the northeast, following the main channel. As such, boundary elements in those particular regions of the model are assigned as inflow and outflow elements respectively.

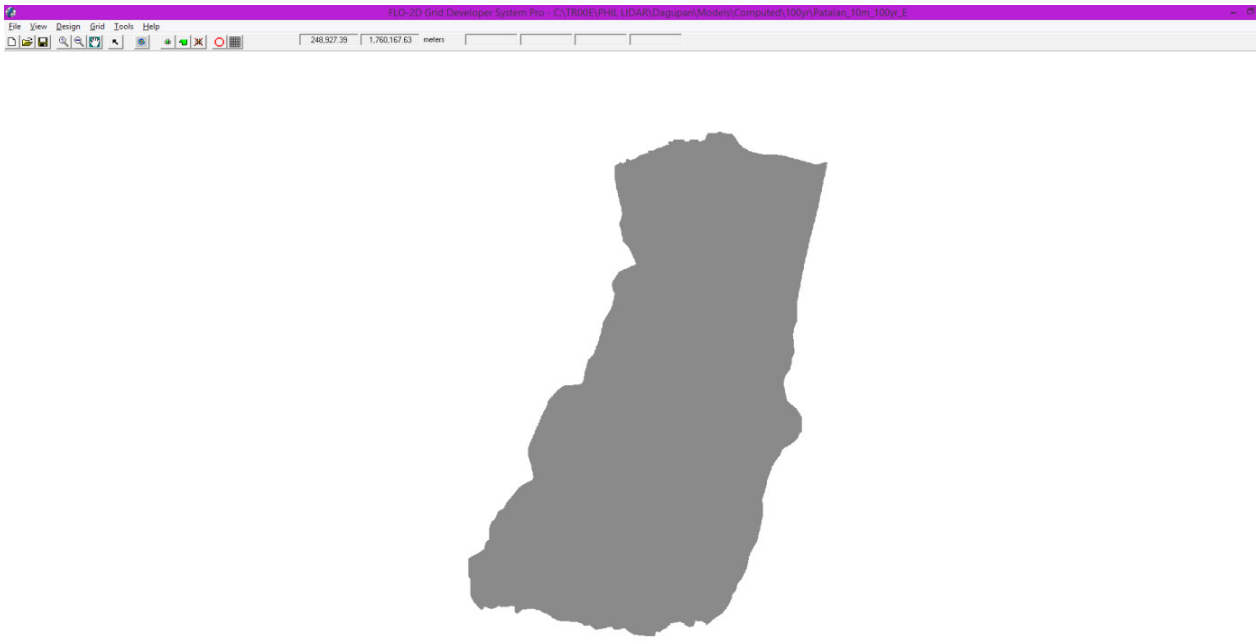


Figure 61. Screenshot of subcatchment with the computational area to be modeled in FLO-2D GDS Pro

The simulation is then run through FLO-2D GDS Pro. This particular model had a computer run time of 69.68286 hours. After the simulation, FLO-2D Mapper Pro is used to transform the simulation results into spatial data that shows flood hazard levels, as well as the extent and inundation of the flood. Assigning the appropriate flood depth and velocity values for Low, Medium, and High creates the following food hazard map. Most of the default values given by FLO-2D Mapper Pro are used, except for those in the Low hazard level. For this particular level, the minimum h (Maximum depth) is set at 0.2 m while the minimum vh (Product of maximum velocity (v) times maximum depth (h)) is set at 0 m2/s.

The creation of a flood hazard map from the model also automatically creates a flow depth map depicting the maximum amount of inundation for every grid element. The legend used by default in Flo-2D Mapper is not a good representation of the range of flood inundation values, so a different legend is used for the layout. In this particular model, the inundated parts cover a maximum land area of 47 889 900.00 m2.

There is a total of 161 393 676.48 m3 of water entering the model. Of this amount, 20 623 556.93 m3 is due to rainfall while 140 770 119.55 m3 is inflow from other areas outside the model. 11 760 266.00 m3 of this water is lost to infiltration and interception, while 17 676 605.89 m3 is stored by the flood plain. The rest, amounting up to 131 956 810.24 m3, is outflow.

5.6 Results of HMS Calibration

After calibrating the Dagupan HEC-HMS river basin model, its accuracy was measured against the observed values. Figure 13 shows the comparison between the two discharge data.

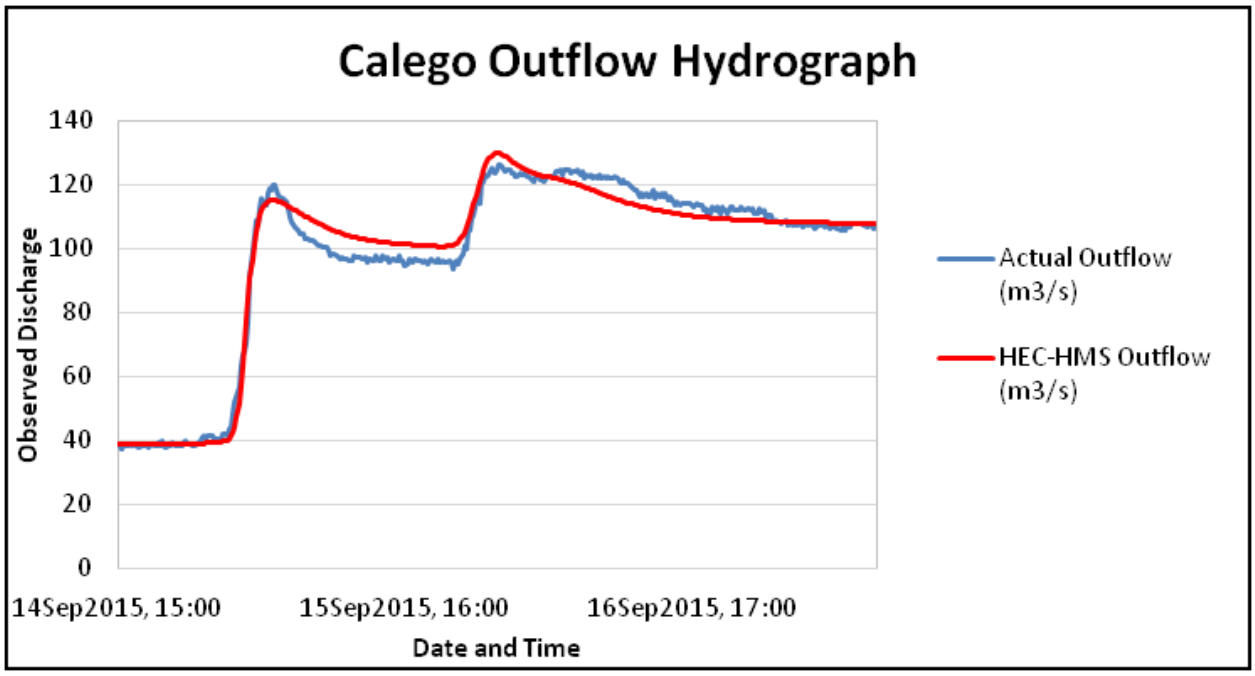


Figure 62. Outflow Hydrograph of Dagupan produced by the HEC-HMS model compared with observed outflow

Table 2 shows adjusted ranges of values of the parameters used in calibrating the model.

Table 2. Range of calibrated values for the Dagupan River Basin.

Hydrologic Element	Calculation Type	Method	Parameter	Range of Calibrated Values
Basin	Loss	SCS Curve number	Initial Abstraction (mm)	5 - 28
			Curve Number	42 - 99
	Transform	Clark Unit Hydrograph	Time of Concentration (hr)	1 - 15
			Storage Coefficient (hr)	1 - 21
	Baseflow	Recession	Recession Constant	1
			Ratio to Peak	0.44 - 1
Reach	Routing	Muskingum-Cunge	Manning's Coefficient	0.02 – 0.07

Initial abstraction defines the amount of precipitation that must fall before surface runoff. The magnitude of the outflow hydrograph increases as initial abstraction decreases. The range of values from 5mm to 28mm signifies that there is minimal to average amount of infiltration or rainfall interception by vegetation.

The curve number is the estimate of the precipitation excess of soil cover, land use, and antecedent moisture. The magnitude of the outflow hydrograph increases as curve number increases. The range for the curve number of Dagupan River Basin is 42-99. For Dagupan, the basin mostly consists of cultivated area and brushland and the soil mostly consists of sandy loam, clay loam and sand.

The time of concentration and storage coefficient are the travel time and index of temporary storage of runoff in a watershed. The range of calibrated values from 1 hour to 21 hours determines the reaction time of the model with respect to the rainfall. The peak magnitude of the hydrograph also decreases when these parameters are increased.

Recession constant is the rate at which baseflow recedes between storm events, while ratio to peak is the ratio of the baseflow discharge to the peak discharge. Recession constant of 1 indicates that the basin is unlikely to quickly go back to its original discharge and instead, will be higher. Ratio to peak of 0.44 - 1

indicates a steep receding limb of the outflow hydrograph.

Manning's roughness coefficient of 0.02 – 0.07 corresponds to the common roughness in Dagupan watershed, which is determined to have scattered brush with heavy weeds (Brunner, 2010).

Table 3. Summary of the Efficiency Test of Dagupan HMS Model

Accuracy Measure	Value
RMSE	3.9
r^2	0.979
NSE	1.0
PBIAS	-0.40
RSR	0.06

The Root Mean Square Error (RMSE) method aggregates the individual differences of these two measurements. It was computed at 3.9 m3/s.

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. The computed value of r2 = 0.979 was acquired in this model. This means that the degree of collinearity between simulated and measured data is relatively high.

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 1.0 which means that the model has a very good performance rating in simulating discharge.

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. The PBIAS in the model is -0.40 which implies that the model was overestimated at 0.40 percent difference in streamflow volume between simulated and measured data for a particular period.

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 is quantified. The model has an RSR value of 0.06 which indicates that the model has a better simulation performance due to low value of computed RSR.

5.7 Calculated outflow hydrographys and discharge values for different rainfall return periods

5.7.1 Hydrograph using the Rainfall Runoff Model

The summary graph (Figure 14) shows the Dagupan outflow using the Dagupan Rainfall Intensity-Duration-Frequency curves (RIDF) in 5 different return periods (5-year, 10-year, 25-year, 50-year, and 100-year rainfall time series) based on the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAG-ASA) data. The simulation results reveal significant increase in outflow magnitude as the rainfall intensity increases for a range of durations and return periods.

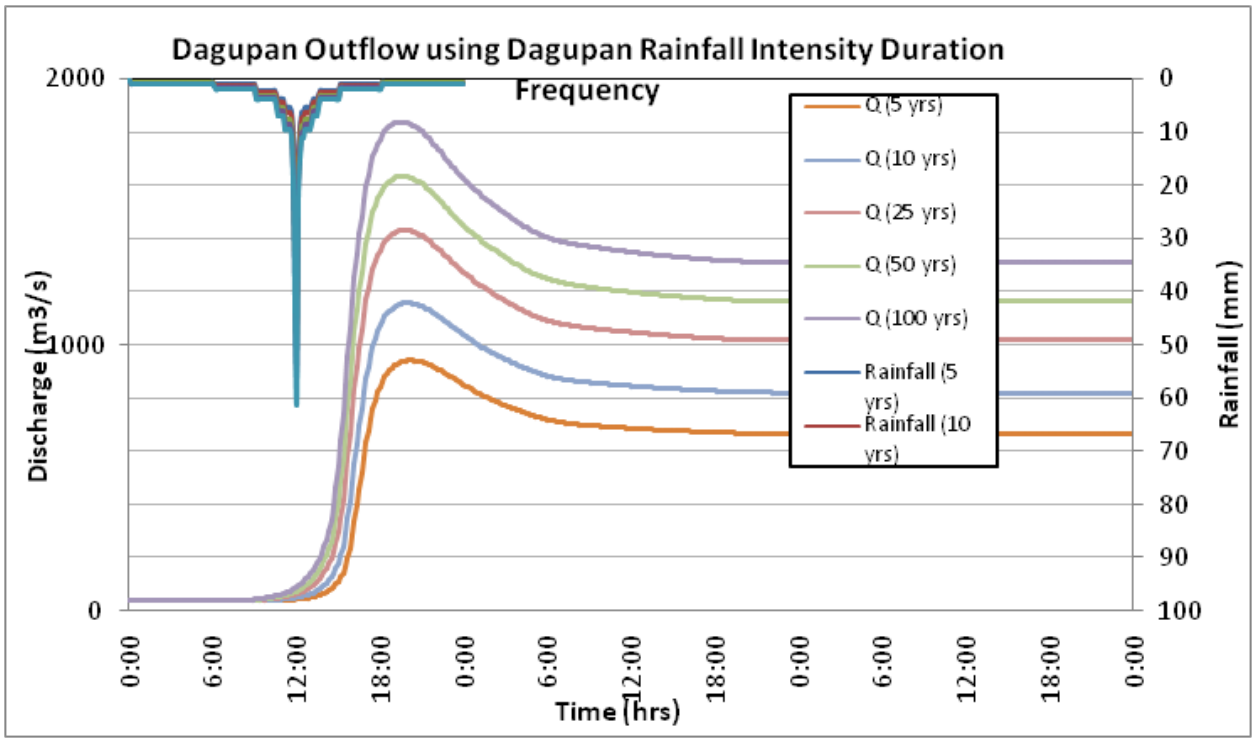


Figure 63. Outflow hydrograph at Dagupan Station generated using Dagupan RIDF simulated in HEC HMS

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

Table 4. Peak values of the Dagupan HEC-HMS Model outflow using the Dagupan RIDF

RIDF Period	Total Precipitation (mm)	Peak rainfall (mm)	Peak outflow (m^3/s)	Time to Peak
5-Year	246.7	33.9	942.0	8 hours 10 minutes
10-Year	293.6	40.5	1157.7	8 hours
25-Year	352.9	48.9	1431.0	7 hours 40 minutes
50-Year	396.8	55.1	1635.0	7 hours 40 minutes
100-Year	440.5	61.2	1838.3	7 hours 30 minutes

5.7.2 Discharge data using Dr. Horritts's recommended hydrologic method

The river discharge values for the eight rivers entering the floodplain are shown in Figure 13 to Figure 20 and the peak values are summarized in Table 4 to Table 11.

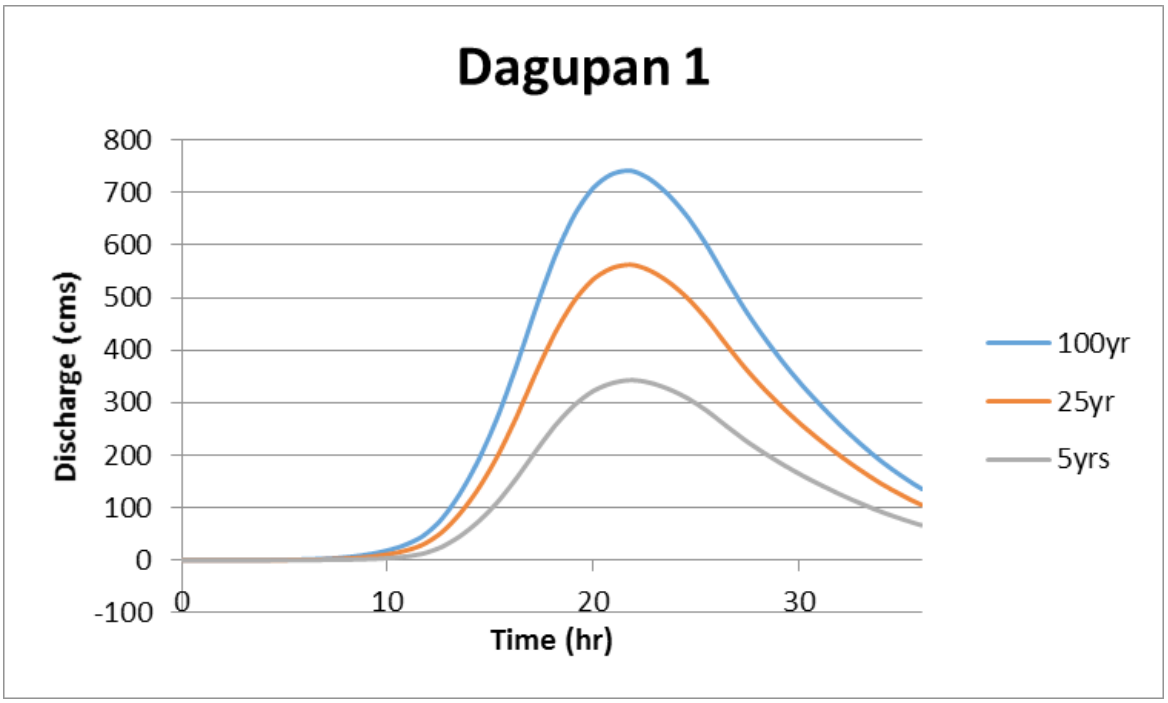


Figure 64. Dagupan river (1) generated discharge using 5-, 25-, and 100-year rainfall intensity-duration-frequency (RIDF) in HEC-HMS

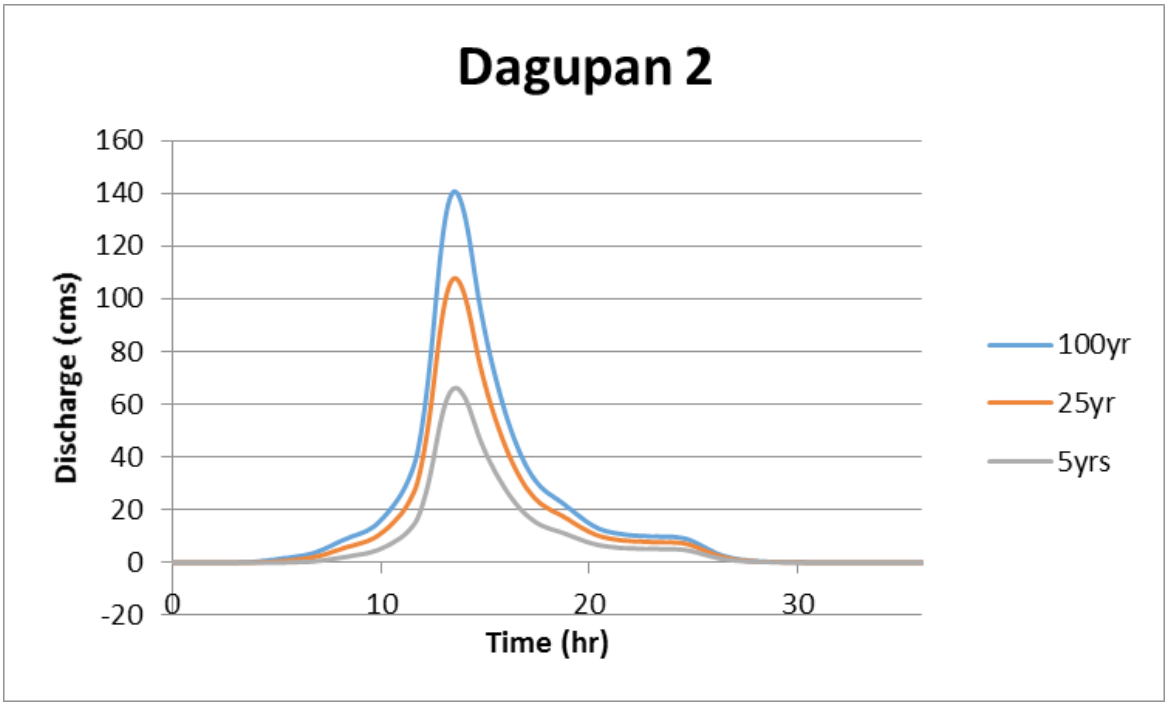


Figure 65. Dagupan river (2) generated discharge using 5-, 25-, and 100-year rainfall intensity-duration-frequency (RIDF) in HEC-HMS

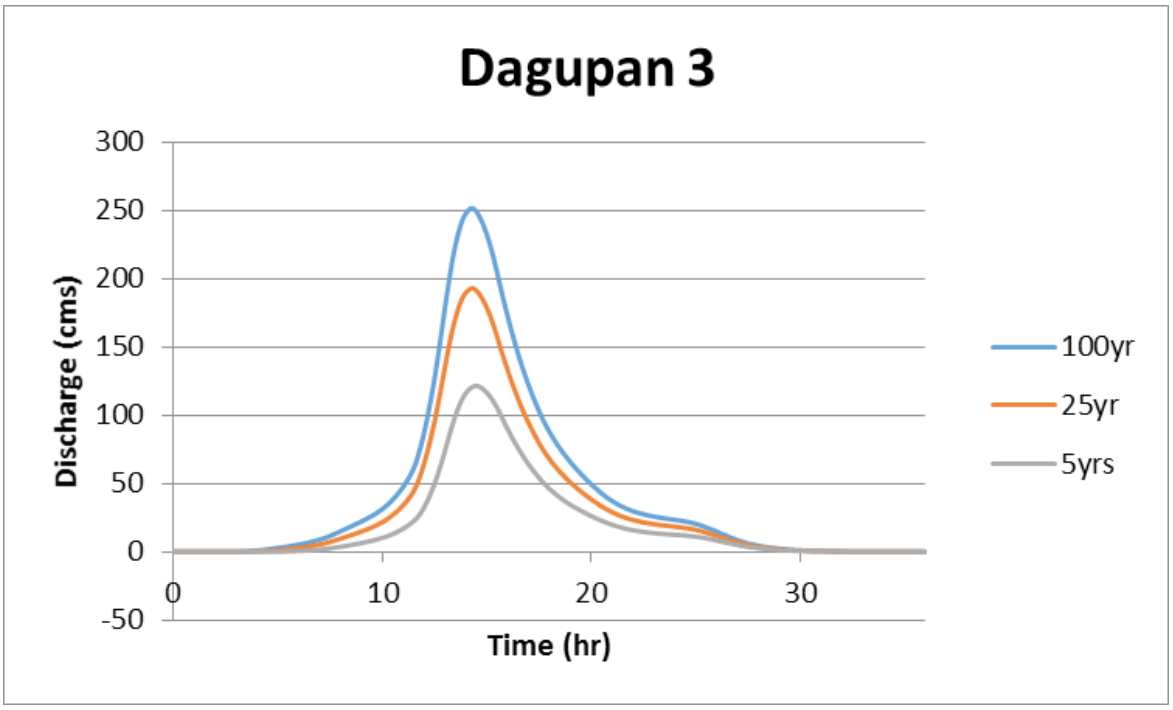


Figure 66. Dagupan river (3) generated discharge using 5-, 25-, and 100-year rainfall intensity-duration-frequency (RIDF) in HEC-HMS

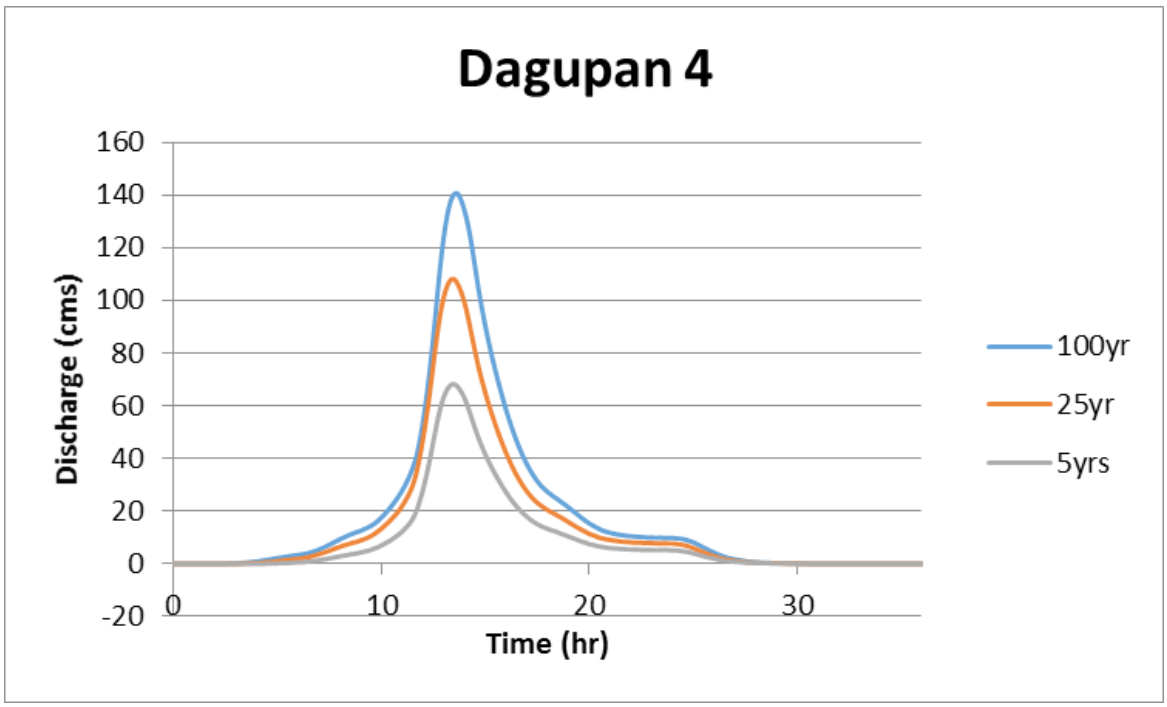


Figure 67. Dagupan river (4) generated discharge using 5-, 25-, and 100-year rainfall intensity-duration-frequency (RIDF) in HEC-HMS

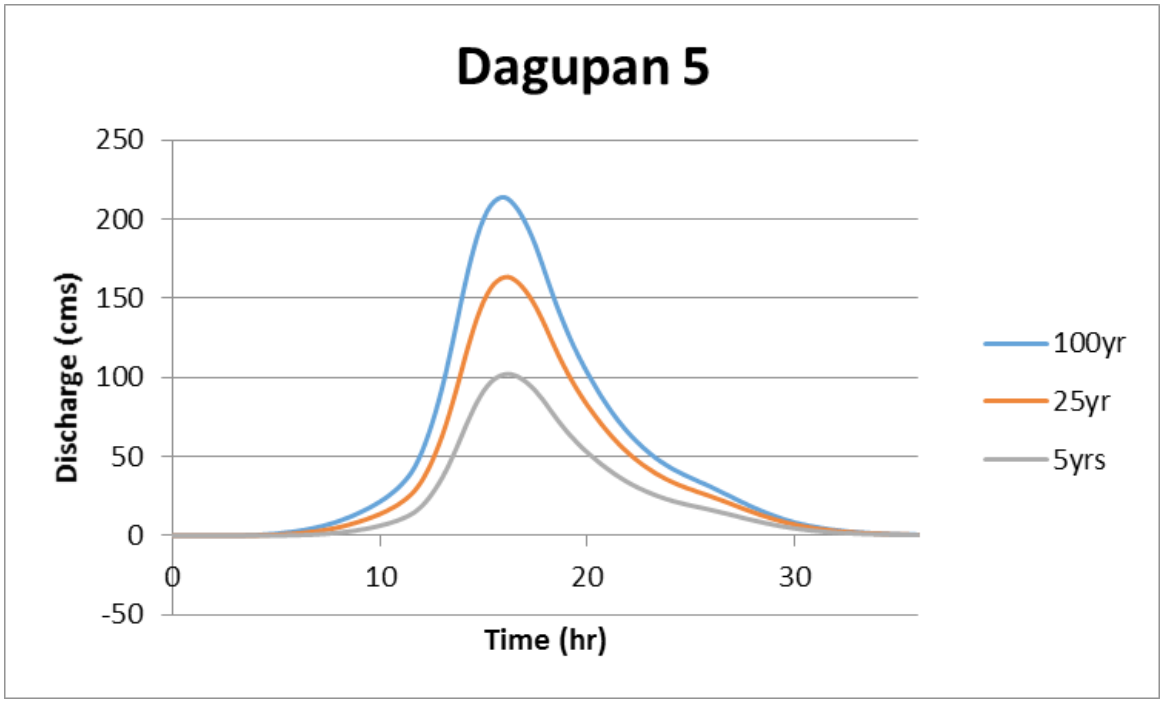


Figure 68. Dagupan river (5) generated discharge using 5-, 25-, and 100-year rainfall intensity-duration-frequency (RIDF) in HEC-HMS

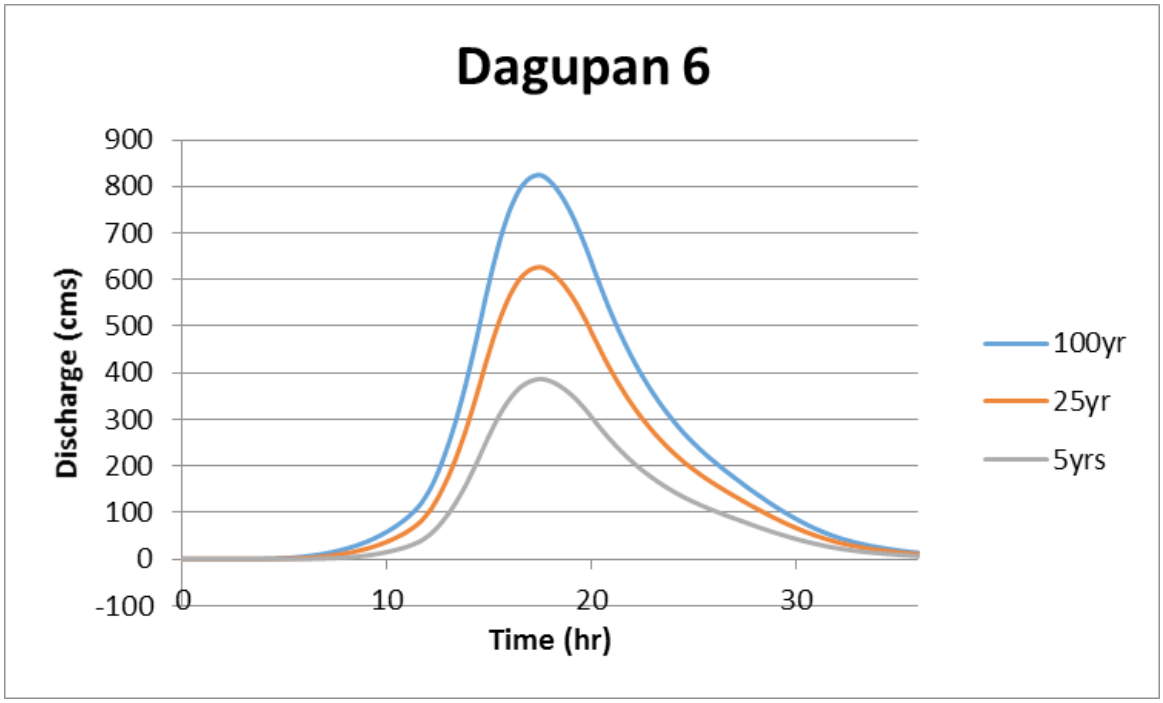


Figure 69. Dagupan river (6) generated discharge using 5-, 25-, and 100-year rainfall intensity-duration-frequency (RIDF) in HEC-HMS

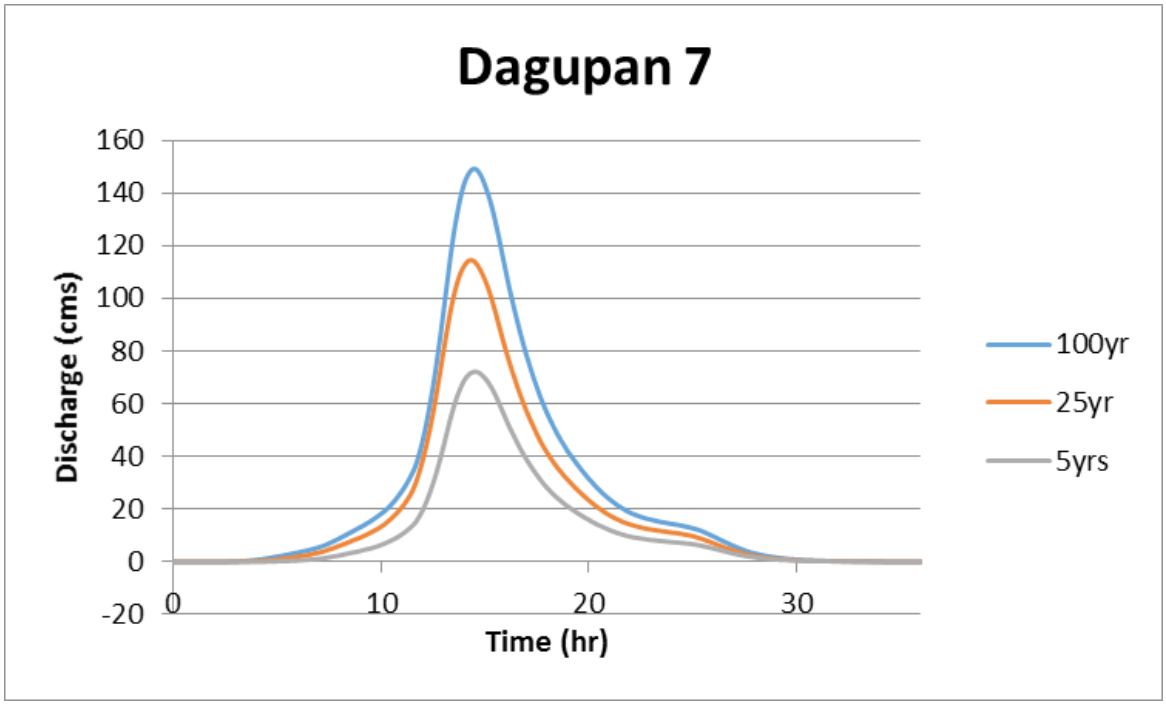


Figure 70. Dagupan river (7) generated discharge using 5-, 25-, and 100-year rainfall intensity-duration-frequency (RIDF) in HEC-HMS

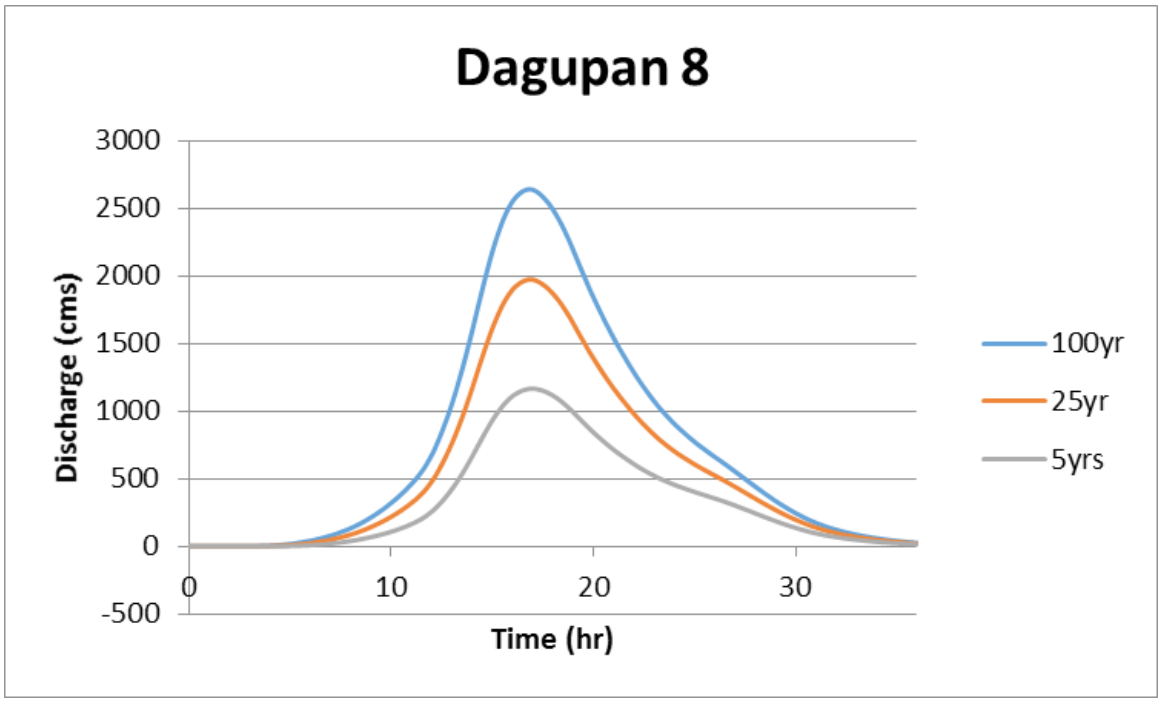


Figure 71. Dagupan river (8) generated discharge using 5-, 25-, and 100-year rainfall intensity-duration-frequency (RIDF) in HEC-HMS

Table 5. Summary of Dagupan river (1) discharge generated in HEC-HMS

RIDF Period	Peak discharge (cms)	Time-to-peak (mins)
100-Year	742.0	551.18
25-Year	562.7	551.18
5-Year	342.8	551.18

Table 6. Summary of Dagupan river (2) discharge generated in HEC-HMS

RIDF Period	Peak discharge (cms)	Time-to-peak (mins)
100-Year	140.6	98.96
25-Year	107.7	98.96
5-Year	66.1	98.96

Table 7. Summary of Dagupan river (3) discharge generated in HEC-HMS

RIDF Period	Peak discharge (cms)	Time-to-peak (mins)
100-Year	251.4	150.11
25-Year	192.9	150.11
5-Year	121.6	150.11

Table 8. Summary of Dagupan river (4) discharge generated in HEC-HMS

RIDF Period	Peak discharge (cms)	Time-to-peak (mins)
100-Year	140.6	102.24
25-Year	108.1	102.24
5-Year	68.2	102.24

Table 9. Summary of Dagupan river (5) discharge generated in HEC-HMS

RIDF Period	Peak discharge (cms)	Time-to-peak (mins)
100-Year	213.8	243.88
25-Year	163.5	243.88
5-Year	102.2	243.88

Table 10. Summary of Dagupan river (6) discharge generated in HEC-HMS

RIDF Period	Peak discharge (cms)	Time-to-peak (mins)
100-Year	824.5	315.97
25-Year	626.9	315.97
5-Year	386.9	315.97

Table 11. Summary of Dagupan river (7) discharge generated in HEC-HMS

RIDF Period	Peak discharge (cms)	Time-to-peak (mins)
100-Year	149.2	152.56
25-Year	114.5	152.56
5-Year	72.2	152.56

Table 12. Summary of Dagupan river (8) discharge generated in HEC-HMS

RIDF Period	Peak discharge (cms)	Time-to-peak (mins)
100-Year	2639.9	282.21
25-Year	1972.9	282.21
5-Year	1166.4	282.21

The comparison of the discharge results using Dr. Horritt's recommended hydrological method against the bankful and specific discharge estimates is shown in Table 13.

Table 13. Validation of river discharge estimates

Discharge Point	$Q_{MED(SCS)}$, cms	$Q_{BANKFUL}$, cms	$Q_{MED(SPEC)}$, cms	VALIDATION	
				Bankful Discharge	Specific Discharge
Dagupan (1)	301.664	611.608	682.048	Fail	Fail
Dagupan (2)	58.168	263516.738	103.959	Fail	Pass
Dagupan (3)	107.008	102637.612	161.061	Fail	Pass
Dagupan (4)	60.016	1902.678	88.546	Fail	Pass
Dagupan (5)	89.936	61892.379	159.228	Fail	Pass
Dagupan (6)	340.472	52870.009	455.731	Fail	Pass
Dagupan (7)	63.536	19185.961	100.235	Fail	Pass
Dagupan (8)	1026.432	21400.700	889.171	Fail	Pass

Seven out eight of the results from the HEC-HMS river discharge estimates were able to satisfy the conditions for validation using the specific discharge method. One did not pass and will need further recalculation. The passing values are based on theory but are supported using other discharge computation methods so they were good to use flood modeling. These values will need further investigation for the purpose of validation. It is therefore recommended to obtain actual values of the river discharges for higher-accuracy modeling.

5.8 River Analysis (RAS) Model Simulation

The HEC-RAS Flood Model produced a simulated water level at every cross-section for every time step for every flood simulation created. The resulting model will be used in determining the flooded areas within the model. The simulated model will be an integral part in determining real-time flood inundation extent of the river after it has been automated and uploaded on the DREAM website.

The Dagupan model has a minimum and maximum flow discharge of 11.3 and 71.3 m3/s, respectively and this was needed for unsteady flow analysis as input file. The simulation results showed that the maximum water surface depth elevation of Dagupan River has a value of 6.39 meter and this was located at the downstream portion of the river. The simulation results also showed that there is no overflow of water along the bank of the river. However, there are low lying areas which will be flooded like fishpond and agricultural land located in Dagupan (Barangay Pugaro Suit, Lomboy, Calmay, Carael, Tapuac, Malued, Lucao, Bacayao Norte, Bacayao Sur, Lasip Grande, Pogo Grande, Caranglaan, Mayombo, Herrero, Tebeng, Pantal, Tambac, Bonuan Gueset, Bonuan Boquig, Bonuan Binloc, Mamalengleng, Bolosan, Mangen, and Salisay), Binmaley (Barangay Linoc, Gayaman, Calit, and Tombor), Calasiao (Barangay Banaoang, San Vicente, Lumbang, Nalsian, Quesban, and Bued), Mangaldan (Barangay Talogtog, Maasin, Anolid, Malabago, and Alitaya), Santa Barbara (Barangay Tuliao, Alibago, Malanay, Gueguesangen, Nilombot, Dalongue, Sonquil, Balingueo and Payas), and Malasiqui (Barangay Ican, Potiocan, Loqueb Norte, Loqueb Sur, Loqueb Este, Abonogan, and Tolonguat) . The sample 1D flood hazard map using the calibrated discharge of Dagupan River from HMS model is shown in Figure 20.

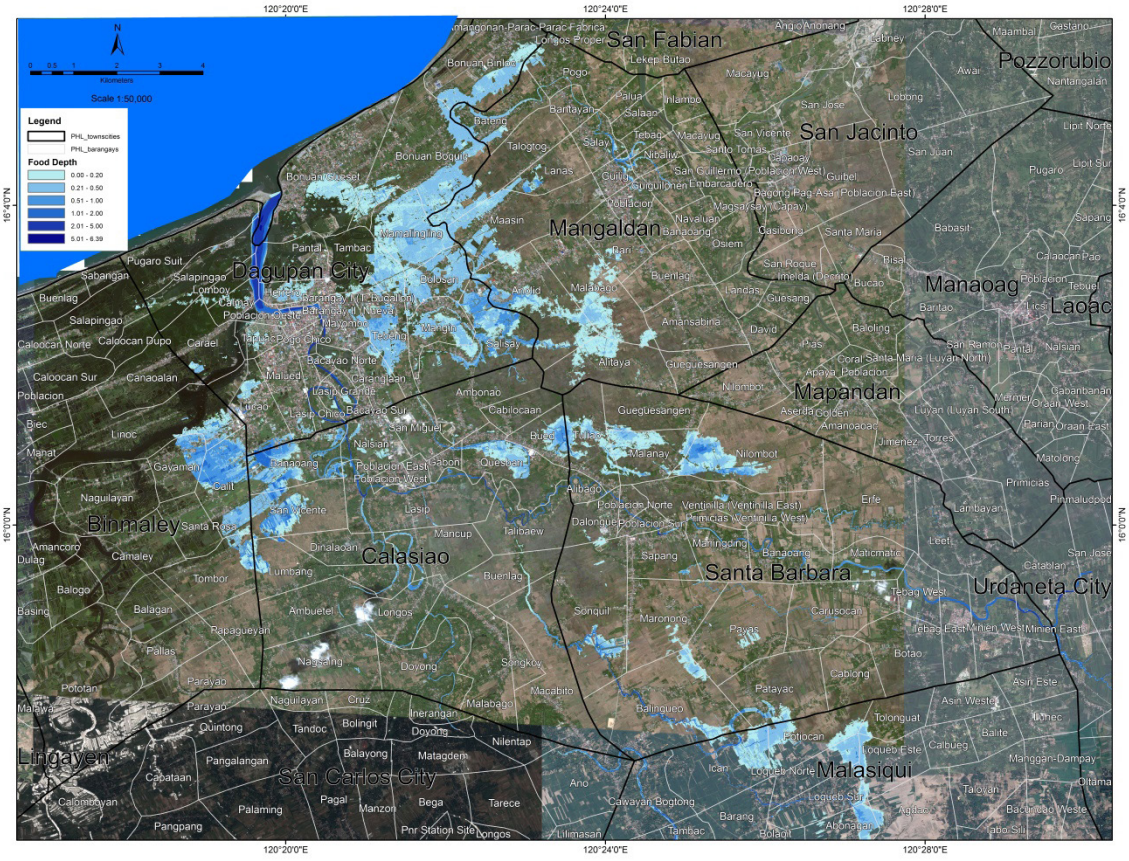


Figure 72. Sample output of Dagupan RAS Model

5.9 Flow Depth and Flood Hazard

The resulting hazard and flow depth maps have a 10m resolution. Figure 65 to Figure 70 shows the 5-, 25-, and 100-year rain return scenarios of the Dagupan floodplain. The floodplain, with an area of 386.10 sq. km., covers thirteen municipalities namely Binmaley, Calasiao, Dagupan City, Laoac, Malasiqui, Manaoag, Mangaldan, Mapandan, San Carlos City, San Fabian, Santa Barbara, Urdaneta City and Villasis. Table shows the percentage of area affected by flooding per municipality.

Table 14. Municipalities affected in Dagupan floodplain

Municipality	Total Area	Area Flooded	% Flooded
Binmaley	61.84	33.79	55%
Calasiao	49.20	49.20	100%
Dagupan City	47.76	42.90	90%
Laoac	40.70	0.23	0.6%
Malasiqui	124.81	45.93	37%
Manaoag	42.42	0.20	0.5%
Mangaldan	43.42	34.86	80%
Mapandan	21.35	13.29	62%
San Carlos City	151.28	23.85	16%
San Fabian	69.27	0.03	0.04%
Santa Barbara	64.71	64.68	100%
Urdaneta City	107.79	61.38	57%
Villasis	76.04	15.76	21%

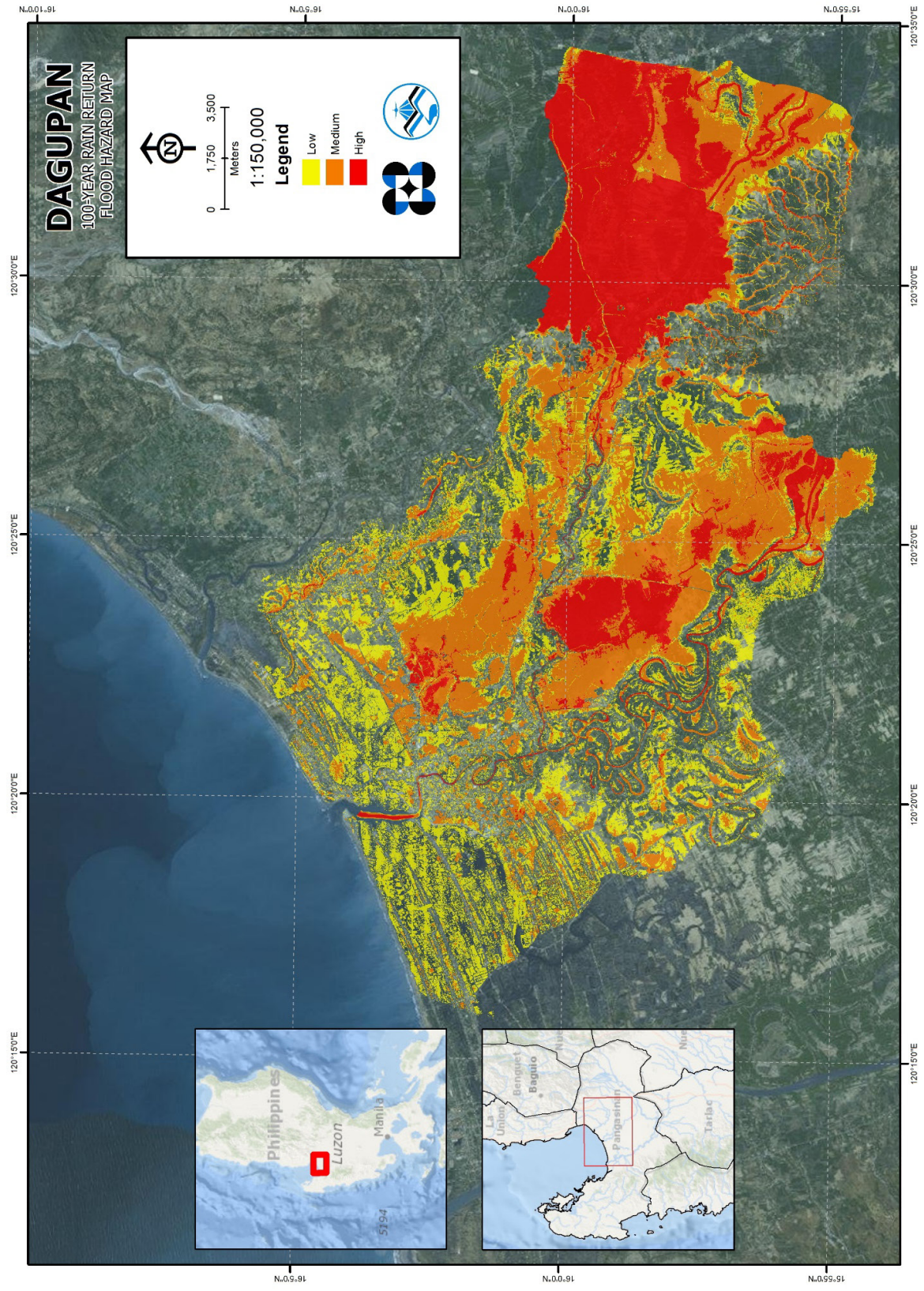


Figure 73. 100-year Flood Hazard Map for Dagupan Floodplain

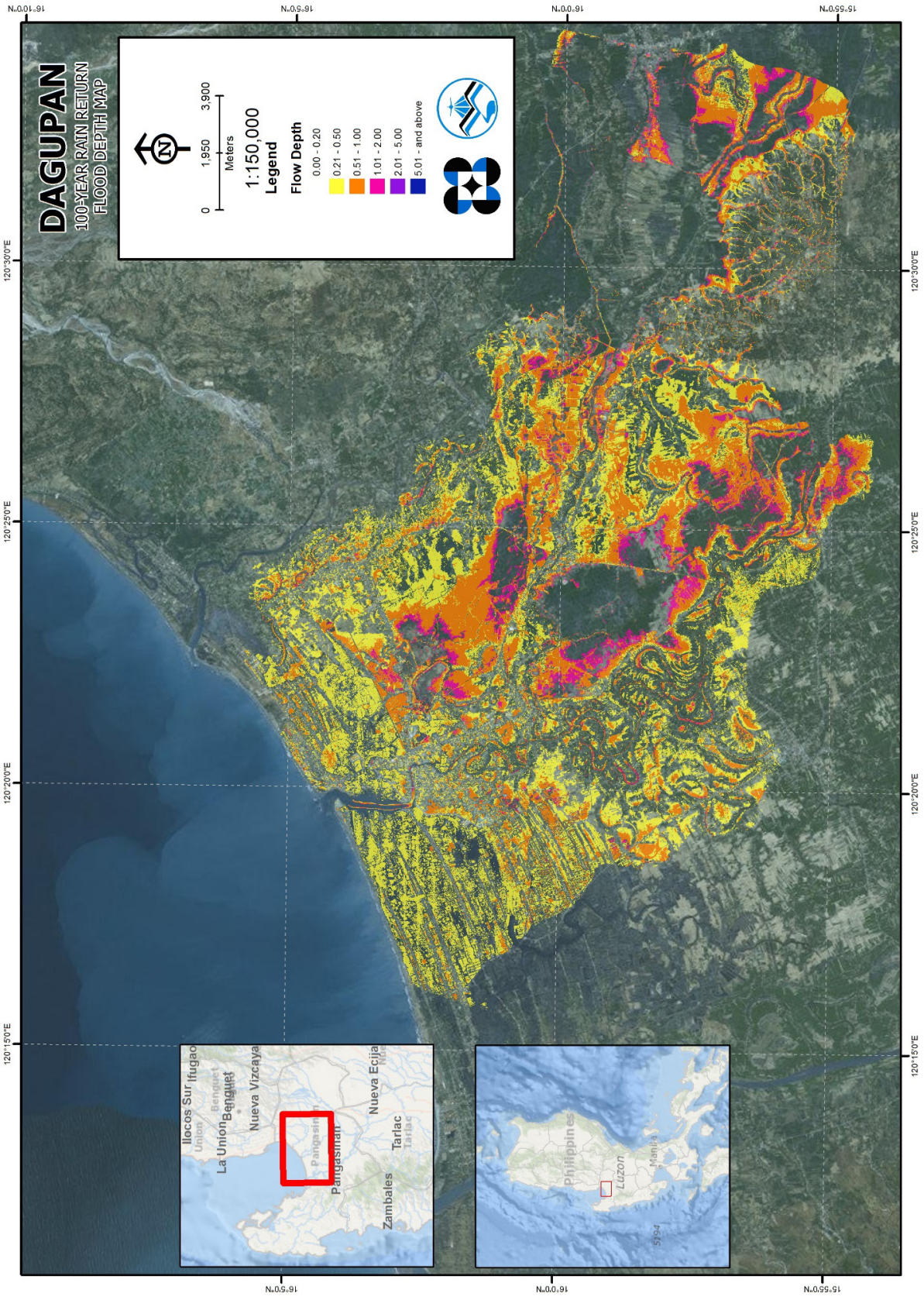


Figure 74. 100-year Flow Depth Map for Dagupan Floodplain

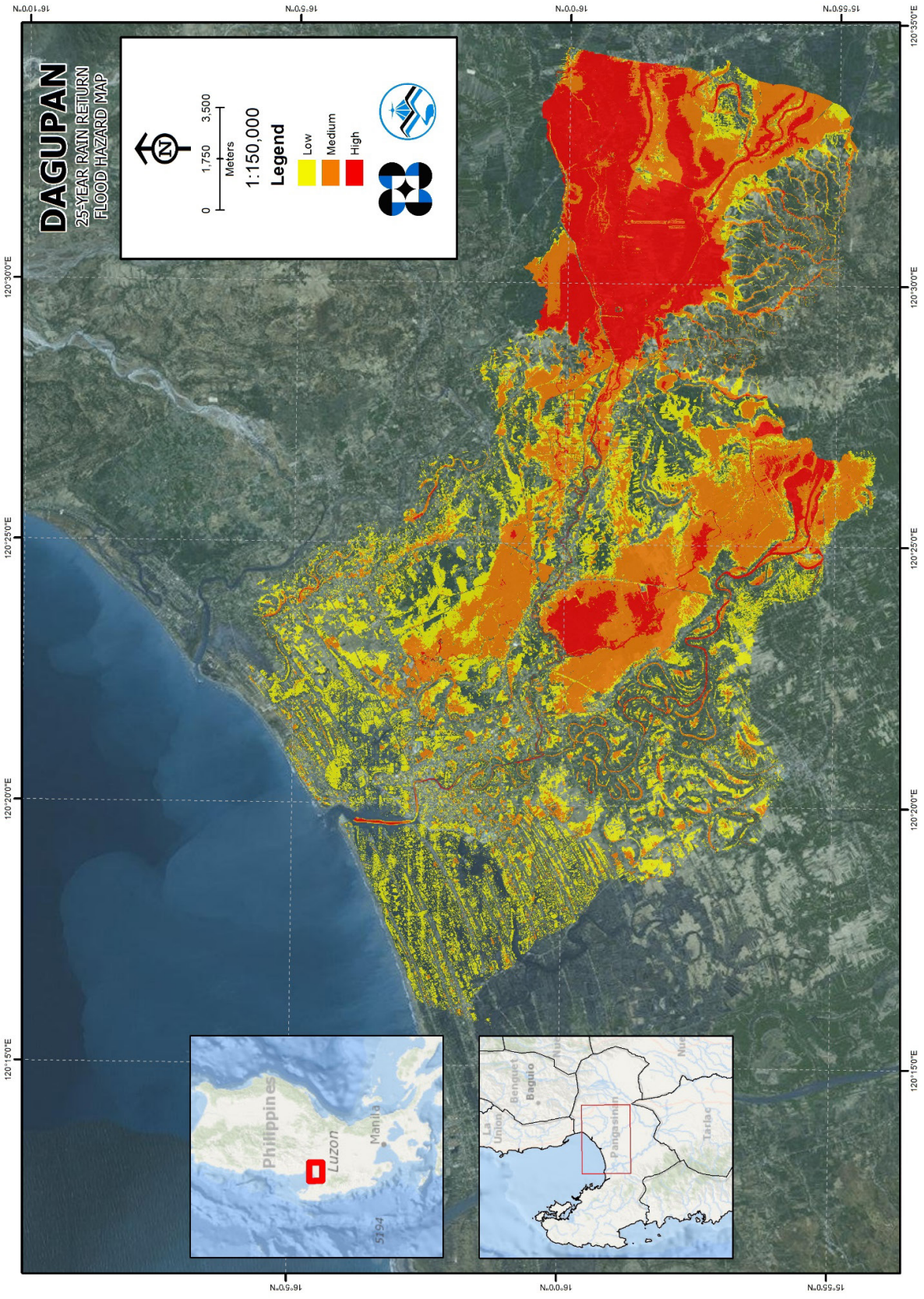


Figure 75. 25-year Flood Hazard Map for Dagupan Floodplain

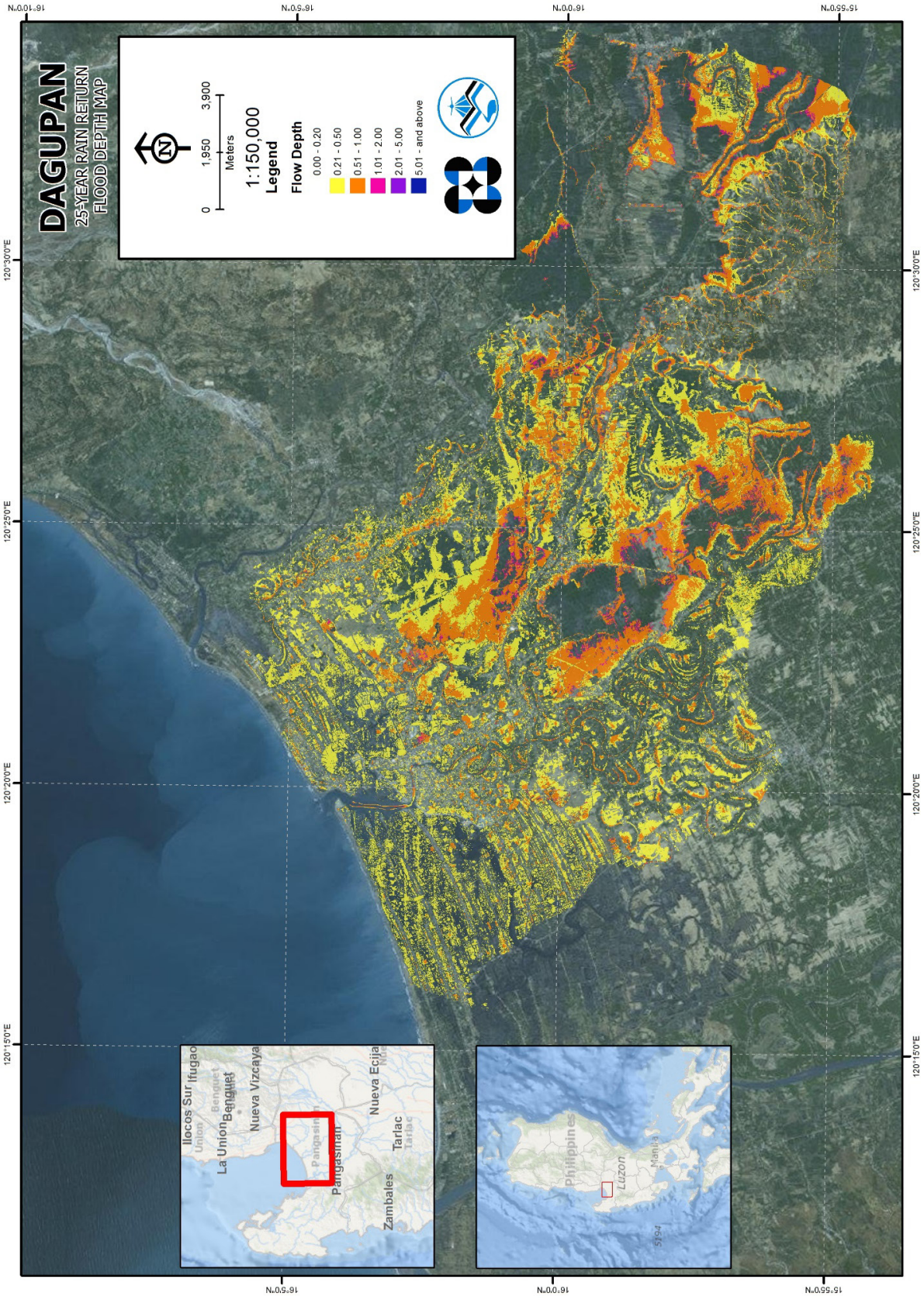


Figure 76. 25-year Flow Depth Map for Dagupan Floodplain

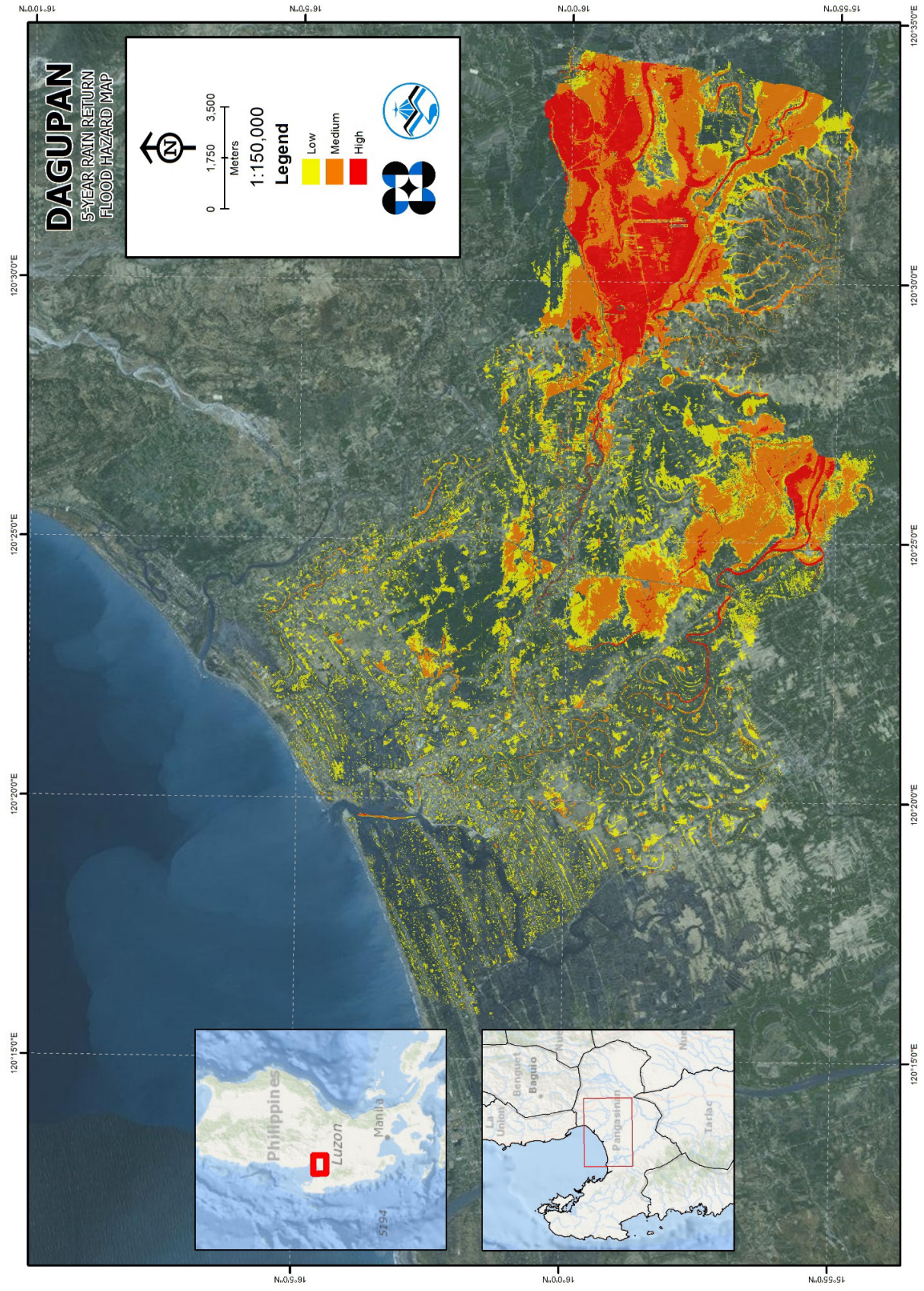


Figure 77. 5-year Flood Hazard Map for Dagupan Floodplain

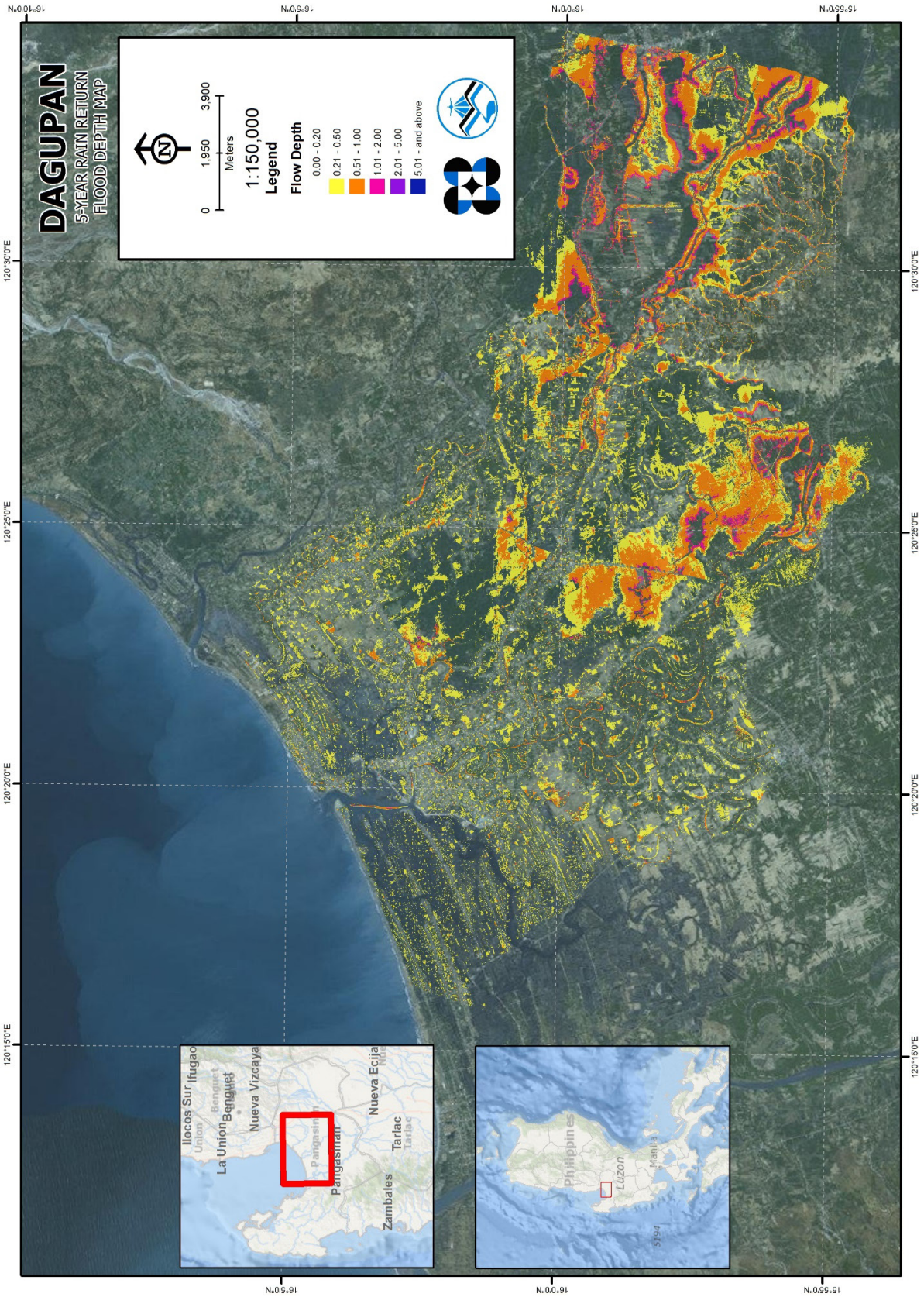


Figure 78. 5-year Flood Depth Map for Dagupan Floodplain

5.10 Inventory of Areas Exposed to Flooding

Affected barangays in Dagupan river basin, grouped by municipality, are listed below. For the said basin, thirteen municipalities consisting of 240 barangays are expected to experience flooding when subjected to 5-, 25-, and 100-yr rainfall return period.

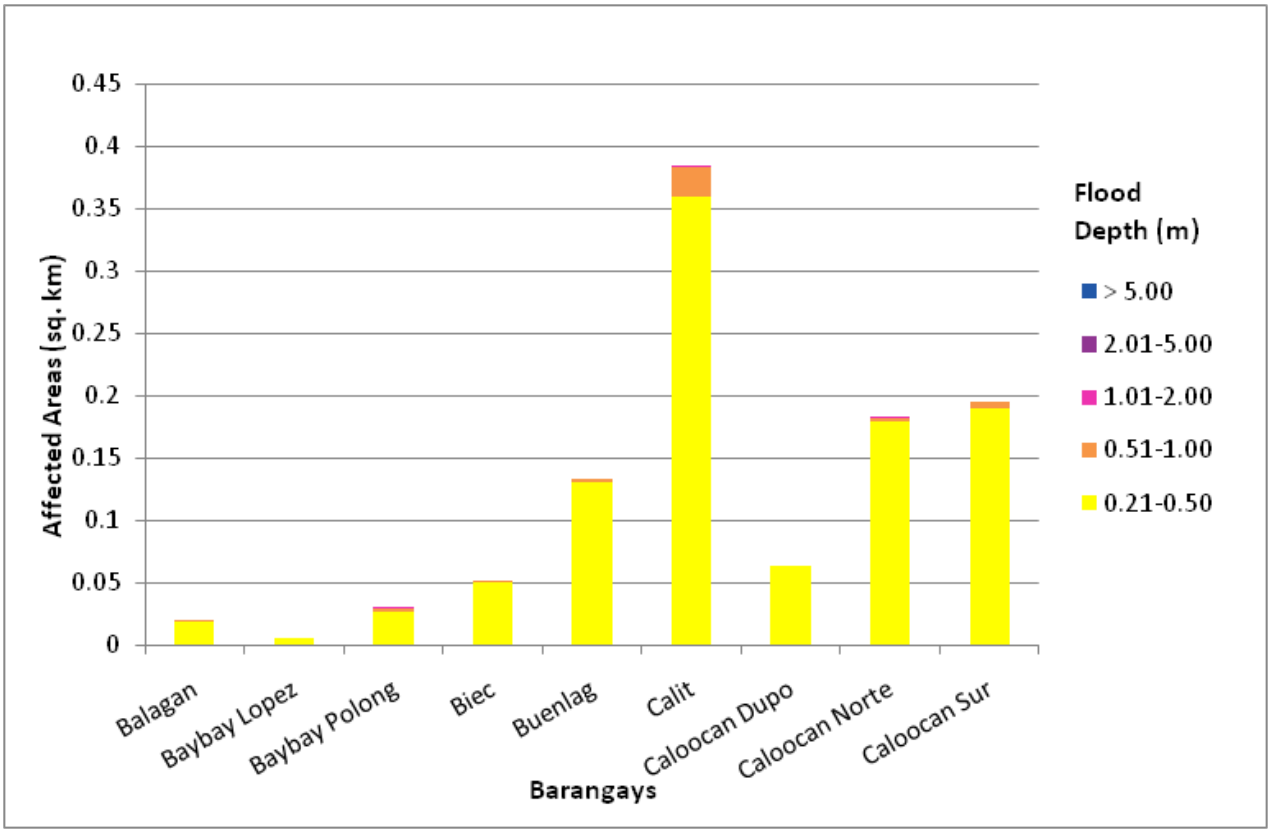
For the 5-year return period, 46.68% of the municipality of Binmaley with an area of 61.839261 sq. km. will experience flood levels of less than 0.20 meters. 7.30% of the area will experience flood levels of 0.21 to 0.50 meters while 0.46% and 0.02% of the area will experience flood depths of 0.51 to 1 meter and 1.01 to 2 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

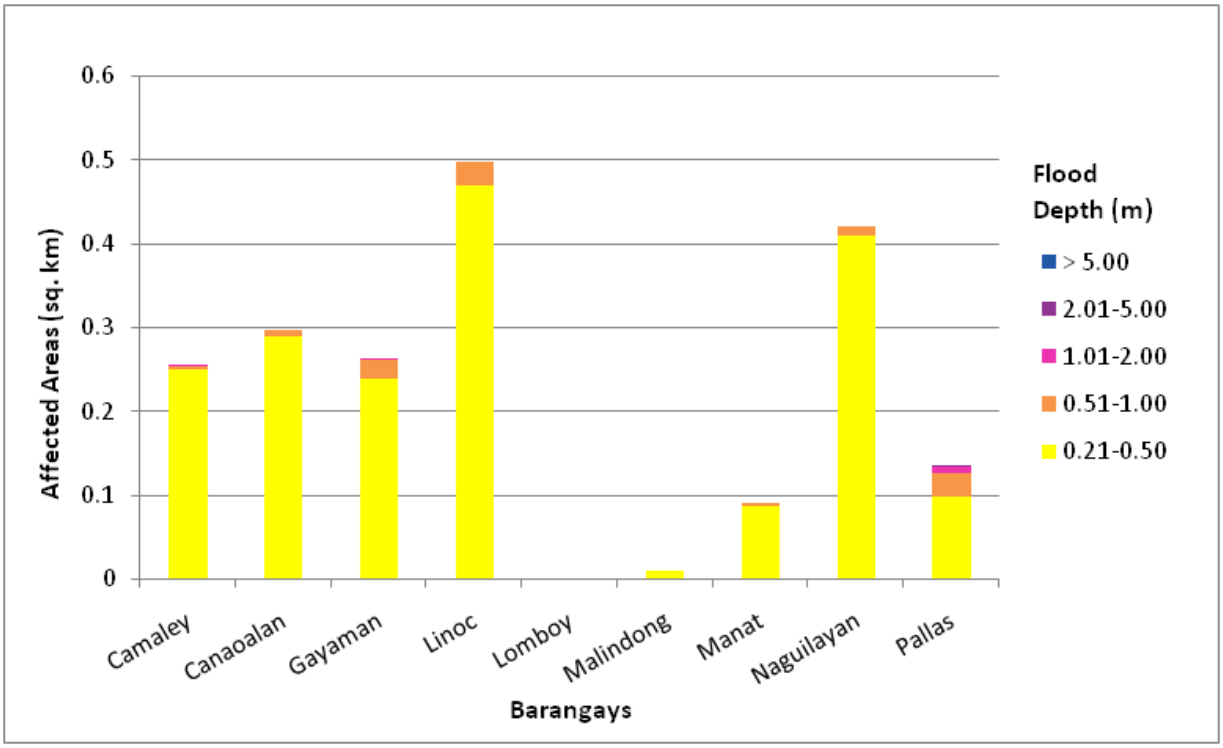
Table 15. Affected Areas in Binmaley, Pangasinan during 5-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binmaley (in sq. km)								
	Balagan	Baybay Lopez	Baybay Polong	Biec	Buenlag	Calit	Caloocan Dupo	Caloocan Norte	Caloocan Sur
0.03-0.20	0.23	0.049	0.16	0.58	0.7	1.86	0.63	0.89	1.45
0.21-0.50	0.019	0.005	0.026	0.052	0.13	0.36	0.063	0.18	0.19
0.51-1.00	0.001	0	0.0042	0.0001	0.0033	0.025	0	0.0038	0.0051
1.01-2.00	0	0	0.0002	0	0	0.0003	0	0.000097	0
2.01-5.00	0	0	0	0	0	0	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binmaley (in sq. km)								
	Camaley	Canaoalan	Gayaman	Linoc	Lomboy	Malindong	Manat	Naguilayan	Pallas
0.03-0.20	1.26	1.99	1.15	4.14	0.019	0.19	0.39	2.05	0.79
0.21-0.50	0.25	0.29	0.24	0.47	0	0.011	0.087	0.41	0.1
0.51-1.00	0.0056	0.0081	0.022	0.027	0	0	0.0041	0.01	0.027
1.01-2.00	0.0002	0	0.0008	0	0	0	0	0	0.0086
2.01-5.00	0	0	0	0	0	0	0	0	0.0002
> 5.00	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binmaley (in sq. km)								
	Papagueyan	Parayao	Poblacion	Sabangan	Salapingao	San Isidro Norte	San Isidro Sur	Santa Rosa	Tombor
0.03-0.20	1.48	1.09	1.07	0.4	1.99	0.77	0.51	1.1	1.93
0.21-0.50	0.17	0.23	0.1	0.057	0.27	0.13	0.087	0.22	0.37
0.51-1.00	0.013	0.03	0.0054	0.0028	0.0041	0.0055	0.0049	0.0078	0.065
1.01-2.00	0.00088	0	0.0003	0	0.0005	0	0.0005	0.0004	0.0024
2.01-5.00	0	0	0	0	0	0	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0


0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Affected Areas (sq. km)
Balagan
Baybay Lopez
Baybay Polong
Biec
Buenlag
Calit
Caloocan Dupo
Caloocan Norte
Caloocan Sur
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50


0.6
0.5
0.4
0.3
0.2
0.1
0
Affected Areas (sq. km)
Camaley
Canaoalan
Gayaman
Linoc
Lomboy
Malindong
Manat
Naguilayan
Pallas
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50

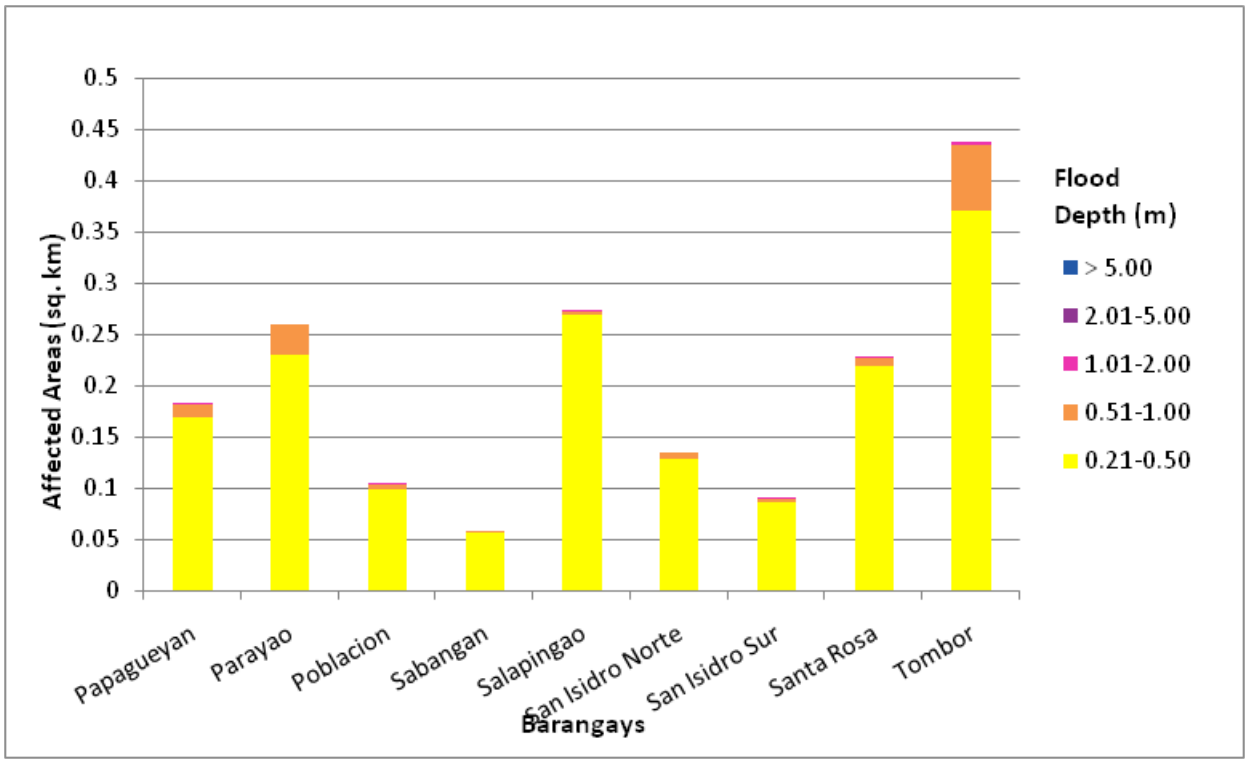


Figure. 79. Affected Areas in Binmaley, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 81.53% of the municipality of Calasiao with an area of 49.196934 sq. km. will experience flood levels of less than 0.20 meters. 14.25% of the area will experience flood levels of 0.21 to 0.50 meters while 3.16%, 0.82%, and 0.24% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 16. Affected Areas in Calasiao, Pangasinan during 5-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Calasiao (in sq. km)											
	Ambonao	Ambuetel	Banaoang	Bued	Buenlag	Cabilocaan	Dinalaoan	Doyong	Gabon	Lasip	Longos	Lumbang
0.03-0.20	2.17	2.37	1.83	0.7	1.41	0.96	1.37	2.32	0.34	3.18	1.38	2.27
0.21-0.50	0.23	0.26	0.33	0.37	0.32	0.071	0.15	0.32	0.043	0.48	0.28	0.28
0.51-1.00	0.013	0.062	0.074	0.029	0.11	0.0009	0.043	0.074	0.011	0.13	0.048	0.071
1.01-2.00	0.0014	0.013	0.0047	0.0012	0.027	0	0.0091	0.048	0.005	0.019	0.0099	0.02
2.01-5.00	0	0	0	0	0	0	0	0.02	0	0.0001	0	0.0001
> 5.00	0	0	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Calasiao (in sq. km)											
	Macabito	Malabago	Mancup	Nagsaing	Nalsian	Poblacion East	Poblacion West	Quesban	San Miguel	San Vicente	Songkoy	Talibaew
0.03-0.20	3.45	2.86	1.76	2.83	1.19	0.26	0.32	2.03	1.08	1.85	0.45	1.73
0.21-0.50	0.69	0.38	0.29	0.44	0.28	0.04	0.036	0.41	0.18	0.39	0.15	0.59
0.51-1.00	0.31	0.081	0.11	0.044	0.032	0.0086	0.0062	0.048	0.033	0.12	0.012	0.086
1.01-2.00	0.12	0.025	0.0046	0.027	0.001	0.00084	0.000096	0.0076	0.005	0.018	0	0.034
2.01-5.00	0.095	0.0024	0	0.0014	0	0	0	0	0	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0	0	0	0

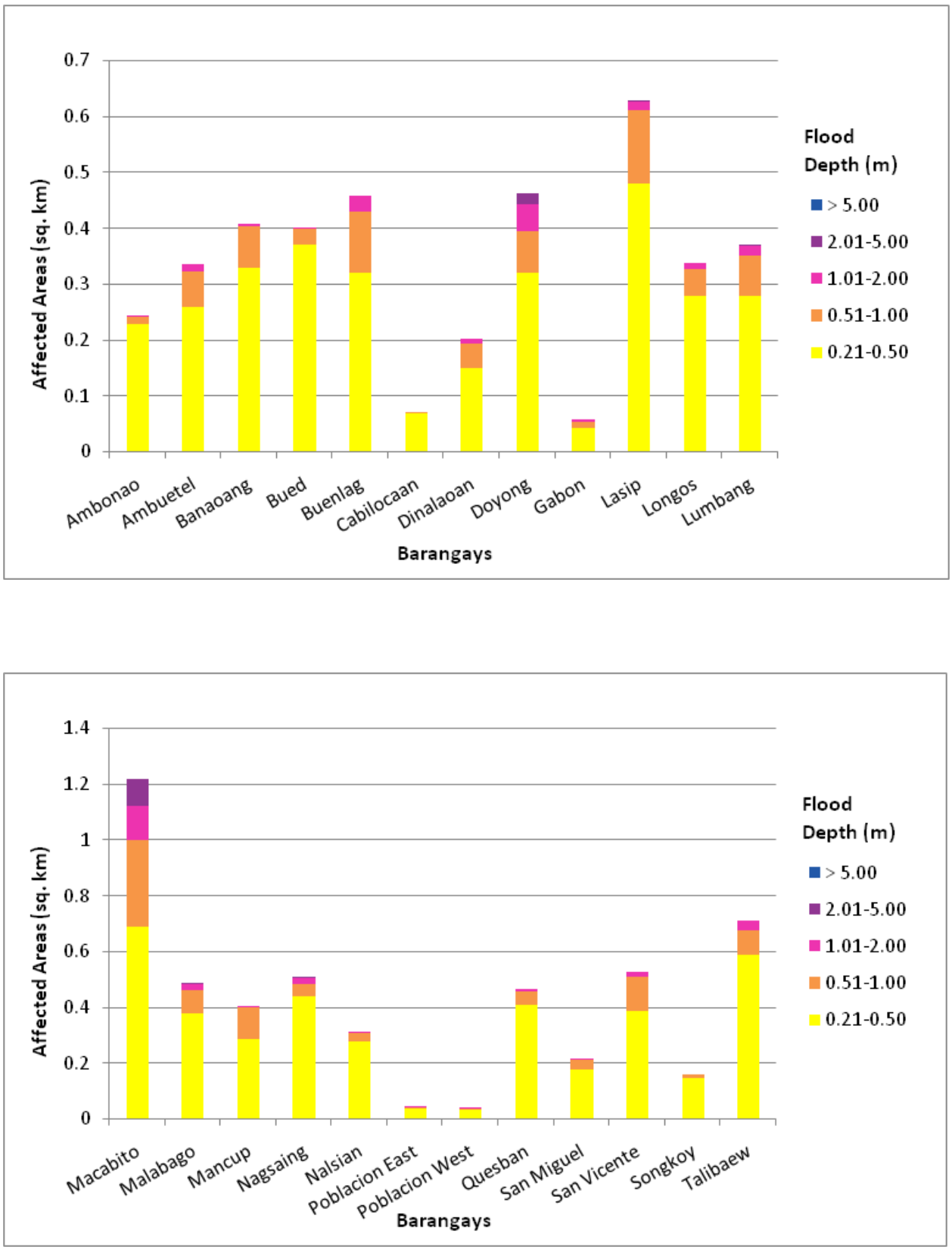


Figure. 80. Affected Areas in Calasiao, Pangasinan during 5-Year Rainfall Return Period

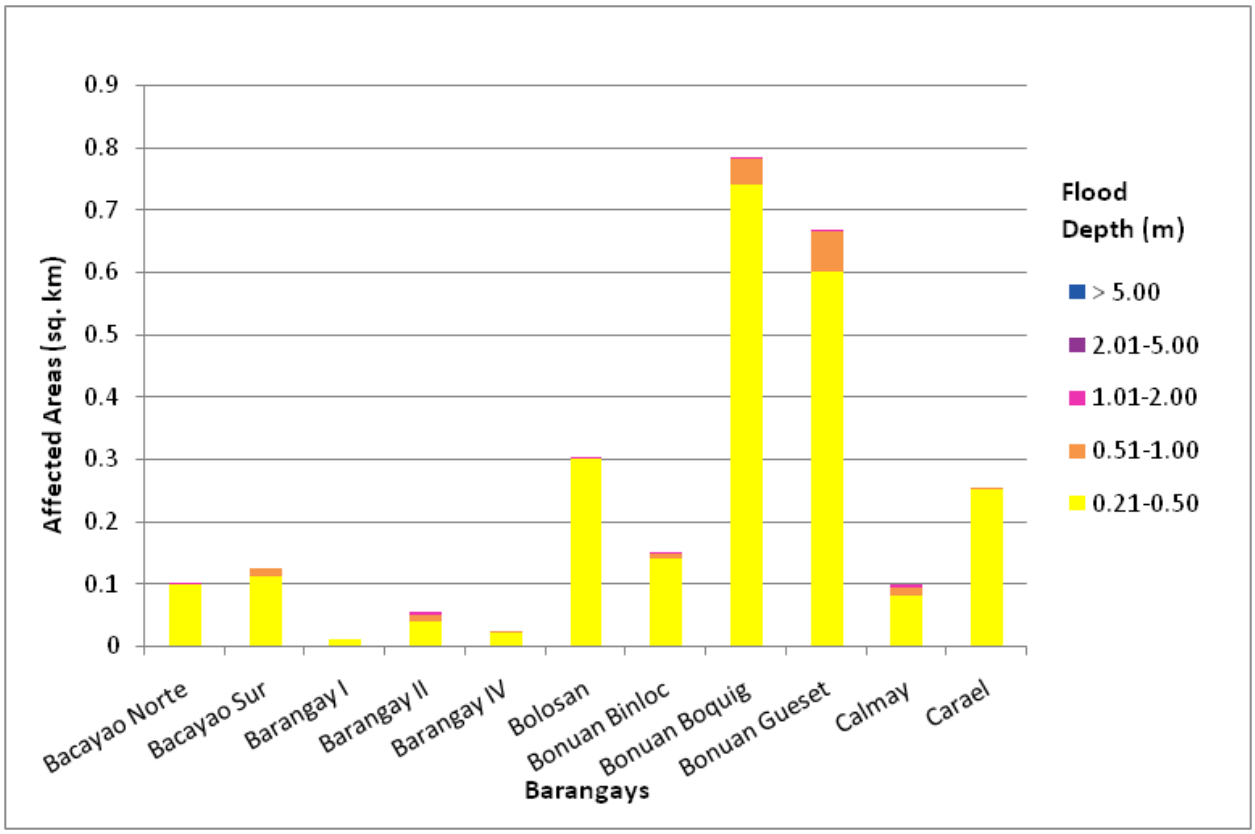
For the 5-year return period, 75.66% of the municipality of Dagupan City with an area of 47.755696 sq. km. will experience flood levels of less than 0.20 meters. 12.50% of the area will experience flood levels of 0.21 to 0.50 meters while 1.52% and 0.18% of the area will experience flood depths of 0.51 to 1 meter and 1.01 to 2 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

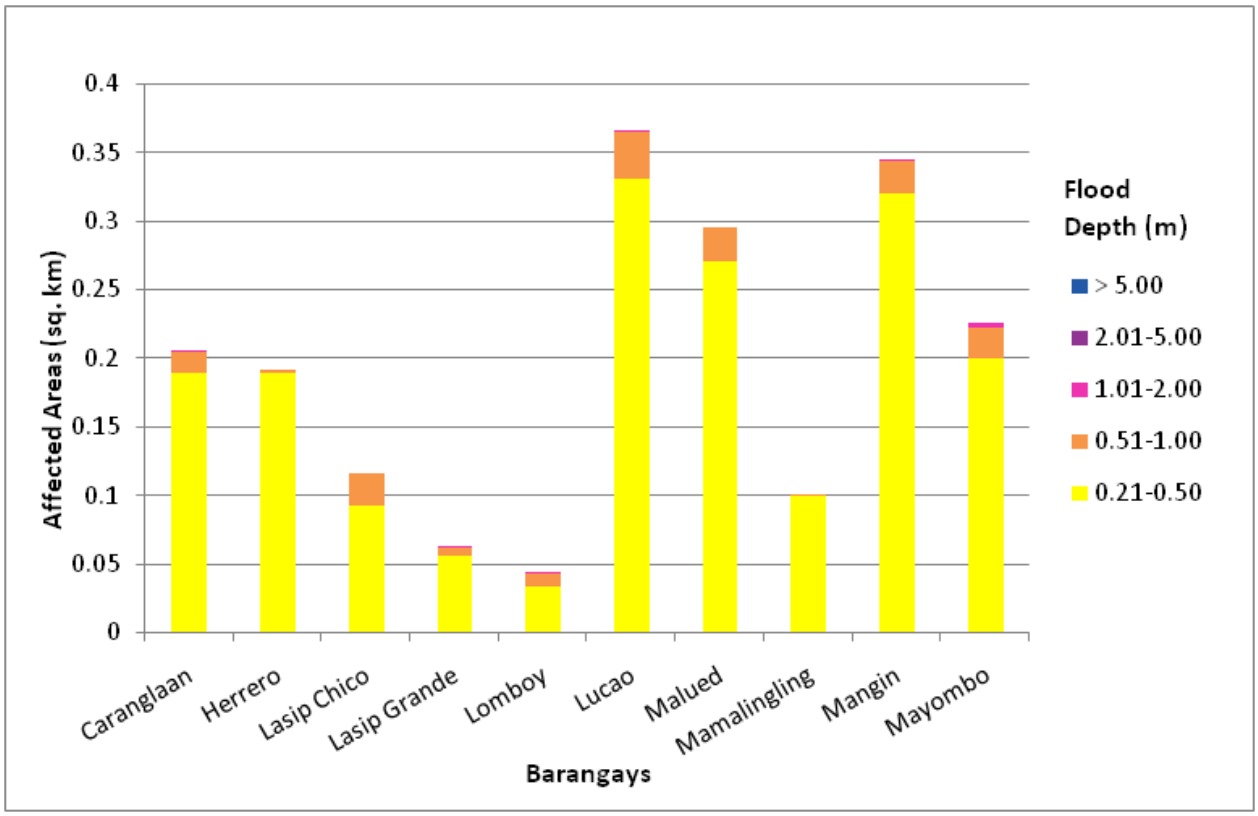
Table 17. Affected Areas in Dagupan City, Pangasinan during 5-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Dagupan City (in sq. km)										
	Bacayao Norte	Bacayao Sur	Barangay I	Barangay II	Barangay IV	Bolosan	Bonuan Binloc	Bonuan Boquig	Bonuan Gueset	Calmay	Carael
0.03-0.20	0.37	0.48	0.11	0.26	0.1	1.13	0.89	4.02	4	0.57	1.86
0.21-0.50	0.098	0.11	0.011	0.038	0.022	0.3	0.14	0.74	0.6	0.081	0.25
0.51-1.00	0.0021	0.013	0	0.011	0.0011	0.0027	0.0098	0.04	0.065	0.013	0.0036
1.01-2.00	0.00037	0	0	0.0053	0	0.0009	0.001	0.0043	0.0025	0.0038	0
2.01-5.00	0	0	0	0	0	0	0	0	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Dagupan City (in sq. km)									
	Caranglaan	Herrero	Lasip Chico	Lasip Grande	Lomboy	Lucao	Malued	Mamalingling	Mangin	Mayombo
0.03-0.20	0.8	1.06	0.52	0.25	0.51	1.65	1.36	2.06	1.16	0.93
0.21-0.50	0.19	0.19	0.093	0.057	0.034	0.33	0.27	0.1	0.32	0.2
0.51-1.00	0.015	0.0023	0.024	0.0069	0.009	0.036	0.025	0.0011	0.025	0.022
1.01-2.00	0.0006	0	0	0.0001	0.0018	0.0001	0	0	0.0001	0.0033
2.01-5.00	0	0	0	0	0	0	0	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Dagupan City (in sq. km)									
	Pantal	Poblacion Oeste	Pogo Chico	Pogo Grande	Pugaro Suit	Salapingao	Salisay	Tambac	Tapuac	Tebeng
0.03-0.20	1.42	0.36	0.33	0.15	2.15	1.92	2.26	1.43	0.61	1.41
0.21-0.50	0.097	0.034	0.057	0.034	0.15	0.15	0.73	0.18	0.085	0.28
0.51-1.00	0.023	0.0031	0.013	0.0062	0.0056	0.0013	0.33	0.0018	0.00084	0.014
1.01-2.00	0.0079	0	0.0011	0	0	3.5E-06	0.051	0	0	0
2.01-5.00	0	0	0	0	0	0	0	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0	0


0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Affected Areas (sq. km)
Bacayao Norte
Bacayao Sur
Barangay I
Barangay II
Barangay IV
Bolosan
Bonuan Binloc
Bonuan Boquig
Bonuan Gueset
Calmay
Carael
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50


0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Affected Areas (sq. km)
Caranglaan
Herrero
Lasip Chico
Lasip Grande
Lomboy
Lucao
Malued
Mamalingling
Mangin
Mayombo
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50

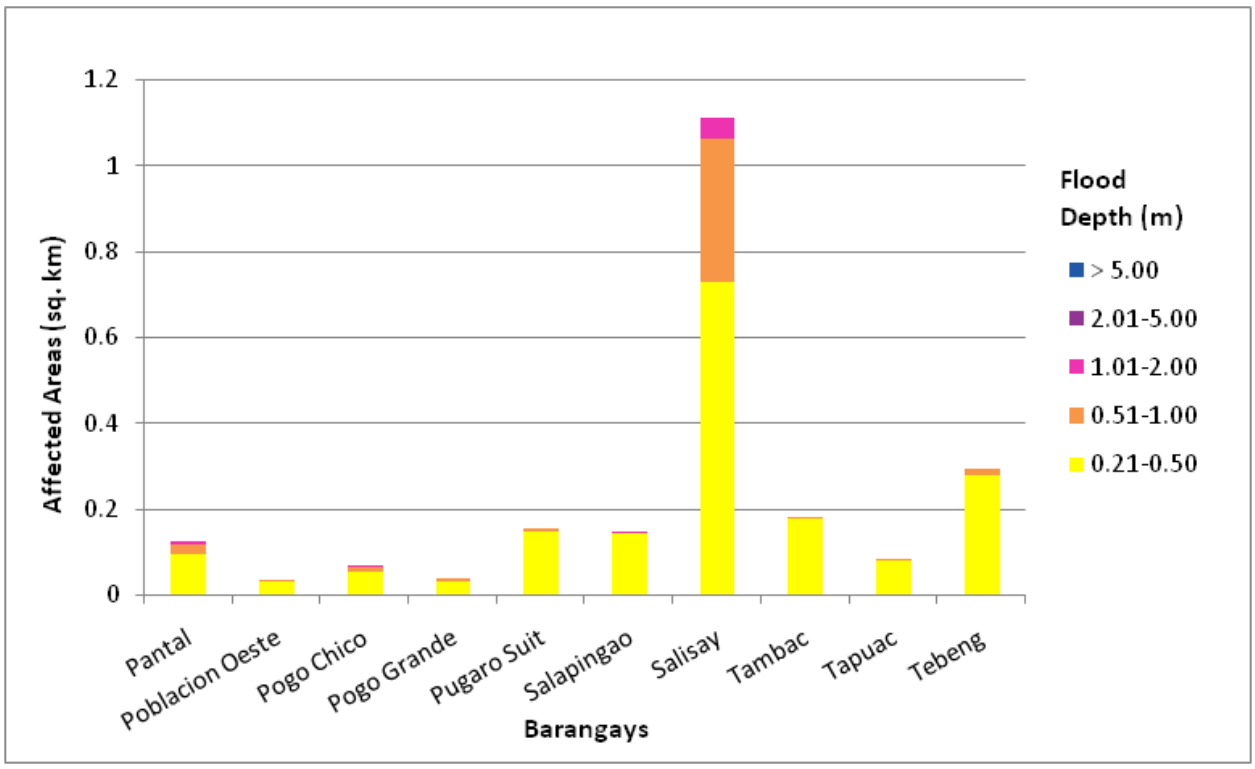


Figure. 81. Affected Areas in Dagupan City, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 0.01% of the municipality of Laoac with an area of 40.697535 sq. km. will experience flood levels of less than 0.20 meters. 0.01% of the area will experience flood levels of 0.21 to 0.50 meters while 0.03%, 0.10%, 0.34%, and 0.08% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 18. Affected Areas in Laoac, Pangasinan during 5-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Laoac (in sq. km)
	Yatyat
0.03-0.20	0.0047
0.21-0.50	0.0042
0.51-1.00	0.011
1.01-2.00	0.041
2.01-5.00	0.14
> 5.00	0.034

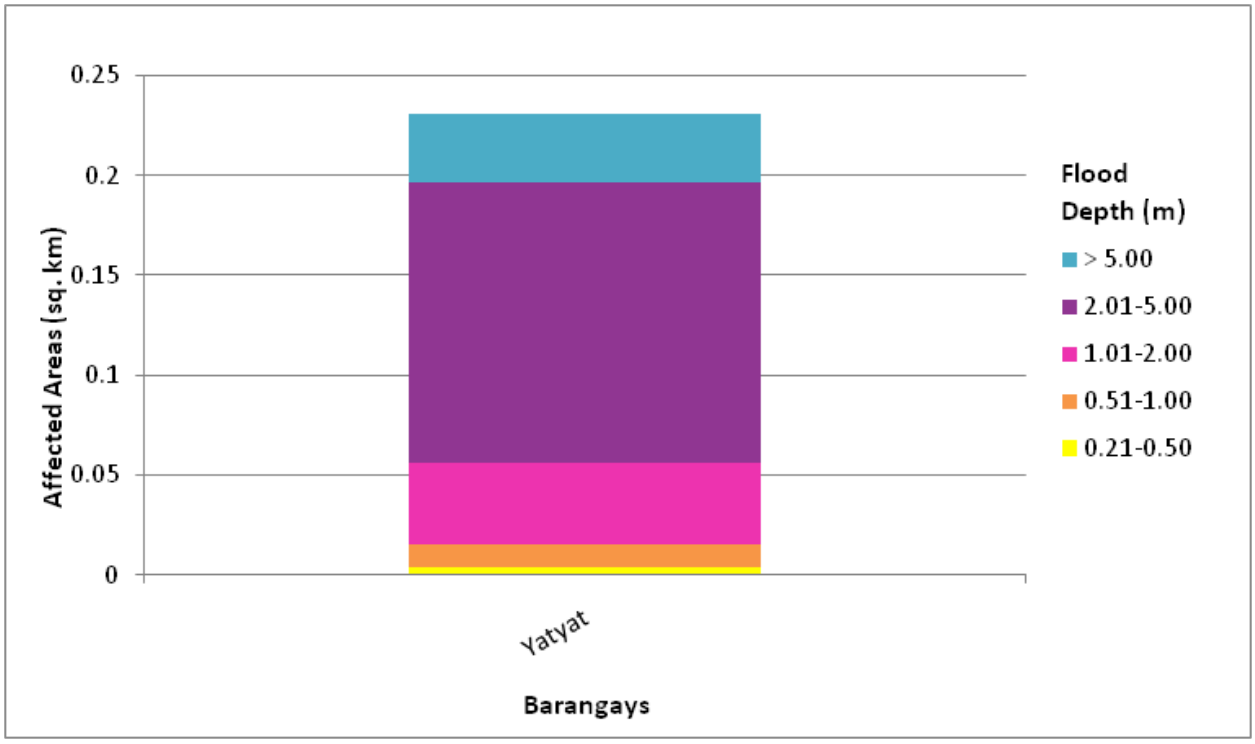


Figure. 82. Affected Areas in Laoac, Pangasinan during 5-Year Rainfall Return Period

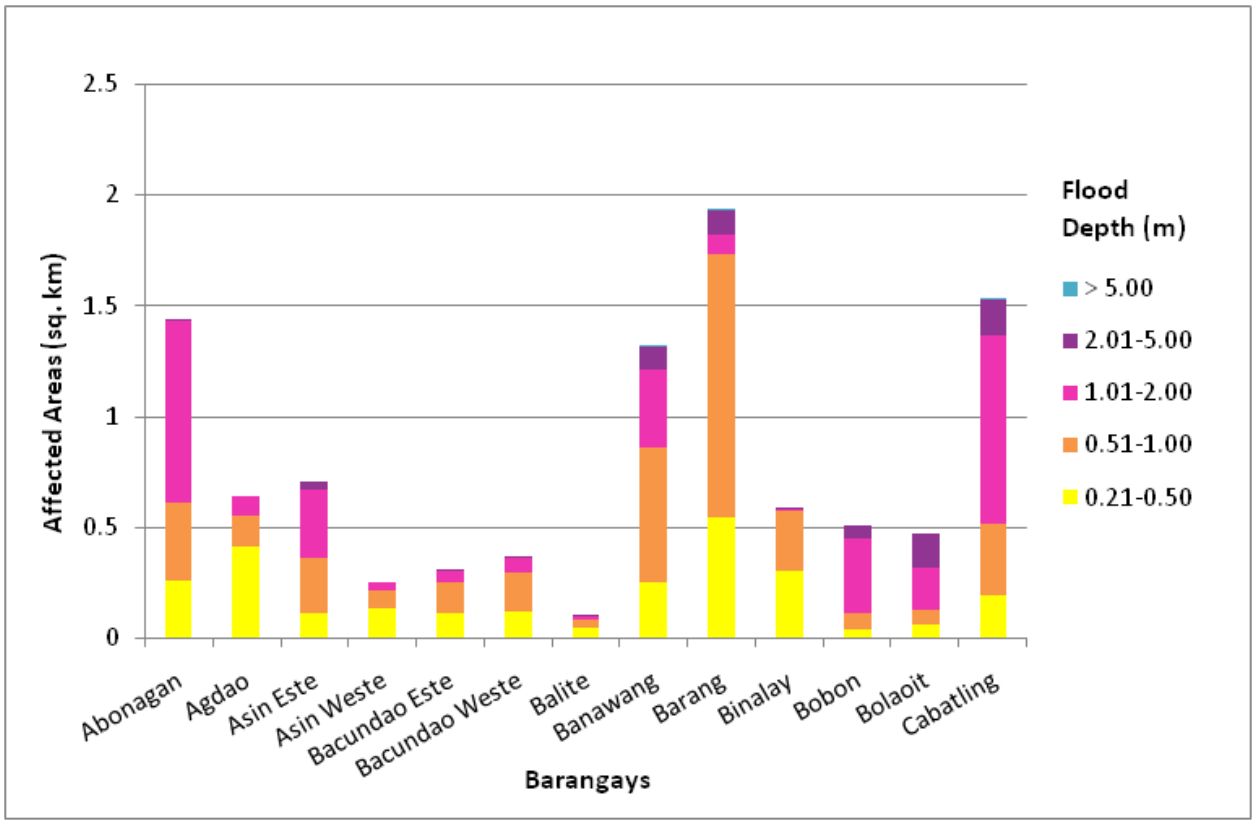
For the 5-year return period, 18.07% of the municipality of Malasiqui with an area of 124.805404 sq. km. will experience flood levels of less than 0.20 meters. 6.68% of the area will experience flood levels of 0.21 to 0.50 meters while 6.90%, 4.23%, 0.91%, and 0.01% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

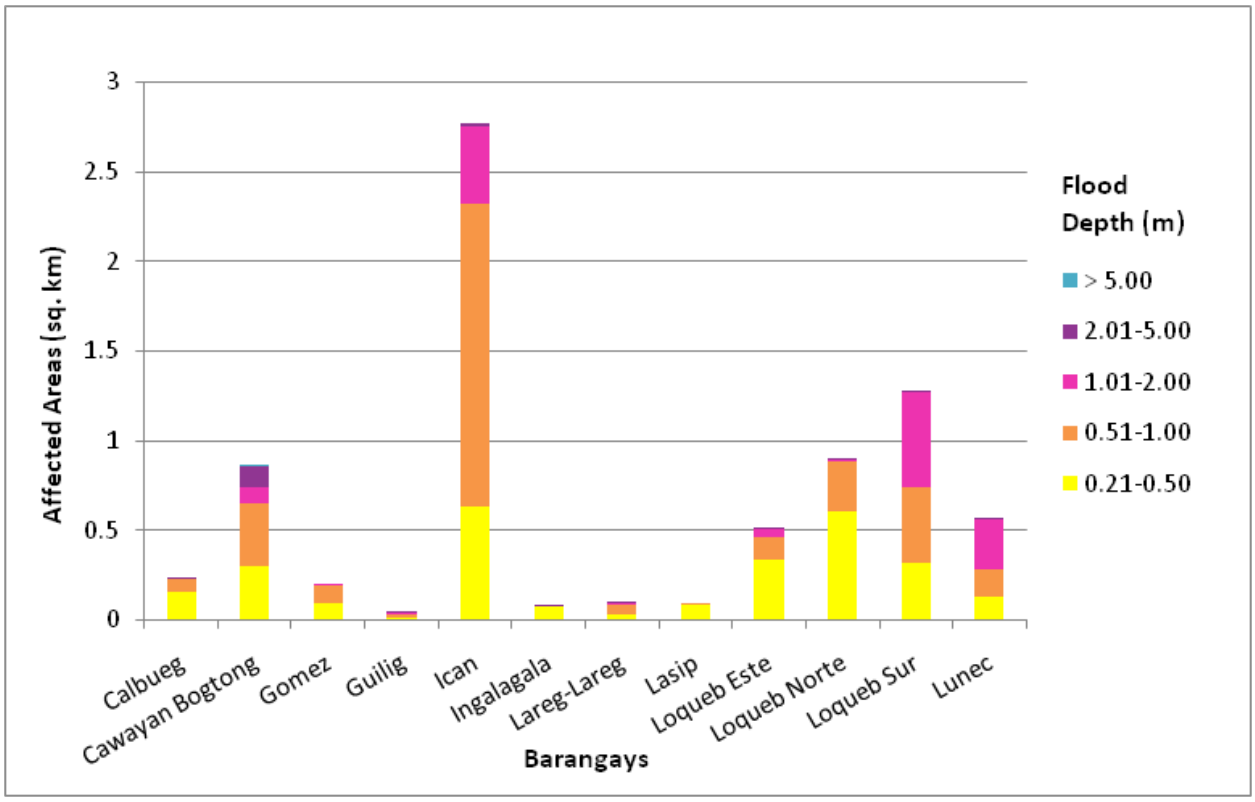
Table 19. Affected Areas in Malasiqui, Pangasinan during 5-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Malasiqui (in sq. km)												
	Abonagan	Agdao	Asin Este	Asin Weste	Bacundao Este	Bacundao Weste	Balite	Banawang	Barang	Binalay	Bobon	Bolaoit	Cabatling
0.03-0.20	0.22	1.24	0.66	1.15	1.98	1.31	0.9	0.083	0.2	0.15	0.0072	0.021	0.1
0.21-0.50	0.26	0.41	0.11	0.13	0.11	0.12	0.043	0.25	0.54	0.3	0.037	0.059	0.19
0.51-1.00	0.35	0.14	0.25	0.086	0.14	0.17	0.04	0.61	1.19	0.27	0.072	0.069	0.32
1.01-2.00	0.83	0.086	0.31	0.033	0.057	0.071	0.014	0.35	0.088	0.016	0.34	0.19	0.85
2.01-5.00	0.0004	0	0.036	0	0.0006	0.0026	0.0031	0.11	0.12	0.0008	0.055	0.15	0.17
> 5.00	0	0	0	0	0	0	0	0.001	0.0005	0	0	0	0.0036

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Malasiqui (in sq. km)											
	Calbueg	Cawayan Bogtong	Gomez	Guilig	Ican	Ingalagala	Lareg-Lareg	Lasip	Loqueb Este	Loqueb Norte	Loqueb Sur	Lunec
0.03-0.20	0.84	1.47	0.091	0.11	0.36	0.25	0.77	0.34	1.16	0.44	0.43	0.62
0.21-0.50	0.16	0.3	0.1	0.02	0.64	0.078	0.039	0.091	0.34	0.61	0.32	0.13
0.51-1.00	0.069	0.35	0.11	0.015	1.68	0.015	0.047	0.0035	0.13	0.28	0.42	0.16
1.01-2.00	0.0092	0.091	0.0002	0.018	0.43	0.0004	0.017	0	0.051	0.011	0.53	0.27
2.01-5.00	0.0007	0.12	0	0.0031	0.017	0.0003	0.0021	0	0.0003	0.0025	0.014	0.0093
> 5.00	0	0.0059	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Malasiqui (in sq. km)											
	Manggan-Dampay	Pasima	Poblacion	Polong Norte	Potiocan	Tabo-Sili	Talospatang	Taloy	Taloyan	Tambac	Tolonguat	Viado
0.03-0.20	0.79	0.98	0.11	0.28	0.95	0.55	0.03	0.58	1.72	0.29	1.09	0.28
0.21-0.50	0.31	0.36	0.14	0.062	0.83	0.024	0.09	0.27	0.099	0.27	0.23	0.27
0.51-1.00	0.16	0.07	0.19	0.0089	0.26	0.021	0.14	0.073	0.063	0.53	0.031	0.081
1.01-2.00	0.024	0.025	0.13	0.0001	0.00012	0.007	0.12	0.053	0.03	0.22	0	0.0026
2.01-5.00	0.0003	0.012	0.062	0	0	0	0.001	0.074	0.0029	0.16	0	0
> 5.00	0	0	0.001	0	0	0	0.00026	0	0	0.0055	0	0


2.5
2
1.5
1
0.5
0
Affected Areas (sq. km)
Abonagan
Agdao
Asin Este
Asin Weste
Bacundao Este
Bacundao Weste
Balite
Banawang
Barang
Binalay
Bobon
Bolaoit
Cabatling
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50


3
2.5
2
1.5
1
0.5
0
Affected Areas (sq. km)
Calbueg
Cawayan Bogtong
Gomez
Guilig
Ican
Ingalagala
Lareg-Lareg
Lasip
Loqueb Este
Loqueb Norte
Loqueb Sur
Lunec
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50

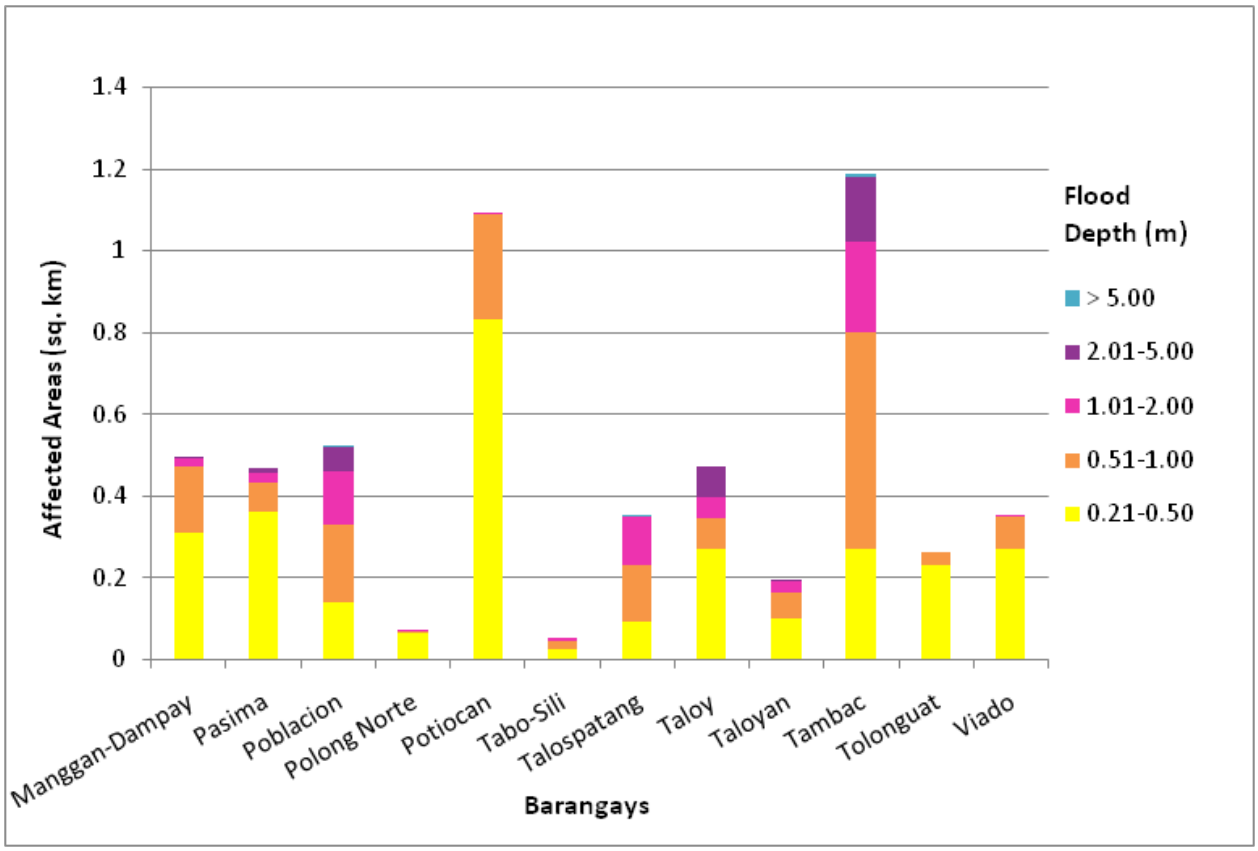


Figure. 83. Affected Areas in Malasiqui, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 0.35% of the municipality of Manaoag with an area of 42.418932 sq. km. will experience flood levels of less than 0.20 meters. 0.11% of the area will experience flood levels of 0.21 to 0.50 meters while 0.00% of the area will experience flood depths of 0.51 to 1 meter. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 20. Affected Areas in Manaoag, Pangasinan during 5-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Manaoag (in sq. km)
	Baguinay
0.03-0.20	0.15
0.21-0.50	0.046
0.51-1.00	0
1.01-2.00	0
2.01-5.00	0
> 5.00	0

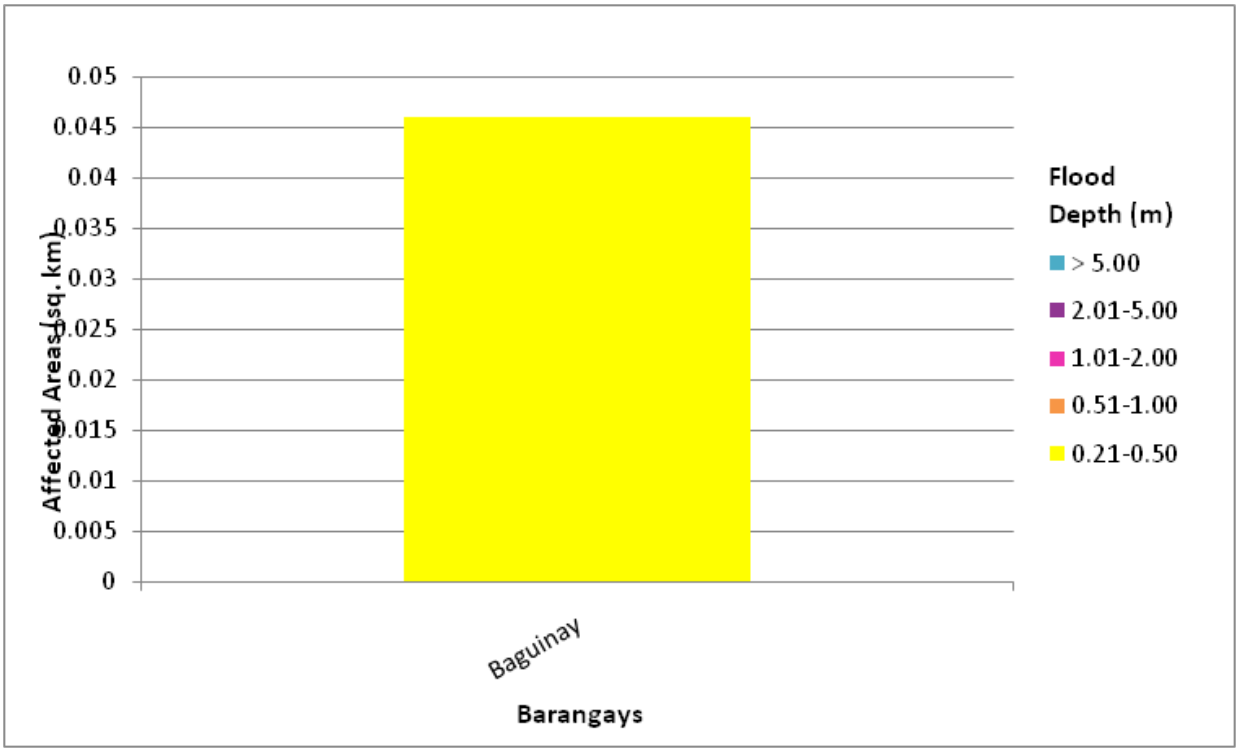


Figure. 84. Affected Areas in Manaoag, Pangasinan during 5-Year Rainfall Return Period

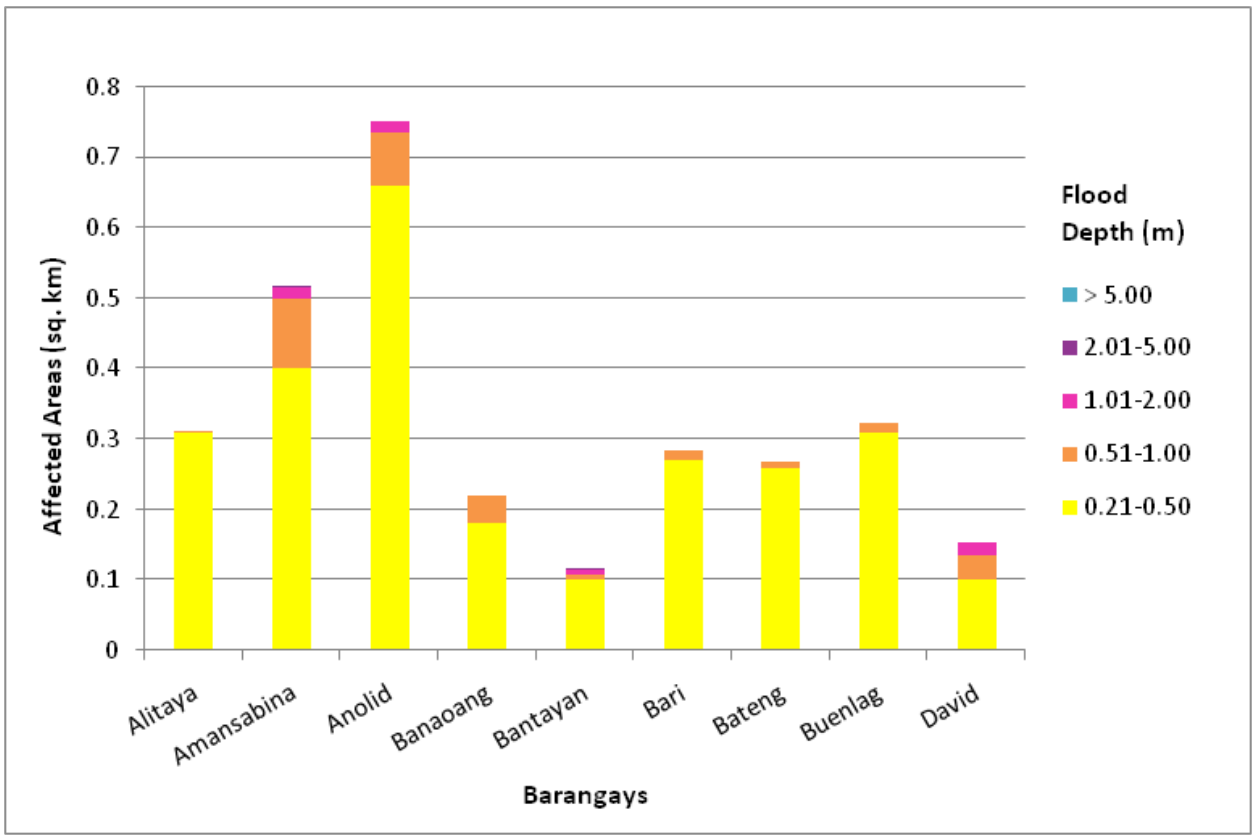
For the 5-year return period, 66.73% of the municipality of Mangaldan with an area of 43.415808 sq. km. will experience flood levels of less than 0.20 meters. 11.92% of the area will experience flood levels of 0.21 to 0.50 meters while 1.40%, 0.23%, and 0.01% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

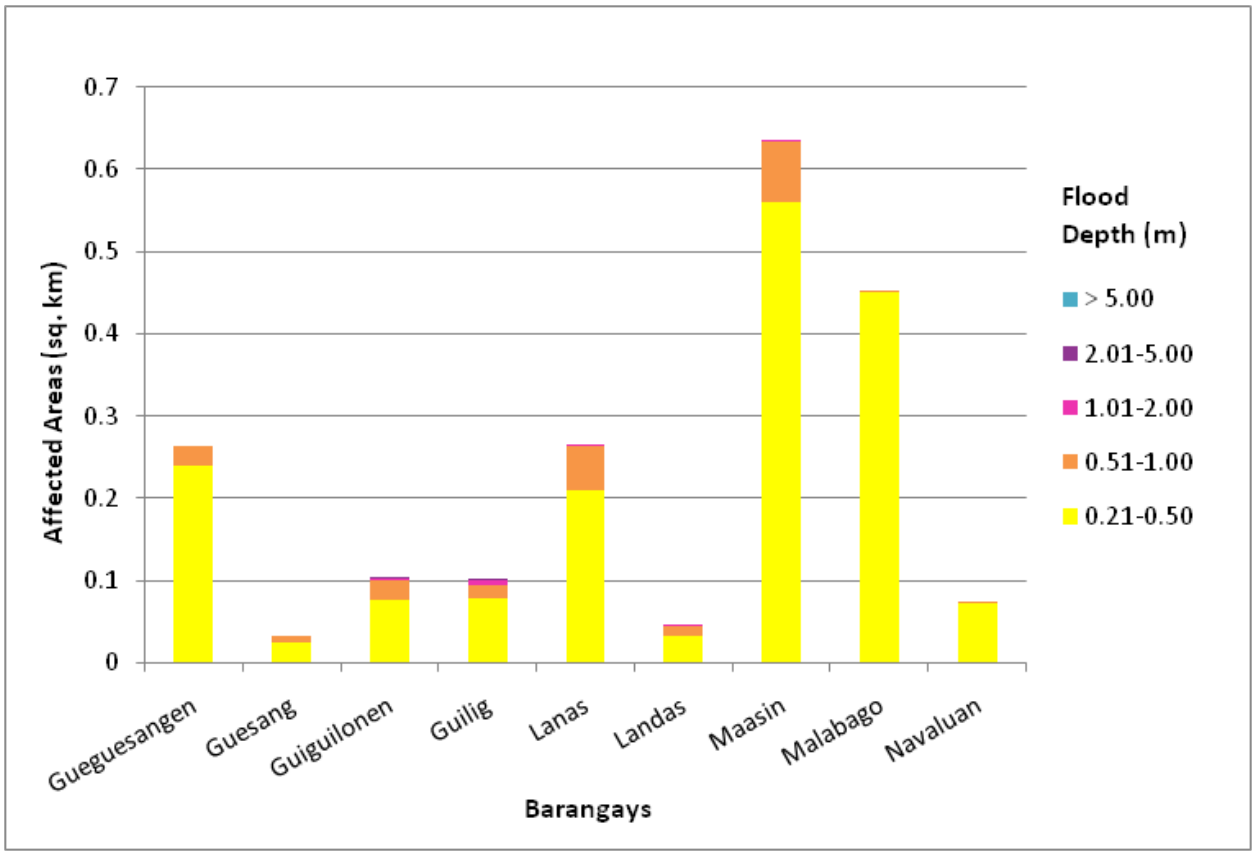
Table 21. Affected Areas in Mangaldan, Pangasinan during 5-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Mangaldan (in sq. km)								
	Alitaya	Amansabina	Anolid	Banaoang	Bantayan	Bari	Bateng	Buenlag	David
0.03-0.20	2.29	1.98	2.86	0.53	0.55	1.28	1.19	1.44	0.63
0.21-0.50	0.31	0.4	0.66	0.18	0.1	0.27	0.26	0.31	0.1
0.51-1.00	0.0024	0.1	0.076	0.039	0.0075	0.014	0.0078	0.013	0.036
1.01-2.00	0	0.019	0.015	0	0.0097	0	0	0	0.018
2.01-5.00	0	0.0001	0	0	0.0002	0	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Mangaldan (in sq. km)								
	Gueguesangen	Guesang	Guiguilonen	Guilig	Lanas	Landas	Maasin	Malabago	Navaluan
0.03-0.20	0.96	0.25	0.6	0.49	1.06	0.25	3.11	2.84	0.46
0.21-0.50	0.24	0.023	0.076	0.077	0.21	0.031	0.56	0.45	0.072
0.51-1.00	0.024	0.0097	0.023	0.016	0.056	0.014	0.075	0.0028	0.00094
1.01-2.00	0	0	0.0044	0.0079	0.0002	0.00084	0.0002	0	0
2.01-5.00	0	0	0.0001	0.0001	0	0	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Mangaldan (in sq. km)								
	Nibaliw	Osiem	Palua	Poblacion	Pogo	Salaan	Salay	Talogtog	Tebag
0.03-0.20	0.42	0.34	0.28	0.61	1.01	0.28	0.79	2.21	0.26
0.21-0.50	0.05	0.025	0.056	0.13	0.11	0.025	0.11	0.3	0.041
0.51-1.00	0.0075	0	0.0003	0.033	0.013	0.000046	0.029	0.0028	0.0059
1.01-2.00	0.0015	0	0	0.0002	0.0039	0	0.016	0.0001	0.0009
2.01-5.00	0.0002	0	0	0	0	0	0.0034	0	0
> 5.00	0	0	0	0	0	0	0	0	0


0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Affected Areas (sq. km)
Alitaya
Amansabina
Anolid
Banaoang
Bantayan
Bari
Bateng
Buenlag
David
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50


0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Affected Areas (sq. km)
Gueguesangen
Guesang
Guiguilonen
Guilig
Lanas
Landas
Maasin
Malabago
Navaluan
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50

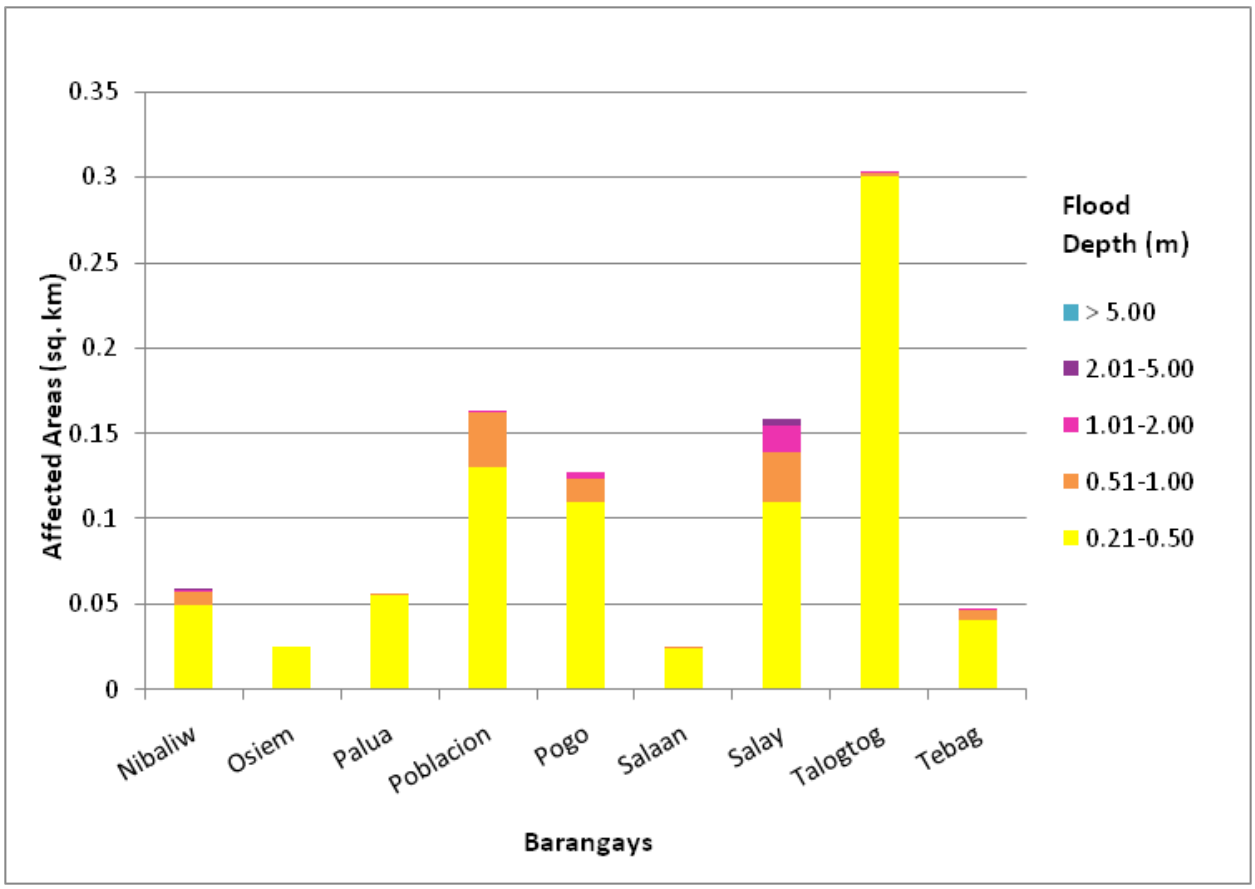


Figure. 85. Affected Areas in Mangaldan, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 47.84% of the municipality of Mapandan with an area of 21.351923 sq. km. will experience flood levels of less than 0.20 meters. 9.19% of the area will experience flood levels of 0.21 to 0.50 meters while 3.37%, 1.59%, and 0.26% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 22. Affected Areas in Mapandan, Pangasinan during 5-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Mapandan (in sq. km)											
	Amanoaoac	Apaya	Aserda	Coral	Golden	Jimenez	Lambayan	Luyan	Nilombot	Pias	Primicias	Torres
0.03-0.20	0.76	0.18	0.55	0.0051	0.4	1.12	1.35	1.01	1.64	1.27	1.08	0.85
0.21-0.50	0.14	0.0093	0.058	0	0.044	0.24	0.24	0.17	0.22	0.15	0.4	0.29
0.51-1.00	0.034	0	0.0091	0	0.0051	0.057	0.075	0.012	0.015	0.023	0.41	0.08
1.01-2.00	0.0006	0	0.0001	0	0	0.0022	0.088	0.001	2.9E-06	0.0064	0.24	0.0015
2.01-5.00	0	0	0	0	0	0.0002	0.024	0	0	0	0.031	0.0001
> 5.00	0	0	0	0	0	0	0	0	0	0	0	0

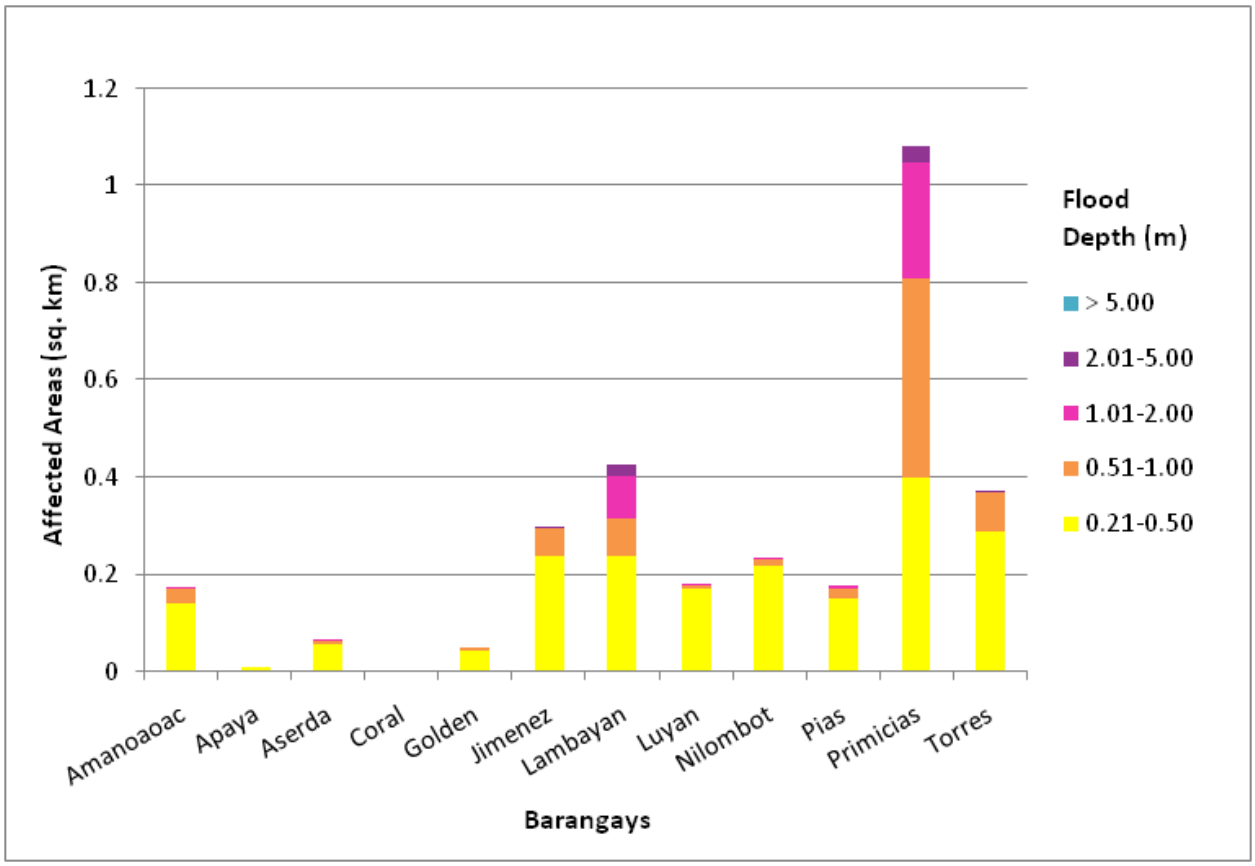


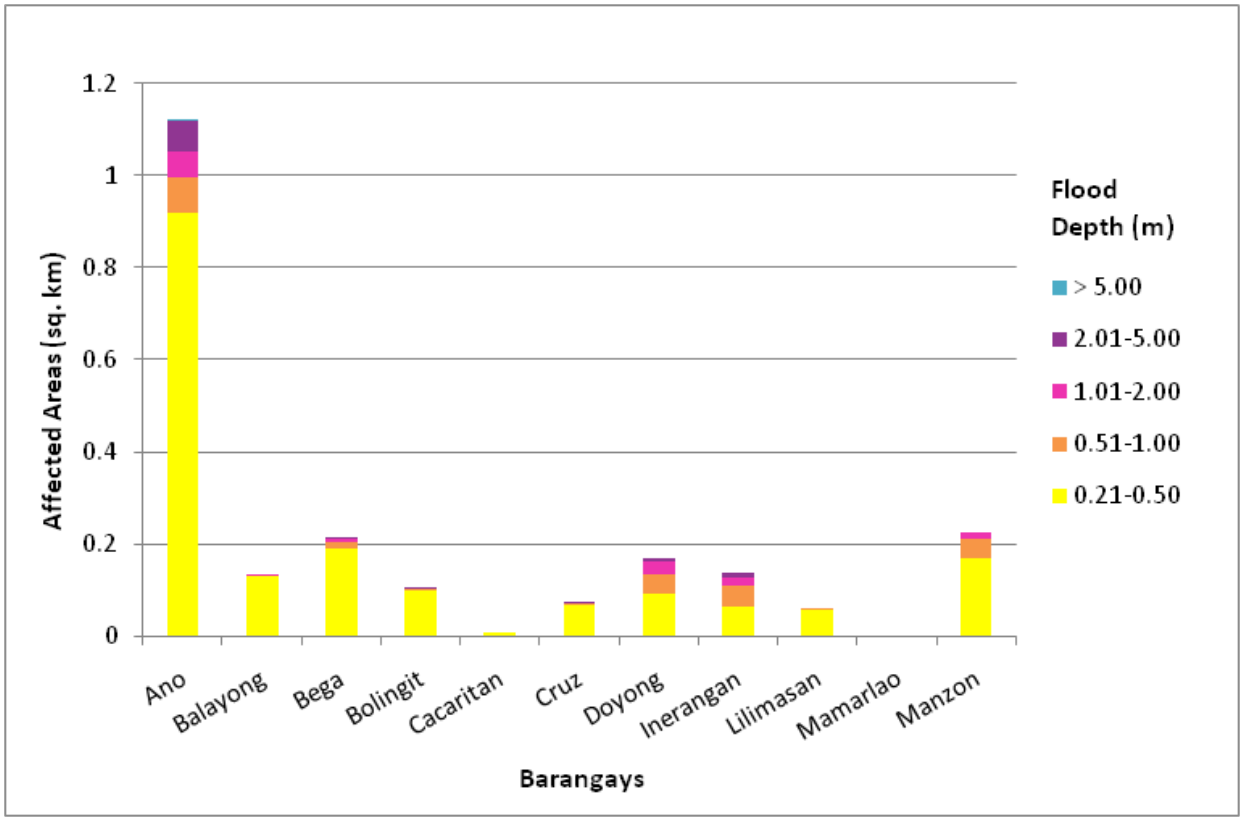
Figure. 86. Affected Areas in Mapandan, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 12.95% of the municipality of San Carlos City with an area of 151.284206 sq. km. will experience flood levels of less than 0.20 meters. 2.34% of the area will experience flood levels of 0.21 to 0.50 meters while 0.26%, 0.13%, and 0.08% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 23. Affected Areas in San Carlos City, Pangasinan during 5-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Carlos City (in sq. km)										
	Ano	Balayong	Bega	Bolingit	Cacaritan	Cruz	Doyong	Inerangan	Lilimasan	Mamarlao	Manzon
0.03-0.20	1.74	0.85	1.15	0.72	0.17	0.57	0.85	0.46	0.31	6.2E-06	0.75
0.21-0.50	0.92	0.13	0.19	0.1	0.0074	0.066	0.092	0.064	0.058	0	0.17
0.51-1.00	0.078	0.0042	0.013	0.0037	0	0.0084	0.04	0.046	0.00032	0	0.04
1.01-2.00	0.054	0.0003	0.0093	0.00068	0	0.0009	0.03	0.016	0	0	0.014
2.01-5.00	0.068	0	0.00034	0.000084	0	0.0001	0.007	0.01	0	0	0
> 5.00	0.0042	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Carlos City (in sq. km)									
	Matagdem	Naguilayan	Nilentap	Pagal	Palaming	Pangalangan	Parayao	Quintong	Tandoc	Tarece
0.03-0.20	1.79	0.57	0.85	2.12	1.97	1.67	0.45	0.73	0.84	1.03
0.21-0.50	0.22	0.051	0.12	0.33	0.22	0.27	0.045	0.19	0.13	0.17
0.51-1.00	0.037	0.002	0.012	0.02	0.026	0.046	0.0048	0.0074	0.00056	0.00027
1.01-2.00	0.012	0.0023	0.033	0.0049	0.0061	0.0097	0.0004	0	0.0001	0
2.01-5.00	0.00076	0.0007	0.035	0.0002	0	0.0011	0	0	0.0016	0
> 5.00	0	0	0	0	0	0	0	0	0	0



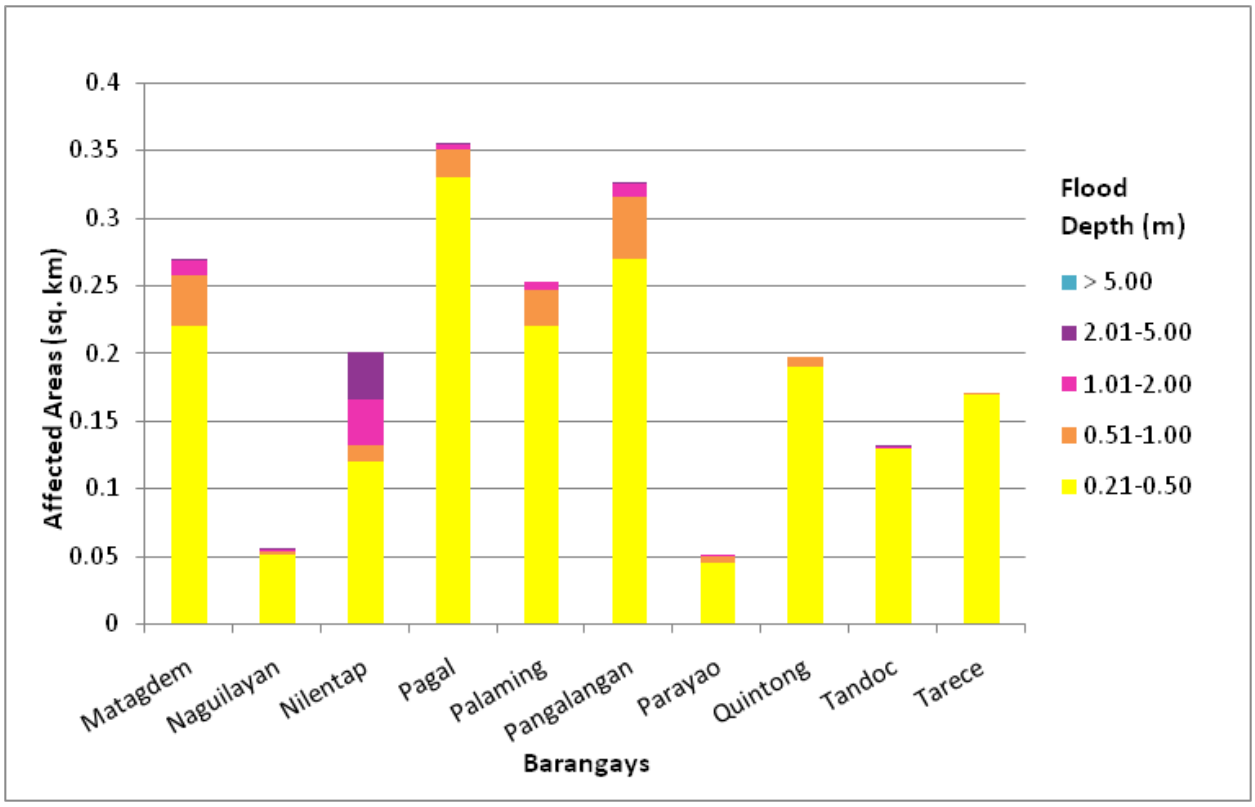


Figure. 87. Affected Areas in San Carlos City, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 0.04% of the municipality of San Fabian with an area of 69.270236 sq. km. will experience flood levels of less than 0.20 meters. 0.00% of the area will experience flood levels of 0.21 to 0.50 meters while 0.00% of the area will experience flood depths of 0.51 to 1 meter. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 24. Affected Areas in San Fabian, Pangasinan during 5-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Fabian (in sq. km)	
	Lekep-Butao	Longos
0.03-0.20	0.024	0.0039
0.21-0.50	0.0003	0
0.51-1.00	0	0
1.01-2.00	0	0
2.01-5.00	0	0
> 5.00	0	0

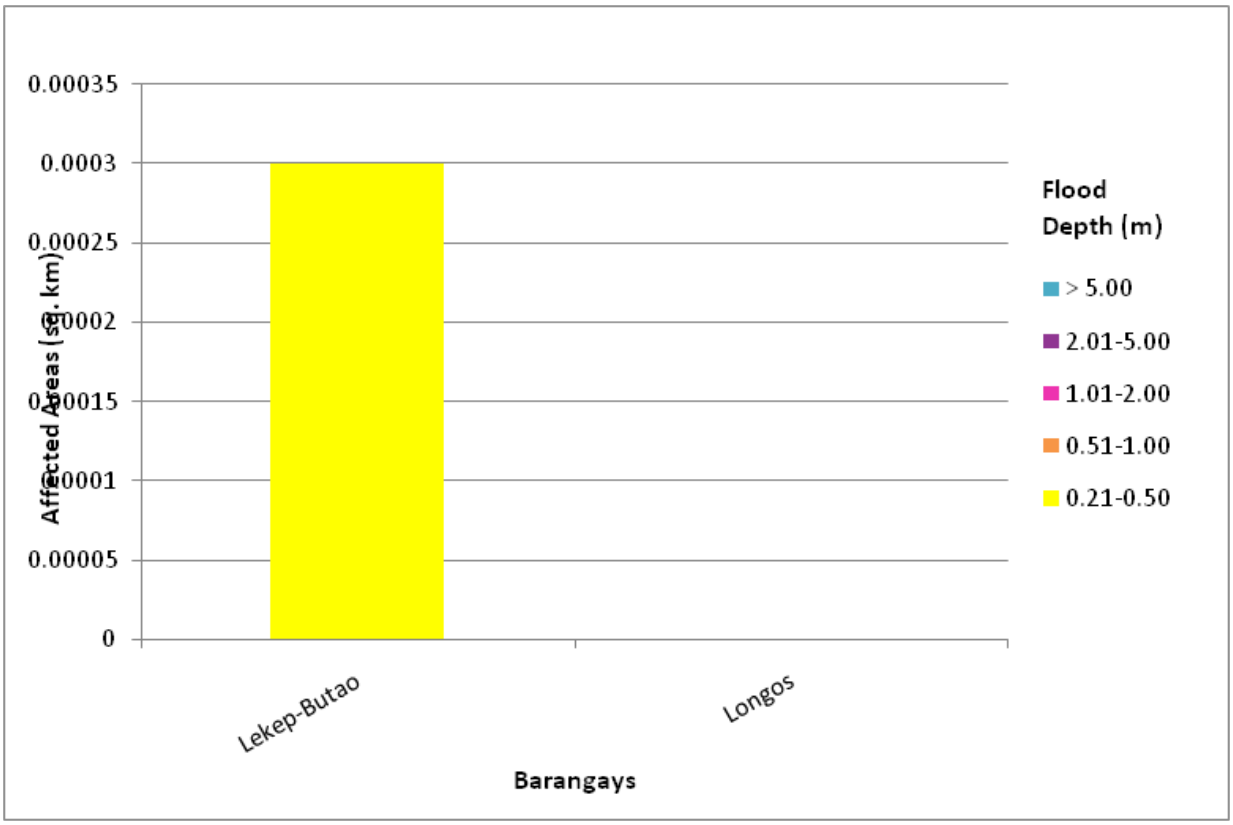


Figure. 88. Affected Areas in San Fabian, Pangasinan during 5-Year Rainfall Return Period

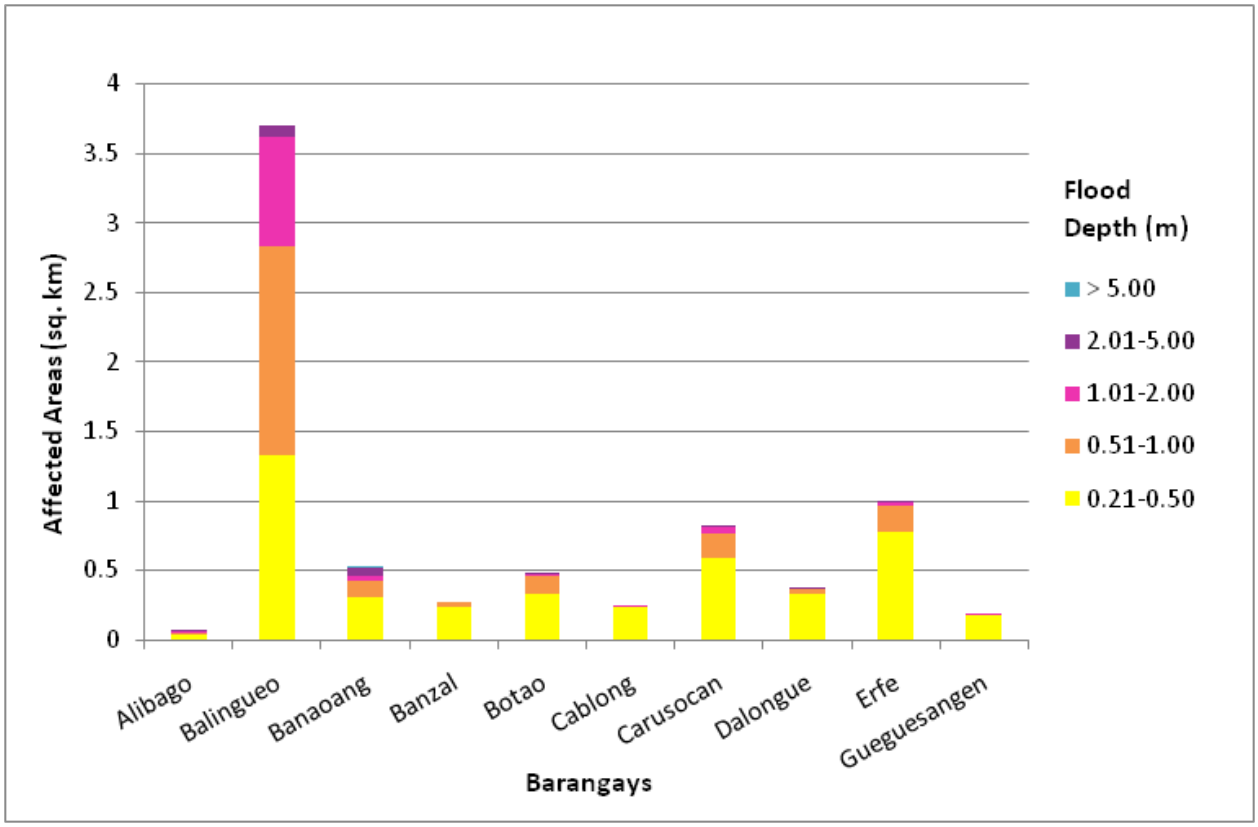
For the 5-year return period, 58.23% of the municipality of Santa Barbara with an area of 64.714151 sq. km. will experience flood levels of less than 0.20 meters. 20.62% of the area will experience flood levels of 0.21 to 0.50 meters while 13.63%, 4.81%, 2.38%, and 0.27% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

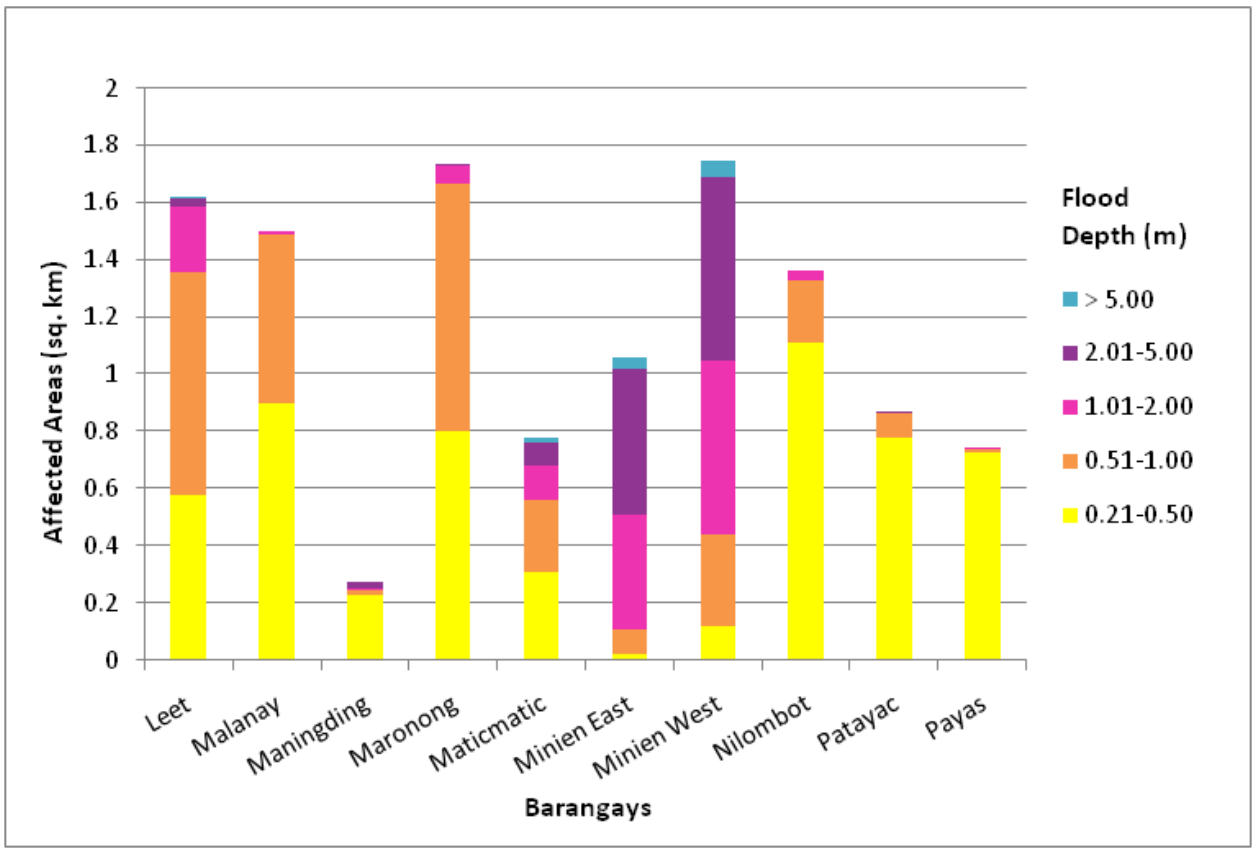
Table 25. Affected Areas in Santa Barbara, Pangasinan during 5-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Santa Barbara (in sq. km)									
	Alibago	Balingueo	Banaoang	Banzal	Botao	Cablong	Carusocan	Dalongue	Erfe	Gueguesangen
0.03-0.20	0.38	1.89	1.66	0.83	2.21	1.54	2.22	0.75	1.94	1.81
0.21-0.50	0.043	1.33	0.3	0.23	0.33	0.24	0.59	0.33	0.78	0.18
0.51-1.00	0.0062	1.5	0.12	0.037	0.13	0.0055	0.17	0.043	0.18	0.0054
1.01-2.00	0.0041	0.78	0.034	0	0.019	0.0001	0.06	0.0015	0.039	0.0001
2.01-5.00	0.016	0.085	0.066	0	0.0025	0	0.00076	0.0043	0.0022	0
> 5.00	0	0	0.0034	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Santa Barbara (in sq. km)									
	Leet	Malanay	Maningding	Maronong	Maticmatic	Minien East	Minien West	Nilombot	Patayac	Payas
0.03-0.20	0.81	0.38	1.4	1.45	0.68	0.026	0.41	3.38	2.2	2.99
0.21-0.50	0.58	0.9	0.23	0.8	0.31	0.021	0.12	1.11	0.78	0.73
0.51-1.00	0.78	0.59	0.015	0.87	0.25	0.087	0.32	0.22	0.088	0.016
1.01-2.00	0.23	0.014	0.0043	0.068	0.12	0.4	0.61	0.035	0.0033	0.0013
2.01-5.00	0.033	0	0.028	0.00026	0.084	0.51	0.64	0	0.0002	0
> 5.00	0.0001	0	0	0	0.016	0.041	0.055	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Santa Barbara (in sq. km)								
	Poblacion Norte	Poblacion Sur	Primicias	Sapang	Sonquil	Tebag East	Tebag West	Tuliao	Ventinilla
0.03-0.20	0.29	0.36	0.24	1.28	0.76	0.81	0.64	1.68	2.67
0.21-0.50	0.089	0.068	0.054	0.37	1.2	0.36	0.24	0.4	0.63
0.51-1.00	0.052	0.01	0.0097	0.069	2.55	0.32	0.13	0.034	0.21
1.01-2.00	0.0019	0.0047	0.0016	0.013	0.34	0.18	0.12	0.0009	0.029
2.01-5.00	0.0065	0.0032	0	0.0025	0.028	0.016	0.011	0.0019	0.0021
> 5.00	0	0	0	0	0	0.025	0.033	0	0


Affected Areas (sq. km)
4
3.5
3
2.5
2
1.5
1
0.5
0
Alibago
Balingueo
Banaoang
Banzal
Botao
Cablong
Carusocan
Dalongue
Erfe
Gueguesangen
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50


Affected Areas (sq. km)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Leet
Malanay
Maningding
Maronong
Maticmatic
Minien East
Minien West
Nilombot
Patayac
Payas
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50

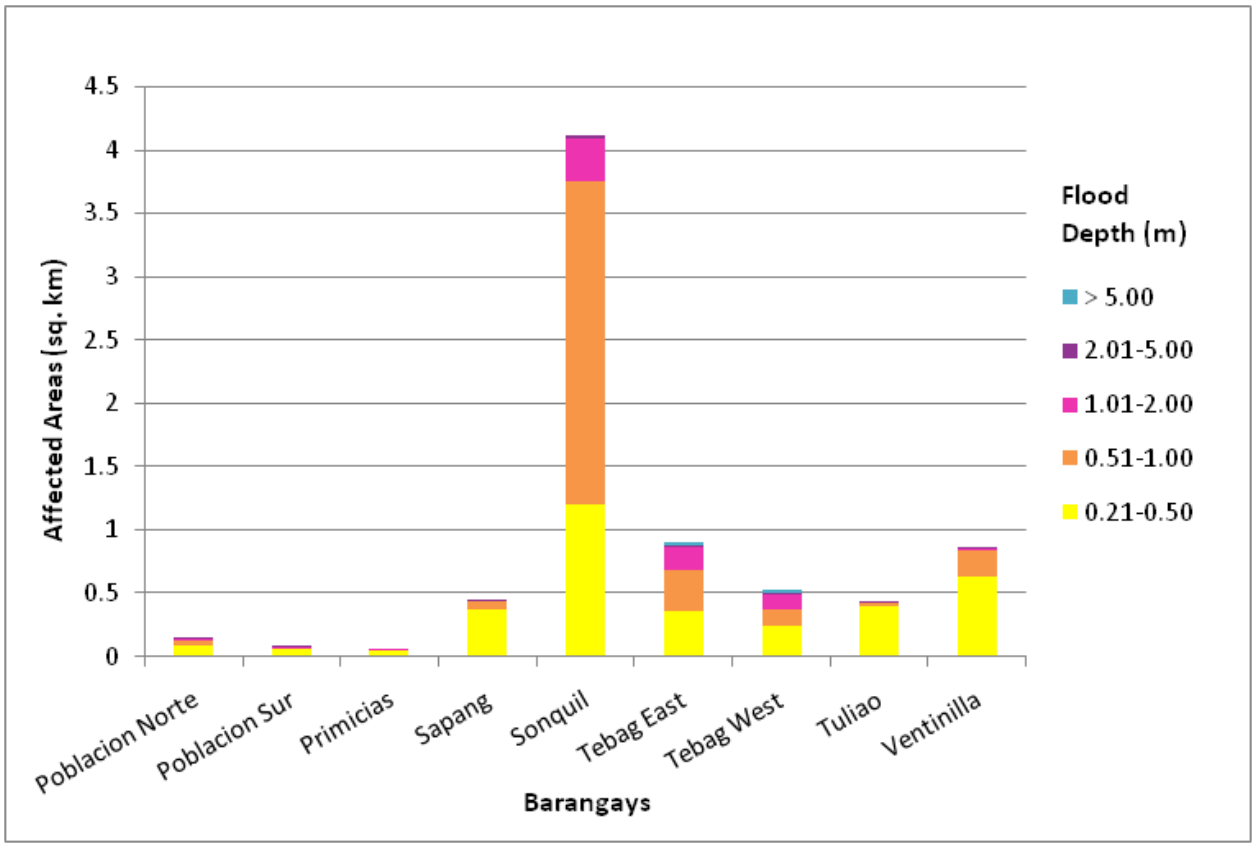


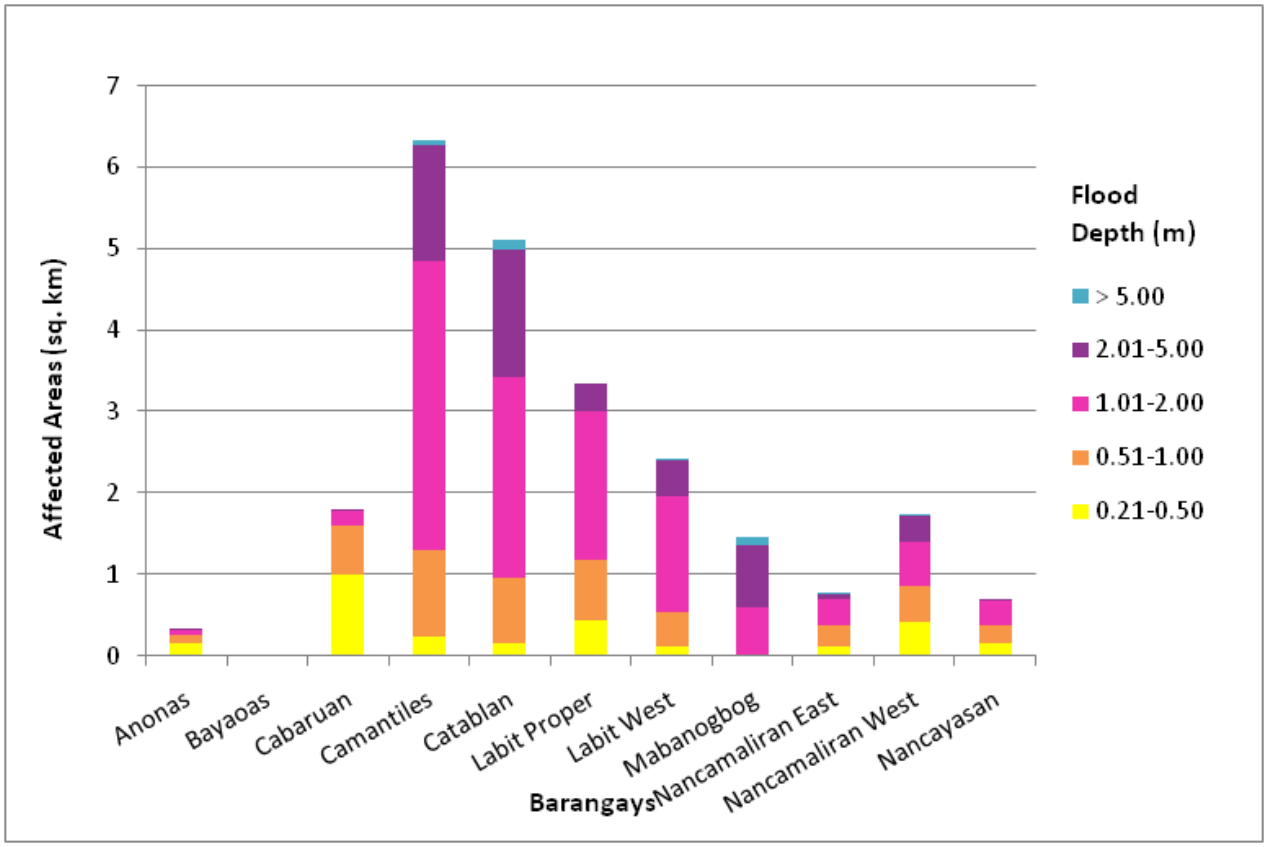
Figure. 89. Affected Areas in Santa Barbara, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 13.06% of the municipality of Urdaneta City with an area of 107.789848 sq. km. will experience flood levels of less than 0.20 meters. 6.03% of the area will experience flood levels of 0.21 to 0.50 meters while 9.35%, 20.48%, 7.51%, and 0.51% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 26. Affected Areas in Urdaneta City, Pangasinan during 5-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Urdaneta City (in sq. km)										
	Anonas	Bayaoas	Cabaruan	Camantiles	Catablan	Labit Proper	Labit West	Mabanogbog	Nancamaliran East	Nancamaliran West	Nancayasan
0.03-0.20	0.48	0.0093	3.37	0.12	0.34	0.4	0.061	0.0083	0.053	0.19	0.75
0.21-0.50	0.16	0.0041	1.01	0.24	0.17	0.44	0.12	0.0051	0.12	0.43	0.17
0.51-1.00	0.11	0.00027	0.59	1.06	0.79	0.75	0.43	0.016	0.27	0.44	0.22
1.01-2.00	0.057	0	0.19	3.56	2.46	1.82	1.42	0.59	0.31	0.53	0.32
2.01-5.00	0.022	0	0.019	1.42	1.58	0.33	0.44	0.76	0.072	0.33	0.00025
> 5.00	0	0	0	0.058	0.11	0	0.013	0.086	0.0081	0.017	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Urdaneta City (in sq. km)										
	Oltama	Palina East	Palina West	Pinmaludpod	Poblacion	San Jose	San Vicente	Santa Lucia	Santo Domingo	Sugcong	Tulong
0.03-0.20	2.42	0.81	1.15	1.84	0.061	0.42	0.021	0.022	0.0042	1.36	0.19
0.21-0.50	0.41	0.36	0.53	0.89	0.14	0.32	0.049	0.068	0.043	0.68	0.14
0.51-1.00	0.42	0.2	0.58	1.32	0.54	0.61	0.3	0.34	0.27	0.7	0.12
1.01-2.00	0.31	0.2	0.61	5.06	0.86	1.81	0.55	0.49	0.32	0.31	0.3
2.01-5.00	0.008	0	0	1.51	0.14	0.57	0.14	0	0	0.082	0.67
> 5.00	0	0	0	0.17	0.027	0.035	0.014	0	0	0	0.014



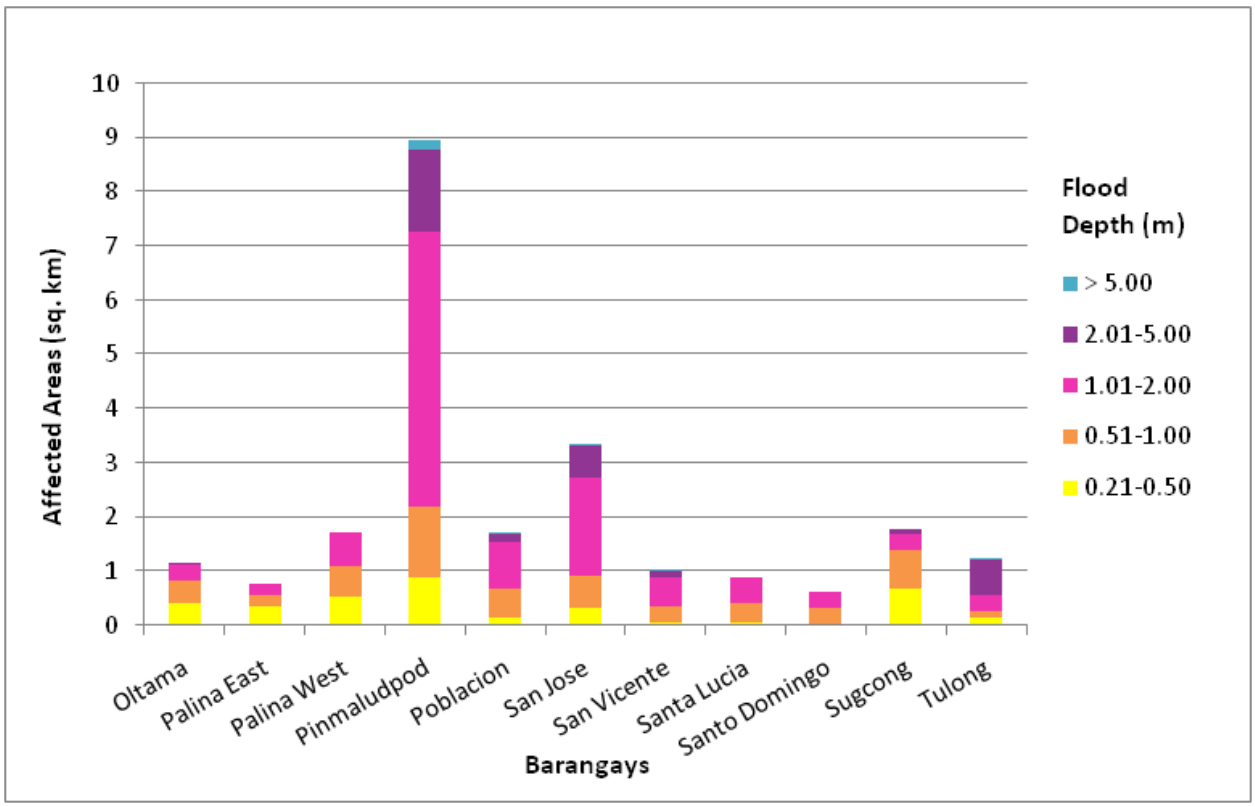


Figure. 90. Affected Areas in Urdaneta City, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 11.24% of the municipality of Villasis with an area of 76.039344 sq. km. will experience flood levels of less than 0.20 meters. 3.10% of the area will experience flood levels of 0.21 to 0.50 meters while 3.82%, 2.42%, and 0.14% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 27. Affected Areas in Villasis, Pangasinan during 5-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Villasis (in sq. km)					
	Barraca	Capulaan	La Paz	Labit	Tombod	Unzad
0.03-0.20	0.55	0.29	2.99	1.92	0.66	2.14
0.21-0.50	0.92	0.11	0.19	0.31	0.53	0.3
0.51-1.00	1.1	0.073	0.13	0.38	1.07	0.15
1.01-2.00	0.62	0.0096	0.05	0.12	0.99	0.051
2.01-5.00	0.036	0.0001	0.0056	0.0065	0.058	0.002
> 5.00	0	0	0	0.0006	0	0

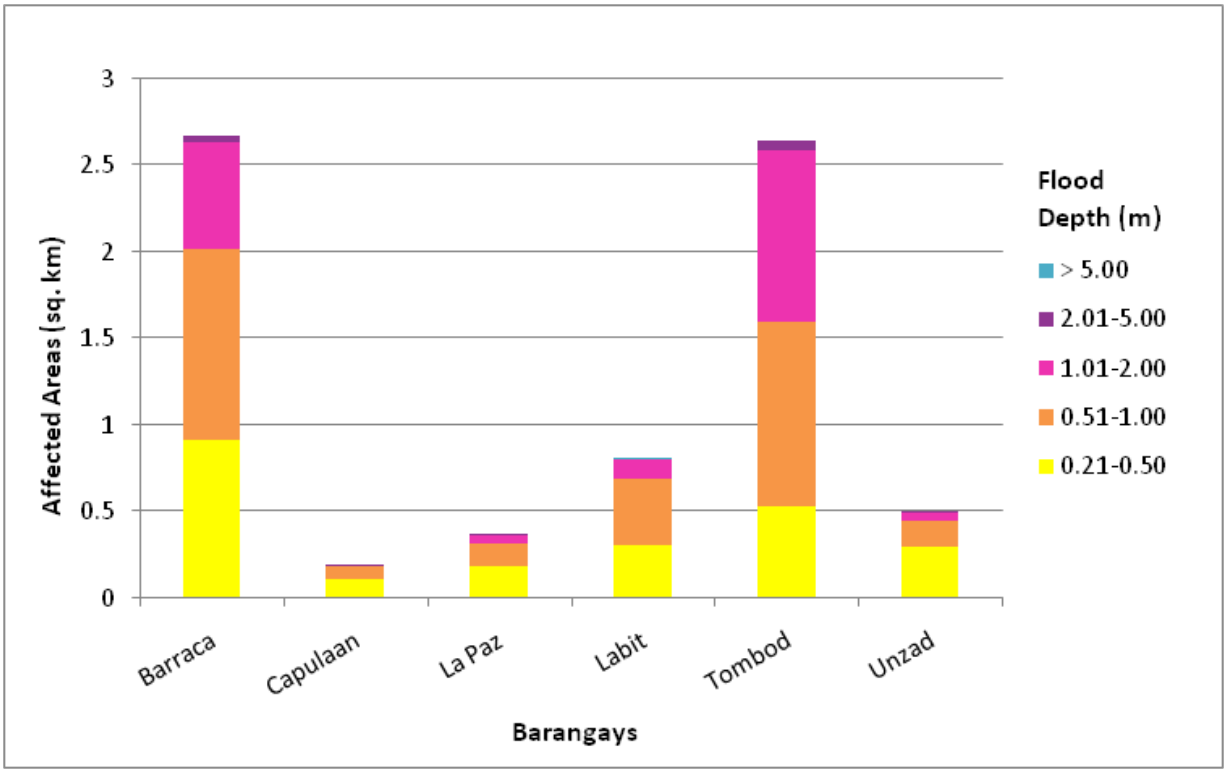


Figure. 91. Affected Areas in Villasis, Pangasinan during 5-Year Rainfall Return Period

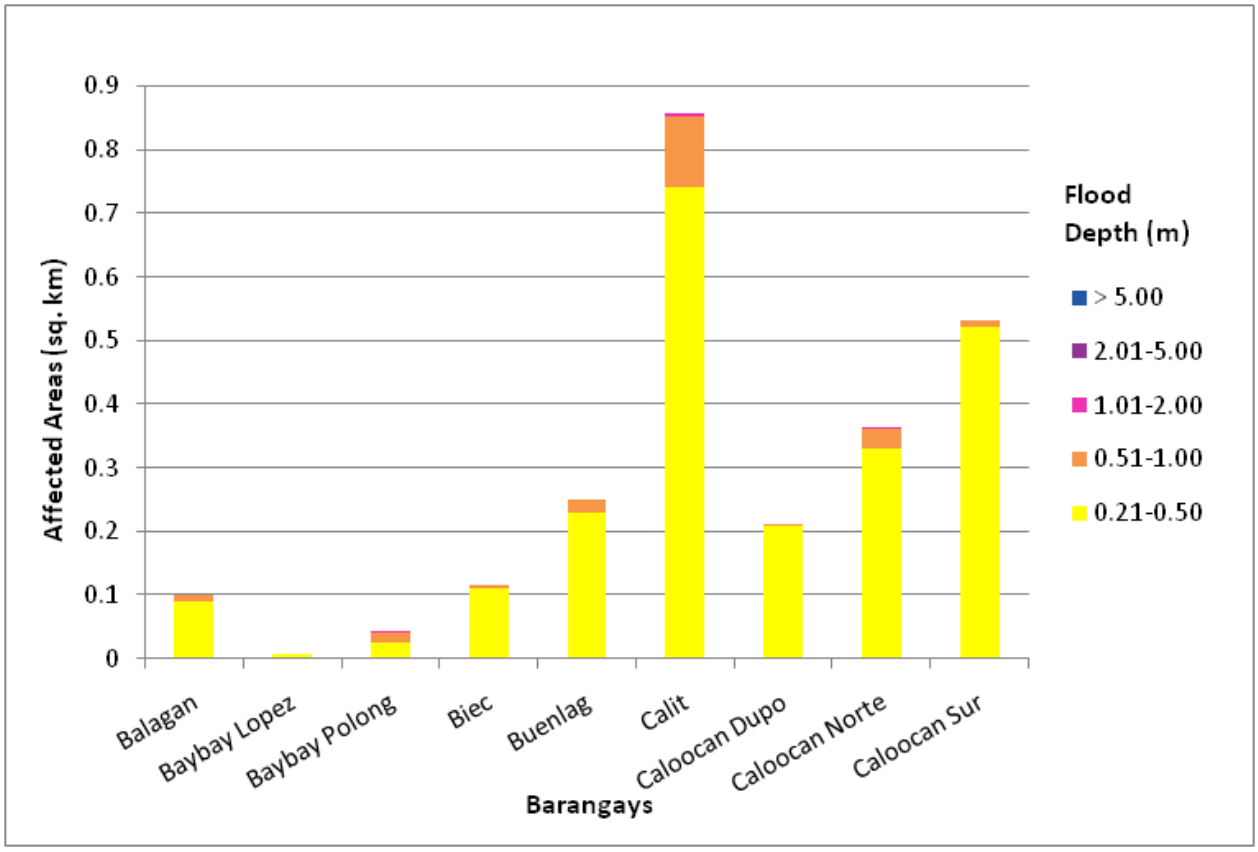
For the 25-year return period, 36.05% of the municipality of Binmaley with an area of 61.839261 sq. km. will experience flood levels of less than 0.20 meters. 16.55% of the area will experience flood levels of 0.21 to 0.50 meters while 1.84% and 0.12% of the area will experience flood depths of 0.51 to 1 meter and 1.01 to 2 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

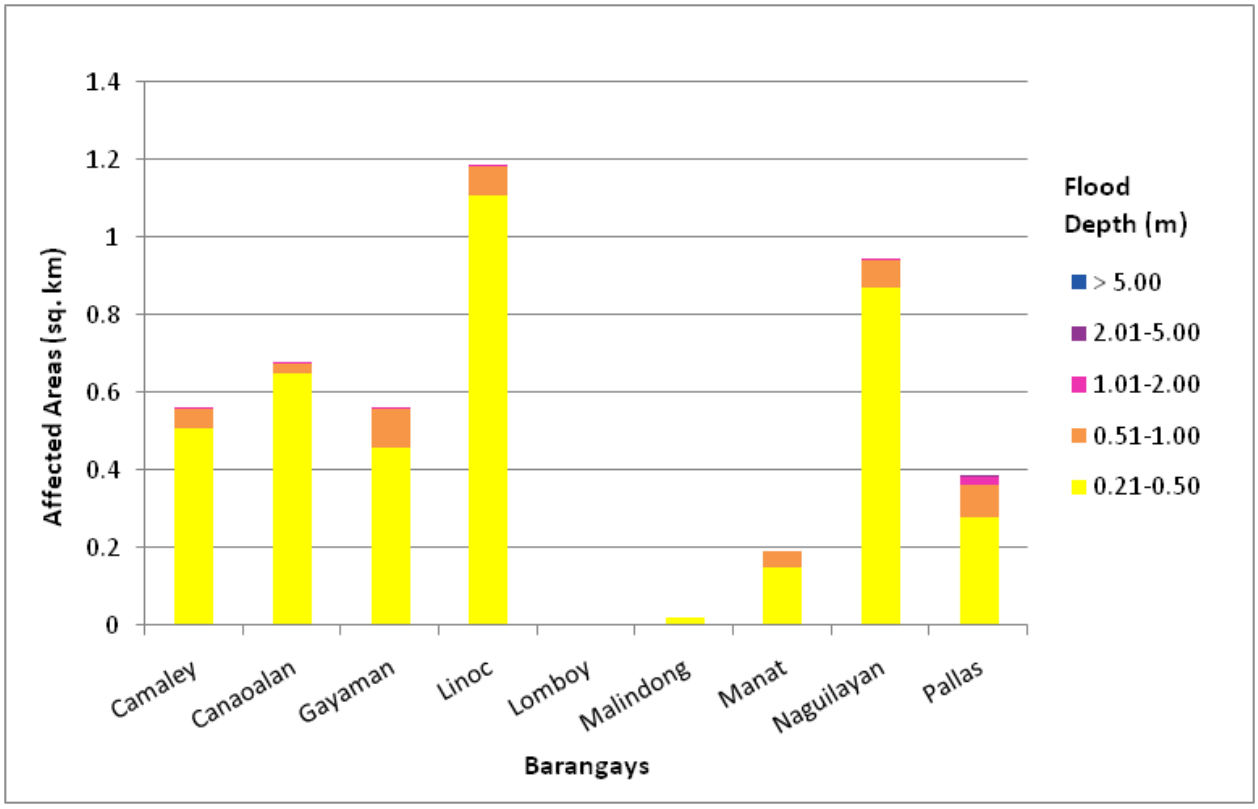
Table 28. Affected Areas in Binmaley, Pangasinan during 25-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binmaley (in sq. km)								
	Balagan	Baybay Lopez	Baybay Polong	Biec	Buenlag	Calit	Caloocan Dupo	Caloocan Norte	Caloocan Sur
0.03-0.20	0.15	0.045	0.15	0.52	0.58	1.39	0.48	0.72	1.11
0.21-0.50	0.091	0.0088	0.027	0.11	0.23	0.74	0.21	0.33	0.52
0.51-1.00	0.009	0	0.017	0.0071	0.021	0.11	0.0003	0.034	0.011
1.01-2.00	0	0	0.0004	0	0	0.0055	0	0.0004	0
2.01-5.00	0	0	0	0	0	0	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binmaley (in sq. km)								
	Camaley	Canaoalan	Gayaman	Linoc	Lomboy	Malindong	Manat	Naguilayan	Pallas
0.03-0.20	0.96	1.6	0.86	3.45	0.019	0.18	0.3	1.53	0.54
0.21-0.50	0.51	0.65	0.46	1.11	0.0001	0.019	0.15	0.87	0.28
0.51-1.00	0.053	0.029	0.099	0.077	0	0	0.04	0.075	0.083
1.01-2.00	0.0004	0.0002	0.0035	0.0001	0	0	0	0.0029	0.022
2.01-5.00	0	0	0	0	0	0	0	0	0.0018
> 5.00	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binmaley (in sq. km)								
	Papagueyan	Parayao	Poblacion	Sabangan	Salapingao	San Isidro Norte	San Isidro Sur	Santa Rosa	Tombor
0.03-0.20	1.1	0.72	0.89	0.31	1.42	0.59	0.4	0.82	1.46
0.21-0.50	0.5	0.55	0.28	0.15	0.82	0.29	0.19	0.45	0.69
0.51-1.00	0.063	0.075	0.01	0.0065	0.022	0.027	0.02	0.052	0.2
1.01-2.00	0.0043	0.0062	0.0021	0	0.0006	0.0004	0.00072	0.0024	0.019
2.01-5.00	0	0	0	0	0	0	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0


0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Affected Areas (sq. km)
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50
Balagan
Baybay Lopez
Baybay Polong
Biec
Buenlag
Calit
Caloocan Dupo
Caloocan Norte
Caloocan Sur
Barangays


1.4
1.2
1
0.8
0.6
0.4
0.2
0
Affected Areas (sq. km)
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50
Camaley
Canaoalan
Gayaman
Linoc
Lomboy
Malindong
Manat
Naguilayan
Pallas
Barangays

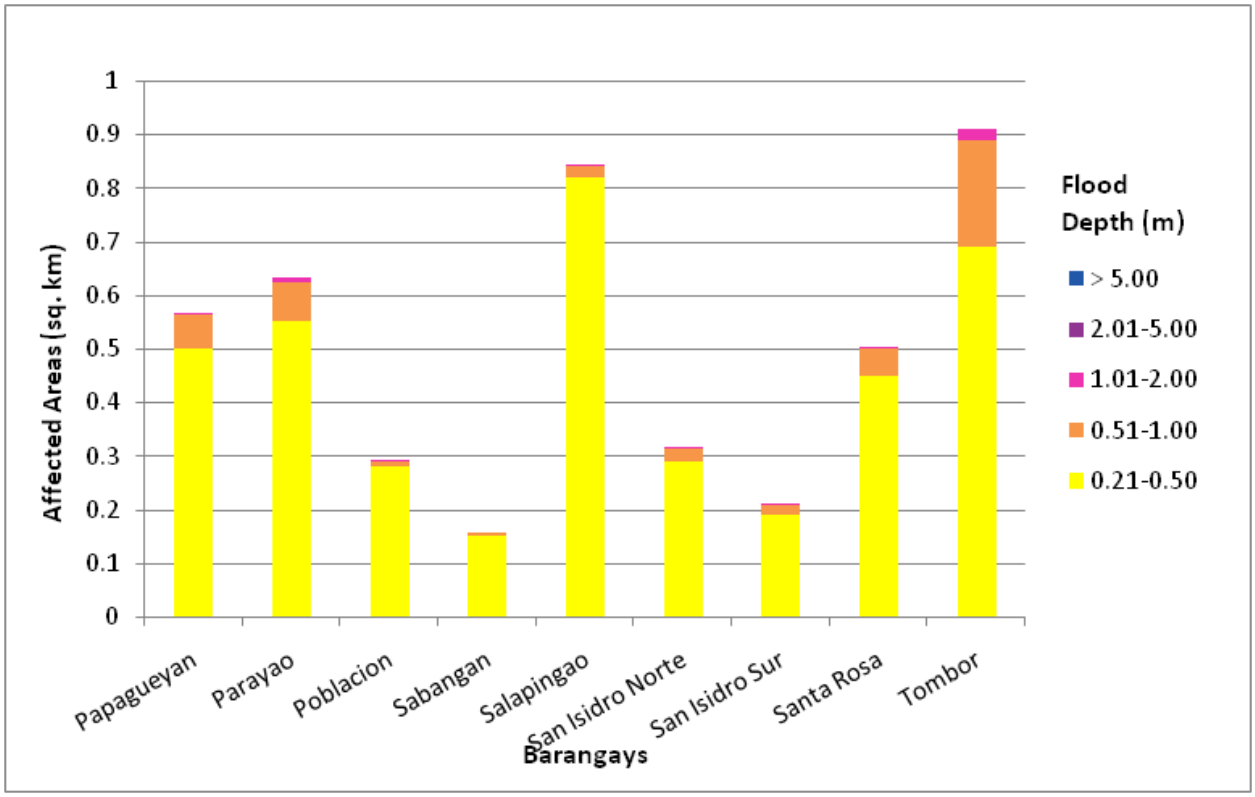


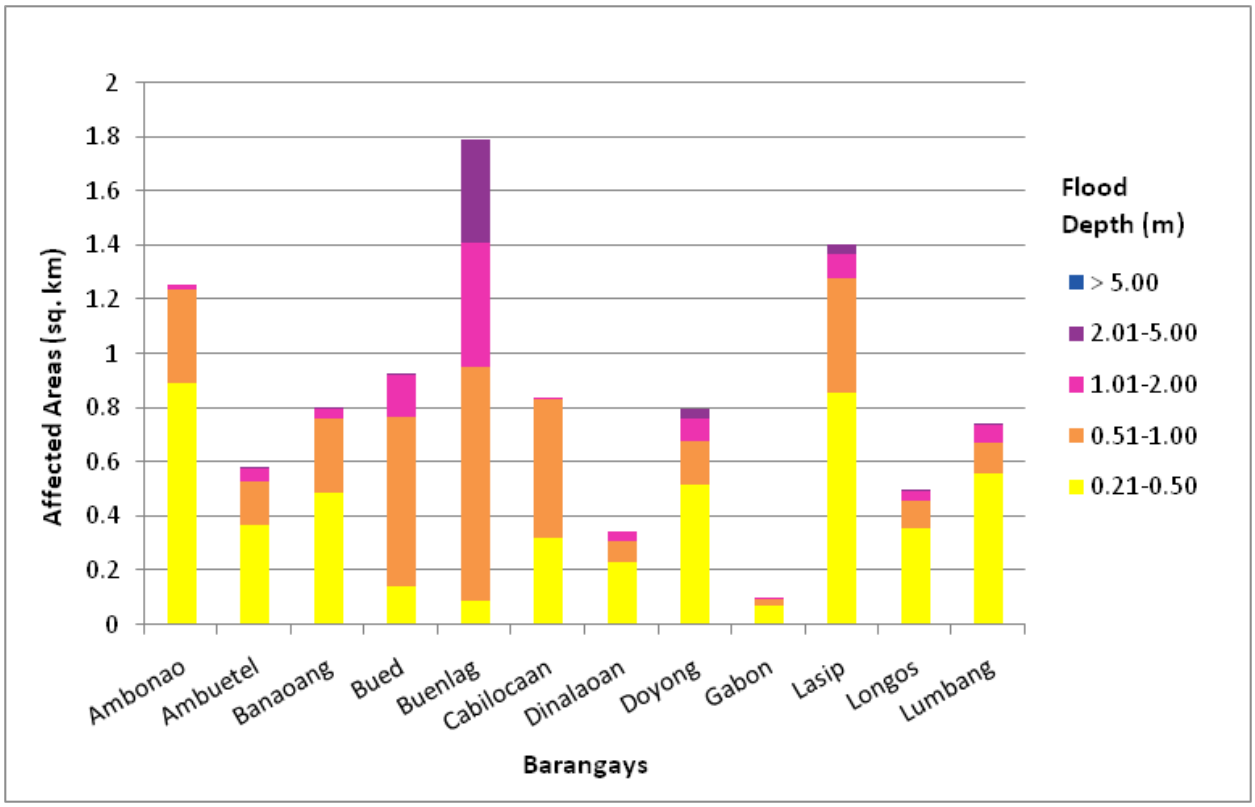
Figure. 92. Affected Areas in Binmaley, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 54.19% of the municipality of Calasiao with an area of 49.196934 sq. km. will experience flood levels of less than 0.20 meters. 20.68% of the area will experience flood levels of 0.21 to 0.50 meters while 15.15%, 6.94%, 3.01%, and 0.01% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 29. Affected Areas in Calasiao, Pangasinan during 25-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Calasiao (in sq. km)											
	Ambonao	Ambuetel	Banaoang	Bued	Buenlag	Cabilocaan	Dinalaoan	Doyong	Gabon	Lasip	Longos	Lumbang
0.03-0.20	1.16	2.12	1.45	0.16	0.068	0.19	1.21	1.98	0.3	2.41	1.22	1.9
0.21-0.50	0.89	0.37	0.49	0.14	0.092	0.32	0.23	0.52	0.073	0.86	0.36	0.56
0.51-1.00	0.35	0.16	0.27	0.63	0.86	0.52	0.082	0.16	0.021	0.42	0.096	0.11
1.01-2.00	0.016	0.054	0.044	0.16	0.46	0.0011	0.036	0.08	0.0094	0.089	0.037	0.073
2.01-5.00	0	0.0004	0.0004	0.0014	0.38	0	0	0.035	0	0.037	0.0086	0.0024
> 5.00	0	0	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Calasiao (in sq. km)											
	Macabito	Malabago	Mancup	Nagsaing	Nalsian	Poblacion East	Poblacion West	Quesban	San Miguel	San Vicente	Songkoy	Talibaew
0.03-0.20	1.39	2.29	0.77	2.18	0.96	0.23	0.29	1.6	0.9	1.21	0.13	0.54
0.21-0.50	0.58	0.73	0.39	0.92	0.35	0.054	0.055	0.69	0.28	0.86	0.13	0.23
0.51-1.00	1.12	0.22	0.85	0.18	0.17	0.025	0.011	0.17	0.11	0.24	0.22	0.46
1.01-2.00	1.39	0.1	0.15	0.051	0.018	0.0033	0.006	0.018	0.012	0.067	0.14	0.4
2.01-5.00	0.18	0.014	0.0004	0.013	0.0027	0	0.000052	0.0055	0	0	0	0.8
> 5.00	0	0	0	0	0	0	0	0.0012	0	0	0	0.006



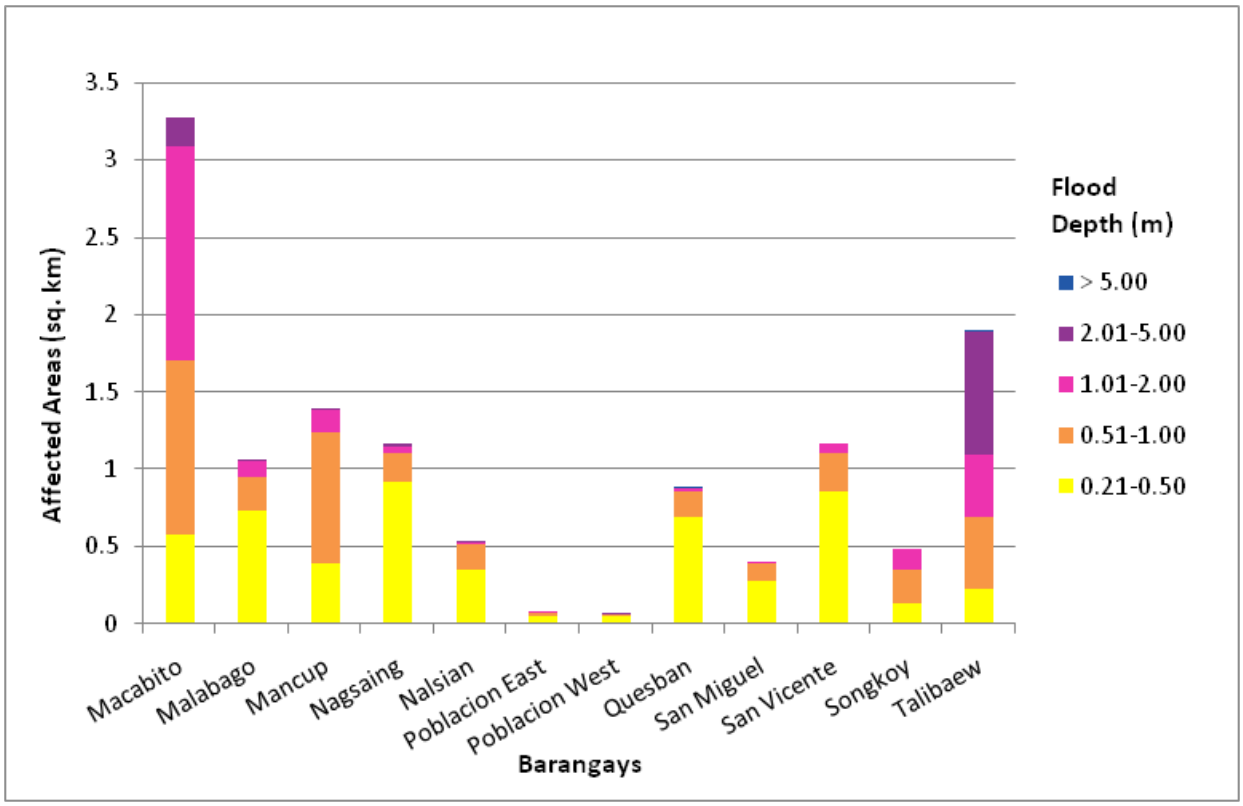


Figure. 93. Affected Areas in Calasiao, Pangasinan during 25-Year Rainfall Return Period

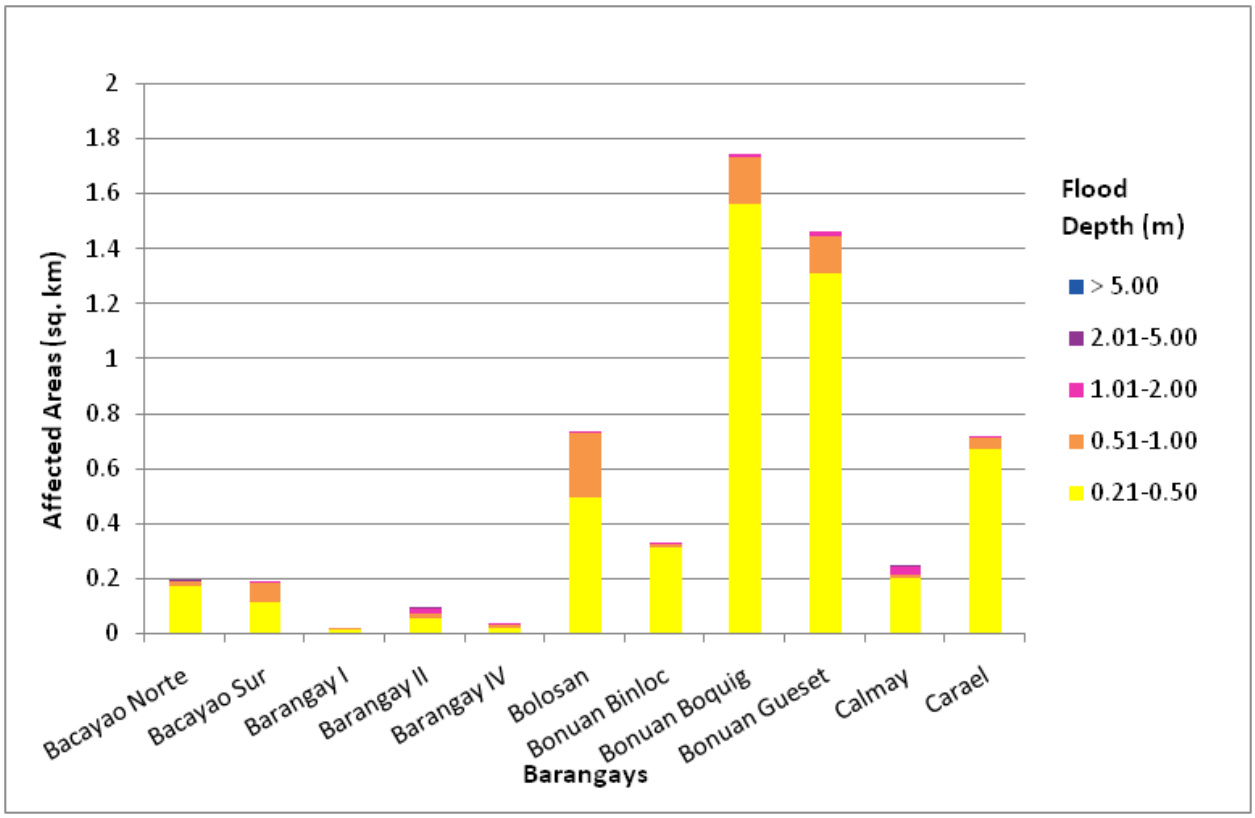
For the 25-year return period, 56.73% of the municipality of Dagupan City with an area of 47.755696 sq. km. will experience flood levels of less than 0.20 meters. 25.05% of the area will experience flood levels of 0.21 to 0.50 meters while 6.30%, 1.62%, and 0.07% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

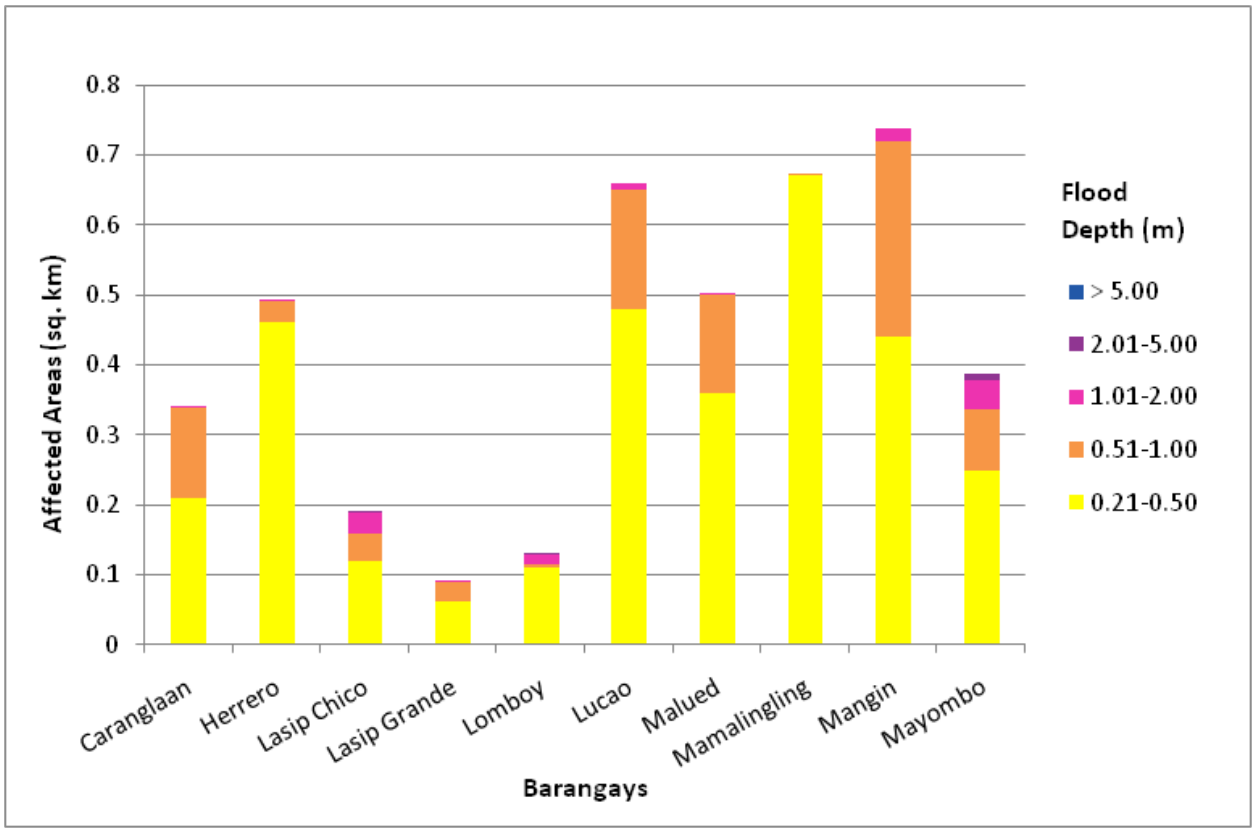
Table 30. Affected Areas in Dagupan City, Pangasinan during 25-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Dagupan City (in sq. km)										
	Bacayao Norte	Bacayao Sur	Barangay I	Barangay II	Barangay IV	Bolosan	Bonuan Binloc	Bonuan Boquig	Bonuan Gueset	Calmay	Carael
0.03-0.20	0.27	0.42	0.1	0.22	0.091	0.69	0.72	3.06	3.2	0.42	1.4
0.21-0.50	0.17	0.11	0.02	0.054	0.02	0.49	0.31	1.56	1.31	0.2	0.67
0.51-1.00	0.026	0.071	0.00012	0.016	0.014	0.24	0.015	0.17	0.13	0.014	0.044
1.01-2.00	0	0.0043	0	0.019	0.0023	0.0025	0.0046	0.011	0.022	0.03	0.0002
2.01-5.00	0.00037	0	0	0.002	0	0	0	0	0	0.0033	0
> 5.00	0	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Dagupan City (in sq. km)									
	Caranglaan	Herrero	Lasip Chico	Lasip Grande	Lomboy	Lucao	Malued	Mamalingling	Mangin	Mayombo
0.03-0.20	0.66	0.75	0.45	0.22	0.43	1.36	1.15	1.49	0.76	0.77
0.21-0.50	0.21	0.46	0.12	0.063	0.11	0.48	0.36	0.67	0.44	0.25
0.51-1.00	0.13	0.032	0.038	0.026	0.0055	0.17	0.14	0.0028	0.28	0.087
1.01-2.00	0.0017	0.00071	0.032	0.0042	0.014	0.01	0.0023	0	0.017	0.04
2.01-5.00	0	0	0.00055	0	0.0011	0	0	0	0	0.01
> 5.00	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Dagupan City (in sq. km)									
	Pantal	Poblacion Oeste	Pogo Chico	Pogo Grande	Pugaro Suit	Salapingao	Salisay	Tambac	Tapuac	Tebeng
0.03-0.20	1.19	0.25	0.29	0.13	1.62	1.5	0.84	1.14	0.43	1.07
0.21-0.50	0.29	0.13	0.084	0.043	0.68	0.55	0.88	0.44	0.24	0.55
0.51-1.00	0.024	0.016	0.0096	0.014	0.012	0.009	1.16	0.03	0.018	0.065
1.01-2.00	0.036	0	0.0069	0.0054	0.0008	0.0032	0.49	0.000077	0	0.012
2.01-5.00	0.0064	0	0.0097	0.000095	0	0	0	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0	0


Affected Areas (sq. km)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Bacayao Norte
Bacayao Sur
Barangay I
Barangay II
Barangay IV
Bolosan
Bonuan Binloc
Bonuan Boquig
Bonuan Gueset
Calmay
Carael
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50


Affected Areas (sq. km)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Caranglaan
Herrero
Lasip Chico
Lasip Grande
Lomboy
Lucao
Malued
Mamalingling
Mangin
Mayombo
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50

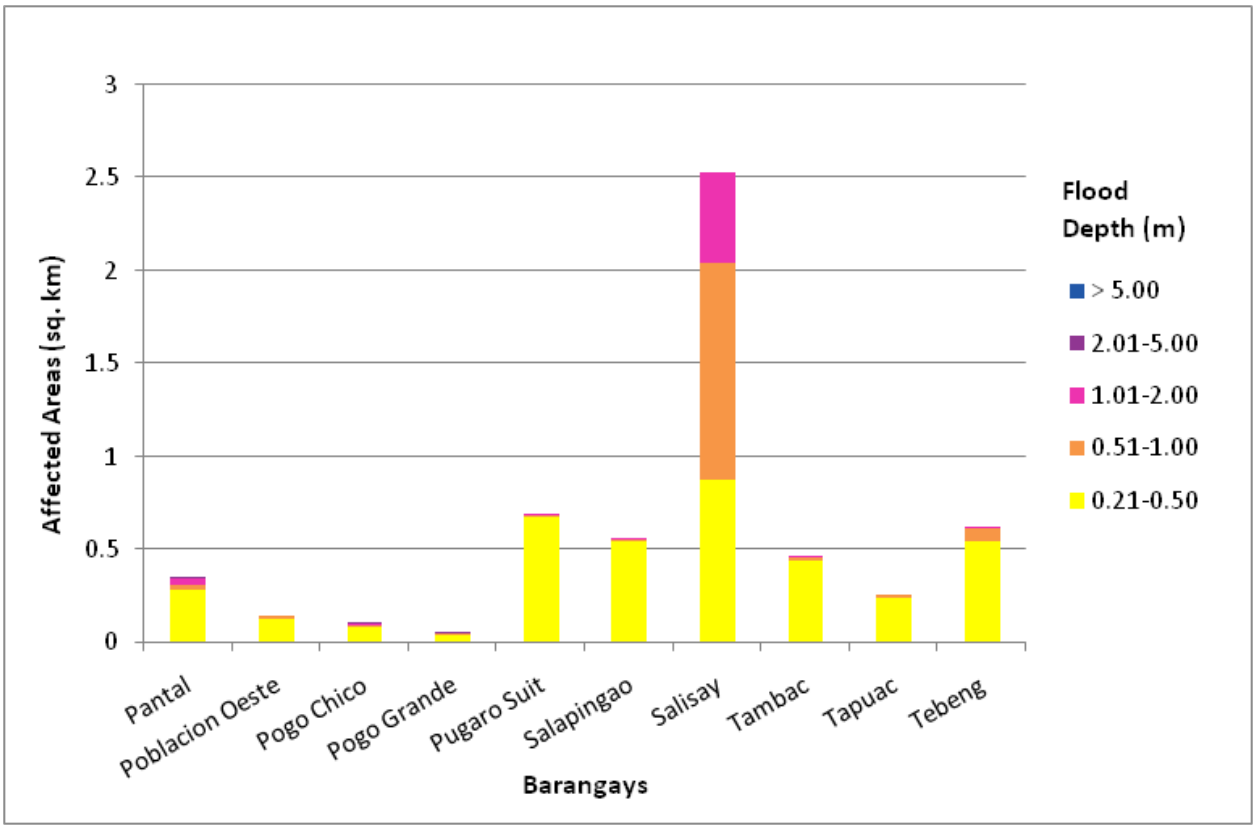


Figure. 94. Affected Areas in Dagupan City, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 0.00% of the municipality of Laoac with an area of 40.697535 sq. km. will experience flood levels of less than 0.20 meters. 0.00% of the area will experience flood levels of 0.21 to 0.50 meters while 0.01%, 0.05%, 0.37%, and 0.13% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 31. Affected Areas in Laoac, Pangasinan during 25-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Laoac (in sq. km)
	Yatyat
0.03-0.20	0.0000029
0.21-0.50	0.00031
0.51-1.00	0.0055
1.01-2.00	0.021
2.01-5.00	0.15
> 5.00	0.053

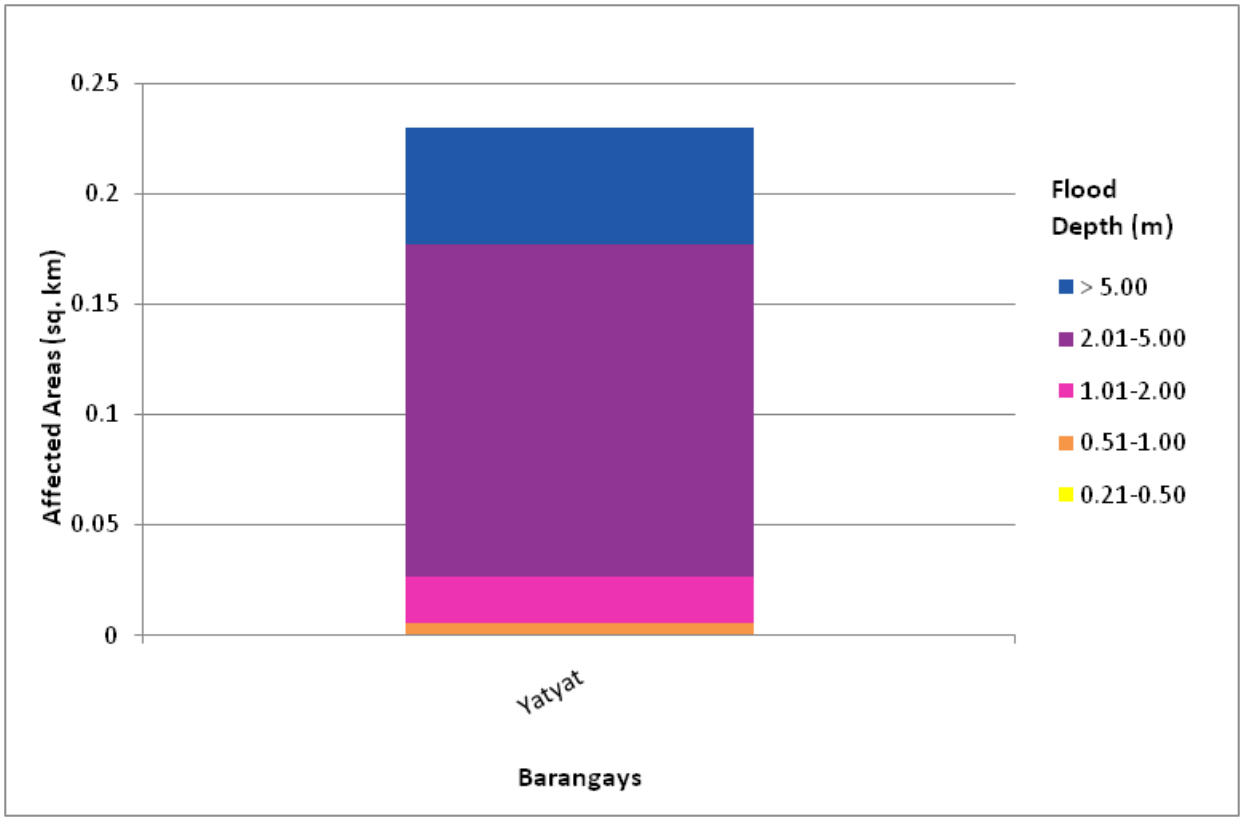


Figure. 95. Affected Areas in Laoac, Pangasinan during 25-Year Rainfall Return Period

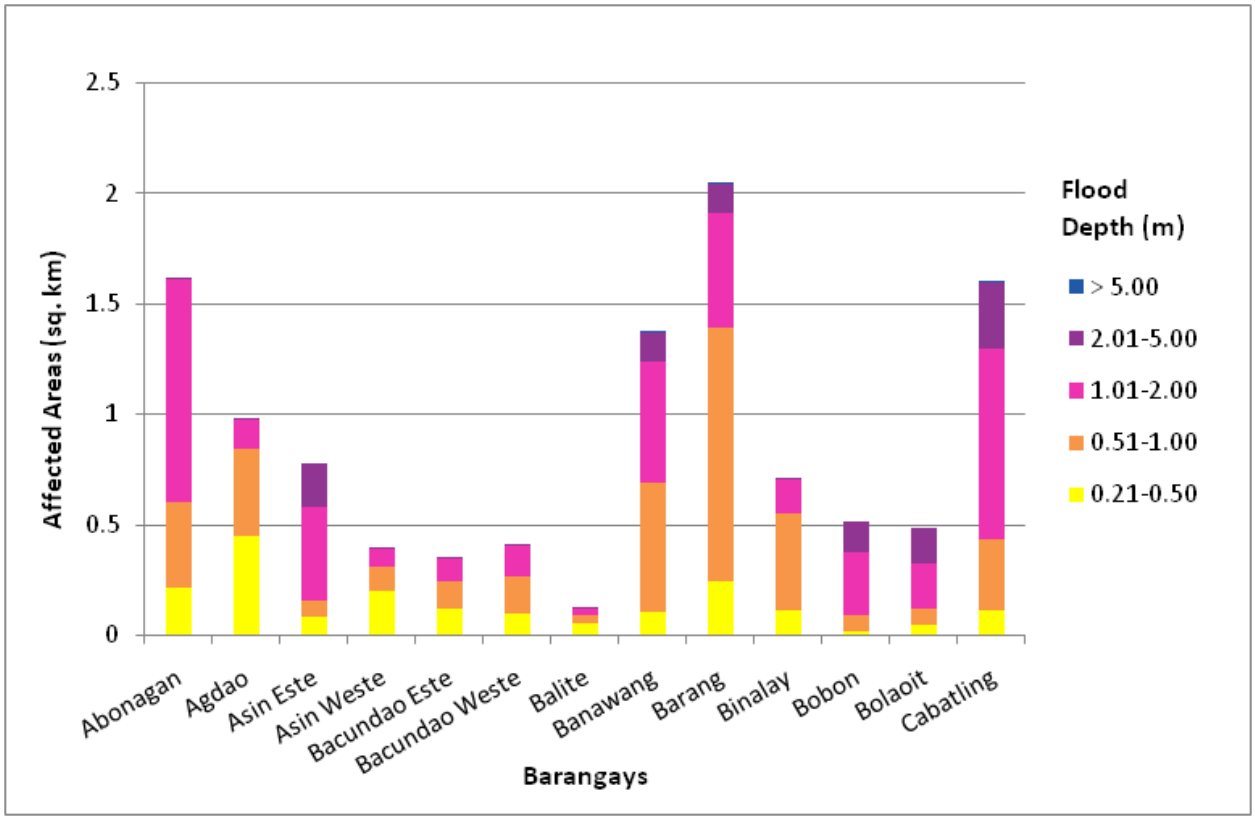
For the 25-year return period, 14.24% of the municipality of Malasiqui with an area of 124.805404 sq. km. will experience flood levels of less than 0.20 meters. 5.60% of the area will experience flood levels of 0.21 to 0.50 meters while 8.25%, 7.22%, 1.49%, and 0.02% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

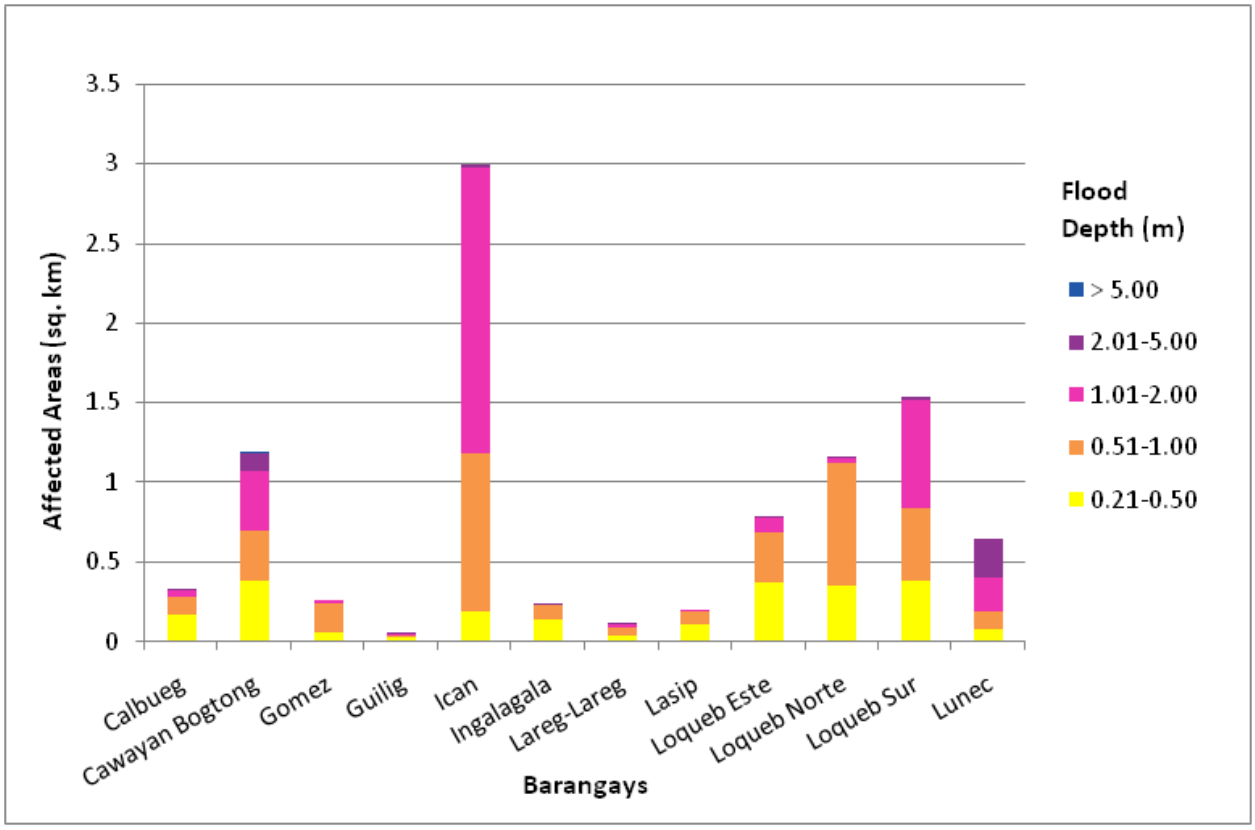
Table 32. Affected Areas in Malasiqui, Pangasinan during 25-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Malasiqui (in sq. km)												
	Abonagan	Agdao	Asin Este	Asin Weste	Bacundao Este	Bacundao Weste	Balite	Banawang	Barang	Binalay	Bobon	Bolaoit	Cabatling
0.03-0.20	0.034	0.9	0.58	1.01	1.93	1.26	0.87	0.027	0.1	0.018	0.0005	0.0064	0.03
0.21-0.50	0.21	0.45	0.082	0.2	0.12	0.095	0.049	0.1	0.24	0.11	0.018	0.046	0.11
0.51-1.00	0.39	0.39	0.074	0.11	0.12	0.17	0.04	0.59	1.15	0.44	0.068	0.068	0.32
1.01-2.00	1.02	0.14	0.42	0.089	0.11	0.14	0.033	0.55	0.52	0.16	0.29	0.21	0.87
2.01-5.00	0.0026	0.003	0.2	0.00035	0.0038	0.0071	0.0045	0.14	0.14	0.0016	0.14	0.16	0.3
> 5.00	0	0	0	0	0	0	0	0.0014	0.0007	0	0	0	0.006

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Malasiqui (in sq. km)											
	Calbueg	Cawayan Bogtong	Gomez	Guilig	Ican	Ingalagala	Lareg-Lareg	Lasip	Loqueb Este	Loqueb Norte	Loqueb Sur	Lunec
0.03-0.20	0.75	1.14	0.038	0.097	0.13	0.096	0.75	0.23	0.89	0.19	0.17	0.55
0.21-0.50	0.17	0.38	0.064	0.027	0.19	0.14	0.039	0.11	0.37	0.35	0.38	0.079
0.51-1.00	0.11	0.32	0.18	0.013	0.99	0.097	0.047	0.093	0.32	0.77	0.46	0.11
1.01-2.00	0.049	0.37	0.021	0.022	1.79	0.0065	0.031	0.0003	0.1	0.041	0.68	0.22
2.01-5.00	0.0008	0.12	0	0.0035	0.023	0.0003	0.0054	0	0.0003	0.0028	0.022	0.24
> 5.00	0	0.0073	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Malasiqui (in sq. km)											
	Manggan-Dampay	Pasima	Poblacion	Polong Norte	Potiocan	Tabo-Sili	Talospatang	Taloy	Taloyan	Tambac	Tolonguat	Viado
0.03-0.20	0.65	0.77	0.068	0.17	0.38	0.54	0.0078	0.5	1.68	0.2	0.93	0.074
0.21-0.50	0.26	0.54	0.13	0.089	0.72	0.027	0.026	0.33	0.089	0.21	0.3	0.14
0.51-1.00	0.3	0.098	0.21	0.083	0.81	0.024	0.16	0.087	0.095	0.51	0.12	0.36
1.01-2.00	0.074	0.028	0.16	0.0034	0.13	0.014	0.18	0.056	0.048	0.38	0	0.053
2.01-5.00	0.0006	0.013	0.064	0	0	0.0001	0.0023	0.077	0.0071	0.17	0	0
> 5.00	0	0	0.0013	0	0	0	0.0004	0	0	0.0063	0	0


2.5
2
1.5
1
0.5
0
Affected Areas (sq. km)
Abonagan
Agdao
Asin Este
Asin Weste
Bacundao Este
Bacundao Weste
Balite
Banawang
Barang
Binalay
Bobon
Bolaoit
Cabatling
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50


3.5
3
2.5
2
1.5
1
0.5
0
Affected Areas (sq. km)
Calbueg
Cawayan Bogtong
Gomez
Guilig
Ican
Ingalagala
Lareg-Lareg
Lasip
Loqueb Este
Loqueb Norte
Loqueb Sur
Lunec
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50

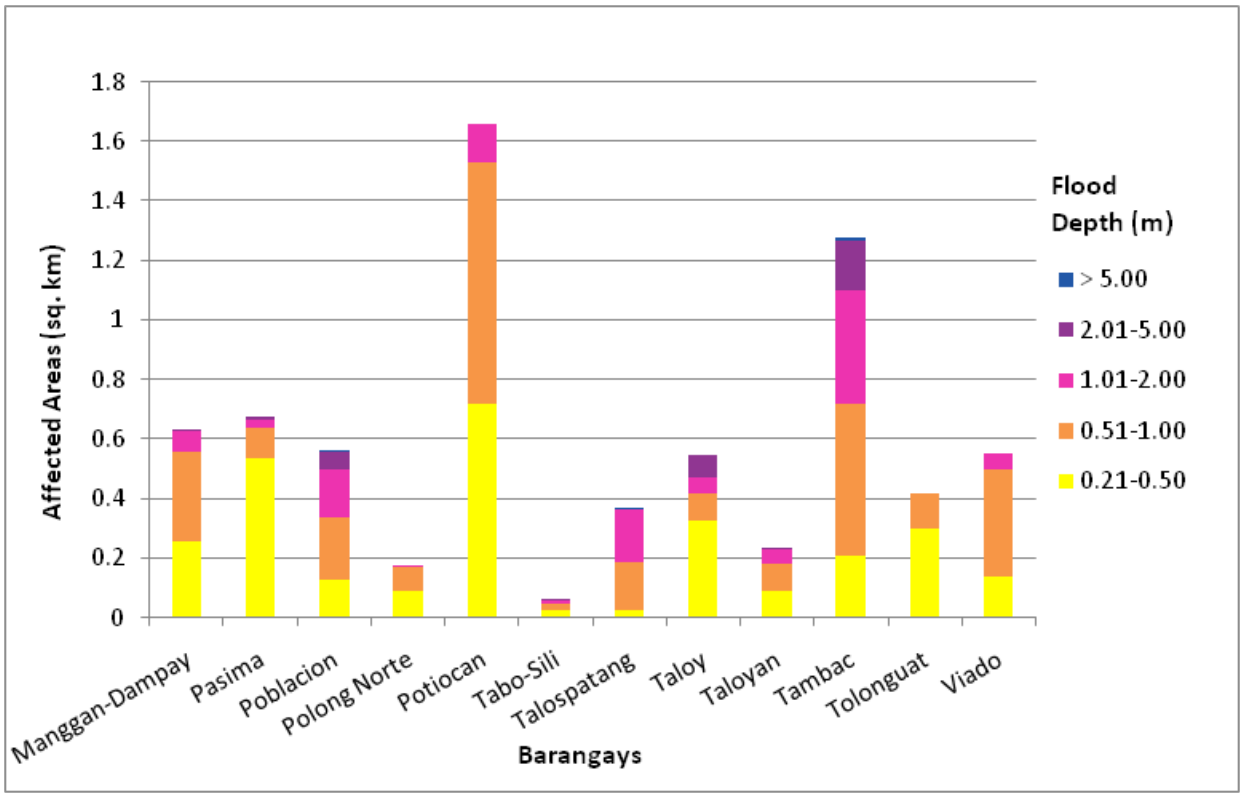


Figure. 96. Affected Areas in Malasiqui, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 0.01% of the municipality of Manaoag with an area of 42.418932 sq. km. will experience flood levels of less than 0.20 meters. 0.02% of the area will experience flood levels of 0.21 to 0.50 meters while 0.28% and 0.15% of the area will experience flood depths of 0.51 to 1 meter and 1.01 to 2 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 33. Affected Areas in Manaoag, Pangasinan during 25-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Manaoag (in sq. km)
	Baguinay
0.03-0.20	0.0042
0.21-0.50	0.0078
0.51-1.00	0.12
1.01-2.00	0.065
2.01-5.00	0
> 5.00	0

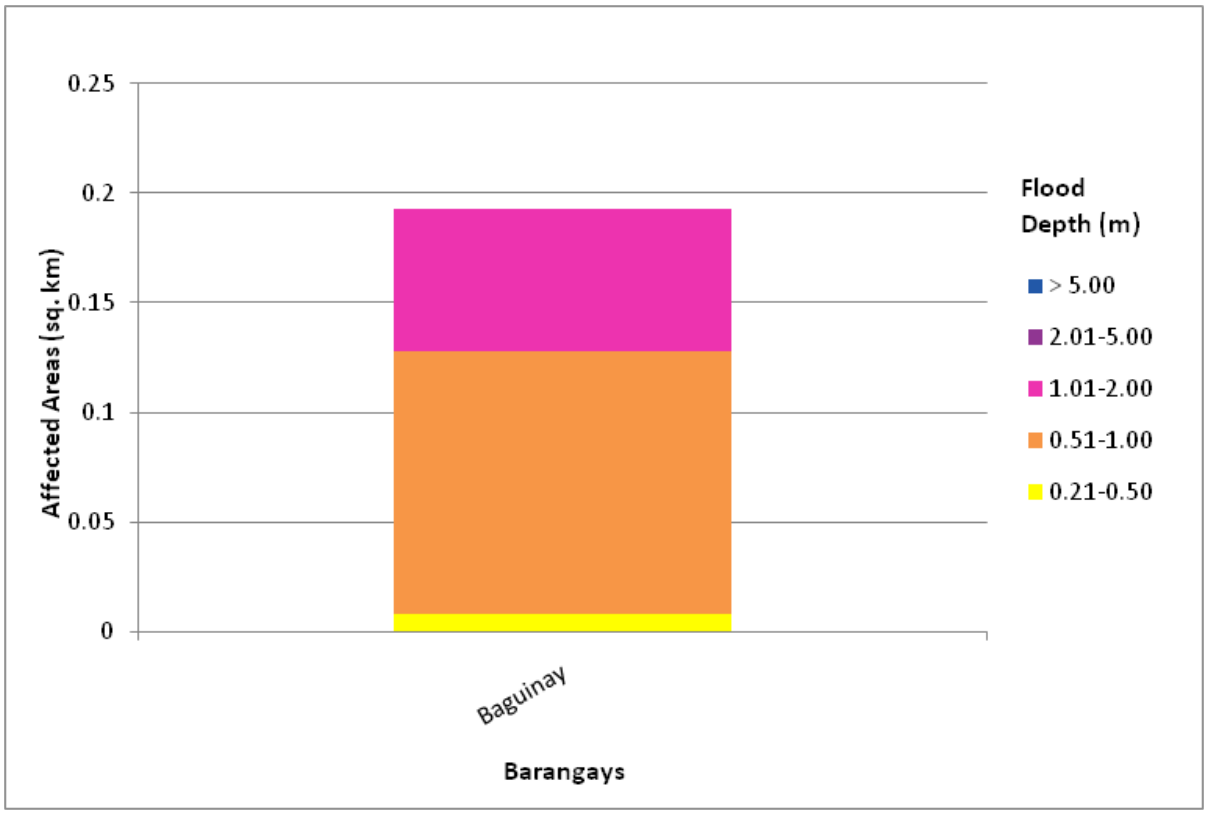


Figure. 97. Affected Areas in Manaoag, Pangasinan during 25-Year Rainfall Return Period

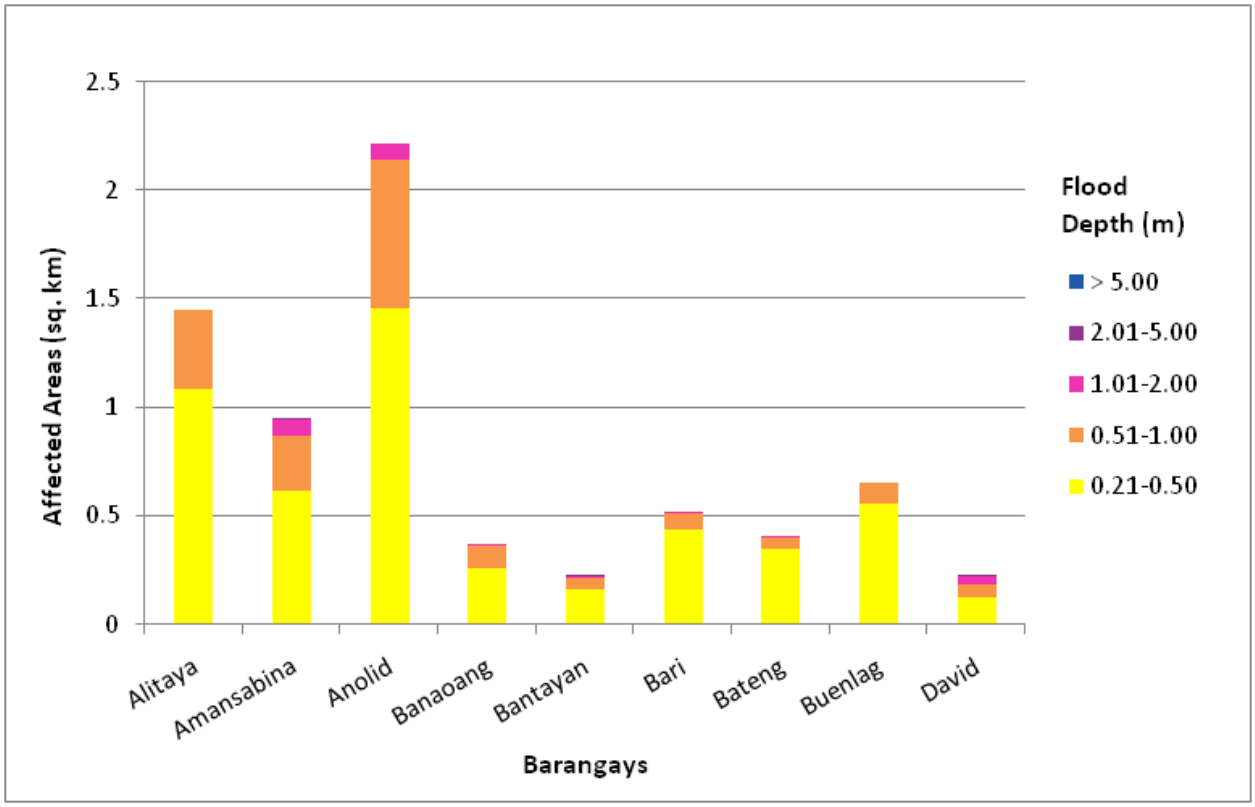
For the 25-year return period, 48.85% of the municipality of Mangaldan with an area of 43.415808 sq. km. will experience flood levels of less than 0.20 meters. 24.57% of the area will experience flood levels of 0.21 to 0.50 meters while 5.93%, 0.85%, and 0.08% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

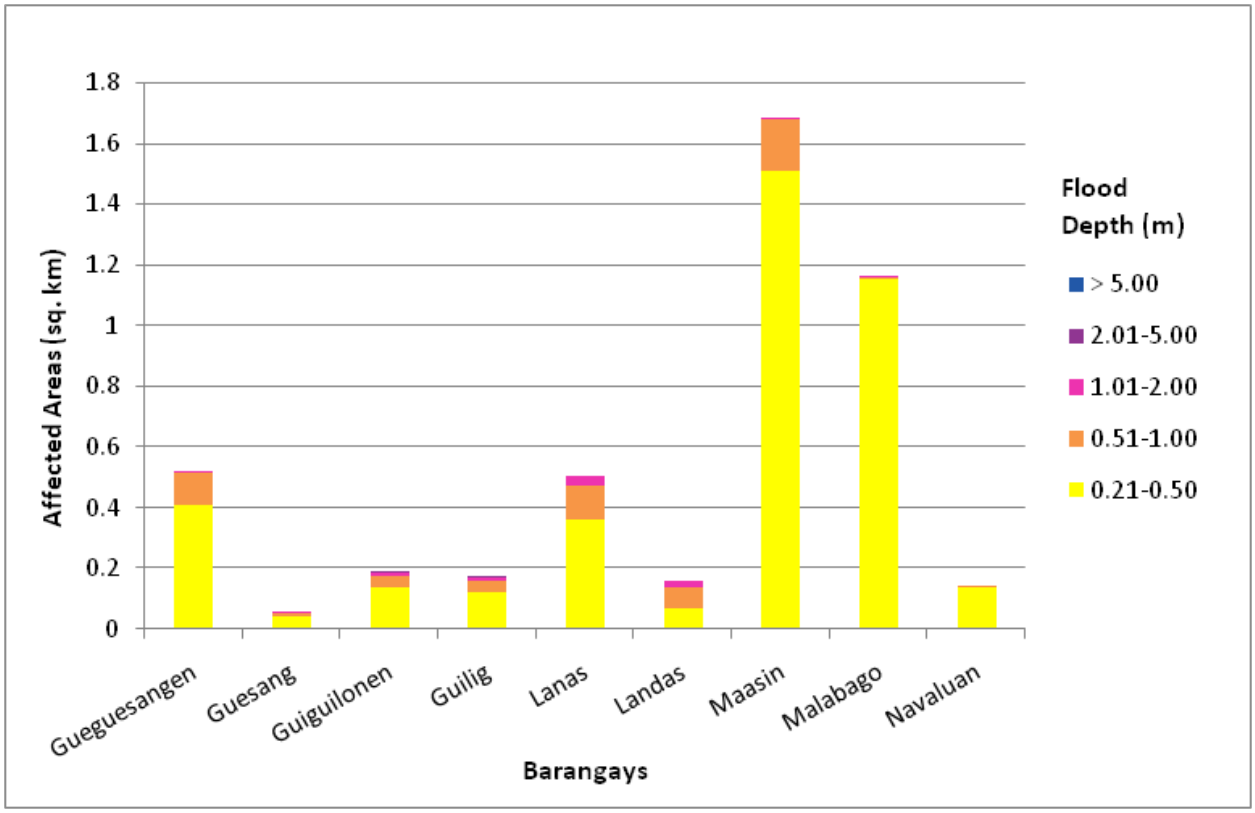
Table 34. Affected Areas in Mangaldan, Pangasinan during 25-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Mangaldan (in sq. km)								
	Alitaya	Amansabina	Anolid	Banaoang	Bantayan	Bari	Bateng	Buenlag	David
0.03-0.20	1.16	1.55	1.39	0.37	0.44	1.04	1.05	1.1	0.56
0.21-0.50	1.09	0.62	1.46	0.26	0.16	0.44	0.35	0.56	0.13
0.51-1.00	0.36	0.25	0.68	0.11	0.054	0.078	0.055	0.095	0.053
1.01-2.00	0	0.077	0.075	0.00069	0.012	0.0003	0.0007	0	0.041
2.01-5.00	0	0.0036	0	0	0.007	0	0	0	0.006
> 5.00	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Mangaldan (in sq. km)								
	Gueguesangen	Guesang	Guiguilonen	Guilig	Lanas	Landas	Maasin	Malabago	Navaluan
0.03-0.20	0.71	0.22	0.52	0.42	0.83	0.14	2.06	2.12	0.38
0.21-0.50	0.41	0.04	0.14	0.12	0.36	0.067	1.51	1.15	0.14
0.51-1.00	0.11	0.017	0.034	0.038	0.11	0.072	0.17	0.015	0.006
1.01-2.00	0.0015	0.00012	0.016	0.012	0.033	0.021	0.0046	0.0001	0
2.01-5.00	0	0	0.0006	0.0032	0	0	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Mangaldan (in sq. km)								
	Nibaliw	Osiem	Palua	Poblacion	Pogo	Salaan	Salay	Talogtog	Tebag
0.03-0.20	0.38	0.31	0.23	0.51	0.86	0.26	0.6	1.77	0.23
0.21-0.50	0.09	0.054	0.09	0.17	0.22	0.05	0.2	0.73	0.057
0.51-1.00	0.015	0.00019	0.013	0.073	0.04	0.00055	0.1	0.0081	0.019
1.01-2.00	0.0019	0	0.0001	0.023	0.006	0	0.042	0.0001	0.0028
2.01-5.00	0.0007	0	0	0	0.0013	0	0.011	0	0.0002
> 5.00	0	0	0	0	0	0	0	0	0


2.5
2
1.5
1
0.5
0
Affected Areas (sq. km)
Alitaya
Amansabina
Anolid
Banaoang
Bantayan
Bari
Bateng
Buenlag
David
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50


1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Affected Areas (sq. km)
Gueguesangen
Guesang
Guiguilonen
Guilig
Lanas
Landas
Maasin
Malabago
Navaluan
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50

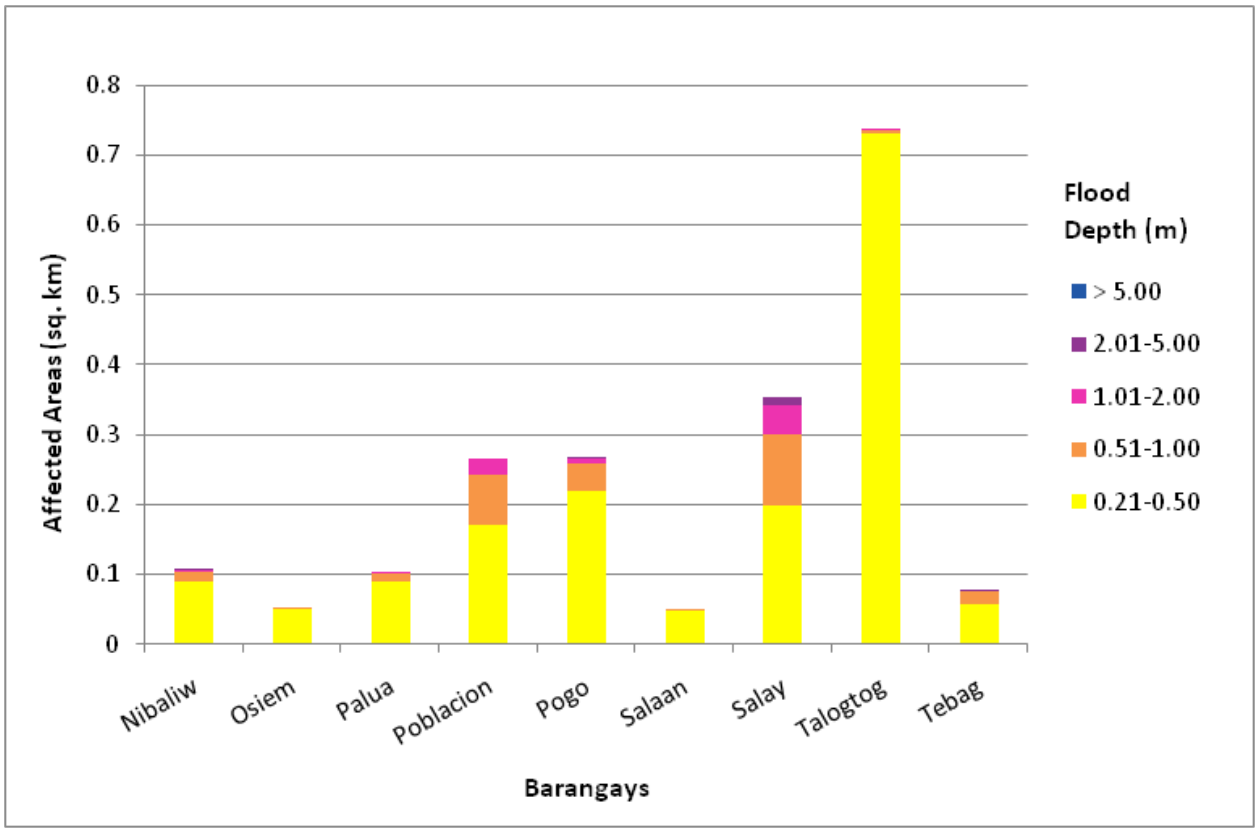


Figure. 98. Affected Areas in Mangaldan, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 28.12% of the municipality of Mapandan with an area of 21.351923 sq. km. will experience flood levels of less than 0.20 meters. 7.40% of the area will experience flood levels of 0.21 to 0.50 meters while 2.79%, 0.77%, and 0.46% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 35. Affected Areas in Mapandan, Pangasinan during 25-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Mapandan (in sq. km)											
	Amanoaoac	Apaya	Aserda	Coral	Golden	Jimenez	Lambayan	Luyan	Nilombot	Pias	Primicias	Torres
0.03-0.20	0.61	0.17	0.48	0.0051	0.37	0.87	1.18	0.9	1.42	1.15	0.78	0.64
0.21-0.50	0.23	0.02	0.12	0	0.069	0.28	0.17	0.27	0.42	0.22	0.18	0.31
0.51-1.00	0.089	0.00007	0.013	0	0.0096	0.2	0.23	0.027	0.028	0.069	0.099	0.25
1.01-2.00	0.0068	0	0.00097	0	0.00028	0.064	0.09	0.0023	0.0001	0.011	0.79	0.012
2.01-5.00	0	0	0	0	0	0.0002	0.099	0	0	0	0.31	0.0002
> 5.00	0	0	0	0	0	0	0	0	0	0	0	0

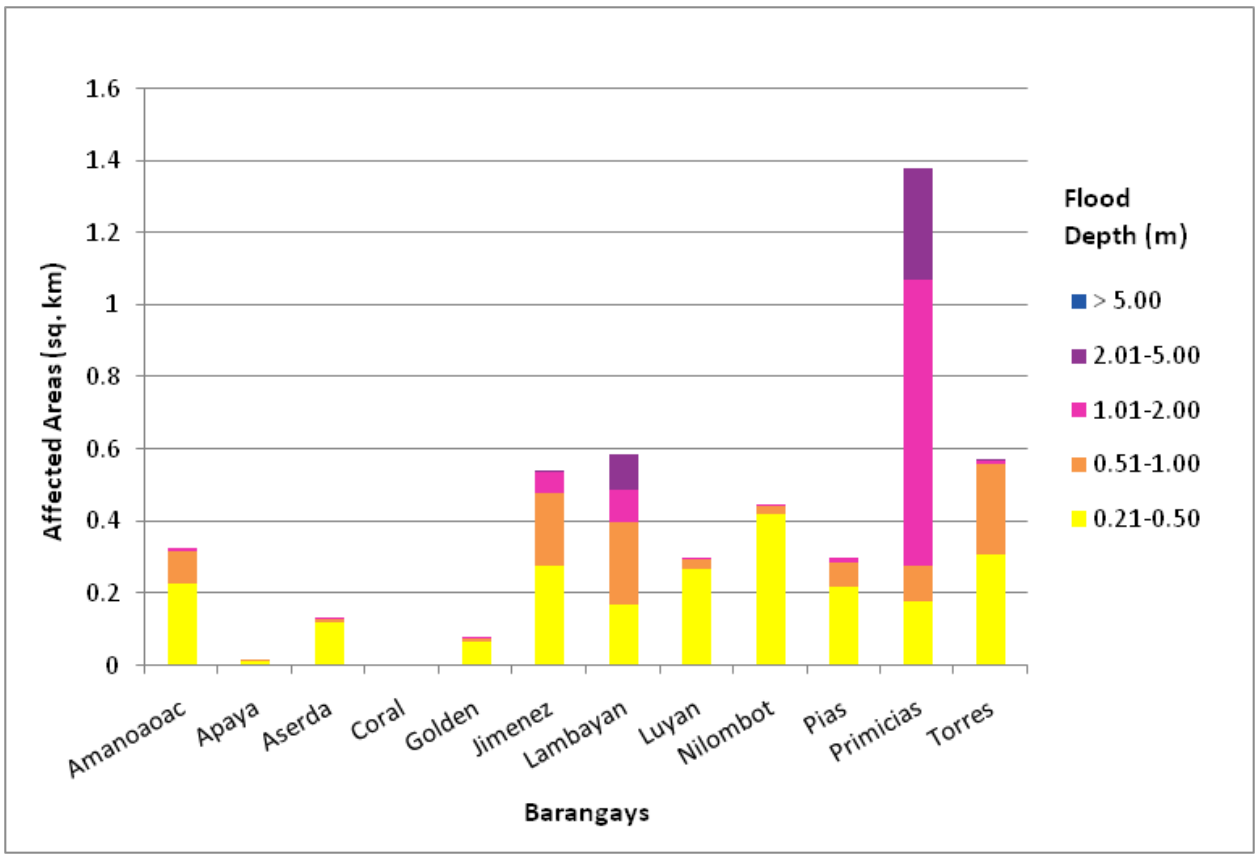


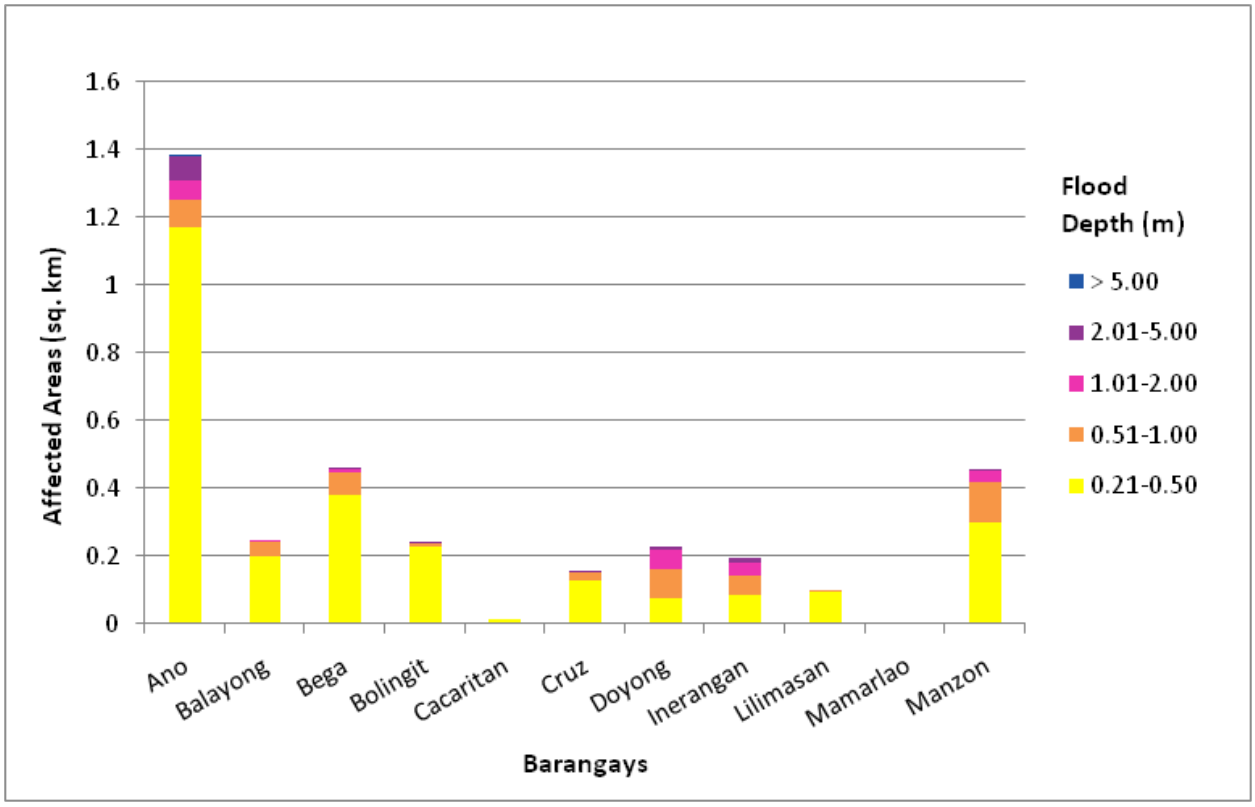
Figure. 99. Affected Areas in Mapandan, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 10.78% of the municipality of San Carlos City with an area of 151.284206 sq. km. will experience flood levels of less than 0.20 meters. 3.92% of the area will experience flood levels of 0.21 to 0.50 meters while 0.74%, 0.21%, and 0.10% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 36. Affected Areas in San Carlos City, Pangasinan during 25-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Carlos City (in sq. km)										
	Ano	Balayong	Bega	Bolingit	Cacaritan	Cruz	Doyong	Inerangan	Lilimasan	Mamarlao	Manzon
0.03-0.20	1.48	0.74	0.91	0.58	0.16	0.48	0.79	0.41	0.26	6.2E-06	0.52
0.21-0.50	1.17	0.2	0.38	0.23	0.014	0.13	0.078	0.087	0.1	0	0.3
0.51-1.00	0.083	0.045	0.066	0.009	0	0.026	0.085	0.056	0.0017	0	0.12
1.01-2.00	0.056	0.0013	0.013	0.002	0	0.0019	0.056	0.04	0	0	0.034
2.01-5.00	0.07	0	0.00054	0.00026	0	0.0003	0.01	0.012	0	0	0.0011
> 5.00	0.0044	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Carlos City (in sq. km)									
	Matagdem	Naguilayan	Nilentap	Pagal	Palaming	Pangalangan	Parayao	Quintong	Tandoc	Tarece
0.03-0.20	1.48	0.45	0.77	1.72	1.73	1.42	0.36	0.57	0.69	0.79
0.21-0.50	0.45	0.16	0.16	0.62	0.36	0.42	0.13	0.29	0.24	0.41
0.51-1.00	0.097	0.014	0.036	0.13	0.11	0.12	0.012	0.07	0.041	0.0026
1.01-2.00	0.025	0.0027	0.028	0.0083	0.015	0.032	0.0007	0	0.0003	0
2.01-5.00	0.002	0.0008	0.041	0.0006	0.0037	0.0027	0	0	0.0016	0
> 5.00	0	0	0	0	0	0	0	0	0	0



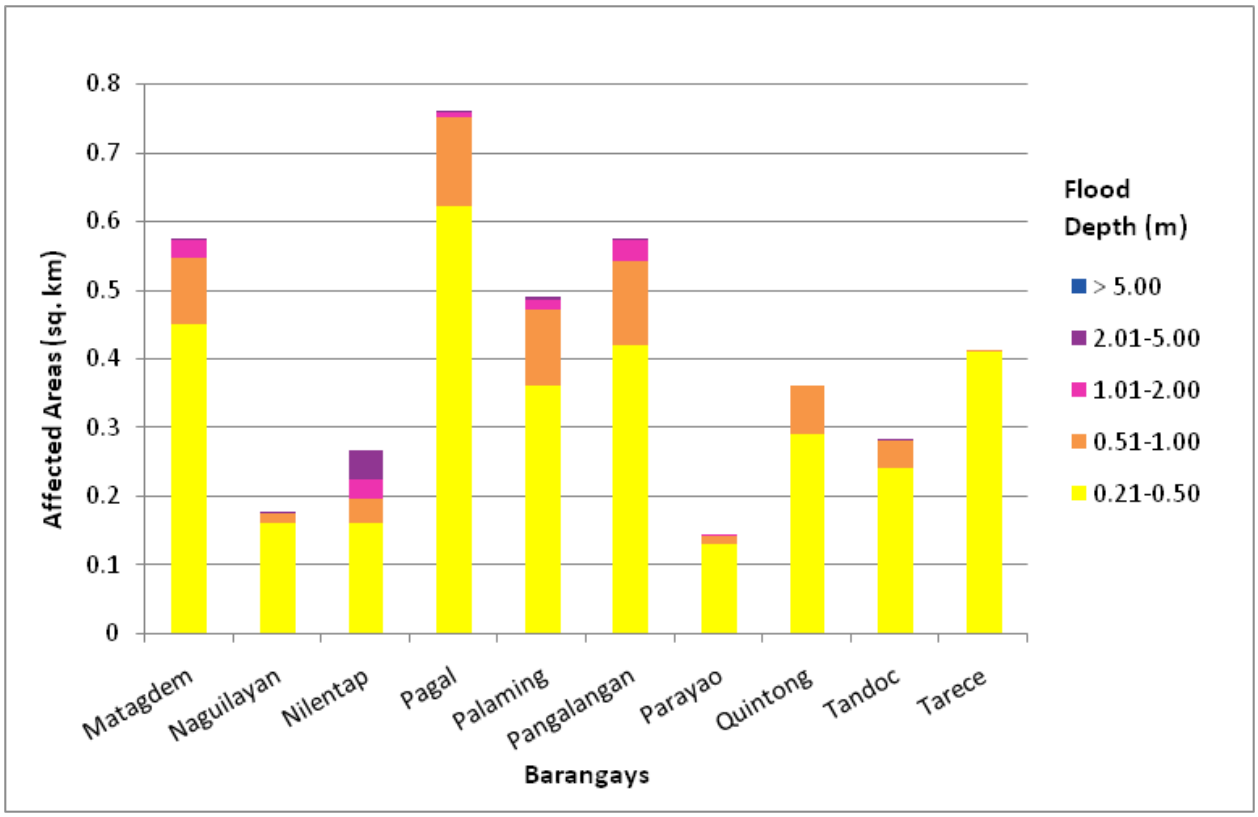


Figure. 100. Affected Areas in San Carlos City, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 0.04% of the municipality of San Fabian with an area of 69.270236 sq. km. will experience flood levels of less than 0.20 meters. 0.00% of the area will experience flood levels of 0.21 to 0.50 meters while 0.00% of the area will experience flood depths of 0.51 to 1 meter. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 37. Affected Areas in San Fabian, Pangasinan during 25-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Fabian (in sq. km)	
	Lekep-Butao	Longos
0.03-0.20	0.024	0.0039
0.21-0.50	0.00086	0
0.51-1.00	0	0
1.01-2.00	0	0
2.01-5.00	0	0
> 5.00	0	0

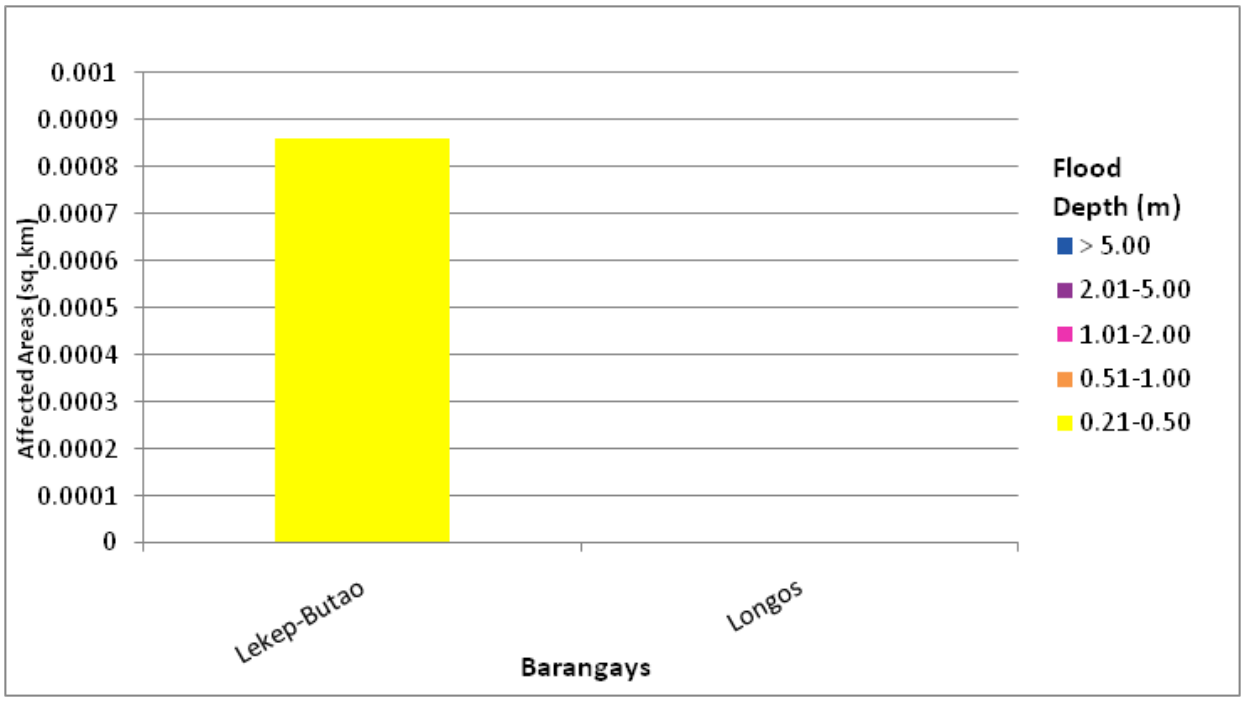


Figure. 101. Affected Areas in San Fabian, Pangasinan during 25-Year Rainfall Return Period

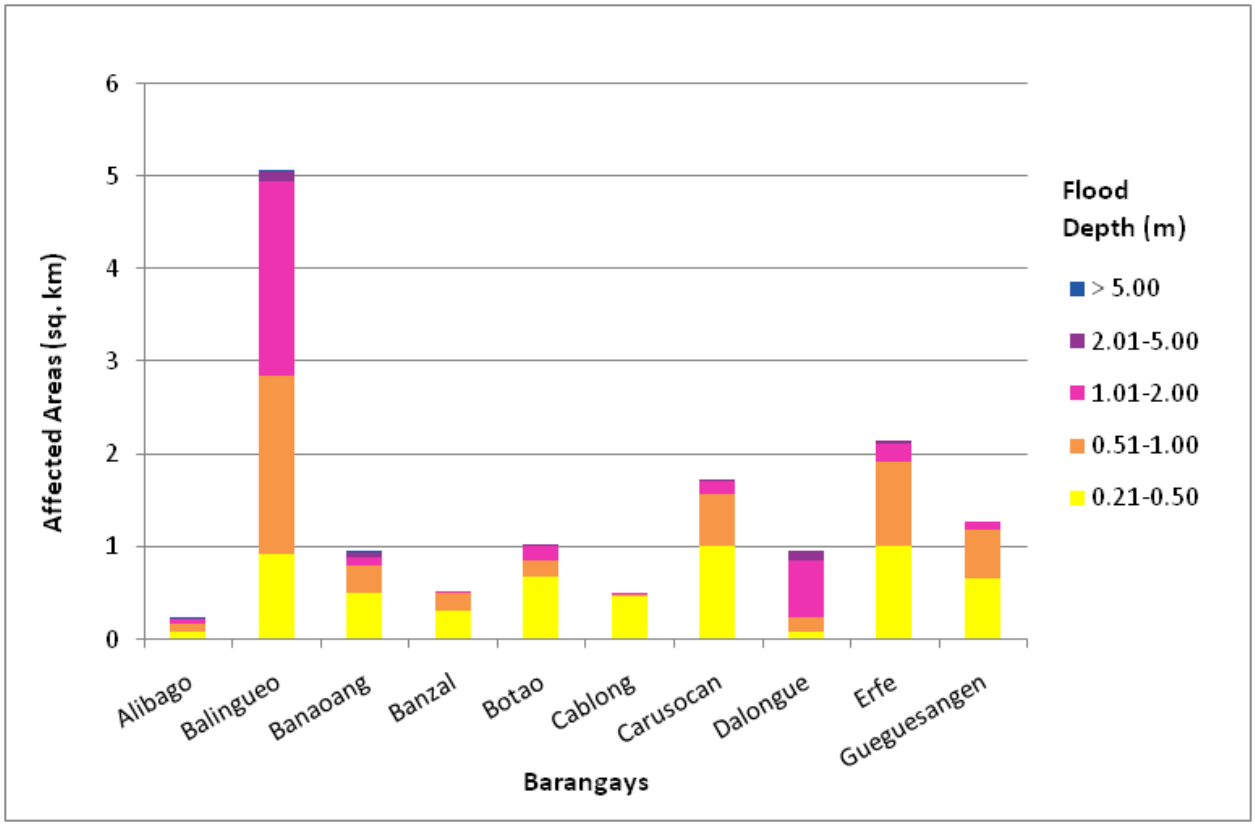
For the 25-year return period, 30.89% of the municipality of Santa Barbara with an area of 64.714151 sq. km. will experience flood levels of less than 0.20 meters. 22.56% of the area will experience flood levels of 0.21 to 0.50 meters while 21.16%, 20.97%, 4.11%, and 0.33% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

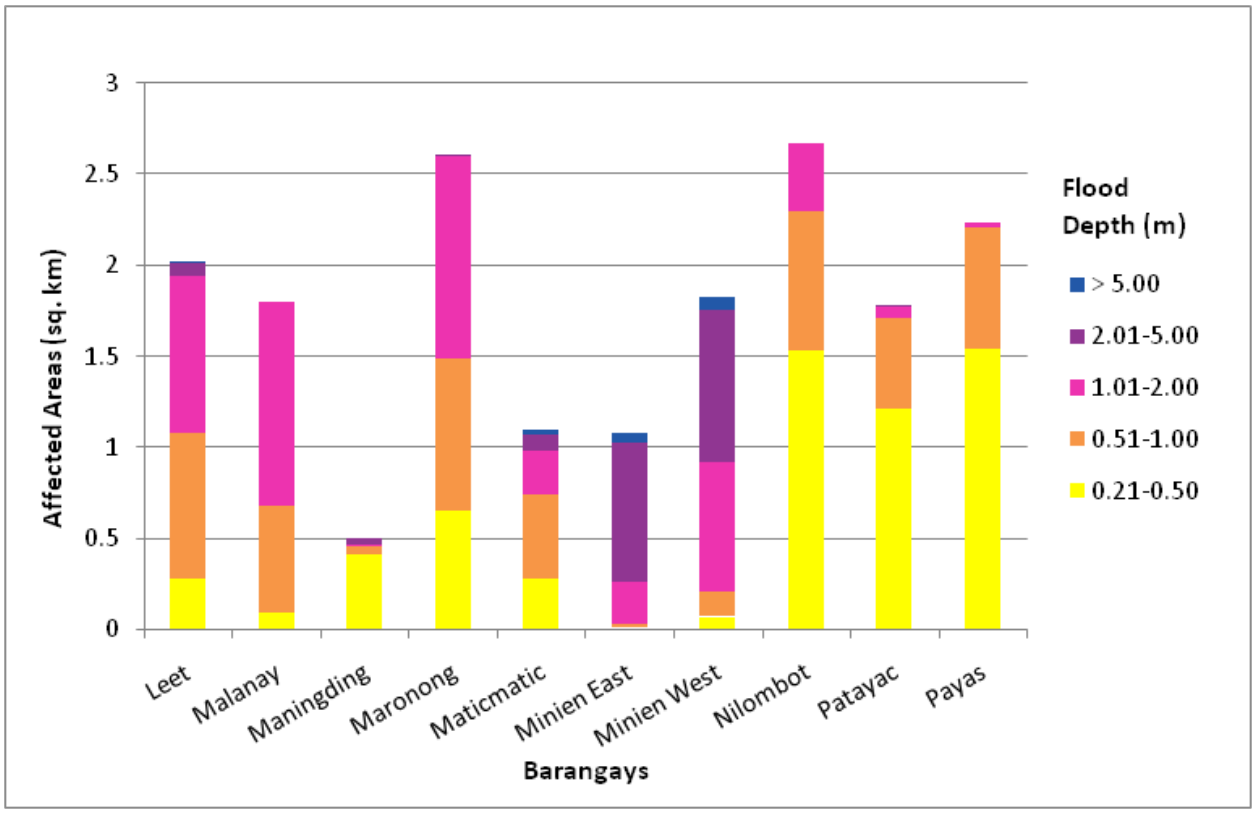
Table 38. Affected Areas in Santa Barbara, Pangasinan during 25-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Santa Barbara (in sq. km)									
	Alibago	Balingueo	Banaoang	Banzal	Botao	Cablong	Carusocan	Dalongue	Erfe	Gueguesangen
0.03-0.20	0.2	0.52	1.22	0.58	1.66	1.28	1.31	0.17	0.79	0.72
0.21-0.50	0.087	0.92	0.51	0.32	0.69	0.48	1.01	0.093	1.01	0.66
0.51-1.00	0.082	1.93	0.29	0.18	0.17	0.032	0.56	0.15	0.91	0.53
1.01-2.00	0.062	2.1	0.087	0.019	0.16	0.0001	0.16	0.61	0.19	0.089
2.01-5.00	0.019	0.12	0.066	0	0.0045	0	0.0018	0.11	0.048	0
> 5.00	0.00019	0.000038	0.007	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Santa Barbara (in sq. km)									
	Leet	Malanay	Maningding	Maronong	Maticmatic	Minien East	Minien West	Nilombot	Patayac	Payas
0.03-0.20	0.41	0.087	1.18	0.59	0.35	0.013	0.34	2.09	1.29	1.5
0.21-0.50	0.28	0.09	0.41	0.65	0.28	0.0051	0.067	1.53	1.21	1.54
0.51-1.00	0.8	0.59	0.051	0.84	0.46	0.021	0.14	0.77	0.5	0.67
1.01-2.00	0.86	1.12	0.0032	1.11	0.24	0.23	0.71	0.37	0.071	0.023
2.01-5.00	0.079	0	0.031	0.0047	0.086	0.77	0.84	0	0.0022	0
> 5.00	0.0005	0	0	0	0.028	0.049	0.067	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Santa Barbara (in sq. km)								
	Poblacion Norte	Poblacion Sur	Primicias	Sapang	Sonquil	Tebag East	Tebag West	Tuliao	Ventinilla
0.03-0.20	0.25	0.3	0.15	0.88	0.053	0.53	0.36	0.17	1
0.21-0.50	0.049	0.082	0.096	0.59	0.078	0.31	0.23	0.29	1.03
0.51-1.00	0.11	0.049	0.051	0.21	0.52	0.43	0.32	1.15	1.18
1.01-2.00	0.023	0.011	0.0021	0.05	3.87	0.39	0.2	0.5	0.31
2.01-5.00	0.0068	0.0038	0.00092	0.0047	0.37	0.03	0.03	0.0024	0.03
> 5.00	0	0	0	0	0	0.028	0.036	0.00021	0


Affected Areas (sq. km)
6
5
4
3
2
1
0
Alibago
Balingueo
Banaoang
Banzal
Botao
Cablong
Carusocan
Dalongue
Erfe
Gueguesangen
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50


Affected Areas (sq. km)
3
2.5
2
1.5
1
0.5
0
Leet
Malanay
Maningding
Maronong
Maticmatic
Minien East
Minien West
Nilombot
Patayac
Payas
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50

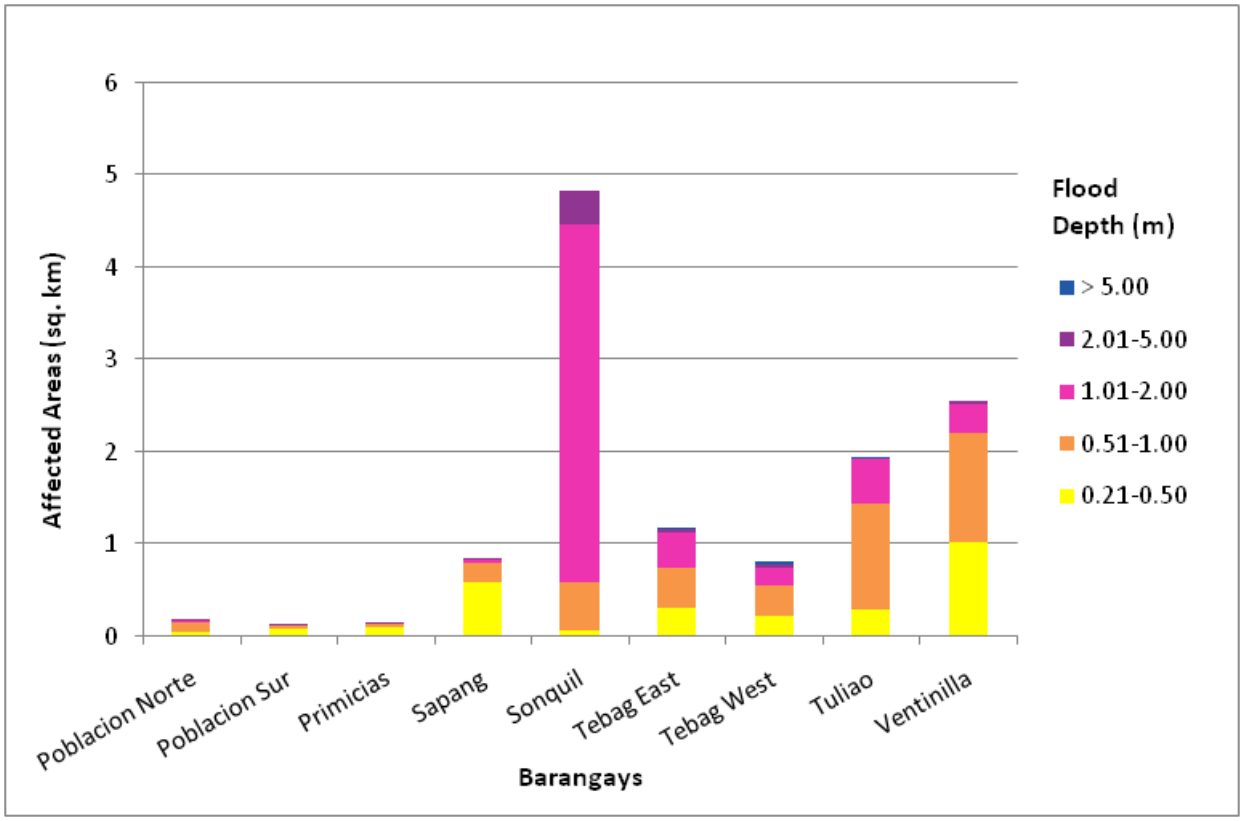


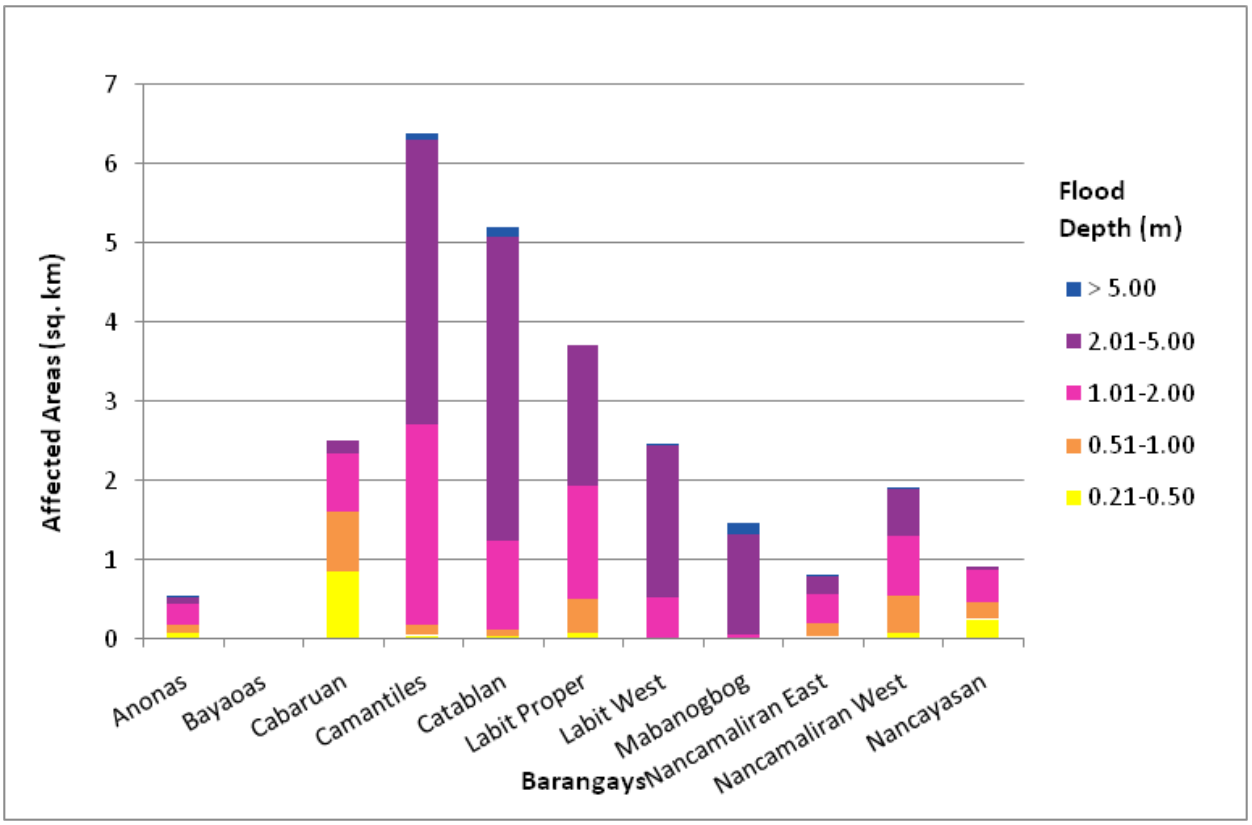
Figure. 102. Affected Areas in Santa Barbara, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 7.28% of the municipality of Urdaneta City with an area of 107.789848 sq. km. will experience flood levels of less than 0.20 meters. 3.61% of the area will experience flood levels of 0.21 to 0.50 meters while 5.38%, 17.48%, 22.46%, and 0.70% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 39. Affected Areas in Urdaneta City, Pangasinan during 25-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Urdaneta City (in sq. km)										
	Anonas	Bayaoas	Cabaruan	Camantiles	Catablan	Labit Proper	Labit West	Mabanogbog	Nancamaliran East	Nancamaliran West	Nancayasan
0.03-0.20	0.28	0.0015	2.69	0.056	0.24	0.034	0.0008	0.0027	0.0027	0.014	0.55
0.21-0.50	0.078	0.0016	0.85	0.042	0.038	0.077	0.0001	0.0027	0.029	0.078	0.25
0.51-1.00	0.094	0.0076	0.75	0.14	0.069	0.42	0.0099	0.0063	0.16	0.47	0.21
1.01-2.00	0.27	0.0028	0.75	2.54	1.13	1.45	0.53	0.058	0.38	0.76	0.41
2.01-5.00	0.1	0	0.16	3.58	3.84	1.76	1.91	1.26	0.24	0.58	0.05
> 5.00	0.0012	0	0	0.091	0.13	0	0.029	0.14	0.012	0.026	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Urdaneta City (in sq. km)										
	Oltama	Palina East	Palina West	Pinmaludpod	Poblacion	San Jose	San Vicente	Santa Lucia	Santo Domingo	Sugcong	Tulong
0.03-0.20	2.2	0.46	0.12	0.34	0.0067	0.013	0.015	0.00035	0.00063	0.76	0.063
0.21-0.50	0.29	0.42	0.53	0.4	0.023	0.0051	0.0017	0.0054	0.0046	0.73	0.03
0.51-1.00	0.32	0.4	0.66	0.91	0.18	0.012	0.013	0.087	0.11	0.66	0.11
1.01-2.00	0.47	0.27	1.29	3.79	1	1.11	0.21	0.79	0.5	0.84	0.29
2.01-5.00	0.29	0.024	0.26	5.15	0.5	2.58	0.8	0.045	0.021	0.15	0.91
> 5.00	0	0	0	0.19	0.039	0.041	0.037	0	0	0	0.021



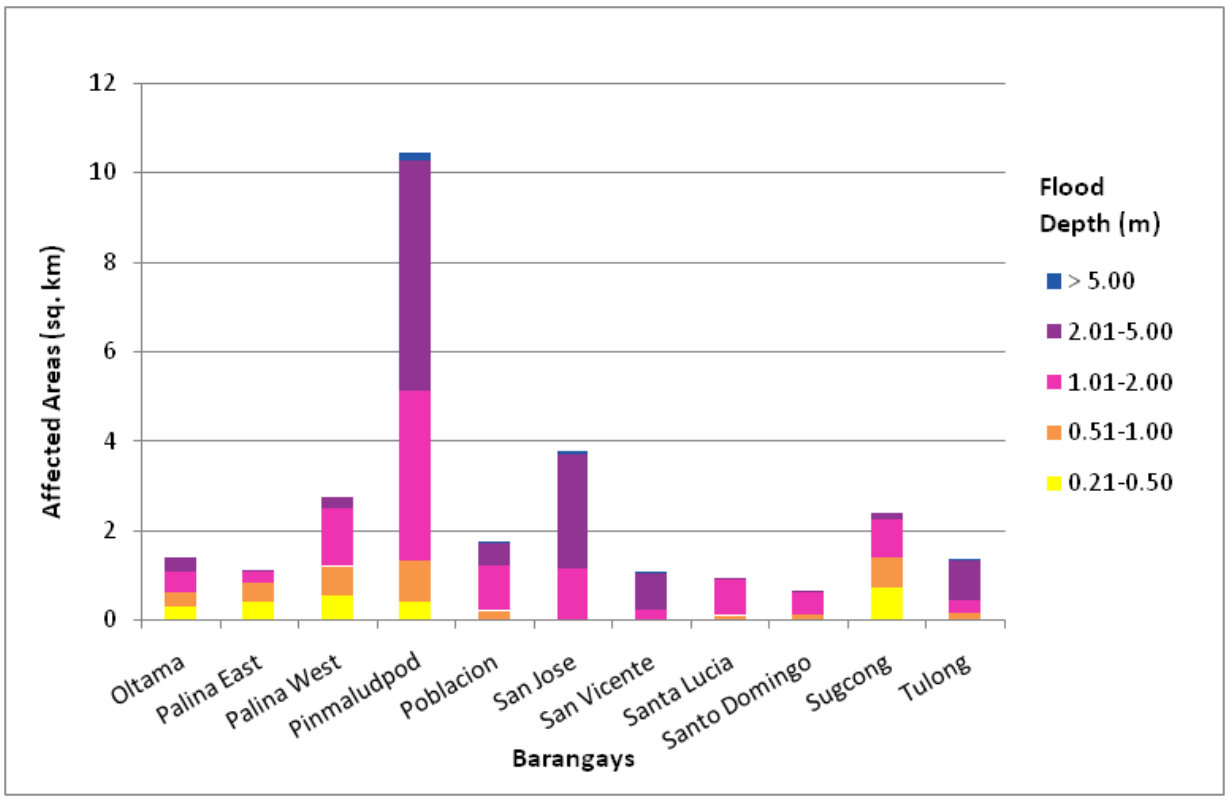


Figure. 103. Affected Areas in Urdaneta City, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 9.42% of the municipality of Villasis with an area of 76.039344 sq. km. will experience flood levels of less than 0.20 meters. 2.62% of the area will experience flood levels of 0.21 to 0.50 meters while 3.80%, 4.62%, and 0.27% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 40. Affected Areas in Villasis, Pangasinan during 25-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Villasis (in sq. km)					
	Barraca	Capulaan	La Paz	Labit	Tombod	Unzad
0.03-0.20	0.09	0.25	2.89	1.73	0.25	1.95
0.21-0.50	0.52	0.09	0.23	0.31	0.46	0.38
0.51-1.00	1.27	0.12	0.14	0.27	0.9	0.19
1.01-2.00	1.29	0.026	0.095	0.41	1.57	0.12
2.01-5.00	0.054	0.0003	0.0094	0.012	0.13	0.0026
> 5.00	0	0	0	0.0006	0	0

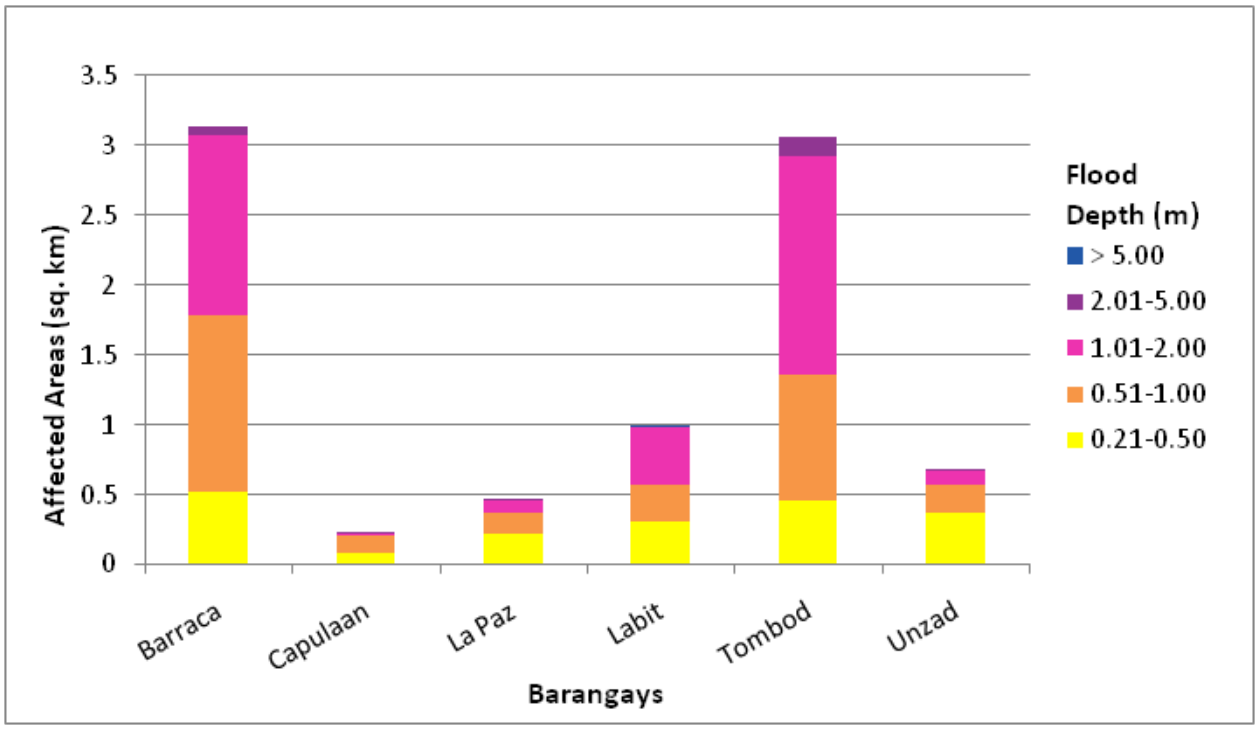


Figure. 104. Affected Areas in Villasis, Pangasinan during 25-Year Rainfall Return Period

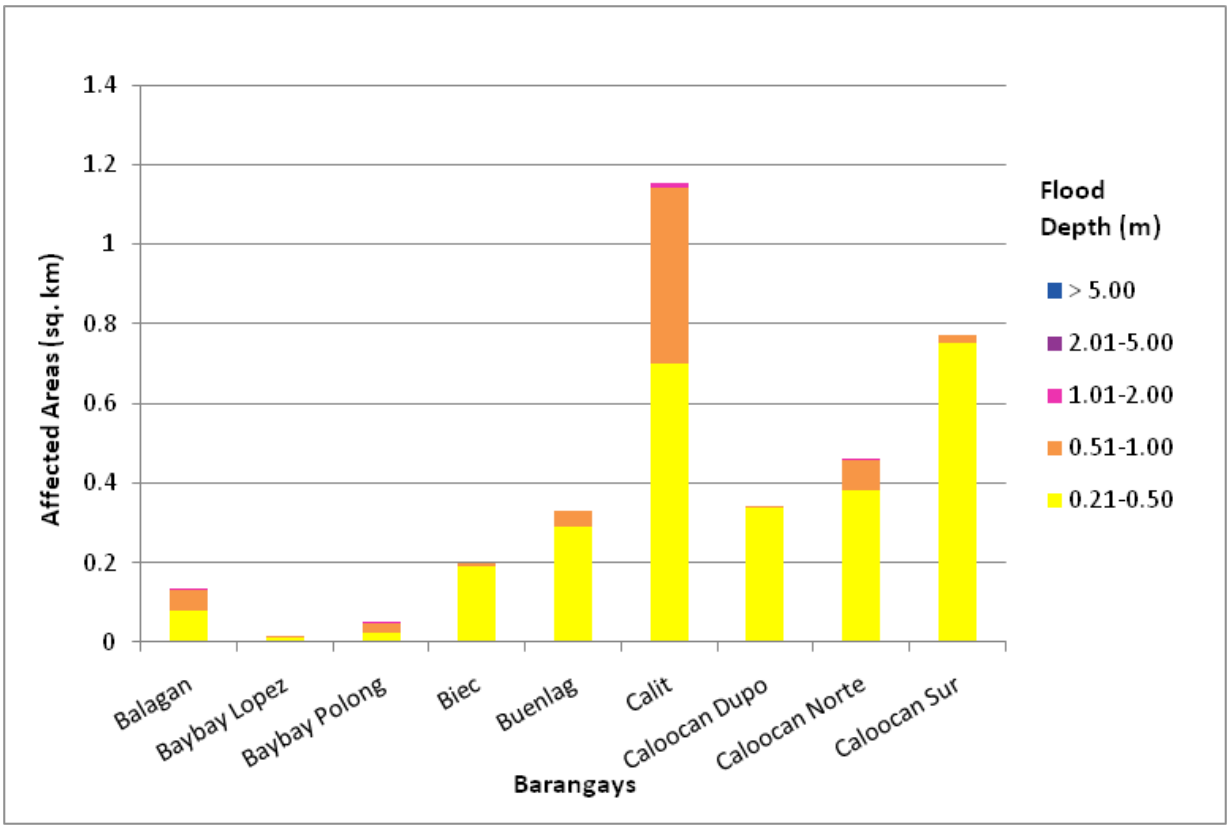
For the 100-year return period, 28.64% of the municipality of Binmaley with an area of 61.839261 sq. km. will experience flood levels of less than 0.20 meters. 20.65% of the area will experience flood levels of 0.21 to 0.50 meters while 5.04%, 0.29%, and 0.01% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

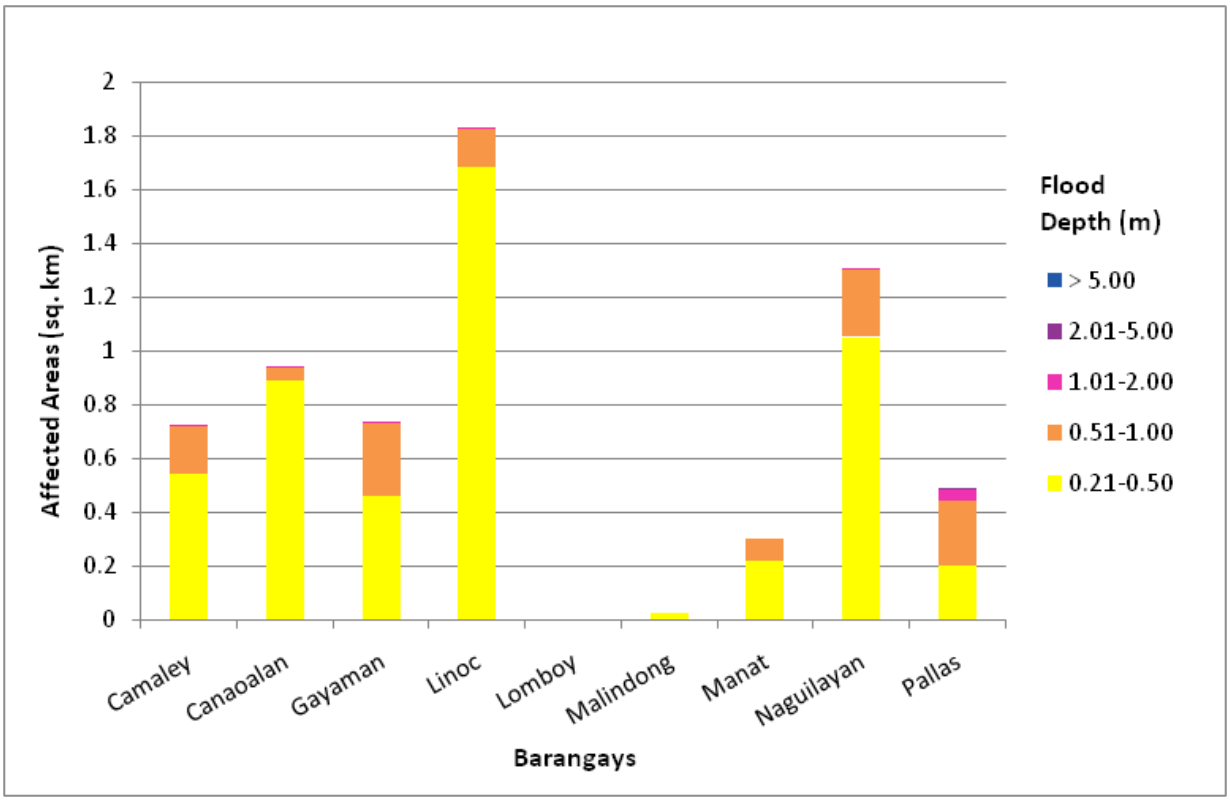
Table 41. Affected Areas in Binmaley, Pangasinan during 100-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binmaley (in sq. km)								
	Balagan	Baybay Lopez	Baybay Polong	Biec	Buenlag	Calit	Caloocan Dupo	Caloocan Norte	Caloocan Sur
0.03-0.20	0.12	0.04	0.14	0.44	0.5	1.09	0.36	0.62	0.87
0.21-0.50	0.078	0.014	0.025	0.19	0.29	0.7	0.34	0.38	0.75
0.51-1.00	0.054	0.00028	0.024	0.01	0.04	0.44	0.0032	0.081	0.023
1.01-2.00	0.0024	0	0.0014	0	0	0.012	0	0.0011	0
2.01-5.00	0	0	0	0	0	0	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binmaley (in sq. km)								
	Camaley	Canaoalan	Gayaman	Linoc	Lomboy	Malindong	Manat	Naguilayan	Pallas
0.03-0.20	0.8	1.34	0.69	2.81	0.019	0.18	0.19	1.17	0.43
0.21-0.50	0.54	0.89	0.46	1.68	0.0001	0.024	0.22	1.05	0.2
0.51-1.00	0.18	0.05	0.27	0.15	0	0	0.08	0.25	0.24
1.01-2.00	0.002	0.0007	0.0059	0.0002	0	0	0	0.0063	0.046
2.01-5.00	0	0	0	0	0	0	0	0	0.0033
> 5.00	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binmaley (in sq. km)								
	Papagueyan	Parayao	Poblacion	Sabangan	Salapingao	San Isidro Norte	San Isidro Sur	Santa Rosa	Tombor
0.03-0.20	0.86	0.39	0.66	0.28	1.12	0.5	0.33	0.61	1.15
0.21-0.50	0.66	0.54	0.5	0.18	1.1	0.35	0.23	0.53	0.85
0.51-1.00	0.13	0.41	0.018	0.012	0.055	0.057	0.042	0.19	0.31
1.01-2.00	0.02	0.016	0.0024	0	0.0009	0.0009	0.00072	0.006	0.057
2.01-5.00	0.0002	0	0	0	0	0	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0


1.4
1.2
1
0.8
0.6
0.4
0.2
0
Affected Areas (sq. km)
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50
Balagan
Baybay Lopez
Baybay Polong
Biec
Buenlag
Calit
Caloocan Dupo
Caloocan Norte
Caloocan Sur
Barangays


2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Affected Areas (sq. km)
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50
Camaley
Canaoalan
Gayaman
Linoc
Lomboy
Malindong
Manat
Naguilayan
Pallas
Barangays

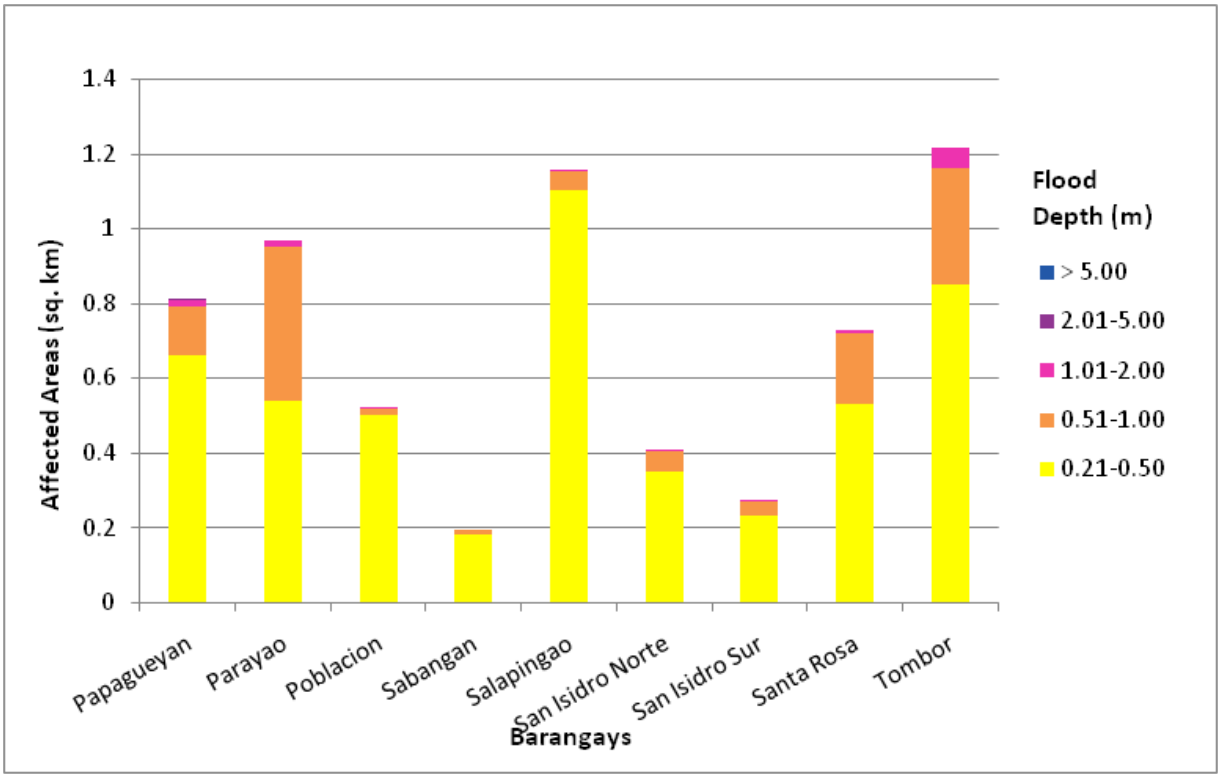


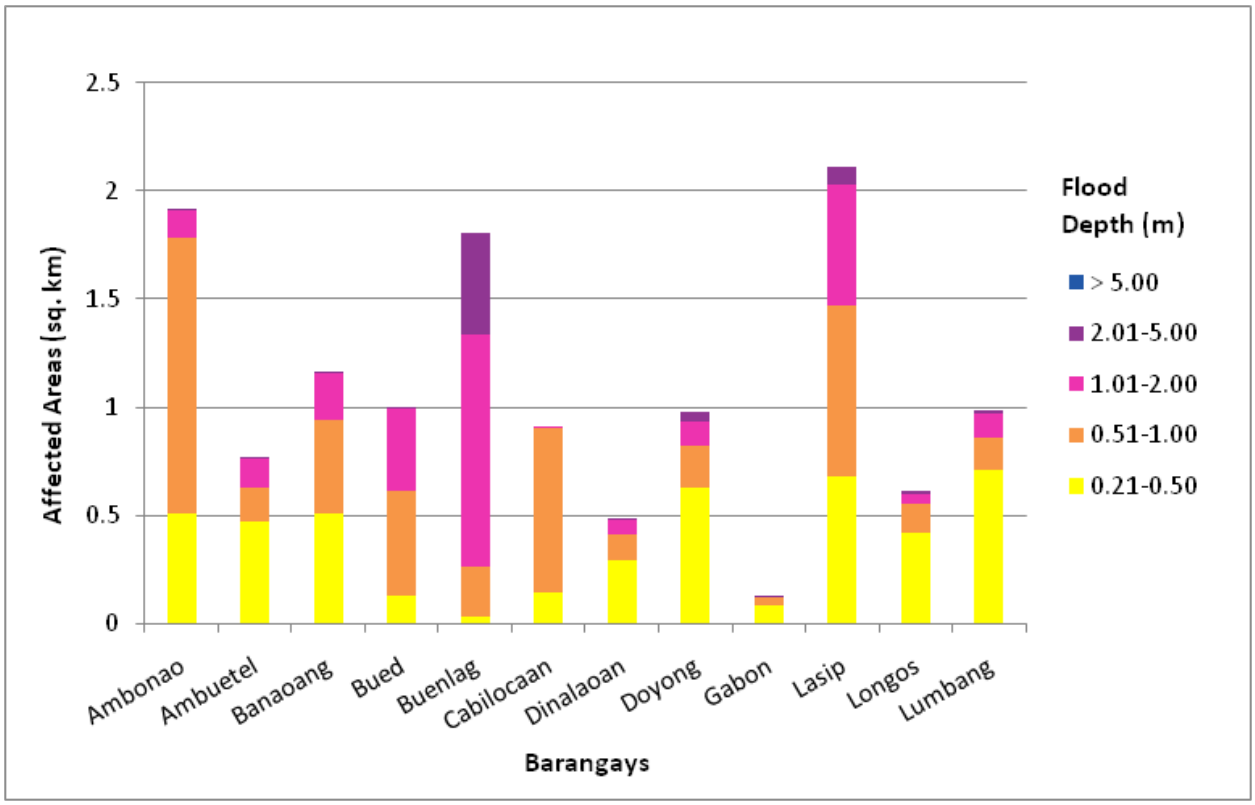
Figure. 105. Affected Areas in Binmaley, Pangasinan during 100-Year Rainfall Return Period

For the 100-year return period, 42.40% of the municipality of Calasiao with an area of 49.196934 sq. km. will experience flood levels of less than 0.20 meters. 19.98% of the area will experience flood levels of 0.21 to 0.50 meters while 18.24%, 15.24%, 4.15%, and 0.04% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 42. Affected Areas in Calasiao, Pangasinan during 100-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Calasiao (in sq. km)											
	Ambonao	Ambuetel	Banaoang	Bued	Buenlag	Cabilocaan	Dinalaoan	Doyong	Gabon	Lasip	Longos	Lumbang
0.03-0.20	0.5	1.94	1.09	0.11	0.047	0.13	1.08	1.8	0.27	1.7	1.11	1.65
0.21-0.50	0.51	0.47	0.51	0.13	0.029	0.14	0.29	0.63	0.08	0.68	0.42	0.71
0.51-1.00	1.27	0.16	0.43	0.48	0.23	0.76	0.12	0.19	0.036	0.79	0.13	0.15
1.01-2.00	0.14	0.13	0.22	0.39	1.08	0.0075	0.072	0.11	0.013	0.56	0.047	0.11
2.01-5.00	0.00082	0.01	0.0029	0.0022	0.47	0	0.0021	0.051	0.0015	0.081	0.017	0.016
> 5.00	0	0	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Calasiao (in sq. km)											
	Macabito	Malabago	Mancup	Nagsaing	Nalsian	Poblacion East	Poblacion West	Quesban	San Miguel	San Vicente	Songkoy	Talibaew
0.03-0.20	1	1.64	0.61	1.74	0.85	0.2	0.27	1.19	0.75	0.79	0.012	0.38
0.21-0.50	0.4	0.74	0.21	1.1	0.29	0.061	0.068	0.76	0.32	1.05	0.072	0.16
0.51-1.00	0.67	0.6	0.57	0.39	0.33	0.043	0.016	0.47	0.18	0.43	0.15	0.38
1.01-2.00	2.25	0.3	0.76	0.089	0.021	0.0052	0.0027	0.056	0.044	0.12	0.38	0.59
2.01-5.00	0.35	0.072	0.0045	0.019	0.012	0.0014	0.0058	0.011	0.00081	0	0	0.91
> 5.00	0	0	0	0	0	0	0	0.0025	0	0	0	0.016



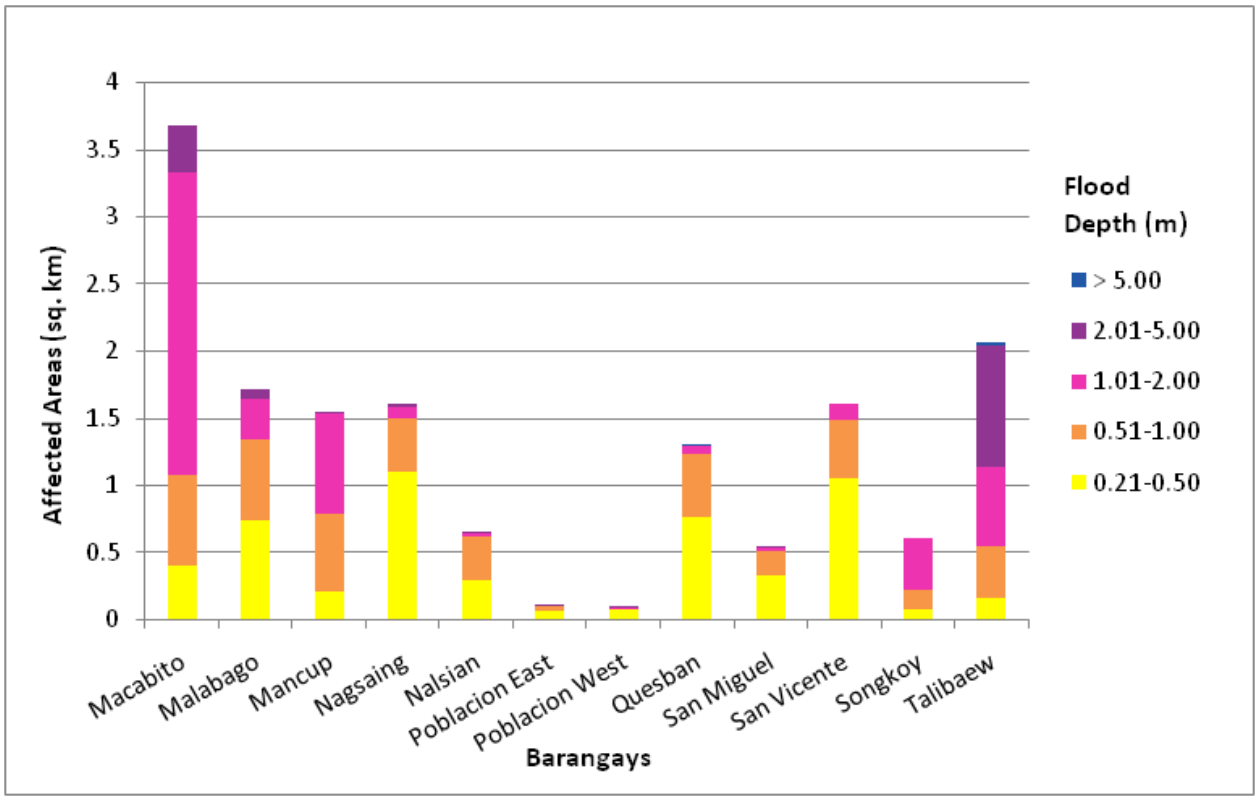


Figure. 106. Affected Areas in Calasiao, Pangasinan during 100-Year Rainfall Return Period

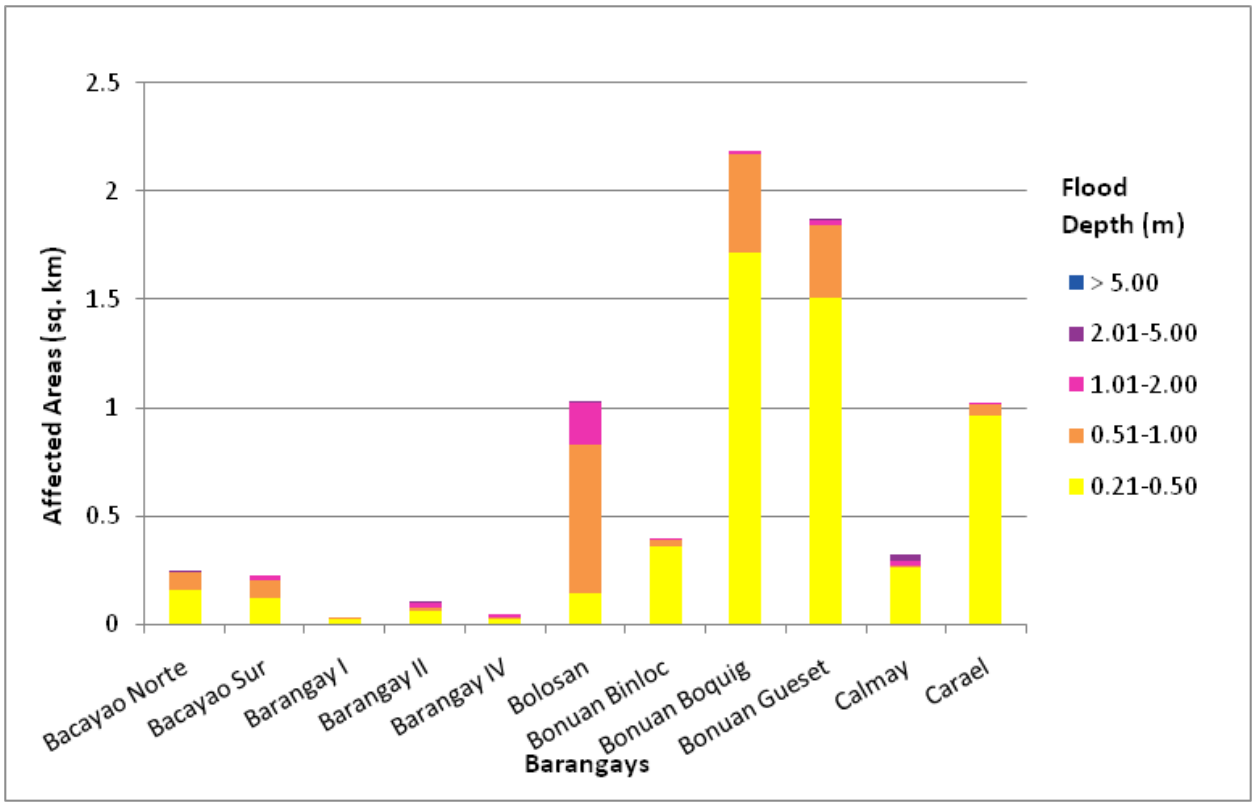
For the 100-year return period, 43.94% of the municipality of Dagupan City with an area of 47.755696 sq. km. will experience flood levels of less than 0.20 meters. 28.54% of the area will experience flood levels of 0.21 to 0.50 meters while 9.42%, 7.14%, and 0.70% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

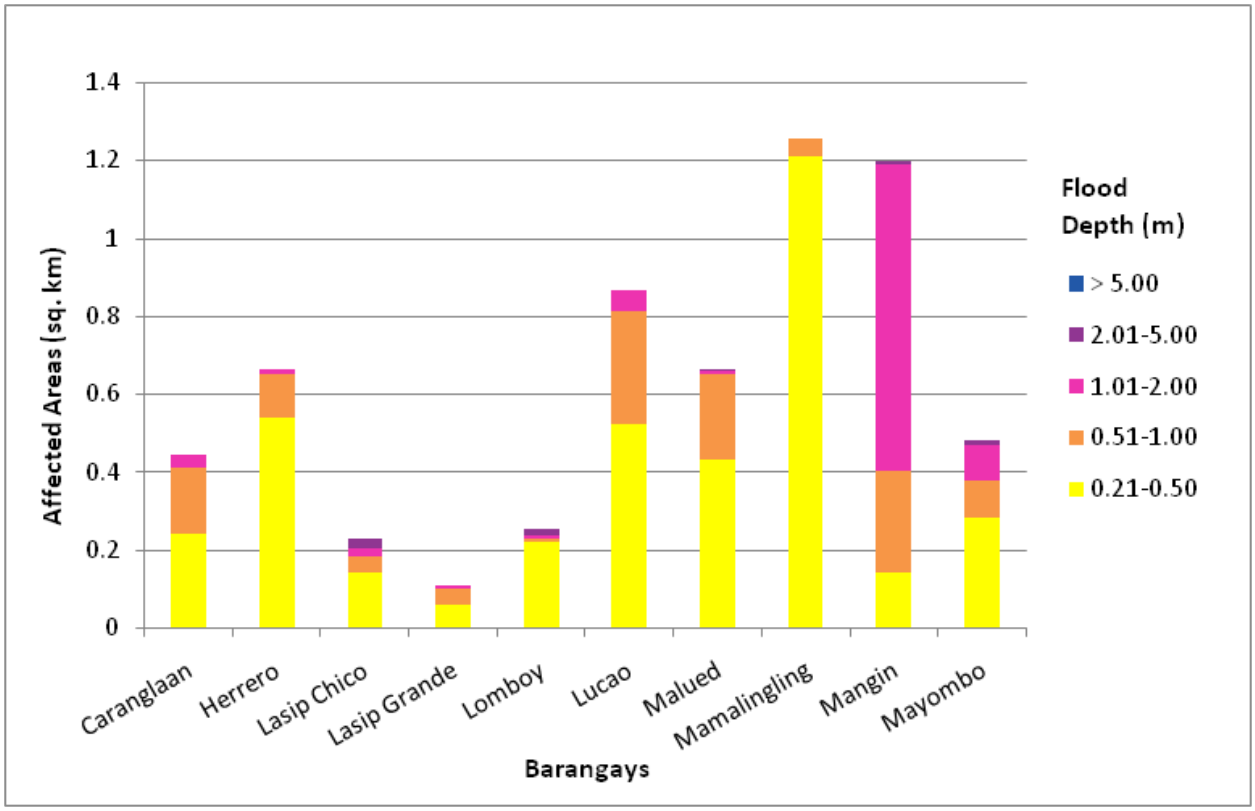
Table 43. Affected Areas in Dagupan City, Pangasinan during 100-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Dagupan City (in sq. km)										
	Bacayao Norte	Bacayao Sur	Barangay I	Barangay II	Barangay IV	Bolosan	Bonuan Binloc	Bonuan Boquig	Bonuan Gueset	Calmay	Carael
0.03-0.20	0.22	0.38	0.098	0.21	0.084	0.4	0.65	2.62	2.79	0.34	1.09
0.21-0.50	0.16	0.12	0.026	0.063	0.026	0.14	0.36	1.72	1.51	0.26	0.96
0.51-1.00	0.083	0.079	0.00042	0.011	0.0072	0.69	0.027	0.45	0.33	0.0098	0.062
1.01-2.00	0	0.023	0	0.025	0.01	0.2	0.0059	0.014	0.032	0.022	0.0013
2.01-5.00	0.00037	0	0	0.0081	0	0.0014	0	0	0.00051	0.03	0
> 5.00	0	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Dagupan City (in sq. km)									
	Caranglaan	Herrero	Lasip Chico	Lasip Grande	Lomboy	Lucao	Malued	Mamalingling	Mangin	Mayombo
0.03-0.20	0.55	0.59	0.41	0.21	0.3	1.15	0.99	0.91	0.3	0.67
0.21-0.50	0.24	0.54	0.14	0.06	0.22	0.52	0.43	1.21	0.14	0.28
0.51-1.00	0.17	0.11	0.041	0.038	0.0067	0.29	0.22	0.044	0.26	0.098
1.01-2.00	0.035	0.013	0.021	0.01	0.011	0.057	0.012	0	0.79	0.088
2.01-5.00	0	0	0.024	0	0.015	0	0.00088	0	0.0064	0.014
> 5.00	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Dagupan City (in sq. km)									
	Pantal	Poblacion Oeste	Pogo Chico	Pogo Grande	Pugaro Suit	Salapingao	Salisay	Tambac	Tapuac	Tebeng
0.03-0.20	0.95	0.19	0.26	0.11	1.2	1.08	0.28	0.75	0.35	0.85
0.21-0.50	0.5	0.16	0.1	0.056	1.08	0.95	0.17	0.66	0.21	0.62
0.51-1.00	0.029	0.037	0.016	0.013	0.02	0.017	0.85	0.19	0.13	0.17
1.01-2.00	0.035	0.01	0.00019	0.0054	0.0012	0.012	1.91	0.0024	0	0.065
2.01-5.00	0.038	0	0.017	0.0044	0	0.0026	0.17	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0	0


2.5
2
1.5
1
0.5
0
Affected Areas (sq. km)
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50
Bacayao Norte
Bacayao Sur
Barangay I
Barangay II
Barangay IV
Bolosan
Bonuan Binloc
Bonuan Boquig
Bonuan Gueset
Calmay
Carael
Barangays


1.4
1.2
1
0.8
0.6
0.4
0.2
0
Affected Areas (sq. km)
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50
Caranglaan
Herrero
Lasip Chico
Lasip Grande
Lomboy
Lucao
Malued
Mamalingling
Mangin
Mayombo
Barangays

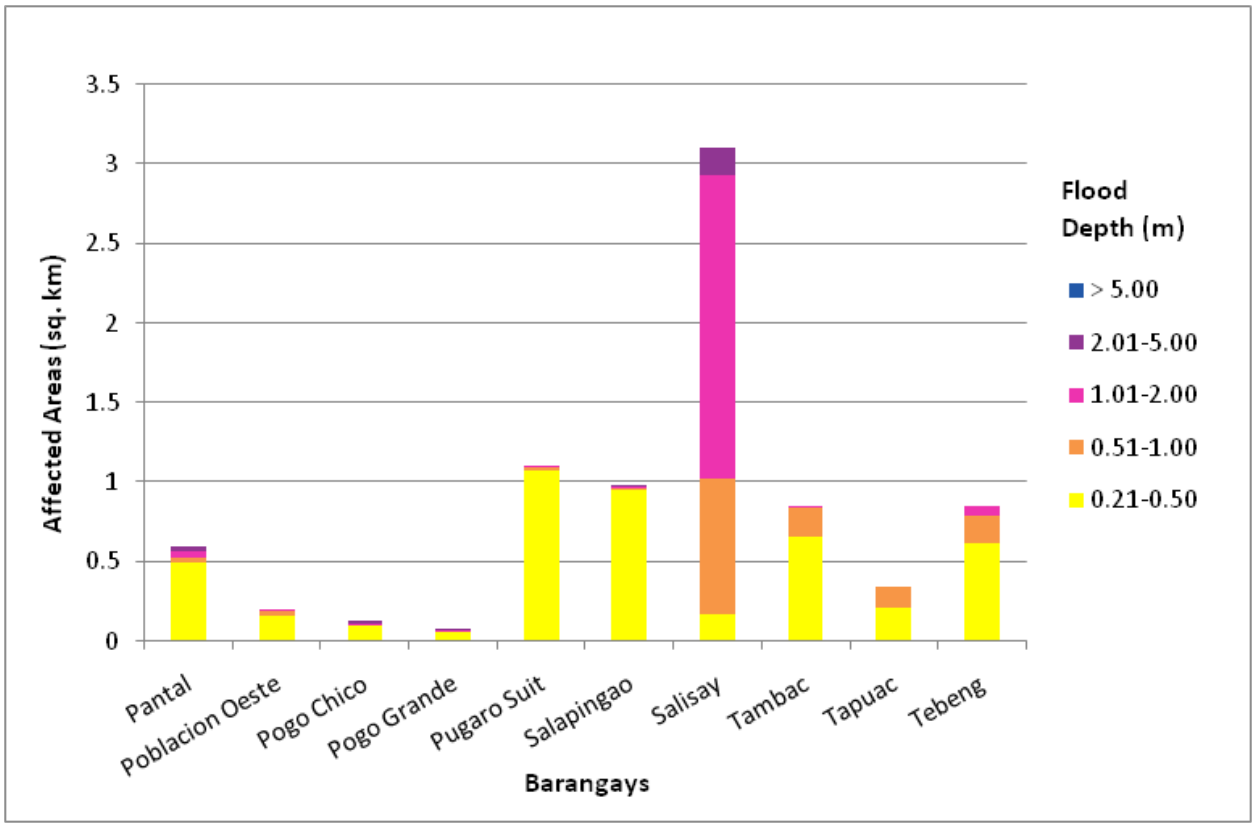


Figure. 107. Affected Areas in Dagupan City, Pangasinan during 100-Year Rainfall Return Period

For the 100-year return period, 0.00% of the municipality of Laoac with an area of 40.697535 sq. km. will experience flood levels of less than 0.20 meters. 0.00% of the area will experience flood levels of 0.21 to 0.50 meters while 0.00%, 0.04%, 0.34%, and 0.18% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 44. Affected Areas in Laoac, Pangasinan during 100-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Laoac (in sq. km) Yatyat
0.03-0.20	0
0.21-0.50	0
0.51-1.00	0.00053
1.01-2.00	0.016
2.01-5.00	0.14
> 5.00	0.074

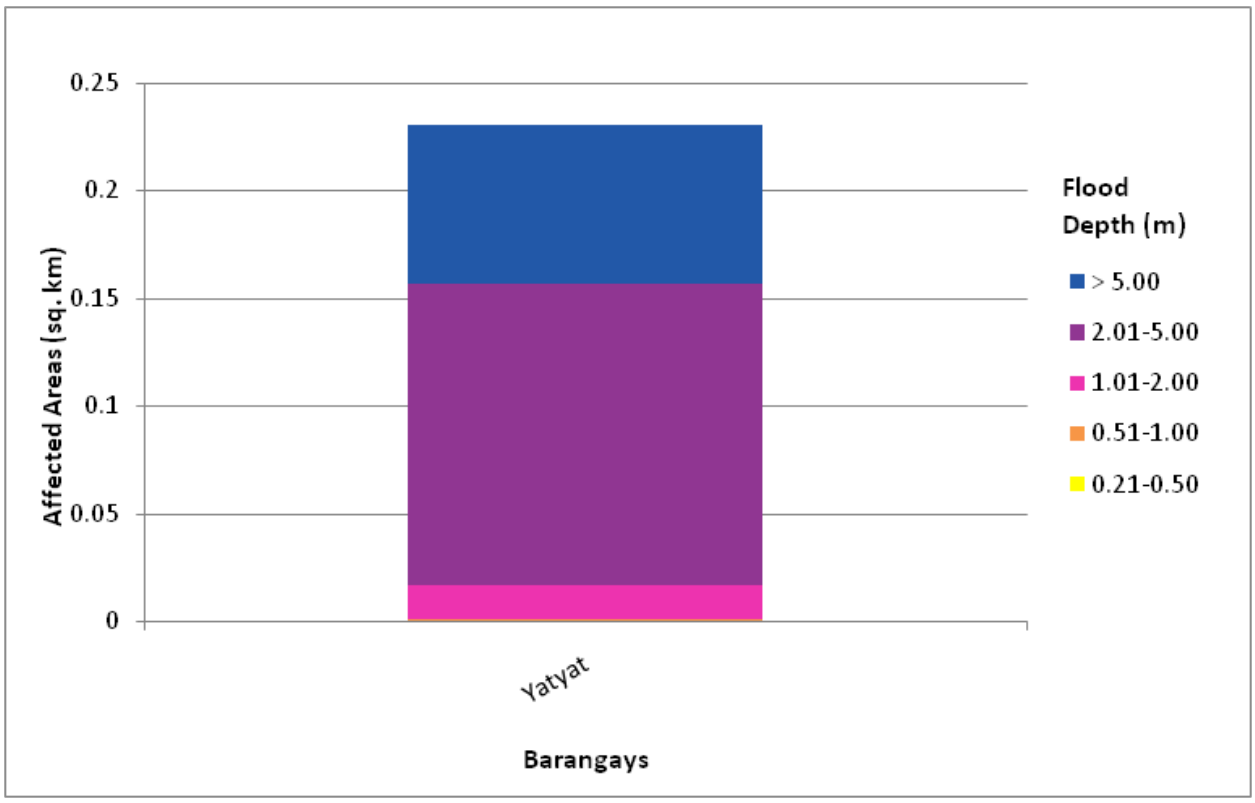


Figure. 108. Affected Areas in Laoac, Pangasinan during 100-Year Rainfall Return Period

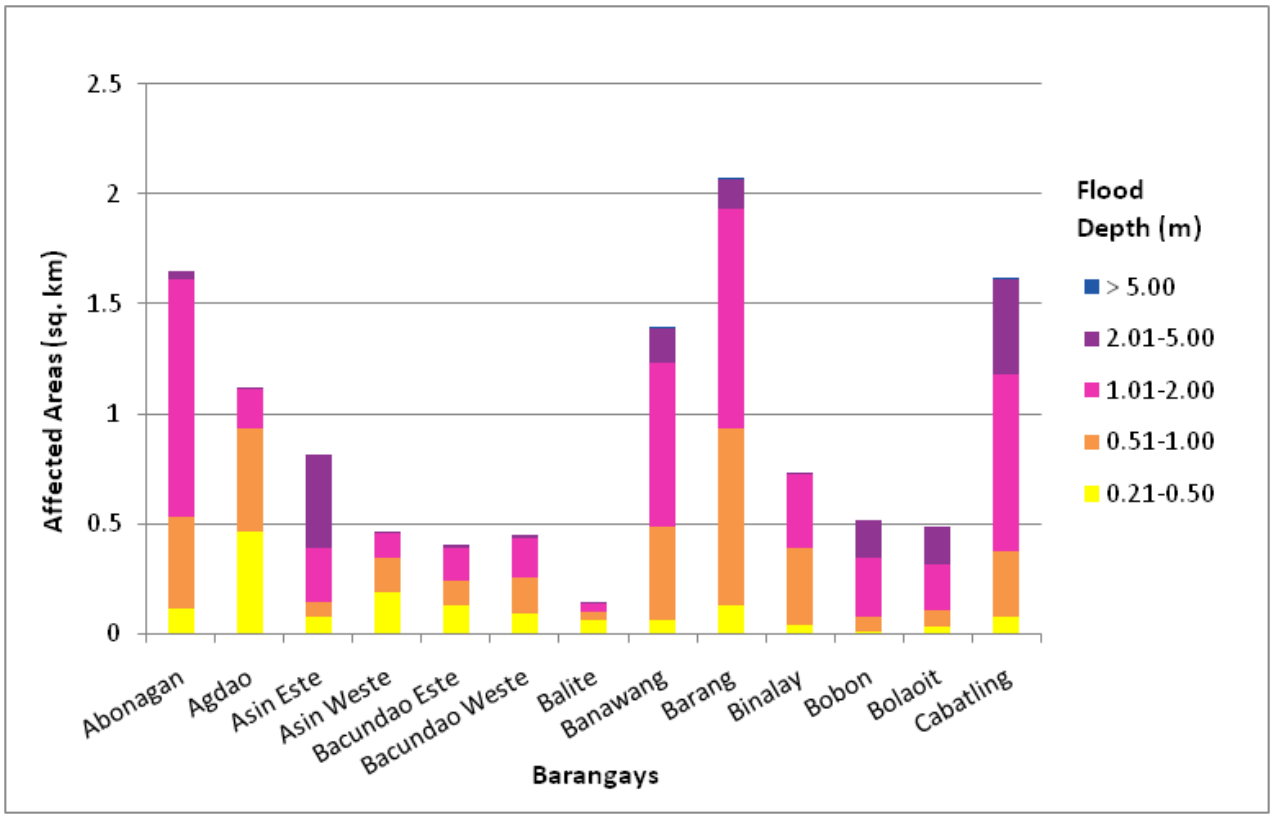
For the 100-year return period, 12.63% of the municipality of Malasiqui with an area of 124.805404 sq. km. will experience flood levels of less than 0.20 meters. 5.01% of the area will experience flood levels of 0.21 to 0.50 meters while 7.92%, 9.21%, 2.03%, and 0.02% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

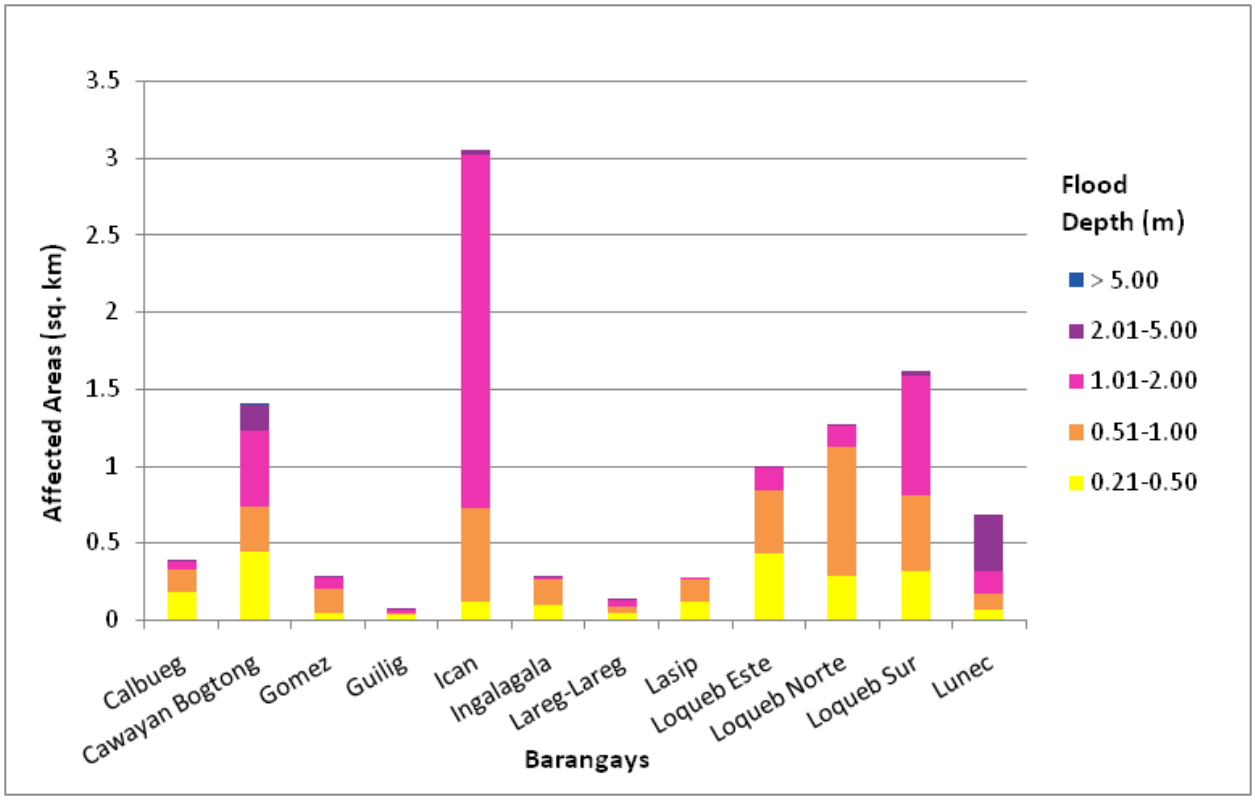
Table 45. Affected Areas in Malasiqui, Pangasinan during 100-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Malasiqui (in sq. km)												
	Abonagan	Agdao	Asin Este	Asin Weste	Bacundao Este	Bacundao Weste	Balite	Banawang	Barang	Binalay	Bobon	Bolaoit	Cabatling
0.03-0.20	0.0078	0.76	0.55	0.94	1.89	1.23	0.85	0.017	0.067	0.0044	0.0002	0.0025	0.013
0.21-0.50	0.11	0.46	0.076	0.19	0.13	0.091	0.056	0.063	0.13	0.036	0.0096	0.032	0.072
0.51-1.00	0.42	0.47	0.069	0.15	0.11	0.16	0.042	0.42	0.8	0.35	0.062	0.072	0.3
1.01-2.00	1.08	0.18	0.24	0.12	0.15	0.18	0.04	0.75	1	0.34	0.27	0.21	0.81
2.01-5.00	0.038	0.007	0.43	0.0017	0.014	0.014	0.0072	0.16	0.14	0.0026	0.17	0.17	0.43
> 5.00	0	0	0	0	0	0	0	0.0015	0.0012	0	0	0	0.0085

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Malasiqui (in sq. km)											
	Calbueg	Cawayan Bogtong	Gomez	Guilig	Ican	Ingalagala	Lareg-Lareg	Lasip	Loqueb Este	Loqueb Norte	Loqueb Sur	Lunec
0.03-0.20	0.69	0.95	0.028	0.092	0.074	0.065	0.74	0.17	0.7	0.09	0.096	0.51
0.21-0.50	0.18	0.44	0.041	0.031	0.12	0.099	0.039	0.12	0.43	0.28	0.31	0.067
0.51-1.00	0.14	0.29	0.16	0.013	0.6	0.16	0.043	0.14	0.41	0.84	0.5	0.1
1.01-2.00	0.07	0.5	0.079	0.024	2.3	0.019	0.043	0.0073	0.15	0.14	0.77	0.15
2.01-5.00	0.0015	0.16	0.0001	0.0036	0.028	0.0004	0.0085	0	0.0004	0.0029	0.031	0.36
> 5.00	0	0.0091	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Malasiqui (in sq. km)											
	Manggan-Dampay	Pasima	Poblacion	Polong Norte	Potiocan	Tabo-Sili	Talospatang	Taloy	Taloyan	Tambac	Tolonguat	Viado
0.03-0.20	0.57	0.65	0.053	0.13	0.18	0.53	0.0051	0.46	1.65	0.14	0.83	0.032
0.21-0.50	0.21	0.64	0.12	0.11	0.46	0.027	0.01	0.36	0.09	0.19	0.34	0.085
0.51-1.00	0.29	0.12	0.22	0.093	1.09	0.025	0.13	0.097	0.1	0.44	0.17	0.29
1.01-2.00	0.22	0.029	0.18	0.016	0.31	0.02	0.23	0.057	0.06	0.53	0.0002	0.22
2.01-5.00	0.0019	0.013	0.065	0	0	0.0003	0.0065	0.079	0.013	0.17	0	0.000096
> 5.00	0	0	0.0014	0	0	0	0.00066	0	0	0.0066	0	0


2.5
2
1.5
1
0.5
0
Affected Areas (sq. km)
Abonagan
Agdao
Asin Este
Asin Weste
Bacundao Este
Bacundao Weste
Balite
Banawang
Barang
Binalay
Bobon
Bolaoit
Cabatling
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50


3.5
3
2.5
2
1.5
1
0.5
0
Affected Areas (sq. km)
Calbueg
Cawayan Bogtong
Gomez
Guilig
Ican
Ingalagala
Lareg-Lareg
Lasip
Loqueb Este
Loqueb Norte
Loqueb Sur
Lunec
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50

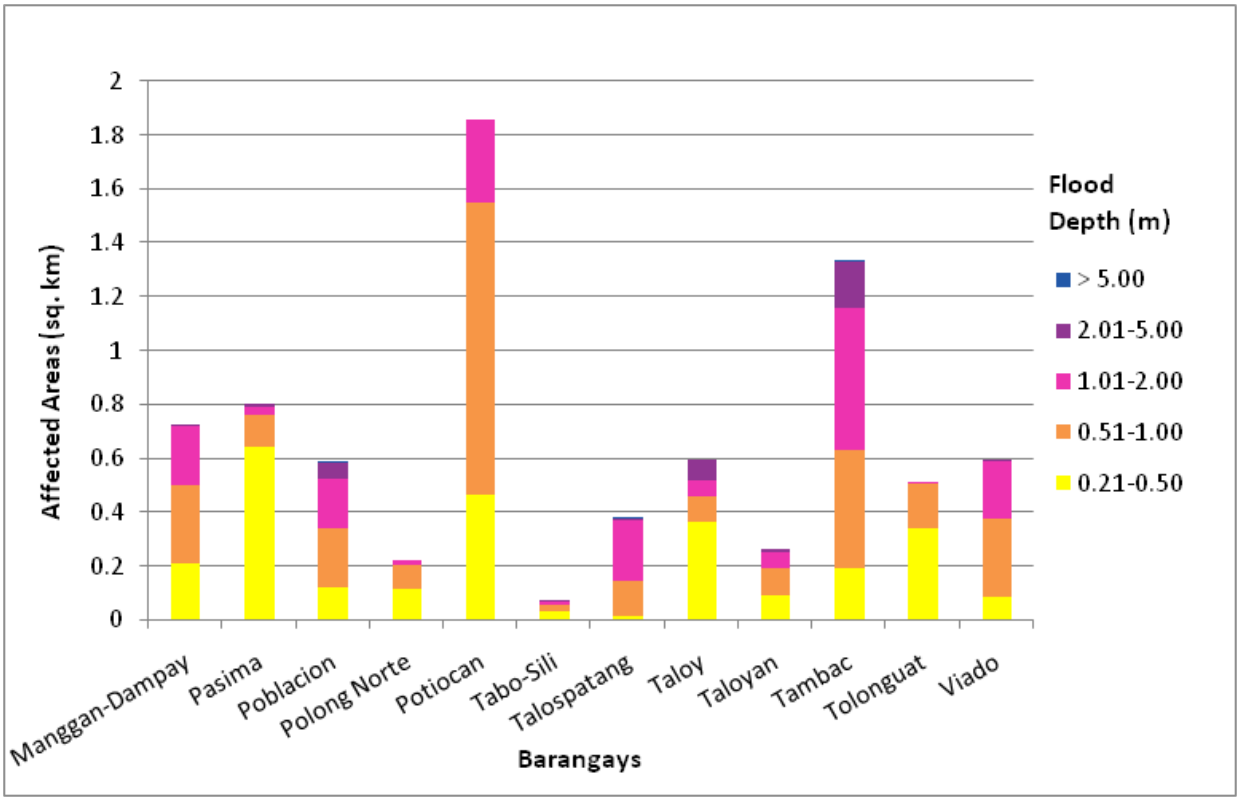


Figure. 109. Affected Areas in Malasiqui, Pangasinan during 100-Year Rainfall Return Period

For the 100-year return period, 0.00% of the municipality of Manaoag with an area of 42.418932 sq. km. will experience flood levels of less than 0.20 meters. 0.00% of the area will experience flood levels of 0.21 to 0.50 meters while 0.00%, 0.26%, and 0.19% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 46. Affected Areas in Manaoag, Pangasinan during 100-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Manaoag (in sq. km) Baguinay
0.03-0.20	0.0003
0.21-0.50	0.0001
0.51-1.00	0.0018
1.01-2.00	0.11
2.01-5.00	0.082
> 5.00	0

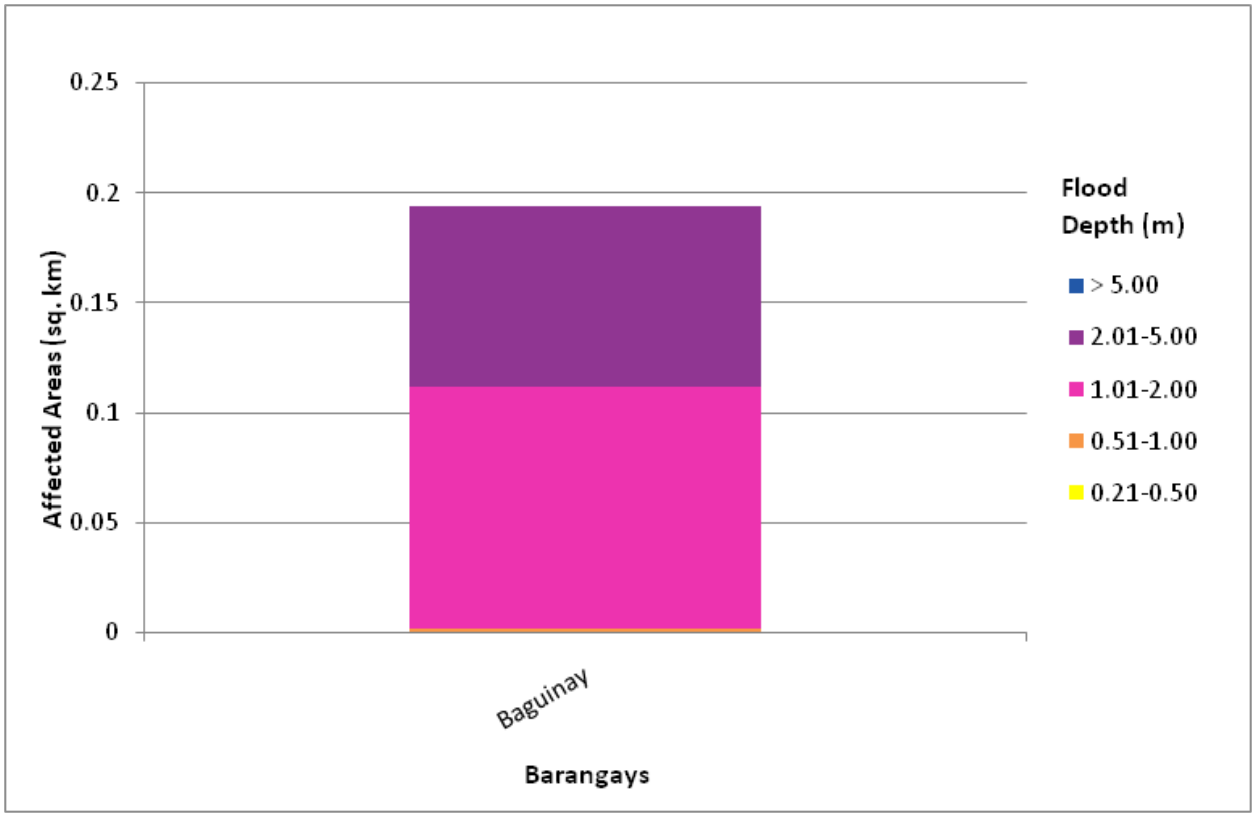


Figure. 110. Affected Areas in Manaoag, Pangasinan during 100-Year Rainfall Return Period

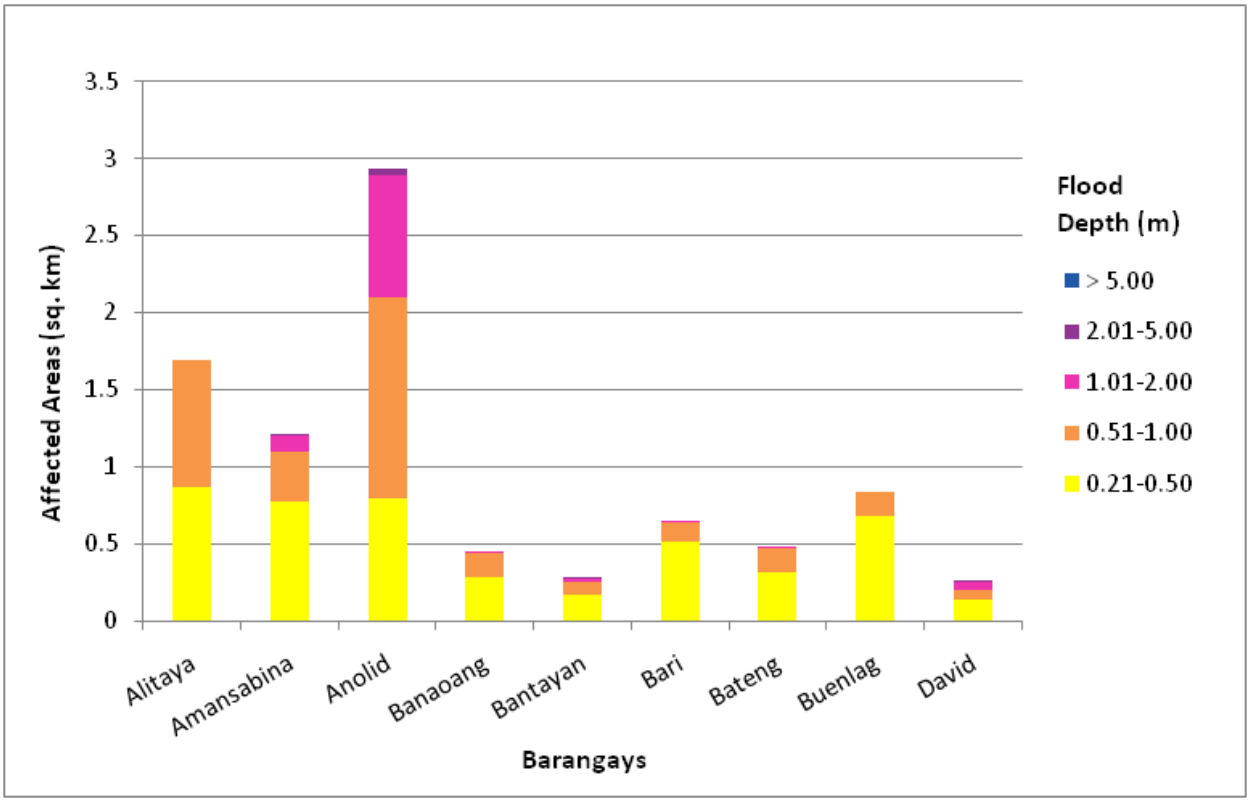
For the 100-year return period, 38.88% of the municipality of Mangaldan with an area of 43.415808 sq. km. will experience flood levels of less than 0.20 meters. 26.70% of the area will experience flood levels of 0.21 to 0.50 meters while 11.36%, 3.01%, and 0.22% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

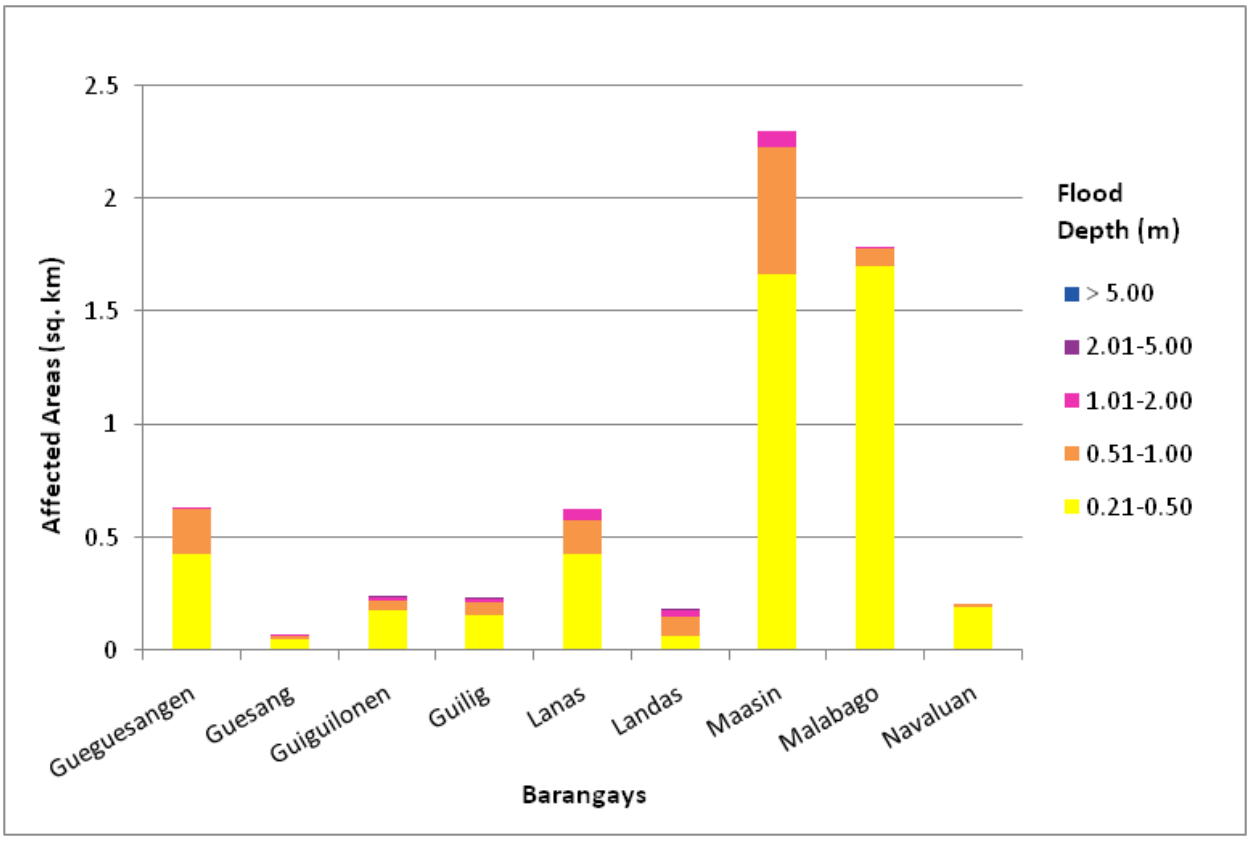
Table 47. Affected Areas in Mangaldan, Pangasinan during 100-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Mangaldan (in sq. km)								
	Alitaya	Amansabina	Anolid	Banaoang	Bantayan	Bari	Bateng	Buenlag	David
0.03-0.20	0.91	1.29	0.67	0.29	0.38	0.9	0.97	0.92	0.52
0.21-0.50	0.87	0.77	0.79	0.28	0.17	0.51	0.31	0.68	0.14
0.51-1.00	0.82	0.33	1.31	0.17	0.081	0.14	0.17	0.16	0.06
1.01-2.00	0	0.099	0.79	0.0038	0.025	0.0003	0.0025	0	0.056
2.01-5.00	0	0.0097	0.041	0	0.0083	0	0	0	0.01
> 5.00	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Mangaldan (in sq. km)								
	Gueguesangen	Guesang	Guiguilonen	Guilig	Lanas	Landas	Maasin	Malabago	Navaluan
0.03-0.20	0.59	0.21	0.47	0.36	0.69	0.11	1.44	1.5	0.33
0.21-0.50	0.43	0.048	0.18	0.16	0.43	0.063	1.67	1.7	0.19
0.51-1.00	0.2	0.018	0.044	0.054	0.15	0.09	0.56	0.087	0.015
1.01-2.00	0.0043	0.0024	0.02	0.019	0.048	0.033	0.07	0.0002	0
2.01-5.00	0	0	0.0007	0.0045	0	0.00059	0	0	0
> 5.00	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Mangaldan (in sq. km)								
	Nibaliw	Osiem	Palua	Poblacion	Pogo	Salaan	Salay	Talogtog	Tebag
0.03-0.20	0.33	0.29	0.2	0.44	0.72	0.22	0.45	1.48	0.2
0.21-0.50	0.13	0.076	0.1	0.2	0.3	0.082	0.24	1	0.072
0.51-1.00	0.023	0.0015	0.032	0.1	0.093	0.0042	0.17	0.024	0.025
1.01-2.00	0.0029	0	0.00086	0.033	0.01	0	0.079	0.0001	0.0058
2.01-5.00	0.0008	0	0	0	0.0017	0	0.016	0	0.0006
> 5.00	0	0	0	0	0	0	0	0	0


3.5
3
2.5
2
1.5
1
0.5
0
Affected Areas (sq. km)
Alitaya
Amansabina
Anolid
Banaoang
Bantayan
Bari
Bateng
Buenlag
David
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50


2.5
2
1.5
1
0.5
0
Affected Areas (sq. km)
Gueguesangen
Guesang
Guiguilonen
Guilig
Lanas
Landas
Maasin
Malabago
Navaluan
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50

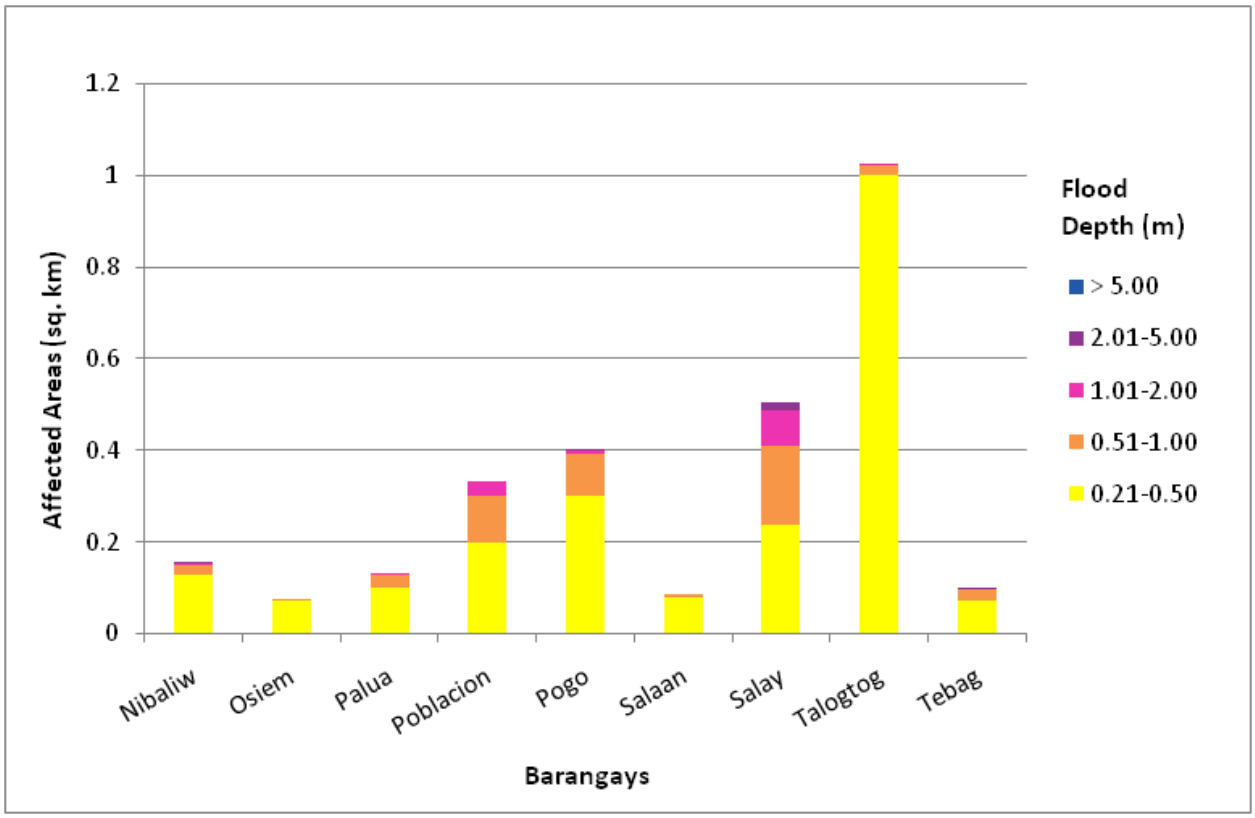


Figure. 111. Affected Areas in Mangaldan, Pangasinan during 100-Year Rainfall Return Period

For the 100-year return period, 36.13% of the municipality of Mapandan with an area of 21.351923 sq. km. will experience flood levels of less than 0.20 meters. 12.85% of the area will experience flood levels of 0.21 to 0.50 meters while 5.74%, 2.51%, and 5.06% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 48. Affected Areas in Mapandan, Pangasinan during 100-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Mapandan (in sq. km)											
	Amanoaoac	Apaya	Aserda	Coral	Golden	Jimenez	Lambayan	Luyan	Nilombot	Pias	Primicias	Torres
0.03-0.20	0.49	0.16	0.43	0.0051	0.35	0.73	1.13	0.82	1.29	1.07	0.69	0.55
0.21-0.50	0.31	0.028	0.17	0	0.085	0.36	0.17	0.32	0.53	0.27	0.17	0.33
0.51-1.00	0.12	0.0001	0.014	0	0.014	0.23	0.24	0.047	0.051	0.09	0.11	0.31
1.01-2.00	0.019	0	0.0031	0	0.00038	0.098	0.12	0.0029	0.0005	0.015	0.24	0.036
2.01-5.00	0	0	0	0	0	0.0002	0.12	0	0	0.0002	0.96	0.0004
> 5.00	0	0	0	0	0	0	0	0	0	0	0	0

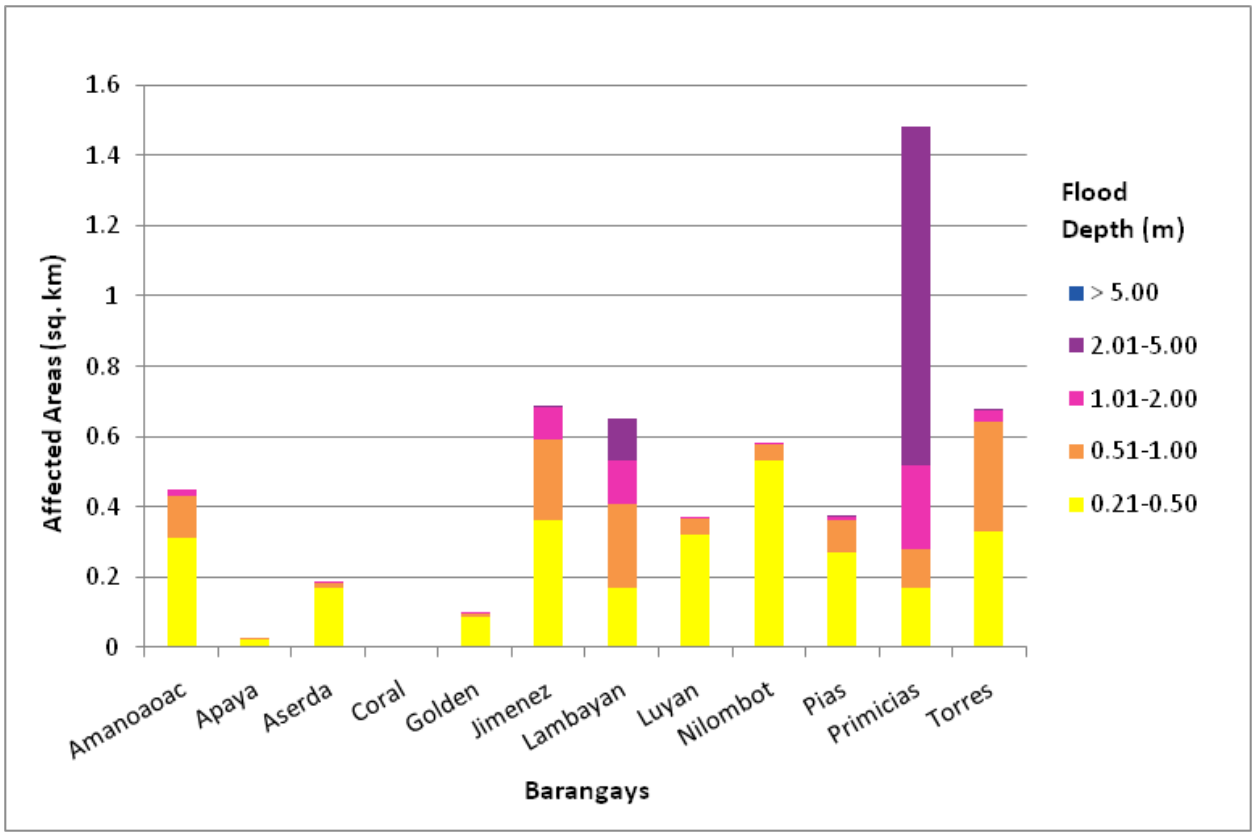


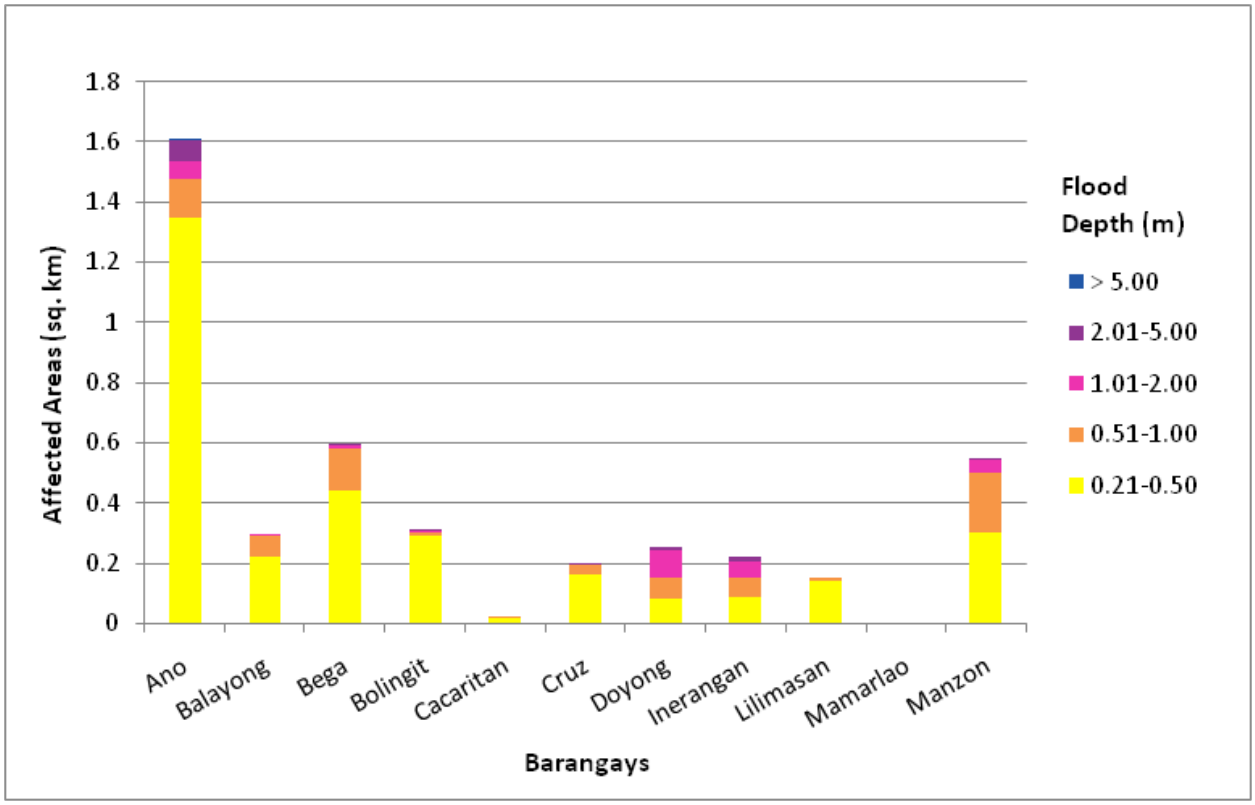
Figure. 112. Affected Areas in Mapandan, Pangasinan during 100-Year Rainfall Return Period

For the 100-year return period, 9.47% of the municipality of San Carlos City with an area of 151.284206 sq. km. will experience flood levels of less than 0.20 meters. 4.63% of the area will experience flood levels of 0.21 to 0.50 meters while 1.24%, 0.28%, and 0.11% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 49. Affected Areas in San Carlos City, Pangasinan during 100-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Carlos City (in sq. km)										
	Ano	Balayong	Bega	Bolingit	Cacaritan	Cruz	Doyong	Inerangan	Lilimasan	Mamarlao	Manzon
0.03-0.20	1.25	0.69	0.76	0.51	0.16	0.44	0.76	0.38	0.22	6.2E-06	0.42
0.21-0.50	1.35	0.22	0.44	0.29	0.02	0.16	0.081	0.088	0.14	0	0.3
0.51-1.00	0.13	0.071	0.14	0.017	0.0002	0.032	0.067	0.061	0.0094	0	0.2
1.01-2.00	0.059	0.0022	0.016	0.0013	0	0.0087	0.093	0.057	0	0	0.046
2.01-5.00	0.071	0	0.00074	0.0016	0	0.0003	0.014	0.014	0	0	0.0022
> 5.00	0.0044	0	0	0	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Carlos City (in sq. km)									
	Matagdem	Naguilayan	Nilentap	Pagal	Palaming	Pangalangan	Parayao	Quintong	Tandoc	Tarece
0.03-0.20	1.33	0.38	0.73	1.52	1.58	1.24	0.25	0.48	0.56	0.66
0.21-0.50	0.53	0.19	0.19	0.65	0.45	0.48	0.23	0.33	0.33	0.54
0.51-1.00	0.15	0.05	0.057	0.29	0.16	0.21	0.022	0.13	0.073	0.0083
1.01-2.00	0.038	0.0026	0.019	0.012	0.017	0.054	0.0014	0.000065	0.0003	0.00017
2.01-5.00	0.0031	0.0016	0.051	0.0012	0.0056	0.0037	0	0	0.0016	0
> 5.00	0	0	0	0	0	0	0	0	0	0



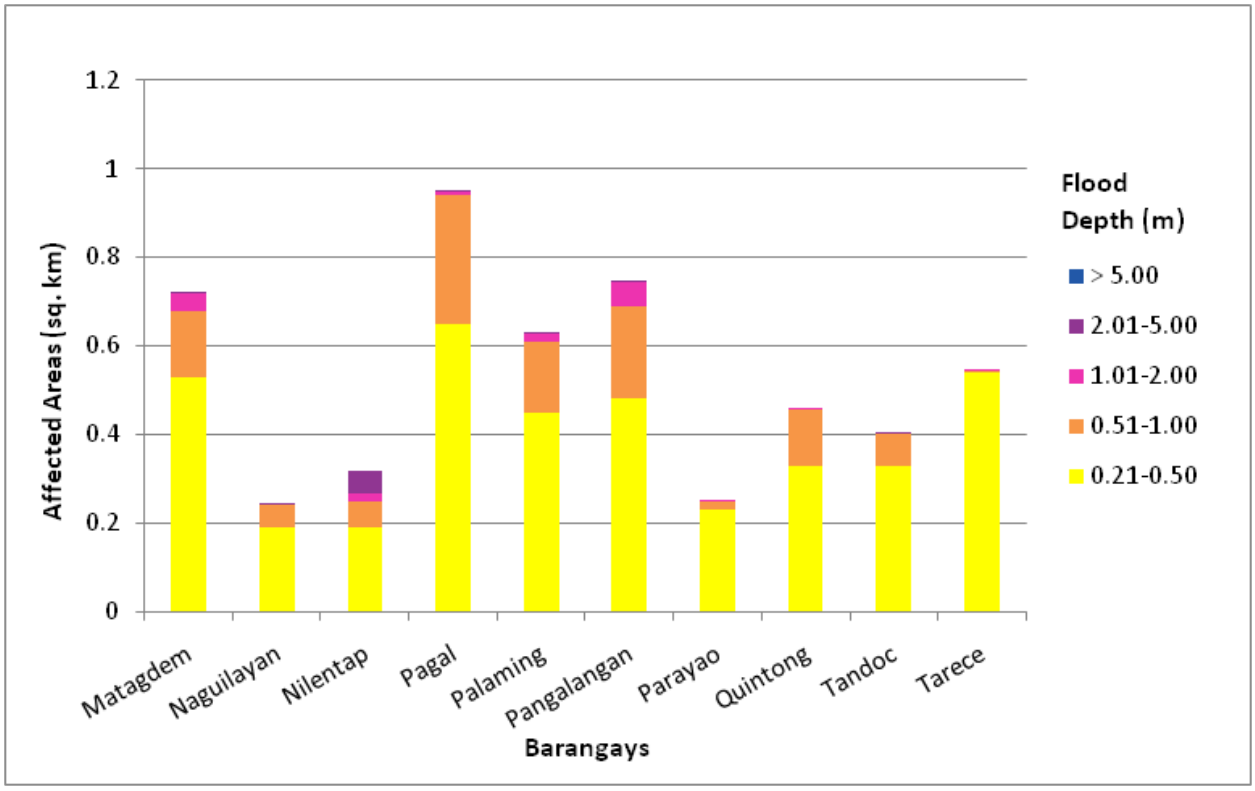


Figure. 113. Affected Areas in San Carlos City, Pangasinan during 100-Year Rainfall Return Period

For the 100-year return period, 0.04% of the municipality of San Fabian with an area of 69.270236 sq. km. will experience flood levels of less than 0.20 meters. 0.00% of the area will experience flood levels of 0.21 to 0.50 meters while 0.00% of the area will experience flood depths of 0.51 to 1 meter. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 50. Affected Areas in San Fabian, Pangasinan during 100-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Fabian (in sq. km)	
	Lekep-Butao	Longos
0.03-0.20	0.024	0.0039
0.21-0.50	0.00096	0
0.51-1.00	0	0
1.01-2.00	0	0
2.01-5.00	0	0
> 5.00	0	0

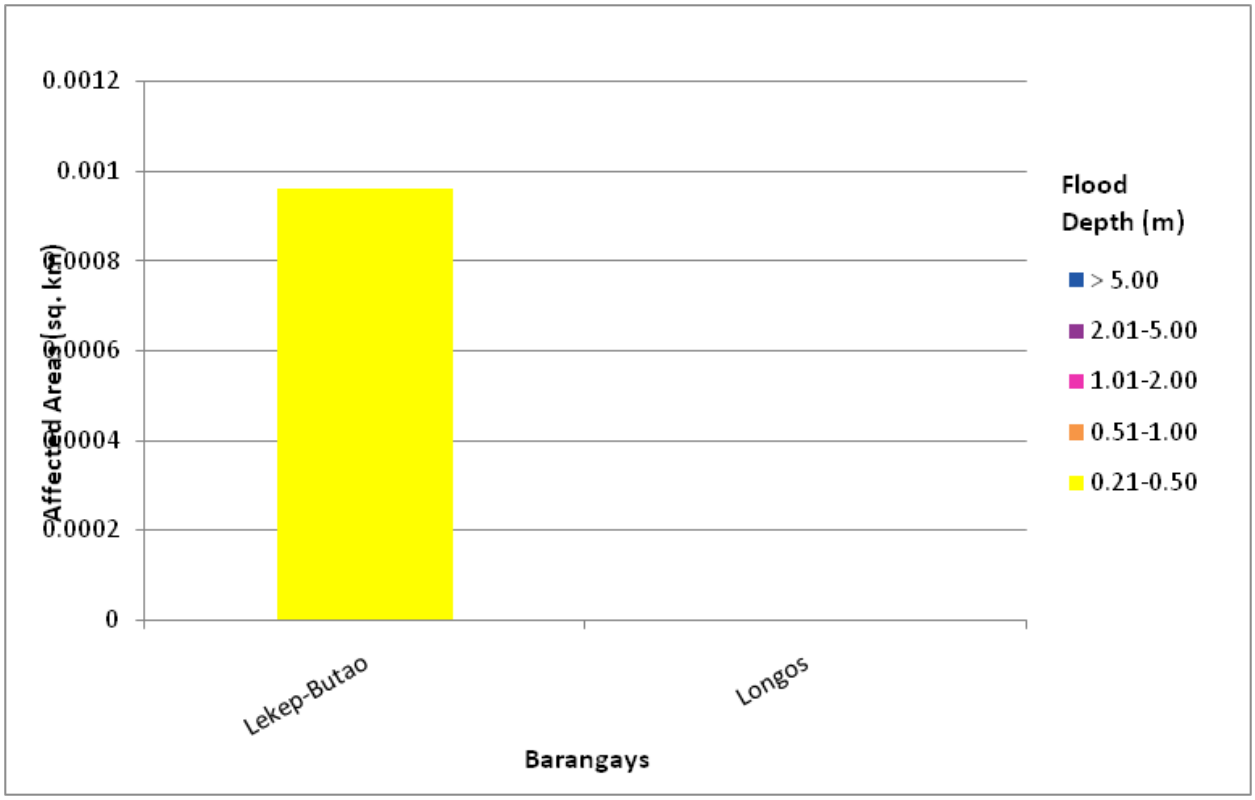


Figure. 114. Affected Areas in San Fabian, Pangasinan during 100-Year Rainfall Return Period

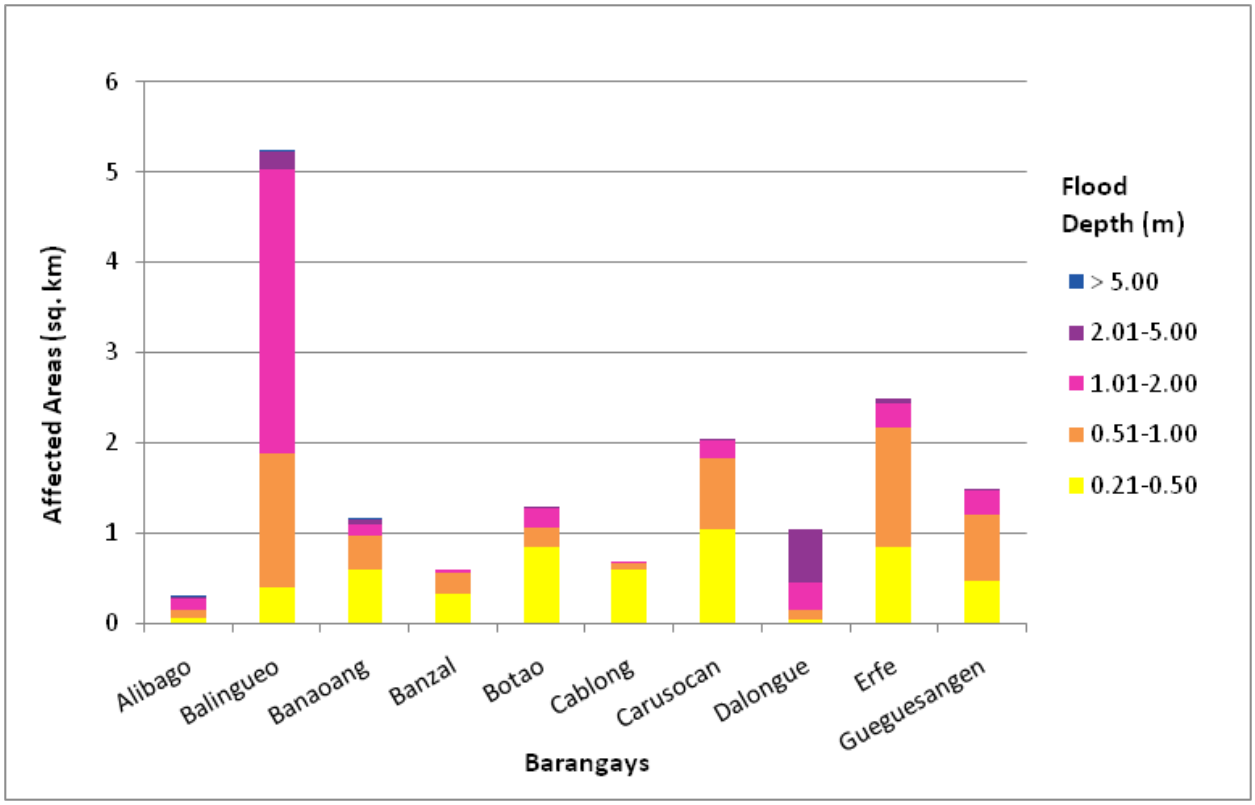
For the 100-year return period, 22.77% of the municipality of Santa Barbara with an area of 64.714151 sq. km. will experience flood levels of less than 0.20 meters. 20.02% of the area will experience flood levels of 0.21 to 0.50 meters while 23.60%, 24.30%, 8.91%, and 0.37% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

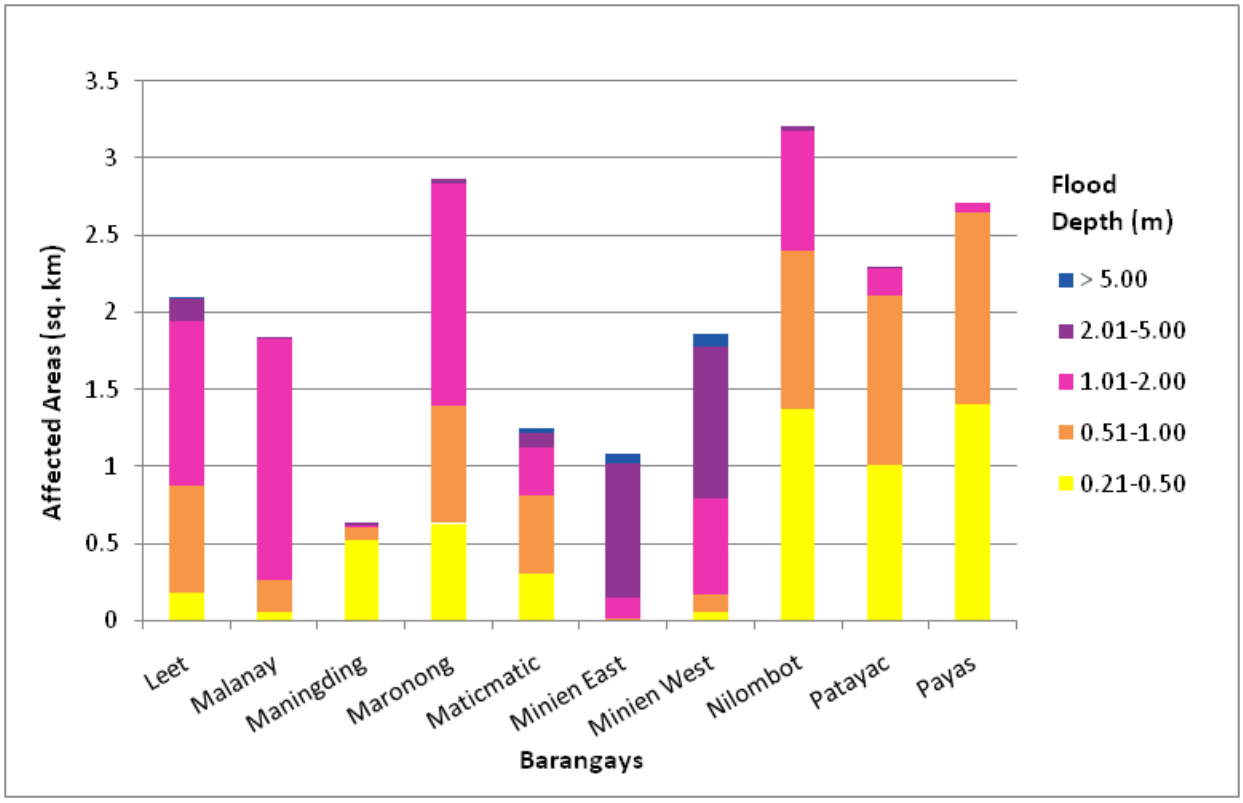
Table 51. Affected Areas in Santa Barbara, Pangasinan during 100-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Santa Barbara (in sq. km)									
	Alibago	Balingueo	Banaoang	Banzal	Botao	Cablong	Carusocan	Dalongue	Erfe	Gueguesangen
0.03-0.20	0.14	0.33	1.03	0.5	1.39	1.1	1.02	0.099	0.44	0.52
0.21-0.50	0.046	0.39	0.59	0.32	0.84	0.6	1.04	0.043	0.84	0.46
0.51-1.00	0.096	1.49	0.38	0.24	0.22	0.079	0.78	0.1	1.32	0.74
1.01-2.00	0.13	3.16	0.12	0.037	0.22	0.0001	0.21	0.3	0.28	0.28
2.01-5.00	0.031	0.2	0.066	0	0.015	0	0.003	0.59	0.058	0.0001
> 5.00	0.00019	0.001	0.0073	0	0	0	0	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Santa Barbara (in sq. km)									
	Leet	Malanay	Maningding	Maronong	Maticmatic	Minien East	Minien West	Nilombot	Patayac	Payas
0.03-0.20	0.33	0.042	1.04	0.33	0.21	0.0099	0.3	1.54	0.78	1.02
0.21-0.50	0.18	0.057	0.52	0.63	0.3	0.0032	0.057	1.37	1.01	1.4
0.51-1.00	0.69	0.2	0.084	0.76	0.51	0.0091	0.11	1.03	1.1	1.25
1.01-2.00	1.07	1.58	0.0037	1.45	0.31	0.13	0.62	0.78	0.18	0.065
2.01-5.00	0.16	0.0027	0.031	0.025	0.09	0.88	0.99	0.028	0.003	0
> 5.00	0.0007	0	0	0	0.032	0.054	0.079	0	0	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Santa Barbara (in sq. km)								
	Poblacion Norte	Poblacion Sur	Primicias	Sapang	Sonquil	Tebag East	Tebag West	Tuliao	Ventinilla
0.03-0.20	0.22	0.26	0.085	0.63	0.008	0.44	0.25	0.11	0.56
0.21-0.50	0.058	0.095	0.13	0.62	0.015	0.23	0.22	0.13	0.76
0.51-1.00	0.093	0.061	0.08	0.36	0.099	0.47	0.37	0.95	1.6
1.01-2.00	0.061	0.028	0.0077	0.11	2.33	0.5	0.26	0.92	0.58
2.01-5.00	0.0068	0.004	0.001	0.0094	2.43	0.051	0.046	0.0031	0.043
> 5.00	0	0	0	0	0	0.029	0.036	0.00021	0


Affected Areas (sq. km)
6
5
4
3
2
1
0
Alibago
Balingueo
Banaoang
Banzal
Botao
Cablong
Carusocan
Dalongue
Erfe
Gueguesangen
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50


Affected Areas (sq. km)
3.5
3
2.5
2
1.5
1
0.5
0
Leet
Malanay
Maningding
Maronong
Maticmatic
Minien East
Minien West
Nilombot
Patayac
Payas
Barangays
Flood Depth (m)
> 5.00
2.01-5.00
1.01-2.00
0.51-1.00
0.21-0.50

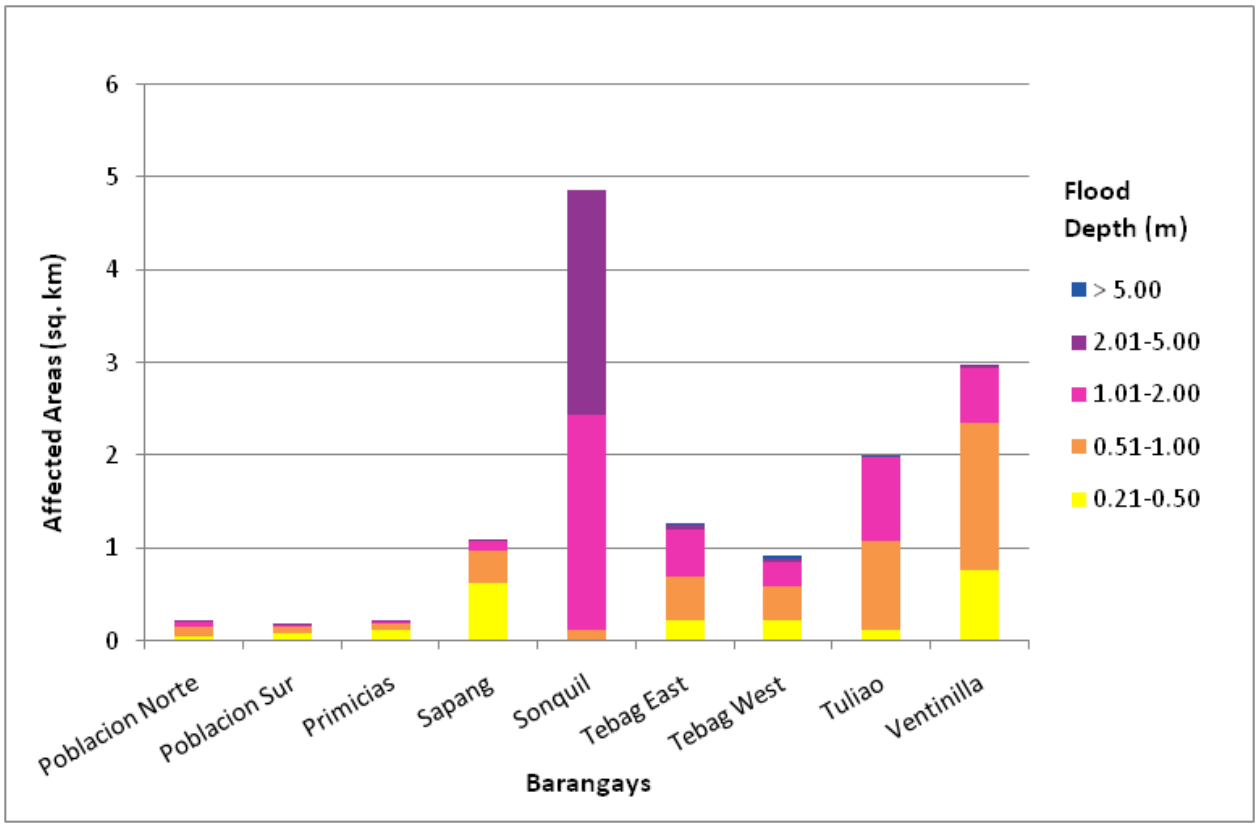


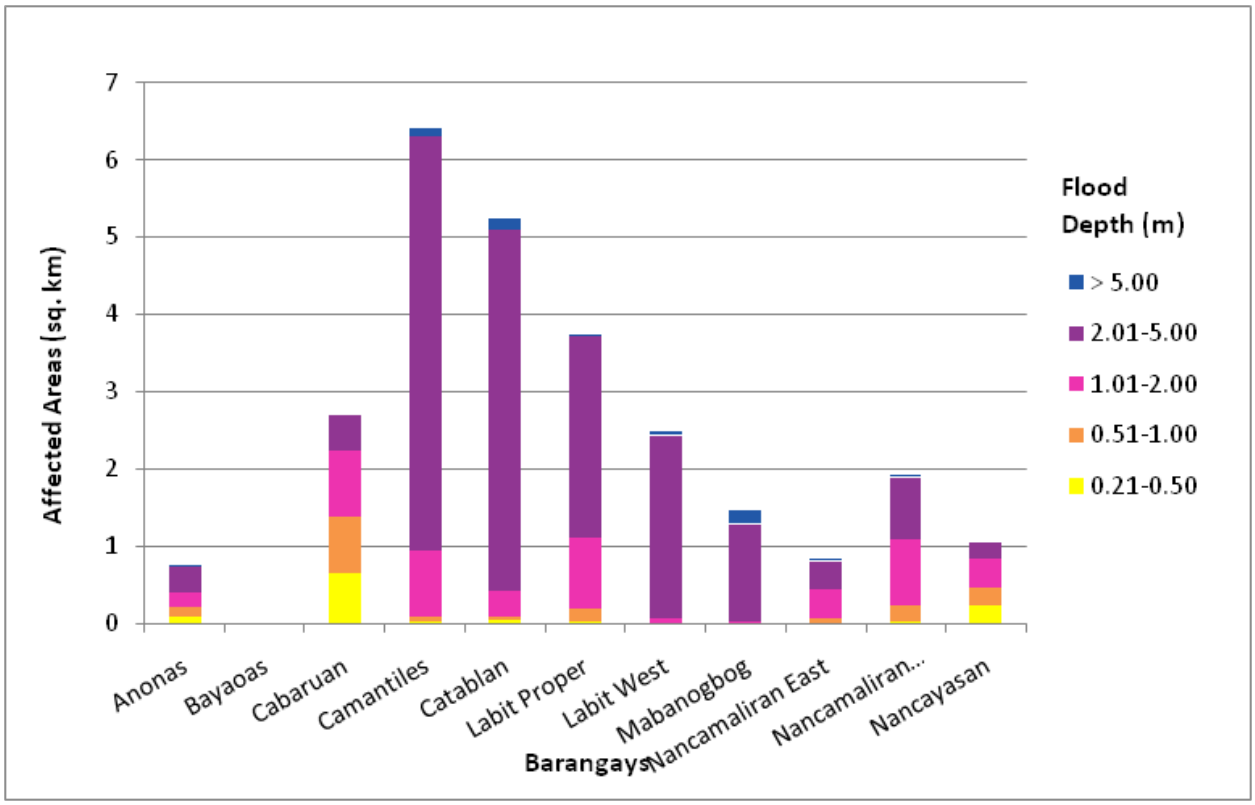
Figure. 115. Affected Areas in Santa Barbara, Pangasinan during 100-Year Rainfall Return Period

For the 100-year return period, 5.80% of the municipality of Urdaneta City with an area of 107.789848 sq. km. will experience flood levels of less than 0.20 meters. 2.23% of the area will experience flood levels of 0.21 to 0.50 meters while 4.32%, 10.63%, 32.99%, and 0.92% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 52. Affected Areas in Urdaneta City, Pangasinan during 100-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Urdaneta City (in sq. km)										
	Anonas	Bayaoas	Cabaruan	Camantiles	Catablan	Labit Proper	Labit West	Mabanogbog	Nancamaliran East	Nancamaliran West	Nancayasan
0.03-0.20	0.067	0.0009	2.47	0.035	0.2	0.016	0.0002	0.0011	0.0001	0.0023	0.4
0.21-0.50	0.094	0.00023	0.65	0.029	0.04	0.024	0.0005	0.0012	0.0021	0.015	0.24
0.51-1.00	0.13	0.00076	0.73	0.063	0.054	0.17	0.0001	0.0046	0.063	0.23	0.23
1.01-2.00	0.18	0.011	0.87	0.85	0.34	0.93	0.065	0.018	0.39	0.85	0.38
2.01-5.00	0.35	0.00085	0.46	5.36	4.66	2.61	2.37	1.27	0.36	0.8	0.2
> 5.00	0.0036	0	0	0.11	0.15	0.0008	0.041	0.17	0.014	0.033	0

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Urdaneta City (in sq. km)										
	Oltama	Palina East	Palina West	Pinmaludpod	Poblacion	San Jose	San Vicente	Santo Domingo	Sugcong	Tulong	Santa Lucia
0.03-0.20	2.12	0.28	0.0049	0.061	0.0009	0.0001	0.0021	0.00061	0.57	0.018	0
0.21-0.50	0.23	0.31	0.078	0.11	0.0024	0.0038	0.0073	0.00011	0.54	0.024	0.00035
0.51-1.00	0.28	0.53	0.71	0.53	0.053	0.012	0.0064	0.024	0.78	0.043	0.0073
1.01-2.00	0.41	0.39	1.3	1.34	0.8	0.075	0.025	0.5	0.97	0.25	0.51
2.01-5.00	0.53	0.062	0.77	8.53	0.85	3.63	0.97	0.11	0.26	1	0.41
> 5.00	0.00043	0	0	0.22	0.051	0.047	0.062	0	0	0.088	0



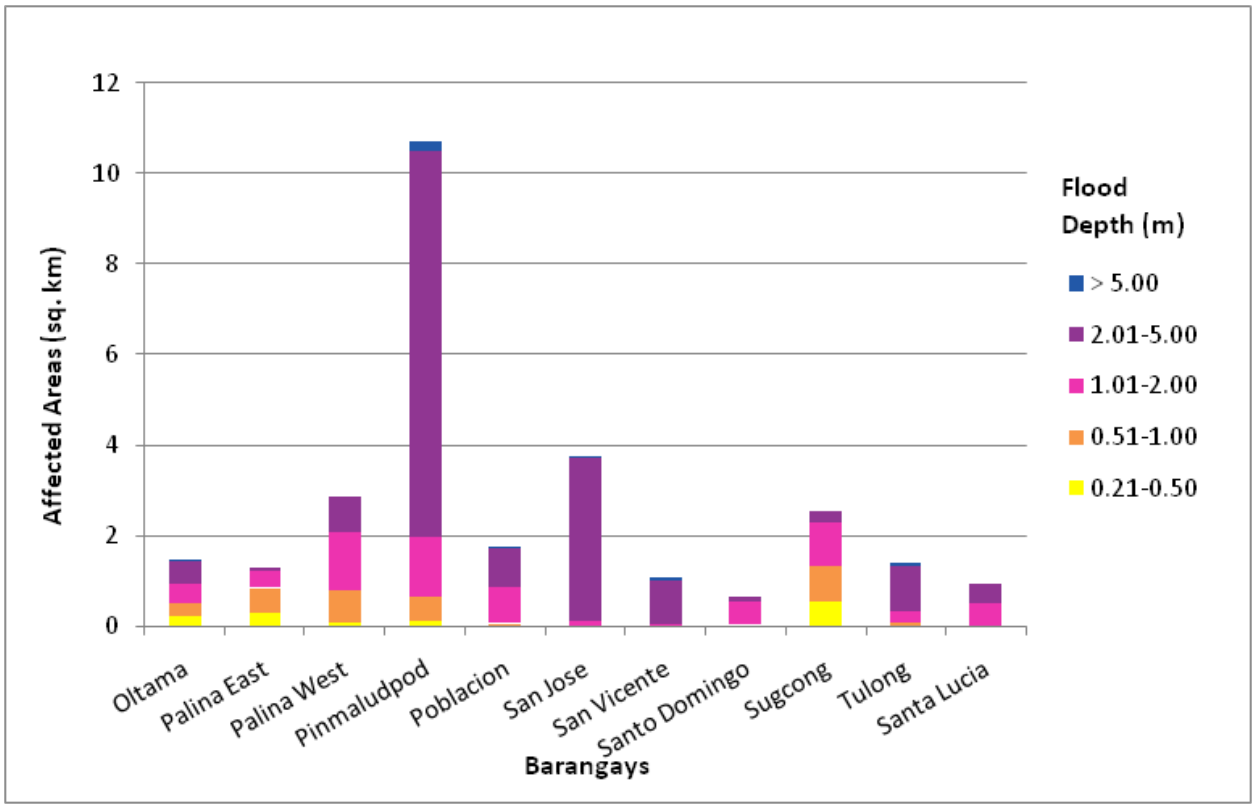


Figure. 116. Affected Areas in Urdaneta City, Pangasinan during 100-Year Rainfall Return Period

For the 100-year return period, 8.89% of the municipality of Villasis with an area of 76.039344 sq. km. will experience flood levels of less than 0.20 meters. 2.67% of the area will experience flood levels of 0.21 to 0.50 meters while 4.00%, 4.84%, and 0.30% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 53. Affected Areas in Villasis, Pangasinan during 100-Year Rainfall Return Period

Affected Area (sq. km.) by flood depth (in m.)	Area of affected barangays in Villasis (in sq. km)					
	Barraca	Capulaan	La Paz	Labit	Tombod	Unzad
0.03-0.20	0.07	0.23	2.81	1.64	0.19	1.82
0.21-0.50	0.51	0.074	0.25	0.32	0.43	0.45
0.51-1.00	1.36	0.14	0.16	0.3	0.86	0.22
1.01-2.00	1.24	0.04	0.12	0.45	1.69	0.14
2.01-5.00	0.049	0.0006	0.018	0.02	0.14	0.0039
> 5.00	0	0	0	0.0006	0	0

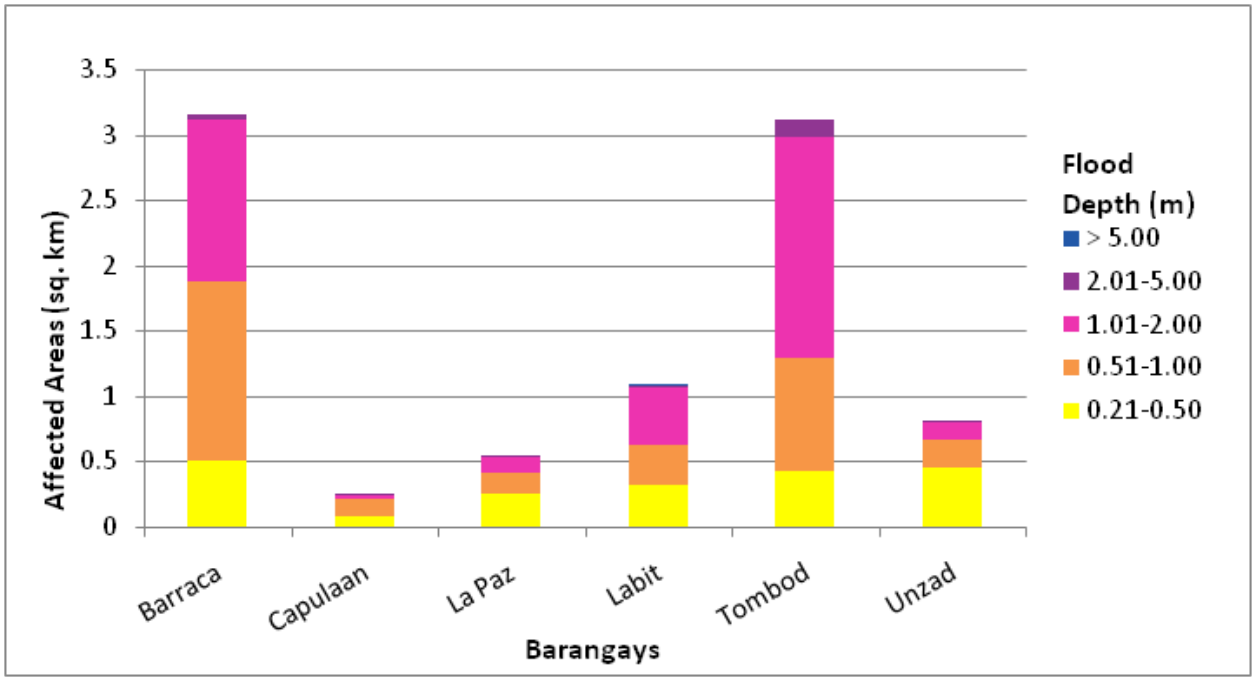


Figure. 117. Affected Areas in Villasis, Pangasinan during 100-Year Rainfall Return Period

Among the barangays in the municipality of Binmaley in Pangasinan, Linoc is projected to have the highest percentage of area that will experience flood levels at 7.50%. Meanwhile, Naguilayan posted the second highest percentage of area that may be affected by flood depths at 4.00%.

Among the barangays in the municipality of Calasiao in Pangasinan, Macabito is projected to have the highest percentage of area that will experience flood levels at 7.55%. Meanwhile, Lasip posted the second highest percentage of area that may be affected by flood depths at 6.16%.

Among the barangays in the municipality of Dagupan City in Pangasinan, Bonuan Boquig is projected to have the highest percentage of area that will experience flood levels at 7.77%. Meanwhile, Bonuan Gueset posted the second highest percentage of area that may be affected by flood depths at 7.54%.

Brgy. Yatyat is the only barangay affected in the municipality of Laoac in Pangasinan. The barangay is projected to experience flood in 0.37% of the municipality.

Among the barangays in the municipality of Malasiqui in Pangasinan, Ican is projected to have the highest percentage of area that will experience flood levels at 5.05%. Meanwhile, Cawayan Bogtong posted the second highest percentage of area that may be affected by flood depths at 3.80%.

Brgy. Baguinay is the only barangay affected in the municipality of Manaoag in Pangasinan. The barangay is projected to experience flood in 0.31% of the municipality.

Among the barangays in the municipality of Mangaldan in Pangasinan, Maasin is projected to have the highest percentage of area that will experience flood levels at 6.05%. Meanwhile, Anolid posted the second highest percentage of area that may be affected by flood depths at 5.82%.

Among the barangays in the municipality of Mapandan in Pangasinan, Primicias is projected to have the highest percentage of area that will experience flood levels at 3.51%. Meanwhile, Nilombot posted the second highest percentage of area that may be affected by flood depths at 3.03%.

Among the barangays in the municipality of San Carlos City in Pangasinan, Ano is projected to have the highest percentage of area that will experience flood levels at 4.63%. Meanwhile, Pagal posted the second highest percentage of area that may be affected by flood depths at 4.00%.

Among the barangays in the municipality of San Fabian in Pangasinan, Lekep-Butao is projected to have the highest percentage of area that will experience flood levels at 0.04%. Meanwhile, Longos posted the second highest percentage of area that may be affected by flood depths at 0.01%.

Among the barangays in the municipality of Santa Barbara in Pangasinan, Balingueo is projected to have the highest percentage of area that will experience flood levels at 9.01%. Meanwhile, Sonquil posted the second highest percentage of area that may be affected by flood depths at 7.89%.

Among the barangays in the municipality of Urdaneta City in Pangasinan, Pinmaludpod is projected to have the highest percentage of area that will experience flood levels at 17.45%. Meanwhile, Camantiles posted the second highest percentage of area that may be affected by flood depths at 10.43%.

Among the barangays in the municipality of Villasis in Pangasinan, La Paz is projected to have the highest percentage of area that will experience flood levels at 5.43%. Meanwhile, Tombod posted the second highest percentage of area that may be affected by flood depths at 5.35%.

Moreover, the generated flood hazard maps for the Dagupan Floodplain were used to assess the vulnerability of the educational and medical institutions in the floodplain. Using the flood depth units of PAG-ASA for hazard maps (“Low”, “Medium”, and “High”), the affected institutions were given their individual assessment for each Flood Hazard Scenario (5-year, 25-year, and 10-year).

Table 54. Areas covered by each warning level with respect to the rainfall scenarios

Warning Level	Area Covered in sq. km.		
	5 year	25 year	100 year
Low	62.03	81.62	83.27
Medium	55.56	81.14	94.42
High	25.77	52.88	70.18
Total	143.36	215.64	247.87

Of the 877 identified buildings of the Educational Institutions in Dagupan Flood Plain, one hundred sixty six (166) school buildings were discovered exposed to Low-level flooding while twenty seven (27) school buildings were found exposed to Medium-level flooding, both during a 5-year scenario.

For the 25-year scenario, two hundred sixty eight (268) school buildings were discovered exposed to Low-level flooding while one hundred seven (107) school buildings were found exposed to Medium-level flooding. In the same scenario, two (2) school buildings were discovered exposed to High-level flooding.

For the 100-year scenario, three hundred eighteen (318) school buildings were discovered exposed to Low-level flooding while one hundred forty two (142) school buildings were found exposed to Medium-level flooding. In the same scenario, fourteen (14) school buildings were discovered exposed to High-level flooding.

Of the 99 identified buildings of Medical Institutions in Dagupan Flood Plain, six (6) buildings were discovered exposed to Low-level flooding during a 5-year scenario.

For the 25-year scenario, eight (8) buildings were discovered exposed to Low-level flooding while three (3) buildings were found exposed to Medium-level flooding.

For the 100-year scenario, fifteen (15) buildings were discovered exposed to Low-level flooding while four (4) buildings were found exposed to Medium-level flooding.

5.11 Flood Validation

In order to check and validate the extent of flooding in different river systems, there is a need to perform validation survey work. Field personnel gathered secondary data regarding flood occurrence in the area within the river system.

From the Flood Depth Maps produced by Phil-LiDAR 1 Program, multiple points representing the different flood depths for different scenarios were identified for validation.

The validation personnel went to the specified points identified in a river basin and gathered data regarding the actual flood level in each location. Data gathering can be done through a local DRRM office to obtain maps or situation reports about the past flooding events or interview of some residents with knowledge of or have had experienced flooding in a particular area.

After which, the actual data from the field was compared to the simulated data to assess the accuracy of the Flood Depth Maps produced and to improve on what is needed.

The flood validation consists of 180 points randomly selected all over the Dagupan flood plain. It has an RMSE value of 0.56

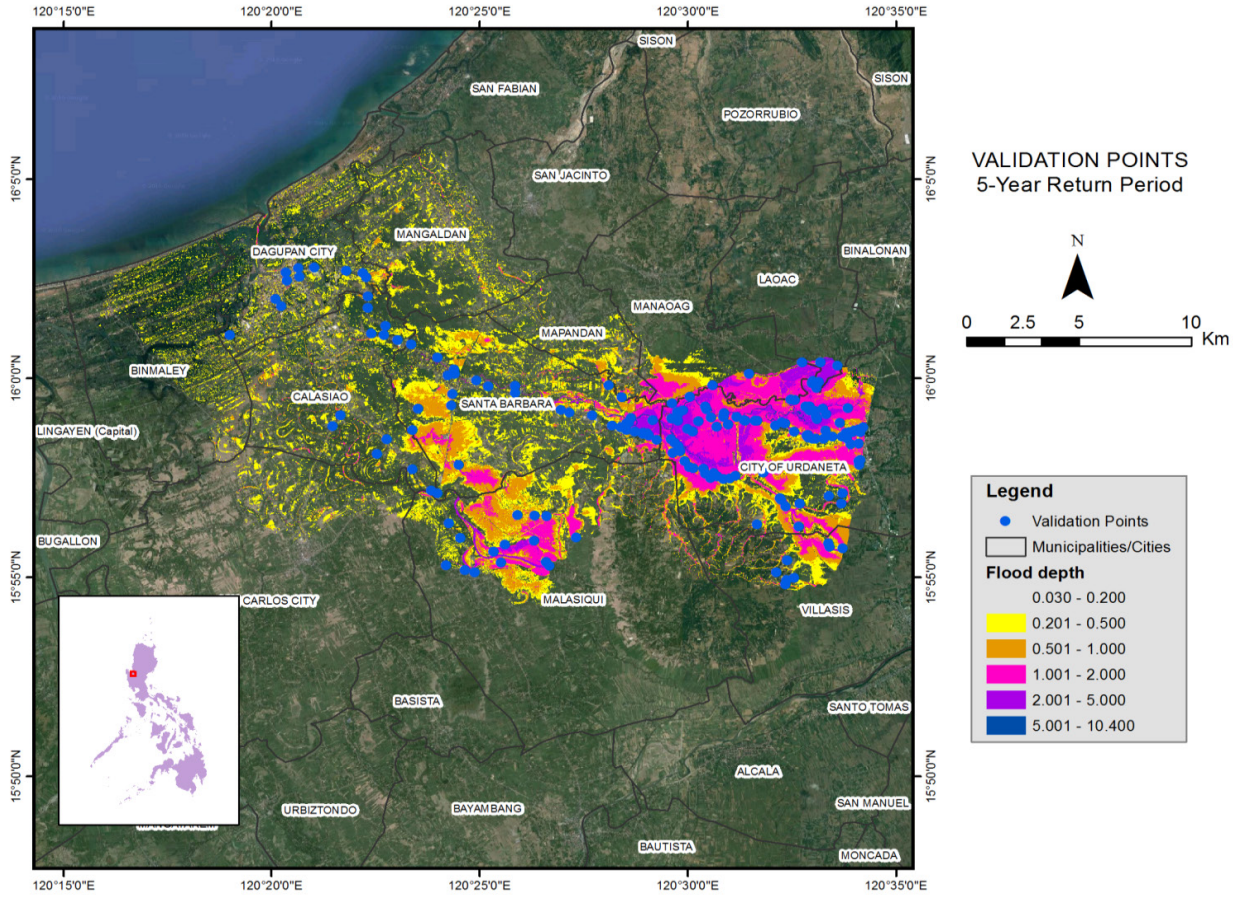


Figure. 118. Validation points for 5-year Flood Depth Map of Dagupan Floodplain

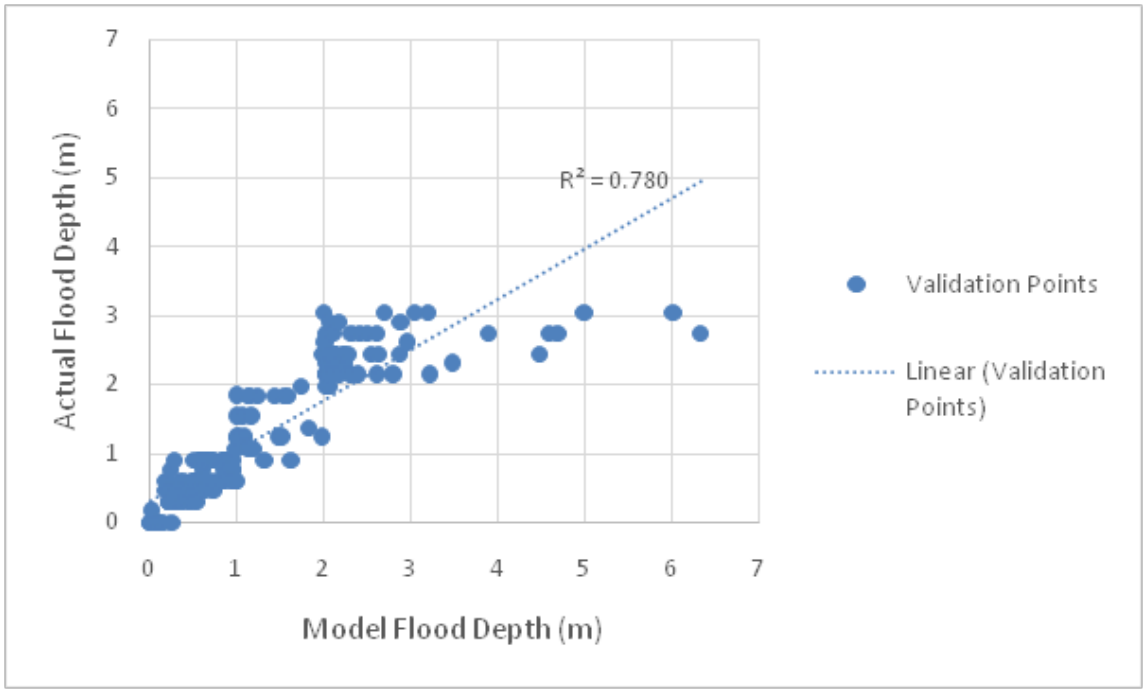


Figure. 119. Model flood depth vs actual flood depth

Table 55. Actual Flood Depth vs Simulated Flood Depth in Dagupan

Actual Flood Depth (m)	Modeled Flood Depth (m)						
	0.21-0.50	0.51-1.00	1.01-2.00	2.01-5.00	> 5.00	Total	
0-0.20	31	1	0	0	0	0	32
0.21-0.50	0	24	3	0	0	0	27
0.51-1.00	0	5	36	2	0	0	43
1.01-2.00	0	0	0	23	2	0	25
2.01-5.00	0	0	0	0	50	3	53
> 5.00	0	0	0	0	0	0	0
Total	31	30	39	25	52	3	180

The overall accuracy generated by the flood model is estimated at 91.11% with 164 points correctly matching the actual flood depths. In addition, there were 11 points estimated one level above and below the correct flood depths while there were 0 points and 0 points estimated two levels above and below, and three or more levels above and below the correct flood. A total of 4 points were overestimated while a total of 5 points were underestimated in the modelled flood depths of Dagupan.

Table 56. Summary of Accuracy Assessment in Dagupan River Basin Survey

No. of Points		%
Correct	164	**91.11**
Overestimated	11	**6.11**
Underestimated	5	**2.78**
Total	180	**100.00**

ANNEXES

Annex 1. Technical Specifications of the LIDAR Sensors used in the Dagupan Floodplain Survey

AQUARIUS

Table A-1.1. Parameters and Specification of Aquarius Sensor

Parameter	Specification
Operational altitude	300-600 m AGL
Laser pulse repetition rate	33, 50. 70 kHz
Scan rate	0-70 Hz
Scan half-angle	0 to ± 25 ˚
Laser footprint on water surface	30-60 cm
Depth range	0 to > 10 m (for k < 0.1/m)
Topographic mode	
Operational altitude	300-2500
Range Capture	Up to 4 range measurements, including 1st, 2nd, 3rd, and last returns
Intensity capture	12-bit dynamic measurement range
Position and orientation system	POS AVTM 510 (OEM) includes embedded 72-channel GNSS receiver (GPS and GLONASS)
Data Storage	Ruggedized removable SSD hard disk (SATA III)
Power	28 V, 900 W, 35 A
Image capture	5 MP interline camera (standard); 60 MP full frame (optional)
Full waveform capture	12-bit Optech IWD-2 Intelligent Waveform Digitizer (optional)
Dimensions and weight	Sensor:250 x 430 x 320 mm; 30 kg; Control rack: 591 x 485 x 578 mm; 53 kg
Operating temperature	0-35˚C
Relative humidity	0-95% no-condensing

GEMINI

Table A-1.2. Parameters and Specification of Gemini Sensor

Parameter	Specification
Operational envelope (1,2,3,4)	150-4000 m AGL, nominal
Laser wavelength	1064 nm
Horizontal accuracy (2)	1/5,500 x altitude, (m AGL)
Elevation accuracy (2)	<5-35 cm, 1 σ
Effective laser repetition rate	Programmable, 33-167 kHz
Position and orientation system	POS AV™ AP50 (OEM); 220-channel dual frequency GPS/GNSS/Galileo/L-Band receiver
Scan width (WOV)	Programmable, 0-50˚
Scan frequency (5)	Programmable, 0-70 Hz (effective)
Sensor scan product	1000 maximum
Beam divergence	Dual divergence: 0.25 mrad (1/e) and 0.8 mrad (1/e), nominal
Roll compensation	Programmable, ±5˚ (FOV dependent)
Range capture	Up to 4 range measurements, including 1st, 2nd, 3rd, and last returns
Intensity capture	Up to 4 intensity returns for each pulse, including last (12 bit)
Video Camera	Internal video camera (NTSC or PAL)
Image capture	Compatible with full Optech camera line (optional)
Full waveform capture	12-bit Optech IWD-2 Intelligent Waveform Digitizer (optional)
Data storage	Removable solid state disk SSD (SATA II)
Power requirements	28 V; 900 W;35 A(peak)
Dimensions and weight	Sensor: 260 mm (w) x 190 mm (l) x 570 mm (h); 23 kg Control rack: 650 mm (w) x 590 mm (l) x 530 mm (h); 53 kg
Operating temperature	-10˚C to +35˚C (with insulating jacket)
Relative humidity	0-95% no-condensing

Annex 2. NAMRIA Certification of Reference Points Used in the LIDAR Survey

PNG-66

Republic of the Philippines
Department of Environment and Natural Resources
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY

May 29, 2014

CERTIFICATION

To whom it may concern:

This is to certify that according to the records on file in this office, the requested survey information is as follows -

Province: **PANGASINAN**
Station Name: **PNG-66**
Order: **2nd**

Island: **LUZON**
Municipality: **SAN CARLOS**
Barangay: **CALOMBOYAN**

PRS92 Coordinates

Latitude: **15° 56' 47.31803"** Longitude: **120° 17' 57.03550"** Ellipsoidal Hgt: **10.57500 m.**

WGS84 Coordinates

Latitude: **15° 56' 41.53646"** Longitude: **120° 18' 1.81867"** Ellipsoidal Hgt: **48.46800 m.**

PTM Coordinates

Northing: **1763650.683 m.** Easting: **424968.98 m.** Zone: **3**

UTM Coordinates

Northing: **1,764,780.62** Easting: **210,862.35** Zone: **51**

Location Description

PNG-66

From San Carlos Mun. Hall, travel along the highway going to Binmaley. Then turn left to the brgy. road going to Brgy. Pangalangan. Station is located inside the compound of Calomboyan Elem. School. It is situated along and beside the SE side of the concrete base of the flagpole, which is about 20 m. NW of the gate. Mark is the head of a 4 in. copper nail centered and embedded in a 30 cm. x 30 cm. concrete block protruding 20 cm. above ground surface, with inscriptions "PNG-66 2007 NAMRIA".

Requesting Party: **UP-DREAM**
Pupose: **Reference**
OR Number: **8796226 A**
T.N.: **2014-1185**

RUEL DM. BELEN, MNSA
Director, Mapping And Geodesy Branch

9905292014124506

CIP/4701/12/09/814

NAMRIA OFFICES:
Main : Lawton Avenue, Fort Bonifacio, 1634 Taguig City, Philippines Tel. No.: (632) 810-4831 to 41
Branch : 421 Barraca St. San Nicolas, 1010 Manila, Philippines, Tel. No. (632) 241-3494 to 98
www.namria.gov.ph

ISO 9001: 2008 CERTIFIED FOR MAPPING AND GEOSPATIAL INFORMATION MANAGEMENT

TRC-3008

Republic of the Philippines
Department of Environment and Natural Resources
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY

May 29, 2014

CERTIFICATION

To whom it may concern:

This is to certify that according to the records on file in this office, the requested survey information is as follows -

Province: **TARLAC**
Station Name: **TRC-3008**
Order: **3rd**

Island: **LUZON**
Municipality: **GERONA**
Barangay: **MAGASPAC**

PRS92 Coordinates

Latitude: **15° 37' 1.26155"** Longitude: **120° 35' 46.75495"** Ellipsoidal Hgt: **28.39700 m.**

WGS84 Coordinates

Latitude: **15° 36' 55.57785"** Longitude: **120° 35' 51.56455"** Ellipsoidal Hgt: **67.99500 m.**

PTM Coordinates

Northing: **1727112.619 m.** Easting: **456712.374 m.** Zone: **3**

UTM Coordinates

Northing: **1,727,923.03** Easting: **242,273.84** Zone: **51**

Location Description

TRC-3008
Mark is located in Magaspac Elementary School, about 6m SW of the flagpole. Station is marked with a head of a 4" copper nail embedded on the center of a 0.30 x 0.30 x 1 m concrete monument with inscriptions TRC-3008 2007 NAMRIA.

Requesting Party: **UP-DREAM**
Pupose: **Reference**
OR Number: **8796226 A**
T.N.: **2014-1186**

RUEL DM. BELEN, MNSA
Director, Mapping And Geodesy Branch

9 9 0 5 2 9 2 0 1 4 1 2 4 5 2 1

CERTIFICATION INTERNATIONAL ISO 9001:2008 — AB ACCREDITED — CIP/4701/12/09/814

NAMRIA OFFICES:
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ISO 9001: 2008 CERTIFIED FOR MAPPING AND GEOSPATIAL INFORMATION MANAGEMENT

TRC-1

Republic of the Philippines
Department of Environment and Natural Resources
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY

May 10, 2013

CERTIFICATION

To whom it may concern:

This is to certify that according to the records on file in this office, the requested survey information is as follows -

Province: **TARLAC**
Station Name: **TRC-1**
Order: **1st**

Island: **LUZON**
Municipality: **TARLAC**
Barangay: **SAN ROQUE**

PRS92 Coordinates

Latitude: **15° 28' 44.13765"** Longitude: **120° 35' 52.67202"** Ellipsoidal Hgt: **46.89100 m.**

WGS84 Coordinates

Latitude: **15° 28' 38.48550"** Longitude: **120° 35' 57.49329"** Ellipsoidal Hgt: **86.90220 m.**

PTM Coordinates

Northing: **1711833.357 m.** Easting: **456859.89 m.** Zone: **3**

UTM Coordinates

Northing: **1,712,636.20** Easting: **242,278.30** Zone: **51**

Location Description

TRC-1
Is located in a NIA irrigation canal concrete floodgate 300 m. E of the natl. highway, 1.5 km. SE of Tarlac town proper. From Manila, travel along MacArthur Highway to Tarlac. A small bridge, 10 m. NW of Sombrero Food Center along the irrigation canal bank to the railroad. It is 2 m. W of the railroad on the eastern floodgate wall, which is 5 min. walk from highway. Mark is a 0.15 m. x 0.01 m. dia. brass rod set on a drilled hole in a standard concrete block with cement putty, 0.03 m. above the top of the concrete railing, inscribed with station name. Reference marks (RM): RM's 1, 2 & 3 are 0.15 m. x 0.01 m. dia. brass rods set in a drilled hole with cement putties. RM-2 is a 0.15 m. x 0.01 m. dia. brass rod set on concrete block, 0.6 m. below ground level; Sub-RM is a 0.15 m. x 0.01 m. dia. brass rod set on a drilled hole on top of the concrete railing.

Requesting Party: **Christopher Cruz**
Pupose: **Reference**
OR Number: **3943636B**
T.N.: **2013-0420**

RUEL DM. BELEN, MNSA
Director, Mapping and Geodesy Department

9905102013160403

CERTIFICATION INTERNATIONAL ISO 9001:2008 CIP/4701/12/09/814

NAMRIA OFFICES:
Main : Lawton Avenue, Fort Bonifacio, 1634 Taguig City, Philippines Tel. No.: (632) 810-4831 to 41
Branch : 421 Barraca St. San Nicolas, 1010 Manila, Philippines, Tel. No. (632) 241-3494 to 98
www.namria.gov.ph

Annex 3. Baseline Processing Reports of Control Points used in the LIDAR Survey

AAC-1

Project information		Coordinate System	
Name:		Name:	UTM
Size:		Datum:	PRS 92
Modified:	10/12/2012 4:40:11 PM (UTC:-6)	Zone:	51 North (123E)
Time zone:	Mountain Standard Time	Geoid:	EGMPH
Reference number:		Vertical datum:	
Description:			

Baseline Processing Report

Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
AAC-01 --- TRC-01 (B1)	TRC-01	AAC-01	Fixed	0.006	0.025	190°03'34"	32347.854	107.369

Acceptance Summary

Processed	Passed	Flag	Fail
1	1	0	0

AAC-01 - TRC-01 (12:30:03 PM-2:08:01 PM) (S1)

Baseline observation:	AAC-01 --- TRC-01 (B1)
Processed:	12/11/2014 4:33:37 PM
Solution type:	Fixed
Frequency used:	Dual Frequency (L1, L2)
Horizontal precision:	0.006 m
Vertical precision:	0.025 m
RMS:	0.010 m
Maximum PDOP:	1.937
Ephemeris used:	Broadcast
Antenna model:	Trimble Relative
Processing start time:	12/11/2014 12:30:03 PM (Local: UTC+8hr)
Processing stop time:	12/11/2014 2:08:01 PM (Local: UTC+8hr)
Processing duration:	01:37:58
Processing interval:	1 second

Vector Components (Mark to Mark)

From:	TRC-01				
Grid		Local		Global	
Easting	242278.307 m	Latitude	N15°28'44.13767"	Latitude	N15°28'38.48550"
Northing	1712636.202 m	Longitude	E120°35'52.67202"	Longitude	E120°35'57.49329"
Elevation	44.420 m	Height	46.891 m	Height	86.902 m

To:	AAC-01				
Grid		Local		Global	
Easting	236272.483 m	Latitude	N15°11'27.81685"	Latitude	N15°11'22.22626"
Northing	1680836.256 m	Longitude	E120°32'43.37833"	Longitude	E120°32'48.22418"
Elevation	151.882 m	Height	154.260 m	Height	194.988 m

Vector					
ΔEasting	-6005.824 m	NS Fwd Azimuth	190°03'34"	ΔX	523.697 m
ΔNorthing	-31799.946 m	Ellipsoid Dist.	32347.854 m	ΔY	10213.192 m
ΔElevation	107.461 m	ΔHeight	107.369 m	ΔZ	-30689.417 m

Standard Errors

Vector errors:					
σ ΔEasting	0.002 m	σ NS fwd Azimuth	0°00'00"	σ ΔX	0.006 m
σ ΔNorthing	0.002 m	σ Ellipsoid Dist.	0.002 m	σ ΔY	0.011 m
σ ΔElevation	0.013 m	σ ΔHeight	0.013 m	σ ΔZ	0.004 m

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000413905		
Y	-0.0000661260	0.0001225849	
Z	-0.0000191610	0.0000334556	0.0000154812

Occupations

	From	To
Point ID:	TRC-01	AAC-01
Data file:	C:\Users\Windows User\Documents \Business Center - HCE\Unnamed\TRC-01 12-11-2014.T02	C:\Users\Windows User\Documents \Business Center - HCE\Unnamed\AAC-01 12-11-2014.T02
Receiver type:	SPS852	SPS985
Receiver serial number:	5203K81512	5245F15419
Antenna type:	Zephyr Geodetic	SPS985 Internal
Antenna serial number:	--------	--------
Antenna height (measured):	1.568 m	1.688 m
Antenna method:	Bottom of antenna mount	Bottom of antenna mount

Annex 4. The LIDAR Survey Team Composition

Data Acquisition Component Sub-team	Designation	Name	Agency/Affiliation
PHIL-LIDAR 1	Program Leader	ENRICO PARINGIT, D.ENG	UP-TCAGP
Data Acquisition Component Leader	Data Component Project Leader -I	ENGR. CZAR JAKIRI SARMIENTO	UP-TCAGP
		ENGR. LOUIE P. BALICANTA	
Survey Supervisor	Chief Science Research Specialist (CSRS)	ENGR. CHRISTOPHER CRUZ	UP-TCAGP
	Supervising Science Research Specialist	ENGR. LOVELYN ASUNCION	UP-TCAGP
		LOVELY GRACIA ACUNA	UP-TCAGP
FIELD TEAM			
LiDAR Operation	Senior Science Research Specialist	ENGR. GEROME HIPOLITO	UP-TCAGP
	Senior Science Research Specialist	JULIE PEARL MARS	UP-TCAGP
	Research Associate (RA)	ENGR. IRO NIEL ROXAS	UP-TCAGP
	RA	MA. REMEDIOS VILLANUEVA	UP-TCAGP
	RA	ENGR. LARAH KRISELLE PARAGAS	UP-TCAGP
	RA	MA. VERLINA TONGA	UP-TCAGP
Ground Survey, Data Download and Transfer	RA	ENGR. KENNETH QUISADO	UP-TCAGP
LiDAR Operation	Airborne Security	SSG. DIOSCORO SOBERANO	PHILIPPINE AIR FORCE (PAF)
	Pilot	CAPT. RAUL CZ SAMAR II	ASIAN AEROSPACE CORPORATION (AAC)
		CAPT. JOHN BRYAN DONGUINES	AAC
		CAPT. FERDINAND DE OCAMPO	AAC
		CAPT. CESAR SHERWIN ALFONSO III	AAC

Annex 5. Data Transfer Sheet for Dagupan Floodplain

DATA TRANSFER SHEET
5/29/2014(Pampanga Ready)

DATE	FLIGHT NO.	MISSION NAME	SENSOR	RAW LAS		LOGS(KB)	POS	RAW IMAGES/CASI	MISSION LOG FILE/CASI LOGS	RANGE	DIGITIZER	BASE STATION(S)		OPERATOR LOGS (OPLOG)	FLIGHT PLAN		SERVER LOCATION
				Output LAS	KML (swath)							BASE STATION(S)	Base Info (.txt)		Actual	KML	
5/22/2014	7264GC	2BLK15S142A	GEMINI	NA	89.2	276	205	NA	NA	8.92	NA	6.63	1KB	1KB	187	24	Z:\Airborne_Raw\7264GC
5/23/2014	7266GC	2BLK15S143A	GEMINI	NA	168	374	220	NA	NA	14.4	NA	13.2	1KB	1KB	13	18	Z:\Airborne_Raw\7266GC
5/24/2014	7268GC	2PAMS8144A	GEMINI	NA	192	364	223	NA	NA	14.7	NA	11.3	1KB	1KB	23	26	Z:\Airborne_Raw\7268GCA
5/24/2014	7269GC	2PAMS8144B	GEMINI	NA	236	197	140	NA	NA	7.93	NA	11.3	1KB	1KB	18	NA	Z:\Airborne_Raw\7269GC
5/25/2014	7271GC	2PAMS1S3145B	GEMINI	NA	91.8	383	233	NA	NA	15.5	NA	3.68	1KB	1KB	17	na	Z:\Airborne_Raw\7271GC

Received from

Name C. Sobaqeu
Position RA
Signature [signature]

Received by

Name JOIDA PRIETO
Position SSRS
Signature [signature] 5/29/14

14-217

DATA TRANSFER SHEET
02/09/2015(CLARK)

DATE	FLIGHT NO.	MISSION NAME	SENSOR	RAW LAS		LOGS(MB)	POS	RAW IMAGES/CASI	MISSION LOG FILE/CASI LOGS	RANGE	DIGITIZER	BASE STATION(S)		OPERATOR LOGS (OPLOG)	FLIGHT PLAN		SERVER LOCATION
				Output LAS	KML (swath)							BASE STATION(S)	Base Info (.txt)		Actual	KML	
4-Dec-14	2270A	3PAMV338A	AQUARIUS	NA	173	352	201	NA	NA	7.79	14.8	23.7	1KB	1KB	NA	48	Z:\DAC\RAW DATA
5-Dec-14	2274A	3NEJV339A	AQUARIUS	NA	70	180	163	NA	NA	3.8	473MB	17.2	1KB	1KB	23	23	Z:\DAC\RAW DATA
6-Dec-14	2278A	3PAMV340A	AQUARIUS	NA	181	425	238	NA	NA	8.18	NA	26.5	1KB	1KB	23	NA	Z:\DAC\RAW DATA
10-Dec-14	2294A	3TRCV344A	AQUARIUS	NA	128	266	174	NA	NA	5.02	652	28.9	1KB	1KB	23	48	Z:\DAC\RAW DATA
11-Dec-14	7670GC	2TRCV345A	GEMINI	NA	301	1.89	256	NA	NA	13.4	NA	8.41	1KB	1KB	1.15MB		Z:\DAC\RAW DATA
11-Dec-14	2298A	3NEJV345A	AQUARIUS	NA	301	455	216	NA	NA	8.18	NA	19.3	1KB	1KB	NA	NA	Z:\DAC\RAW DATA
12-Dec-14	2302A	3NEJV346A	AQUARIUS	NA	113	259	169	NA	NA	5.17	NA	31.1	1KB	1KB	29	57	Z:\DAC\RAW DATA
12-Dec-14	2304A	3NEJV346B	AQUARIUS	NA	NA	515	173	NA	NA	4.2	NA	31.1	1KB	1KB	29	NA	Z:\DAC\RAW DATA

Received from

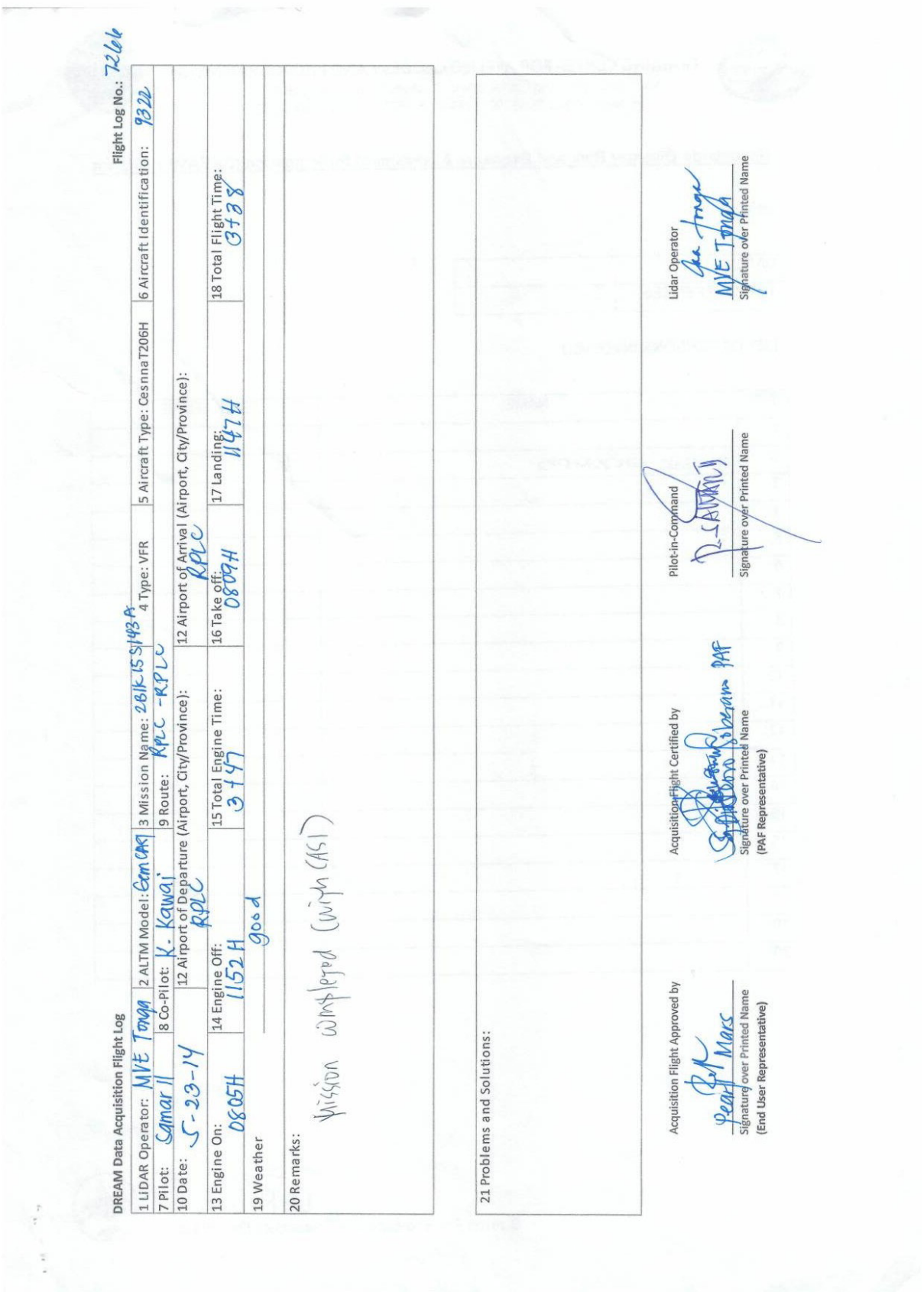
Name C-SOA-AIN
Position
Signature

Received by

Name AC Bongat 2/12/15
Position SSRS
Signature

Annex 6. Flight Logs for the Flight Missions

1. Flight Log for Mission 2BLK15S143A



DREAM Data Acquisition Flight Log

Flight Log No.: 7266

1 LiDAR Operator: MVE Tonga	2 ALTM Model: Gemini	3 Mission Name: 2BLK15S143A	4 Type: VFR	5 Aircraft Type: Cessna T206H	6 Aircraft Identification: 9322
7 Pilot: Samar II	8 Co-Pilot: K. Kawaji	9 Route: RPLC - RPLC			
10 Date: 5-23-14	11 Airport of Departure (Airport, City/Province): RPLC		12 Airport of Arrival (Airport, City/Province): RPLC		
13 Engine On: 0805H	14 Engine Off: 1152H	15 Total Engine Time: 3+47	16 Take off: 0809H	17 Landing: 1147H	18 Total Flight Time: 3+38
19 Weather: Good					
20 Remarks: Mission completed (with GAS)					
21 Problems and Solutions:					

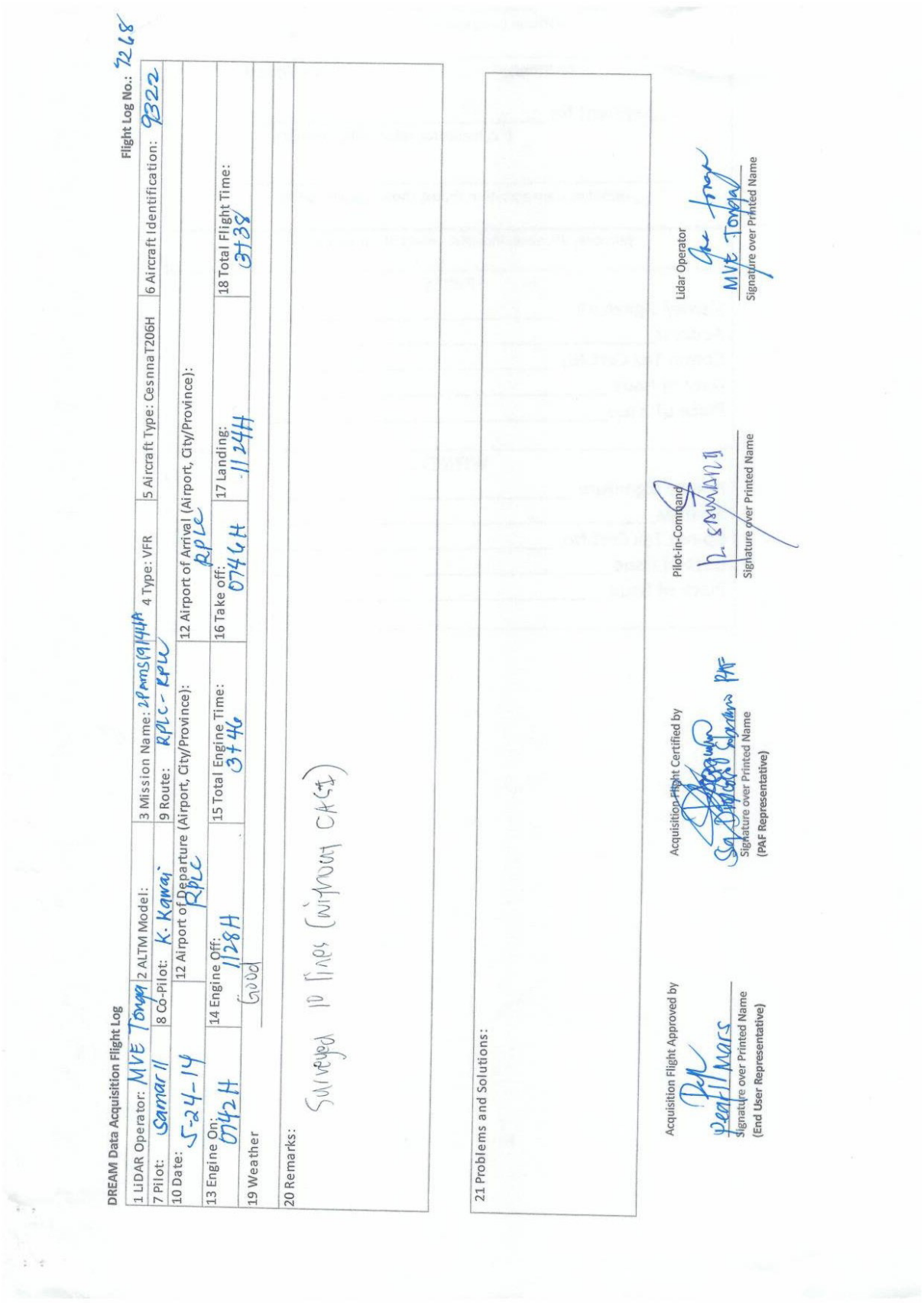
Acquisition Flight Approved by
Signature over Printed Name
(End User Representative)

Acquisition Flight Certified by
Signature over Printed Name
(PAF Representative)

Pilot-in-Command
Signature over Printed Name

Lidar Operator
Signature over Printed Name

2. Flight Log for Mission 2PAMS8144A



DREAM Data Acquisition Flight Log

Flight Log No.: 72 68

1 LiDAR Operator: MVE Tonga	2 ALTM Model:	3 Mission Name: 2PAMS8144A	4 Type: VFR	5 Aircraft Type: Cessna T206H	6 Aircraft Identification: 9322
7 Pilot: Samar II	8 Co-Pilot: K. Kawai	9 Route: RPLC - RPLC			
10 Date: 5-24-14	12 Airport of Departure (Airport, City/Province): RPLC		12 Airport of Arrival (Airport, City/Province): RPLC		
13 Engine On: 0742H	14 Engine Off: 1128H	15 Total Engine Time: 3+46	16 Take off: 0746H	17 Landing: 1124H	18 Total Flight Time: 3+38
19 Weather: Good					

20 Remarks:

Surveyed 10 lines (without CA/T)

21 Problems and Solutions:

Acquisition Flight Approved by

Signature over Printed Name
(End User Representative)

Acquisition Flight Certified by

Signature over Printed Name
(PAF Representative)

Pilot-in-Command

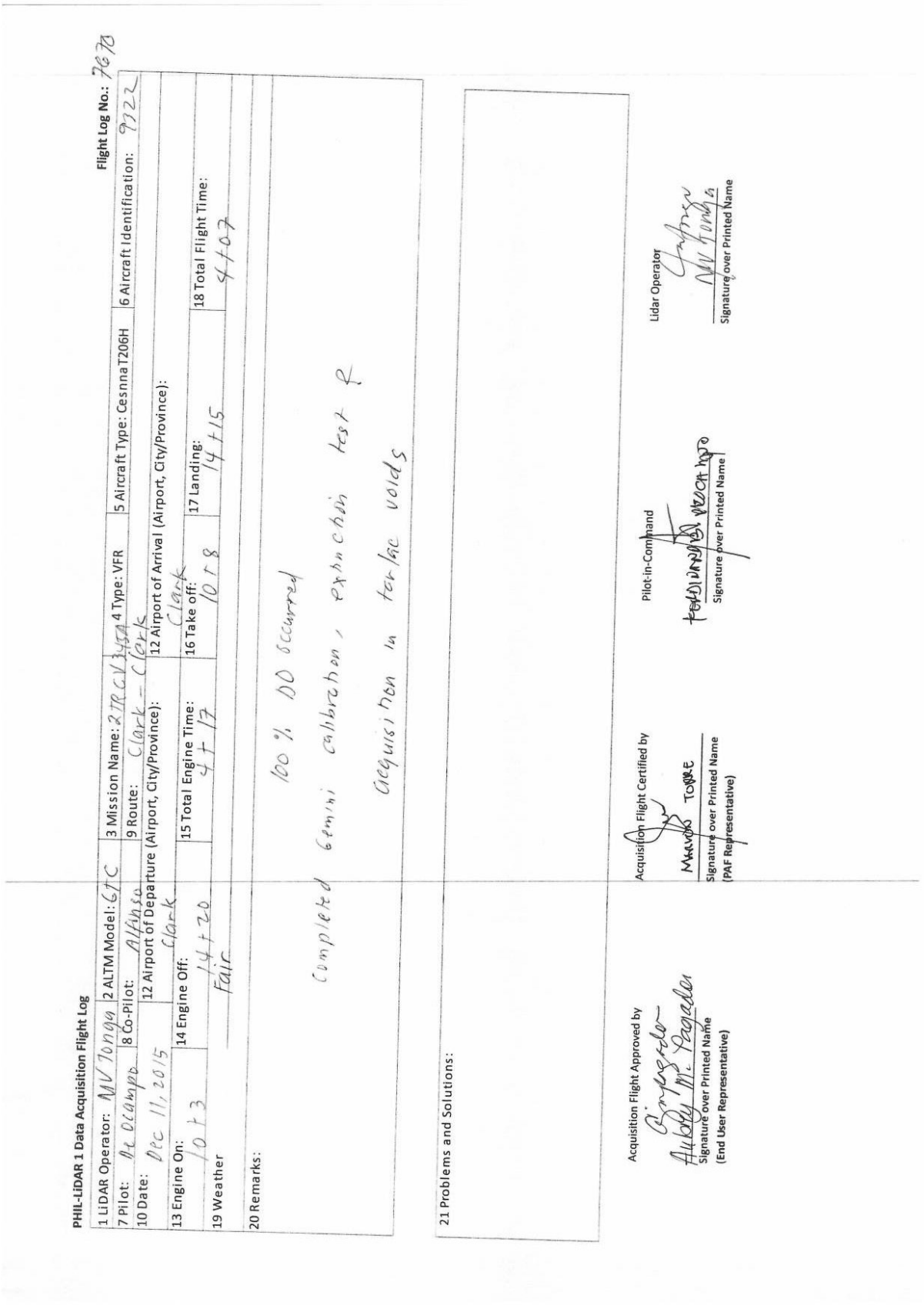
Signature over Printed Name

Lidar Operator

MVE Tonga

Signature over Printed Name

3. Flight Log for Mission 2TRCV345A



PHIL-LiDAR 1 Data Acquisition Flight Log

Flight Log No.: 76

1 LiDAR Operator: MV Tonga	2 ALTM Model: GTC	3 Mission Name: 2TRCV345A	4 Type: VFR	5 Aircraft Type: Cessna T206H	6 Aircraft Identification: 9722
7 Pilot: Lt Ocampo	8 Co-Pilot: Alfaro	9 Route: Clark - Clark			
10 Date: Dec 11, 2015	11 Airport of Departure (Airport, City/Province): Clark		12 Airport of Arrival (Airport, City/Province): Clark		
13 Engine On: 10:13	14 Engine Off: 14:20	15 Total Engine Time: 4:17	16 Take off: 10:18	17 Landing: 14:15	18 Total Flight Time: 4:07
19 Weather: Fair					

20 Remarks:

100% DD accomplished. Gemini calibration, parachute test & acquisition in terrace voids

21 Problems and Solutions:

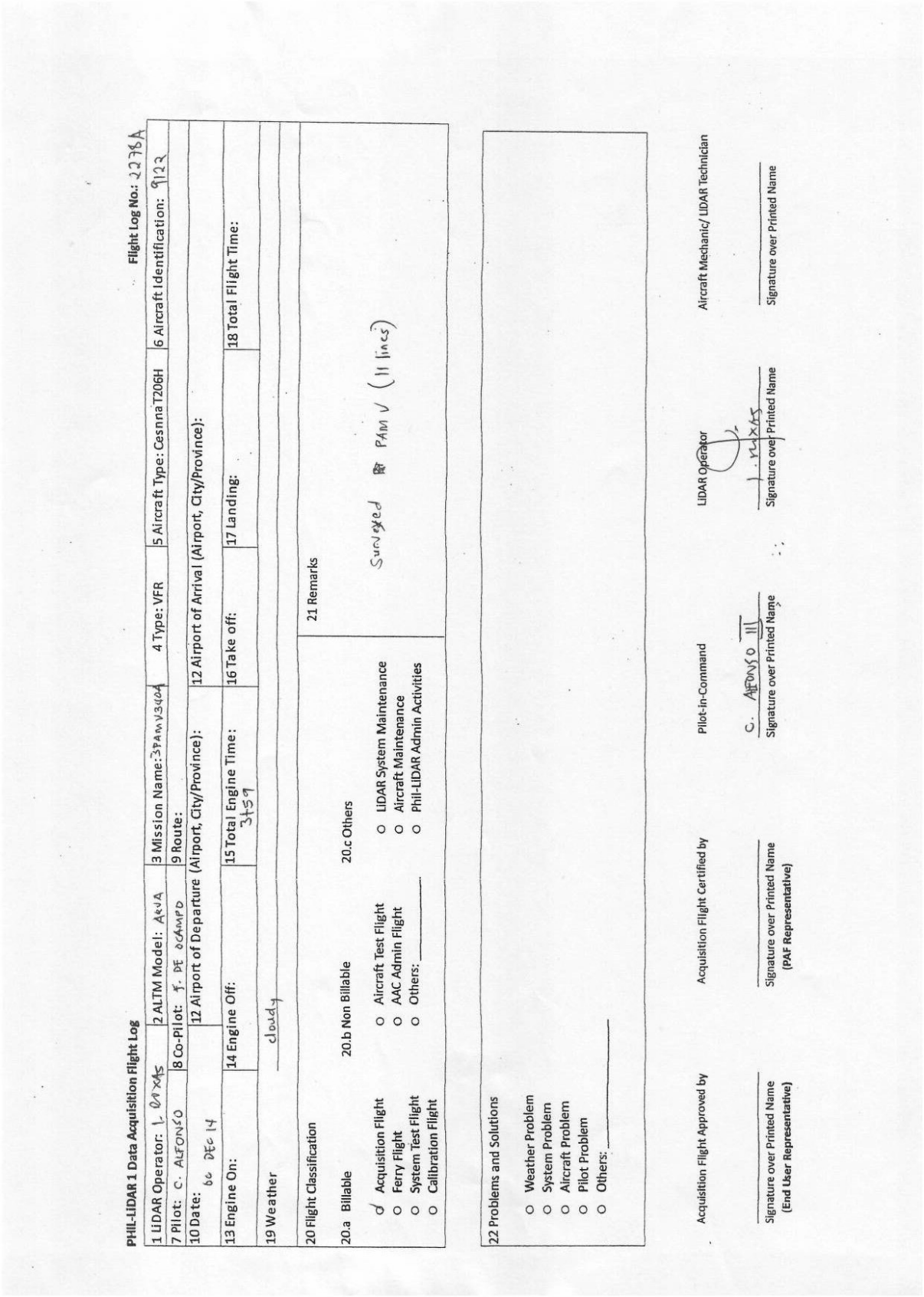
Acquisition Flight Approved by
Signature over Printed Name
(End User Representative)

Acquisition Flight Certified by
MARVIN TORRE
Signature over Printed Name
(PAF Representative)

Pilot-in-Command
Signature over Printed Name

Lidar Operator
Signature over Printed Name

4. Flight Log for Mission 3PAMV340A



PHIL-LIDAR 1 Data Acquisition Flight Log — **Flight Log No.:** 2276A

1 LiDAR Operator: L. RAMOS	2 ALTM Model: AGUA	3 Mission Name: 3PAMV3404	4 Type: VFR	5 Aircraft Type: Cessna T206H	6 Aircraft Identification: 9122
7 Pilot: C. ALFONSO	8 Co-Pilot: F. DE OCAMPO	9 Route:			
10 Date: 06 DEC 14	11 Airport of Departure (Airport, City/Province):		12 Airport of Arrival (Airport, City/Province):		
13 Engine On:	14 Engine Off:	15 Total Engine Time: 3+59	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: cloudy					

20 Flight Classification

20.a Billable
- ☑ Acquisition Flight
- ○ Ferry Flight
- ○ System Test Flight
- ○ Calibration Flight

20.b Non Billable
- ○ Aircraft Test Flight
- ○ AAC Admin Flight
- ○ Others: _____

20.c Others
- ○ LiDAR System Maintenance
- ○ Aircraft Maintenance
- ○ Phil-LIDAR Admin Activities

21 Remarks: Surveyed for PAMV (11 lines)

22 Problems and Solutions
- ○ Weather Problem
- ○ System Problem
- ○ Aircraft Problem
- ○ Pilot Problem
- ○ Others: _____

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	LiDAR Operator	Aircraft Mechanic/ LiDAR Technician
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	C. ALFONSO III Signature over Printed Name	L. RAMOS Signature over Printed Name	Signature over Printed Name

PHIL-LiDAR 1 Data Acquisition Flight Log

Flight Log No.: 2294A

1 LiDAR Operator:	2 ALTM Model: Aqua	3 Mission Name:	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: 9122
7 Pilot:	8 Co-Pilot:	9 Route:			
10 Date: 10 Dec 2014	12 Airport of Departure (Airport, City/Province):		12 Airport of Arrival (Airport, City/Province):		
13 Engine On:	14 Engine Off:	15 Total Engine Time: 3+11	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather	cloudy				

20 Flight Classification

20.a Billable
- ✓ Acquisition Flight
- O Ferry Flight
- O System Test Flight
- O Calibration Flight

20.b Non Billable
- O Aircraft Test Flight
- O AAC Admin Flight
- O Others: _____

20.c Others
- O LiDAR System Maintenance
- O Aircraft Maintenance
- O Phil-LiDAR Admin Activities

21 Remarks

surveyed TRCV (11 lines)

22 Problems and Solutions
- O Weather Problem
- O System Problem
- O Aircraft Problem
- O Pilot Problem
- O Others: _____

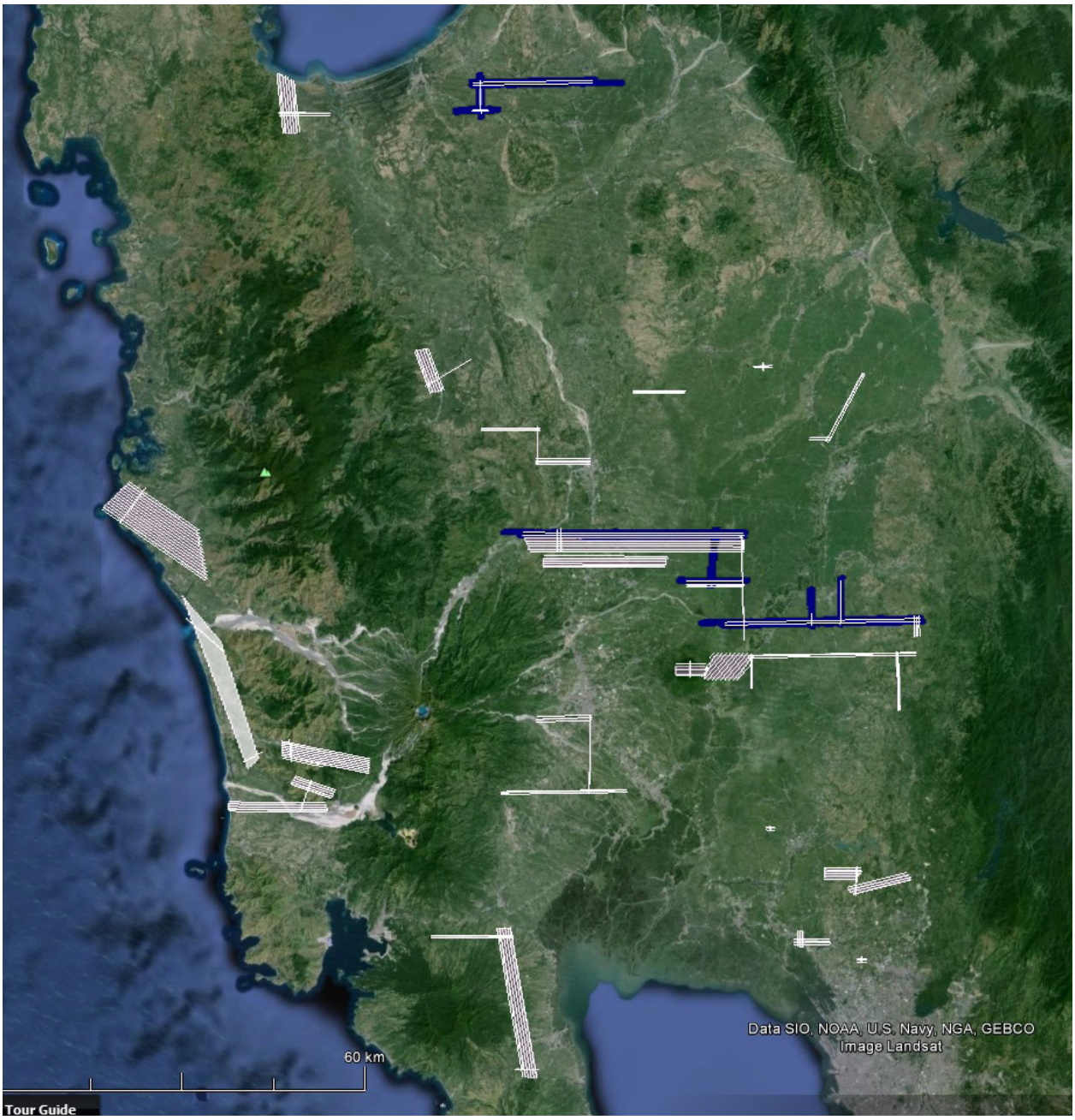
Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	LiDAR Operator	Aircraft Mechanic/ LiDAR Technician
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	C. ALFONSO III Signature over Printed Name	Signature over Printed Name	Signature over Printed Name

Annex 7. Flight Status Reports

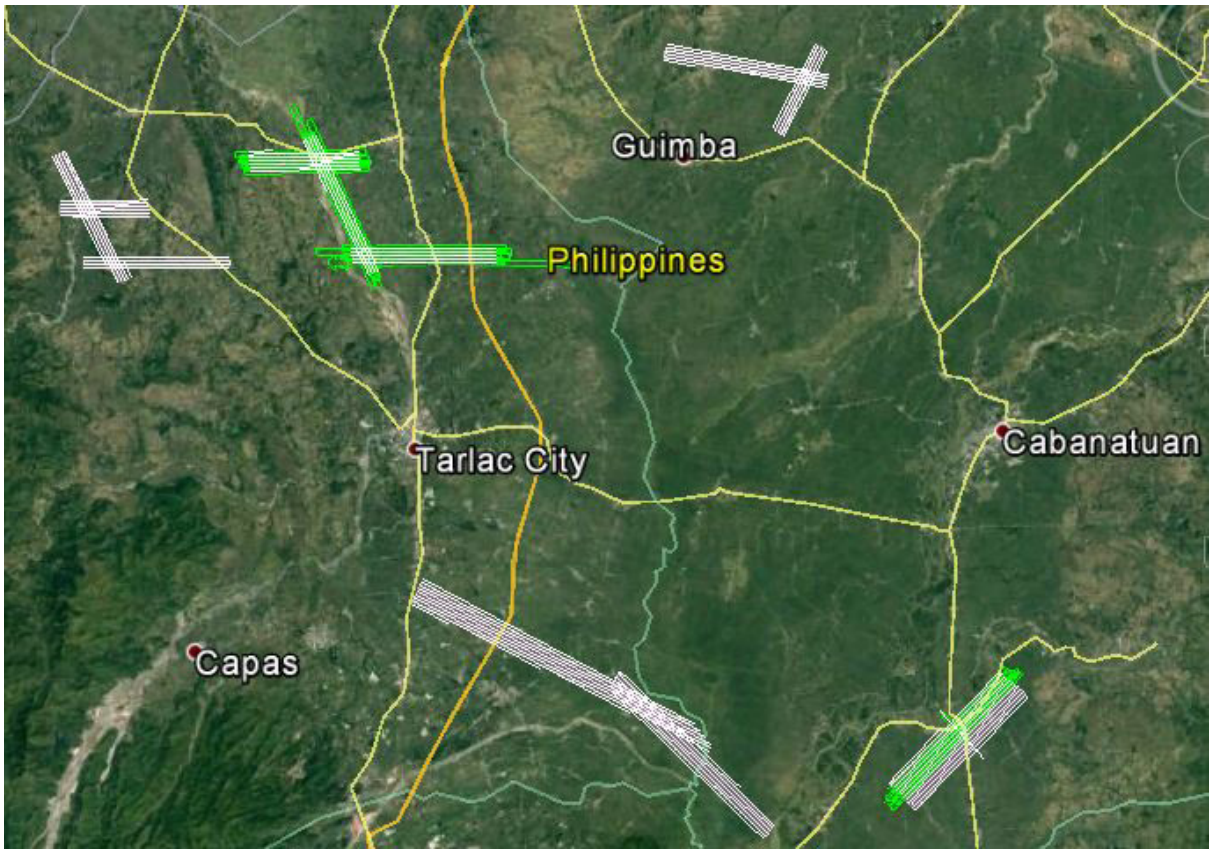
FLIGHT NO	AREA	MISSION	OPERATOR	DATE FLOWN	REMARKS
7266G	BLK15S	2BLK15S143A	V E R L I N A TONGA	23-May-2014	Completed 20 lines; changed altitude 3 times due to clouds
7268G	PAMS8	2PAMS8144A	V E R L I N A TONGA	24-May-2014	Completed 10 lines at 1000m
2278A	PAMV	3PAMV340A	IRO ROXAS	06-Dec-2014	Surveyed 11 lines over Tarlac and 4 lines over Nueva Ecija
2294A	TRCV	3TRCV344A	R E M E D I O S VILLANUEVA	10-Dec-2014	Surveyed 11 lines over Tarlac
7670G	PAMS	2TRCV345A + Extinction Test + Gemini Calibration	V E R L I N A TONGA	11-Dec-2014	Surveyed one mission but 100% DO persisted

Flight No. :	7266G
Area:	2BLK15S143A
Mission name:	BLK15S
Parameters:	Altitude: 1000m; Scan Frequency: 50Hz; Scan Angle: 20; Overlap: 30%
Area covered:	103.894 sq.km.

Flight No. : 7268G
Area: PAMS8
Mission name: 2PAMS8144B
Parameters: Altitude: 1000m; Scan Frequency: 50Hz; Scan Angle: 20; Overlap: 40%
Area covered: 110.105 sq.km.

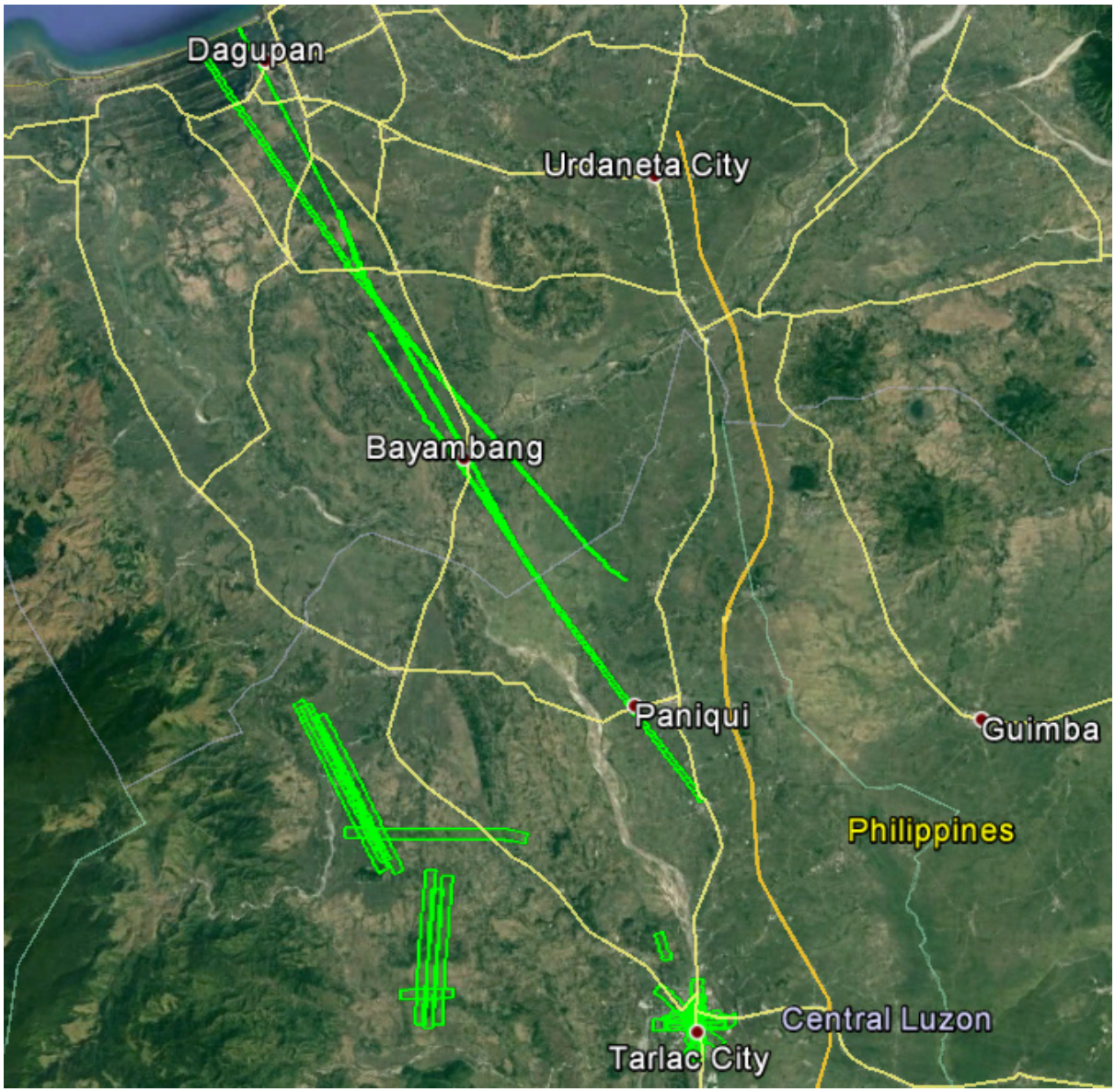


Flight No. :	2278A
Area:	PAMV
Mission name:	3PAMV340A
Parameters:	Altitude:600m; Scan Frequency:50Hz; Scan Angle:18; Overlap: 25,40%
Area covered:	60.63 sq.km.



Flight No. : 2294A
Area: TRCV
Mission name: 3TRCV344A
Parameters: Altitude: 1000; Scan Frequency: 50Hz; Scan Angle: 20; Overlap: 40%
Area covered: 37.05 sq.km.

Flight No. :	7670G
Area:	2PAMS145A
Mission name:	PAMS
Parameters:	Altitude: 1000m; Scan Frequency: 50Hz; Scan Angle: 20; Overlap: 40%
Area covered:	57.98 sq.km.



Annex 8. Mission Summary Reports

Flight Area	Clark Reflights
Mission Name	Agno10I_additional
Inclusive Flights	2294A, 7670G, 2278A
Range data size	26.6 MB
POS data size	665 MB
Base data size	63.81 MB
Image	NA
Transfer date	December 11, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	No
Processing Mode (<=1)	Yes
Smoothed Performance Metrics (in cm)	
RMSE for North Position (<4.0 cm)	2.34
RMSE for East Position (<4.0 cm)	1.44
RMSE for Down Position (<8.0 cm)	3.94
Boresight correction stdev (<0.001deg)	0.000448
IMU attitude correction stdev (<0.001deg)	0.000812
GPS position stdev (<0.01m)	0.0268
Minimum % overlap (>25)	43.15%
Ave point cloud density per sq.m. (>2.0)	2.95
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	84
Maximum Height	158.03 m
Minimum Height	59.79 m
Classification (# of points)	
Ground	28,101,730
Low vegetation	31,596,605
Medium vegetation	12,065,228
High vegetation	7,490,685
Building	752,280
Orthophoto	No
Processed By	Engr. Jennifer Saguran, Engr. Analyn Naldo, Engr. Harmond Santos, Engr. Gladys Mae Apat

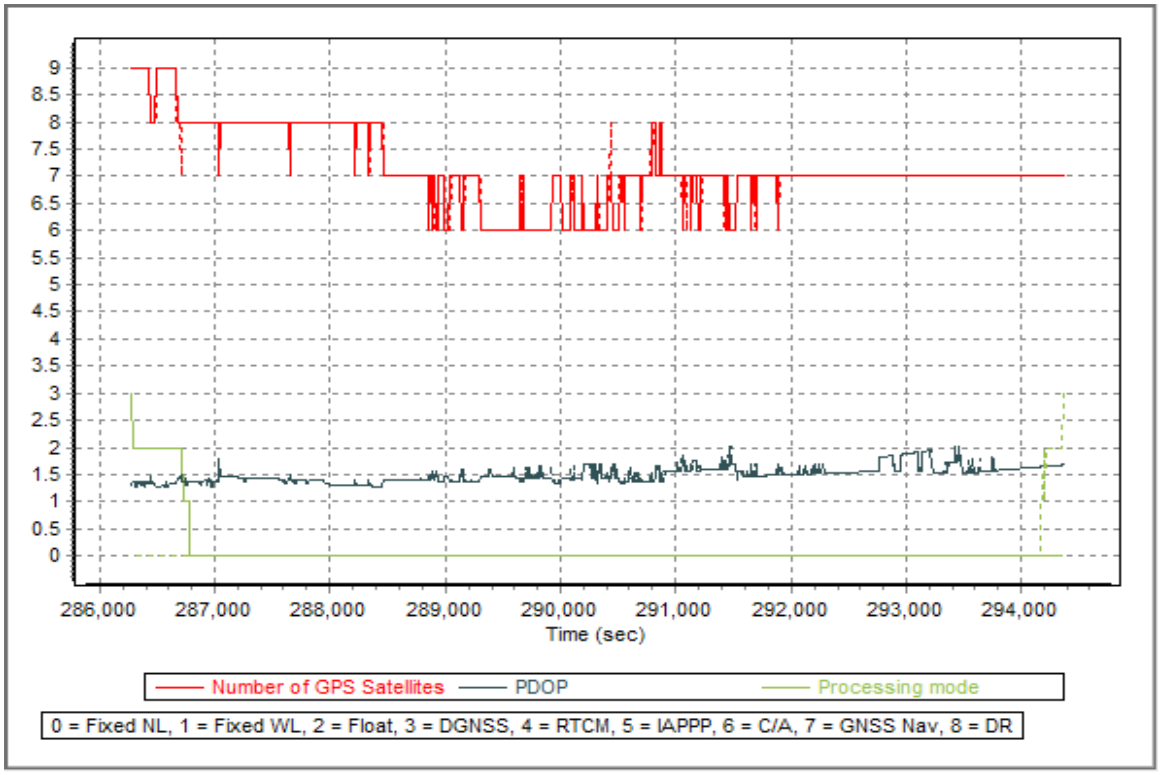


Figure 1.1.1. Solution Status

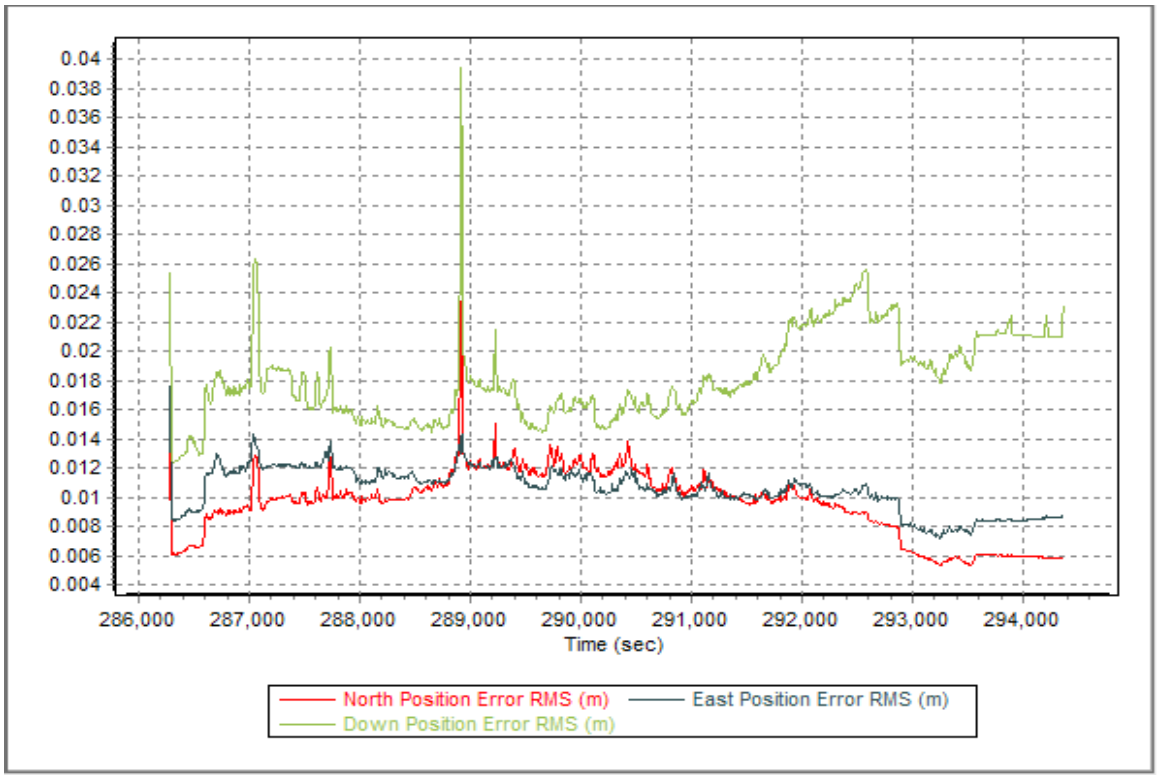


Figure 1.1.2 Smoothed Performance Metric Parameters

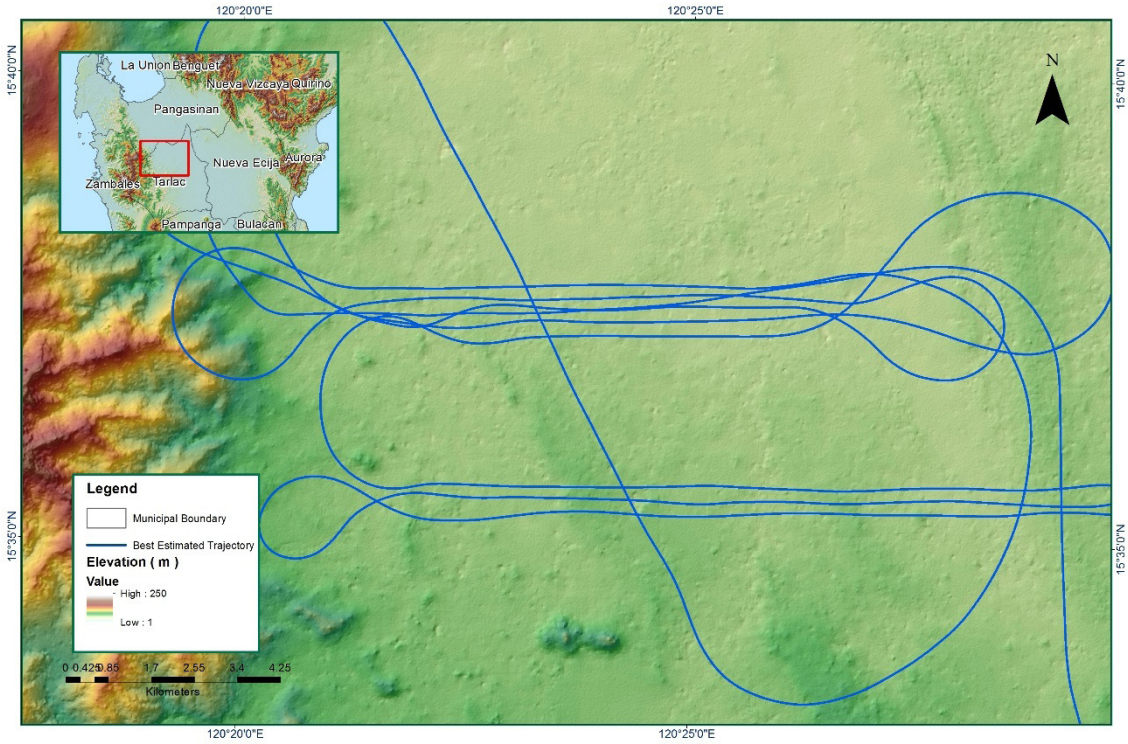


Figure 1.1.3 Best Estimated Trajectory

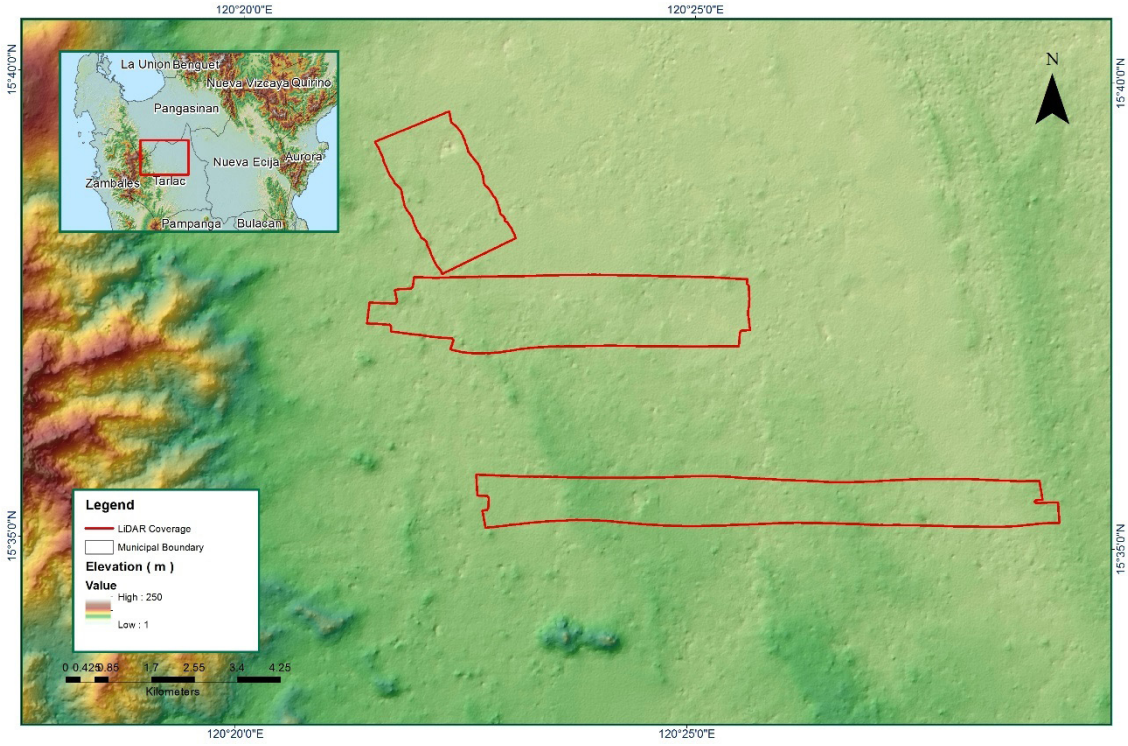


Figure 1.1.4 Coverage of LiDAR Data

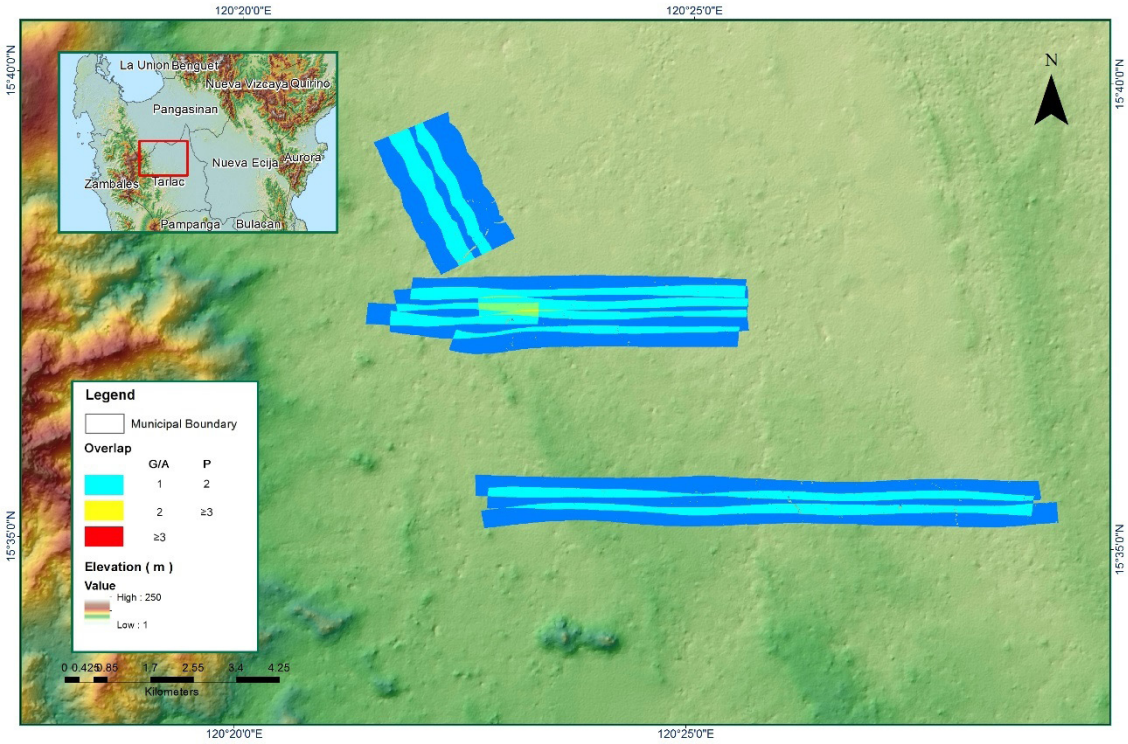


Figure 1.1.5 Image of Data Overlap

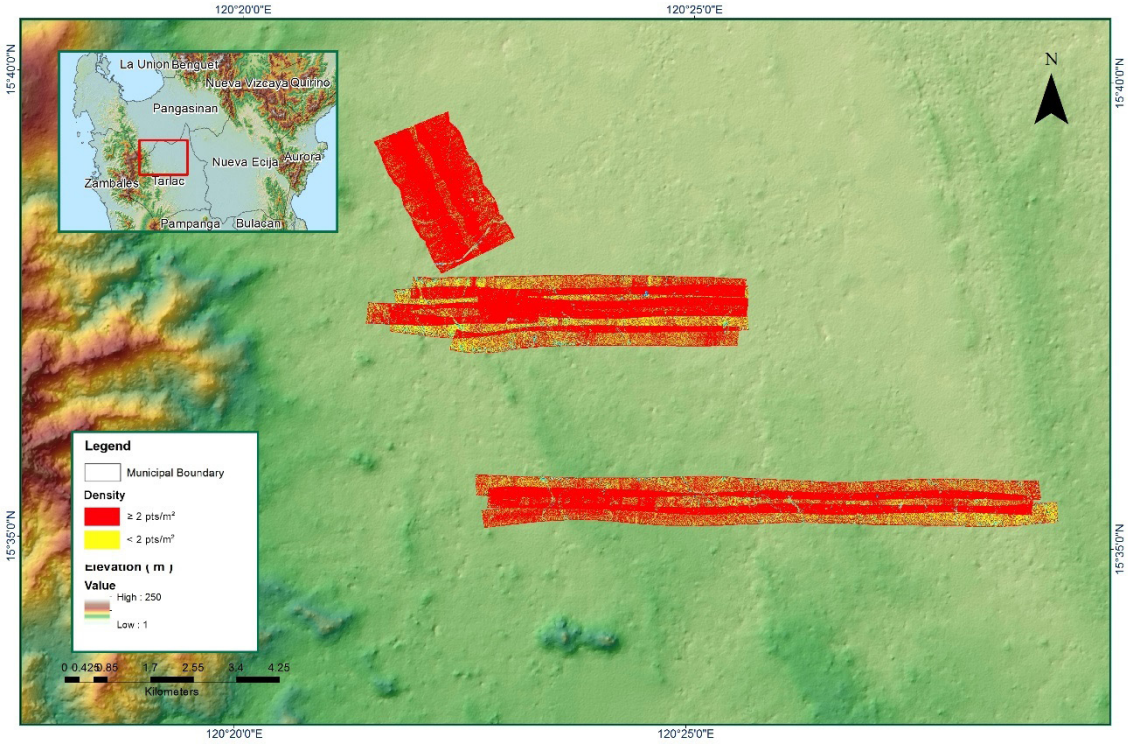


Figure 1.1.6 Density Map of merged LiDAR data

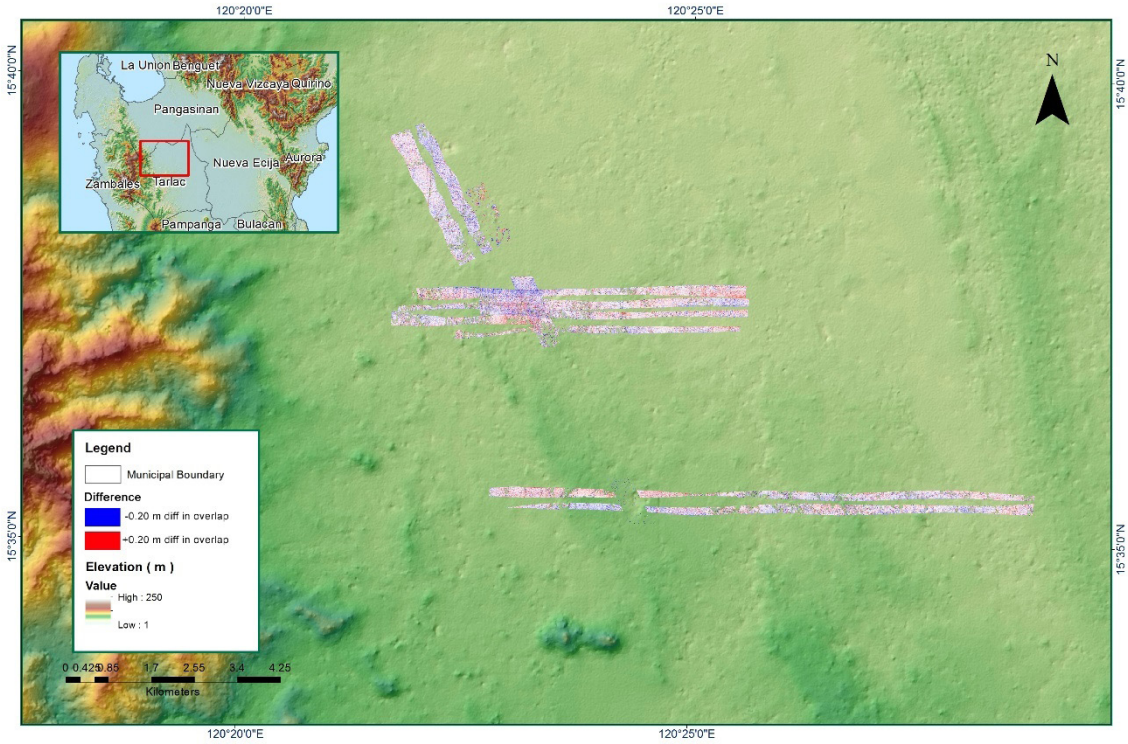


Figure 1.1.7 Elevation Difference Between flight lines

Flight Area	Clark Reflights
Mission Name	Agno10H_additional
Inclusive Flights	2278A
Range data size	8.18 MB
POS data size	238 MB
Base data size	26.5 MB
Image	NA
Transfer date	December 6, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	No
Processing Mode (<=1)	No
Smoothed Performance Metrics (in cm)	
RMSE for North Position (<4.0 cm)	0.03285
RMSE for East Position (<4.0 cm)	0.04359
RMSE for Down Position (<8.0 cm)	0.07524
Boresight correction stdev (<0.001deg)	0.000448
IMU attitude correction stdev (<0.001deg)	0.000812
GPS position stdev (<0.01m)	0.0268
Minimum % overlap (>25)	37.57%
Ave point cloud density per sq.m. (>2.0)	2.71
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	47
Maximum Height	365.98 m
Minimum Height	53.70 m
Classification (# of points)	
Ground	19,486,782
Low vegetation	11,274,741
Medium vegetation	6,064,344
High vegetation	2,712,503
Building	554,155
Orthophoto	No
Processed By	Engr. Analyn Naldo, Engr. Harmond Santos, Jovy Narisma

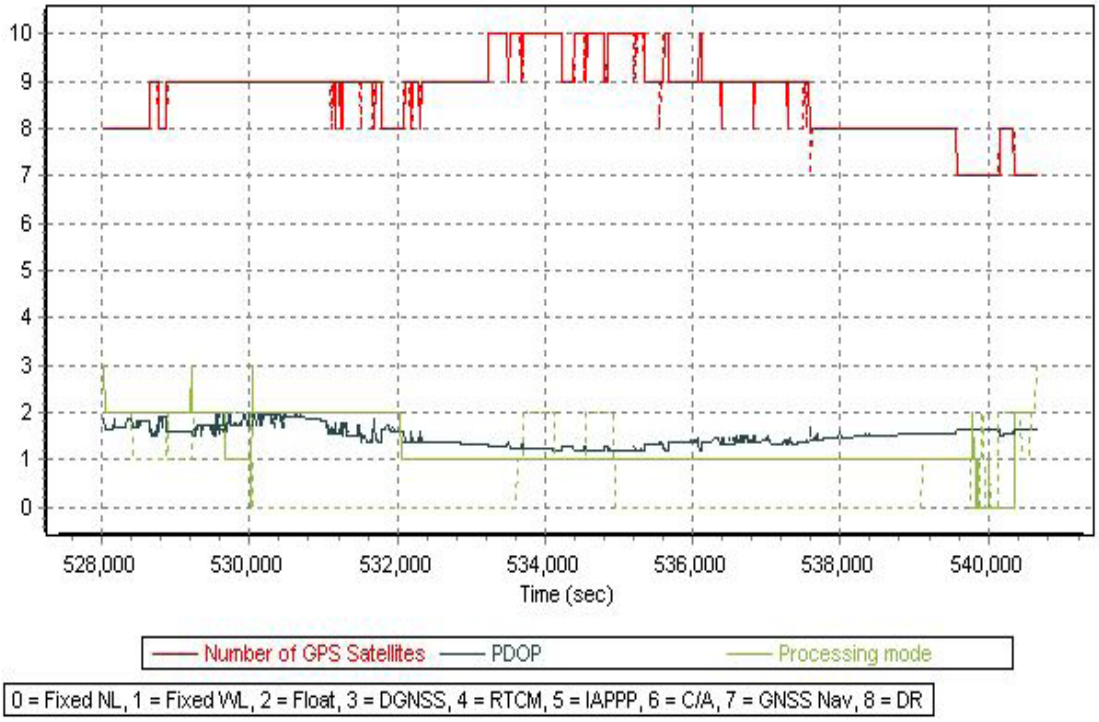


Figure 1.2.1 Solution Status

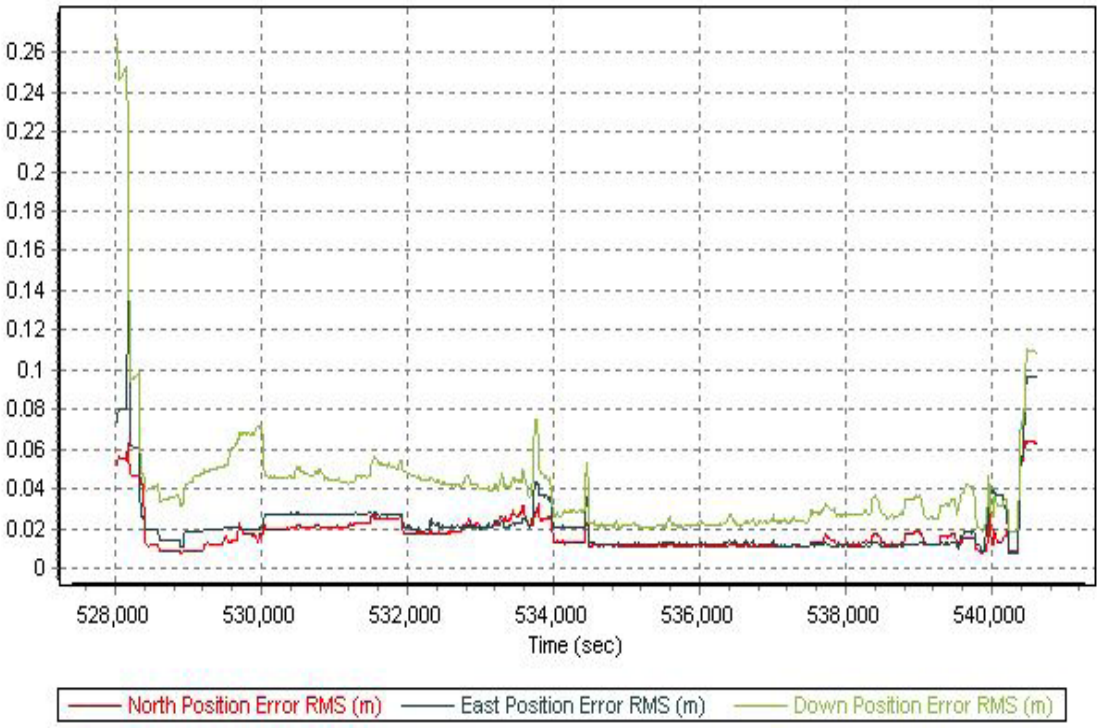


Figure 1.2.2 Smoothed Performance Metric Parameters

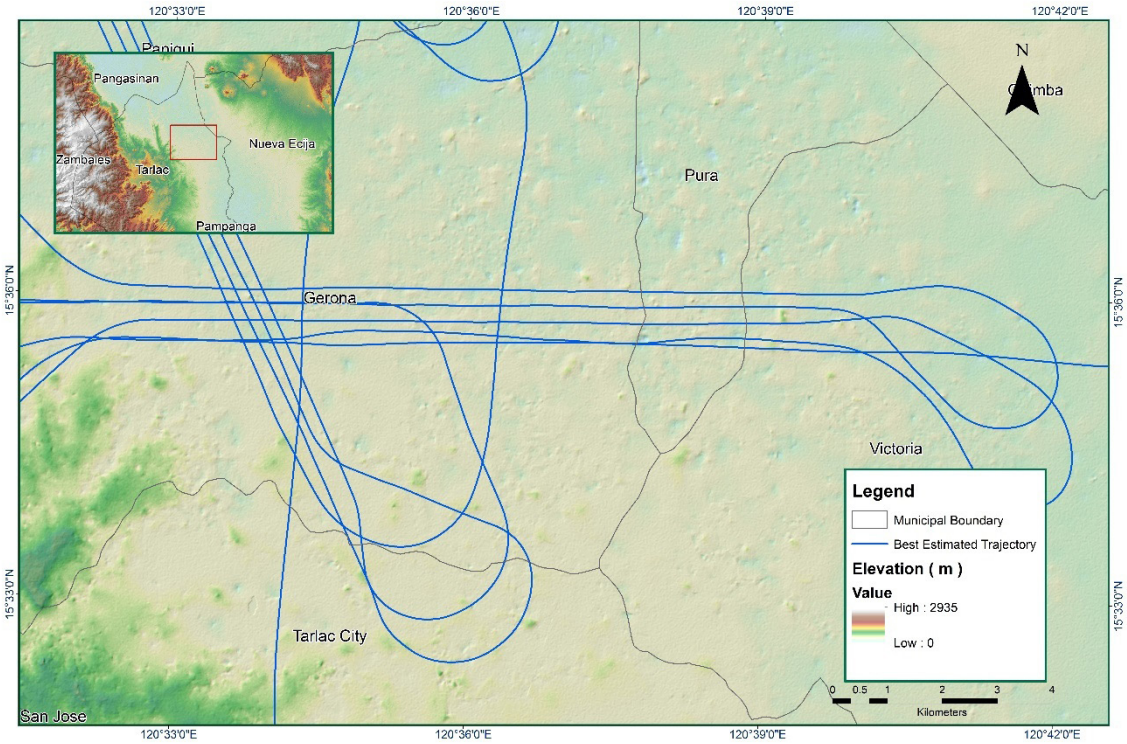


Figure 1.2.3 Best Estimated Trajectory

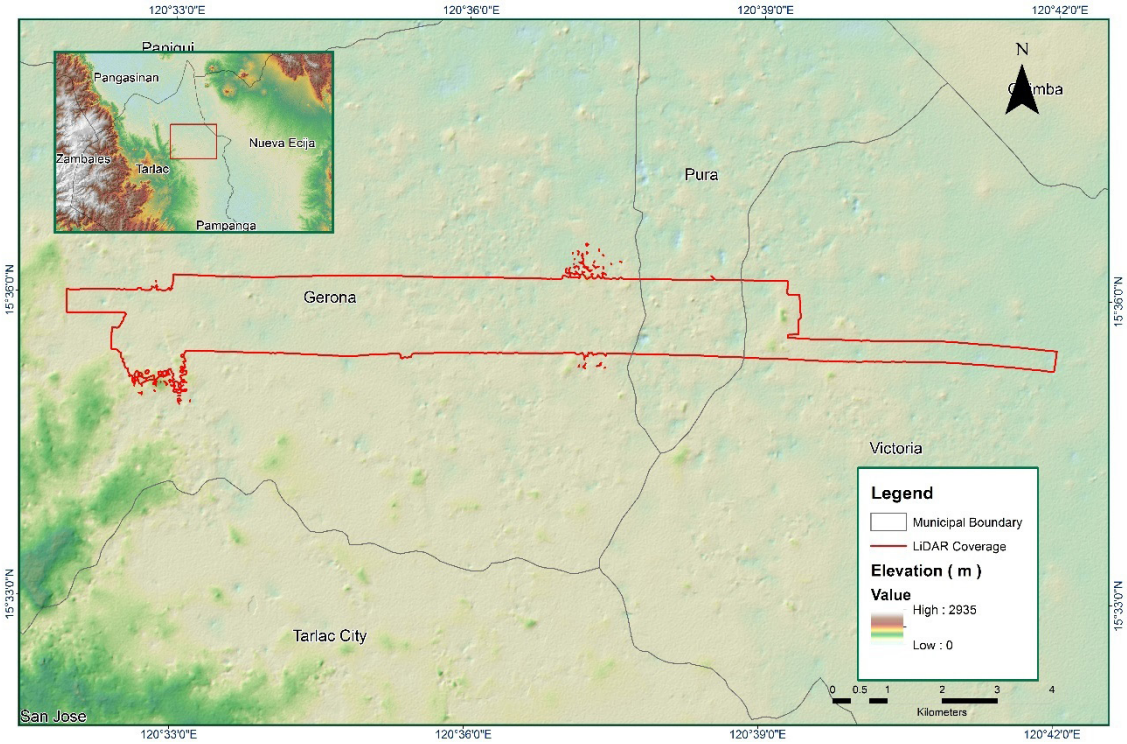


Figure 1.2.4 Coverage of LiDAR Data

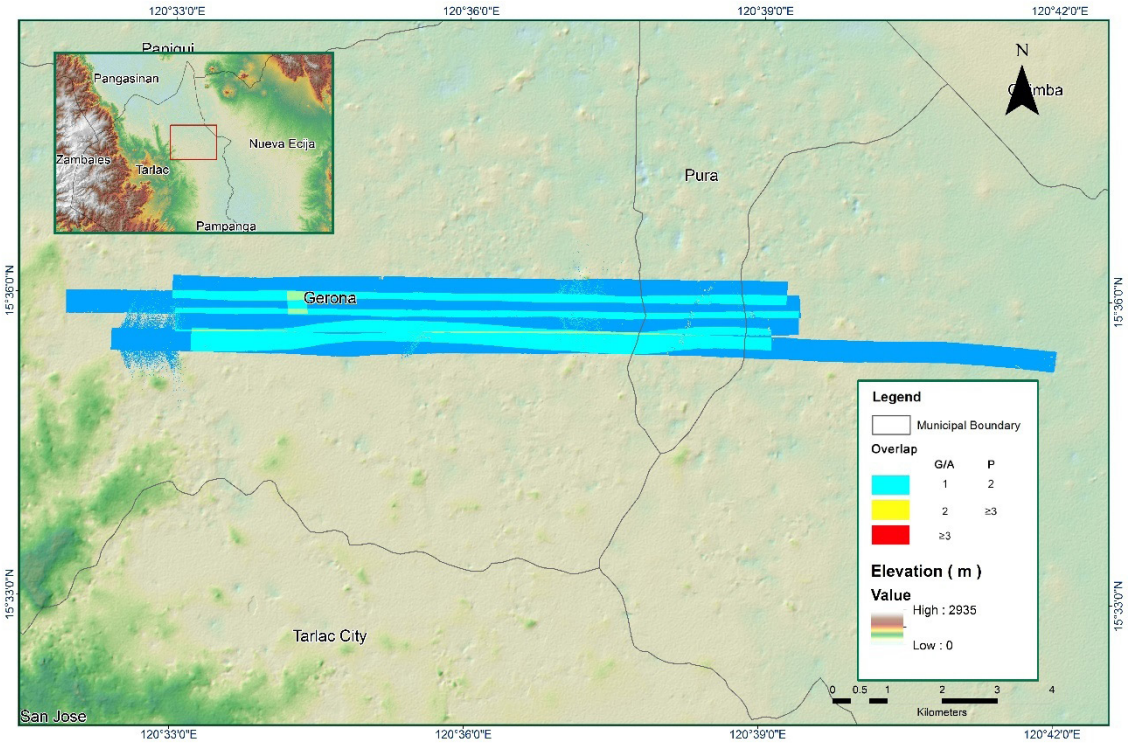


Figure 1.2.5 Image of Data Overlap

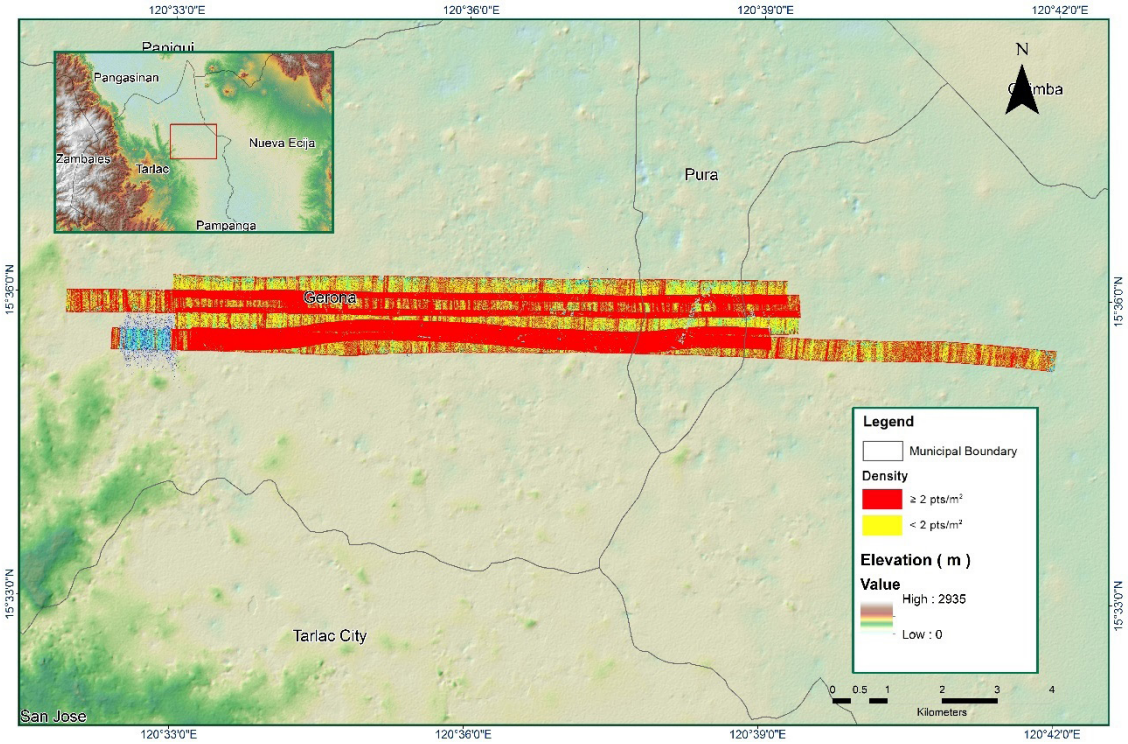


Figure 1.2.6 Density Map of merged LiDAR data

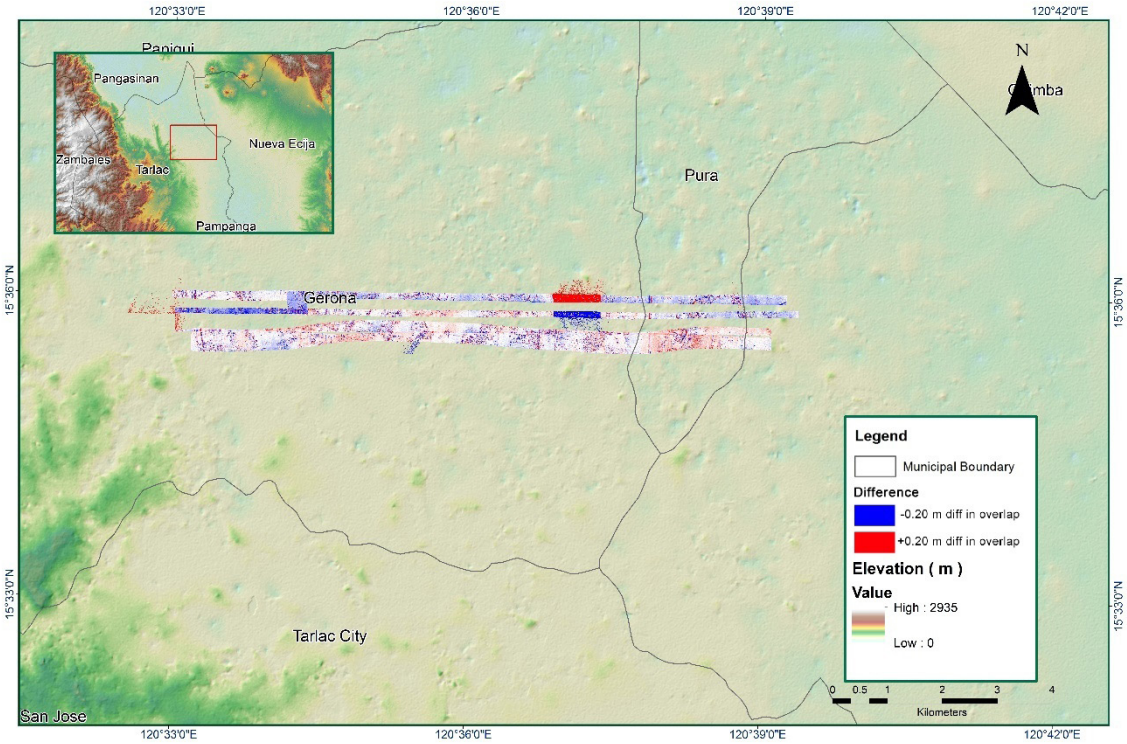


Figure 1.2.7 Elevation Difference Between flight lines

Flight Area	Pam_Agno Reflights
Mission Name	**Agno_Blk5H_reflight**
Inclusive Flights	7266G
Range data size	14.4 GB
Base data size	13.2 MB
POS	220 MB
Image	NA
Transfer date	May 29, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	No
Processing Mode (<=1)	No
Smoothed Performance Metrics (in cm)	
RMSE for North Position (<4.0 cm)	2.21
RMSE for East Position (<4.0 cm)	3.16
RMSE for Down Position (<8.0 cm)	5.68
Boresight correction stdev (<0.001deg)	0.000516
IMU attitude correction stdev (<0.001deg)	0.001521
GPS position stdev (<0.01m)	0.0320
Minimum % overlap (>25)	17.03%
Ave point cloud density per sq.m. (>2.0)	4.08
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	49
Maximum Height	434.34 m
Minimum Height	45.90 m
Classification (# of points)	
Ground	11,720,236
Low vegetation	11,820,837
Medium vegetation	66,060,507
High vegetation	32,085,532
Building	104,630
Ortophoto	No
Processed by	Engr. Analyn Naldo, Engr. Melanie Hingpit, Engr. Elainne Lopez

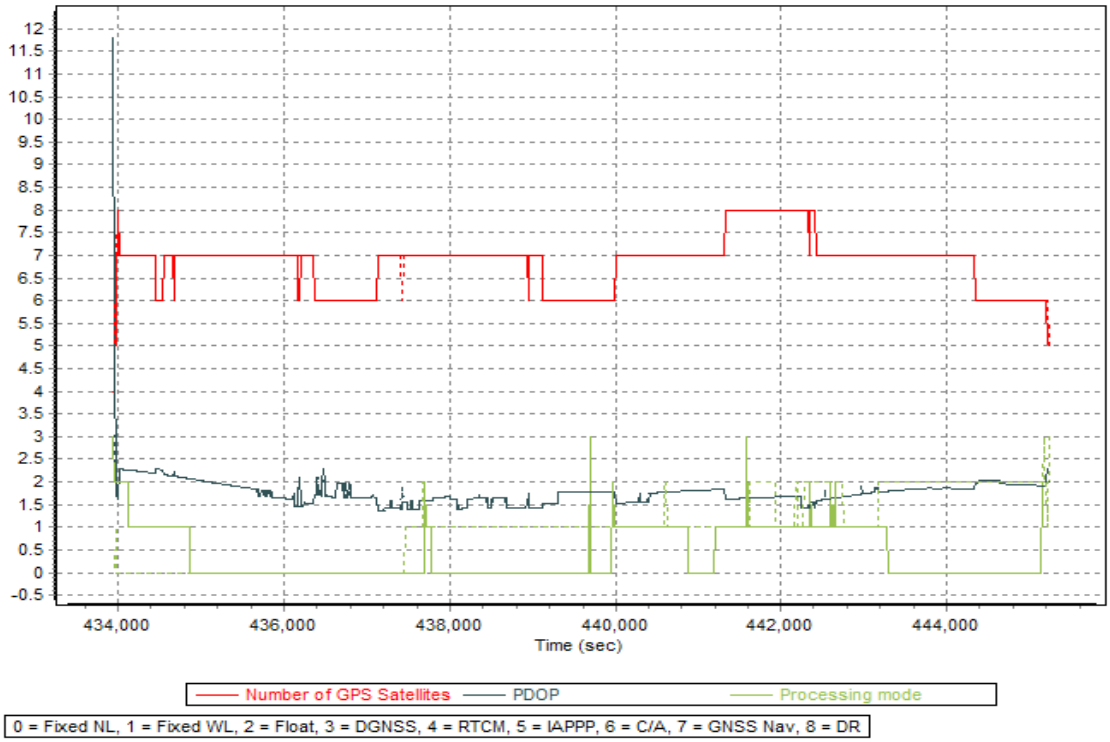


Figure 1.3.1. Solution Status

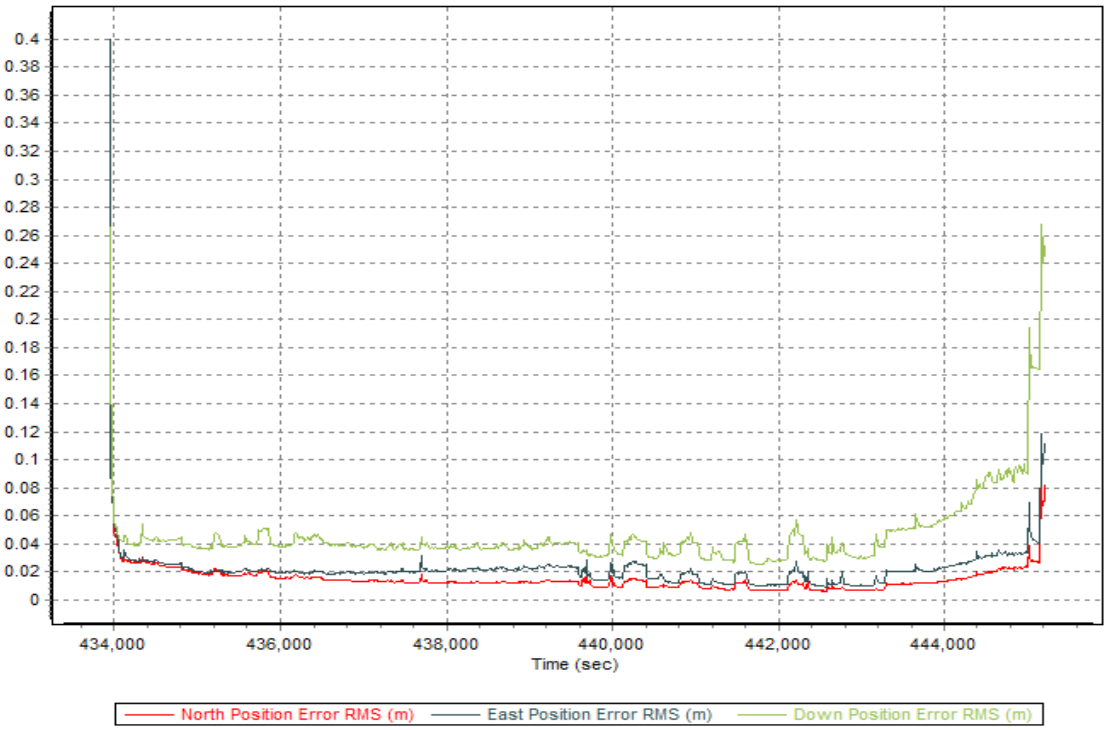


Figure 1.3.2. Smoothed Performance Metric Parameters

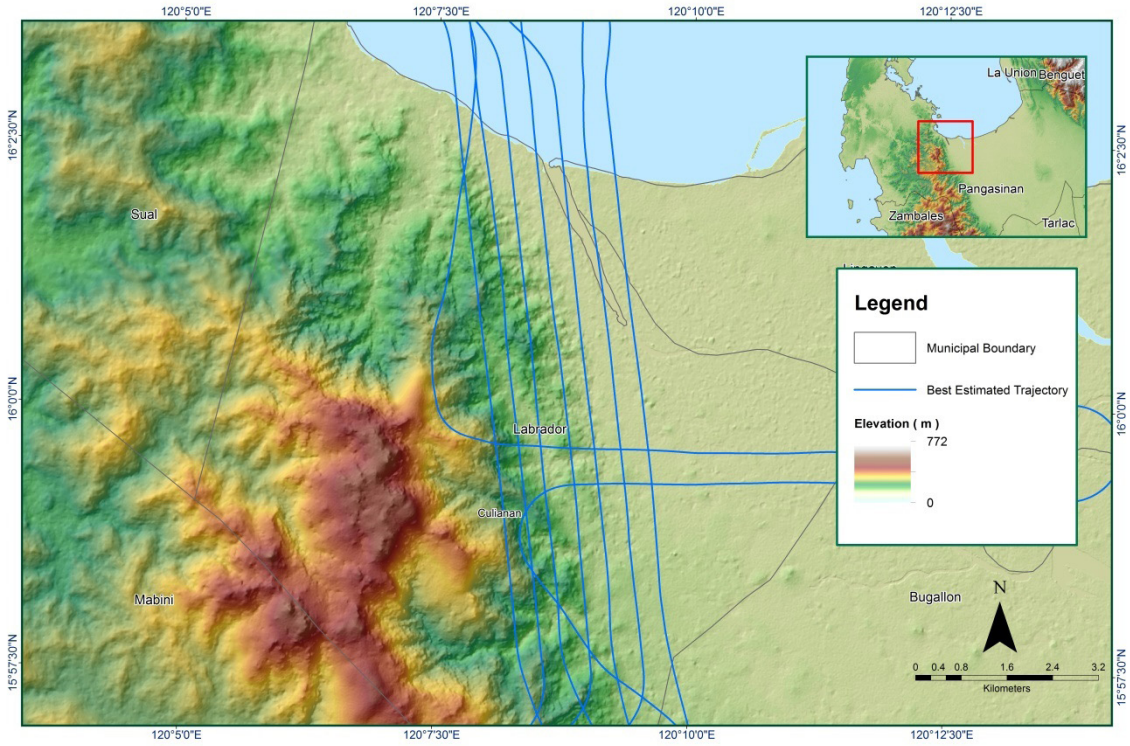


Figure 1.3.3 Best Estimated Trajectory

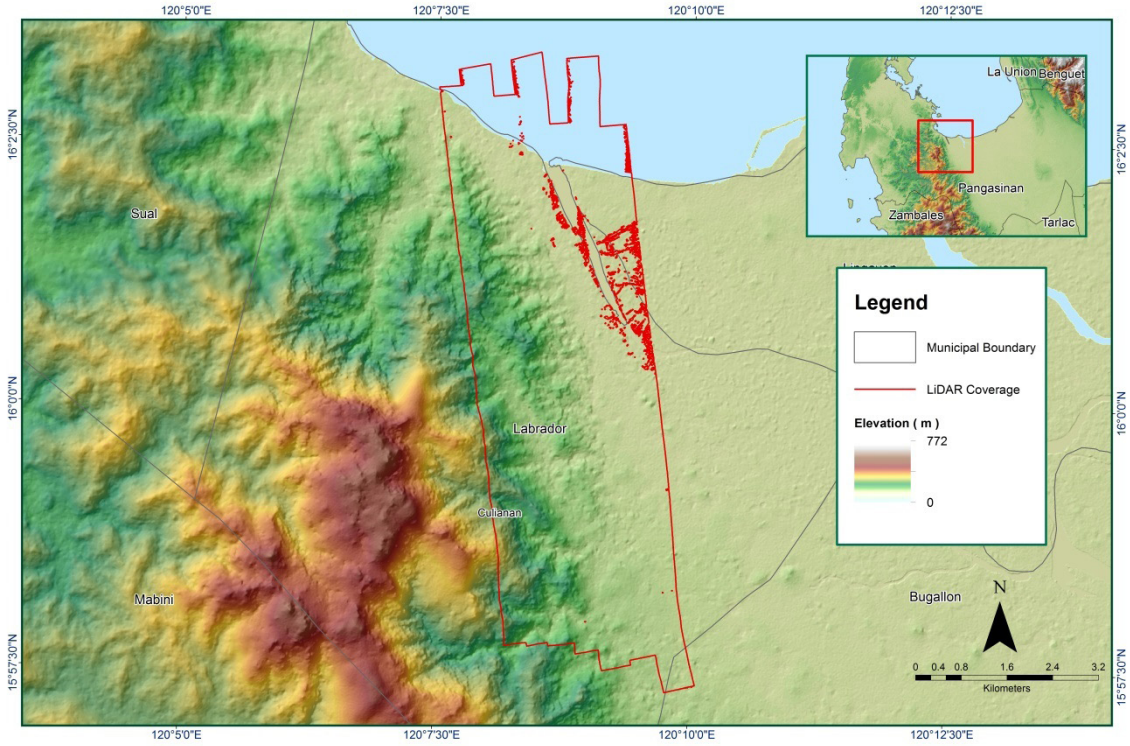


Figure 1.3.4 Coverage of LiDAR data

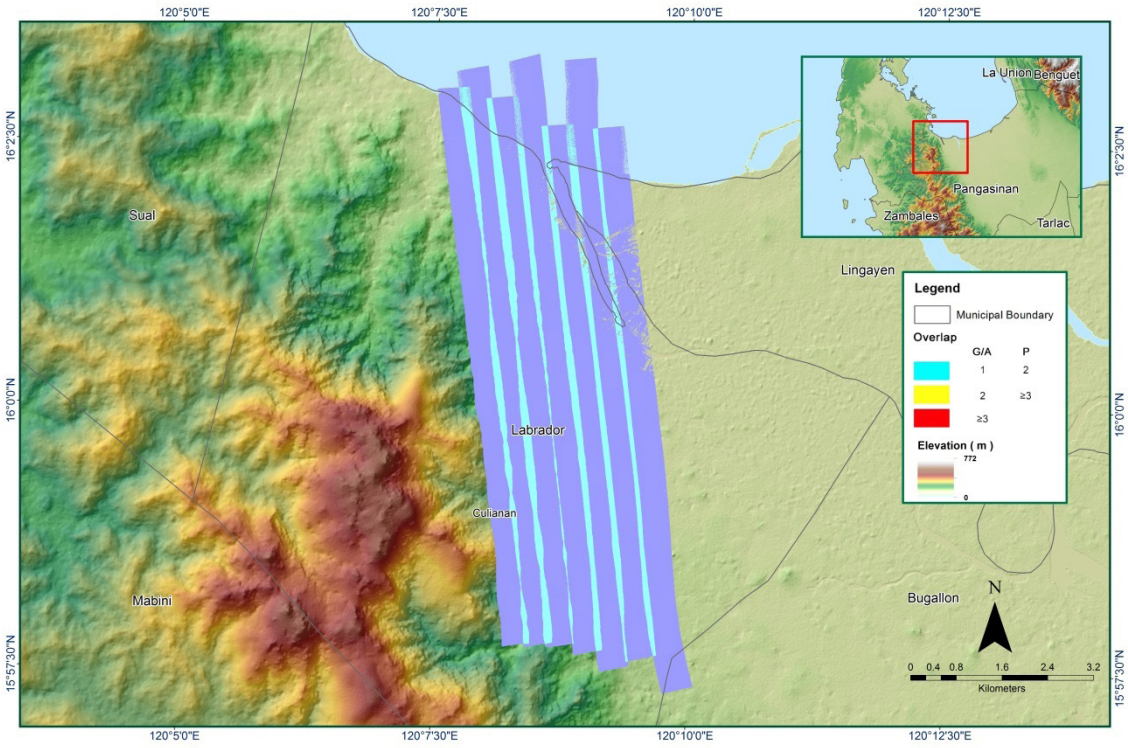


Figure 1.3.5 Image of data overlap

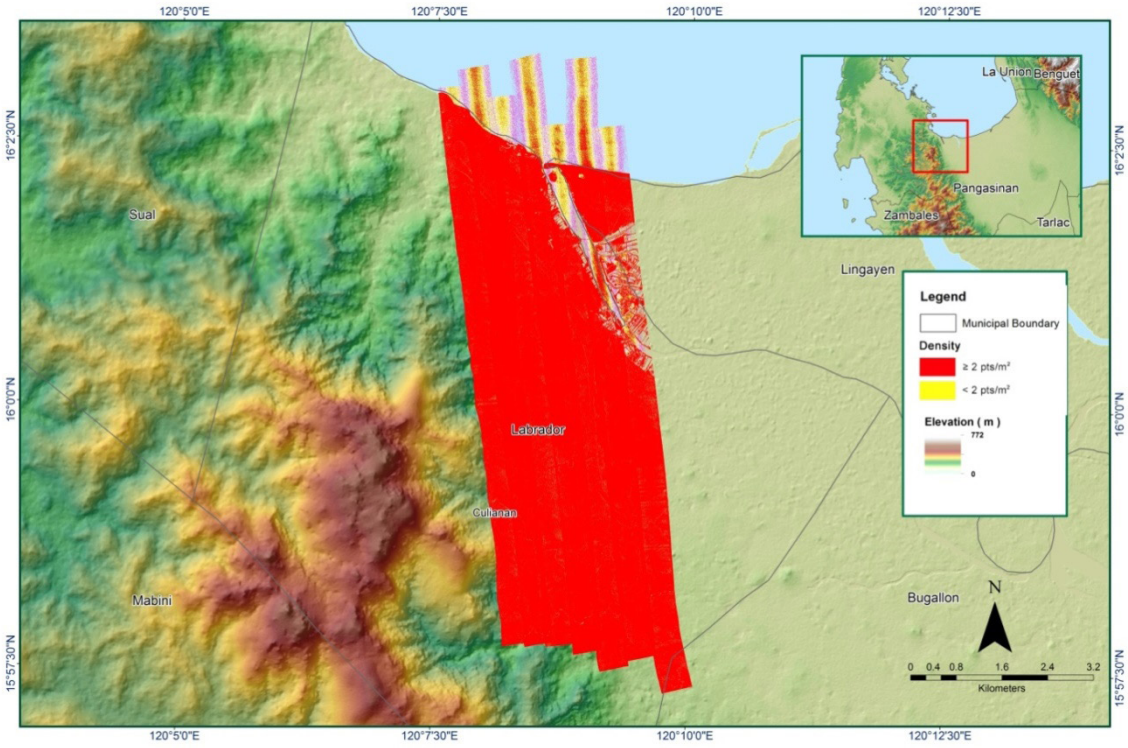


Figure 1.3.6 Density Map of merged LiDAR data

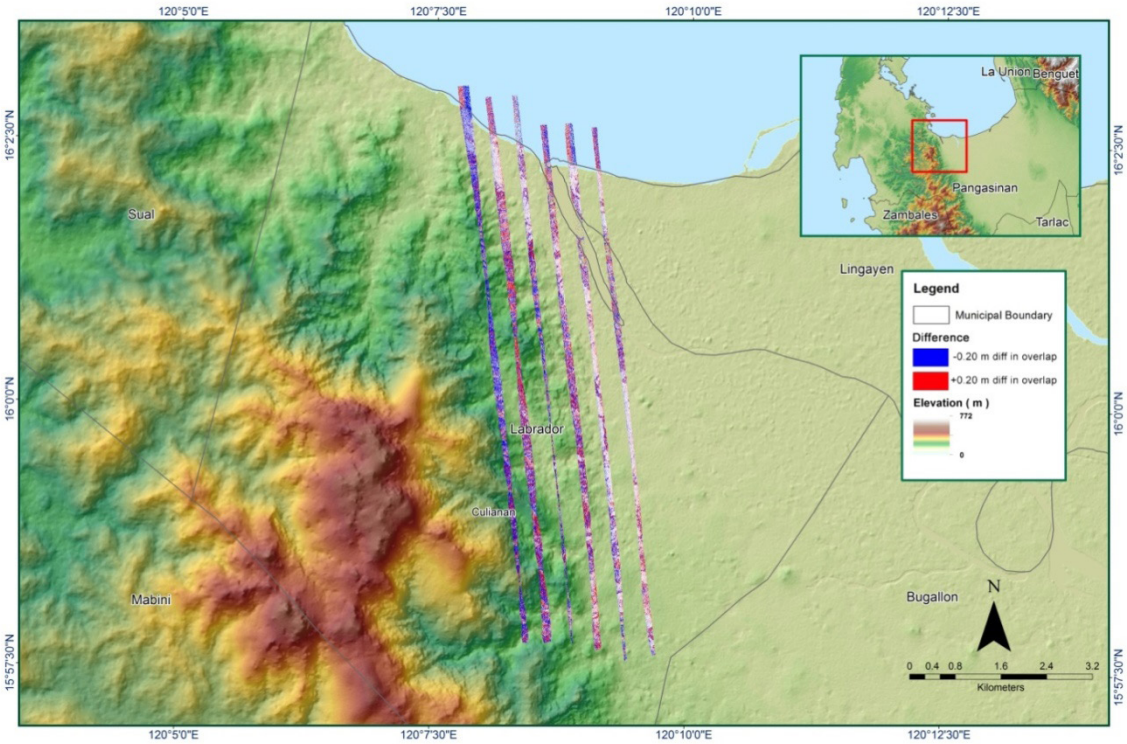


Figure 1.3.7 Elevation Difference Between flight lines

Flight Area	Pam_Agno Reflights
Mission Name	Agno_Blk6I_reflight
Inclusive Flights	7268G
Range data size	14.7 MB
POS data size	223 MB
Base data size	11.3 MB
Image	NA
Transfer date	May 24, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	No
Baseline Length (<30km)	No
Processing Mode (<=1)	No
Smoothed Performance Metrics (in cm)	
RMSE for North Position (<4.0 cm)	0.021973
RMSE for East Position (<4.0 cm)	0.019964
RMSE for Down Position (<8.0 cm)	0.057124
Boresight correction stdev (<0.001deg)	0.000470
IMU attitude correction stdev (<0.001deg)	0.008570
GPS position stdev (<0.01m)	0.0178
Minimum % overlap (>25)	17.03%
Ave point cloud density per sq.m. (>2.0)	2.77
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	62
Maximum Height	152.25 m
Minimum Height	47.31 m
Classification (# of points)	
Ground	15,169,804
Low vegetation	21,935,354
Medium vegetation	15,863,901
High vegetation	14,465,796
Building	2,010,314
Orthophoto	No
Processed By	Engr. Jennifer Saguran, Engr. Harmond Santos, Engr. John Dill Macapagal

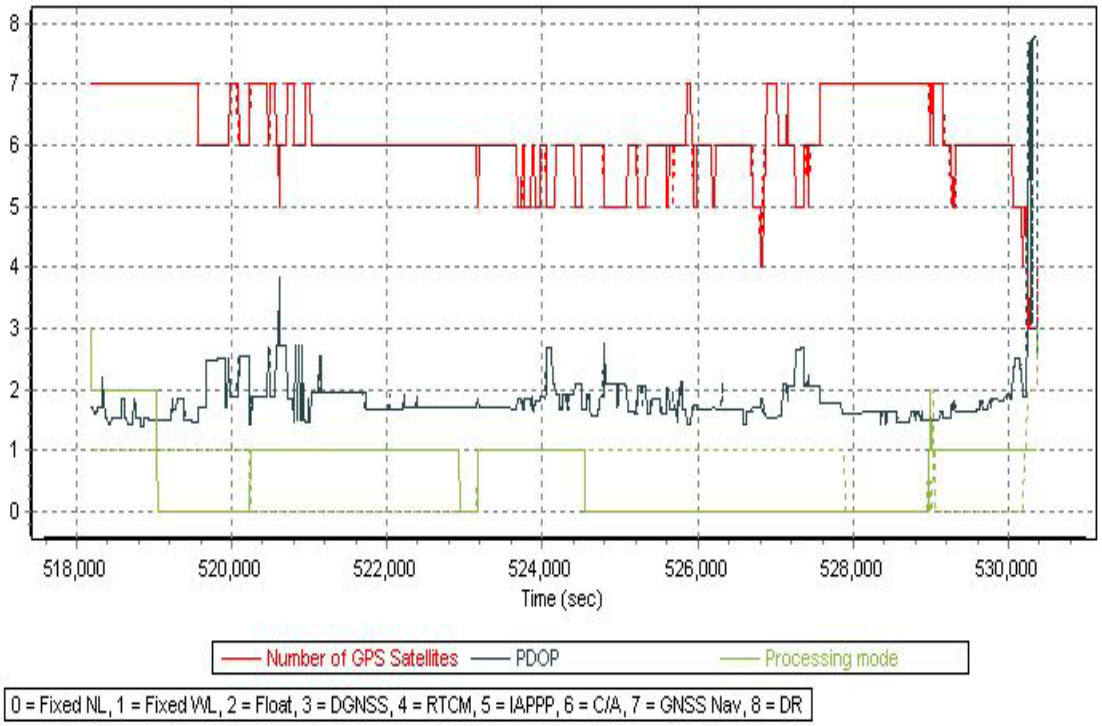


Figure 1.4.1 Solution Status

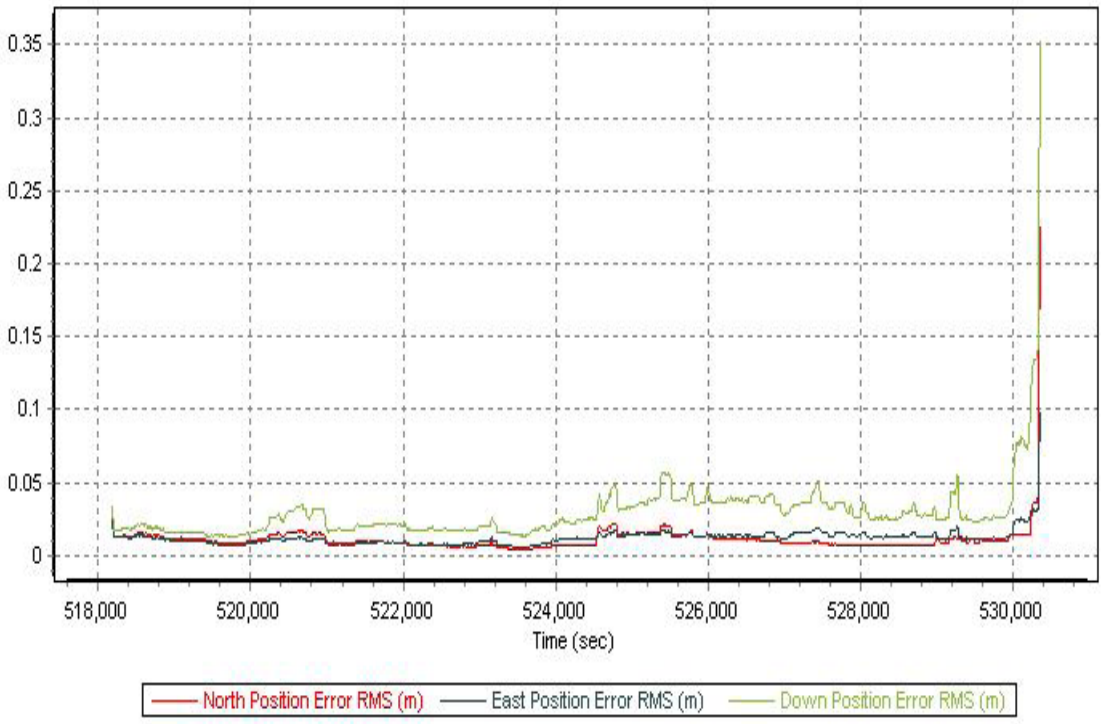


Figure 1.4.2 Smoothed Performance Metric Parameters

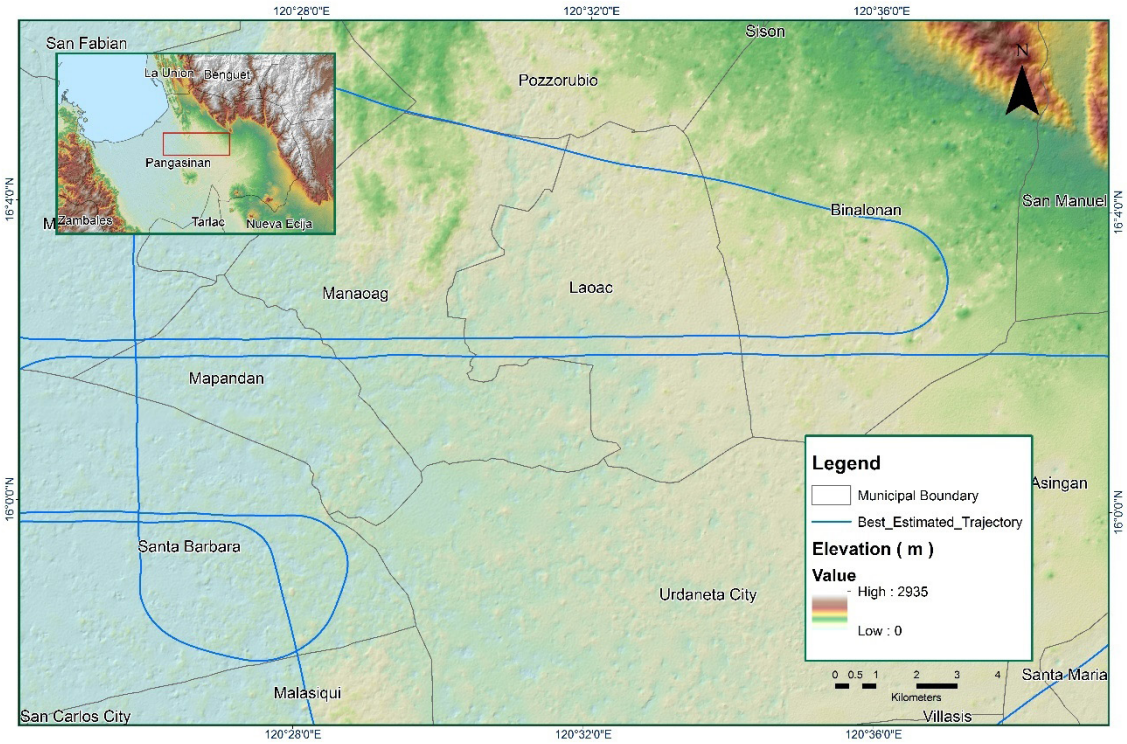


Figure 1.4.3 Best Estimated Trajectory

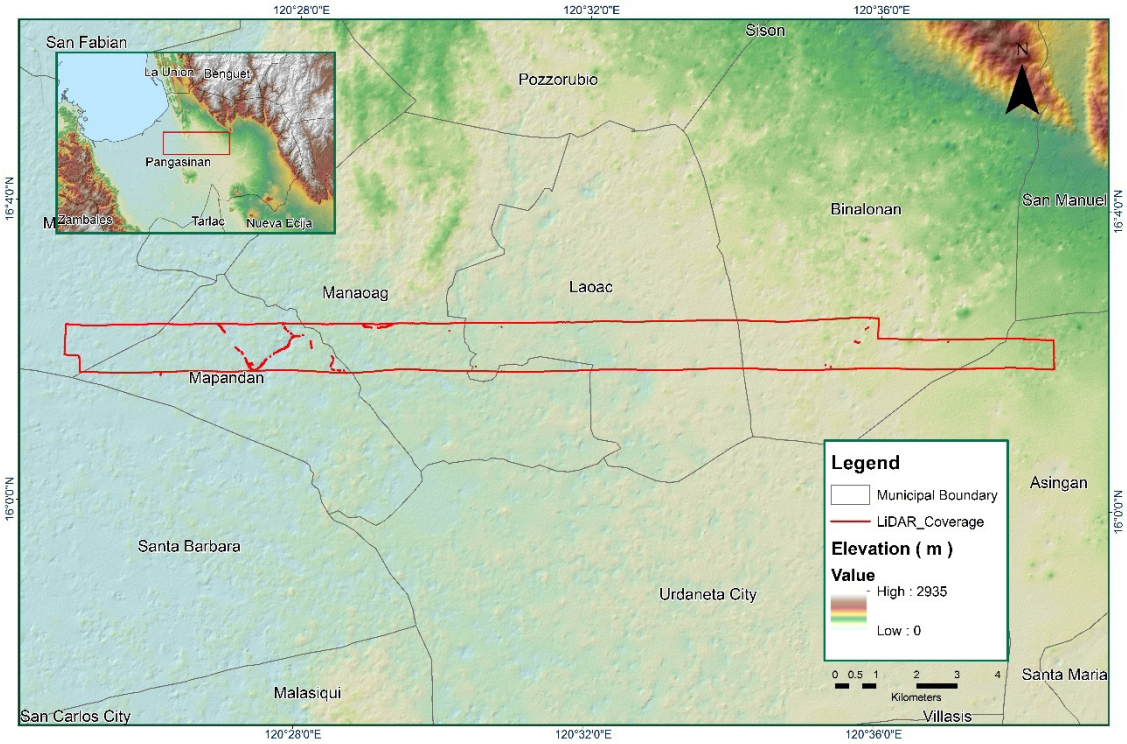


Figure 1.4.4 Coverage of LiDAR data

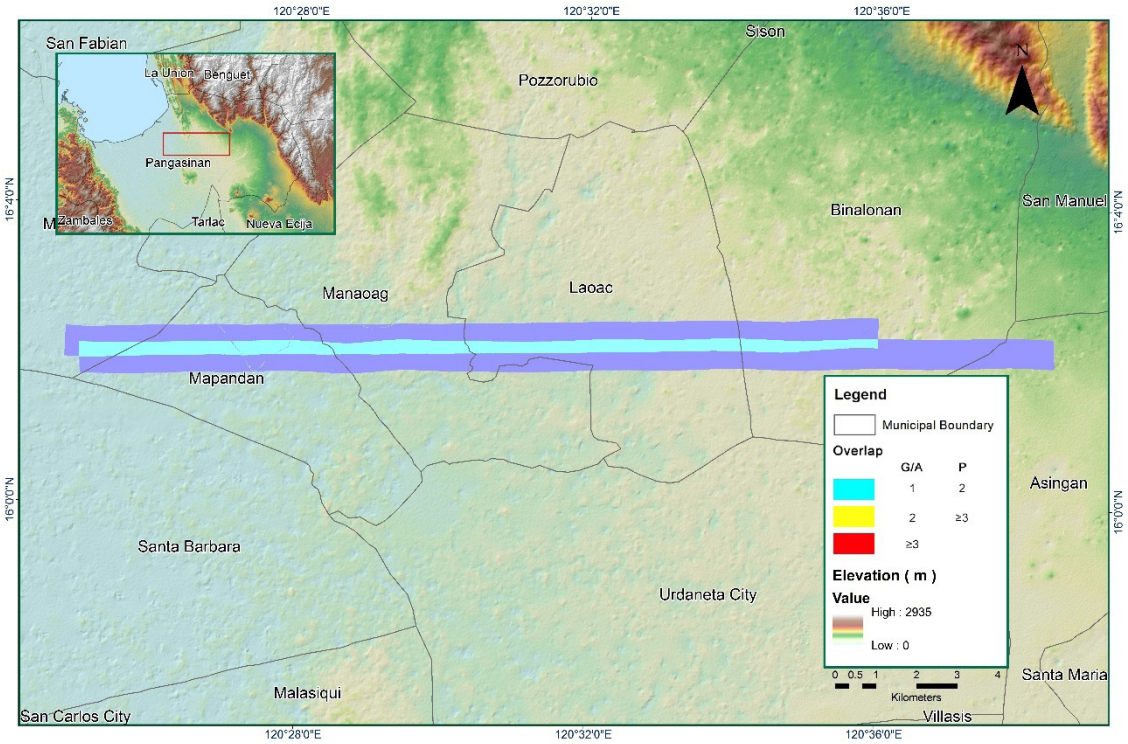


Figure 1.4.5 Image of data overlap

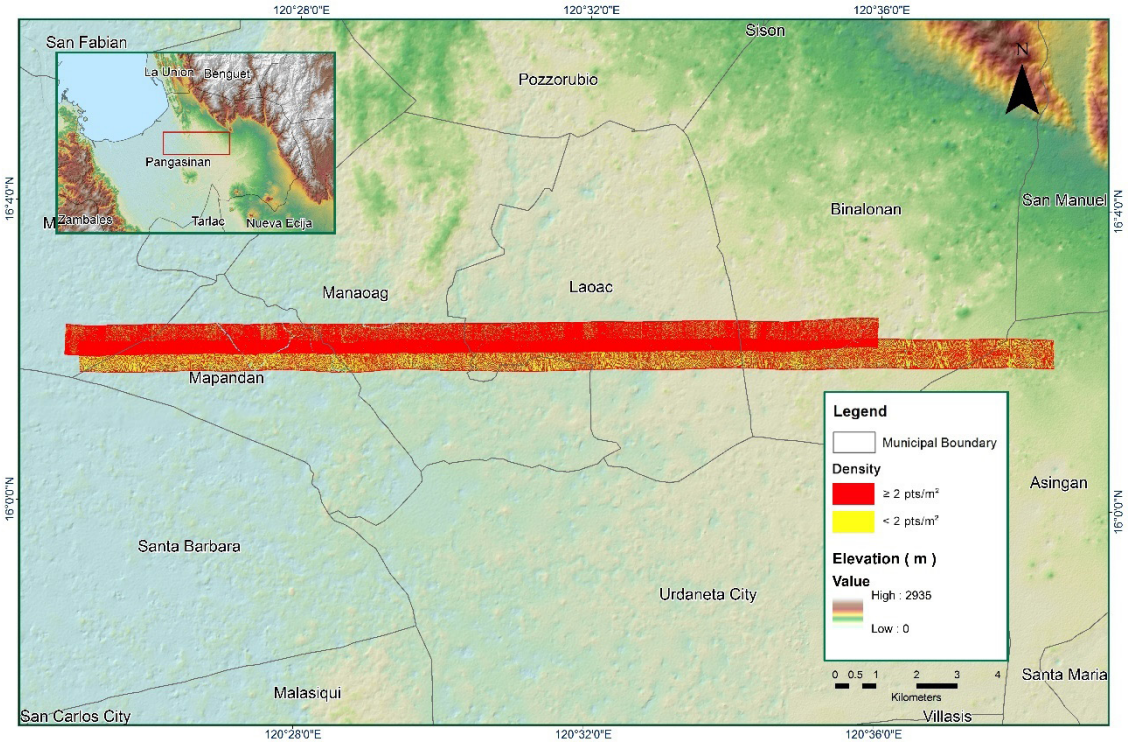


Figure 1.4.6 Density Map of merged LiDAR data

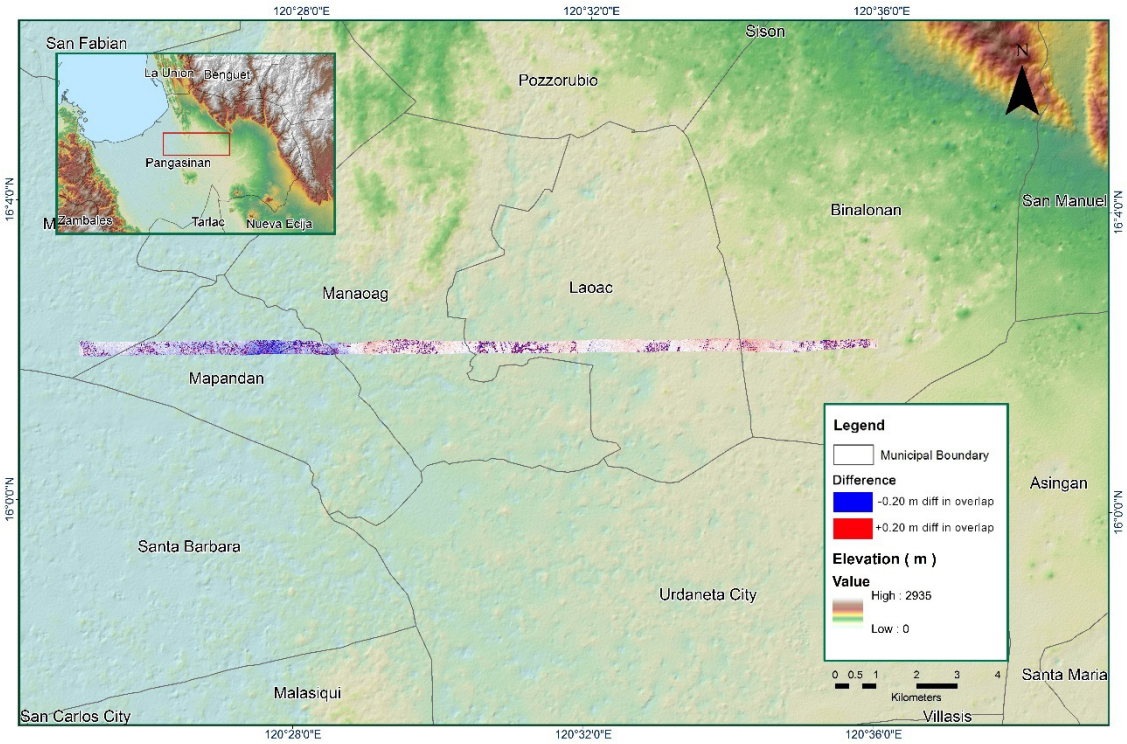


Figure 1.4.7 Elevation Difference Between flight lines

Flight Area	Pam_Agno Reflights
Mission Name	**Agno_Blk5H_reflight2**
Inclusive Flights	7268G
Range data size	11.3 MB
POS data size	223 MB
Base data size	11.3 MB
Image	NA
Transfer date	May 24, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	No
Baseline Length (<30km)	No
Processing Mode (<=1)	No
Smoothed Performance Metrics (in cm)	
RMSE for North Position (<4.0 cm)	0.021973
RMSE for East Position (<4.0 cm)	0.019964
RMSE for Down Position (<8.0 cm)	0.057125
Boresight correction stdev (<0.001deg)	0.000470
IMU attitude correction stdev (<0.001deg)	0.008570
GPS position stdev (<0.01m)	0.0178
Minimum % overlap (>25)	42.17%
Ave point cloud density per sq.m. (>2.0)	3.07
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	16
Maximum Height	99.00 m
Minimum Height	48.22 m
Classification (# of points)	
Ground	3,371,286
Low vegetation	5,167,086
Medium vegetation	5,312,415
High vegetation	3,913,628
Building	890,505
Orthophoto	No
Processed By	Engr. Jennifer Saguran, Engr. Harmond Santos, Marie Joyce Ilagan

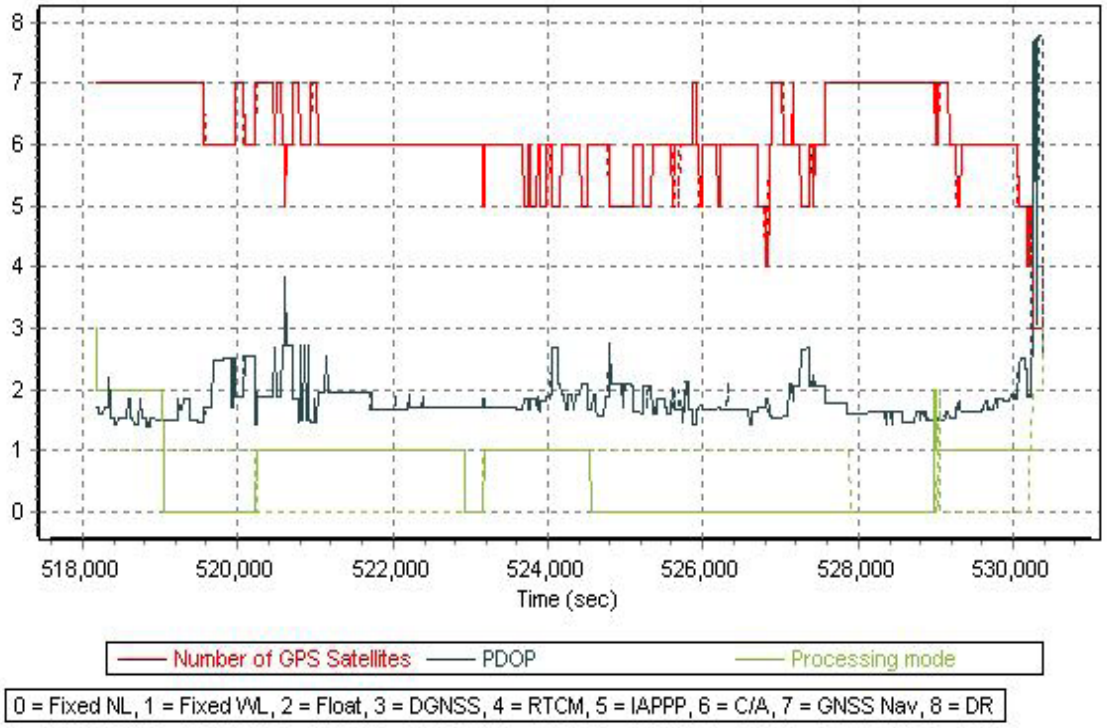


Figure 1.5.1. Solution Status

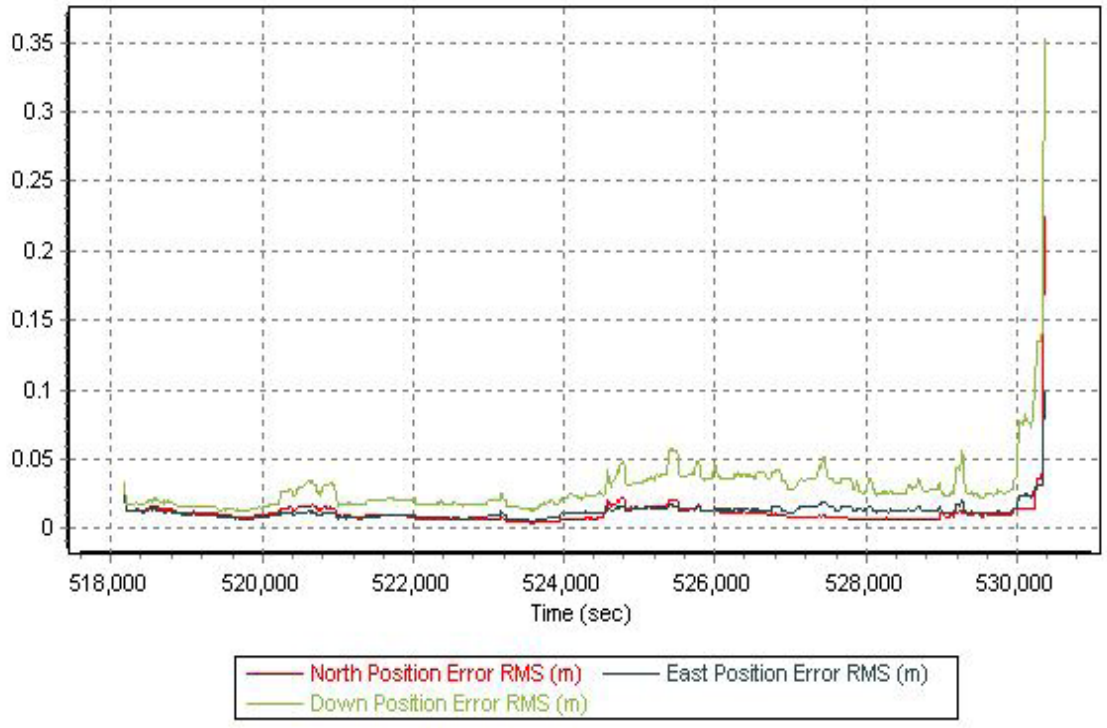


Figure 1.5.2 Smoothed Performance Metric Parameters

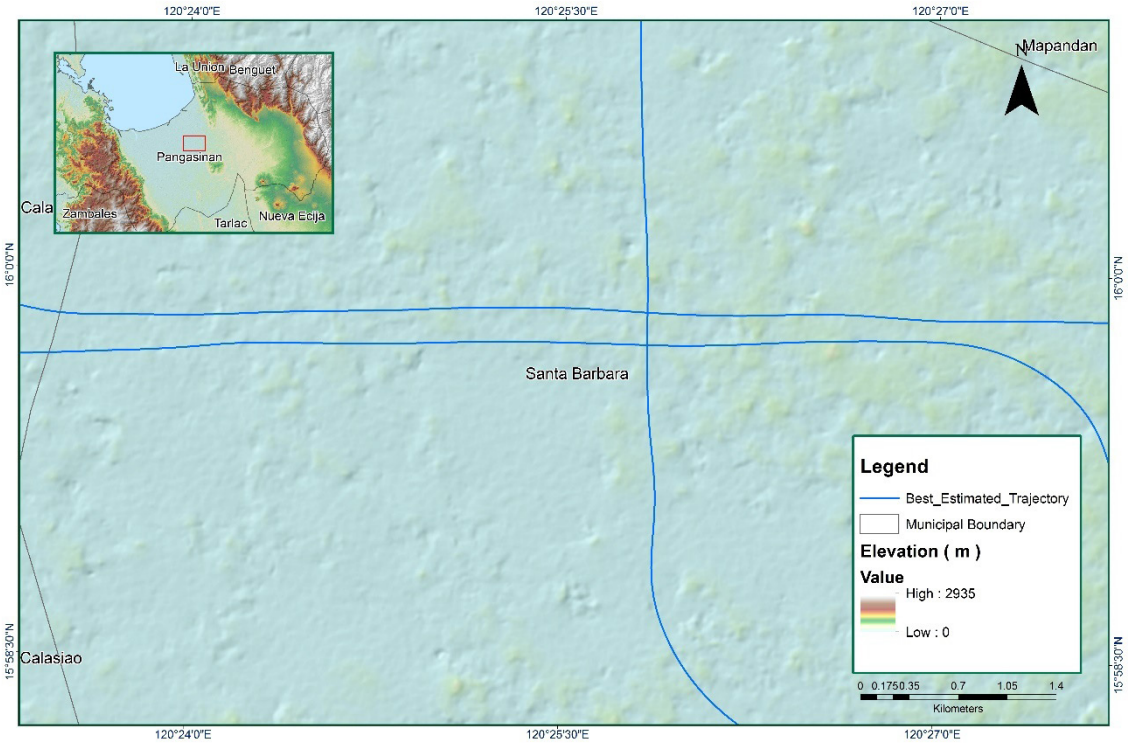


Figure 1.5.3 Best Estimated Trajectory

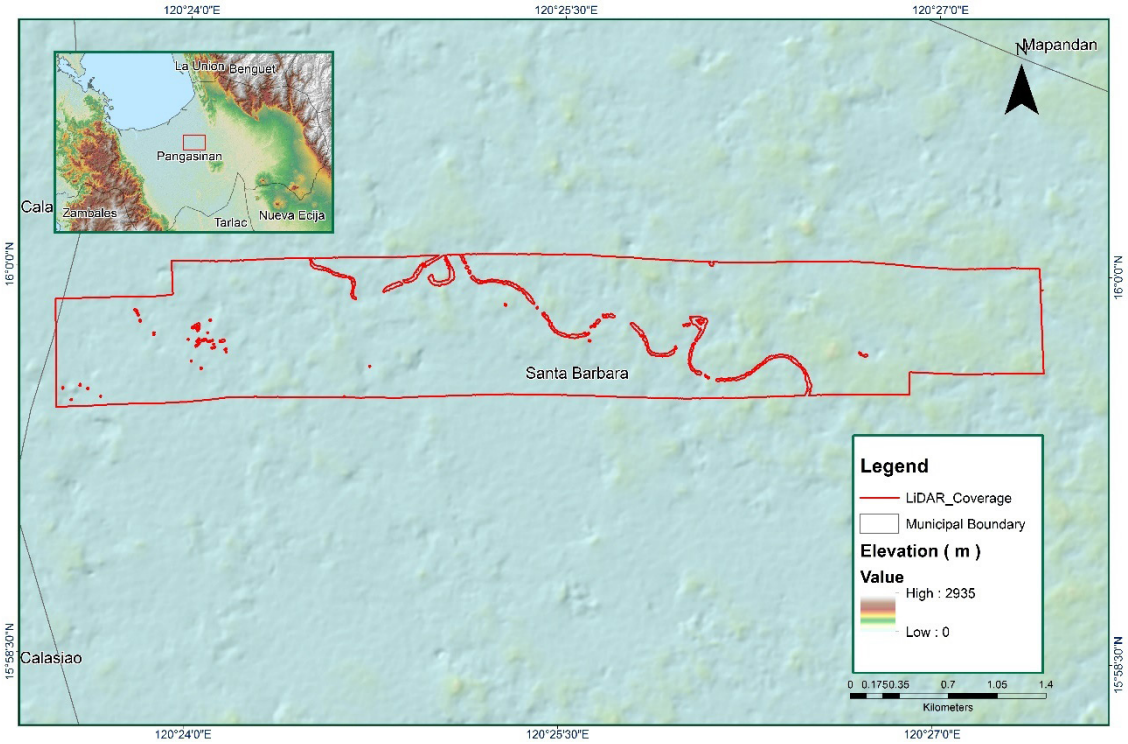


Figure 1.5.4 Coverage of LiDAR data

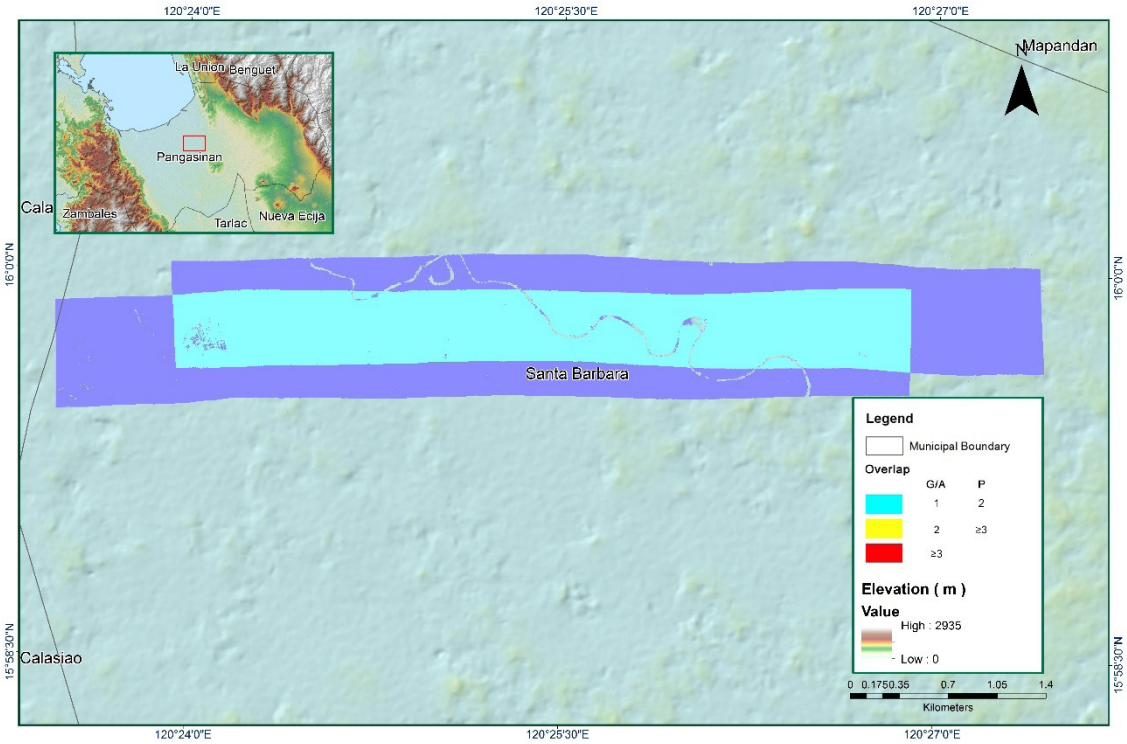


Figure 1.5.5 Image of data overlap

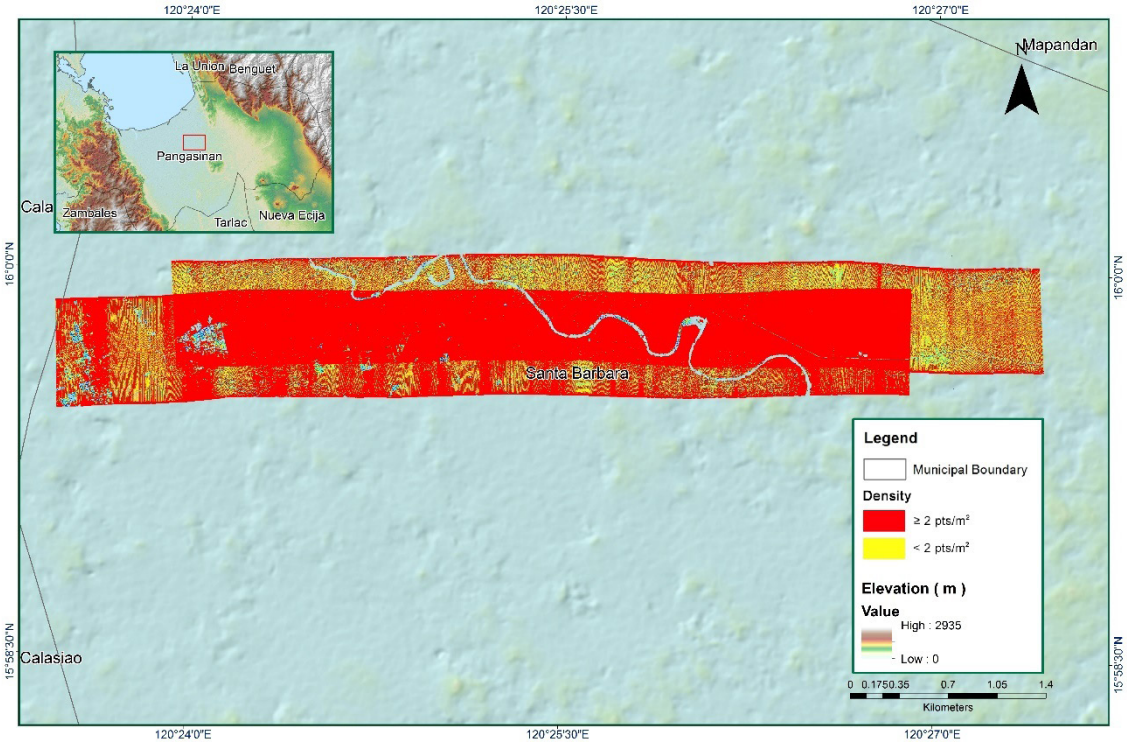


Figure 1.5.6 Density Map of merged LiDAR data

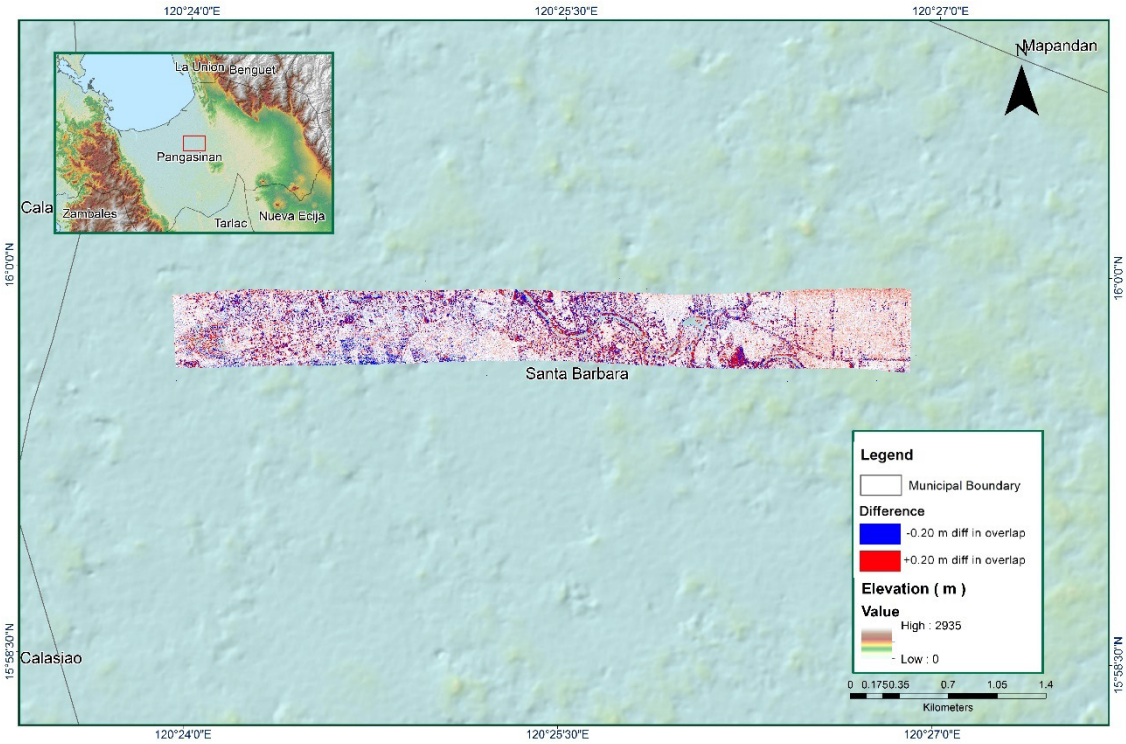


Figure 1.5.7 Elevation Difference Between flight lines

Annex 9. Dagupan 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
W1500	11.112	48.225	0	2.4948	3.1003	Discharge	1.8483	1	Ratio to Peak	0.45294
W1510	10.646	59.538	0	2.5819	3.995	Discharge	2.5112	1	Ratio to Peak	0.45416
W1520	10.914	99	0	2.2378	2.5861	Discharge	2.1085	1	Ratio to Peak	0.67809
W1530	12.766	73.179	0	1.387	1.6156	Discharge	1.1051	1	Ratio to Peak	0.68715
W1540	23.586	79.18	0	1.2503	1.4901	Discharge	1.0662	1	Ratio to Peak	0.68972
W1550	10.801	72.811	0	1.3254	0.97173	Discharge	0.85107	1	Ratio to Peak	0.52229
W1560	8.5355	85.119	0	1.4826	1.1859	Discharge	1.2319	1	Ratio to Peak	0.43801
W1570	10.89	73.982	0	1.02	1.6344	Discharge	0.84273	1	Ratio to Peak	0.68603
W1580	16.63	41.982	0	2.2773	21.249	Discharge	3.712	1	Ratio to Peak	0.45
W1590	15.794	72.094	0	1.9843	3.325	Discharge	1.4118	1	Ratio to Peak	1
W1600	18.06	74.165	0	2.7943	2.3218	Discharge	1.0169	1	Ratio to Peak	0.67628
W1610	9.7737	57.692	0	4.7041	4.8835	Discharge	2.2214	1	Ratio to Peak	0.6532
W1620	15.389	97.467	0	13.574	2.209	Discharge	2.2435	1	Ratio to Peak	0.45
W1630	17.992	99	0	6.2191	7.3434	Discharge	1.4526	1	Ratio to Peak	0.45
W1640	12.137	99	0	5.6196	4.5374	Discharge	1.485	1	Ratio to Peak	0.6782
W1650	10.189	93.716	0	8.0444	2.8607	Discharge	1.3553	1	Ratio to Peak	0.45
W1660	10.452	92.138	0	14.633	16.653	Discharge	0.84747	1	Ratio to Peak	0.45
W1670	9.9355	88.448	0	9.342	3.4906	Discharge	0.85987	1	Ratio to Peak	0.45
W1680	9.4455	99	0	7.4627	4.2619	Discharge	0.34459	1	Ratio to Peak	0.45193
W1690	11.405	99	0	7.0303	2.3881	Discharge	0.86402	1	Ratio to Peak	0.45

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
W1700	16.402	98.075	0	7.3577	7.4431	Discharge	1.0192	1	Ratio to Peak	0.45
W1710	9.83	85.98	0	12.234	4.1777	Discharge	0.84779	1	Ratio to Peak	0.45
W1720	10.082	90.022	0	10.178	17.76	Discharge	2.1313	1	Ratio to Peak	0.45
W1730	11.4	88.754	0	14.445	10.86	Discharge	0.62946	1	Ratio to Peak	0.45
W1740	4.834	69.3	0	7.5378	21.167	Discharge	2.7445	1	Ratio to Peak	0.45
W1750	11.286	84.622	0	5.9878	10.598	Discharge	0.93594	1	Ratio to Peak	0.45
W1760	28.296	67.875	0	5.3133	2.8288	Discharge	0.0531317	1	Ratio to Peak	0.45
W1770	11.066	87.723	0	9.3945	3.8222	Discharge	1.0297	1	Ratio to Peak	0.45
W1780	12.291	90.509	0	7.2692	8.562	Discharge	0.25728	1	Ratio to Peak	0.45

Annex 10. Dagupan Model Reach Parameters

Reach Number	Muskingum Cunge Channel Routing						
	Time Step Method	Length (m)	Slope	Manning's n	Shape	Width	Side Slope
R1240	Automatic Fixed Interval	5015.5	0.0332109	0.0293913	Trapezoid	42.75	1
R1260	Automatic Fixed Interval	2513.1	0.0170281	0.0189882	Trapezoid	94.15	1
R1280	Automatic Fixed Interval	2599.8	0.0134811	0.0199381	Trapezoid	202.27	1
R1320	Automatic Fixed Interval	15988	0.0090763	0.0252097	Trapezoid	233.26	1
R1330	Automatic Fixed Interval	4866.9	0.0017604	0.0366603	Trapezoid	55.23	1
R1370	Automatic Adaption	3471.7	0.001071	0.0336129	Trapezoid	20.71	1
R1400	Automatic Fixed Interval	12655	0.0028941	0.0345047	Trapezoid	21.71	1
R1410	Automatic Fixed Interval	6029.3	0.0020508	0.0317765	Trapezoid	28.51	1
R1420	Automatic Fixed Interval	12459	0.0015355	0.0641713	Trapezoid	22.61	1
R1430	Automatic Fixed Interval	14135	0.0010639	0.0638344	Trapezoid	42.24	1
R1440	Automatic Fixed Interval	3673.2	0.000444013	0.0663771	Trapezoid	30.13	1
R1450	Automatic Fixed Interval	1260.2	0.000857023	0.0179187	Trapezoid	45.16	1
R1460	Automatic Fixed Interval	7726.7	0.00056164	0.0275435	Trapezoid	41.8	1
R1480	Automatic Fixed Interval	5958.2	0.0011606	0.0451167	Trapezoid	33.27	1

Annex 11. Dagupan Field Validation Points

Point Number	Validation Coordinates		Model Var (m)	Validation Points (m)	Error	Event/Date	Rain Return / Scenario
	Lat	Long					
1	15.988912	120.440570	0.03	0	-0.03	TS Lando	5 -Year
2	16.046052	120.344264	0.03	0	-0.03	TS Lando	5 -Year
3	16.046384	120.350697	0.03	0	-0.03	TS Lando	5 -Year
4	16.044076	120.370108	0.03	0	-0.03	TS Lando	5 -Year
5	16.042299	120.371542	0.03	0	-0.03	TS Lando	5 -Year
6	16.034353	120.372208	0.03	0	-0.03	TS Lando	5 -Year
7	16.029486	120.372192	0.03	0.15	0.12	TS Lando	5 -Year
8	16.018099	120.378630	0.03	0	-0.03	TS Lando	5 -Year
9	16.008645	120.399947	0.03	0	-0.03	TS Lando	5 -Year
10	15.968331	120.375883	0.03	0	-0.03	TS Lando	5 -Year
11	15.961964	120.390099	0.03	0	-0.03	TS Lando	5 -Year
12	15.951725	120.400128	0.03	0	-0.03	TS Lando	5 -Year
13	15.939164	120.404508	0.03	0	-0.03	TS Lando	5 -Year
14	15.919547	120.411018	0.03	0	-0.03	TS Lando	5 -Year
15	15.927450	120.422325	0.03	0	-0.03	TS Lando	5 -Year
16	15.915575	120.539755	0.03	0	-0.03	TS Lando	5 -Year
17	15.916489	120.542810	0.03	0	-0.03	TS Lando	5 -Year
18	15.923714	120.540140	0.03	0	-0.03	TS Lando	5 -Year
19	15.918662	120.414826	0.03	0	-0.03	TS Lando	5 -Year
20	15.974405	120.379666	0.04	0	-0.04	TS Lando	5 -Year
21	15.932996	120.409147	0.04	0	-0.04	TS Lando	5 -Year
22	15.930439	120.426989	0.04	0	-0.04	TS Lando	5 -Year
23	15.953029	120.397634	0.05	0	-0.05	TS Lando	5 -Year
24	15.979842	120.358119	0.06	0	-0.06	TS Lando	5 -Year
25	16.021850	120.379348	0.07	0	-0.07	TS Lando	5 -Year
26	16.044325	120.339189	0.08	0	-0.08	TS Lando	5 -Year
27	16.041003	120.339646	0.08	0	-0.08	TS Lando	5 -Year
28	16.042582	120.344819	0.11	0	-0.11	TS Lando	5 -Year
29	15.984496	120.361164	0.12	0	-0.12	TS Lando	5 -Year
30	16.044967	120.363393	0.12	0	-0.12	TS Lando	5 -Year
31	15.921636	120.403410	0.16	0	-0.16	TS Lando	5 -Year
32	15.959024	120.519271	0.21	0.46	0.25	TS Lando	5 -Year
33	15.999011	120.415655	0.21	0.61	0.4	TS Lando	5 -Year
34	15.949035	120.537494	0.22	0.3	0.08	TS Lando	5 -Year
35	15.950620	120.556688	0.23	0.3	0.07	TS Lando	5 -Year
36	15.947508	120.545052	0.24	0.3	0.06	TS Lando	5 -Year
37	15.996832	120.431020	0.25	0.76	0.51	TS Lando	5 -Year
38	15.993778	120.431019	0.25	0.46	0.21	TS Lando	5 -Year

Point Number	Validation Coordinates		Model Var (m)	Validation Points (m)	Error	Event/Date	Rain Return / Scenario
	Lat	Long					
39	15.958003	120.517052	0.26	0.3	0.04	TS Lando	5 -Year
40	16.003611	120.406722	0.26	0.3	0.04	TS Lando	5 -Year
41	15.951760	120.562271	0.27	0.46	0.19	TS Lando	5 -Year
42	15.976692	120.482322	0.27	0.46	0.19	TS Lando	5 -Year
43	15.984556	120.462017	0.28	0	-0.28	TS Lando	5 -Year
44	15.974278	120.487792	0.29	0.3	0.01	TS Lando	5 -Year
45	15.985553	120.452798	0.29	0.91	0.62	TS Lando	5 -Year
46	16.001095	120.404263	0.29	0.46	0.17	TS Lando	5 -Year
47	15.980113	120.469842	0.3	0.3	0	TS Lando	5 -Year
48	16.018629	120.373438	0.31	0.46	0.15	TS Lando	5 -Year
49	16.014108	120.389564	0.33	0.46	0.13	TS Lando	5 -Year
50	15.957689	120.514554	0.34	0.46	0.12	TS Lando	5 -Year
51	15.979476	120.473437	0.34	0.3	-0.04	TS Lando	5 -Year
52	16.001761	120.406904	0.34	0.3	-0.04	TS Lando	5 -Year
53	15.996680	120.420354	0.36	0.61	0.25	TS Lando	5 -Year
54	15.962798	120.500870	0.39	0.3	-0.09	TS Lando	5 -Year
55	15.978399	120.475597	0.39	0.3	-0.09	TS Lando	5 -Year
56	16.015983	120.384050	0.4	0.61	0.21	TS Lando	5 -Year
57	15.968742	120.494188	0.46	0.3	-0.16	TS Lando	5 -Year
58	15.963729	120.408555	0.46	0.3	-0.16	TS Lando	5 -Year
59	15.976071	120.484483	0.5	0.46	-0.04	TS Lando	5 -Year
60	15.961986	120.506414	0.24	0.3	0.06	TS Lando	5 -Year
61	15.958876	120.511940	0.49	0.46	-0.03	TS Lando	5 -Year
62	15.963578	120.568934	0.6	0.91	0.31	TS Lando	5 -Year
63	15.997030	120.468599	0.66	0.91	0.25	TS Lando	5 -Year
64	15.928809	120.562289	0.7	0.61	-0.09	TS Lando	5 -Year
65	16.030092	120.337546	0.51	0.61	0.1	TS Lando	5 -Year
66	16.033164	120.335264	0.52	0.61	0.09	TS Lando	5 -Year
67	15.988588	120.405615	0.54	0.91	0.37	TS Lando	5 -Year
68	15.933277	120.455449	0.55	0.61	0.06	TS Lando	5 -Year
69	15.942316	120.443663	0.56	0.61	0.05	TS Lando	5 -Year
70	15.978319	120.389988	0.56	0.3	-0.26	TS Lando	5 -Year
71	15.987270	120.392176	0.57	0.91	0.34	TS Lando	5 -Year
72	15.979562	120.570345	0.58	0.61	0.03	TS Lando	5 -Year
73	15.986823	120.449394	0.6	0.91	0.31	TS Lando	5 -Year
74	15.942408	120.438836	0.6	0.61	0.01	TS Lando	5 -Year
75	15.978109	120.555311	0.6	0.91	0.31	TS Lando	5 -Year
76	16.018080	120.316847	0.61	0.76	0.15	TS Lando	5 -Year
77	15.965361	120.568580	0.63	0.61	-0.02	TS Lando	5 -Year
78	15.993468	120.405995	0.64	0.46	-0.18	TS Lando	5 -Year
79	15.981265	120.561098	0.64	0.91	0.27	TS Lando	5 -Year

Point Number	Validation Coordinates		Model Var (m)	Validation Points (m)	Error	Event/Date	Rain Return / Scenario
	Lat	Long					
80	15.977703	120.479109	0.67	0.91	0.24	TS Lando	5 -Year
81	15.958258	120.509240	0.7	0.91	0.21	TS Lando	5 -Year
82	15.960519	120.530455	0.72	0.91	0.19	TS Lando	5 -Year
83	16.001928	120.524704	0.75	0.91	0.16	TS Lando	5 -Year
84	15.974800	120.563748	0.76	0.46	-0.3	TS Lando	5 -Year
85	15.918602	120.535634	0.8	0.61	-0.19	TS Lando	5 -Year
86	15.982174	120.527127	0.83	0.91	0.08	TS Lando	5 -Year
87	15.980501	120.516408	0.86	0.91	0.05	TS Lando	5 -Year
88	15.977539	120.502096	0.89	0.61	-0.28	TS Lando	5 -Year
89	15.992257	120.501017	0.89	0.76	-0.13	TS Lando	5 -Year
90	15.977121	120.482301	0.89	0.91	0.02	TS Lando	5 -Year
91	15.913715	120.539335	0.91	0.91	0	TS Lando	5 -Year
92	15.938699	120.528004	0.94	0.91	-0.03	TS Lando	5 -Year
93	15.996942	120.510050	0.96	0.61	-0.35	TS Lando	5 -Year
94	15.980157	120.535351	0.96	0.61	-0.35	TS Lando	5 -Year
95	15.982113	120.528013	0.97	0.76	-0.21	TS Lando	5 -Year
96	15.965216	120.499044	0.97	0.91	-0.06	TS Lando	5 -Year
97	15.979743	120.511861	0.97	0.76	-0.21	TS Lando	5 -Year
98	15.965650	120.569395	0.97	0.61	-0.36	TS Lando	5 -Year
99	15.976148	120.548292	0.99	0.61	-0.38	TS Lando	5 -Year
100	15.972400	120.565499	1	0.61	-0.39	TS Lando	5 -Year
101	15.960264	120.510709	1.01	1.22	0.21	TS Lando	5 -Year
102	15.969460	120.497025	1.01	1.52	0.51	TS Lando	5 -Year
103	15.974522	120.493578	1.01	1.82	0.81	TS Lando	5 -Year
104	15.983501	120.509400	1.01	1.23	0.22	TS Lando	5 -Year
105	15.946239	120.539451	1.02	1.07	0.05	TS Lando	5 -Year
106	15.937990	120.544700	1.03	1.22	0.19	TS Lando	5 -Year
107	15.949724	120.537013	1.07	1.52	0.45	TS Lando	5 -Year
108	15.947566	120.561702	1.09	1.22	0.13	TS Lando	5 -Year
109	15.959448	120.509334	1.11	1.08	-0.03	TS Lando	5 -Year
110	15.983715	120.514376	1.13	1.06	-0.07	TS Lando	5 -Year
111	15.962332	120.502273	1.16	1.83	0.67	TS Lando	5 -Year
112	15.981029	120.475759	1.19	1.52	0.33	TS Lando	5 -Year
113	15.982093	120.523105	1.21	1.06	-0.15	TS Lando	5 -Year
114	15.930798	120.556448	1.24	1.83	0.59	TS Lando	5 -Year
115	15.982017	120.504474	1.34	0.91	-0.43	TS Lando	5 -Year
116	15.960136	120.507256	1.44	1.83	0.39	TS Lando	5 -Year
117	15.991956	120.473943	1.49	1.22	-0.27	TS Lando	5 -Year
118	15.989446	120.493863	1.54	1.22	-0.32	TS Lando	5 -Year
119	15.972545	120.568687	1.55	1.83	0.28	TS Lando	5 -Year
120	15.971263	120.496495	1.59	1.83	0.24	TS Lando	5 -Year

Point Number	Validation Coordinates		Model Var (m)	Validation Points (m)	Error	Event/Date	Rain Return / Scenario
	Lat	Long					
121	15.978714	120.500054	1.65	0.91	-0.74	TS Lando	5 -Year
122	15.975472	120.558226	1.75	1.98	0.23	TS Lando	5 -Year
123	15.985233	120.496399	1.83	1.37	-0.46	TS Lando	5 -Year
124	15.982083	120.496299	1.98	1.22	-0.76	TS Lando	5 -Year
125	15.976972	120.483933	1.14	1.83	0.69	TS Lando	5 -Year
126	15.942776	120.432086	3.48	2.29	-1.19	TS Lando	5 -Year
127	15.974656	120.550152	2.1	2.29	0.19	TS Lando	5 -Year
128	15.985376	120.514640	2.01	3.05	1.04	TS Lando	5 -Year
129	16.006688	120.546012	2.01	2.44	0.43	TS Lando	5 -Year
130	15.984855	120.555539	2.02	2.44	0.42	TS Lando	5 -Year
131	15.983412	120.477378	2.03	2.13	0.1	TS Lando	5 -Year
132	15.982437	120.522717	2.03	2.74	0.71	TS Lando	5 -Year
133	15.986579	120.548930	2.03	1.98	-0.05	TS Lando	5 -Year
134	15.971562	120.496550	2.04	2.44	0.4	TS Lando	5 -Year
135	15.973109	120.494775	2.04	2.44	0.4	TS Lando	5 -Year
136	15.983014	120.493778	2.04	2.59	0.55	TS Lando	5 -Year
137	15.988099	120.547289	2.06	2.13	0.07	TS Lando	5 -Year
138	15.983957	120.551590	2.06	2.13	0.07	TS Lando	5 -Year
139	15.986301	120.551043	2.06	2.29	0.23	TS Lando	5 -Year
140	15.986930	120.507625	2.07	2.9	0.83	TS Lando	5 -Year
141	15.988203	120.548932	2.07	2.29	0.22	TS Lando	5 -Year
142	15.932029	120.438622	2.07	1.98	-0.09	TS Lando	5 -Year
143	15.991151	120.541518	2.09	2.13	0.04	TS Lando	5 -Year
144	15.975670	120.561928	2.1	2.44	0.34	TS Lando	5 -Year
145	15.975919	120.547823	2.11	2.74	0.63	TS Lando	5 -Year
146	15.982372	120.486090	2.11	2.44	0.33	TS Lando	5 -Year
147	15.998020	120.549946	2.12	2.44	0.32	TS Lando	5 -Year
148	15.981359	120.476458	2.13	2.44	0.31	TS Lando	5 -Year
149	16.005268	120.560085	2.14	2.44	0.3	TS Lando	5 -Year
150	15.975067	120.548720	2.15	2.44	0.29	TS Lando	5 -Year
151	15.922934	120.443428	2.18	2.13	-0.05	TS Lando	5 -Year
152	15.982983	120.551969	2.18	2.9	0.72	TS Lando	5 -Year
153	15.995973	120.551821	2.23	2.44	0.21	TS Lando	5 -Year
154	15.929445	120.557012	2.25	2.29	0.04	TS Lando	5 -Year
155	15.921382	120.444810	2.25	2.44	0.19	TS Lando	5 -Year
156	15.983851	120.519744	2.29	2.44	0.15	TS Lando	5 -Year
157	15.977396	120.566016	2.31	2.13	-0.18	TS Lando	5 -Year
158	15.986534	120.498201	2.34	2.74	0.4	TS Lando	5 -Year
159	15.977708	120.542707	2.4	2.13	-0.27	TS Lando	5 -Year
160	15.974672	120.551533	2.42	2.74	0.32	TS Lando	5 -Year
161	15.975269	120.548294	2.51	2.74	0.23	TS Lando	5 -Year

Point Number	Validation Coordinates		Model Var (m)	Validation Points (m)	Error	Event/Date	Rain Return / Scenario
	Lat	Long					
162	15.977300	120.564681	2.55	2.44	-0.11	TS Lando	5 -Year
163	15.988192	120.507153	2.61	2.74	0.13	TS Lando	5 -Year
164	15.987218	120.554229	2.61	2.13	-0.48	TS Lando	5 -Year
165	15.998296	120.552544	2.64	2.44	-0.2	TS Lando	5 -Year
166	15.981130	120.539233	2.7	3.05	0.35	TS Lando	5 -Year
167	15.978356	120.569400	2.82	2.13	-0.69	TS Lando	5 -Year
168	16.006594	120.553425	2.88	2.44	-0.44	TS Lando	5 -Year
169	15.978433	120.568596	2.91	2.9	-0.01	TS Lando	5 -Year
170	15.974687	120.554688	2.96	2.59	-0.37	TS Lando	5 -Year
171	15.981422	120.537811	3.05	3.05	0	TS Lando	5 -Year
172	15.990898	120.542965	3.2	3.05	-0.15	TS Lando	5 -Year
173	15.922901	120.425418	3.23	2.13	-1.1	TS Lando	5 -Year
174	15.985871	120.495924	3.9	2.74	-1.16	TS Lando	5 -Year
175	15.977928	120.568643	4.49	2.44	-2.05	TS Lando	5 -Year
176	15.978048	120.566740	4.6	2.74	-1.86	TS Lando	5 -Year
177	15.998835	120.550439	4.71	2.74	-1.97	TS Lando	5 -Year
178	15.977291	120.569289	5.02	3.05	-1.97	TS Lando	5 -Year
179	15.987502	120.564400	6.04	3.05	-2.99	TS Lando	5 -Year
180	15.977265	120.563664	6.34	2.74	-3.6	TS Lando	5 -Year

Annex 12. Educational Institutions affected by flooding in Dagupan Floodplain

Table A-12.1. Educational Institutions in Calasiao, Pangasinan affected by flooding in Daguan (Sinocalan) Floodplain

Pangasinan				
Calasiao				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
AMBONAO ELEMENTARY	Ambonao			
AMBONAO ELEMENTARY 2	Ambonao			Low
AMBONAO ELEMENTARY 3	Ambonao			Low
AMBONAO ELEMENTARY 4	Ambonao			Medium
AMBONAO ELEMENTARY 5	Ambonao			Low
AMBONAO ELEMENTARY 6	Ambonao			
AMBONAO ELEMENTARY 7	Ambonao			Low
BUED ELEMENTARY 2	Ambonao	Low	Low	Low
BUED ELEMENTARY 3	Ambonao	Low	Low	Medium
BUED ELEMENTARY 4	Ambonao		Low	Low
BUED ELEMENTARY 5	Ambonao		Low	Low
BUED ELEMENTARY 6	Ambonao			Low
BUED NATIONAL HIGH SCHOOL 1	Ambonao			
BUED NATIONAL HIGH SCHOOL 10	Ambonao			
BUED NATIONAL HIGH SCHOOL 11	Ambonao			
BUED NATIONAL HIGH SCHOOL 12	Ambonao			Low
BUED NATIONAL HIGH SCHOOL 13	Ambonao	Low	Low	Low
BUED NATIONAL HIGH SCHOOL 14	Ambonao			
BUED NATIONAL HIGH SCHOOL 2	Ambonao			
BUED NATIONAL HIGH SCHOOL 3	Ambonao		Low	Low
BUED NATIONAL HIGH SCHOOL 4	Ambonao		Low	Low
BUED NATIONAL HIGH SCHOOL 5	Ambonao			
BUED NATIONAL HIGH SCHOOL 6	Ambonao			
BUED NATIONAL HIGH SCHOOL 7	Ambonao			
BUED NATIONAL HIGH SCHOOL 8	Ambonao			
BUED NATIONAL HIGH SCHOOL 9	Ambonao			
DAY CARE CENTER	Ambonao			Low
MOTHER OF GOOD COUNSEL ACADEMY 1	Ambonao			
MOTHER OF GOOD COUNSEL ACADEMY 2	Ambonao	Low	Low	Low
MOTHER OF GOOD COUNSEL ACADEMY 3	Ambonao			
BUED EAST ELEMENTARY	Bued	Low	Medium	Medium
BUED EAST ELEMENTARY 2	Bued	Low	Medium	Medium
BUED EAST ELEMENTARY 3	Bued	Low	Medium	Medium
BUED EAST ELEMENTARY 4	Bued		Medium	Medium
BUED EAST ELEMENTARY 5	Bued		Medium	Medium
BUED EAST ELEMENTARY 6	Bued		Medium	Medium
BUED EAST ELEMENTARY 7	Bued	Low	Medium	Medium
BUED EAST ELEMENTARY 8	Bued		Medium	Medium

CABILOCAAN ELEMENTARY	Cabilocaan			
CABILOCAAN ELEMENTARY 2	Cabilocaan			
CABILOCAAN ELEMENTARY 3	Cabilocaan			
CABILOCAAN ELEMENTARY 4	Cabilocaan			Low
CABILOCAAN ELEMENTARY 5	Cabilocaan			
CABILOCAAN ELEMENTARY 6	Cabilocaan			
DAY CARE CENTER	Gabon	Low	Low	Low
ELPIDIO P. ROY-GABON ELEMENTARY	Gabon		Low	Low
BALINGIT-CONSTANTINO LASIP ELEMENTARY	Lasip			
BALINGIT-CONSTANTINO LASIP ELEMENTARY 2	Lasip			
BALINGIT-CONSTANTINO LASIP ELEMENTARY 3	Lasip			
BALINGIT-CONSTANTINO LASIP ELEMENTARY 4	Lasip			
BALINGIT-CONSTANTINO LASIP ELEMENTARY 5	Lasip			
BALINGIT-CONSTANTINO LASIP ELEMENTARY 6	Lasip			
TALIBAEW ELEMENTARY 1	Lasip			Low
TALIBAEW ELEMENTARY 2	Lasip			
TALIBAEW ELEMENTARY 3	Lasip			
TALIBAEW ELEMENTARY 4	Lasip			Low
TALIBAEW ELEMENTARY 5	Lasip			Low
TALIBAEW ELEMENTARY 6	Lasip			Low
TALIBAEW ELEMENTARY 7	Lasip			Low
TALIBAEW ELEMENTARY 8	Lasip			
CALASIAO COMPREHENSIVE NATIONAL HIGHSCHOOL 10	Nalsian	Low	Low	Low
CALASIAO COMPREHENSIVE NATIONAL HIGHSCHOOL 11	Nalsian			Low
CALASIAO COMPREHENSIVE NATIONAL HIGHSCHOOL 12	Nalsian		Low	Low
CALASIAO COMPREHENSIVE NATIONAL HIGHSCHOOL 13	Nalsian			
CALASIAO COMPREHENSIVE NATIONAL HIGHSCHOOL 7	Nalsian			
CALASIAO COMPREHENSIVE NATIONAL HIGHSCHOOL 8	Nalsian		Low	Low
CALASIAO COMPREHENSIVE NATIONAL HIGHSCHOOL 9	Nalsian			
CALASIAO EDUCATIONAL CENTER 1	Nalsian		Low	Low
CALASIAO EDUCATIONAL CENTER 2	Nalsian			
CALASIAO EDUCATIONAL CENTER 3	Nalsian			Low
CALASIAO EDUCATIONAL CENTER 4	Nalsian			
NALSIAN-BACAYAO ELEMENTARY 1	Nalsian			
NALSIAN-BACAYAO ELEMENTARY 2	Nalsian	Low	Low	Low
NALSIAN-BACAYAO ELEMENTARY 3	Nalsian	Low	Low	Low
NALSIAN-BACAYAO ELEMENTARY 4	Nalsian			
NALSIAN-BACAYAO ELEMENTARY 5	Nalsian			Low
NALSIAN-BACAYAO ELEMENTARY 6	Nalsian		Low	Low
NALSIAN-BACAYAO ELEMENTARY 7	Nalsian			
PHILIPPINE COLLEGE OF SCIENCE AND TECHNOLOGY 1	Nalsian	Low	Low	Low
PHILIPPINE COLLEGE OF SCIENCE AND TECHNOLOGY 2	Nalsian			
PHILIPPINE COLLEGE OF SCIENCE AND TECHNOLOGY 3	Nalsian			
PHILIPPINE COLLEGE OF SCIENCE AND TECHNOLOGY 4	Nalsian	Low	Low	Low
PHILIPPINE COLLEGE OF SCIENCE AND TECHNOLOGY 5	Nalsian			
PHILIPPINE COLLEGE OF SCIENCE AND TECHNOLOGY 6	Nalsian			

PHILIPPINE COLLEGE OF SCIENCE AND TECHNOLOGY 7	Nalsian	Low	Low	Low
PHILIPPINE COLLEGE OF SCIENCE AND TECHNOLOGY 8	Nalsian		Low	Low
SE	Nalsian			
SAN MIGUEL COMMUNITY SCHOOL 1	Poblacion East	Low	Low	Low
SAN MIGUEL COMMUNITY SCHOOL 10	Poblacion East			Low
SAN MIGUEL COMMUNITY SCHOOL 11	Poblacion East		Low	Low
SAN MIGUEL COMMUNITY SCHOOL 2	Poblacion East			Low
SAN MIGUEL COMMUNITY SCHOOL 3	Poblacion East			
SAN MIGUEL COMMUNITY SCHOOL 4	Poblacion East			Low
SAN MIGUEL COMMUNITY SCHOOL 5	Poblacion East		Low	Medium
SAN MIGUEL COMMUNITY SCHOOL 6	Poblacion East			
SAN MIGUEL COMMUNITY SCHOOL 7	Poblacion East	Low	Low	Low
SAN MIGUEL COMMUNITY SCHOOL 8	Poblacion East	Low	Low	Low
SAN MIGUEL COMMUNITY SCHOOL 9	Poblacion East			Low
CALASIAO CENTRAL SCHOOL 1	Poblacion West	Low	Medium	Medium
CALASIAO CENTRAL SCHOOL 10	Poblacion West	Low	Low	Low
CALASIAO CENTRAL SCHOOL 11	Poblacion West			
CALASIAO CENTRAL SCHOOL 12	Poblacion West	Low	Low	Low
CALASIAO CENTRAL SCHOOL 2	Poblacion West			Low
CALASIAO CENTRAL SCHOOL 3	Poblacion West			
CALASIAO CENTRAL SCHOOL 4	Poblacion West		Low	Low
CALASIAO CENTRAL SCHOOL 5	Poblacion West	Low	Low	Low
CALASIAO CENTRAL SCHOOL 6	Poblacion West	Low	Low	Low
CALASIAO CENTRAL SCHOOL 7	Poblacion West	Low	Low	Low
CALASIAO CENTRAL SCHOOL 8	Poblacion West			Low
CALASIAO CENTRAL SCHOOL 9	Poblacion West			
CALASIAO COMPREHENSIVE NATIONAL HIGHSCHOOL 1	Poblacion West		Low	Low
CALASIAO COMPREHENSIVE NATIONAL HIGHSCHOOL 2	Poblacion West	Low	Low	Low
CALASIAO COMPREHENSIVE NATIONAL HIGHSCHOOL 3	Poblacion West	Low	Low	Medium
CALASIAO COMPREHENSIVE NATIONAL HIGHSCHOOL 4	Poblacion West	Low	Low	Medium
CALASIAO COMPREHENSIVE NATIONAL HIGHSCHOOL 5	Poblacion West		Low	Low
PRECIOUS MINDS MONTESSORI AND HIGH SCHOOL	Poblacion West			
PRECIOUS MINDS MONTESSORI AND HIGH SCHOOL 2	Poblacion West			
BUED ELEMENTARY	Quesban	Low	Low	Low
BUED ELEMENTARY 10	Quesban			
BUED ELEMENTARY 11	Quesban		Low	Low
BUED ELEMENTARY 12	Quesban		Low	Low
BUED ELEMENTARY 2	Quesban		Low	Low
BUED ELEMENTARY 4	Quesban		Low	Low
BUED ELEMENTARY 5	Quesban			
BUED ELEMENTARY 6	Quesban		Low	Low
BUED ELEMENTARY 7	Quesban		Low	Low
BUED ELEMENTARY 8	Quesban			
BUED ELEMENTARY 9	Quesban		Low	Low
BUED NATIONAL HIGH SCHOOL 14	Quesban			
QUESBAN ELEMENTARY 1	Quesban		Low	Low
QUESBAN ELEMENTARY 2	Quesban	Low	Low	Low

QUESBAN ELEMENTARY 3	Quesban	Low	Low	Low
QUESBAN ELEMENTARY 4	Quesban		Low	Low
QUESBAN ELEMENTARY 5	Quesban			
QUESBAN ELEMENTARY 6	Quesban			
QUESBAN ELEMENTARY 7	Quesban		Low	Low
QUESBAN ELEMENTARY 8	Quesban			
DAY CARE CENTER	San Miguel			
SE	San Miguel			
DALONGUE ELEMENTARY SCHOOL 1	Talibaew		Medium	High
DALONGUE ELEMENTARY SCHOOL 2	Talibaew	Low	High	High
DALONGUE ELEMENTARY SCHOOL 3	Talibaew	Low	High	High
DALONGUE ELEMENTARY SCHOOL 4	Talibaew		Medium	High
DALONGUE ELEMENTARY SCHOOL 5	Talibaew		Medium	High

Table A-12.2. Educational Institutions in Dagupan City affected by flooding in Daguan (Sinocalan) Floodplain

Dagupan City				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
DO	Bacayao Norte			Low
DAY CARE CENTER	Barangay II			
KIDSWORLD LEARNING AND TUTORIAL CENTER	Barangay II			
PANGASINAN UNIVERSAL INSTITUTE	Barangay II			
SAINT JOHN'S CATHEDRAL SCHOOL 1	Barangay II	Low	Low	Low
SAINT JOHN'S CATHEDRAL SCHOOL 10	Barangay II			
SAINT JOHN'S CATHEDRAL SCHOOL 5	Barangay II			
SAINT JOHN'S CATHEDRAL SCHOOL 6	Barangay II			
SAINT JOHN'S CATHEDRAL SCHOOL 7	Barangay II			
SAINT JOHN'S CATHEDRAL SCHOOL 8	Barangay II	Low	Low	Low
SAINT JOHN'S CATHEDRAL SCHOOL 9	Barangay II			
COLLEGE OF MARITIME EDUCATION	Barangay IV			
INSTITUTO CENTRO ASIA	Barangay IV	Low	Low	Low
SAINT JOHN'S CATHEDRAL SCHOOL 1	Barangay IV			
SAINT JOHN'S CATHEDRAL SCHOOL 10	Barangay IV	Low	Low	Low
SAINT JOHN'S CATHEDRAL SCHOOL 2	Barangay IV		Low	Low
SAINT JOHN'S CATHEDRAL SCHOOL 3	Barangay IV			
SAINT JOHN'S CATHEDRAL SCHOOL 4	Barangay IV	Low	Low	Low
SAINT JOHN'S CATHEDRAL SCHOOL 5	Barangay IV			
SAINT JOHN'S CATHEDRAL SCHOOL 6	Barangay IV			
SAINT JOHN'S CATHEDRAL SCHOOL 9	Barangay IV			
WEST CENTRAL ELEMENTARY 1	Barangay IV			
WEST CENTRAL ELEMENTARY 14	Barangay IV		Low	Low
WEST CENTRAL ELEMENTARY 18	Barangay IV		Low	Low
WEST CENTRAL ELEMENTARY 2	Barangay IV			
WEST CENTRAL ELEMENTARY 21	Barangay IV	Low	Low	Low
WEST CENTRAL ELEMENTARY 22	Barangay IV	Low	Medium	Medium
WEST CENTRAL ELEMENTARY 24	Barangay IV	Low	Low	Low
WEST CENTRAL ELEMENTARY 25	Barangay IV	Low	Low	Low

WEST CENTRAL ELEMENTARY 26	Barangay IV	Low	Low	Low
WEST CENTRAL ELEMENTARY 27	Barangay IV	Low	Low	Low
WEST CENTRAL ELEMENTARY 3	Barangay IV	Low	Low	Low
MAMALINGLING DAY CARE CENTER	Bolosan			
PIMSAT	Bolosan			
PIMSAT COLLEGES 1	Bolosan			
PIMSAT COLLEGES 2	Bolosan			
PIMSAT COLLEGES 3	Bolosan			
PIMSAT COLLEGES 4	Bolosan			
PIMSAT COLLEGES 5	Bolosan			
PIMSAT COLLEGES 6	Bolosan			
PIMSAT COLLEGES 7	Bolosan			
BONUAN BOQUIG ELEMENTARY	Bonuan Boquig			
BONUAN BOQUIG ELEMENTARY 10	Bonuan Boquig			
BONUAN BOQUIG ELEMENTARY 11	Bonuan Boquig			
BONUAN BOQUIG ELEMENTARY 12	Bonuan Boquig			
BONUAN BOQUIG ELEMENTARY 2	Bonuan Boquig			
BONUAN BOQUIG ELEMENTARY 3	Bonuan Boquig	Low	Low	Low
BONUAN BOQUIG ELEMENTARY 4	Bonuan Boquig			
BONUAN BOQUIG ELEMENTARY 5	Bonuan Boquig			Low
BONUAN BOQUIG ELEMENTARY 6	Bonuan Boquig			
BONUAN BOQUIG ELEMENTARY 7	Bonuan Boquig	Low	Low	Low
BONUAN BOQUIG ELEMENTARY 8	Bonuan Boquig			
BONUAN BOQUIG ELEMENTARY 9	Bonuan Boquig			
BONUAN BOQUIG NATIONAL HIGH SCHOOL	Bonuan Boquig	Low	Low	Low
BONUAN BOQUIG NATIONAL HIGH SCHOOL 2	Bonuan Boquig	Low	Low	Low
BONUAN BOQUIG NATIONAL HIGH SCHOOL 3	Bonuan Boquig			
BONUAN BOQUIG NATIONAL HIGH SCHOOL 4	Bonuan Boquig			
BONUAN BOQUIG NATIONAL HIGH SCHOOL 5	Bonuan Boquig			Low
BONUAN BOQUIG NATIONAL HIGH SCHOOL 6	Bonuan Boquig			Low
BONUAN BOQUIG NATIONAL HIGH SCHOOL 7	Bonuan Boquig			Low
BONUAN BOQUIG NATIONAL HIGH SCHOOL 8	Bonuan Boquig			
BONUAN BOQUIG NATIONAL HIGH SCHOOL 9	Bonuan Boquig			
DAY CARE CENTER	Bonuan Boquig			
CLIFFORD INTERACTIVE LEARNING SCHOOL OF DAGUPAN CITY	Bonuan Gueset			
CLIFFORD INTERACTIVE LEARNING SCHOOL OF DAGUPAN CITY 2	Bonuan Gueset			
CLIFFORD INTERACTIVE LEARNING SCHOOL OF DAGUPAN CITY 3	Bonuan Gueset			
CLIFFORD INTERACTIVE LEARNING SCHOOL OF DAGUPAN CITY 4	Bonuan Gueset	Low	Low	Low
CLIFFORD INTERACTIVE LEARNING SCHOOL OF DAGUPAN CITY 5	Bonuan Gueset			
DAY CARE CENTER	Bonuan Gueset	Low	Low	Low
GEN. GREGORIO DEL PILAR ELEMENTARY 1	Bonuan Gueset			
GEN. GREGORIO DEL PILAR ELEMENTARY 10	Bonuan Gueset	Low	Low	Low
GEN. GREGORIO DEL PILAR ELEMENTARY 11	Bonuan Gueset			
GEN. GREGORIO DEL PILAR ELEMENTARY 2	Bonuan Gueset			

GEN. GREGORIO DEL PILAR ELEMENTARY 3	Bonuan Gueset			
GEN. GREGORIO DEL PILAR ELEMENTARY 4	Bonuan Gueset			
GEN. GREGORIO DEL PILAR ELEMENTARY 5	Bonuan Gueset	Low	Low	Low
GEN. GREGORIO DEL PILAR ELEMENTARY 6	Bonuan Gueset			
GEN. GREGORIO DEL PILAR ELEMENTARY 7	Bonuan Gueset			
GEN. GREGORIO DEL PILAR ELEMENTARY 8	Bonuan Gueset	Low	Low	Low
GEN. GREGORIO DEL PILAR ELEMENTARY 9	Bonuan Gueset			
LIVING LIGHTS ACADEMY FOUNDATION 1	Bonuan Gueset		Low	Low
LIVING LIGHTS ACADEMY FOUNDATION 2	Bonuan Gueset	Low	Low	Low
MARY HELP OF CHRISTIANS SEMINARY 2	Bonuan Gueset			
MARY HELP OF CHRISTIANS SEMINARY 3	Bonuan Gueset	Low	Low	Low
MARY HELP OF CHRISTIANS SEMINARY/CHAPEL 1	Bonuan Gueset		Low	Low
NORTH CENTRAL ELEMENTARY 1	Bonuan Gueset			
NORTH CENTRAL ELEMENTARY 10	Bonuan Gueset			
NORTH CENTRAL ELEMENTARY 11	Bonuan Gueset			
NORTH CENTRAL ELEMENTARY 2	Bonuan Gueset			
NORTH CENTRAL ELEMENTARY 3	Bonuan Gueset			
NORTH CENTRAL ELEMENTARY 4	Bonuan Gueset			
NORTH CENTRAL ELEMENTARY 5	Bonuan Gueset			
NORTH CENTRAL ELEMENTARY 6	Bonuan Gueset			
NORTH CENTRAL ELEMENTARY 7	Bonuan Gueset			
NORTH CENTRAL ELEMENTARY 8	Bonuan Gueset		Low	Low
NORTH CENTRAL ELEMENTARY 9	Bonuan Gueset		Low	Low
SABANGAN ELEMENTARY 1	Bonuan Gueset		Low	Low
SABANGAN ELEMENTARY 10	Bonuan Gueset			Low
SABANGAN ELEMENTARY 2	Bonuan Gueset			
SABANGAN ELEMENTARY 3	Bonuan Gueset			
SABANGAN ELEMENTARY 4	Bonuan Gueset			
SABANGAN ELEMENTARY 5	Bonuan Gueset			
SABANGAN ELEMENTARY 6	Bonuan Gueset			
SABANGAN ELEMENTARY 7	Bonuan Gueset			
SABANGAN ELEMENTARY 8	Bonuan Gueset		Low	Low
SABANGAN ELEMENTARY 9	Bonuan Gueset	Low	Low	Low
SAINT MICHAEL ARCHANGEL COLLEGE 1	Bonuan Gueset			
SAINT MICHAEL ARCHANGEL COLLEGE 2	Bonuan Gueset			
SAINT MICHAEL ARCHANGEL COLLEGE 3	Bonuan Gueset	Low	Low	Low
CARANGLAAN ELEMENTARY	Caranglaan			
CARANGLAAN ELEMENTARY 2	Caranglaan			
CARANGLAAN ELEMENTARY 3	Caranglaan			Low
CARANGLAAN ELEMENTARY 4	Caranglaan			Low
CARANGLAAN ELEMENTARY 5	Caranglaan			Low
CARANGLAAN ELEMENTARY 6	Caranglaan			
CARANGLAAN ELEMENTARY 7	Caranglaan			
COLEGIO DE DAGUPAN	Herrero			
COLEGIO DE DAGUPAN 2	Herrero			
COLEGIO DE DAGUPAN 3	Herrero			
COLEGIO DE DAGUPAN 4	Herrero	Low	Low	Low
UNIVERSITY OF PANGASINAN 11	Herrero			

UNIVERSITY OF PANGASINAN 12	Herrero			
VICTORIA Q. ZARATE ELEMENTARY 1	Herrero			
VICTORIA Q. ZARATE ELEMENTARY 2	Herrero			
DON JUAN L. SIAPNO ELEMENTARY SCHOOL 1	Lasip Chico			
DON JUAN L. SIAPNO ELEMENTARY SCHOOL 2	Lasip Chico			
DON JUAN L. SIAPNO ELEMENTARY SCHOOL 3	Lasip Chico	Low	Low	Low
DON JUAN L. SIAPNO ELEMENTARY SCHOOL 4	Lasip Chico			
DON JUAN L. SIAPNO ELEMENTARY SCHOOL 5	Lasip Chico		Low	Low
DON JUAN L. SIAPNO ELEMENTARY SCHOOL 6	Lasip Chico			
POGO-LASIP ELEMENTARY 1	Lasip Chico	Low	Low	Low
POGO-LASIP ELEMENTARY 10	Lasip Chico			
POGO-LASIP ELEMENTARY 2	Lasip Chico	Low	Low	Low
POGO-LASIP ELEMENTARY 3	Lasip Chico			
POGO-LASIP ELEMENTARY 4	Lasip Chico	Low	Low	Low
POGO-LASIP ELEMENTARY 5	Lasip Chico	Low	Low	Low
POGO-LASIP ELEMENTARY 6	Lasip Chico		Low	Low
POGO-LASIP ELEMENTARY 7	Lasip Chico			
POGO-LASIP ELEMENTARY 8	Lasip Chico			
POGO-LASIP ELEMENTARY 9	Lasip Chico			
DAY CARE CENTER	Lasip Grande			
DO	Lasip Grande			
DAGUPAN CITY NATIONAL HIGHSCHOOL 1	Malued			
DAGUPAN CITY NATIONAL HIGHSCHOOL 10	Malued			
DAGUPAN CITY NATIONAL HIGHSCHOOL 11	Malued			
DAGUPAN CITY NATIONAL HIGHSCHOOL 12	Malued	Low	Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 13	Malued	Low	Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 14	Malued	Low	Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 15	Malued	Low	Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 16	Malued			
DAGUPAN CITY NATIONAL HIGHSCHOOL 17	Malued			
DAGUPAN CITY NATIONAL HIGHSCHOOL 18	Malued	Low	Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 19	Malued			
DAGUPAN CITY NATIONAL HIGHSCHOOL 2	Malued			
DAGUPAN CITY NATIONAL HIGHSCHOOL 20	Malued			Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 21	Malued			Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 22	Malued		Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 23	Malued		Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 24	Malued	Low	Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 25	Malued			
DAGUPAN CITY NATIONAL HIGHSCHOOL 26	Malued	Low	Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 27	Malued		Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 28	Malued			Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 29	Malued			
DAGUPAN CITY NATIONAL HIGHSCHOOL 3	Malued			
DAGUPAN CITY NATIONAL HIGHSCHOOL 30	Malued	Low	Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 31	Malued	Low	Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 32	Malued		Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 33	Malued	Low	Low	Low

DAGUPAN CITY NATIONAL HIGHSCHOOL 34	Malued		Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 35	Malued		Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 36	Malued			Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 37	Malued		Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 38	Malued	Low	Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 4	Malued			
DAGUPAN CITY NATIONAL HIGHSCHOOL 5	Malued			
DAGUPAN CITY NATIONAL HIGHSCHOOL 6	Malued	Low	Low	Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 7	Malued			Low
DAGUPAN CITY NATIONAL HIGHSCHOOL 8	Malued			
DAGUPAN CITY NATIONAL HIGHSCHOOL 9	Malued			
DOMINICAN SCHOOL 1	Malued		Low	Low
DOMINICAN SCHOOL 2	Malued	Low	Low	Low
DOMINICAN SCHOOL 3	Malued		Low	Low
DOMINICAN SCHOOL 4	Malued		Low	Low
EDNA'S SCHOOL 1	Malued		Low	Low
EDNA'S SCHOOL 2	Malued		Low	Low
EDNA'S SCHOOL 3	Malued		Low	Low
EDNA'S SCHOOL 4	Malued			Low
EDNA'S SCHOOL 5	Malued			Low
ESCUELA DE NUESTRA SESCORA DE LA SALETTE 1	Malued			
ESCUELA DE NUESTRA SESCORA DE LA SALETTE 2	Malued			
ESCUELA DE NUESTRA SESCORA DE LA SALETTE 3	Malued			
MALUED ELEMENTARY 1	Malued	Low	Low	Low
MALUED ELEMENTARY 2	Malued			Low
MOTHER GOOSE SPECIAL SCHOOL SYSTEM, INC. 1	Malued			
MOTHER GOOSE SPECIAL SCHOOL SYSTEM, INC. 2	Malued			
MOTHER GOOSE SPECIAL SCHOOL SYSTEM, INC. 3	Malued		Low	Low
MOTHER GOOSE SPECIAL SCHOOL SYSTEM, INC. 4	Malued	Low	Low	Low
MOTHER GOOSE SPECIAL SCHOOL SYSTEM, INC. 5	Malued	Low	Low	Low
MOTHER GOOSE SPECIAL SCHOOL SYSTEM, INC. 6	Malued			
MOTHER GOOSE SPECIAL SCHOOL SYSTEM, INC. 7	Malued			
MOTHER GOOSE SPECIAL SCHOOL SYSTEM, INC. 8	Malued			
MOTHER GOOSE SPECIAL SCHOOL SYSTEM, INC. 9/ BANCO DE ORO	Malued		Low	Low
SAINT ALBERT THE GREAT SCHOOL 1	Malued			
SAINT ALBERT THE GREAT SCHOOL 2	Malued			
SAINT ALBERT THE GREAT SCHOOL 3	Malued			Low
SAINT ALBERT THE GREAT SCHOOL 4	Malued			
SAINT ALBERT THE GREAT SCHOOL 5	Malued			
SAINT ALBERT THE GREAT SCHOOL 6	Malued	Medium	Medium	Medium
BARANGAY LEARNING CENTER/DAY CARE CENTER	Mangin			
BOLOSAN ELEMENTARY SCHOOL	Mangin			
BOLOSAN ELEMENTARY SCHOOL 10	Mangin	Low	Low	Low
BOLOSAN ELEMENTARY SCHOOL 11	Mangin	Low	Low	Low
BOLOSAN ELEMENTARY SCHOOL 12	Mangin		Low	Low
BOLOSAN ELEMENTARY SCHOOL 13	Mangin	Low	Low	Low
BOLOSAN ELEMENTARY SCHOOL 14	Mangin	Low	Low	Low

BOLOSAN ELEMENTARY SCHOOL 15	Mangin			
BOLOSAN ELEMENTARY SCHOOL 16	Mangin	Low	Low	Medium
BOLOSAN ELEMENTARY SCHOOL 17	Mangin			
BOLOSAN ELEMENTARY SCHOOL 2	Mangin			
BOLOSAN ELEMENTARY SCHOOL 3	Mangin	Low	Low	Low
BOLOSAN ELEMENTARY SCHOOL 4	Mangin			
BOLOSAN ELEMENTARY SCHOOL 5	Mangin		Low	Low
BOLOSAN ELEMENTARY SCHOOL 6	Mangin	Low	Low	Medium
BOLOSAN ELEMENTARY SCHOOL 7	Mangin	Low	Low	Medium
BOLOSAN ELEMENTARY SCHOOL 8	Mangin	Low	Low	Low
BOLOSAN ELEMENTARY SCHOOL 9	Mangin		Low	Low
DAY CARE CENTER	Mangin			Low
MANGIN-TEBENG ELEMENTARY 1	Mangin			Low
MANGIN-TEBENG ELEMENTARY 10	Mangin	Low	Low	Low
MANGIN-TEBENG ELEMENTARY 2	Mangin			Low
MANGIN-TEBENG ELEMENTARY 3	Mangin			Medium
MANGIN-TEBENG ELEMENTARY 4	Mangin			
MANGIN-TEBENG ELEMENTARY 5	Mangin			
MANGIN-TEBENG ELEMENTARY 6	Mangin			
MANGIN-TEBENG ELEMENTARY 7	Mangin			
MANGIN-TEBENG ELEMENTARY 8	Mangin			
MANGIN-TEBENG ELEMENTARY 9	Mangin		Low	Low
SALISAY DAY CARE CENTER	Mangin			Medium
SALISAY ELEMENTARY SCHOOL 1	Mangin		Low	Medium
SALISAY ELEMENTARY SCHOOL 2	Mangin		Low	Medium
SALISAY ELEMENTARY SCHOOL 3	Mangin			Low
SALISAY ELEMENTARY SCHOOL 4	Mangin			Medium
AMA COMPUTER COLLEGE DAGUPAN CAMPUS	Mayombo			Low
ASIA CAREER COLLEGE 1	Mayombo			
ASIA CAREER COLLEGE 2	Mayombo		Medium	High
ASIA CAREER COLLEGE 3	Mayombo			
ASIA CAREER COLLEGE 4	Mayombo			
EAST CENTRAL ELEMENTARY 1	Mayombo			Low
EAST CENTRAL ELEMENTARY 10	Mayombo			Low
EAST CENTRAL ELEMENTARY 11	Mayombo			
EAST CENTRAL ELEMENTARY 12	Mayombo		Low	Low
EAST CENTRAL ELEMENTARY 13	Mayombo			
EAST CENTRAL ELEMENTARY 14	Mayombo			
EAST CENTRAL ELEMENTARY 15	Mayombo			
EAST CENTRAL ELEMENTARY 16	Mayombo	Low	Low	Low
EAST CENTRAL ELEMENTARY 17	Mayombo	Low	Low	Low
EAST CENTRAL ELEMENTARY 18	Mayombo	Low	Low	Low
EAST CENTRAL ELEMENTARY 19	Mayombo	Low	Low	Low
EAST CENTRAL ELEMENTARY 2	Mayombo			Low
EAST CENTRAL ELEMENTARY 20	Mayombo	Low	Low	Medium
EAST CENTRAL ELEMENTARY 21	Mayombo	Low	Low	Low
EAST CENTRAL ELEMENTARY 22	Mayombo		Low	Low
EAST CENTRAL ELEMENTARY 23	Mayombo		Low	Low

EAST CENTRAL ELEMENTARY 24	Mayombo	Low	Low	Medium
EAST CENTRAL ELEMENTARY 3	Mayombo	Low	Low	Low
EAST CENTRAL ELEMENTARY 4	Mayombo		Low	Low
EAST CENTRAL ELEMENTARY 5	Mayombo		Low	Low
EAST CENTRAL ELEMENTARY 6	Mayombo		Low	Low
EAST CENTRAL ELEMENTARY 7	Mayombo			Low
EAST CENTRAL ELEMENTARY 8	Mayombo			
EAST CENTRAL ELEMENTARY 9	Mayombo	Low	Low	Low
EAST CENTRAL INTEGRATED SCHOOL 1	Mayombo			
EAST CENTRAL INTEGRATED SCHOOL 2	Mayombo			
EAST CENTRAL INTEGRATED SCHOOL 3	Mayombo			
EAST CENTRAL INTEGRATED SCHOOL 4	Mayombo			
MAXIMA TECHNINCA & SKILLS TRAINING INSTITUTE INC.	Mayombo			
PAMMA LEARNING CENTER 1	Mayombo			
PAMMA LEARNING CENTER 10	Mayombo	Medium	Medium	Medium
PAMMA LEARNING CENTER 11	Mayombo	Low	Medium	Medium
PAMMA LEARNING CENTER 12	Mayombo	Medium	Medium	Medium
PAMMA LEARNING CENTER 13	Mayombo	Low	Medium	Medium
PAMMA LEARNING CENTER 14	Mayombo	Low	Medium	Medium
PAMMA LEARNING CENTER 15	Mayombo	Low	Medium	Medium
PAMMA LEARNING CENTER 16	Mayombo	Medium	Medium	Medium
PAMMA LEARNING CENTER 17	Mayombo	Medium	Medium	Medium
PAMMA LEARNING CENTER 18	Mayombo	Medium	Medium	Medium
PAMMA LEARNING CENTER 19	Mayombo	Medium	Medium	Medium
PAMMA LEARNING CENTER 2	Mayombo			
PAMMA LEARNING CENTER 20	Mayombo		Low	Low
PAMMA LEARNING CENTER 21	Mayombo	Medium	Medium	Medium
PAMMA LEARNING CENTER 22	Mayombo		Low	Low
PAMMA LEARNING CENTER 23	Mayombo		Low	Low
PAMMA LEARNING CENTER 26	Mayombo			
PAMMA LEARNING CENTER 27	Mayombo			
PAMMA LEARNING CENTER 28	Mayombo			
PAMMA LEARNING CENTER 29	Mayombo	Low	Low	Medium
PAMMA LEARNING CENTER 3	Mayombo			
PAMMA LEARNING CENTER 30	Mayombo		Low	Low
PAMMA LEARNING CENTER 31	Mayombo			
PAMMA LEARNING CENTER 32	Mayombo			
PAMMA LEARNING CENTER 33	Mayombo			
PAMMA LEARNING CENTER 4	Mayombo			
PAMMA LEARNING CENTER 5	Mayombo		Low	Low
PAMMA LEARNING CENTER 6	Mayombo			
PAMMA LEARNING CENTER 7	Mayombo		Low	Low
PAMMA LEARNING CENTER 8	Mayombo			
PAMMA LEARNING CENTER 9	Mayombo	Low	Low	Medium
STI	Mayombo			
UNIVERSITY OF PANGASINAN 1	Mayombo			
UNIVERSITY OF PANGASINAN 10	Mayombo	Low	Low	Low
UNIVERSITY OF PANGASINAN 11	Mayombo			

UNIVERSITY OF PANGASINAN 12	Mayombo			
UNIVERSITY OF PANGASINAN 13	Mayombo			
UNIVERSITY OF PANGASINAN 2	Mayombo			
UNIVERSITY OF PANGASINAN 3	Mayombo			
UNIVERSITY OF PANGASINAN 4	Mayombo			
UNIVERSITY OF PANGASINAN 5	Mayombo			
UNIVERSITY OF PANGASINAN 6	Mayombo			
UNIVERSITY OF PANGASINAN 7	Mayombo			
UNIVERSITY OF PANGASINAN 8	Mayombo	Low	Low	Low
UNIVERSITY OF PANGASINAN 9	Mayombo		Low	Low
WONDERLAND SCHOOL 1	Mayombo		Low	Low
WONDERLAND SCHOOL 2	Mayombo			
WONDERLAND SCHOOL 3	Mayombo			
FAME BUILDING COLEGIO DE DAGUPAN	Pantal			
ST. ROBERT BELLARMINE CENTER FOR LEARNING, INC. 1	Pantal		Low	Low
ST. ROBERT BELLARMINE CENTER FOR LEARNING, INC. 2	Pantal		Low	Low
DAY CARE CENTER	Poblacion Oeste	Low	Low	Low
JUAN P. GUADIZ ELEMENTARY 1	Poblacion Oeste			
JUAN P. GUADIZ ELEMENTARY 2	Poblacion Oeste			
JUAN P. GUADIZ ELEMENTARY 3	Poblacion Oeste			
JUAN P. GUADIZ ELEMENTARY 4	Poblacion Oeste	Low	Low	Low
JUAN P. GUADIZ ELEMENTARY 5	Poblacion Oeste	Medium	Medium	Medium
WEST CENTRAL ELEMENTARY 10	Poblacion Oeste	Low	Low	Medium
WEST CENTRAL ELEMENTARY 11	Poblacion Oeste		Low	Low
WEST CENTRAL ELEMENTARY 12	Poblacion Oeste	Low	Low	Low
WEST CENTRAL ELEMENTARY 13	Poblacion Oeste			
WEST CENTRAL ELEMENTARY 15	Poblacion Oeste		Low	Low
WEST CENTRAL ELEMENTARY 16	Poblacion Oeste	Low	Low	Low
WEST CENTRAL ELEMENTARY 17	Poblacion Oeste	Low	Low	Low
WEST CENTRAL ELEMENTARY 18	Poblacion Oeste			Low
WEST CENTRAL ELEMENTARY 19	Poblacion Oeste	Low	Low	Low
WEST CENTRAL ELEMENTARY 2	Poblacion Oeste	Low	Low	Low
WEST CENTRAL ELEMENTARY 20	Poblacion Oeste	Low	Low	Low
WEST CENTRAL ELEMENTARY 22	Poblacion Oeste			

WEST CENTRAL ELEMENTARY 23	Poblacion Oeste			
WEST CENTRAL ELEMENTARY 24	Poblacion Oeste			
WEST CENTRAL ELEMENTARY 25	Poblacion Oeste			
WEST CENTRAL ELEMENTARY 3	Poblacion Oeste	Low	Low	Low
WEST CENTRAL ELEMENTARY 4	Poblacion Oeste			Low
WEST CENTRAL ELEMENTARY 5	Poblacion Oeste		Low	Low
WEST CENTRAL ELEMENTARY 6	Poblacion Oeste			
WEST CENTRAL ELEMENTARY 7	Poblacion Oeste	Low	Low	Low
WEST CENTRAL ELEMENTARY 8	Poblacion Oeste			
WEST CENTRAL ELEMENTARY 9	Poblacion Oeste		Low	Low
ASIA CAREER COLLEGE 2	Pogo Chico			
ASIA CAREER COLLEGE 3	Pogo Chico			
ASIA CAREER COLLEGE 4	Pogo Chico			
DIVINE WORLD ACADEMY OF DAGUPAN 1	Pogo Chico			Low
DIVINE WORLD ACADEMY OF DAGUPAN 2	Pogo Chico			
DIVINE WORLD ACADEMY OF DAGUPAN 3	Pogo Chico	Low	Low	Low
DIVINE WORLD ACADEMY OF DAGUPAN 4	Pogo Chico			
DIVINE WORLD ACADEMY OF DAGUPAN KINDERGARTEN 1	Pogo Chico	Low	Low	Low
DIVINE WORLD ACADEMY OF DAGUPAN KINDERGARTEN 2	Pogo Chico		Low	Low
DIVINE WORLD ACADEMY OF DAGUPAN KINDERGARTEN 3	Pogo Chico	Low	Low	Low
DR. LUIS F. SAMSON, SR. MONTESSORI DAY CARE CENTER	Pogo Chico			
HARVENT SCHOOL 1	Pogo Chico			
HARVENT SCHOOL 2	Pogo Chico			
HARVENT SCHOOL 3	Pogo Chico			
HARVENT SCHOOL 4	Pogo Chico			
HARVENT SCHOOL 5	Pogo Chico		Low	Low
HARVENT SCHOOL 6	Pogo Chico			
HARVENT SCHOOL 7	Pogo Chico			
NAZARETH SCHOOL OF PANGASINAN	Pogo Chico			
PAMMA LEARNING CENTER 23	Pogo Chico			
PAMMA LEARNING CENTER 24	Pogo Chico			
PAMMA LEARNING CENTER 25	Pogo Chico			
UNIVERSITY OF LUZON 1	Pogo Chico			
UNIVERSITY OF LUZON 2	Pogo Chico			
UNIVERSITY OF LUZON 3	Pogo Chico	Low	Medium	Medium
UNIVERSITY OF LUZON 4	Pogo Chico	Low	Low	Low
UPS DRIVING SCHOOL	Pogo Chico			
PUGARO INTEGRATED SCHOOL 1	Pugaro Suit	Low	Low	Low

PUGARO INTEGRATED SCHOOL 10	Pugaro Suit	Medium	Medium	Medium
PUGARO INTEGRATED SCHOOL 11	Pugaro Suit			
PUGARO INTEGRATED SCHOOL 12	Pugaro Suit	Medium	Medium	Medium
PUGARO INTEGRATED SCHOOL 2	Pugaro Suit			
PUGARO INTEGRATED SCHOOL 3	Pugaro Suit			
PUGARO INTEGRATED SCHOOL 4	Pugaro Suit		Medium	Medium
PUGARO INTEGRATED SCHOOL 5	Pugaro Suit			
PUGARO INTEGRATED SCHOOL 6	Pugaro Suit			
PUGARO INTEGRATED SCHOOL 7	Pugaro Suit	Low	Low	Low
PUGARO INTEGRATED SCHOOL 8	Pugaro Suit			
PUGARO INTEGRATED SCHOOL 9	Pugaro Suit		Low	Low
BALANI-PARONKING ELEMENTARY 1	Salisay			
BALANI-PARONKING ELEMENTARY 2	Salisay			
BALANI-PARONKING ELEMENTARY 3	Salisay			Low
BALANI-PARONKING ELEMENTARY 4	Salisay			Low
BALANI-PARONKING ELEMENTARY 5	Salisay			Medium
BALANI-PARONKING ELEMENTARY 6	Salisay			Low
BALANI-PARONKING ELEMENTARY 7	Salisay			
LOVESPRING EDUCATIONAL INSTITUTION 1	Salisay			
LOVESPRING EDUCATIONAL INSTITUTION 2	Salisay			
EDNA'S SCHOOL 1	Tapuac		Low	Low
EDNA'S SCHOOL 2	Tapuac	Low	Low	Low
AIE COLLEGE INTERNATIONAL	Tebeng			
BALANI-PARONKING ELEMENTARY 1	Tebeng			
PIMSAT	Tebeng			
TAMBAC ELEMENTARY SCHOOL 1	Tebeng			
TAMBAC ELEMENTARY SCHOOL 10	Tebeng			Medium
TAMBAC ELEMENTARY SCHOOL 2	Tebeng			Low
TAMBAC ELEMENTARY SCHOOL 3	Tebeng			Low
TAMBAC ELEMENTARY SCHOOL 4	Tebeng			Low
TAMBAC ELEMENTARY SCHOOL 5	Tebeng			Medium
TAMBAC ELEMENTARY SCHOOL 6	Tebeng		Low	Medium
TAMBAC ELEMENTARY SCHOOL 7	Tebeng	Low	Low	Low
TAMBAC ELEMENTARY SCHOOL 8	Tebeng	Low	Low	Medium
TAMBAC ELEMENTARY SCHOOL 9	Tebeng			Medium

Table A-12.3. Educational Institutions in Mangaldan affected by flooding in Daguan (Sinocalan) Floodplain

Mangaldan				
Building Name	**Barangay**	**Rainfall Scenario**		
		5-year	**25-year**	**100-year**
ALITAYA ELEMENTARY 2	Alitaya			
ALITAYA ELEMENTARY 3	Alitaya			
ALITAYA ELEMENTARY 4	Alitaya			
DON ROMERO ALEJANDRO DAY CARE CENTER	Alitaya			Low
DAVID ELEMENTARY 1	Amansabina		Low	Low
DAVID ELEMENTARY 10	Amansabina			
DAVID ELEMENTARY 11	Amansabina	Low	Low	Medium
DAVID ELEMENTARY 12	Amansabina			

DAVID ELEMENTARY 13	Amansabina			Low
DAVID ELEMENTARY 14	Amansabina			
DAVID ELEMENTARY 2	Amansabina			
DAVID ELEMENTARY 3	Amansabina			
DAVID ELEMENTARY 4	Amansabina			Low
DAVID ELEMENTARY 5	Amansabina			
DAVID ELEMENTARY 6	Amansabina			
DAVID ELEMENTARY 7	Amansabina			
DAVID ELEMENTARY 8	Amansabina		Low	Low
DAVID ELEMENTARY 9	Amansabina			Low
DAVID NATIONAL HIGHSCHOOL 1	Amansabina			
DAVID NATIONAL HIGHSCHOOL 2	Amansabina		Low	Low
DAVID NATIONAL HIGHSCHOOL 3	Amansabina			Low
DAVID NATIONAL HIGHSCHOOL 4	Amansabina		Low	Low
DAVID NATIONAL HIGHSCHOOL 5	Amansabina		Low	Medium
DAVID NATIONAL HIGHSCHOOL 6	Amansabina	Low	Low	Medium
DAVID NATIONAL HIGHSCHOOL 7	Amansabina		Low	Medium
DAVID NATIONAL HIGHSCHOOL 8	Amansabina			
DAVID NATIONAL HIGHSCHOOL 9	Amansabina		Low	Low
DAY CARE CENTER	Amansabina		Low	Low
DO	Amansabina			Low
ANOLID ELEMENTARY 1	Anolid	Low	Medium	Medium
ANOLID ELEMENTARY 2	Anolid		Medium	Medium
ANOLID ELEMENTARY 3	Anolid			Medium
ANOLID ELEMENTARY 4	Anolid		Low	Medium
ANOLID ELEMENTARY 5	Anolid		Low	Medium
ANOLID ELEMENTARY 6	Anolid		Low	Medium
ANOLID ELEMENTARY 7	Anolid			Medium
DAY CARE CENTER	Anolid		Low	Medium
BANAOANG ELEMENTARY 1	Banaoang		Low	Low
BANAOANG ELEMENTARY 2	Banaoang		Low	Low
BANAOANG ELEMENTARY 3	Banaoang			
BANAOANG ELEMENTARY 4	Banaoang			
BANAOANG ELEMENTARY 5	Banaoang			
BANTAYAN ELEMENTARY 10	Bantayan		Low	Low
BANTAYAN ELEMENTARY 11	Bantayan			
BANTAYAN ELEMENTARY 12	Bantayan			
BANTAYAN ELEMENTARY 13	Bantayan			
BANTAYAN ELEMENTARY 14	Bantayan			
BANTAYAN ELEMENTARY 15	Bantayan			
BANTAYAN ELEMENTARY 5	Bantayan			
BANTAYAN ELEMENTARY 6	Bantayan			
BANTAYAN ELEMENTARY 7	Bantayan			
BANTAYAN ELEMENTARY 8	Bantayan			
BANTAYAN ELEMENTARY 9	Bantayan			
BARI ELEMENTARY 1	Bari			
BARI ELEMENTARY 2	Bari			
BARI ELEMENTARY 3	Bari		Low	Low

BARI ELEMENTARY 4	Bari		Low	Low
BARI ELEMENTARY 5	Bari			
BARI ELEMENTARY 6	Bari			
BATENG EAST DAY CARE CENTER	Bateng			
BATENG WEST DAY CARE CENTER	Bateng			
TALOGTOG ELEMENTARY 1	Bateng			
TALOGTOG ELEMENTARY 2	Bateng			Low
TALOGTOG ELEMENTARY 3	Bateng			
TALOGTOG ELEMENTARY 4	Bateng			
TALOGTOG ELEMENTARY 5	Bateng			
TALOGTOG ELEMENTARY 7	Bateng			
TALOGTOG ELEMENTARY 8	Bateng	Low	Low	Low
TALOGTOG ELEMENTARY 9	Bateng		Low	Low
BUENLAG ELEMENTARY 1	Buenlag	Medium	Medium	Medium
BUENLAG ELEMENTARY 2	Buenlag	Low	Low	Low
BUENLAG ELEMENTARY 3	Buenlag	Medium	Medium	Medium
BUENLAG ELEMENTARY 4	Buenlag	Low	Medium	Medium
BUENLAG ELEMENTARY 5	Buenlag	Medium	Medium	Medium
BUENLAG ELEMENTARY 6	Buenlag	Low	Medium	Medium
DAY CARE CENTER	Buenlag			
GUEGUESANGEN INTEGRATED SCHOOL 1	Gueguesangen	Low	Low	Low
GUEGUESANGEN INTEGRATED SCHOOL 2	Gueguesangen			
GUEGUESANGEN INTEGRATED SCHOOL 3	Gueguesangen			Low
GUEGUESANGEN INTEGRATED SCHOOL 4	Gueguesangen		Low	Low
GUEGUESANGEN INTEGRATED SCHOOL 5	Gueguesangen			
GUEGUESANGEN INTEGRATED SCHOOL 6	Gueguesangen	Low	Low	Low
GUEGUESANGEN INTEGRATED SCHOOL 7	Gueguesangen		Low	Low
EMBARCADERO ELEMENTARY 1	Guiguilonen			
EMBARCADERO ELEMENTARY 5	Guiguilonen			
EMBARCADERO ELEMENTARY 6	Guiguilonen	Low	Low	Low
EMBARCADERO ELEMENTARY 7	Guiguilonen		Low	Low
EMBARCADERO ELEMENTARY 8	Guiguilonen	Low	Low	Low
EMBARCADERO ELEMENTARY 9	Guiguilonen	Low	Low	Low
MANGALDAN ACHIEVERS ACADEMY 1	Guilig			
MANGALDAN ACHIEVERS ACADEMY 2	Guilig		Low	Low
SANTO TOMAS CATHOLIC SCHOOL 1	Guilig			
SANTO TOMAS CATHOLIC SCHOOL 2	Guilig			
SANTO TOMAS CATHOLIC SCHOOL 3	Guilig			
SANTO TOMAS CATHOLIC SCHOOL 4	Guilig			
SANTO TOMAS CATHOLIC SCHOOL 5	Guilig			
SANTO TOMAS CATHOLIC SCHOOL 6	Guilig			
SANTO TOMAS CATHOLIC SCHOOL 7	Guilig			
SANTO TOMAS CATHOLIC SCHOOL 8	Guilig			Low
DAY CARE CENTER	Lanas			
DAY CARE CENTER	Maasin			
MAASIN ELEMENTARY 1	Maasin			
MAASIN ELEMENTARY 2	Maasin			
MAASIN ELEMENTARY 3	Maasin			