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

LiDAR Surveys and Flood Mapping of Patalan River

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

APRIL 2017

Published by the UP Training Center for Applied Geodesy and Photogrammetry (TCAGP)
College of Engineering
University of the Philippines – Diliman
Quezon City
1101 PHILIPPINES

This research project is supported by the Department of Science and Technology (DOST) as part of its Grants-in-Aid (GIA) Program and is to be cited as:

E. C. Paringit and A. M. Paz-Alberto (eds.) (2017), LiDAR Surveys and Flood Mapping of Patalan River, Quezon City: University of the Philippines Training Center on Applied Geodesy and Photogrammetry-346pp.

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National Library of the Philippines
ISBN: 978-621-430-005-1

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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
CLSU	Central Luzon State University
CN	Curve Number
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 PATALAN RIVER

Enrico C. Paringit, Dr. Eng., Dr. Annie Melinda P. 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) Grant-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.

The program also aimed to produce 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 applied in this report are thoroughly described in a separate publication titled 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 th Central Luzon Region. The university is located in Muñoz City in the province of Nueva Ecija.

1.2 Overview of the Patalan River Basin

Patalan River Basin covers most of the Municipalities of San Jacinto, Manaoag, Laoac, Binalonan, Pozzorubio, and Sison; and a small portion of the Municipalities of San Fabian, Mangaldan, Mapandan, and Urdaneta City, all of which are in Pangasinan.The DENR River Basin Control Office identified the basin to have a drainage area of 347 km² and an estimated annual runoff of 388 million cubic meter (MCM) (RBCO, 2015).

Its main stem, Patalan River, passes along the Municipalities of San Fabian, Mangaldan, and Mapandan; and a small portion of the Dagupan City. According to the 2015 national census of NSO, a total of 55,195persons distributed among three (3) barangays in the Municipality of Mapandan, eight (8) barangays in the Municipality of Mangaldan, four (4) in the Municipality of San Fabian, and one (1) in Dagupan City are residing within the immediate vicinity of the river.

Most of the economy and livelihood in Pangasinan are 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).

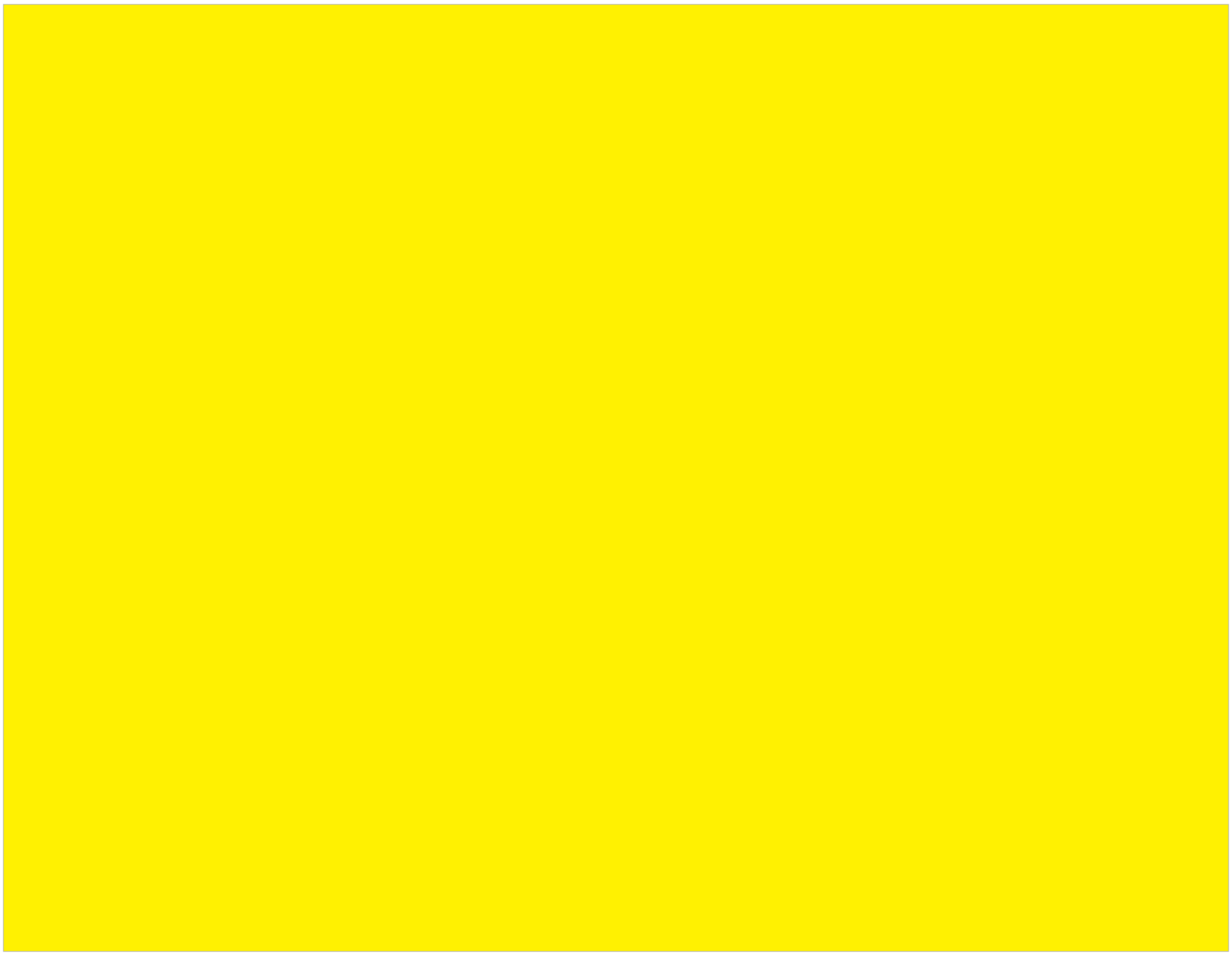

Figure 1. Map of Patalan River Basin (in brown)

CHAPTER 2: LIDAR ACQUISITION IN PATALAN FLOODPLAIN

Engr. Louie P. Balicanta, Engr. Christopher Cruz, Lovely Gracia Acuña, Engr. Gerome Hipolito, Engr. Christopher L. Joaquin, and Ms. Jasmin M. Domingo

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 Patalan Floodplain in Northern Luzon. These missions were planned for 15 lines and ran 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 is found in Table 1. Figure 2 shows the flight plan for Patalan Floodplain.

Table 1. Flight planning parameters for Pegasus LiDAR System.

Block Name	Flying Height (m AGL)	Overlap (%)	Field of View (θ)	Pulse Repetition Frequency (PRF) (Hz)	Scan Frequency (kHz)	Average Speed (kts)	Average Turn Time (Minutes)
BLK10E	1200	30	50	200	30	130	5
BLK10F	1200	30	50	200	30	130	5
BLK10H	1700	30	50	200	30	130	5
BLK10S	1700	30	50	200	30	130	5
BLK10C	1700	30	50	200	30	130	5
BLK10A	1200	30	50	200	30	130	5
BLK10B	1200	30	50	200	30	130	5
BLK10C	1200	30	50	200	30	130	5
BLK10D	1200	30	50	200	30	130	5
NEJB	900	30	50	200	30	130	5
NEJC	900	30	50	200	30	130	5

Table 2. Flight planning parameters for Aquarius LiDAR System.

Block Name	Flying Height (m AGL)	Overlap (%)	Field of View (θ)	Pulse Repetition Frequency (PRF) (Hz)	Scan Frequency (kHz)	Average Speed (kts)	Average Turn Time (Minutes)
PNGA	500	50	36	50	45	120	5
PNGB	500	60	36	50	45	120	5
BLK12A	600	60	36	50	45	120	5
BLK12B	600	60	36	50	45	120	5
BLK12C	600	60	36	50	45	120	5

Table 3. Flight planning parameters for Gemini LiDAR System.

Block Name	Flying Height (m AGL)	Overlap (%)	Field of View (θ)	Pulse Repetition Frequency (PRF) (Hz)	Scan Frequency (kHz)	Average Speed (kts)	Average Turn Time (Minutes)
BLK12A	1000	30	40	125	50	130	5
BLK12B	1000	40	40	100	50	130	5
BLK12L	1200	30	50	70	60	130	5
BLK12K	1200	40	50	125	60	130	5
BLK12C	1000	40	40	100	50	130	5
AGNO	1000	30	40	100	50	130	5
AGNL	850/800	30	50	125	40	130	5
AGNO	1000/850	30	40/50	100/125	50/40	130	5
AGNQ	1000	35	40	100	40	130	5

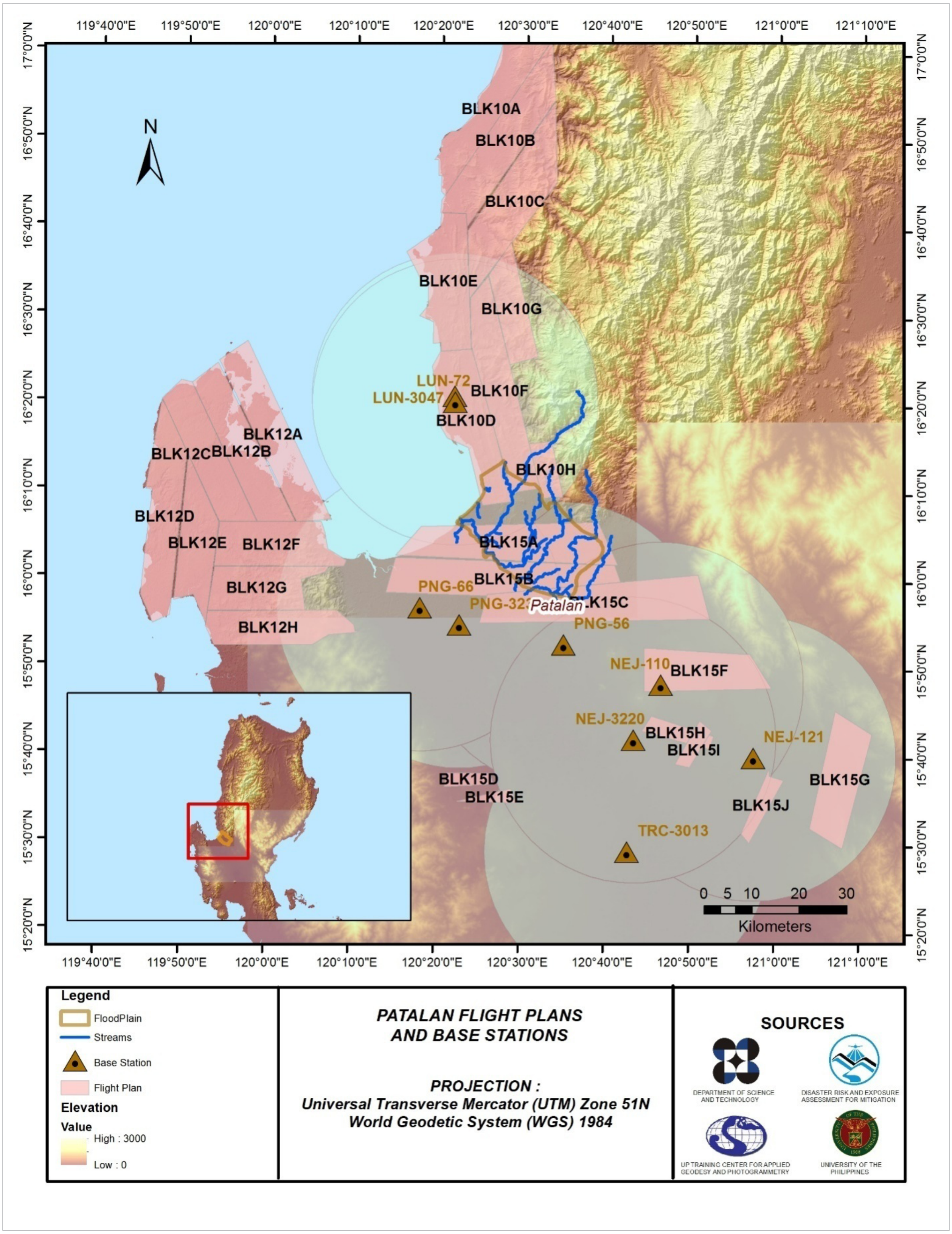

Figure 2. Flight plans and base stations used to cover Patalan Floodplain

2.2 Ground Base Stations

The project team was able to recover one six (6) NAMRIA ground control points: LUN-72, PNG-66, NEJ-110, NEJ-121, and PNG-56 which are of second (2nd) order accuracy. The project team also used six (6) ground control points: LUN-3047, NEJ-3220, TRC-3013, NEJ-120A, NEJ-120B and PNG-3235 which are of third (3rd) and fourth (4th) order accuracy.The certifications for the NAMRIA reference points are found in ANNEX 2 while the baseline processing reports for the established control pointsare found in ANNEX 3. These were used as base stations during flight operations for the entire duration of the survey (January 11 – February 28 2013, January 21 – December 11 2014 and March 31 2016). Base stations were observed using dual frequency GPS receivers, TRIMBLE SPS 882, SPS 852, and SPS 985. Flight plans and location of base stations used during the aerial LiDAR acquisition in Patalan Floodplain are shown in Figure 2.

Figure 3 to Figure 7 show the recovered NAMRIA reference points within the area. Table 4 to Table 13 show the details about the following NAMRIA control stations and establish points while Table 14 lists all ground control points occupied during the acquisition with the corresponding dates of utilization.

(b)

(a)

Figure 3. GPS set-up over LUN-72 as recovered at the right edge of the road, about 20 meters Southwest of the San Agustin Norte Day Care Center in Brgy. San Agustin Norte, Agoo, La Union (a) and NAMRIA reference point LUN-72 as recovered by the field team.

Table 4. Details of the recovered NAMRIA horizontal control point LUN-72 used as base station for the LiDAR Acquisition.

Station Name	LUN-72	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	16° 20' 15.54801" 120° 21' 50.41723" 18.53200 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting Northing	432043.416 meters 1806913.636 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	16° 20' 9.68411" North 120° 21' 55.16713" East 55.39600 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting Northing	218361.13 meters 1807998.48 meters

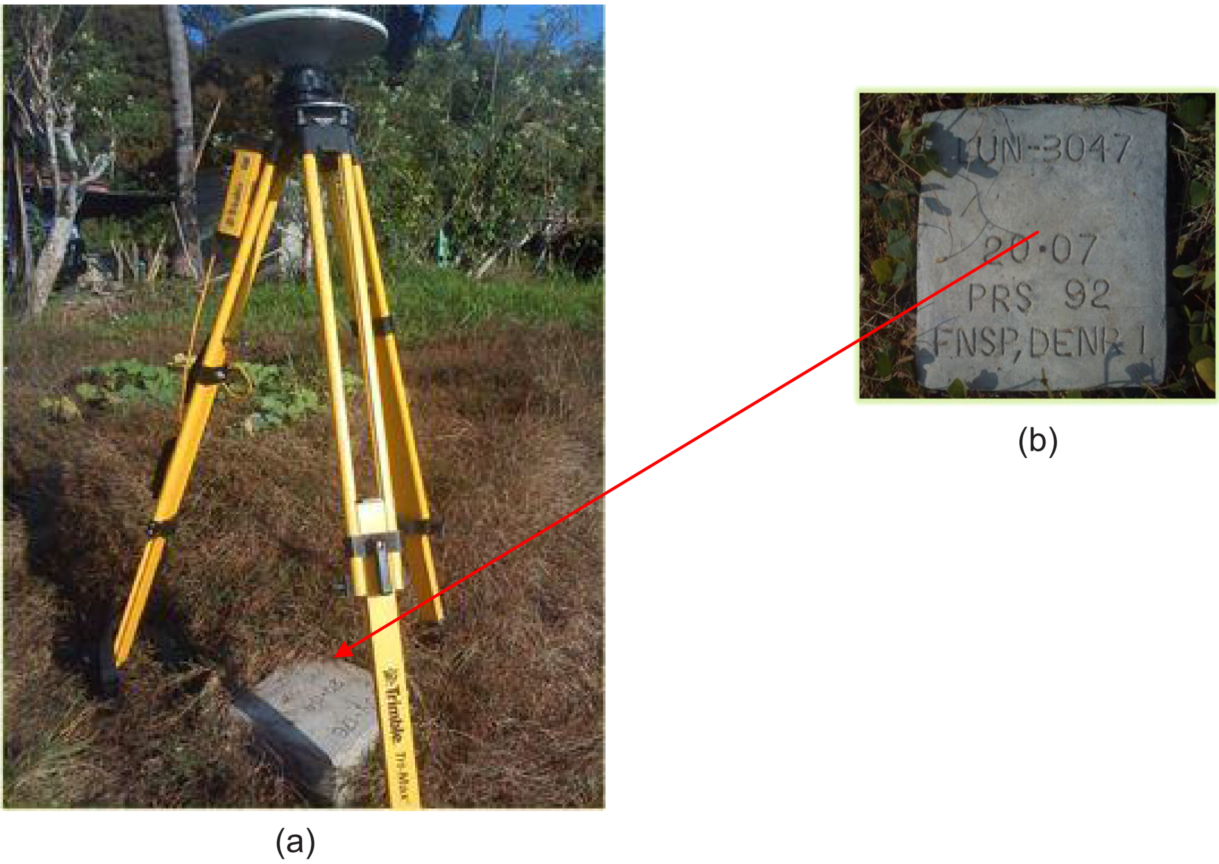

Figure 4. GPS set-up over LUN-3047 as recovered at Brgy. Nazareno, Agoo, La Union (a) and NAMRIA reference point LUN-3047 (b) as recovered by the field team.

Table 5. Details of the recovered NAMRIA horizontal control point LUN-72 used as base station for the LiDAR Acquisition.

Station Name	LUN-3047	
Order of Accuracy	**4th**	
Relative Error (horizontal positioning)	**1 in 10,000**	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	16° 20’ 55.96430” 120° 21’ 47.08672” 43.62100 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting Northing	431948.446 meters 1808156.256 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	16°20’ 50.09786” North 120° 21’ 51.83567” East 80.44800 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting Northing	218278.33 meters 1809242.68 meters

(a)

(b)

Figure 5. GPS set-up over TRC-3013 as recovered inside the premises of La PurisimaPurok II Plaza in La Paz, Tarlac,, E of the basketball court and in front of the second concrete bench from the gate (a) and NAMRIA reference point TRC-3013 (b) as recovered by the field team.

Table 6. Details of the recovered NAMRIA horizontal control point TRC-3013 used as base station for the LiDAR Acquisition.

Station Name	TRC-3013	
Order of Accuracy	3rd	
Relative Error (horizontal positioning)	1 in 20,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	15° 29’ 16.12939” 120° 42’ 38.37207” 23.34200 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting Northing	468953.912 meters 1712797.124 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	15°29’ 10.48416” North 120° 42’ 43.19205” East 63.60100 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting Northing	254385.82 meters 1713487.51 meters

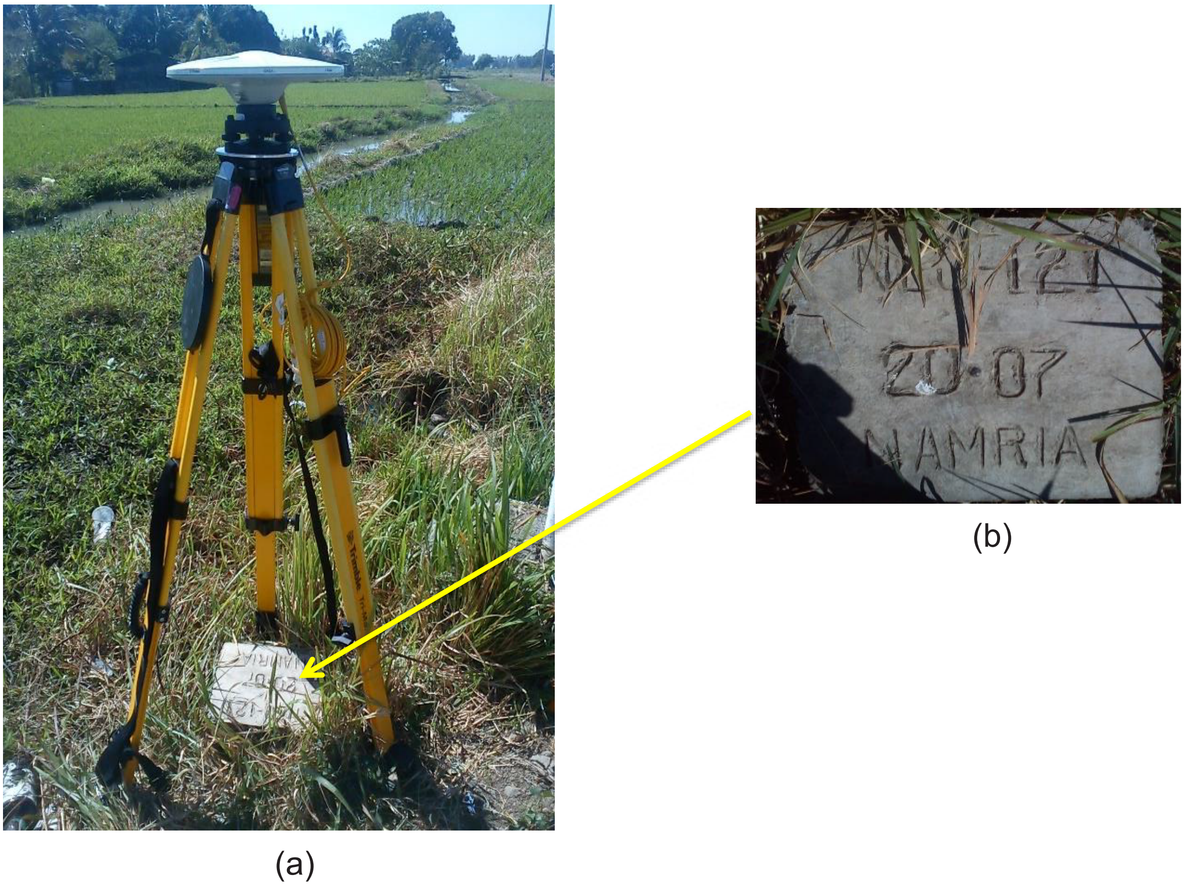

Figure 6. GPS set-up over NEJ-121 as recovered in Brgy. Tagaytay, Talavera, Nueva Ecija (a) and NAMRIA reference point NEJ-121 (b) as recovered by the field team.

Table 7. Details of the recovered NAMRIA horizontal control point NEJ-121 used as a base station for LiDAR acquisition.

Station Name	NEJ-121	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	15° 40' 5.06625" 120° 57' 24.22624" 65.19400 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting Northing	495361.169 meters 1732721.141 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	15° 39' 59.39965" North 120° 57' 29.02968" East 105.51500 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting Northing	280987.12 meters 1733169.16 meters

Table 8. Details of the recovered NAMRIA horizontal control point NEJ-110 as a base station used for LiDAR acquisition.

Station Name	NEJ-110	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	15° 48' 19.61644" 120° 46' 25.11917" 88.30300 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting Northing	475749.671 meters 1747933.483 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	15° 48' 13.90421" North 120° 46' 29.91195" East 127.76900 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting Northing	261514.85 meters 1748571.11 meters

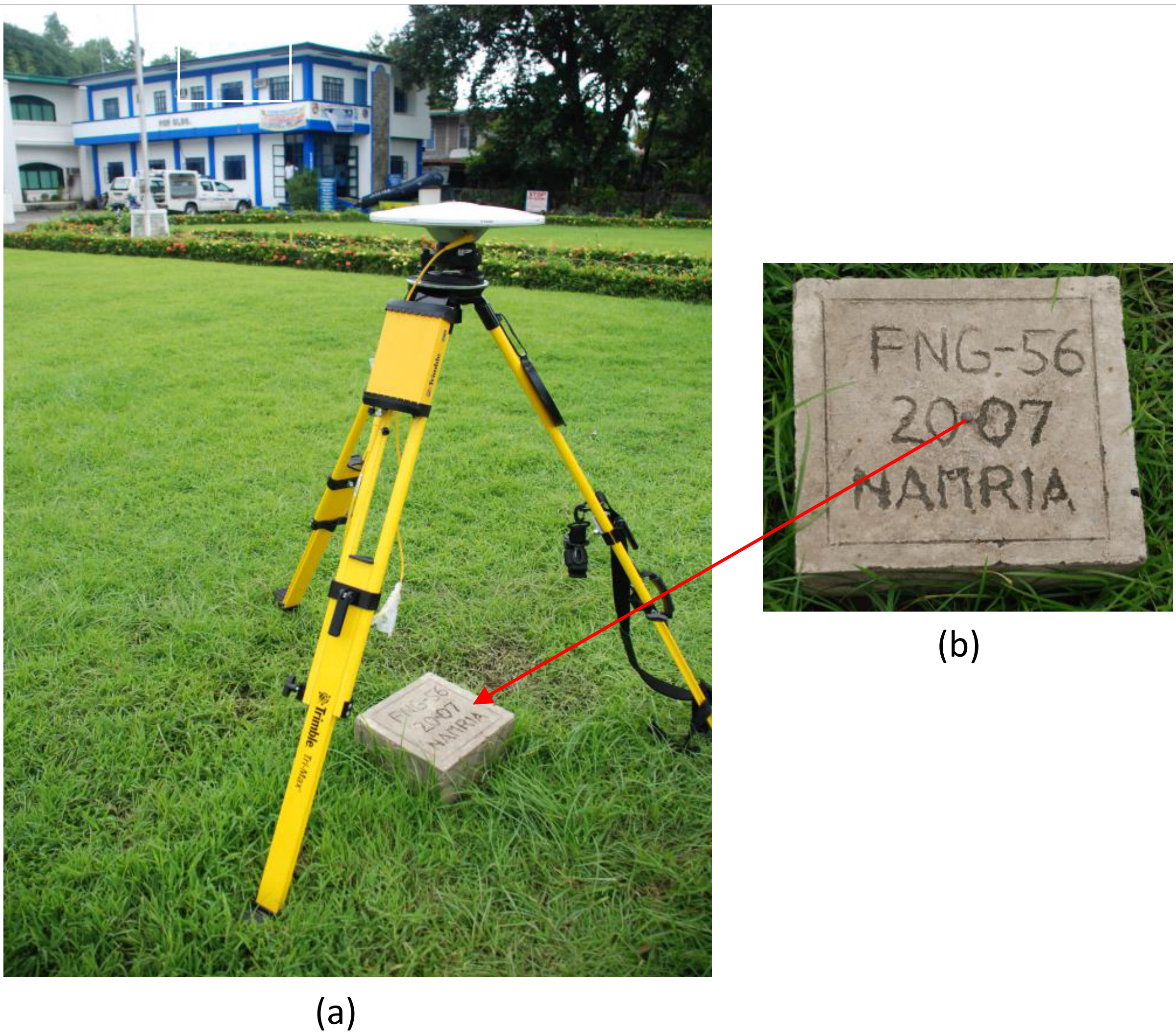

Figure 7. GPS set up over PNG-56 as located in the town plaza fronting Sto. Tomas Municipal Hall in Pangasinan (a) and NAMRIA reference point PNG-56 (b) as recovered by the field team.

Table 9. Details of the recovered NAMRIA horizontal control point PNG-56 used as base station for the LiDAR Acquisition.

Station Name	PNG-56	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	15° 52’ 46.68500” 120° 34’ 54.80152” 30.68000 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting Northing	455222.371 meters 1756173.446 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	15° 52’ 40.94082” North 120° 34’ 59.68898” East 69.55900 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting Northing	241,058.87 meters 1767009.80 meters

Table 10. Details of the recovered NAMRIA horizontal control point PNG-3235 used as base station for the LiDAR Acquisition.

Station Name	PNG-3235	
Order of Accuracy	4th	
Relative Error (horizontal positioning)	1 in 10,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	15° 54' 53.39177" 120° 22' 37.60736" 14.36100 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting Northing	433302.82 meters 1760122.49 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	15° 54' 47.62346" North 120° 22' 42.39285" East 52.53700 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting Northing	219166.89 meters 1761170.53 meters

Table 11. Details of the recovered NAMRIA horizontal control point NEJ-3220 used as base station for the LiDAR Acquisition.

Station Name	NEJ-3220	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	15° 39' 50.84417" North 120° 44' 14.35248" East 75.718 meters

Table 12. Details of the established ground control point NEJ-120A used as base station for the LiDAR Acquisition.

Station Name	NEJ-120A	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	15°46'16.26197"North 120°50'41.36605"East 121.055 m

Table 13. Details of the established ground control point NEJ-120B used as base station for the LiDAR Acquisition.

Station Name	NEJ-120B	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	15°46'16.27891"North 120°50'41.22989"East 121.072 m

Table 14. Ground control points used during LiDAR data acquisition

Date Surveyed	Flight Number	Mission Name	Ground Control Points
11 JAN 13	100G	2A6023A	PNG-56
11 JAN 13	102G	2A6L023B	PNG-56
24 JAN 13	103G	2AGN6L024A	PNG-56
25 JAN 13	105G	2AGN6K025A	PNG-56
4 FEB 13	125G	2AGN5N035B	PNG 56 & PNG 3235
19 FEB 13	158P	1A6Q050A	PNG 56
28 FEB 13	175G	2A5OQ59B	PNG 3235
21 JAN 14	1011P	1NEJ1B021A	NEJ 120A & NEJ 120B
21 JAN 14	1013P	1NEJ1B021B	NEJ 120A & NEJ 120B
21 JAN 14	1004A	3PNG1AB021A	NEJ 120A & NEJ 120B
21 JAN 14	1006A	3PNG1AB021B	NEJ 120A & NEJ 120B
22 JAN 14	1015P	1LMSCAM022A	NEJ 110, NEJ 120A & NEJ 120B
22 JAN 14	1008A	3PNG1AB022A	NEJ-110 & NEJ 120A
23 JAN 14	1019P	1NEJ1C023A	NEJ 110 & NEJ 121
26 JAN 14	7032GC	2NEJ1C026A	TRC-3013
28 JAN 14	7036GC	2NEJ1CS028A	NEJ 121
28 FEB 14	1163P	1BLK10F059A	LUN 72 & LUN 3047
28 FEB 14	1165P	1BLK10E059B	LUN 72 & LUN 3047
1 MAR 14	1167P	1BLK10H060A	LUN 72 & LUN 3047
1 MAR 14	1169P	1BLK10ES060B	LUN 72 & LUN 3047
17 MAY 14	7257GC	2PAMS7138B and 2NEJS1138B	TRC 3013
24 MAY 14	7268GC	2PAMS8144A	PNG 66
11 DEC 14	2298A	3NEJV345A	TRC-3013
31 MAR 16	8416AC	3NEJS1091A	NEJ 3220

2.3 Flight Missions

Twenty-Four (24) missions were conducted to complete the LiDAR Data Acquisition in Patalan Floodplain, for a total of thirty two hours and fifty one minutes (32+51) hours for RP-C9022, RP-C9122 and RP-C9322. All missions are acquired using the Aquarius, Pegasus and Gemini LiDAR systems. Table 15 shows the total area of actual coverage and the corresponding flying hours per mission, while Table 16 presents the actual parameters used during the LiDAR data acquisition.

Table 15. Flight missions for LiDAR Data Acquisition in Patalan 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
11 JAN 13	100G	155.07	219.69	154.74	64.95	639	2	40
11 JAN 13	102G	144.74	171.4	136	35.4	495	3	19
24 JAN 13	103G	94.76	125.49	78.927	46.563	482	3	0
25 JAN 13	105G	90.946	142.16	109.846	32.314	1,068	4	3
4 FEB 13	125G	62.152	73.324	34.9	38.424	287	2	50
19 FEB 13	158P	86.856	124.21	51.89	72.32	269	3	10
28 FEB 13	175G	41.522	60.938	60.938	0	748	4	0
21 JAN 14	1011P	75.4	86.60	0	86.60	253	3	41
21 JAN 14	1013P	50.7	28.80	0	28.8	N.A.	2	23
21 JAN 14	1004A	98.9	168.65	0	168.65	381	3	17
21 JAN 14	1006A	76.5	102.69	0	102.69	127	2	59
22 JAN 14	1015P	101.3	112	0	112	608	4	05
22 JAN 14	1008A	45.21	66.30	0	66.30	410	3	35
23 JAN 14	1019P	104.76	56.21	0	56.21	137	2	47
26 JAN 14	7032GC	80.31	66.5	0	66.5	N.A.	2	53
28 JAN 14	7036GC	70.56	133.1	0	133.1	N.A.	3	17
28 FEB 14	1163P	159.22	171.4	28.32	143.08	821	2	53
28 FEB 14	1165P	232.40	334.8	26.74	308.06	414	3	47
1 MAR 14	1167P	91.49	201.7	2.44	199.26	287	2	47
1 MAR 14	1169P	187.09	122.0	52.73	69.27	443	2	59
17 MAY 14	7257GC	66.12	48.9	0	48.90	N.A.	2	17
24 MAY 14	7268GC	57.44	110.1	22.76	87.34	N.A.	3	46
11 DEC 14	2298A	90.09	95.61	0	95.61	N.A.	2	15
31 MAR 16	8416AC	135.85	40.56	0	40.56	N.A.	2	46
TOTAL		**2399.38**	**2863.132**	**760.231**	**2102.90**	**7869**	**75**	**28**

Table 16. 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)
11 JAN 13	1200	45	52	70	60	130	5
11 JAN 13	1200	45	52	70	60	130	5
24 JAN 13	1200	45	52	70	60	130	5
25 JAN 13	1200	45	52	70	60	130	5
4 FEB 13	1200	40	52	70	60	130	5
19 FEB 13	1700	30	50	200	30	130	5
28 FEB 13	1000	30	40	100	50	130	5
21 JAN 14	1200	30	50	200	30	130	5
21 JAN 14	900	30	50	200	30	130	5
21 JAN 14	700	60	36	50	45	120	5
21 JAN 14	600	60	36	50	45	120	5
22 JAN 14	1200	30	50	200	30	130	5
22 JAN 14	600	60	36	50	45	120	5
23 JAN 14	800	30	50	200	30	130	5
26 JAN 14	1000	30	40	100	50	130	5
28 JAN 14	1000	30	40	100	50	130	5
28 FEB 14	1200	30	50	200	30	130	5
28 FEB 14	1200	30	50	200	30	130	5
1 MAR 14	1700	30	50	200	30	130	5
1 MAR 14	1700	30	50	200	30	130	5
17 MAY 14	1000	30	40	100	50	130	5
24 MAY 14	1000	40	40	100	50	130	5
11 DEC 14	600	60	36	50	45	120	5
31 MAR 16	500	50	36	50	45	120	5

2.4 Survey Coverage

Patalan Floodplain is located in La Union. Municipalities ofAgoo, Rosario, Tubaoand Pugo are mostly covered by the survey. The list of municipalities and cities surveyed with at least (1) square kilometer coverage is shown in Table 17.The actual coverage of the LiDAR acquisition for Patalan Floodplain is presented in Figure 8.

Table 17. List of municipalities and cities surveyed during Patalan Floodplain LiDAR survey.

Province	Municipality/City	Area of Municipality/ City (km²)	Total Area Surveyed (km²)	Percentage of Area Surveyed
Benguet	Tuba	322.02	66.88	20
La Union	Agoo	33.71	33.71	100.00
	Rosario	64.33	64.33	100.00
	Santo Tomas	58.53	58.52	99.99
	Tubao	53.87	53.84	99.95
	Pugo	60.54	60.26	99.54
	Aringay	95.65	89.85	93.94
	Caba	56.19	49.87	88.75
	Naguilian	86.39	65.13	75.39
	Burgos	51.92	4.62	8.90
	Bauang	85.26	6.88	8.07
	San Fernando City	121.05	0.00	0.00
Nueva Ecija	Lupao	130.81	83.71	63.99
	Rizal	162.40	63.06	38.83
	Talugtug	101.03	38.89	38.49
	Palayan City	88.39	33.26	37.63
	Mu±oz City	122.90	38.39	31.24
	General Mamerto Natividad	114.07	32.81	28.76
	San Jose City	169.67	45.56	26.85
	San Antonio	169.06	32.82	19.41
	Cuyapo	180.90	34.60	19.12
	Llanera	106.93	18.07	16.90
	San Isidro	44.49	7.30	16.42
	Gapan City	163.45	25.44	15.57
	Bongabon	225.26	30.88	13.71
	Guimba	214.42	20.91	9.75
	Talavera	100.50	9.07	9.03
	Santo Domingo	75.49	6.08	8.05
	Pantabangan	423.43	20.01	4.73
	Aliaga	103.66	4.56	4.40
	Cabanatuan City	193.42	7.17	3.71
	Cabiao	110.18	4.06	3.68
	Laur	167.97	6.04	3.60
	Quezon	76.29	2.00	2.62
	Jaen	93.66	1.36	1.45
	San Leonardo	51.79	0.51	0.98

Province	Municipality/City	Area of Municipality/ City (km²)	Total Area Surveyed (km²)	Percentage of Area Surveyed
	Licab	55.20	0.30	0.54
	Zaragoza	91.81	0.44	0.48
Pampanga	Mabalacat	257.69	0.72	0.28
	Magalang	99.89	0.19	0.19
Pangasinan	Santa Maria	51.71	50.87	98
	Urdaneta City	107.79	104.21	96
	Mangaldan	43.42	39.13	90
	San Jacinto	34.09	30.29	88
	Dagupan City	47.76	36.39	76
	San Fabian	69.27	50.52	72
	Umingan	254.15	161.57	63
	Mapandan	21.35	13.00	60
	Santa Barbara	64.71	35.25	54
	Sison	151.96	82.09	54
	Manaoag	42.42	22.55	53
	Asingan	65.93	31.72	48
	Tayug	51.95	21.24	40
	Pozzorubio	74.75	27.47	36
	San Quintin	117.37	42.18	35
	Binalonan	78.54	20.74	26
	Laoac	40.70	9.44	23
	Malasiqui	124.81	28.72	23
	Balungao	84.49	16.17	19
	Villasis	76.04	14.23	18
	Calasiao	49.20	8.05	16
	Binmaley	61.84	7.55	12
	Lingayen	68.74	1.97	2
	Rosales	59.10	1.31	2
	San Manuel	119.59	1.99	1
	Natividad	74.39	0.90	1
Tarlac	Victoria	107.37	14.34	13
	Concepcion	234.56	27.02	11
	Santa Ignacia	145.32	11.84	8
	La Paz	122.26	8.01	6
	Mayantoc	244.09	10.89	4
	Capas	467.83	17.42	3
	San Manuel	37.34	1.04	2
	Moncada	90.55	2.01	2
	Camiling	130.78	1.92	1
	Tarlac City	241.67	2.05	0.84
	Pura	28.52	0.19	0.66
	Victoria	69.75	14.34	0.35

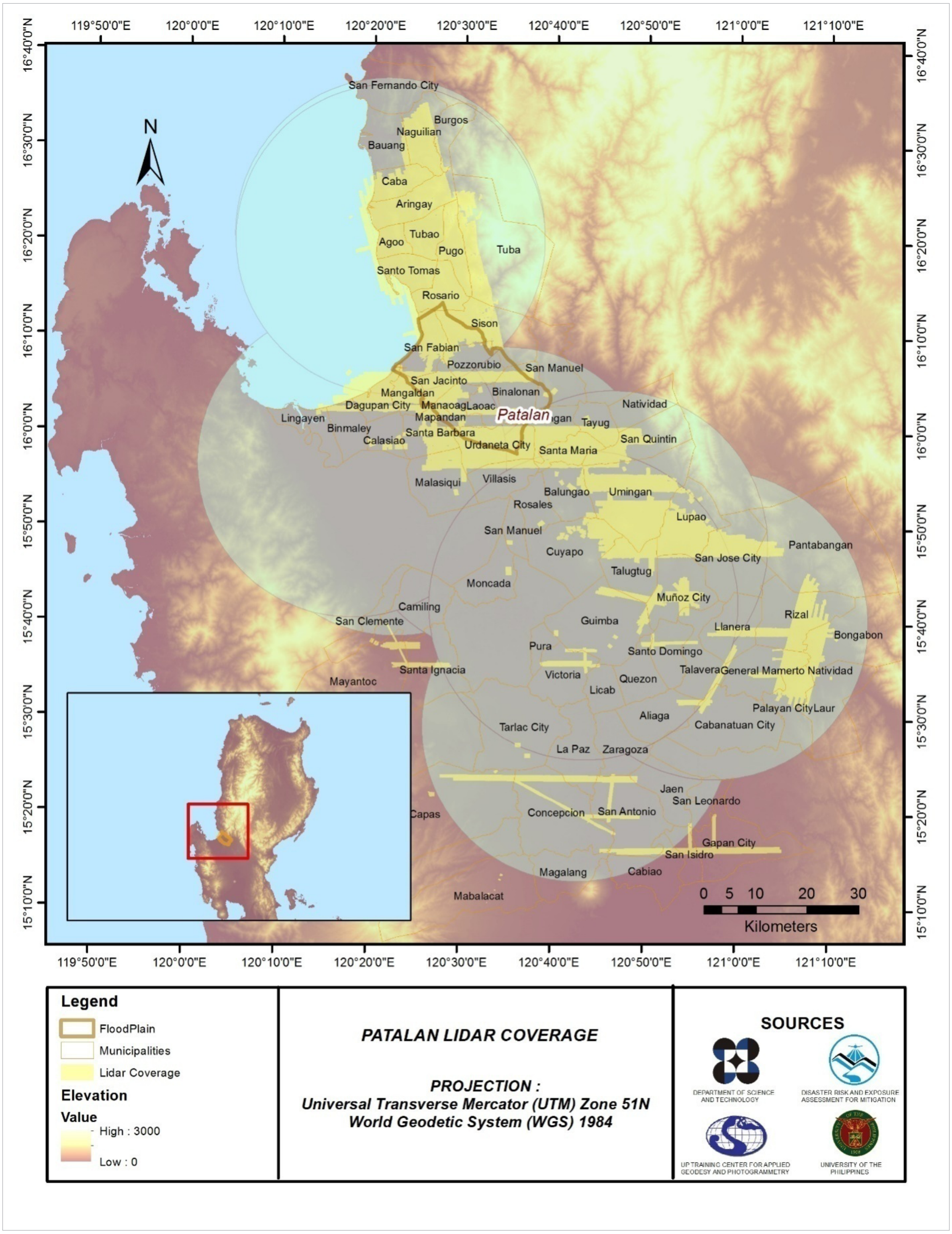

Figure 8. Actual LiDAR data acquisition for Patalan Floodplain.

CHAPTER 3: LIDAR DATA PROCESSING FOR PATALAN 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 were 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 was done in order to obtain the exact location of the LiDAR sensor when the laser was shot. Point cloud georectification was 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 were the minimum point density, vertical and horizontal accuracies, are met. The point clouds were then classified into various classes before generating Digital Elevation Models such as Digital Terrain Model and Digital Surface Model.

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

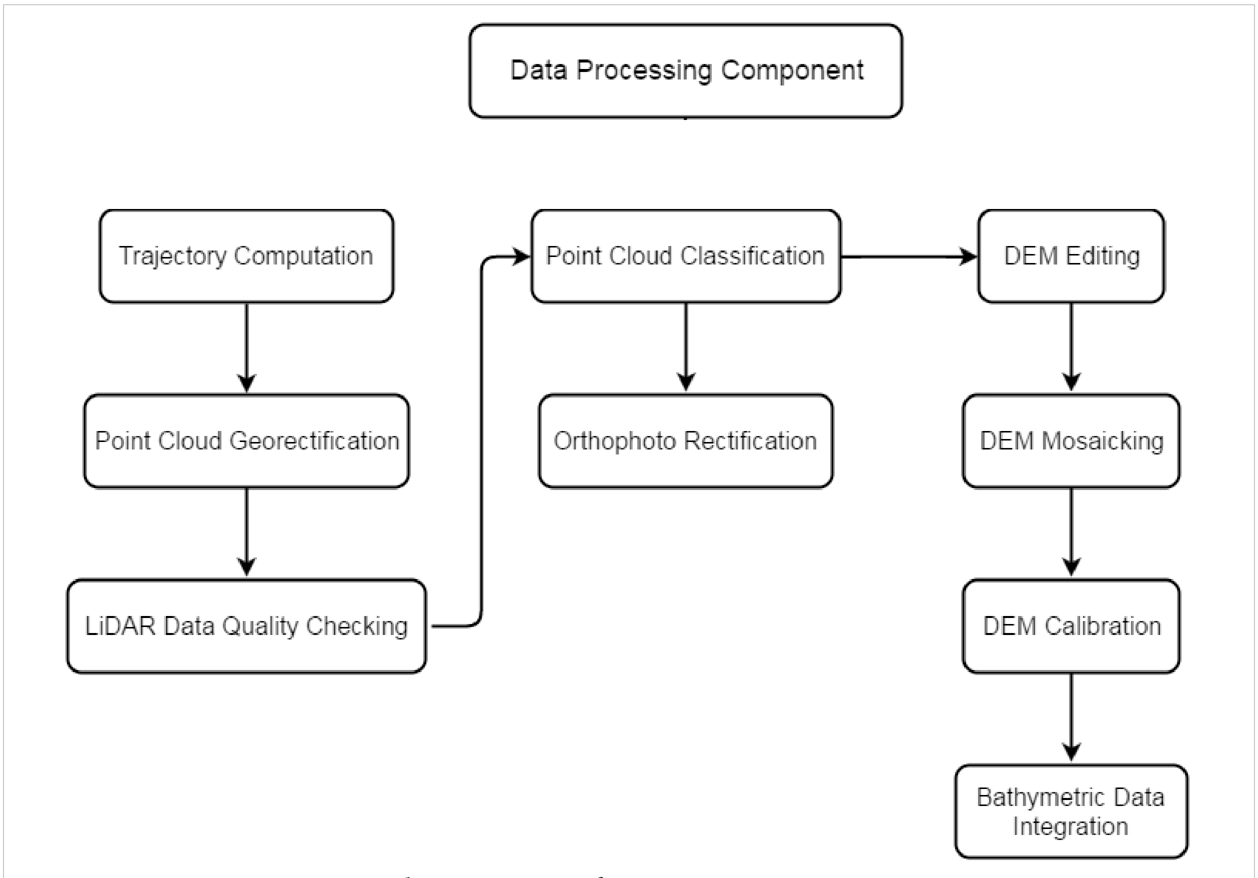


Figure 9. Schematic Diagram for Data Pre-Processing Component

3.2 Transmittal of Acquired LiDAR Data

Data transfer sheets for all the LiDAR missions for Patalan Floodplain can be found in ANNEX 5. Missions flown during the first survey conducted in February 2013 used the Airborne LiDAR Terrain Mapper (ALTM™ Optech Inc.) Gemini and Pegasus system. The second survey started on Jan 2014 using Aquarius, Gemini CASI and Pegasus systems while missions acquired during the third survey on March 2016 were flown using the Aquarius CASI system over La Union, Pampanga and Nueva Ecija. The Data Acquisition Component (DAC) transferred a total of 427.83 Gigabytes of Range data, 5.91 Gigabytes of POS data, 372.8 Megabytes of GPS base station data, and 781.56 Gigabytes of raw image data to the data server on March 1, 2013 for the first survey, February 9, 2015 for the second survey and April 12, 2016 for the third survey. The Data Pre-processing Component (DPPC) verified the completeness of the transferred data. The whole dataset for Patalan was fully transferred on April 22, 2016, as indicated in the Data Transfer Sheets for Patalan Floodplain.

3.3 Trajectory Computation

The Smoothed Performance Metrics of the computed trajectory for flight 1161P, one of the Patalan flights, which is the North, East, and Down position RMSE values are shown in Figure 10. 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 onFebruary 27, 2014 00:00AM. The y-axis is the RMSE value for that particular position.

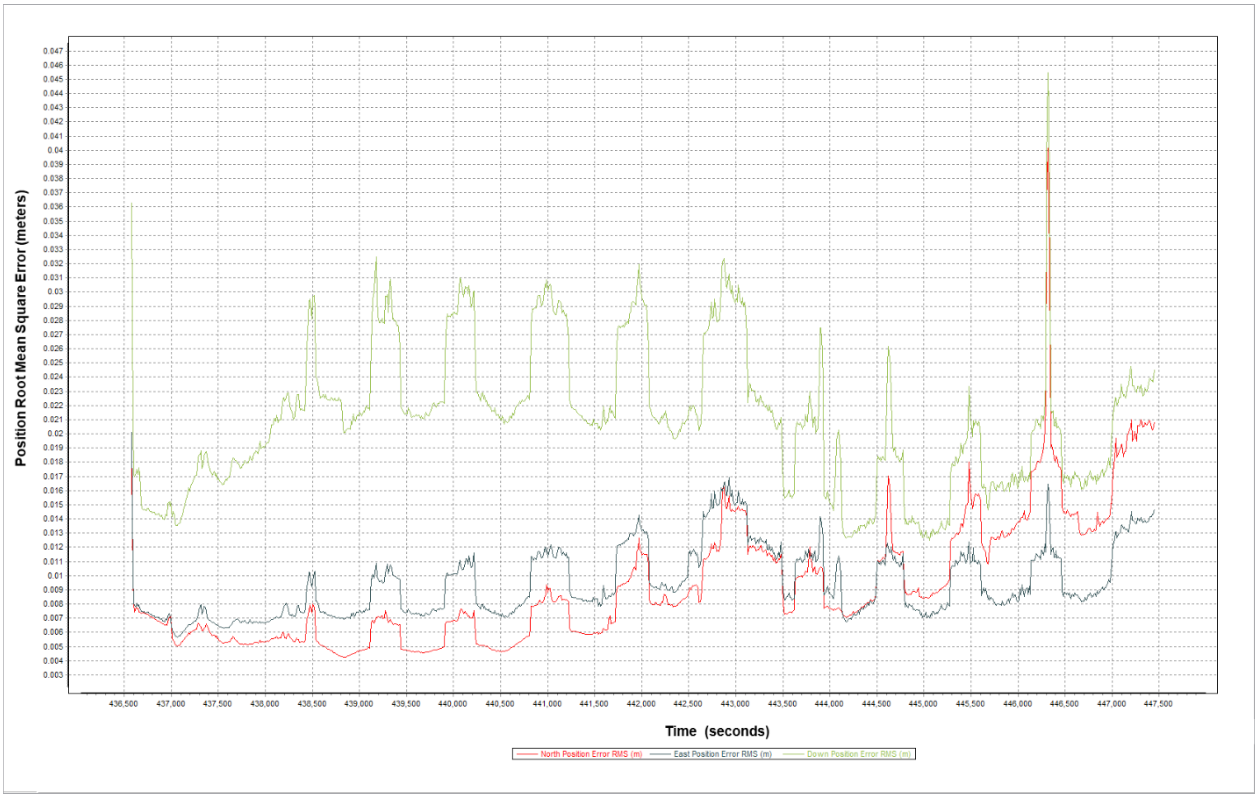


Figure 10. Smoothed Performance Metrics of a Patalan Flight 1161P.

The time of flight was from 436500 seconds to 447500 seconds, which corresponds to afternoon of February 27, 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 10 shows that the North position RMSE peaks at 1.80 centimeters, the East position RMSE peaks at 1.70 centimeters, and the Down position RMSE peaks at 3.20 centimeters, which are within the prescribed accuracies described in the methodology.

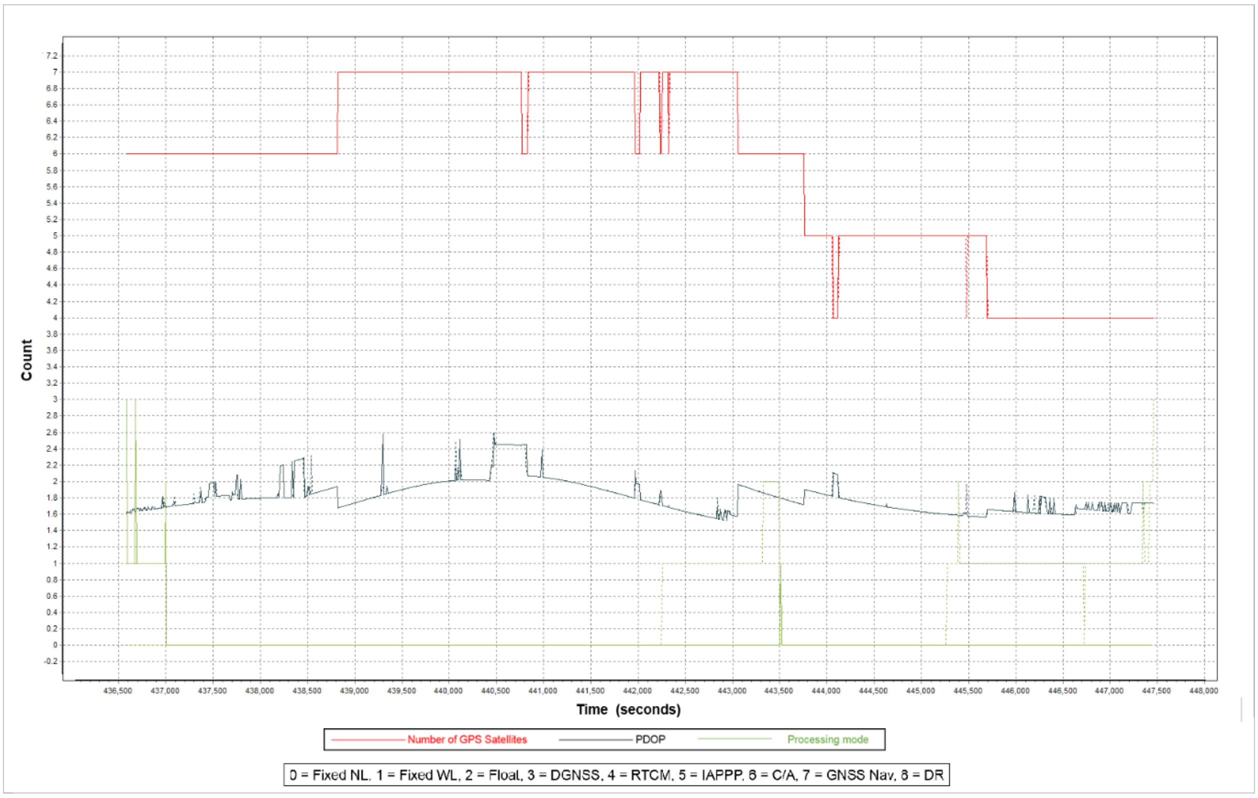


Figure 11. Solution Status Parameters of Patalan Flight 1161P.

The Solution Status parameters of flight 1161P, one of the Patalan flights, which indicate the number of GPS satellites, Positional Dilution of Precision (PDOP), and the GPS processing mode used, are shown in Figure 11. The graphs indicate that the number of satellites during the acquisition did not go down to 4. Most of the time, the number of satellites tracked was between 6 and 7. 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 2 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 Patalan flights is shown in Figure 12.

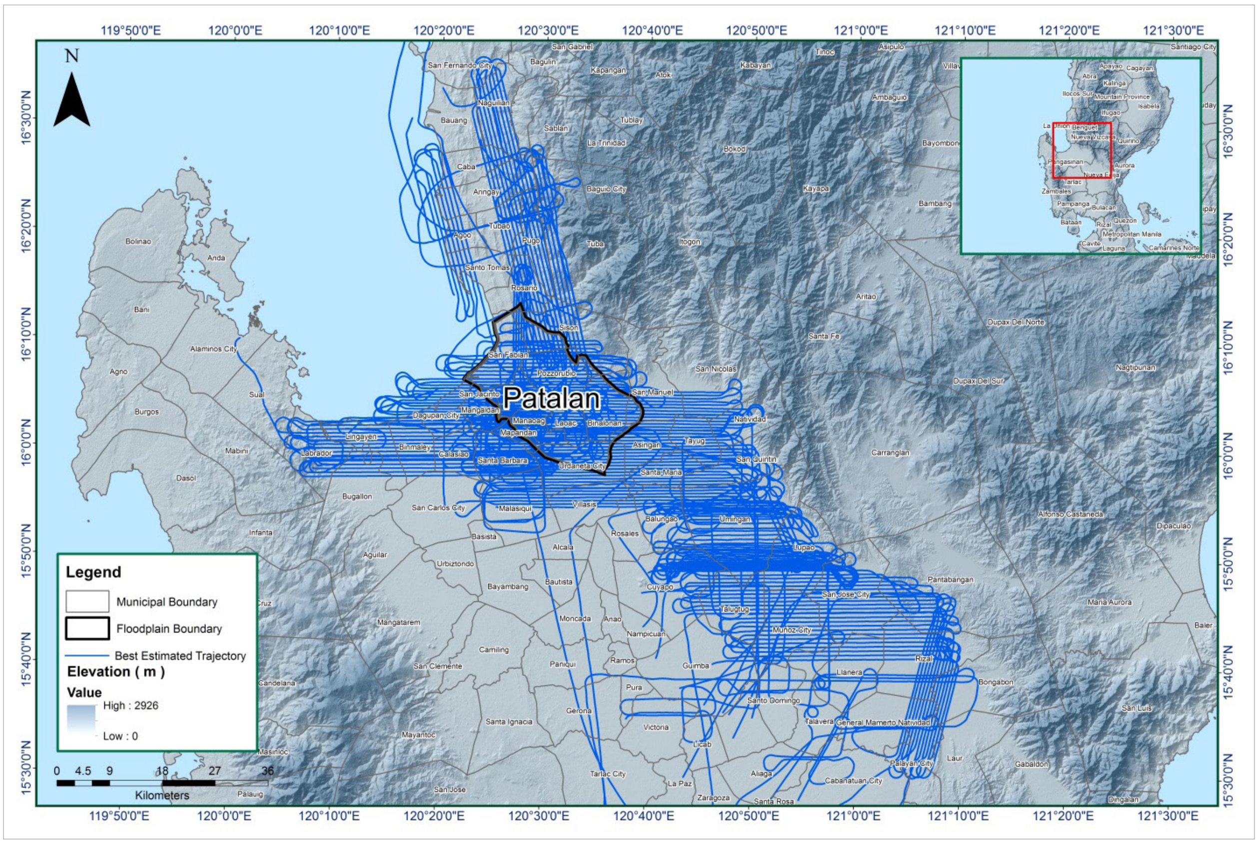


Figure 12. Best estimated trajectory for Patalan Floodplain.

3.4 LiDAR Point Cloud Computation

The produced LAS data contains 96 and 105 flight lines, with each flight line containing one and two channels, respectively. The Gemini and Aquarius systems contain one channel each while the Pegasus system contains two channels. The summary of the self-calibration results obtained from LiDAR processing in LiDAR Mapping Suite (LMS) software for all flights over Patalan Floodplain are given in Table 18.

Table 18. Self-Calibration Results values for Patalan flights.

Parameter		Computed Value
Boresight Correction stdev	(<0.001degrees)	0.000412
IMU Attitude Correction Roll and Pitch Corrections stdev	(<0.001degrees)	0.001085
GPS Position Z-correction stdev	(<0.01meters)	0.0015

The optimum accuracy is obtained for all Patalan 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 13. The map shows gaps in the LiDAR coverage that are attributed to cloud coverage.

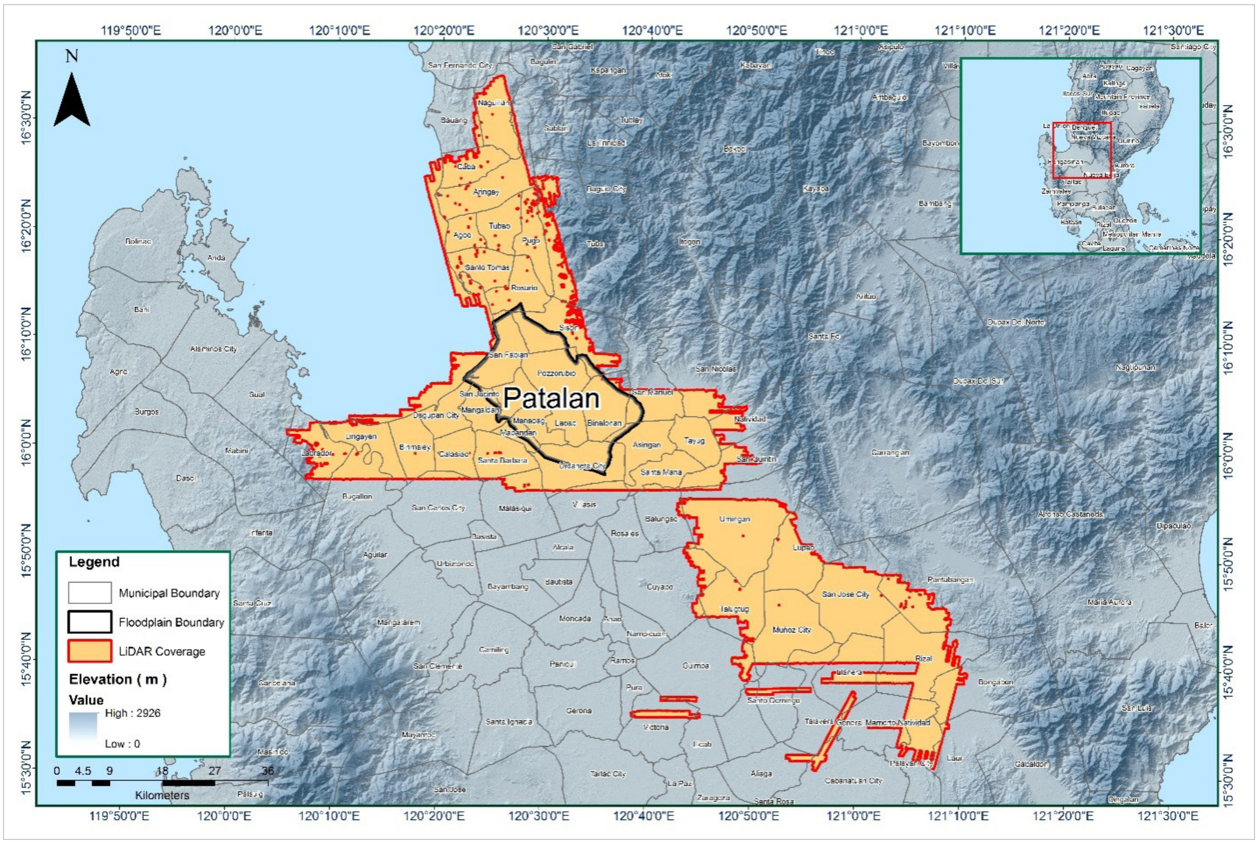


Figure 13. Boundary of the processed LiDAR data on top of a SAR Elevation Data over Patalan Floodplain.

The total area covered by the Patalan missions is 3414.94 sq.km comprised of thirty six (36) flight acquisitions grouped and merged into twenty seven (27) blocks as shown in Table 19.

Table 19. List of LiDAR blocks for Patalan Floodplain.

LiDAR Blocks	Flight Numbers	Area (sq. km)
LaUnion_Blk10H	1165P	106.478
LaUnion_Blk10F	1161P	324.81
LaUnion_Blk10E	1163P	184.81
LaUnion_Blk10E_additional	1167P	205.49
Clark_reflights_Agno6B_additional	2298A	11.02
Pam_Nej_reflights_Blk1B	8416AC	39.01
Agno_Blk6I_reflight	7268GC	26.71
Pam3J_reflights	7257G	23.91
Pam3H_reflights	7257G	21.23
NuevaEcija_1017P	1017P	307.50
NuevaEcija_7032GC	7032GC	67.04
NuevaEcija_7036GC	7036GC	88.88
NuevaEcija_NEJ1B	1011P	265.75
	1013P	
NuevaEcija_NEJ_1015P_1019P	1015P	175.86
	1019P	
NuevaEcija_NEJ_additional	7032GC	49.14
	7036GC	
Agno_Blk5O	175G	111.17
	128G	
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_Blk6L	102G	147.88
	103G	
	105G	
Agno_Blk6Q	158P	48.94
Agno_Blk6P	97G	148.59
Agno_Blk6O	98G	165.62
Agno_Blk6N	99G	29.41
	100G	
Agno_Blk6M	99G	161.65
	100G	
	102G	
TOTAL		**3414.94 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 14. Since the Gemini and Aquarius systems both employ one channel, 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 are expected; since it employs two channels, 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 are expected.

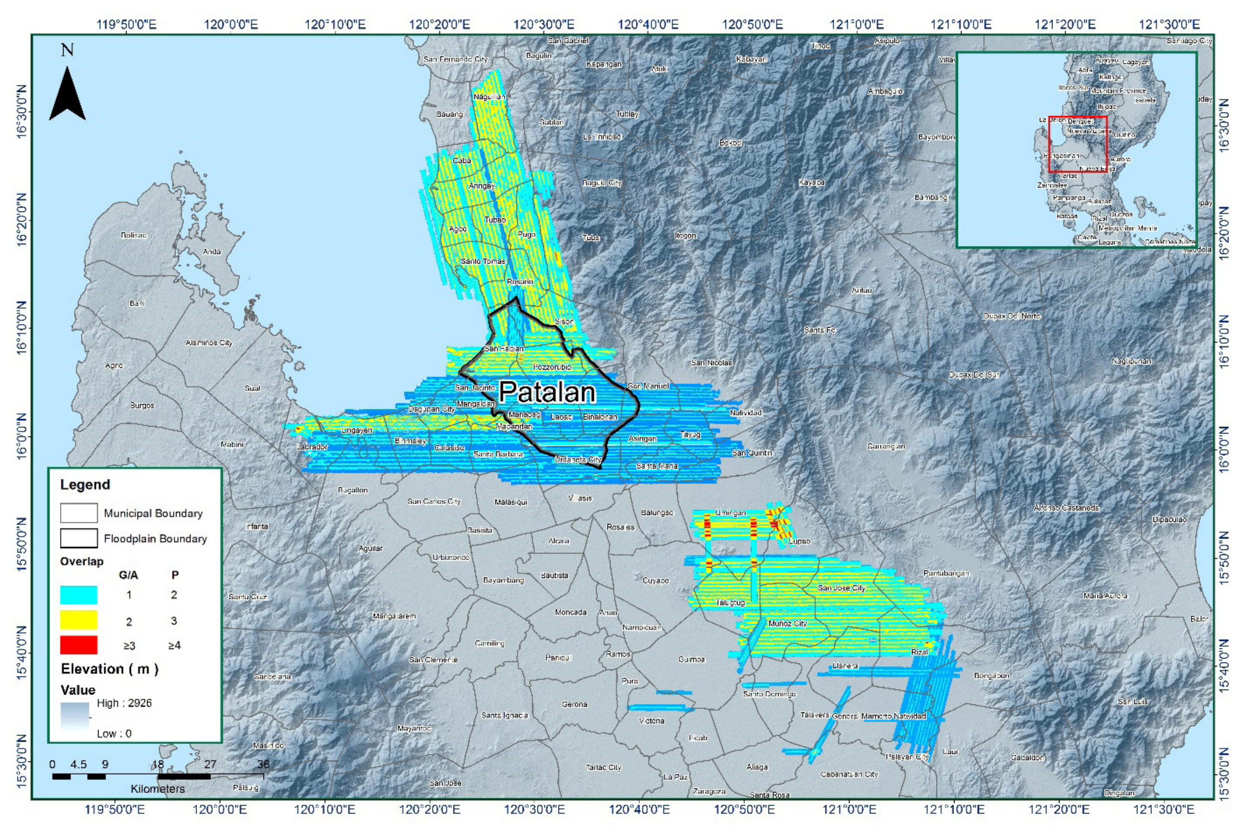


Figure 14. Image of data overlap for Patalan Floodplain.

The overlap statistics per block for the Patalan floodplain can be found in Annex 8. 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 25.45% and 96.38% 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 15. It was determined that all LiDAR data for Patalan Floodplain satisfy the point density requirement, and the average density for the entire survey area is 2.93 points per square meter.

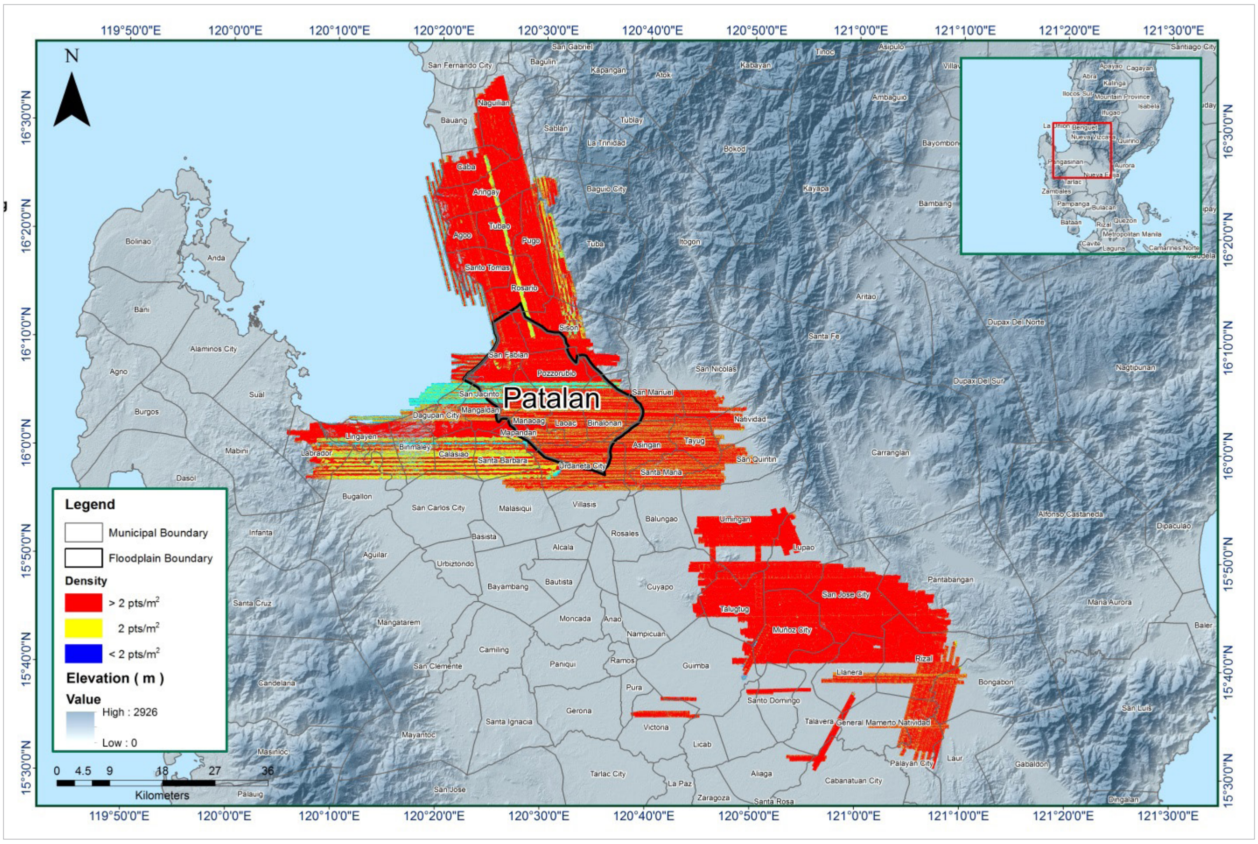


Figure 15. Pulse density map of merged LiDAR data for Patalan Floodplain.

The elevation difference between overlaps of adjacent flight lines is shown in Figure 16. 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.

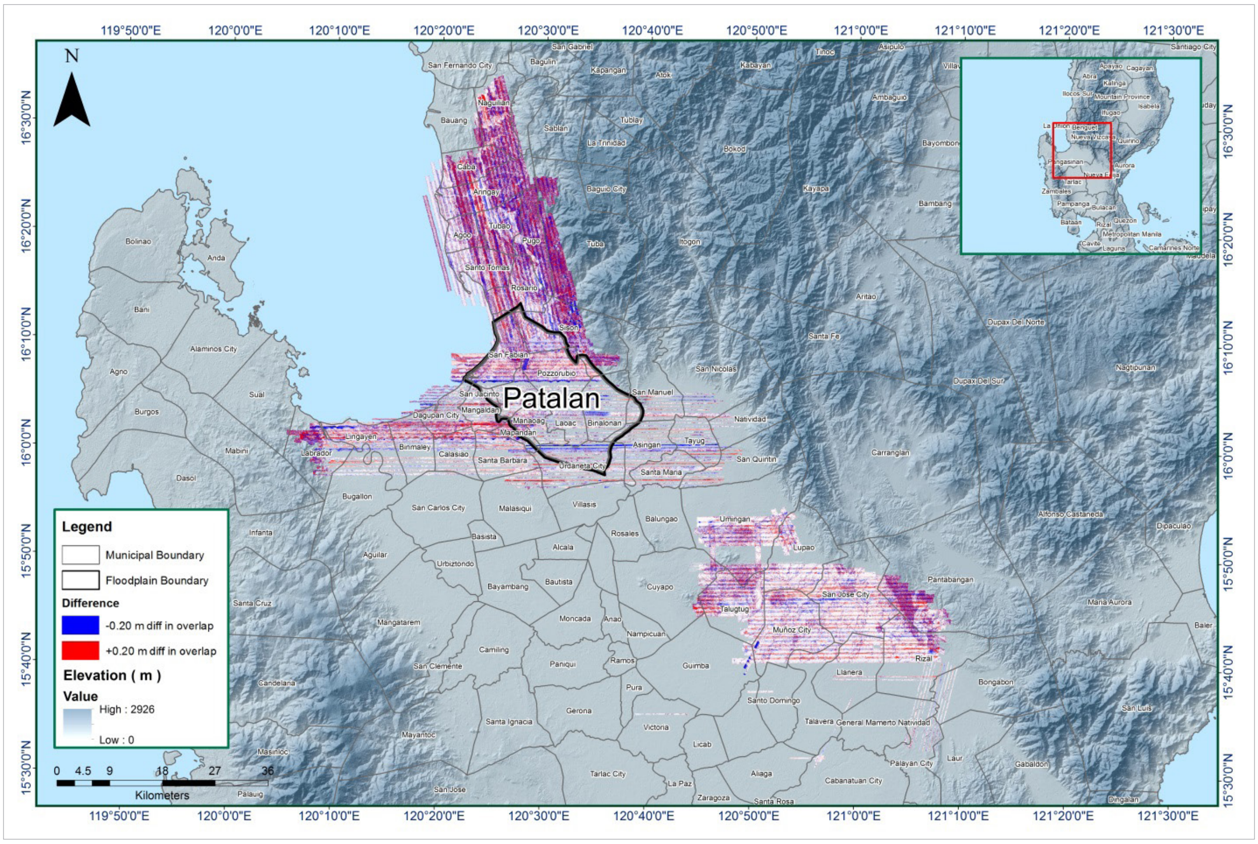


Figure 16. Elevation difference map between flight lines for Patalan Floodplain.

A screen capture of the processed LAS data from a Patalan flight 1161P loaded in QT Modeler is shown in Figure 17. The upper left image shows the elevations of the points from two overlapping flight strips traversed by the profile, illustrated by a dashed yellow 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.

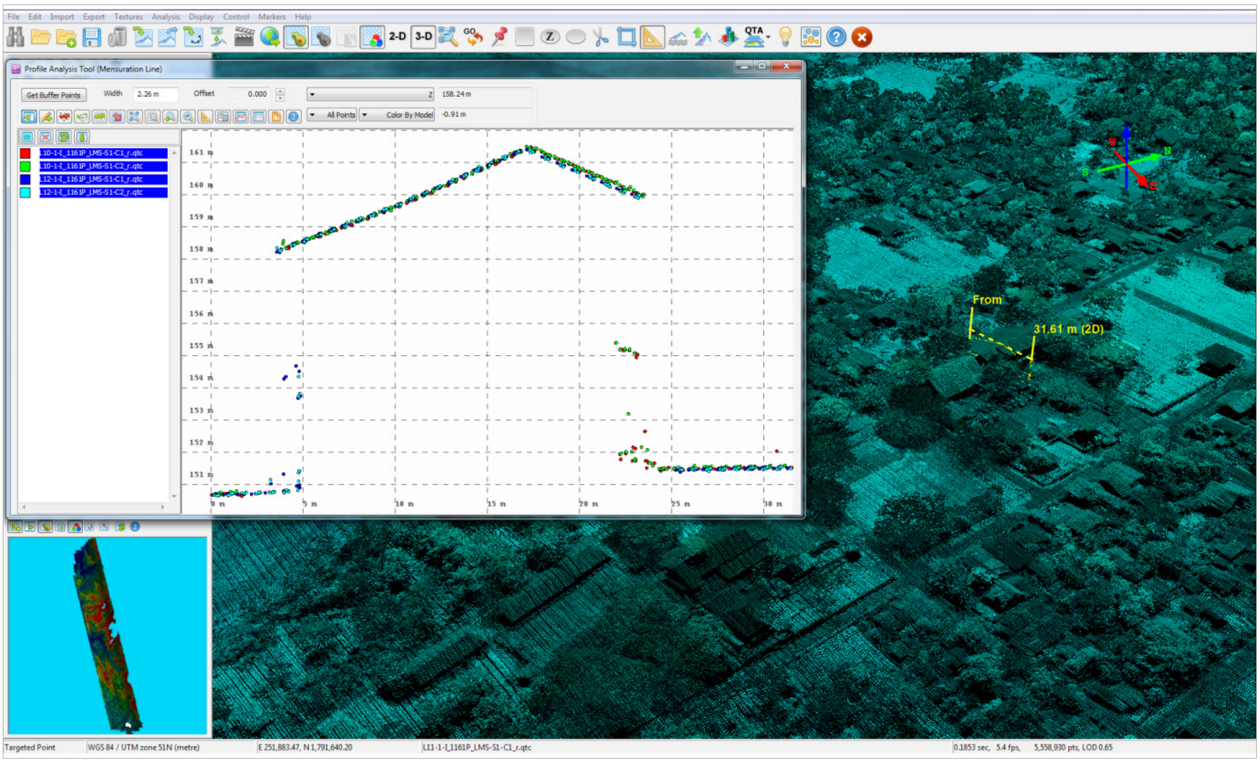


Figure 17. Quality checking for a Patalan flight 1161P using the Profile Tool of QT Modeler.

3.6 LiDAR Point Cloud Classification and Rasterization

Table 20. Patalan classification results in TerraScan.

Pertinent Class	Total Number of Points
Ground	3,076,802,256
Low Vegetation	3,034,571,084
Medium Vegetation	2,732,838,882
High Vegetation	1,725,737,224
Building	318,319,574

The tile system that TerraScan employed for the LiDAR data and the final classification image for a block in Patalan Floodplain is shown in Figure 18. A total of 5,060 1km by 1km tiles were produced. The number of points classified to the pertinent categories is illustrated in Table 20. The point cloud has a maximum and minimum height of 1,257.47 meters and 16.80 meters respectively.

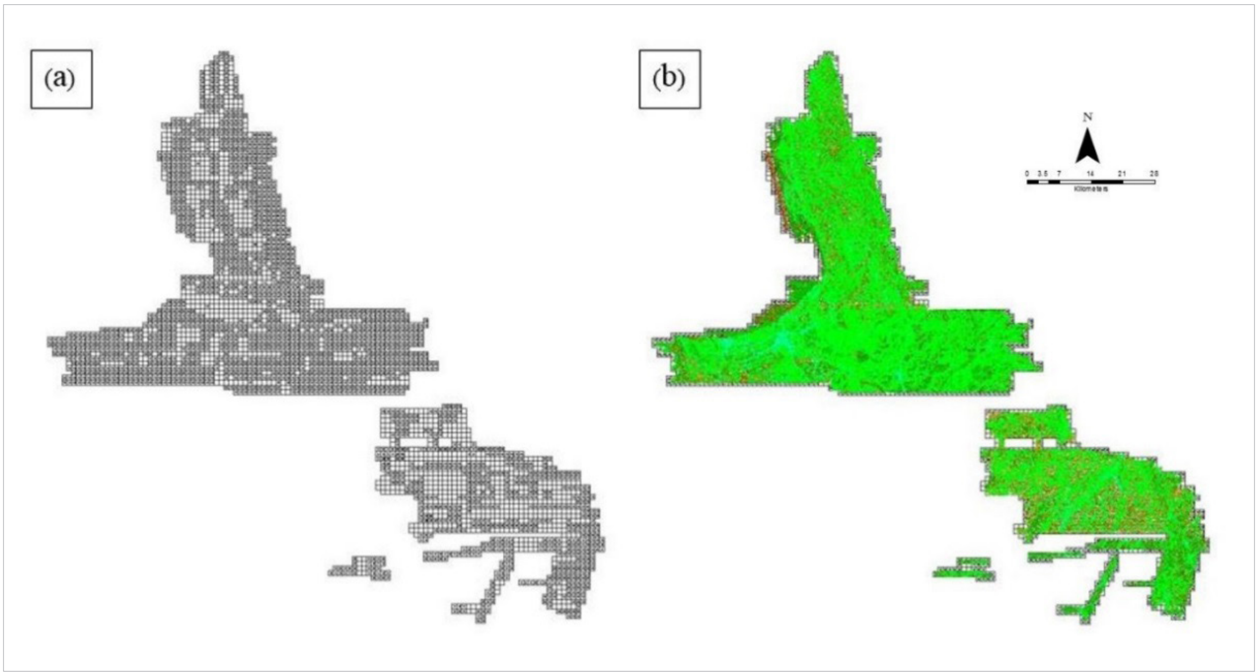


Figure 18. Figure 18. Tiles for Patalan Floodplain (a) and classification results (b) in TerraScan

An isometric view of an area before and after running the classification routines is shown in Figure 19. 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.

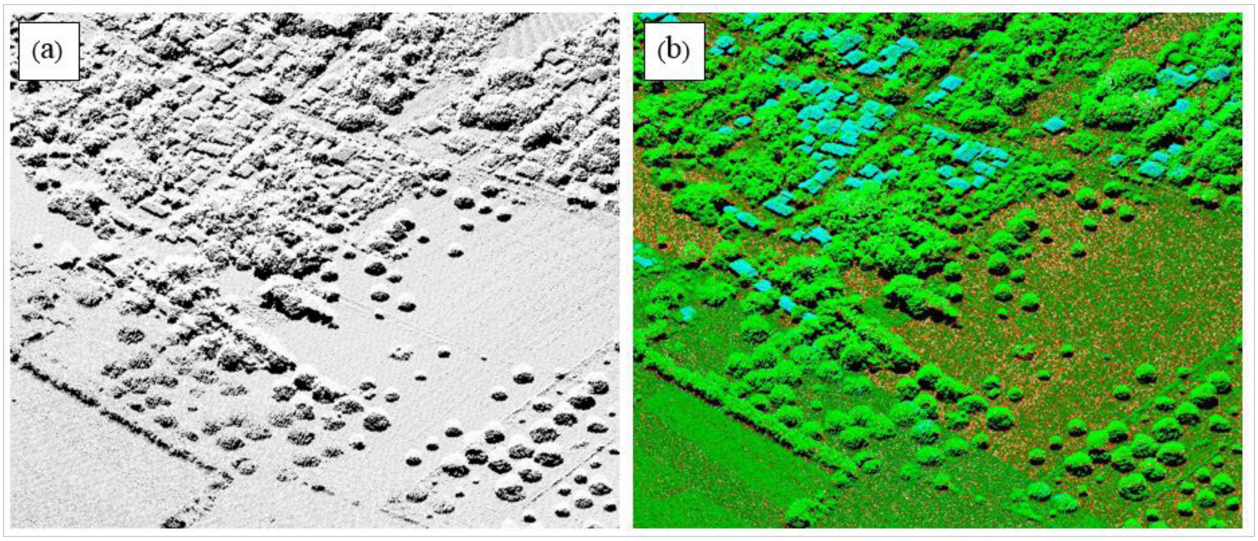


Figure 19. Point cloud before (a) and after (b) classification.

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 20. It shows that DTMs are the representation of the bare earth while on the DSMs, all features are present such as buildings and vegetation.

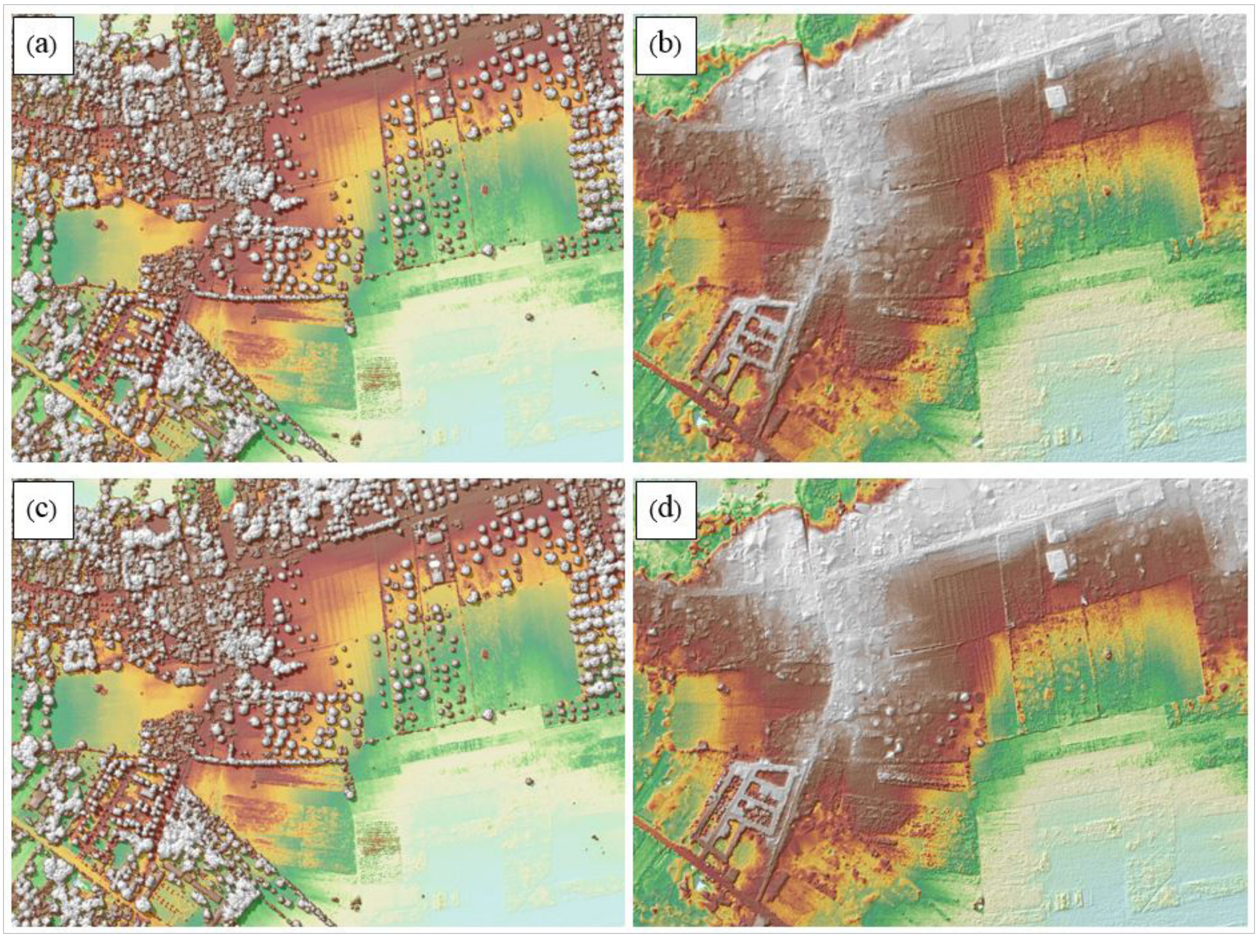


Figure 20. The production of last return DSM (a) and DTM (b), first return DSM (c) and secondary DTM (d) in some portion of Patalan Floodplain.

3.7 LiDAR Image Processing and Orthophotograph Rectification

The 3,247 1km by 1km tiles area covered by Patalan Floodplain is shown in Figure 21. After tie point selection to fix photo misalignments, color points were added to smoothen out visual inconsistencies along the seamlines where photos overlap. The Patalan Floodplain has a total of 2,115.07 sq.km orthophotogaph coverage comprised of 7,299 images. A zoomed in version of sample orthophotographs named in reference to its tile number is shown in Figure 22.

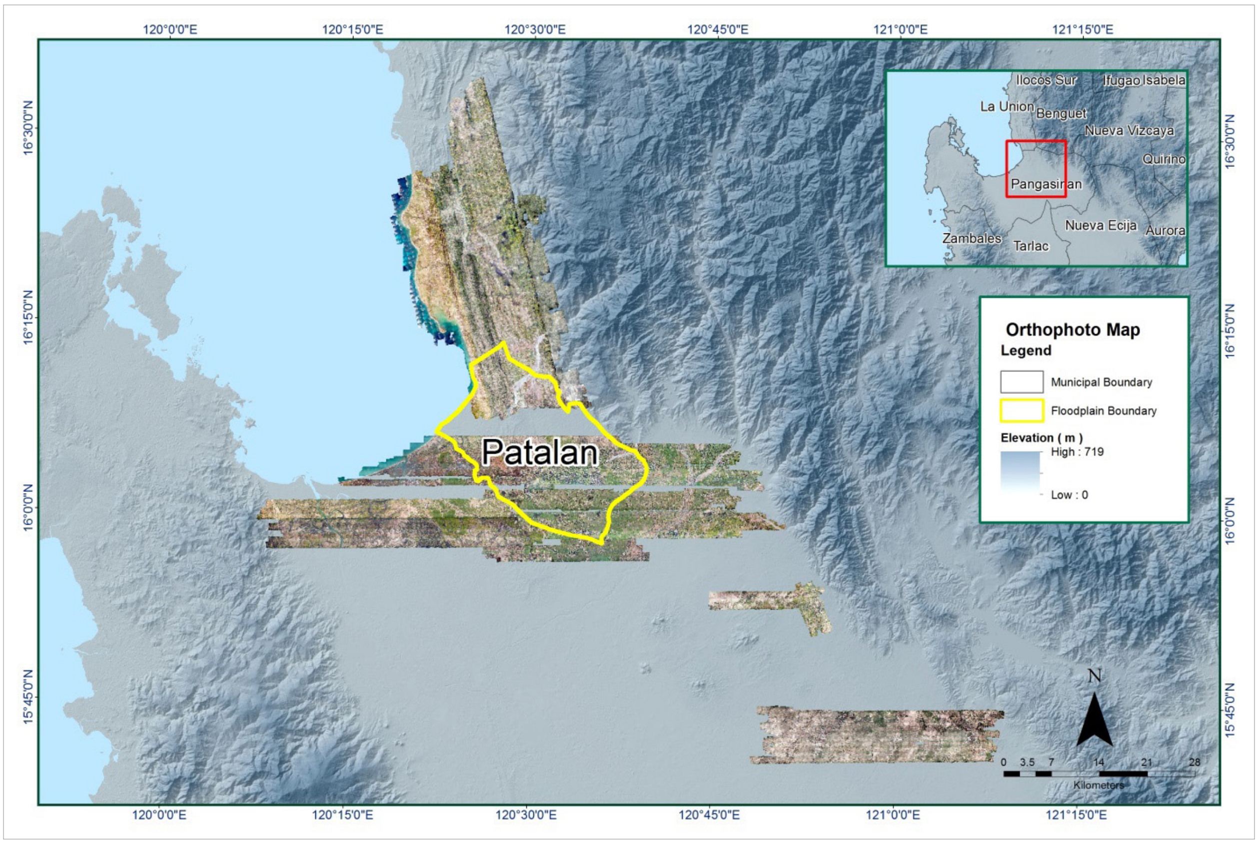


Figure 21. Patalan Floodplain with available orthophotographs.

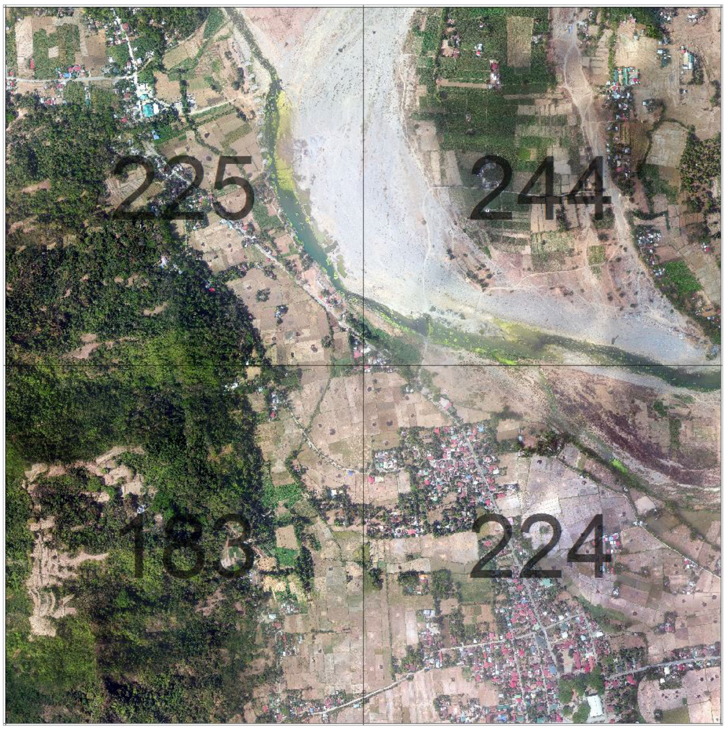


Figure 22. Sample orthophotograph tiles for Patalan Floodplain.

3.8 DEM Editing and Hydro-Correction

Twenty seven (27) mission blocks were processed for Patalan Floodplain. These blocks are composed of La Union, Clark_reflights, Pam_NEJ_reflights, Pam_Agno_reflights, Nueva Ecija, Agno 5 and Agno6 blocks with a total area of 3414.94 square kilometers. Table 21 shows the name and corresponding area of each block in square kilometers.

Table 21. LiDAR blocks with its corresponding area.

LiDAR Blocks	Area (sq.km)
LaUnion_Blk10H	106.48
LaUnion_Blk10F	324.81
LaUnion_Blk10E	184.81
LaUnion_Blk10E_additional	205.49
Clark_reflights_Agno6B_additional	11.02
Pam_Nej_reflights_Blk1B	39.01
Agno_Blk6I_reflight	26.71
Pam3J_reflights	23.91
Pam3H_reflights	21.23
NuevaEcija_1017P	307.50
NuevaEcija_7032GC	67.04
NuevaEcija_7036GC	88.88
NuevaEcija_NEJ1B	265.75
NuevaEcija_NEJ_1015P_1019P	175.86
NuevaEcija_NEJ_additional	49.14
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_Blk6L	147.88
Agno_Blk6Q	48.94
Agno_Blk6P	148.59
Agno_Blk6O	165.62
Agno_Blk6N	29.41
Agno_Blk6M	161.65
TOTAL	**3414.94 sq. km**

Portions of DTM before and after manual editing are shown in Figure 23. The bridge (Figure 23a) is considered to be an obstruction to the water flow and has to be removed (Figure 23b) in order to hydrologically correct the river. A depression or pit (Figure 23c) has been identified and interpolated to complete the surface (Figure 23d). A misclassification of ground points due to high vegetation is present in the DTM after classification (Figure 23e) and has been retrieved from secondary DTM (Figure 23f).

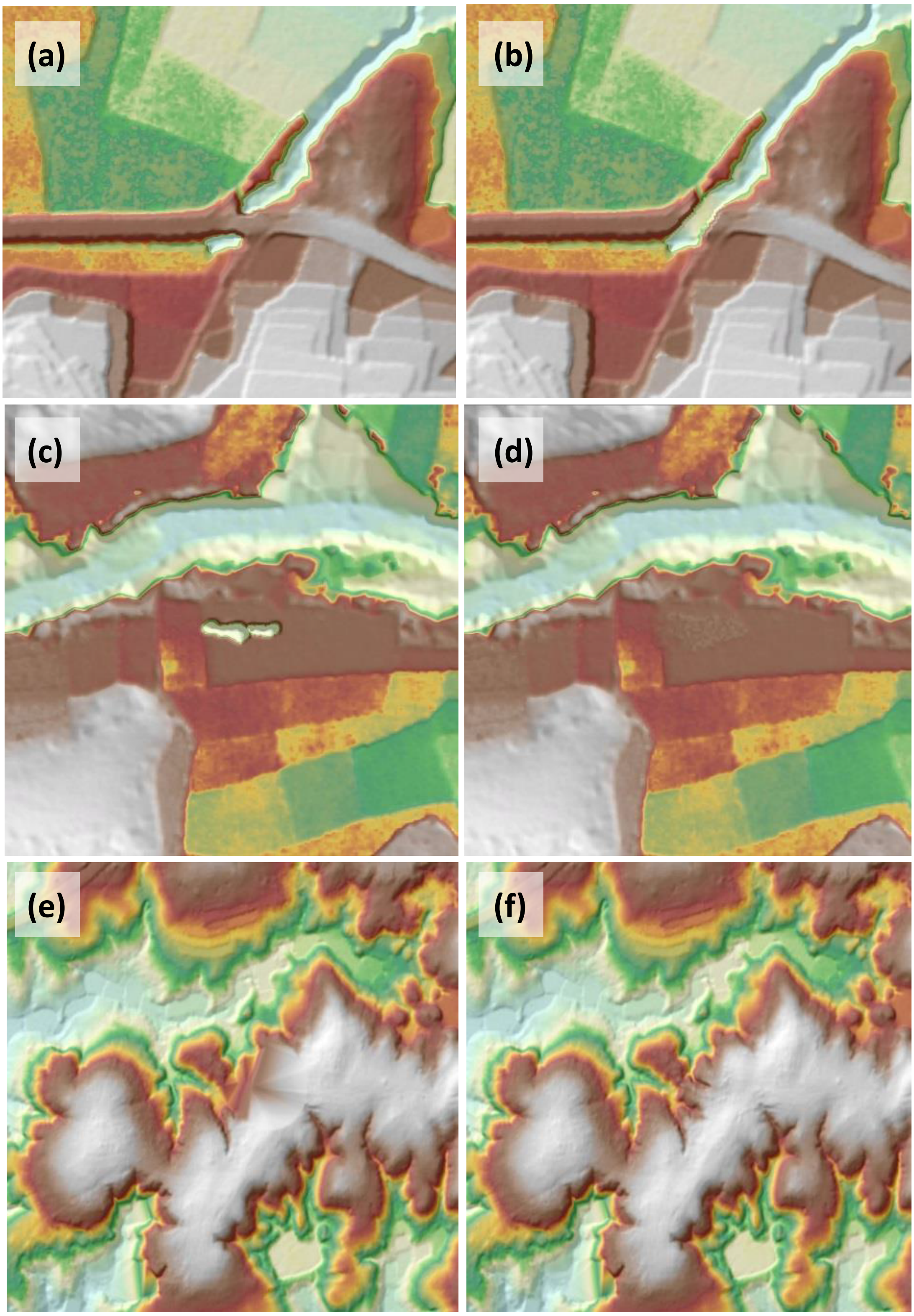


Figure 23. Figure 23. Portions in the DTM of Patalan Floodplain – a bridge before (a) and after (b) manual editing; a pit before (c) and after (d) interpolation; and an interpolated surface before (e) and after (f) object retrieval

3.9 Mosaicking of Blocks

The blocks covering Patalan 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 Patalan Floodplain are Agno mission blocks. Table 22 shows the shift values applied to each LiDAR block during mosaicking. No shift values were applied to NuevaEcija_BlkNEJ1B because it covers the same area as the other blocks that were mosaicked first.

Mosaicked LiDAR DTM for Patalan Floodplain is shown in Figure 24. It can be seen that the entire Patalan Floodplain is 99.75% covered by LiDAR data.

Table 22. Shift Values of each LiDAR Block of Patalan floodplain

Mission Blocks	Shift Values (meters)		
	x	y	z
Agno_Blk5L	0.00	0.00	-3.20
Agno_Blk5M	0.05	0.12	-3.65
Agno_Blk5N	0.37	0.09	-3.50
Agno_Blk5O	-0.56	0.11	-3.50
Agno_Blk5P	0.00	0.00	-3.80
Agno_Blk5P_add	0.30	-0.83	-3.70
Agno_Blk6L	0.00	0.00	-4.38
Agno_Blk6M	0.00	0.00	-4.38
Agno_Blk6N	0.00	0.00	-4.38
Agno_Blk6O	0.00	0.00	-4.38
Agno_Blk6P	0.00	0.00	-4.34
Agno_Blk6Q	-0.4	14.31	-3.1
Clark_reflights_Agno6B_additional	-2.98	-1.75	-4.40
LaUnion_Blk10E	0.00	0.00	1.34
LaUnion_Blk10E_additional	0.00	0.00	0.00
LaUnion_Blk10F	0.00	0.00	0.00
LaUnion_Blk10H	0.00	0.00	0.00
NuevaEcija_Blk1017P	-1.1	-0.55	40.2
NuevaEcija_Blk1015P_1019P	-0.3	-0.9	-3.1
NuevaEcija_Blk7032GC	-2.9	-2.15	-2.6
NuevaEcija_Blk7036GC	-0.8	-0.45	-2.6
NuevaEcija_BlkNEJ1B	N/A		
NuevaEcija_BlkNEJ_additional	-3	-2.3	-2.73
Pam_Agno_reflights_AgnoBlk6I_reflights	0.00	0.00	-3.60
Pam_Agno_reflights_Pam3J_reflight	-1.00	-1.50	-3.50
Pam_Agno_reflights_Pam3H_reflight	0.00	-1.00	-3.65
Pam_NEJ_reflights_Blk1B	-0.50	-0.80	-2.25

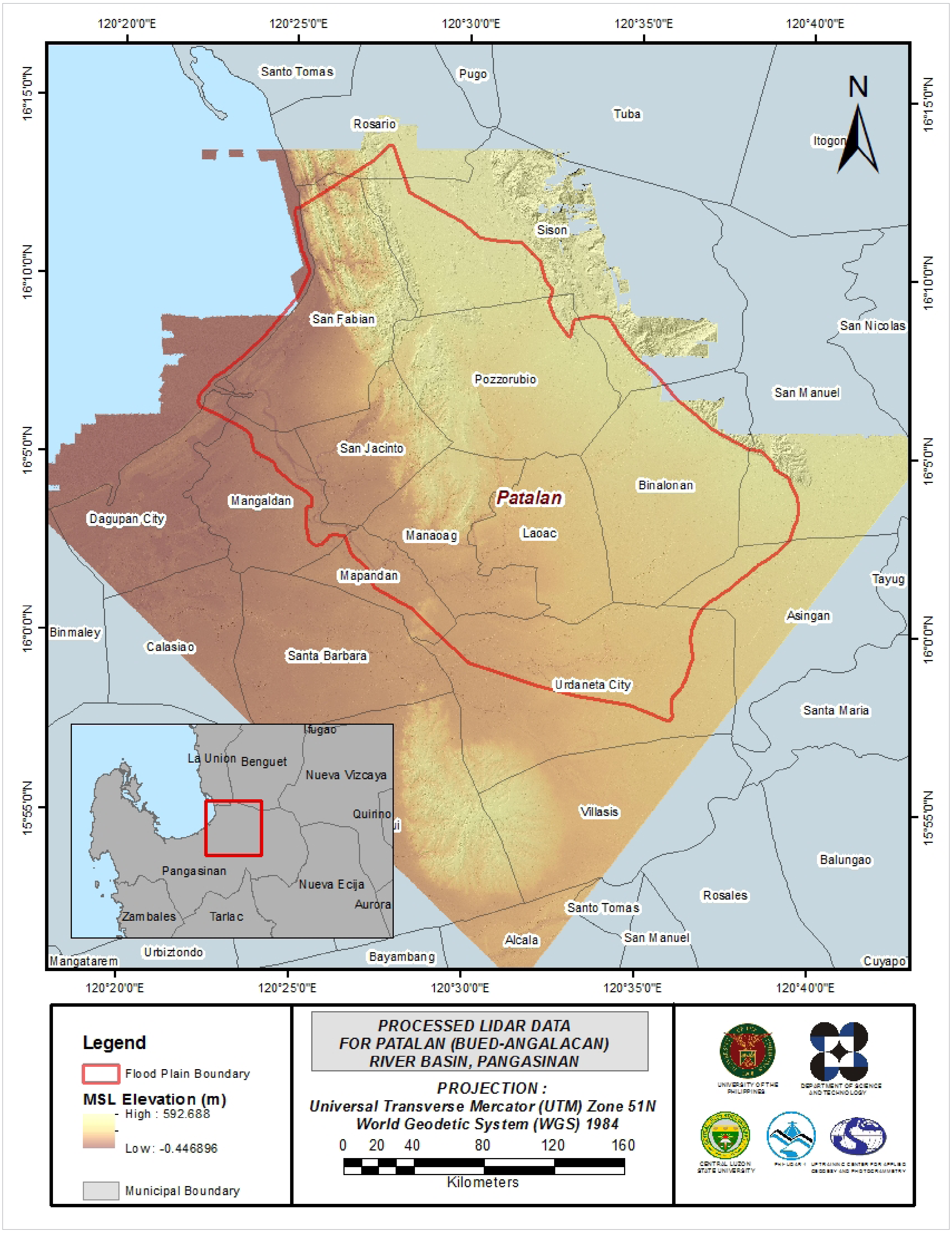


Figure 24. Figure 24. Map of Processed LiDAR Data for Patalan Floodplain.

3.10 Calibration and Validation of Mosaicked LiDAR Digital Elevation Model

The extent of the validation survey done by the Data Validation and Bathymetry Component (DVBC) in Patalan to collect points with which the LiDAR dataset was validated is shown in Figure 25. Patalan LiDAR data were 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 Patalan 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 26. 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 Patalan LiDAR data was done by subtracting the height difference value, 3.41 meters, to Patalan mosaicked LiDAR data. Table 23 shows the statistical values of the compared elevation values between LiDAR data and calibration data.

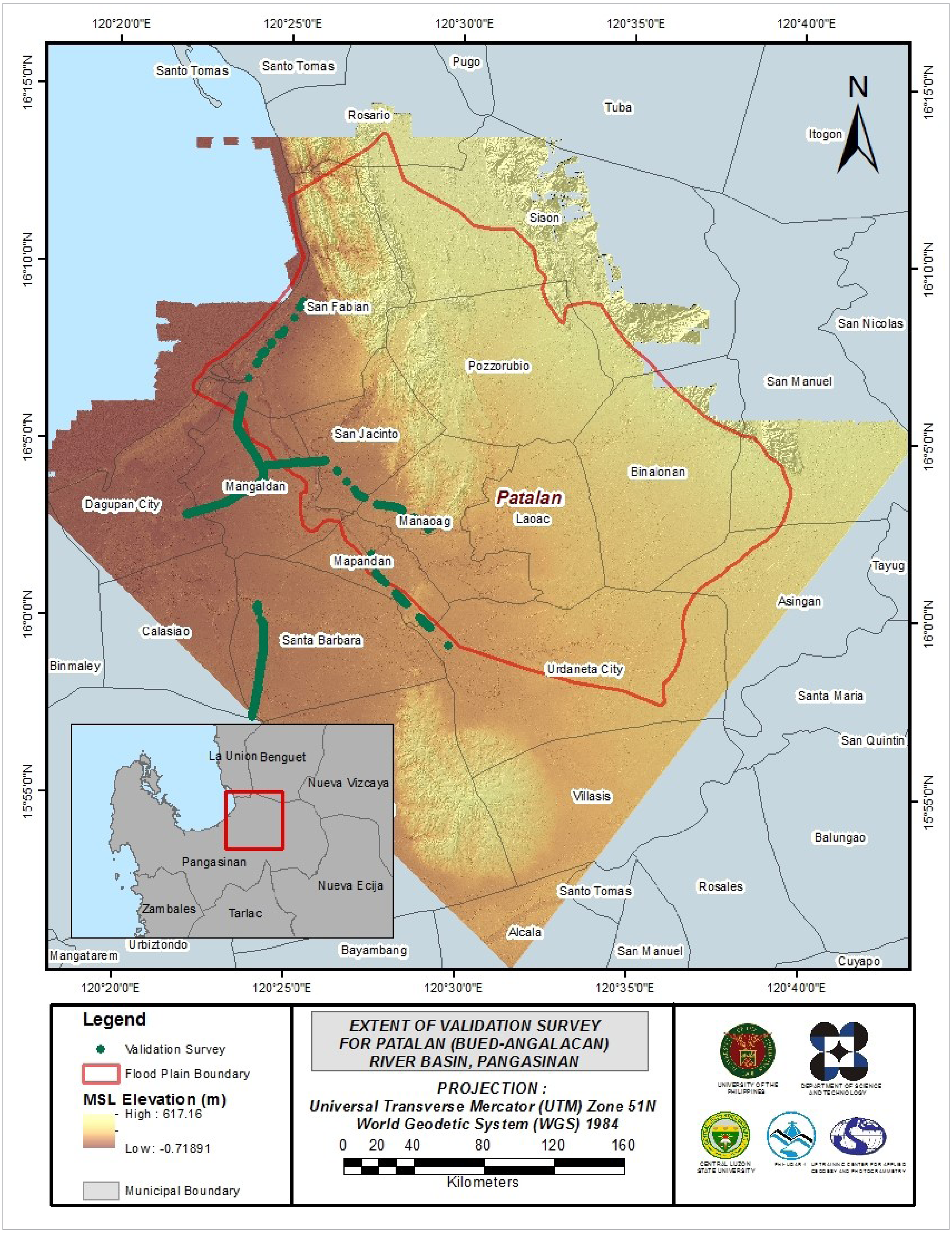


Figure 25. Map of Patalan Floodplain with validation survey points in green.

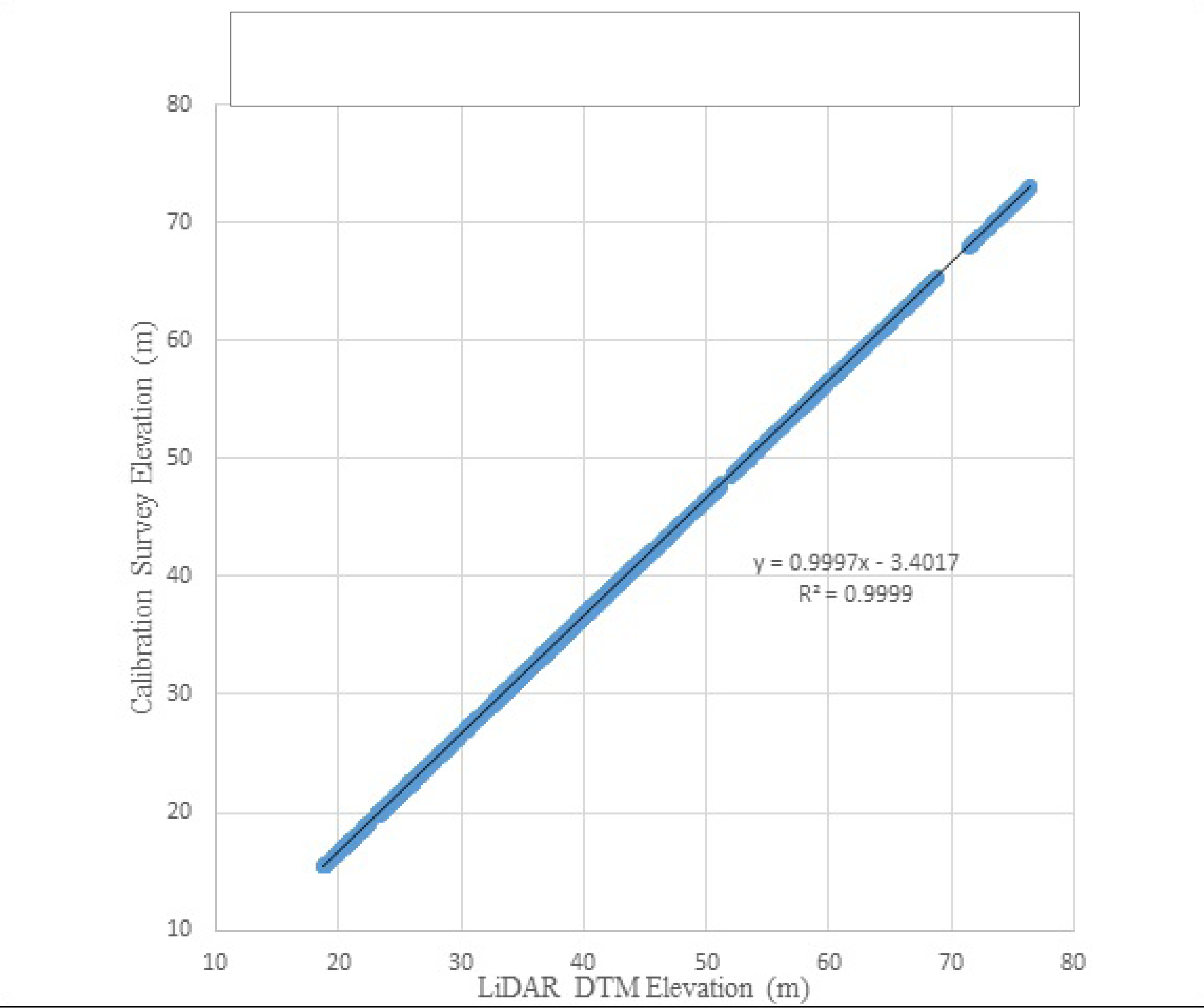


Figure 26. Correlation plot between calibration survey points and LiDAR data

Table 23. 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 Patalan that was forwarded after the calibration of Patalan LiDAR data was used. Randomly selected 20% of the total survey points, resulting to 96 points, were used for the validation of calibrated Patalan 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 27. The computed RMSE between the calibrated LiDAR DTM and validation elevation values is 0.17 meters with a standard deviation of 0.08 meters, as shown in Table 24.

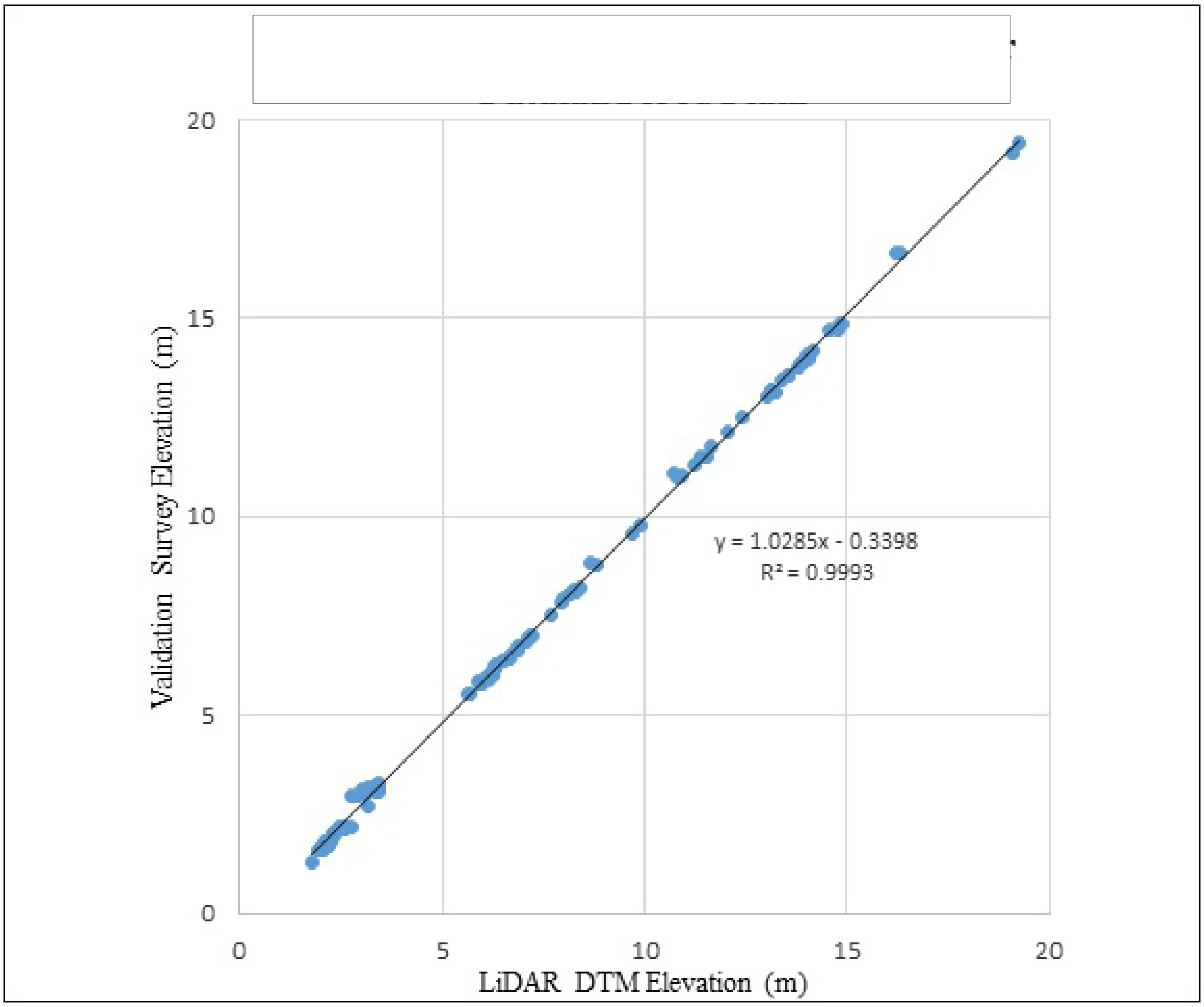


Figure 27. Correlation plot between validation survey points and LiDAR data

Table 24. Validation Statistical Measures..

Validation Statistical Measures	Value (meters)
RMSE	0.17
Standard Deviation	0.08
Average	-0.15
Minimum	-0.31
Maximum	0.02

3.11 Integration of Bathymetric Data into the LiDAR Digital Terrain Model

For bathy integration, centerline and zigzag data were available for Patalan with 14,430 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 0.53 meters. The extent of the bathymetric survey done by the Data Validation and Bathymetry Component (DVBC) in Patalan (Bued-Angalacan) integrated with the processed LiDAR DEM is shown in Figure 28.

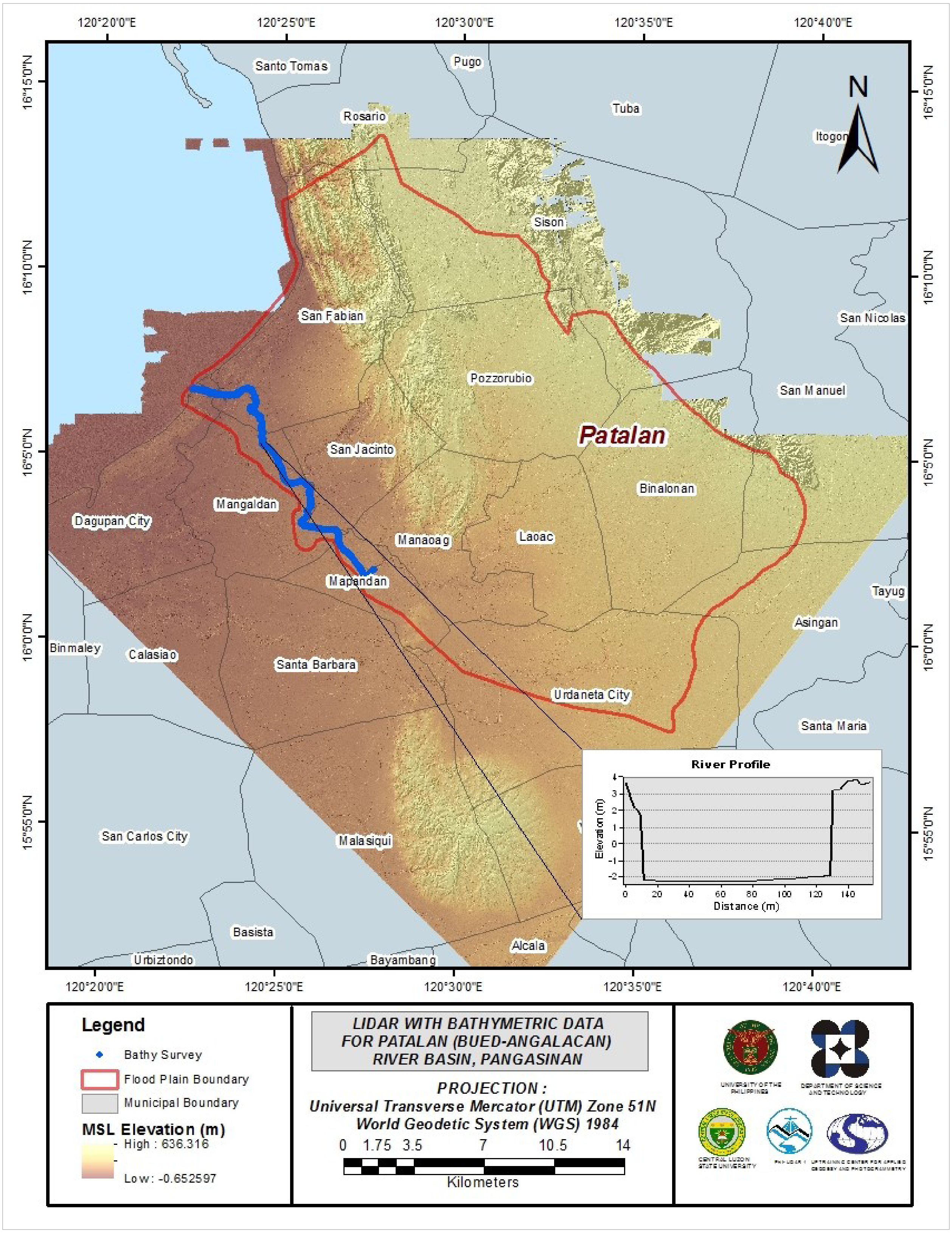


Figure 28. Map of Patalan Floodplain with bathymetric survey points shown in blue.

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

Patalan Floodplain, including its 200 m buffer, has a total area of 469.19 sq km. For this area, a total of 15.0 sq km, corresponding to a total of 10745 building features, are considered for QC. Figure 29 shows the QC blocks for Patalan Floodplain.

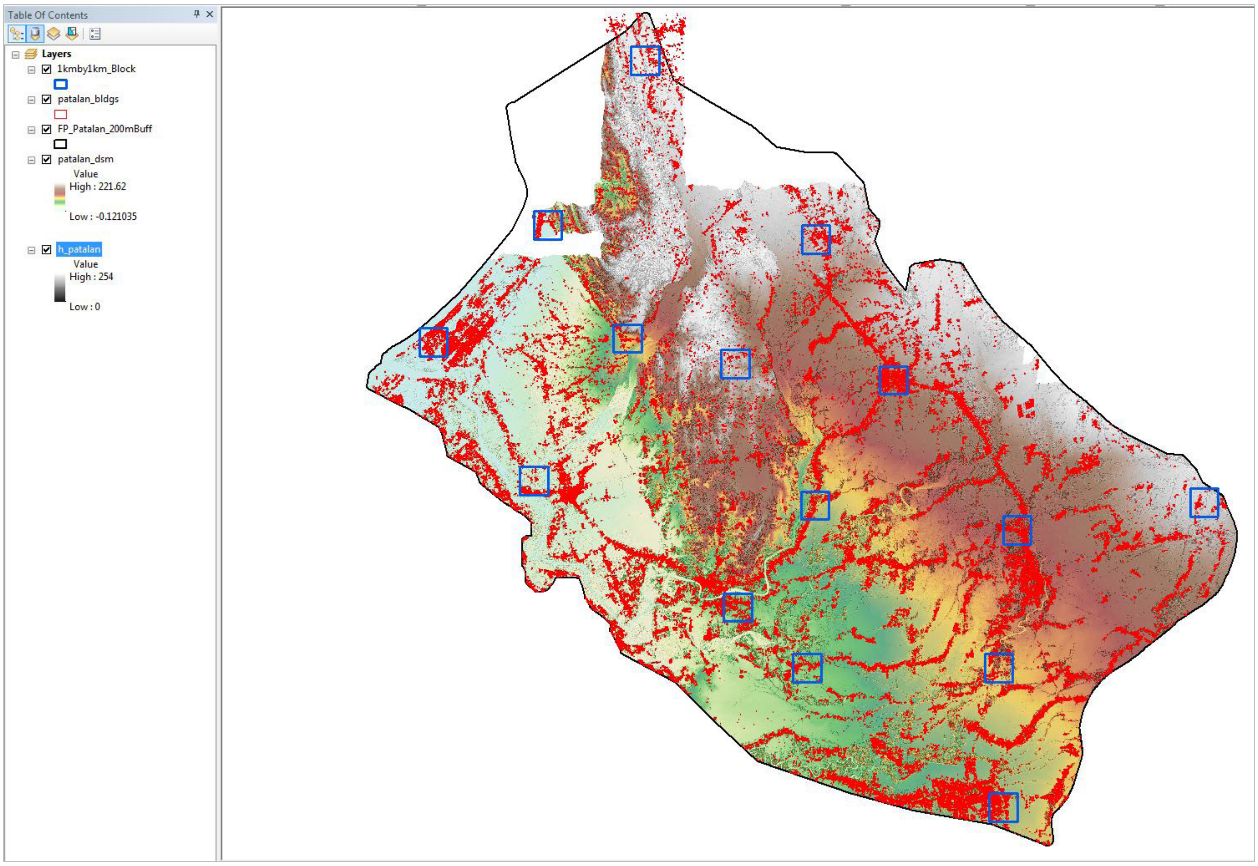


Figure 29. QC blocks for Patalan building features.

Quality checking of Patalan building features resulted in the ratings shown in Table 25.

Table 25. Quality Checking Ratings for Patalan Building Features.

Floodplain	Completeness	Correctness	Quality	Remarks
Patalan	97.97	98.16	92.11	PASSED

3.12.2 Height Extraction

Height extraction was done for 127,527 building features in Patalan Floodplain. Of these building features, none was filtered out after height extraction, resulting to 127,527 buildings with height attributes. There were identified 1,607 new buildings that were not in the DSM and 29 buildings were in the DSM but already demolished as validated. The lowest building height is at 2.00 m, while the highest building is at 10.42 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 26 summarizes the number of building features per type. On the other hand, Table 27 shows the total length of each road type, while Table 28 shows the number of water features extracted per type.

Table 26. Building Features Extracted for Patalan Floodplain.

Facility Type	No. of Features
Residential	122410
School	1175
Market	87
Agricultural/Agro-Industrial Facilities	175
Medical Institutions	41
Barangay Hall	105
Military Institution	1
Sports Center/Gymnasium/Covered Court	27
Telecommunication Facilities	1
Transport Terminal	28
Warehouse	61
Power Plant/Substation	35
NGO/CSO Offices	4
Police Station	9
Water Supply/Sewerage	6
Religious Institutions	229
Bank	27
Factory	
Gas Station	51
Fire Station	3
Other Government Offices	45
Other Commercial Establishments	503
Total	**125,023**

Table 27. Total Length of Extracted Roads for Patalan Floodplain.

Floodplain	Road Network Length (km)					Total
	Barangay Road	City/ Municipal Road	Provincial Road	National Road	Others	
Patalan	728.55	105.88	57.57	69.53	0.00	**961.54**

Table 28. Number of Extracted Water Bodies for Patalan Floodplain.

Floodplain	Water Body Type					Total
	Rivers/ Streams	Lakes/Ponds	Sea	Dam	Fish Pen	
Patalan	122	483	0	0	0	**605**

A total of 179 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 30 shows the Digital Surface Model (DSM) of Patalan Floodplain overlaid with its ground features.

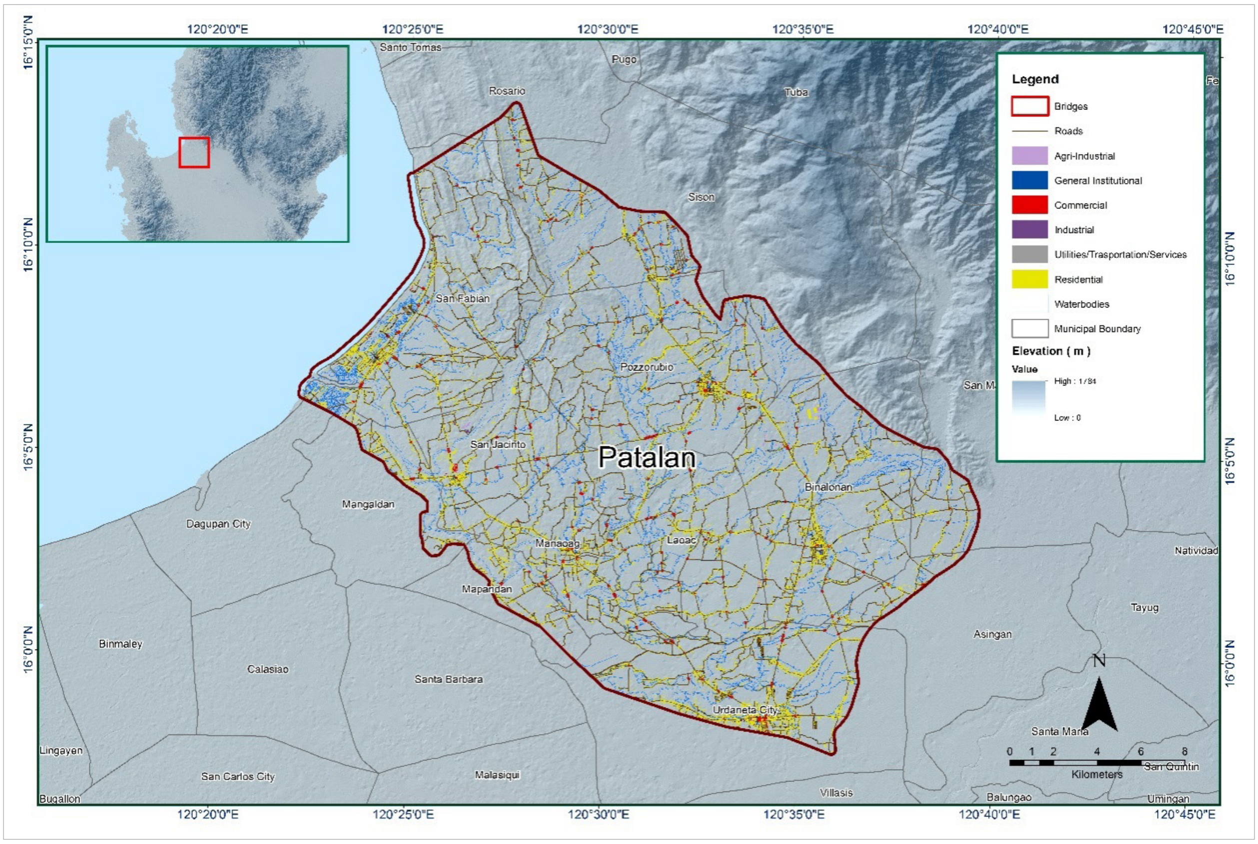


Figure 30. Extracted features for Patalan Floodplain.

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

Engr. Louie P. Balicanta, Engr. Joemarie S. Caballero, Ms. Patrizcia Mae. P. dela Cruz, Engr. Dexter T. Lozano, For. Dona Rina Patricia C. Tajora, Elaine Bennet Salvador, and For. Rodel C. Alberto

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 Patalan River on September 8 to 22, 2015 with the following scope of work: reconnaissance; control survey for the establishment of a control point; cross-section, bridge as-built of Baloling Bridge in Brgy. Poblacion, Municipality of Mapandan, Pangasinan; ground validation data acquisition of about 162.06 km for the whole province of Pangasinan; and bathymetric survey from Brgy. Poblacion, Mdunicipality of Mapandan down to Brgy. Bonuan Binloc, Dagupan City with an estimated length of 17.8 km using GNSS PPK survey technique.

Figure 31. Extent of the bathymetric survey (in blue) in Patalan River and the LiDAR data validation survery (in red)

4.2 Control Survey

The GNSS network used for Patalan 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 Brgy. Calomboyan, San Carlos City, PS-36B, first-order BM, located in Brgy. Catablan, Urdaneta City, and PS-522, first-order BM, located in Brgy. Poblacion, Municipality of Sual, Pangasinan.

Three (3) 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 while the GNSS network established is illustrated in .

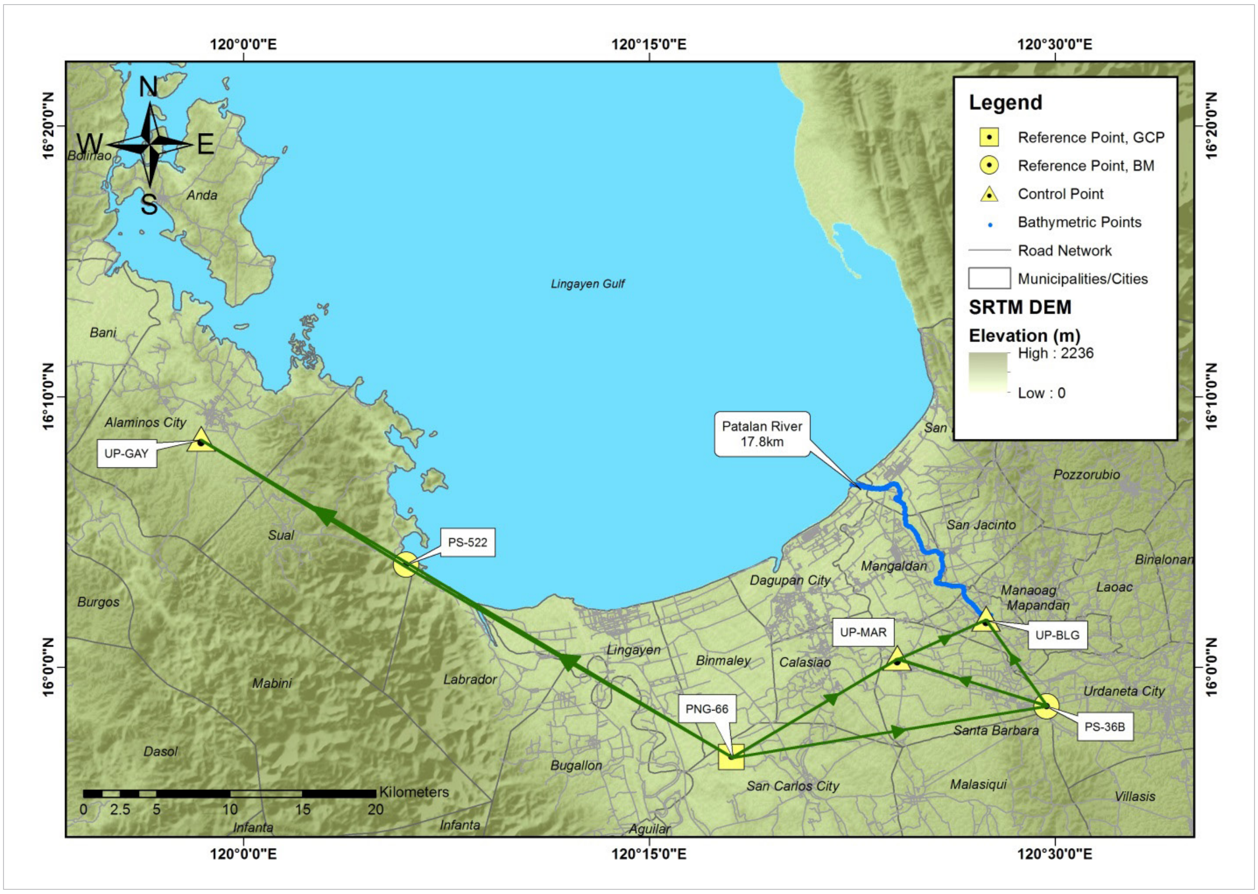


Figure 32. GNSS Network of Patalan River Field Survey

Table 29. List of references and control points used in Pangasinan fieldwork from September 8 - 22, 2015 (Source: NAMRIA, UP-TCAGP)

Control Point	Order of Accuracy	Geographic Coordinates (WGS UTM Zone 52N)				
		Latitude	Longitude	Ellipsoid Height (m)	Elevation (MSL) (m)	Date of Establish-ment
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 shown in to .

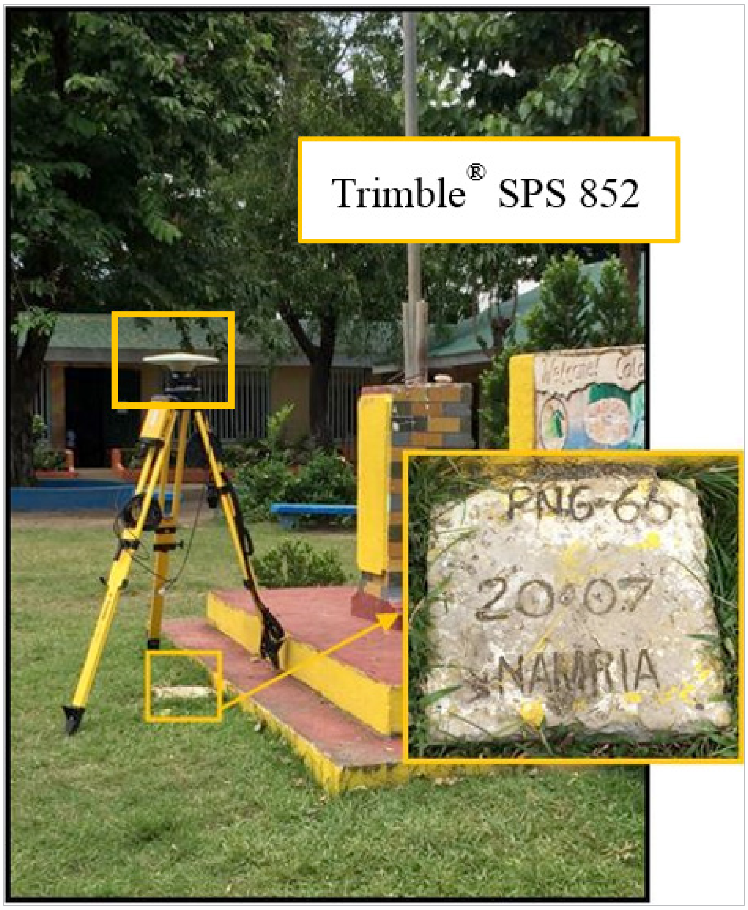


Figure 33. Figure 33. GNSS base receiver setup, Trimble® SPS 852 at PNG-66 in Calamboyan Elementary School in Brgy. Calomboyan, San Carlos City, Pangasinan

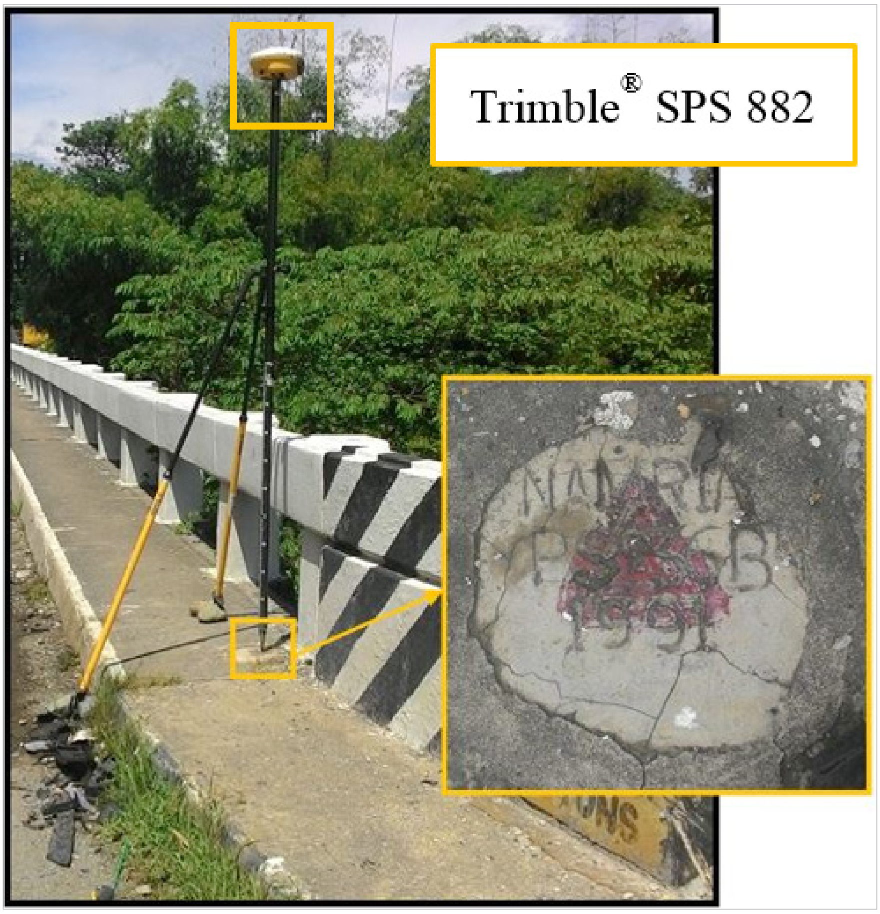


Figure 34. GNSS receiver setup, Trimble® SPS 882 at PS-36B at Villamil Bridge inBrgy. Catablan, Urdaneta City, Pangasinan

Figure 35. Figure 35. GNSS receiver occupation, Trimble® SPS 882 at PS-522 at Quartel Bridge in Brgy. Poblacion, Municipality of Sual, Pangasinan

Figure 36. GNSS base receiver setup, Trimble® SPS 852 at UP-BLG at Baloling Bridge in Brgy. Poblacion Municipality of Mapandan, Pangasinan

Figure 37. GNSS base receiver setup, Trimble® SPS 852 at UP-GAY at Gayaga Bridge in Brgy. Amandiego, Alaminos City, Pangasinan

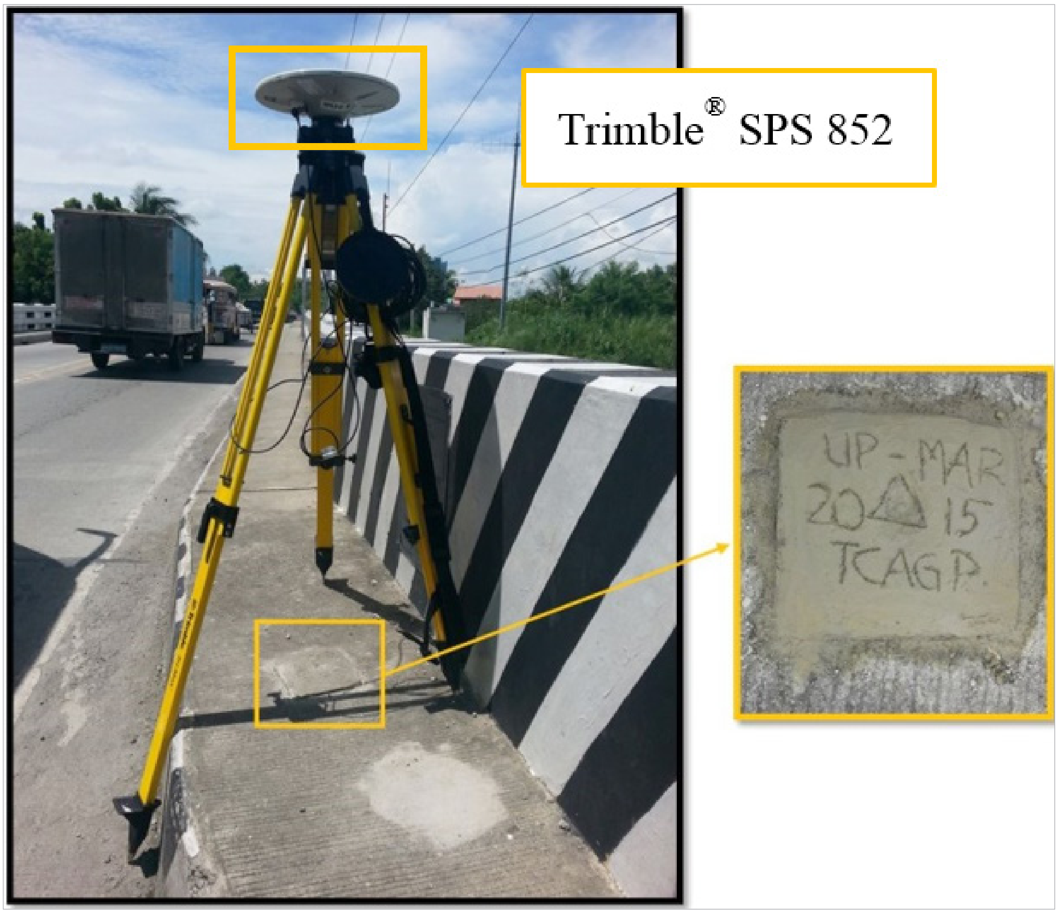


Figure 38. GNSS base receiver setup, Trimble® SPS 852 at UP-MAR at Maramba Bridge in Brgy. Dalongue, Municipality of Santa Barbara, Pangasinan

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 was 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 Patalan River Basin is summarized in generated by TBC software.

Table 30. Baseline Processing Report for Patalan 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 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 was 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:

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

Where:

x_e is the Easting Error,
y_e is the Northing Error, and
z_e 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 .Through these reference points, the coordinates and elevation of the unknown control points were computed.

Table 31. Control Point Constraints

Point ID	Type	North (Meter)	East (Meter)	Height (Meter)	Elevation (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 . All fixed control points have no values for grid and elevation values.

Table 32. 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, $\sqrt{((x_e)^2 + (y_e)^2)} < 20$ cm for horizontal and $z_e < 10$ cm for the vertical; the computation for the accuracy are as follows:

a. PNG-66

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

b. PS-36B

horizontal accuracy = √((0.8)² + (0.7)²)
= √(0.64 + 0.49)
= 1.06 cm < 20 cm
vertical accuracy = Fixed

c. PS-522

horizontal accuracy = √((1.2)² + (0.9)²)
= √(1.44 + 0.81)
= 1.50cm < 20 cm
vertical accuracy = Fixed

d. UP-BLG

horizontal accuracy = √((1.1)² + (1.0)²)
= √((1.21 + 1)
= 1.49 cm < 20 cm
vertical accuracy = 8.3 cm < 10 cm

e. UP-GAY

horizontal accuracy = √((1.1)² + (0.9)²)
= √(1.21 + 0.81)
= 1.42 cm < 20 cm
vertical accuracy = 8.2 cm < 10 cm

f. UP-MAR

horizontal accuracy = √((1.1)² + (0.9)²)
= √(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 33. 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 . 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 34. 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	Ellipsoid 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 survey were conducted on September 22, 2015at the upstream side of Baloling Bridge, Brgy. Poblacion, Municipality of Mapandan, Pangasinan. A Trimble® SPS 882 GNSS in PPK survey technique was used as shown in .

The cross-sectional line for Baloling Bridge is about 174.5 m with one hundred thirty (130) points.

Figure 39. Figure 39. Bridge As-Built Survey using PPK Technique

The cross-sectional line of Baloling Bridge is about 174.50 m with 130 cross-sectional points using the control point UP-BLG as the GNSS base station. The cross-section diagram, planimetric map, and bridge data form are shown in to , respectively.

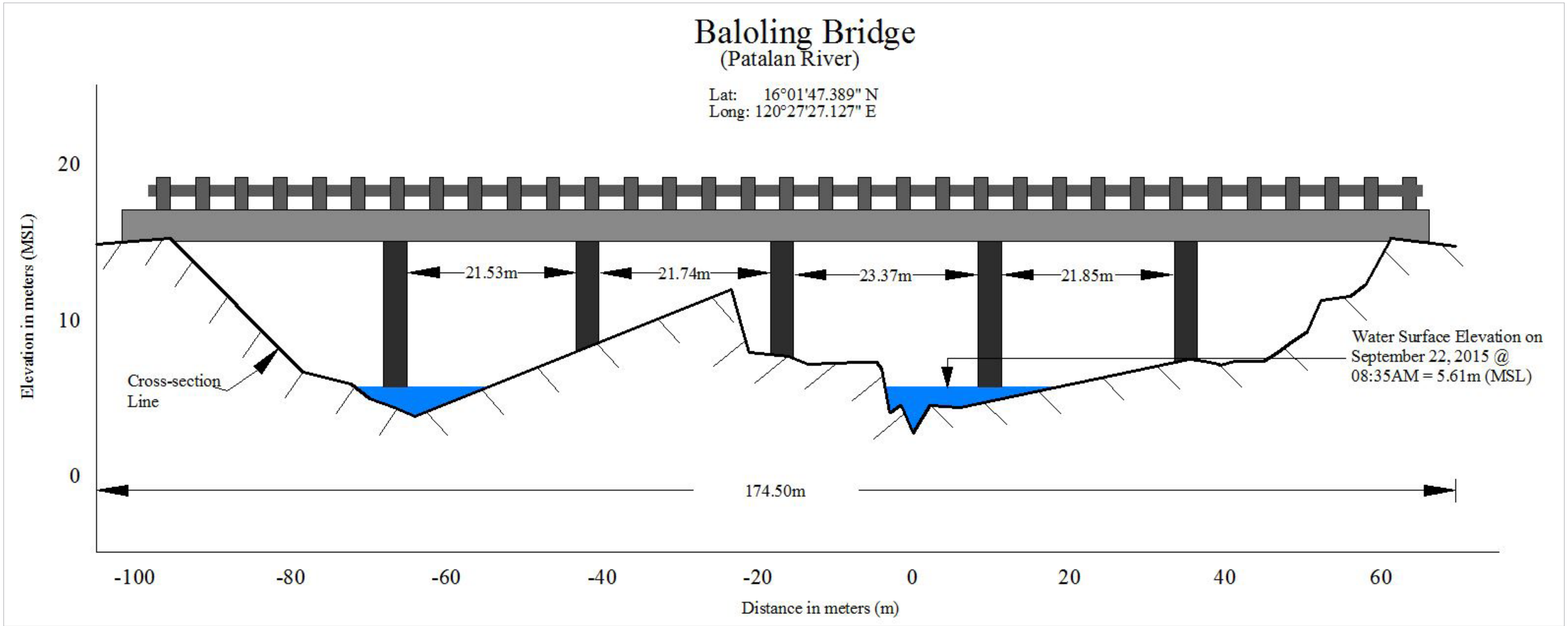


Figure 40. Baloling Bridge cross-section diagram

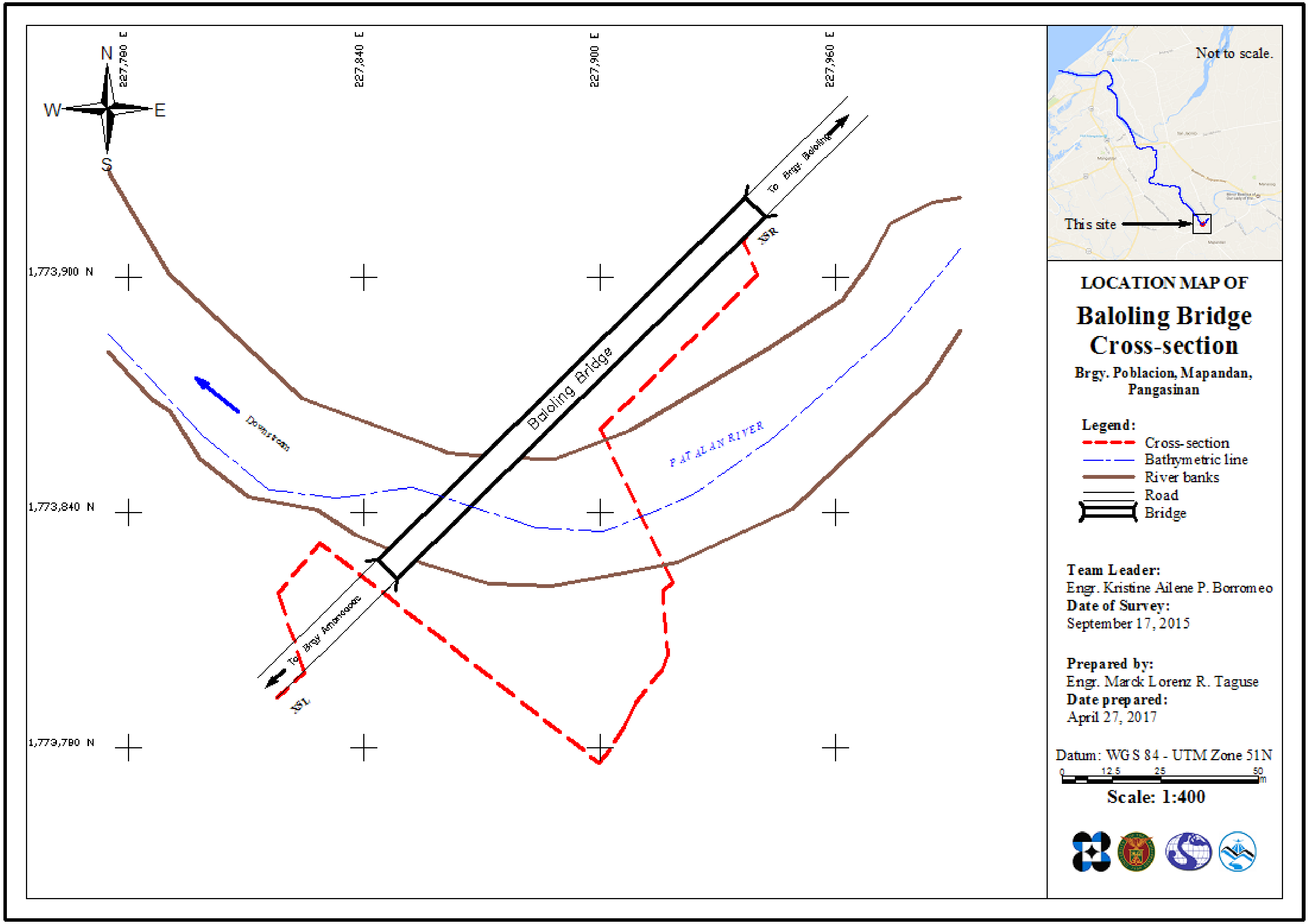


Figure 41. Baloling Bridge cross-section diagram

Bridge Data Form

Bridge Name: **Baloling Bridge** — **Date:** **September 17, 2015**

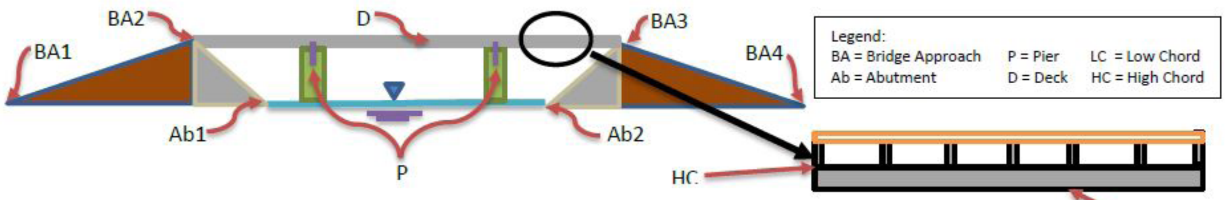
River Name: **Patalan River** — **Time:** **3:11 PM**

Location (Brgy, City,Region): **Brgy. Poblacion, Municipality of Mapandan**

Survey Team: **Abrio, Alberto, Borromeo, Salvador**

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

Latitude: **16d01'47.38930"** — **Longitude:** **120d27'27.12744"**



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	14.807m	BA3	166.20m	15.125m
BA2	9.50m	15.174m	BA4	174.50m	14.673m

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	38.23m	14.332m	
Pier 2	62.82m	14.379m	
Pier 3	87.90m	14.367	
Pier 4	N/A	N/A	
Pier 5	N/A	N/A	

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

DREAM
Disaster Risk and Exposure Assessment for Mitigation

Figure 42. Bridgeas-built form of Baloling Bridge

Figure 43. Water level marking on the post of Baloling Bridge

Water surface elevation of Patalan River was determined using a survey grade GNSS receiver Trimble® SPS 882 in PPK survey techniqe on September 22, 2015 at 08:35 AM with a value of 5.61 m in MSL as shown in . This was translated into marking on the Baloling Bridge's abutment using the same technique as shown in . This served as reference for flow data gathering and depth gauge deployment of partner HEI responsible for Patalan river, the Central Luzon State University.

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

Figure 45. Validation points acquisition survey along Pangasinan Province

4.7 Bathymetric Survey

Bathymetric survey was executed on September 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 . The survey started in the downstream part of the river in Brgy. Bonuan Binloc, Dagupan City with coordinates 16°06’44.21273”N, 120°22’28.75000”E, and ended at the upstream of the river with coordinates 16°01’55.74422”N, 120°27’38.24445”E in Brgy. Poblacion, Municipality of Mapandan, Pangasinan. The control UP-BLG was used as GNSS base station all throughout the entire survey.

Figure 46. (A) Preparation for the bathymetric survey in Patalan River with assistance from the PDDRMO Pangasinan, and (B) set-up of the GNSS Trimble® SPS 882 attached to the rescue boat

The bathymetric survey for Patalan River gathered a total of 15,777 points covering 17.450 km of the river traversing Brgy. Poblacion, Municipality of Mapandan, Pangasinan downstream to Brgy. Bonuan Binloc, Dagupan City, Pangasinan as shown in . A CAD drawing was also produced to illustrate the riverbed profile of Patalan River. As shown in 48 and Figure 49, the highest and lowest elevation has a –7.708-m below MSL difference for Patalan River. The highest elevation observed was 3.198 m above MSL located at the upstream part of Patalan river; while the lowest was –10.905 m below MSL located in the downstream portion of the river.

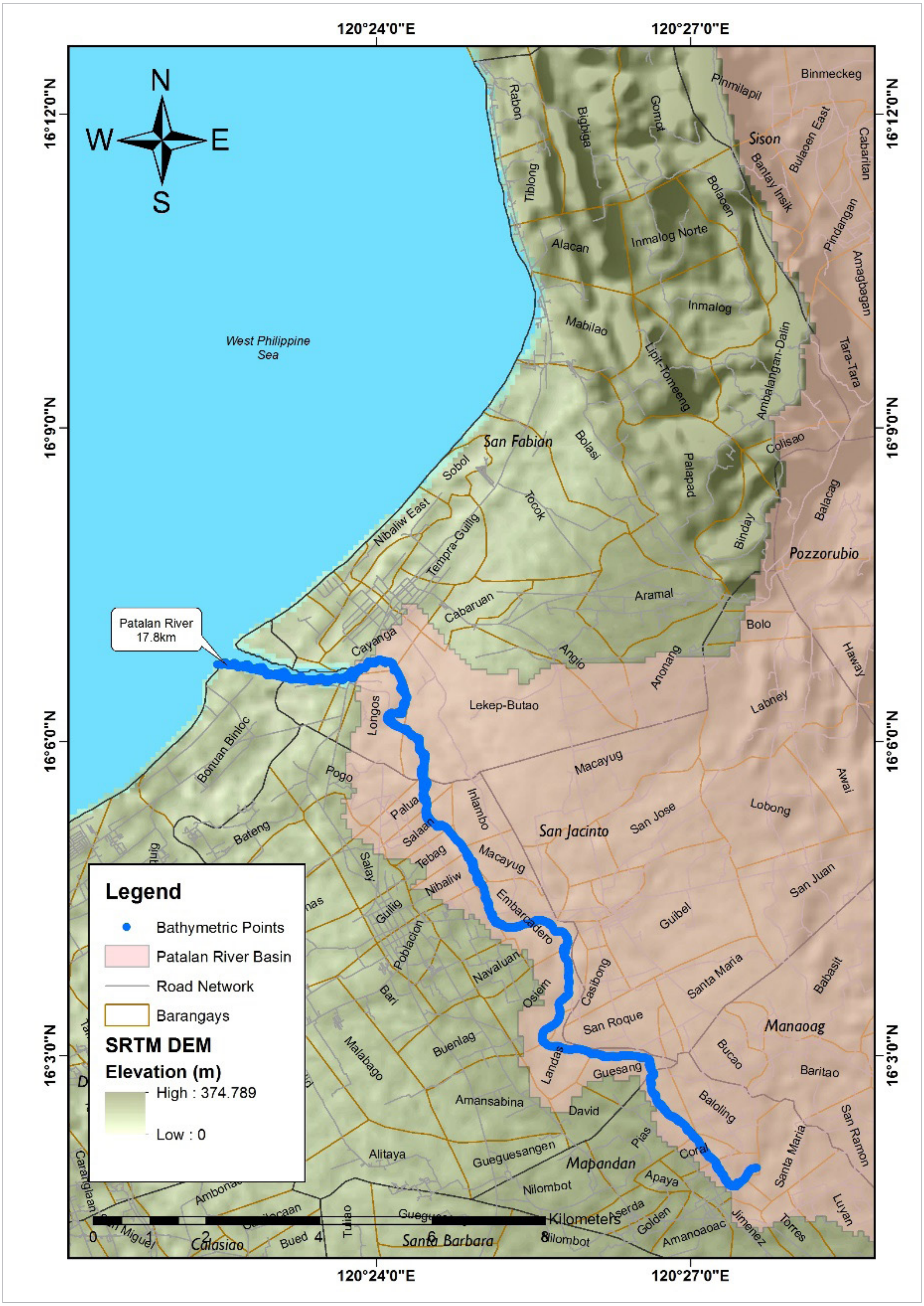


Figure 47. Bathymetric points gathered from Patalan River

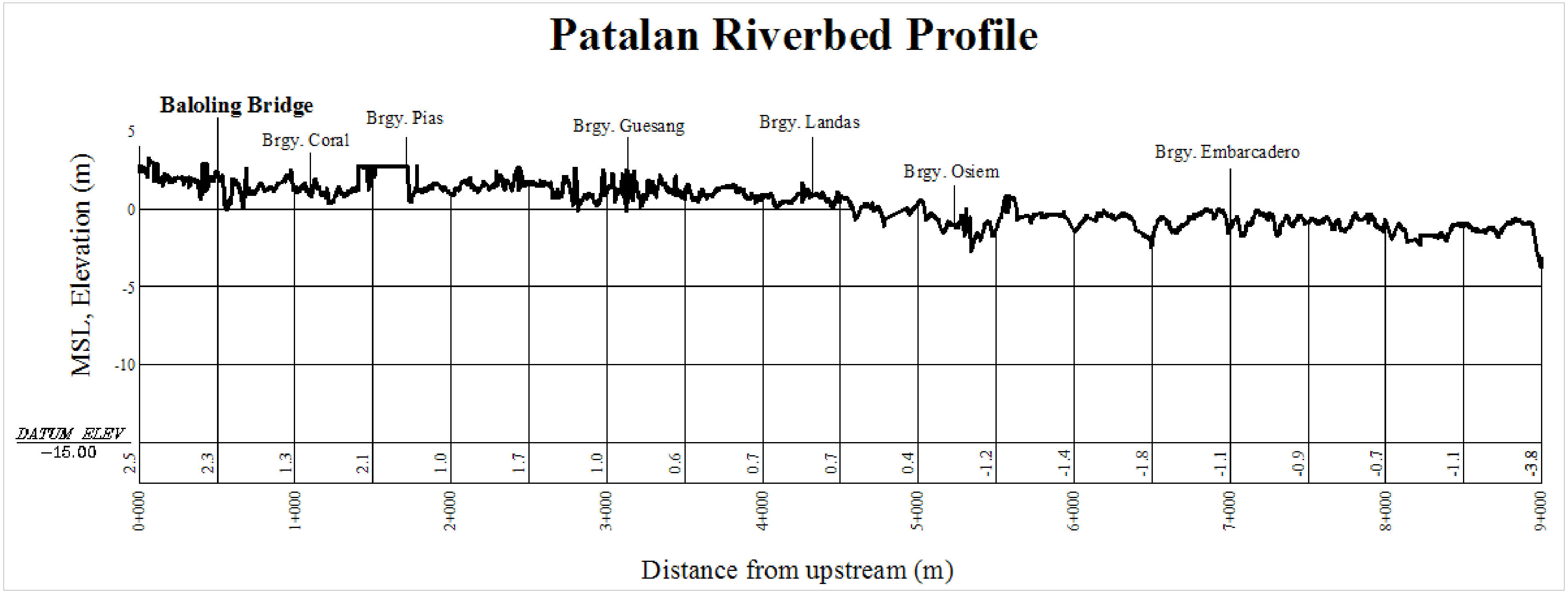


Figure 48. Patalan Riverbed Profile from Brgy. Poblacion, Municipality of Mapandan down to Brgy. Embarcadero, Municipality of Mangaldan

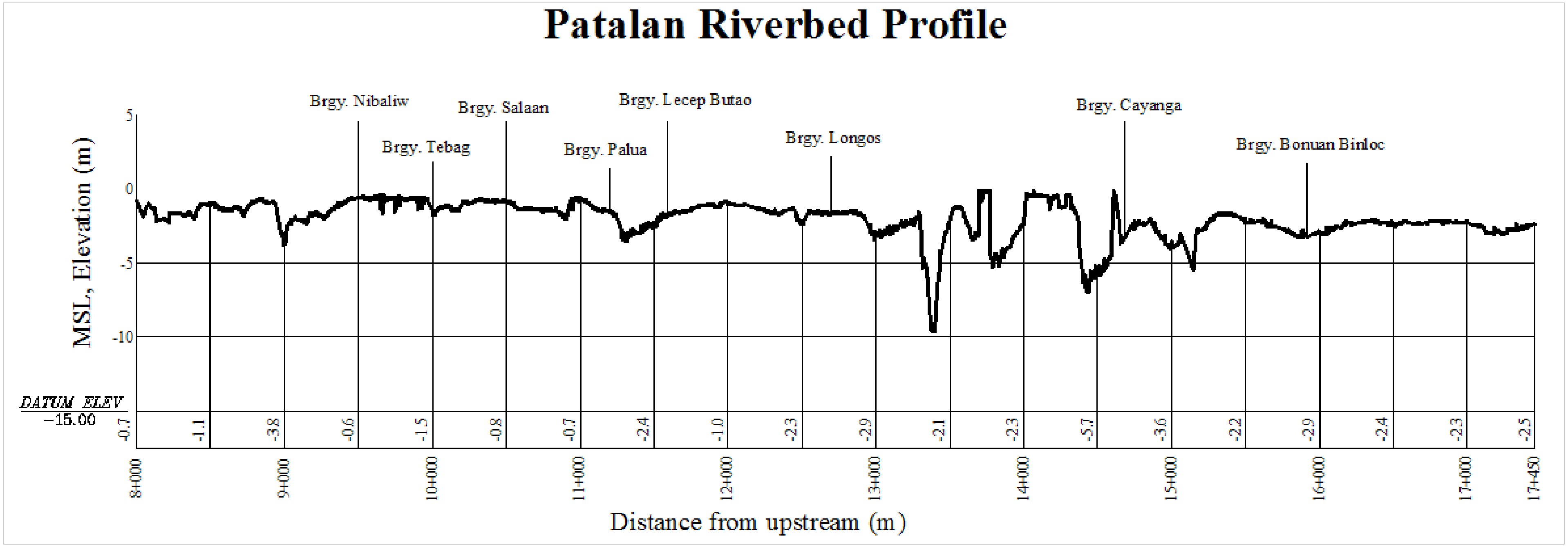


Figure 49. Continuation of Patalan Riverbed Profile from Brgy. Nibaliw, Municipality of Mangaldan down to Brgy. Bonuan Binloc, Dagupan City

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 Patalan River Basin was 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 the Department of Science and Technology – Advanced Science and Technology Institute (DOST-ASTI). These were the Laoac and Aloragat ARGs (located at Binalonan). The location of the rain gauges is seen in Figure 50.

The total precipitation for this event in Laoac ARG was 40.2 mm. It has a peak rainfall of 4.6 mm on 02 October 2015 at 6:45 AM. The lag time between the peak rainfall and discharge is 9 hours and 35 minutes. For Aloragat, total precipitation for this event was 32.6 mm. It has a peak rainfall of 5.8 mm on 02 October 2015 at 5:50 AM. The lag time between the peak rainfall and discharge is 10 hours and 30 minutes as seen in Figure 52.

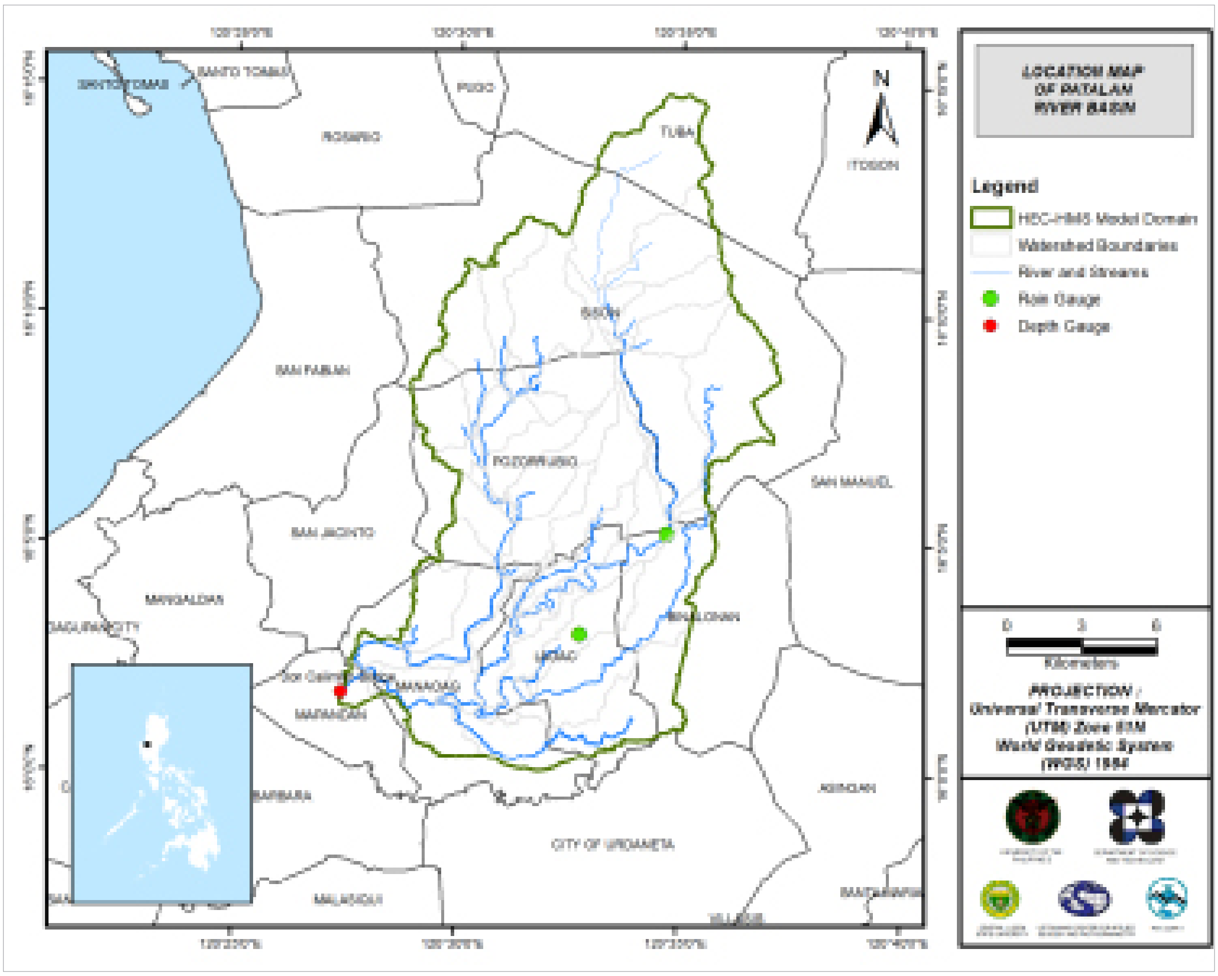


Figure 50. The location map of Patalan HEC-HMS model used for calibration.

5.1.3 Rating Curves and River Outflow

A rating curve was developed at Don Calimlim Bridge, Mapandan, Pangasinan (16°1' 45.5118"N, 120°27' 24.8499"E). It gives the relationship between the observed water levels from Don Calimlim Bridge and outflow of the watershed at this location.

For Don Calimlim Bridge, the rating curve is expressed as Q = 0.2016e0.9203h as shown in Figure 52.

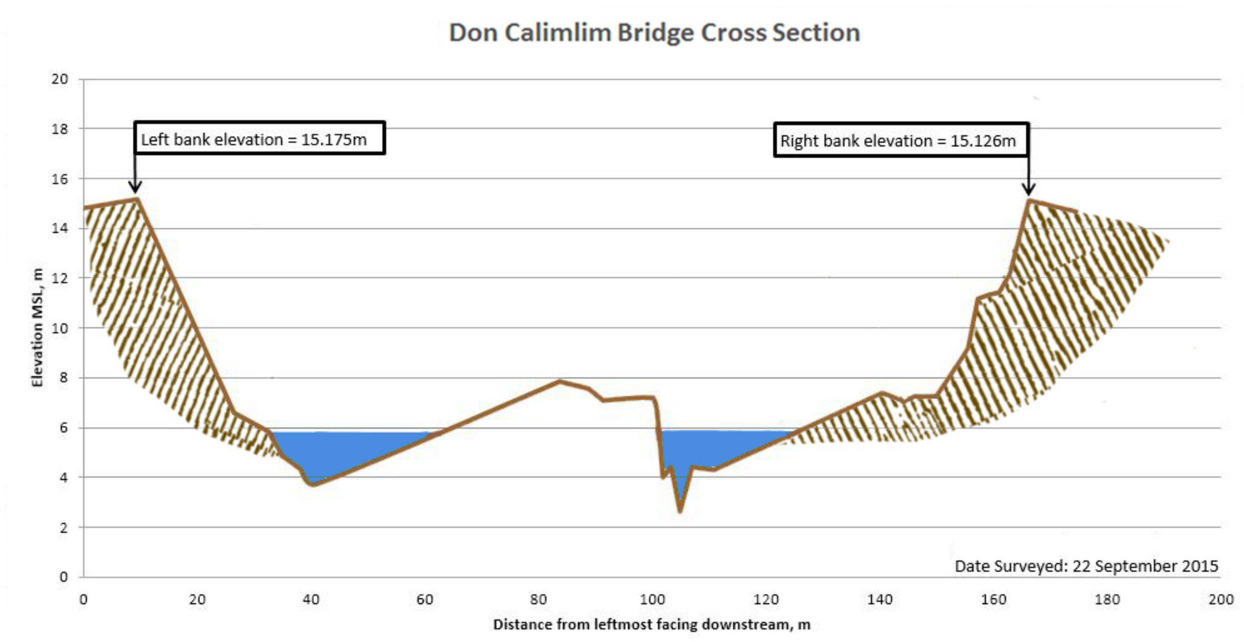


Figure 51. Cross Section Plot of Don Calimlim Bridge

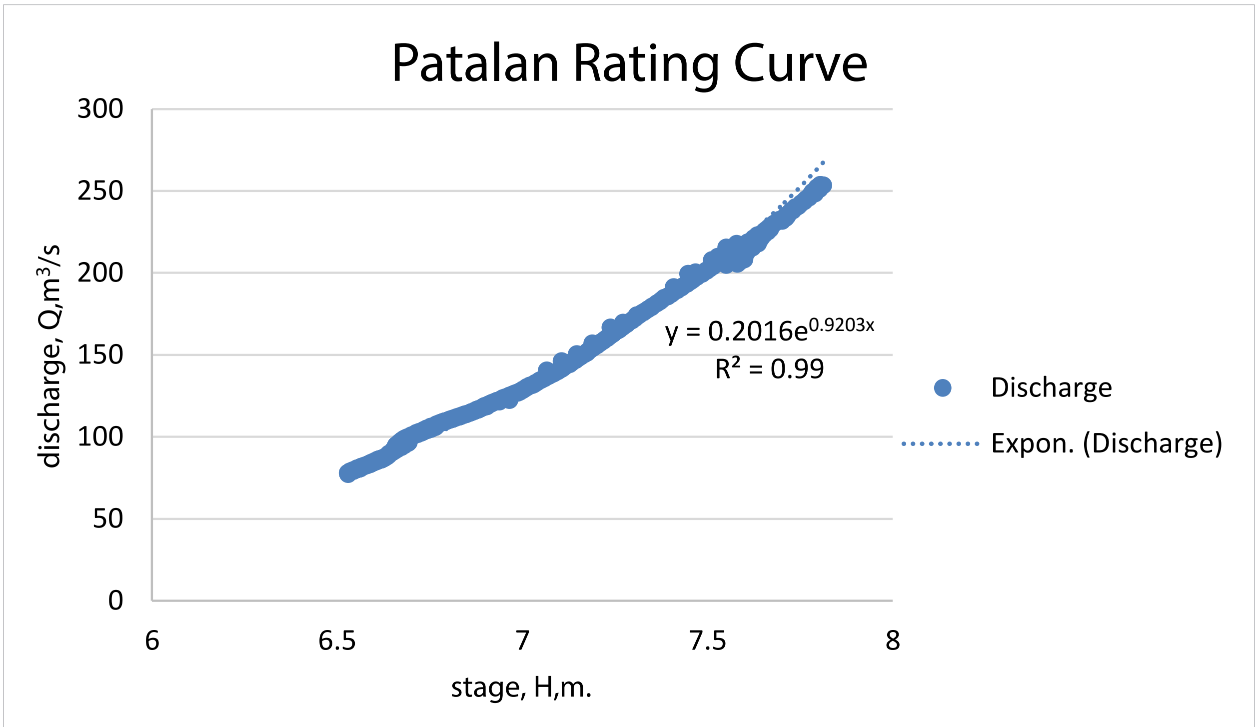


Figure 52. Rating Curve at Don Calimlim Bridge, Mapandan, Pangasinan

This rating curve equation was used to compute the river outflow at Don Calimlim Bridge for the calibration of the HEC-HMS model shown in Figure 52. Peak discharge is 253.6 cms at 16:20 PM, October 2, 2015.

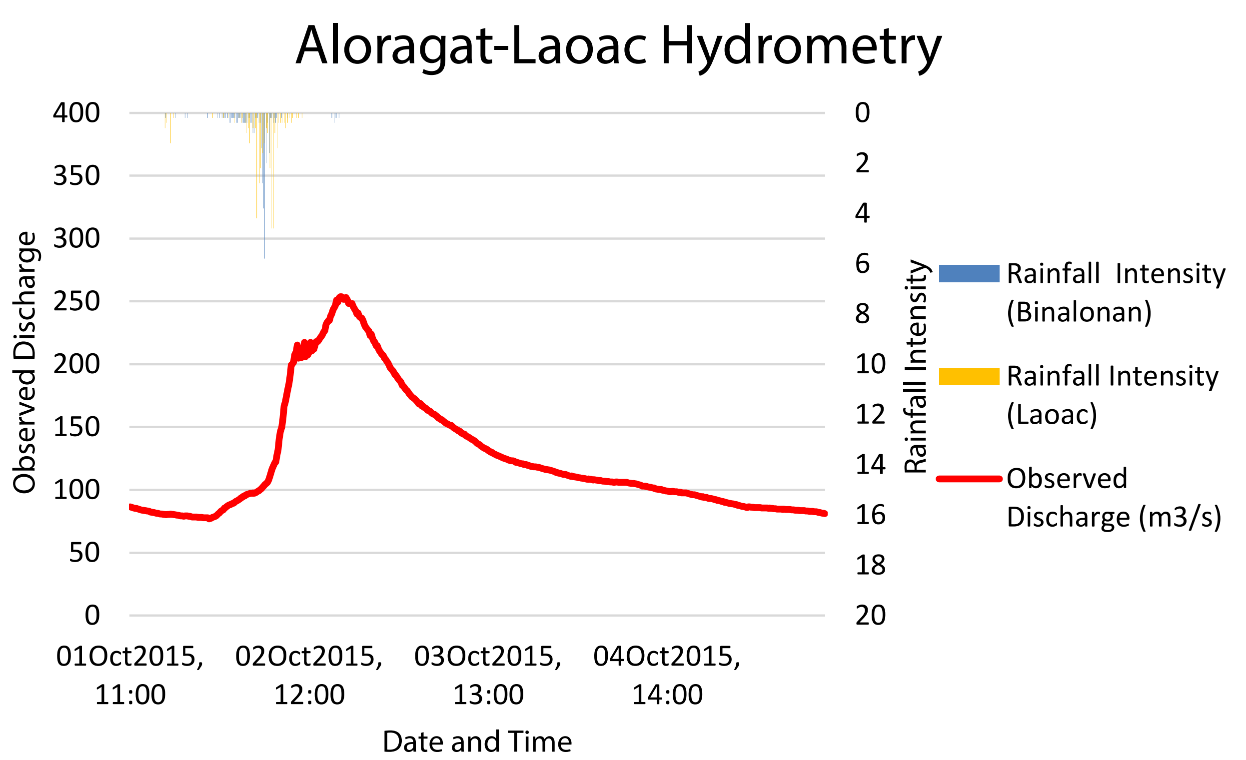


Figure 53. Rainfall and outflow data at Patalan used for modeling

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 would be attained at a certain time. This station was chosen based on its proximity to the Patalan watershed. The extreme values for this watershed were computed based on a 26-year record

Table 35. 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

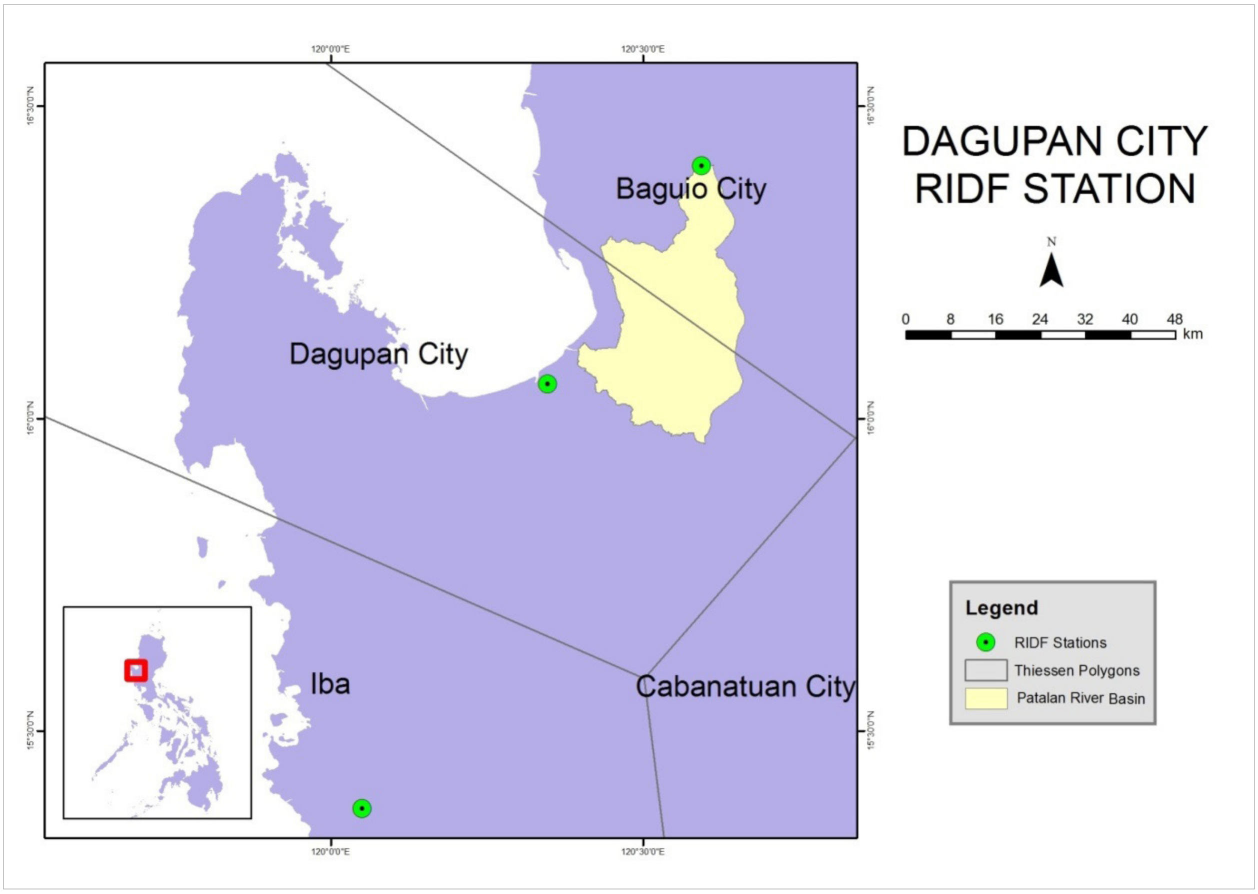


Figure 54. Dagupan RIDF location relative to Patalan River Basin

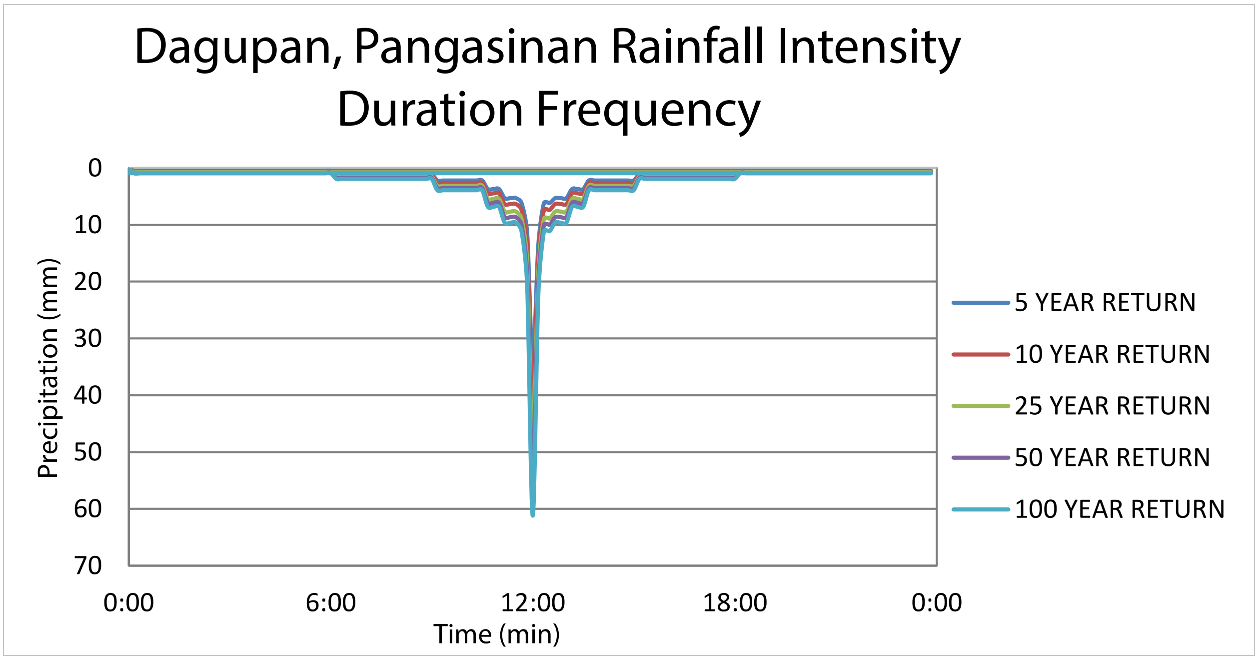


Figure 55. Synthetic storm generated for a 24-hr period rainfall for various return periods

5.3 HMS Model

The soil dataset was taken from and generated by the Bureau of Soils and Water Management (BSWM) under the Department of Agriculture. The land cover shape file is from the National Mapping and Resource information Authority (NAMRIA). The soil and land cover of the Patalan River Basin are shown in Figure 56 and Figure 57, respectively.

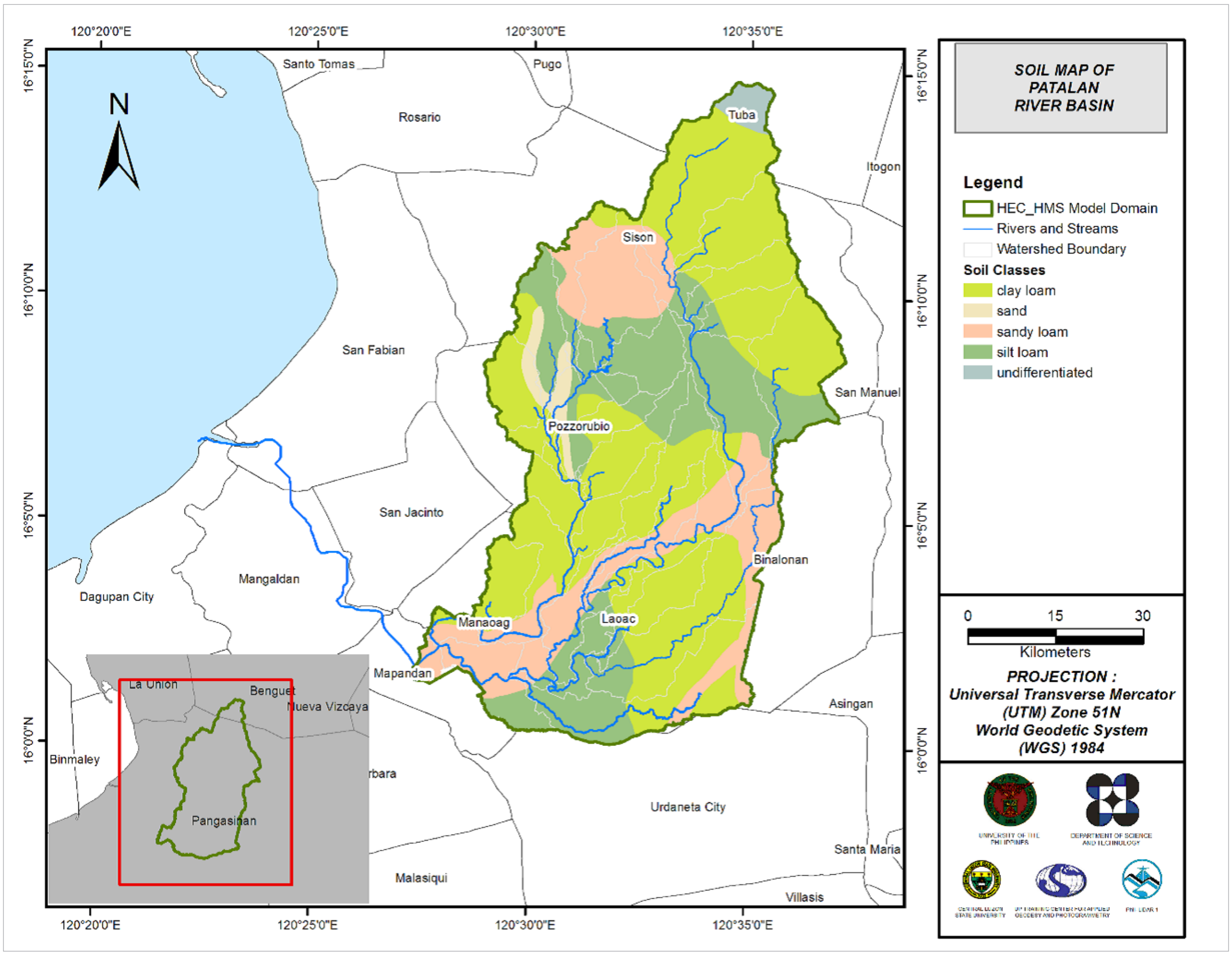


Figure 56. Soil Map of Patalan River Basin

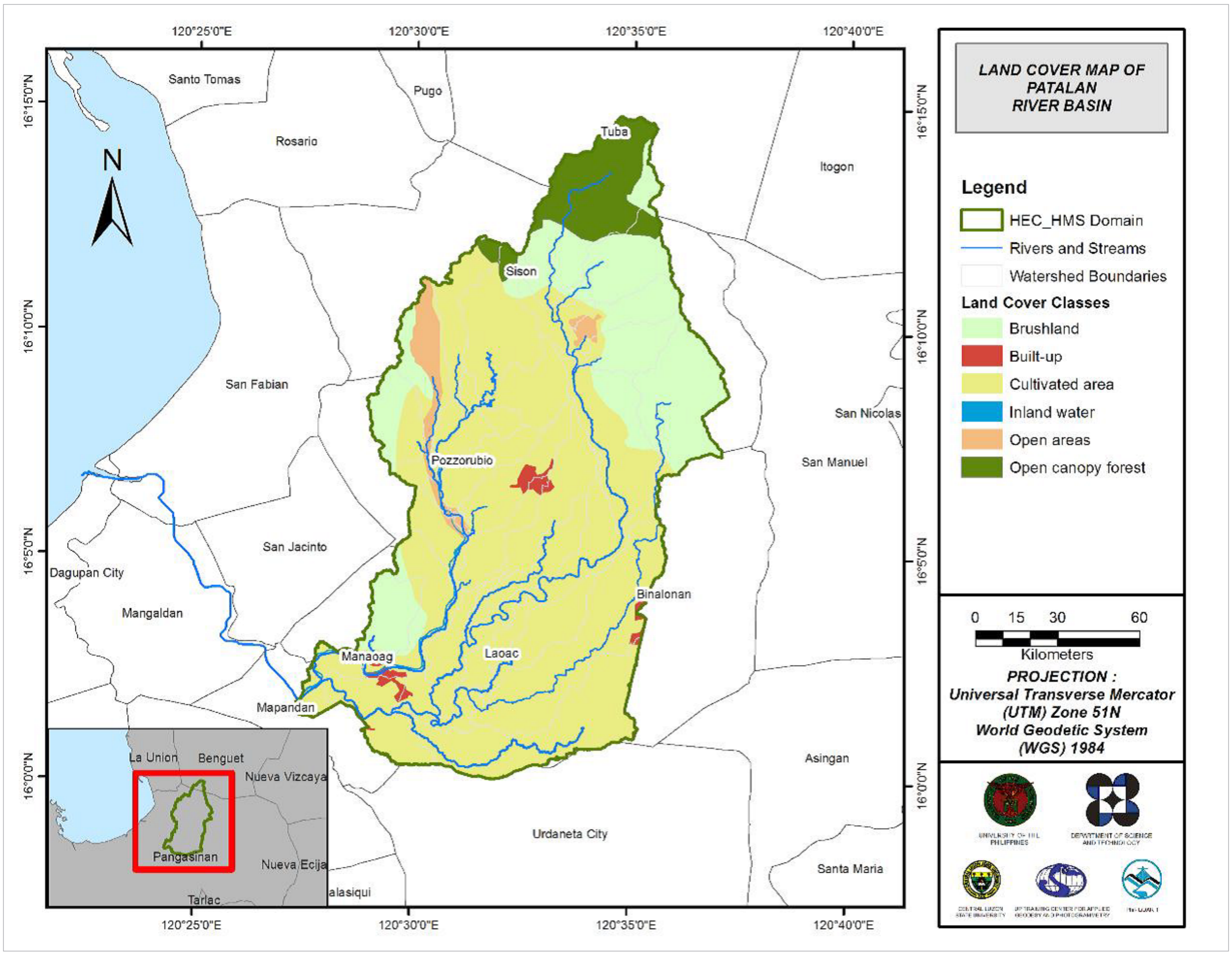


Figure 57. Land Cover of Patalan River Basin

For Patalan, 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, inland water, open areas and open canopy forest.

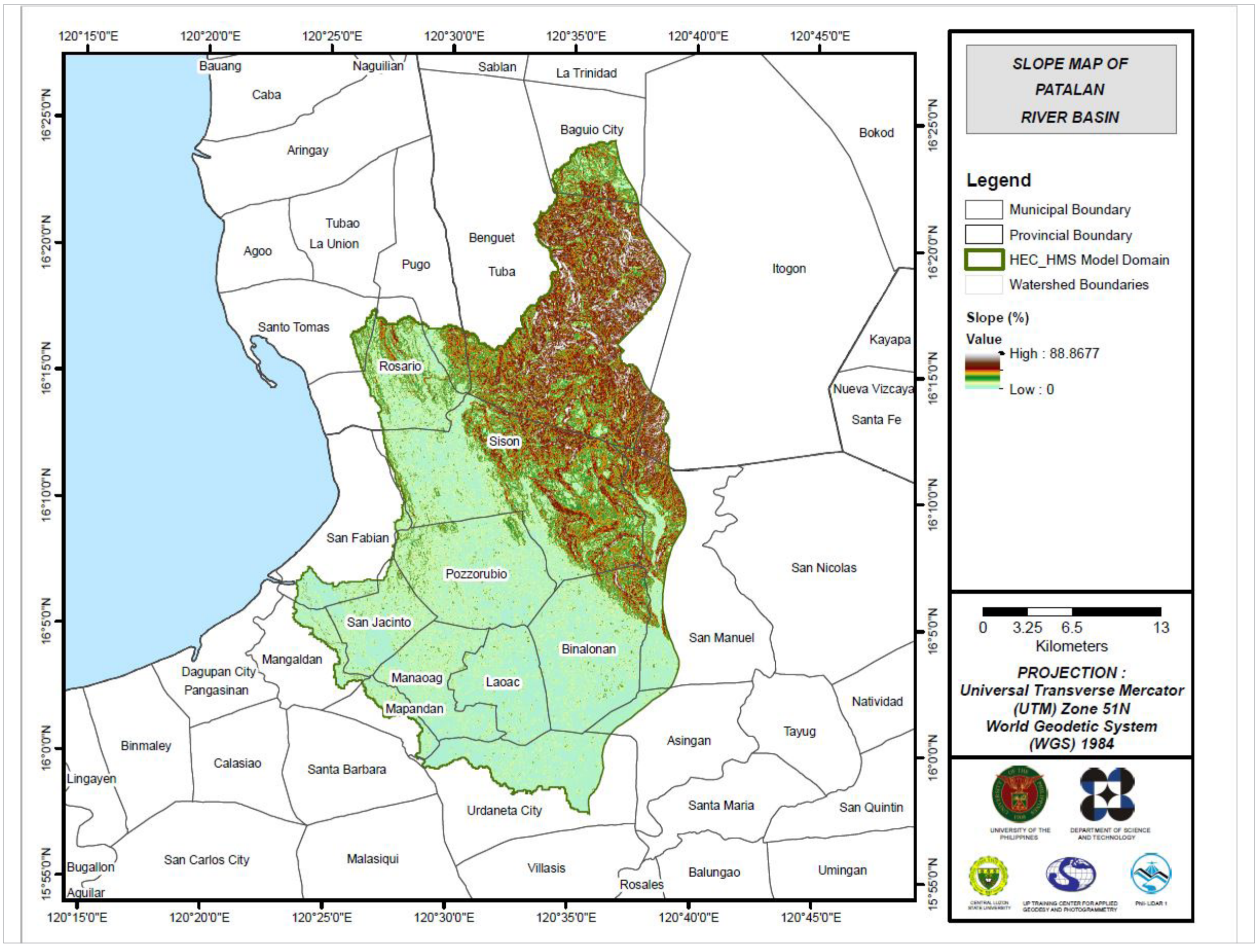


Figure 58. Slope Map of Patalan River Basin

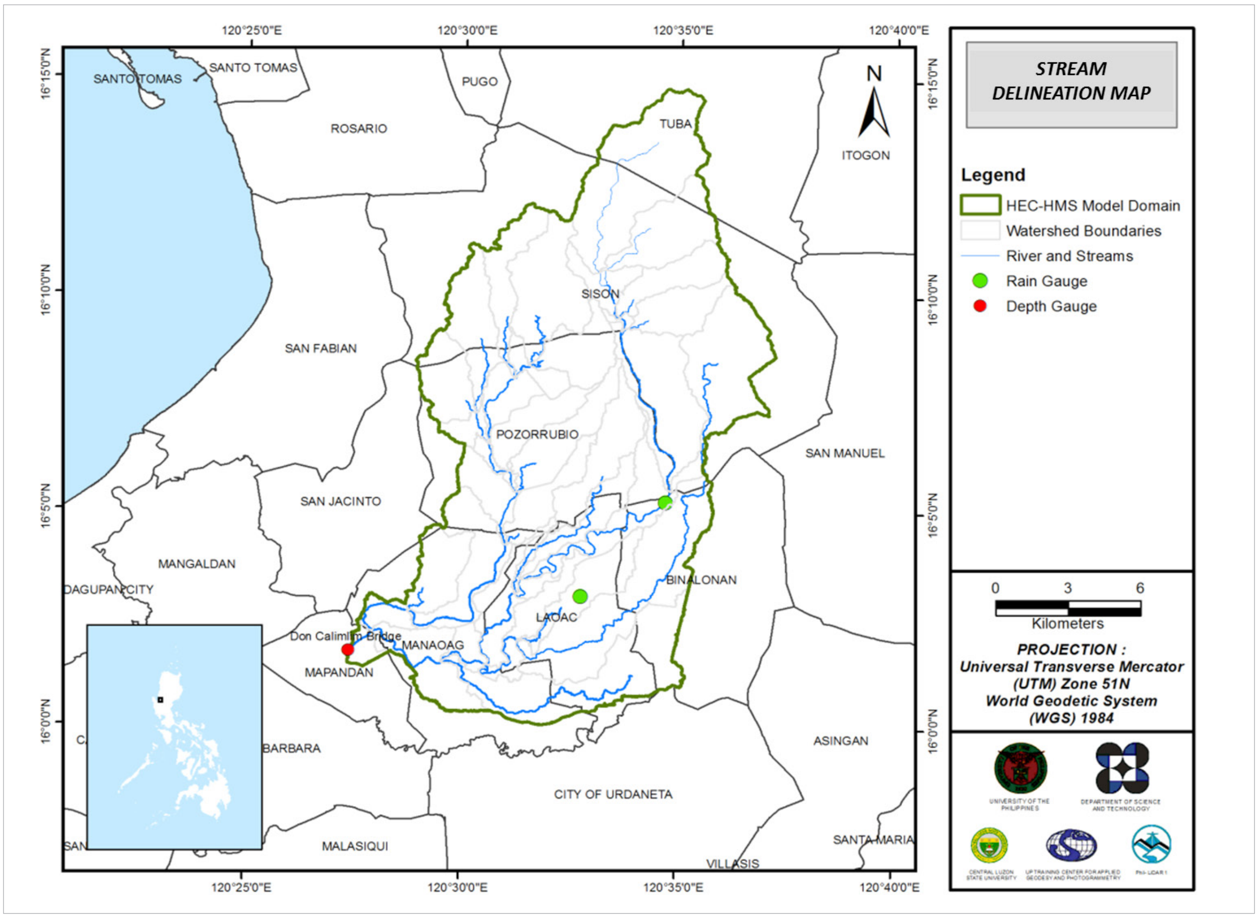


Figure 59. Figure 59. Stream Delineation Map of Patalan River Basin

Using the SAR-based DEM, the Patalan basin was delineated and further subdivided into subbasin. The Patalan basin model consists of 37 sub basins, 18 reaches, and 18 junctions as shown in Figure 60. Finally, it was calibrated using depth gauge installed in Don Calimlim Bridge.

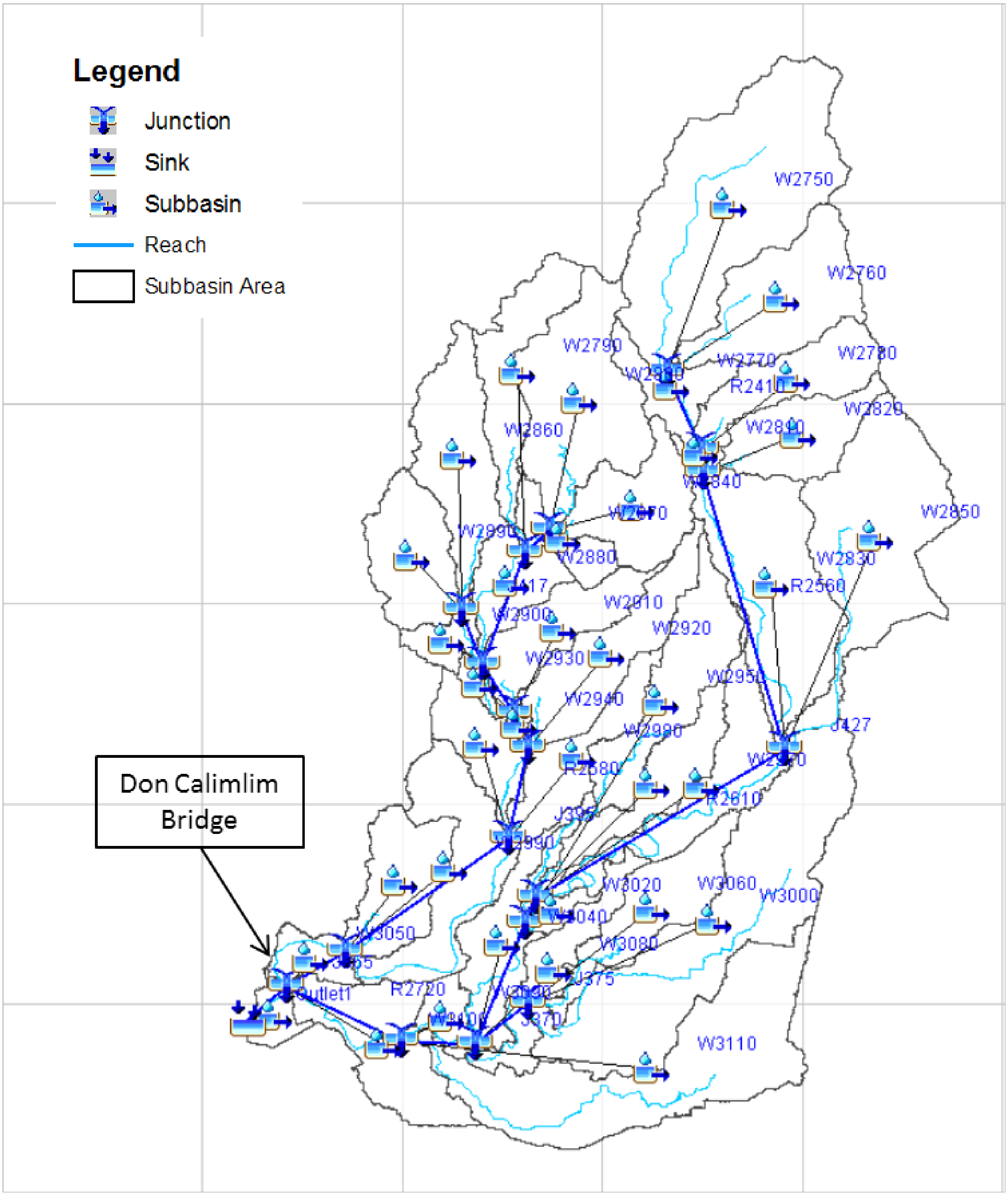


Figure 60. The Patalan river basin model generated using HEC-HMS

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.

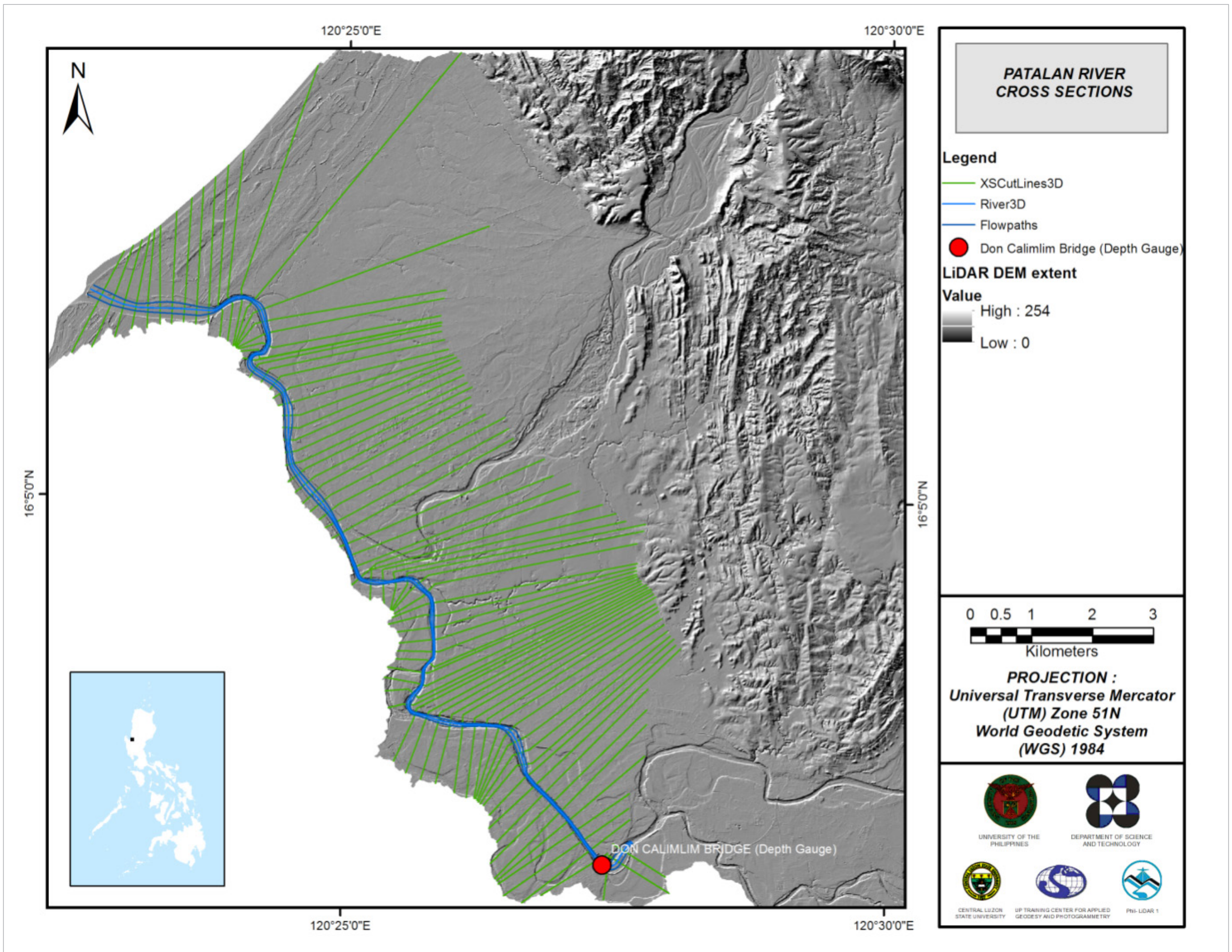


Figure 61. River cross-section of Patalan River generated through Arcmap HEC GeoRAS tool

5.5 Flo 2D Model

The automated modelling process allowed 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 was divided into square grid elements, 10 meter by 10 meter in size. Each element was assigned a unique grid element number which served 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 were 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 southwest of the model to the north, following the main channel. As such, boundary elements in those particular regions of the model were assigned as inflow and outflow elements respectively.

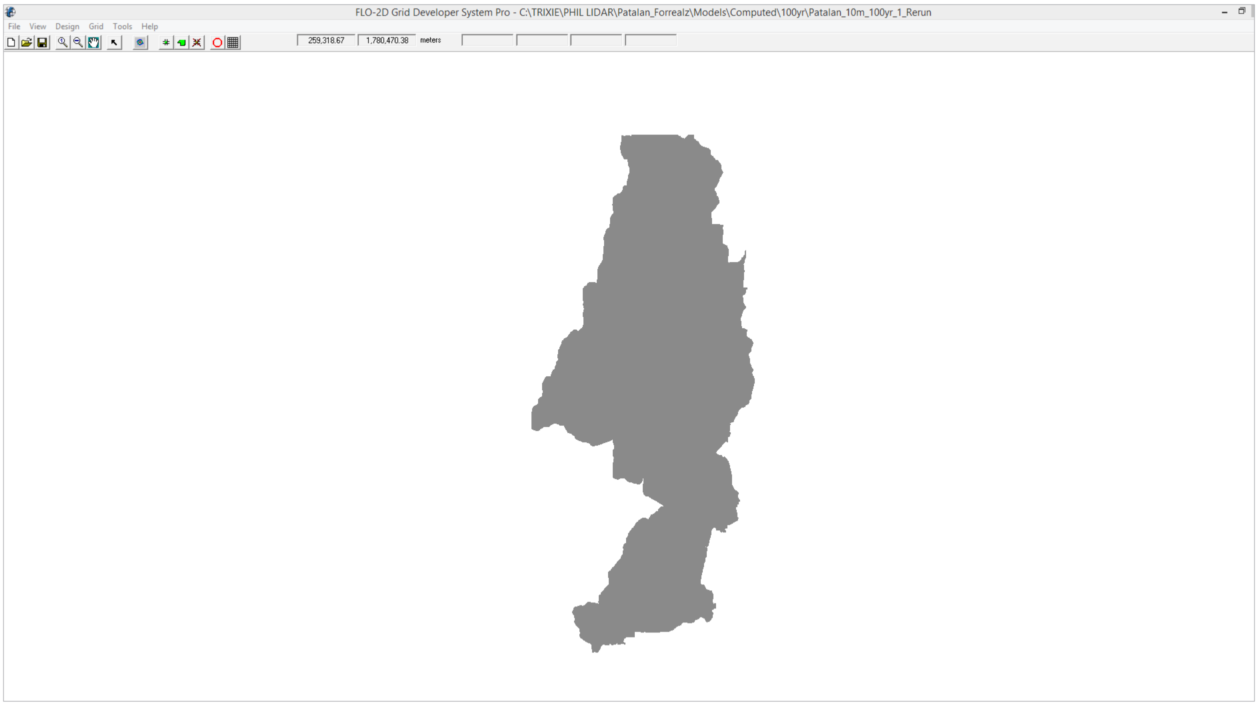


Figure 62. Screenshot of subcatchment with the computational area to be modeled in FLO-2D GDS Pro

The simulation is then run through FLO-2D GDS Pro. This particular model had a computer run time of 100.41064 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 m^2/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 63477900.00 m^2.

There is a total of 66015038.26 m^3 of water entering the model. Of this amount, 32840781.38 m^3 is due to rainfall while 33174256.88 m^3 is inflow from other areas outside the model. 10888662.00 m^3 of this water is lost to infiltration and interception, while 5049192.13 m^3 is stored by the floodplain. The rest, amounting up to 50077164.29 m^3,is outflow.

5.6 Results of HMS Calibration

After calibrating the Patalan HEC-HMS river basin model, its accuracy was measured against the observed values. Figure 63 shows the comparison between the two discharge data.

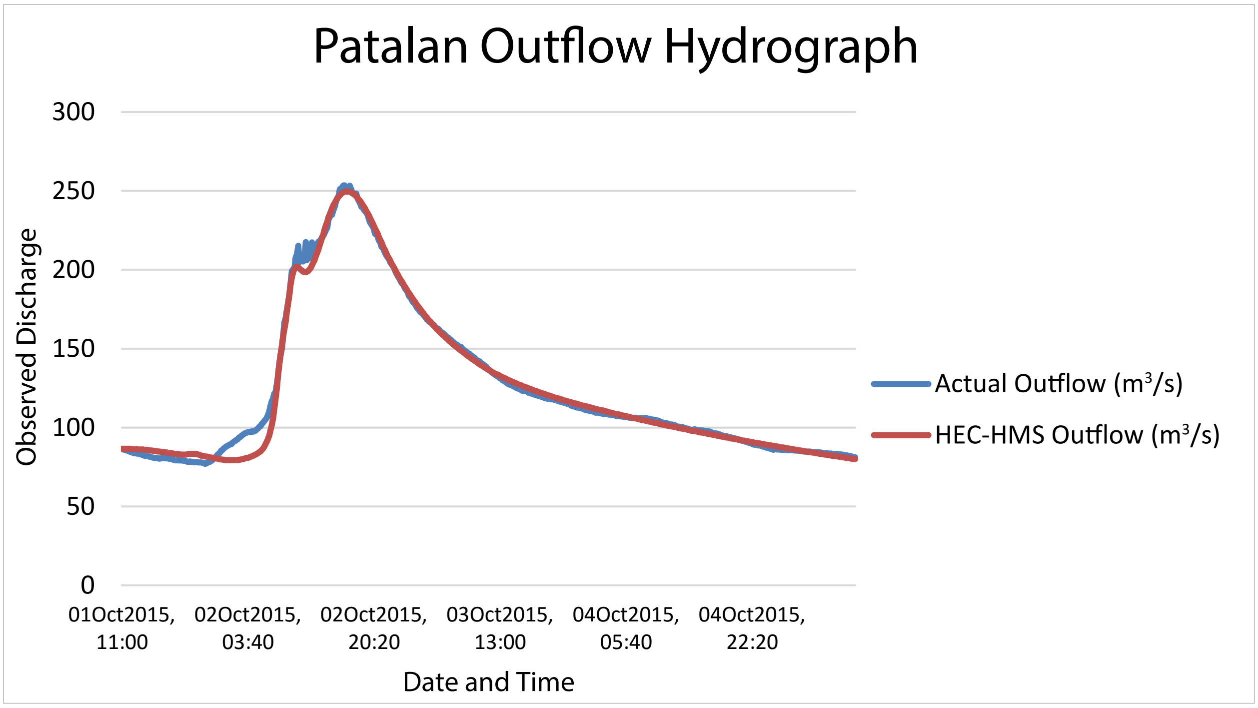


Figure 63. Outflow Hydrograph of Patalan produced by the HEC-HMS model compared with observed outflow

Table 36 shows adjusted ranges of values of the parameters used in calibrating the model.

Table 36. Range of calibrated values for the Patalan River Basin.

Hydrologic Element	Calculation Type	Method	Parameter	Range of Calibrated Values
Basin	Loss	SCS Curve number	Initial Abstraction (mm)	0.05 – 0.7
			Curve Number	90 – 99
	Transform	Clark Unit Hydrograph	Time of Concentration (hr)	0.63 – 27
			Storage Coefficient (hr)	0.20 – 15
	Baseflow	Recession	Recession Constant	0.42 - 1
			Ratio to Peak	0.16 - 1
Reach	Routing	Muskingum-Cunge	Manning's Coefficient	0.01 – 0.09

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 0.05mm to 0.7mm signifies that there is minimal 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 Patalan River Basin is 90-99. For Patalan, the basin mostly consists of cultivated areas and brushland and the soil mostly consists of clay loam, silt loam and sandy loam.

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 0.2 hour to 27 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 0.42 - 1 indicates that the basin is unlikely to quickly go back to its original discharge and instead, will be higher. Ratio to peak of 0.16 - 1 indicates a steep receding limb of the outflow hydrograph.

Manning's roughness coefficient of 0.01 – 0.09 corresponds to the common roughness in Patalan watershed, which is determined to be cultivated with mature field crops (Brunner, 2010).

Table 37. Summary of the Efficiency Test of Patalan HMS Model

Accuracy measure	Value
RMSE	4.5
r^2	0.992
NSE	1
PBIAS	0.50
RSR	0.07

The Root Mean Square Error (RMSE) method aggregates the individual differences of these two measurements. It was computed at 4.5 m^3/s.

The Pearson correlation coefficient (r^2) 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. A value of $r^2 = 0.992$ was computed for this model.

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 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. In the model, the computed value for PBIAS is 0.50 which implies that the model was underestimated at 0.50 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 are quantified. The model has an RSR value of 0.07 which indicates that the model has a better simulation performance due to low value of computed RSR.

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

5.7.1 Hydrograph using the Rainfall Runoff Model

The summary graph (Figure 64) shows the Patalan outflow using the Dagupan RIDF in 5 different return periods (5-year, 10-year, 25-year, 50-year, and 100-year rainfall time series) based on the 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.

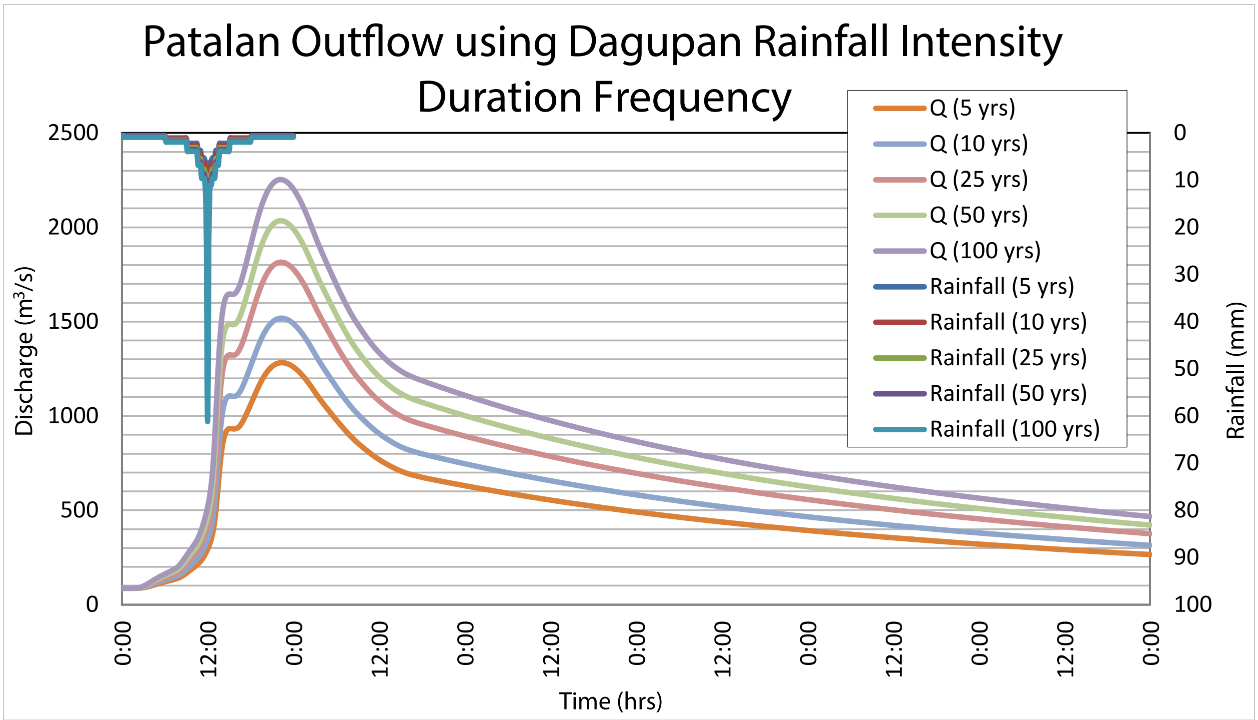


Figure 64. Outflow hydrograph at Patalan Station generated using Dagupan RIDF simulated in HEC HMS

A summary of the total precipitation, peak rainfall, peak outflow and time to peak of the Patalan discharge using the Daguapan RIDF curves in five different return periods is shown in Table 38.

Table 38. Peak values of the Patalan 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	1282.3	10 hours, 20 minutes
10-Year	293.6	40.5	1518.6	10 hours, 20 minutes
25-Year	352.9	48.9	1815.1	10 hours, 20 minutes
50-Year	396.8	55.1	2034.9	10 hours, 10 minutes
100-Year	440.5	61.2	2253.1	10 hours, 10 minutes

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

The river discharge values for the four rivers entering the floodplain are shown in to Error! Reference source not found. and the peak values are summarized in to Error! Reference source not found..

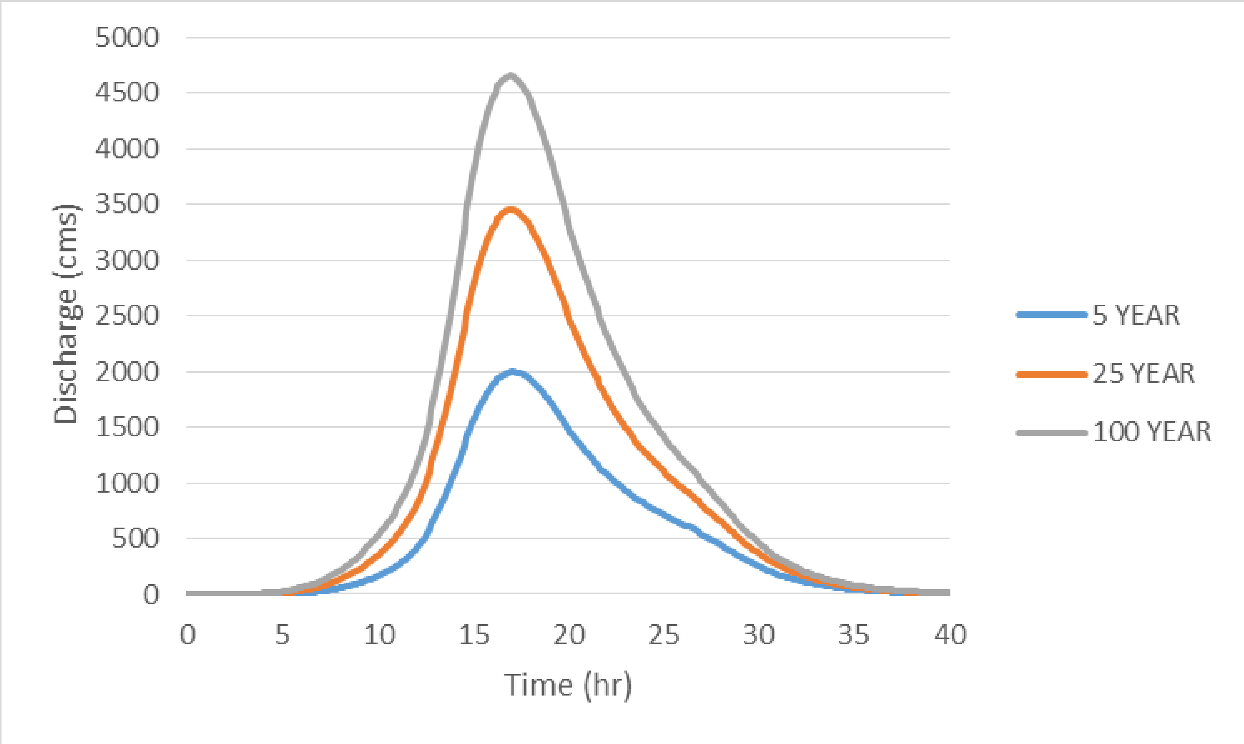


Figure 65. Patalan river (1) generated discharge using 5-, 25-, and 100-year rainfall intensity-duration-frequency (RIDF) in HEC-HMS

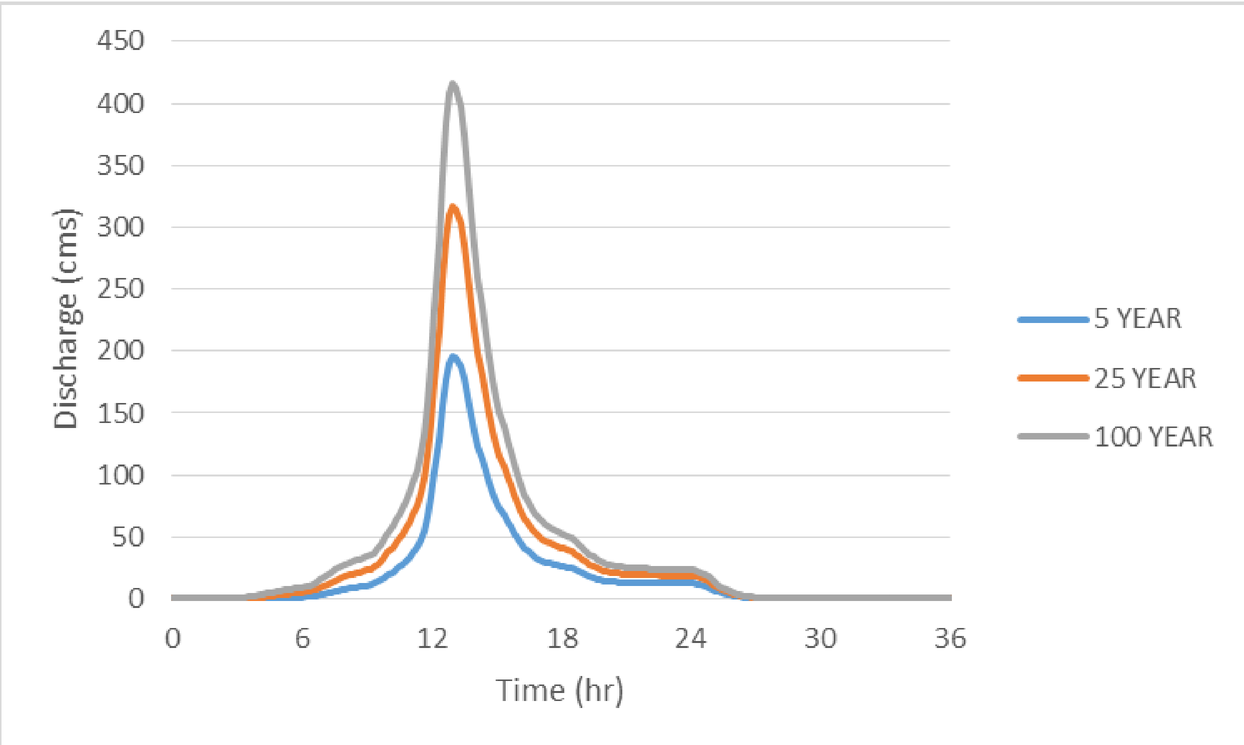


Figure 66. Patalan river (2) generated discharge using 5-, 25-, and 100-year rainfall intensity-duration-frequency (RIDF) in HEC-HMS

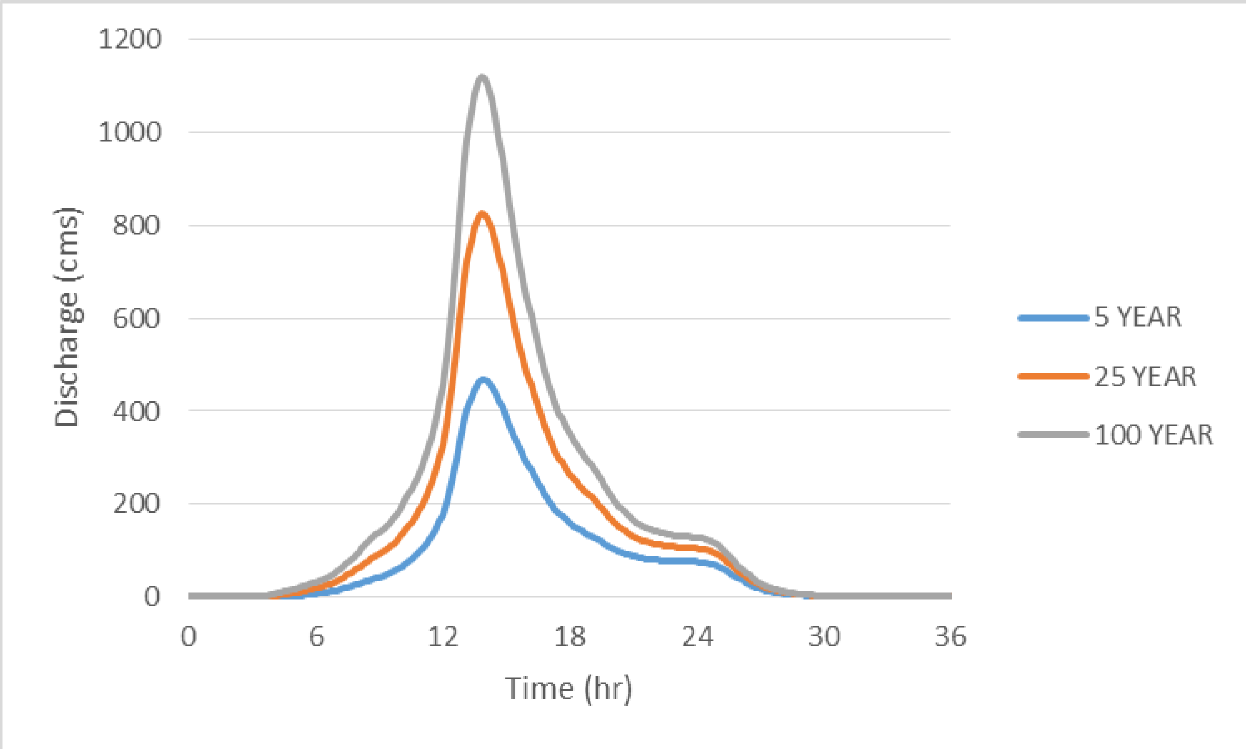


Figure 67. Patalan river (3) generated discharge using 5-, 25-, and 100-year rainfall intensity-duration-frequency (RIDF) in HEC-HMS

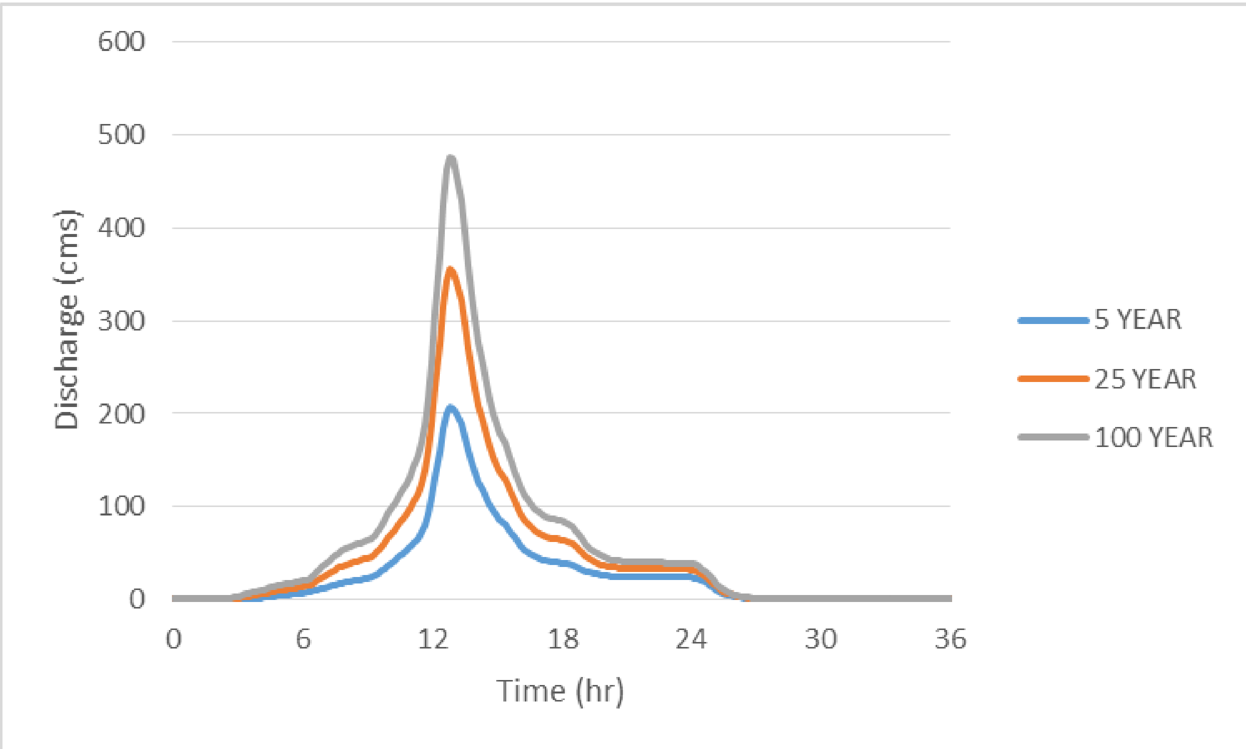


Figure 68. Patalan river (4) generated discharge using 5-, 25-, and 100-year rainfall intensity-duration-frequency (RIDF) in HEC-HMS

Table 39. Summary of Patalan river (1) discharge generated in HEC-HMS

RIDF Period	Peak discharge (cms)	Time-to-peak
100-Year	4659.5	286.35 minutes
25-Year	3455.7	286.35 minutes
5-Year	1999.5	286.35 minutes

Table 40. Summary of Patalan river (2) discharge generated in HEC-HMS

RIDF Period	Peak discharge (cms)	Time-to-peak
100-Year	416.8	71.06 minutes
25-Year	317.1	71.06 minutes
5-Year	195.1	71.06 minutes

Table 41. Summary of Patalan river (3) discharge generated in HEC-HMS

RIDF Period	Peak discharge (cms)	Time-to-peak
100-Year	1121.9	115.84 minutes
25-Year	825.8	115.84 minutes
5-Year	468	115.84 minutes

Table 42. Summary of Patalan river (4) discharge generated in HEC-HMS

RIDF Period	Peak discharge (cms)	Time-to-peak
100-Year	477	62.98 minutes
25-Year	355.1	62.98 minutes
5-Year	206.7	62.98 minutes

The comparison of the discharge results using Dr. Horritt's recommended hydrological method against the bankful and specific discharge estimates is shown in Table 43.

Table 43. Validation of river discharge estimates

Discharge Point	$Q_{MED(SCS)}$, cms	$Q_{BANKFUL}$, cms	$Q_{MED(SPEC)}$, cms	VALIDATION	
				Bankful Discharge	Specific Discharge
Patalan (1)	1759.560	1888.443	1088.056	Pass	Fail
Patalan (2)	171.688	197.960	137.608	Pass	Pass
Patalan (3)	411.840	753.194	367.269	Pass	Pass
Patalan (4)	181.896	274.170	166.076	Pass	Pass

Three out of four values from the HEC-HMS river discharge estimates were able to satisfy the conditions for validation using the bankful and specific discharge methods while the other one satisfies the condition for validation using the bankful discharge method only. The calculated values are based on theory but is supported using other discharge computation methods so they were good to use flood modeling. However, 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 was 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 Patalan HEC-RAS model has a minimum and maximum flow discharge of 153.8 and 358.6 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 Patalan river has a value of 6.58 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 banks of the river. However, some areas are being flooded due to low lying areas like fishpond located in Barangay Bonuan Binloc in Dagupan city (located at the left downstream of the river), Barangay Longos-Amagonan-Parac Fabrica, Cayanga, Nibaliw Narvarte, Nibaliw Central, Poblacion, Sagud-Bahley, Sobol, Tempra-Guilig, and Tococ in San Fabian city (located at the right downstream portion of the river). The sample generated map of Patalan River using the calibrated HMS flow is shown in Figure 69.

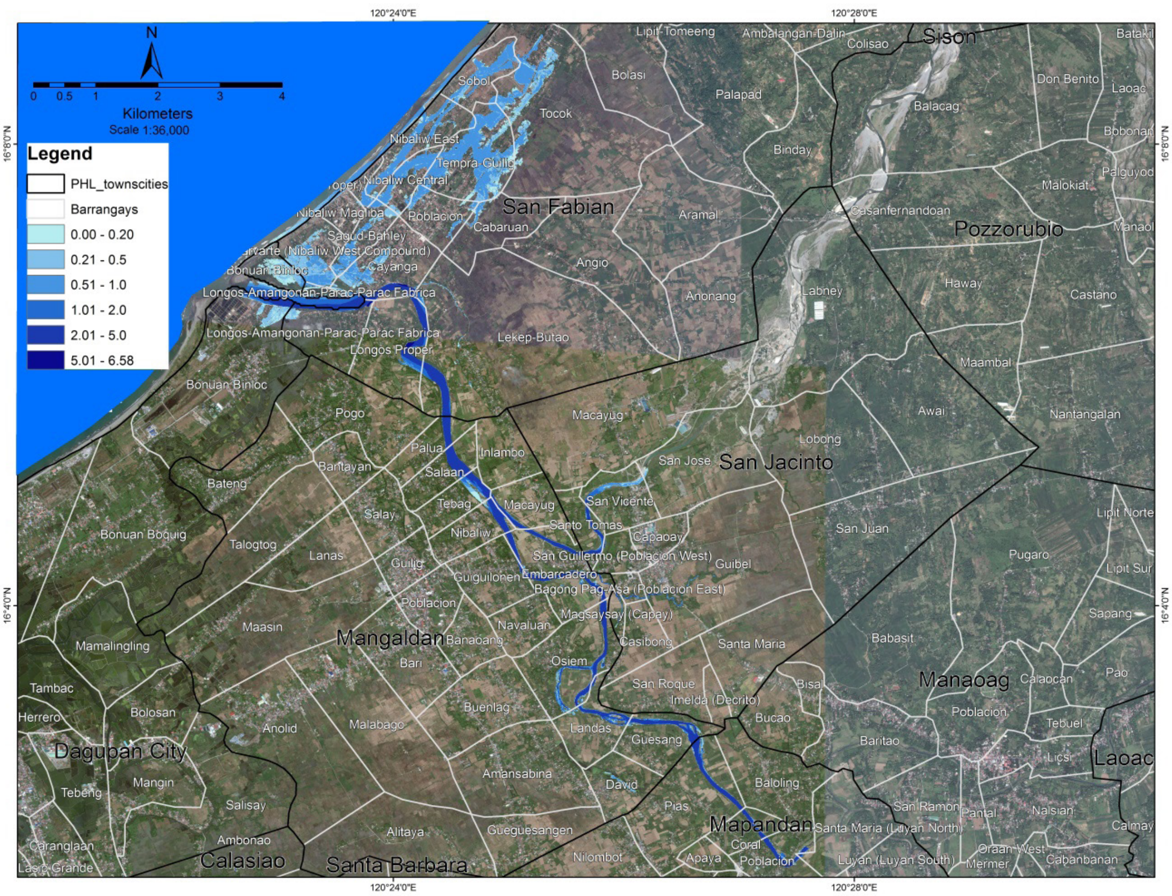


Figure 69. Sample output of Patalan RAS Model

5.9 Flood Hazard and Flow Depth

The resulting hazard and flow depth maps have a 10m resolution. Figure 70 to Figure 75 shows the 100-, 25-, and 5-year rain return scenarios of the Patalan Floodplain. The floodplain, with an area of 433.25 sq. km., covers eleven municipalities namely Binalonan, Dagupan City, Laoac, Manaoag, Mangaldan, Mapandan, Pozzorubio, San Fabian, San Jacinto, Sison and Urdaneta City. Table 44 shows the percentage of area affected by flooding per municipality.

Table 44. Municipalities affected in Patalan Floodplain

City / Municipality	Total Area	Area Flooded	% Flooded
Binalonan	78.54	29.67	38%
Dagupan City	47.76	1.40	3%
Laoac	40.70	40.47	99%
Manaoag	42.42	41.28	97%
Mangaldan	43.42	6.21	14%
Mapandan	21.35	5.78	27%
Pozzorubio	74.75	72.30	97%
San Fabian	69.27	37.55	54%
San Jacinto	34.09	34.08	100%
Sison	250.37	160.08	64%
Urdaneta City	130.22	4.43	3%

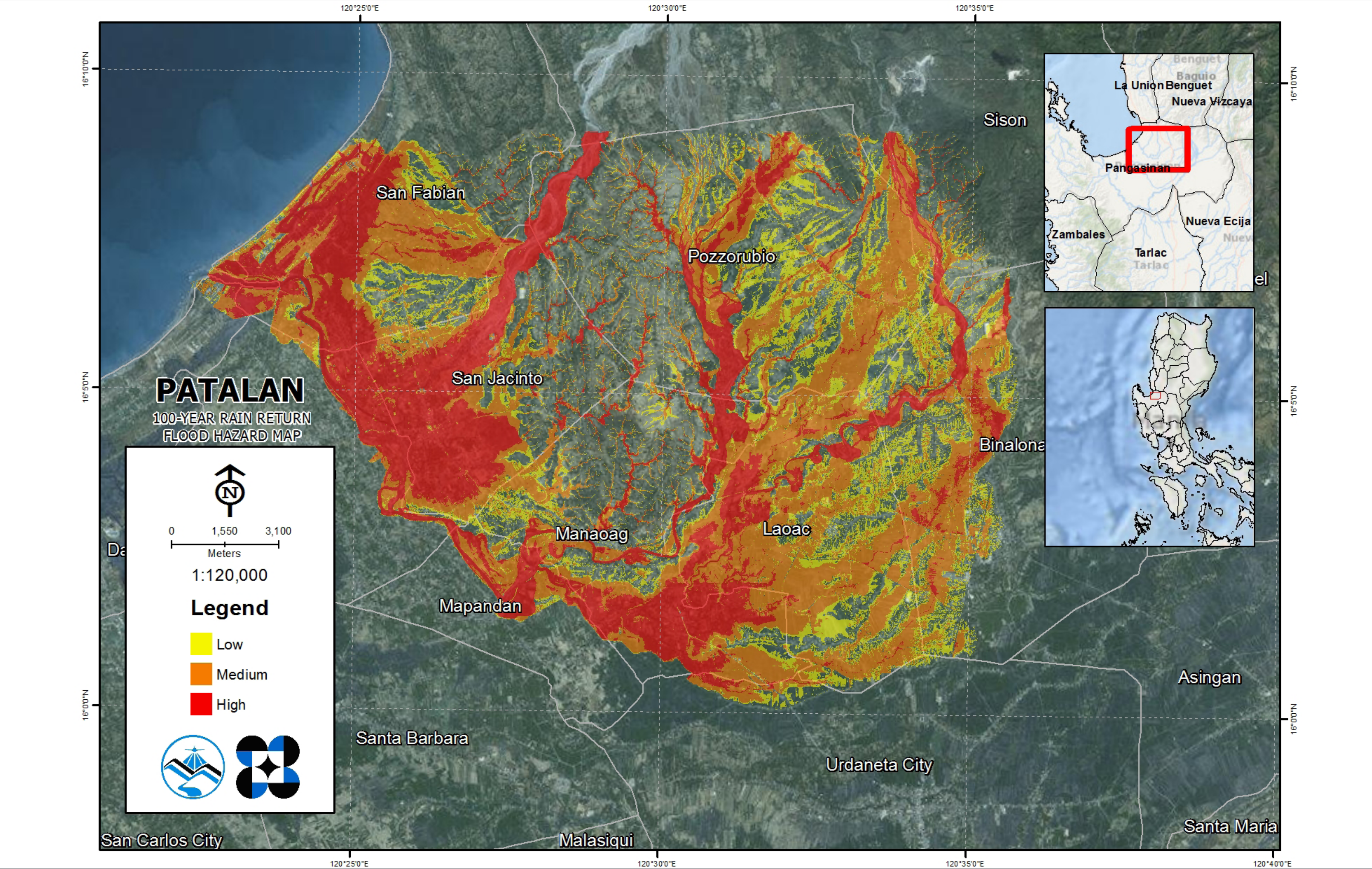


Figure 70. 100-year Flood Hazard Map for Patalan Floodplain

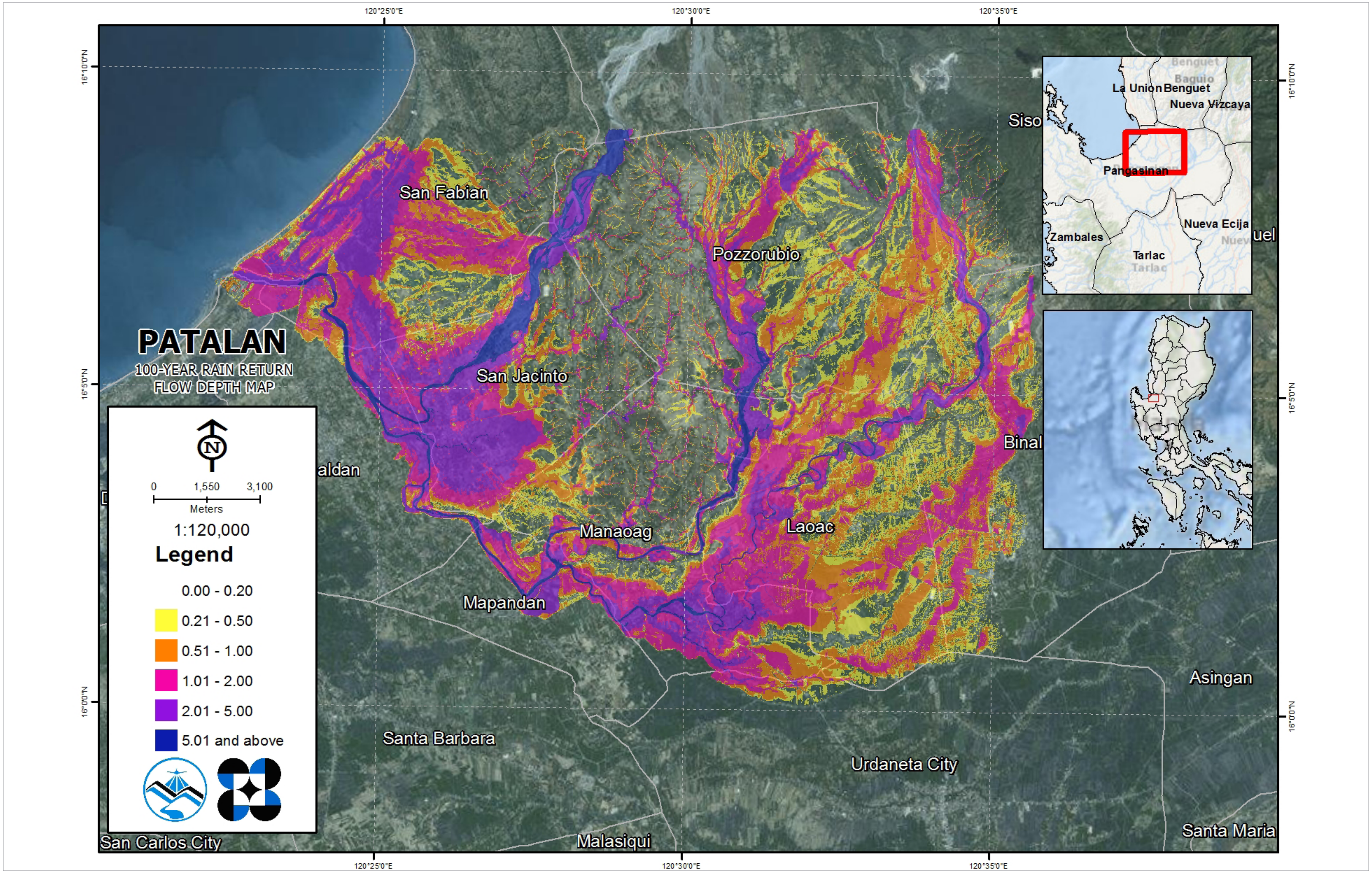


Figure 71. 100-year Flow Depth Map for Patalan Floodplain

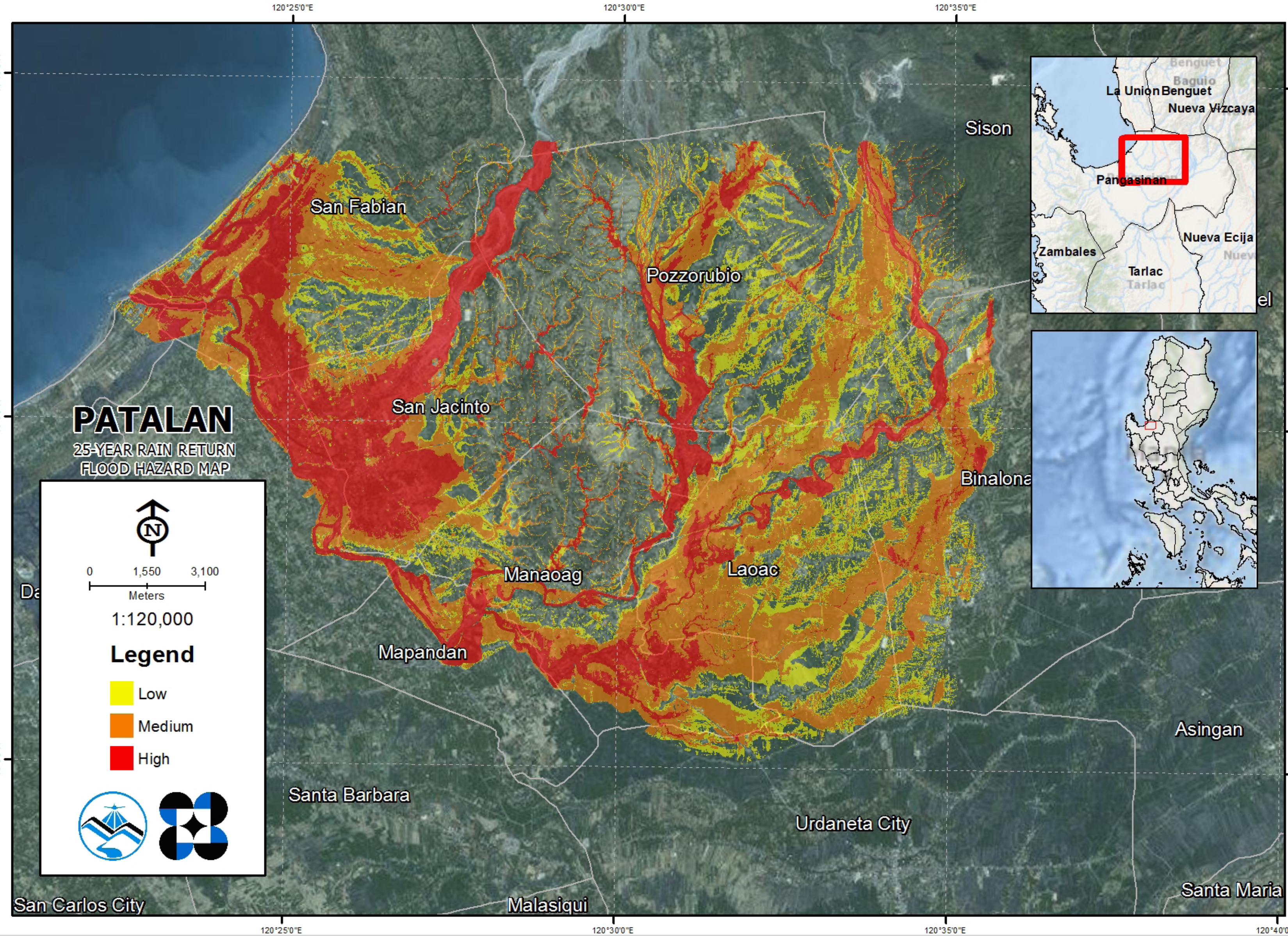


Figure 72. 25-year Flood Hazard Map for Patalan Floodplain

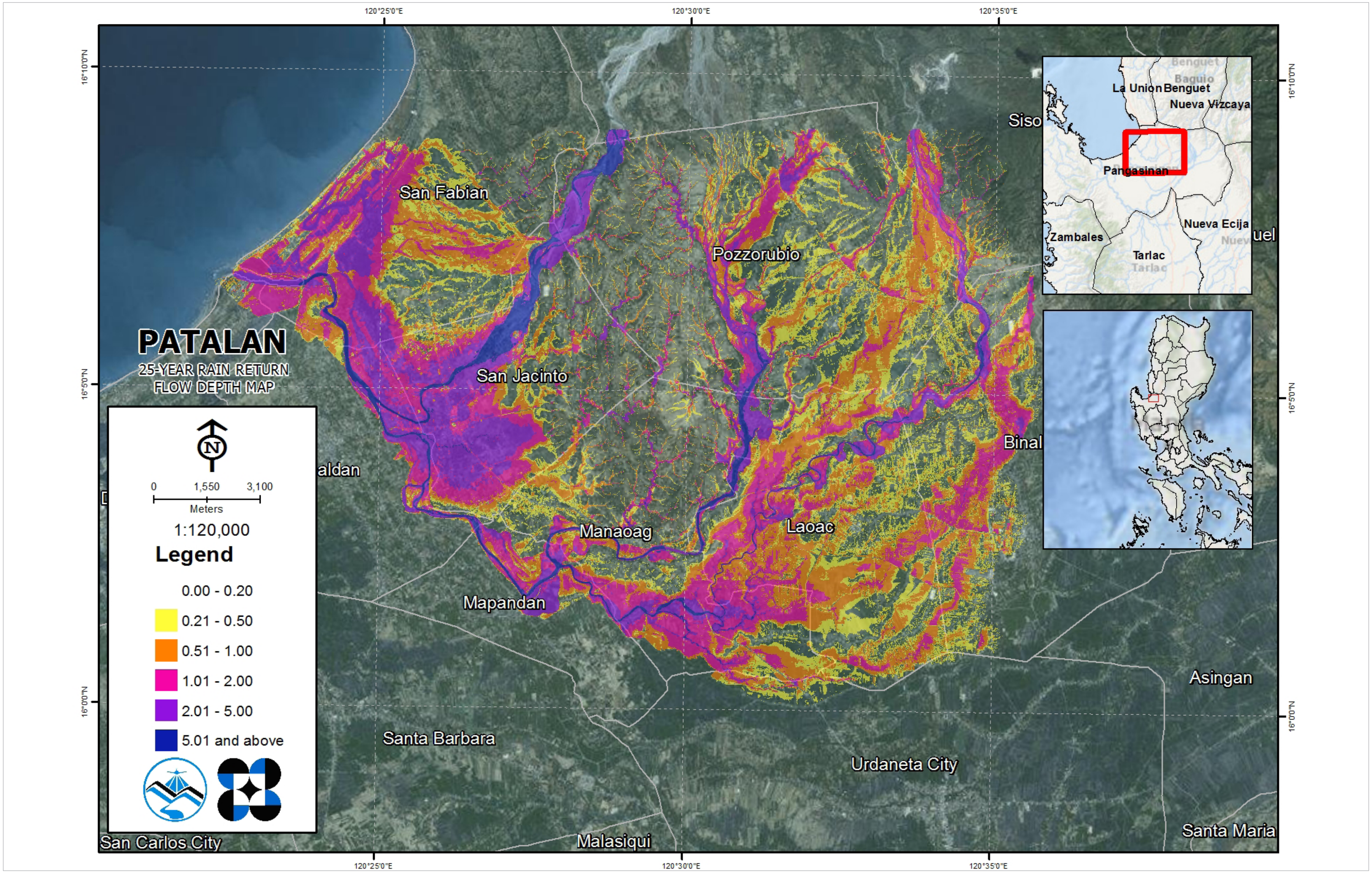


Figure 73. 25-year Flow Depth Map for Patalan Floodplain

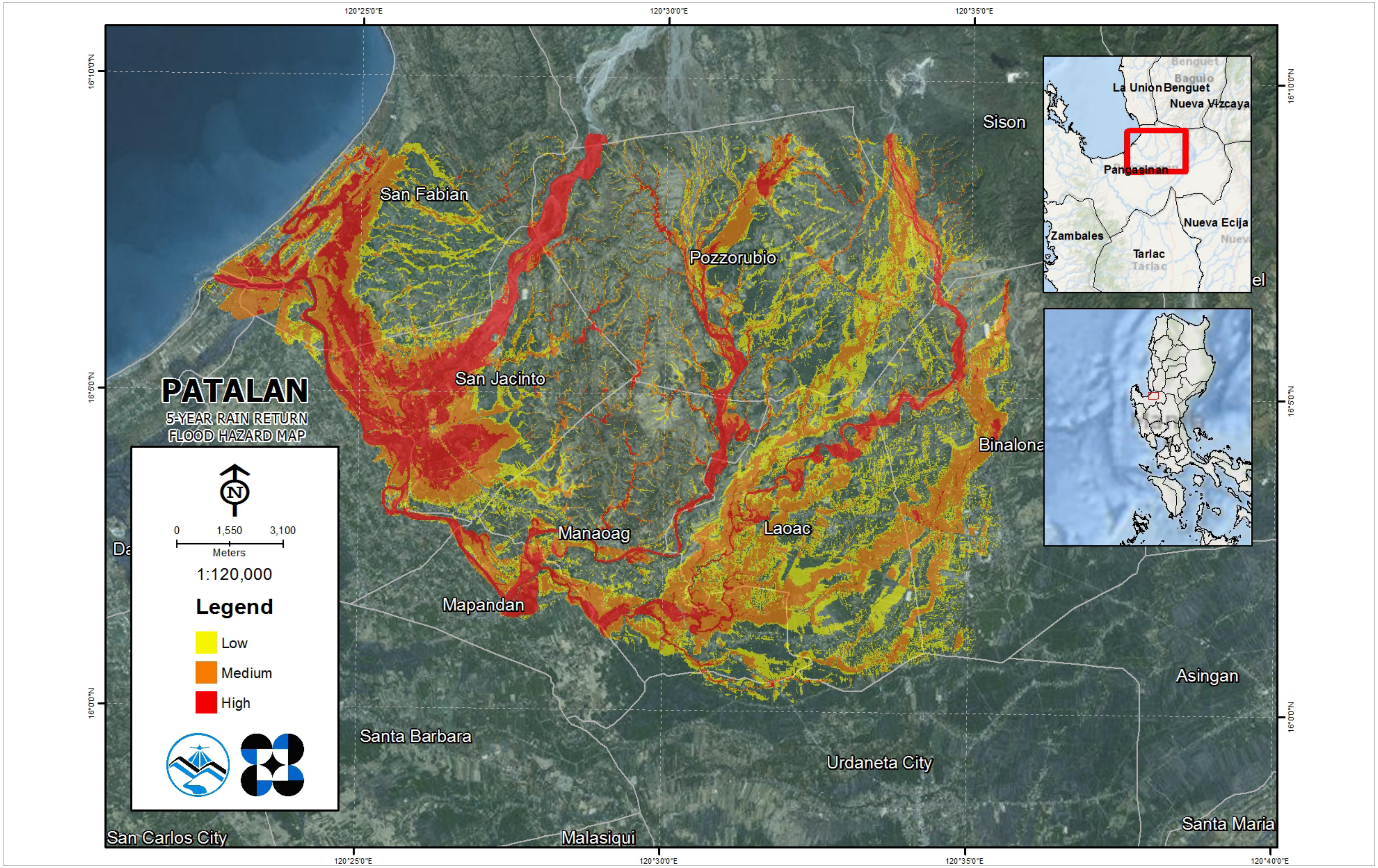


Figure 74. 5-year Flood Hazard Map for Patalan Floodplain

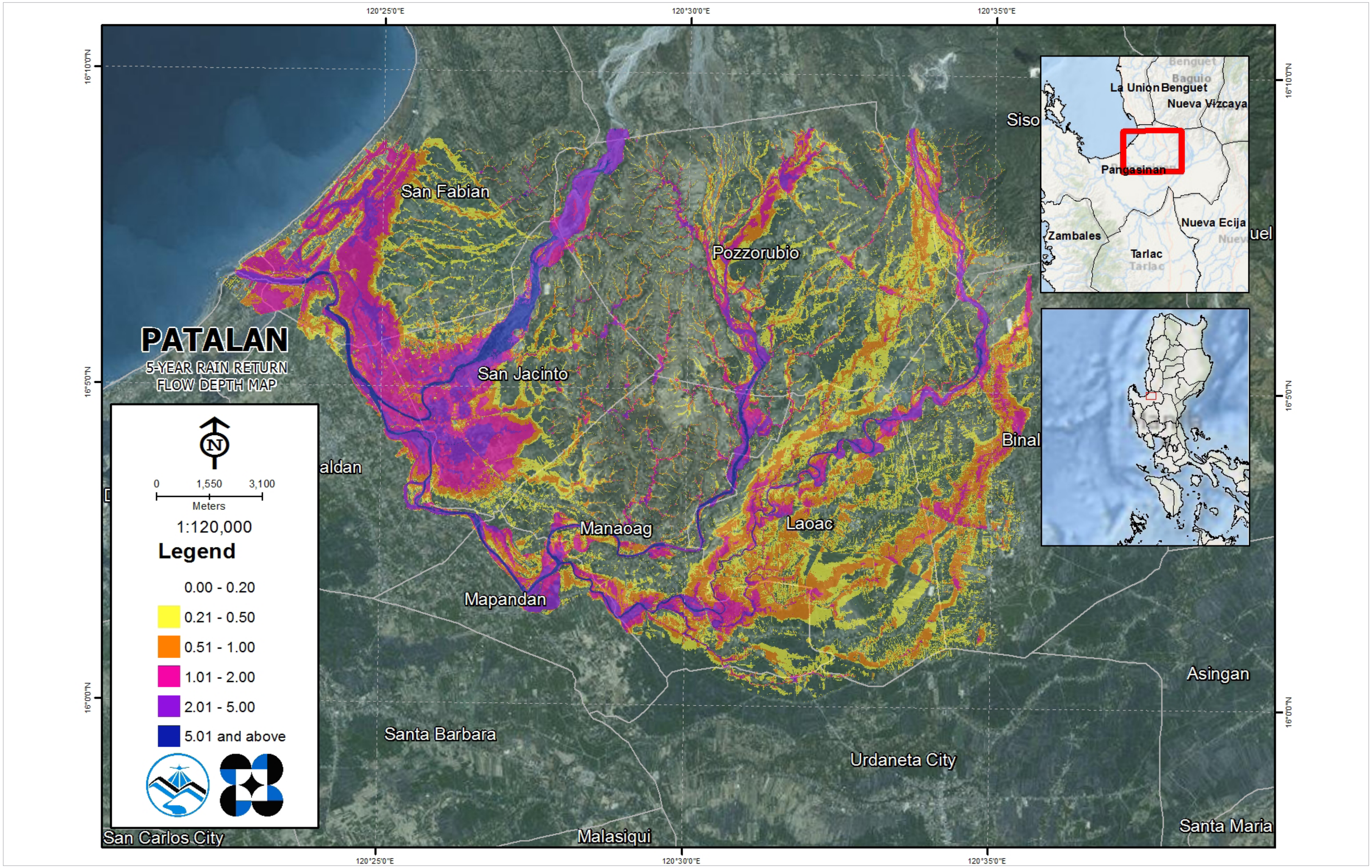


Figure 75. 5-year Flood Depth Map for Patalan Floodplain

5.10 Inventory of Areas Exposed to Flooding

Affected barangays in Patalan (Bued) river basin, grouped by municipality, are listed below. For the said basin, eleven municipalities consisting of 174 barangays are expected to experience flooding when subjected to 5-, 25-, and 100-yr rainfall return period.

For the 5-year return period, 19.93% of the municipality of Binalonan with an area of 78.537828 sq. km. will experience flood levels of less than 0.20 meters. 7.44% of the area will experience flood levels of 0.21 to 0.50 meters while 6.35%, 2.82%, 1.09%, 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 45. Affected Areas in Binalonan, Pangasinan during 5-Year Rainfall Return Period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binalonan (in sq. km)							
	Bued	Bugayong	Camangaan	Canarvacanan	Cili	Dumayat	Linmansangan	Pasileng Norte
0.03-0.20	0.52	2.46	3.39	0.43	1.64	0.67	0.51	0.092
0.21-0.50	0.44	0.69	0.75	0.33	0.52	0.28	0.34	0.042
0.51-1.00	0.43	0.22	0.75	0.74	0.68	0.021	0.53	0.02
1.01-2.00	0.087	0.13	0.54	0.26	0.46	0.0001	0.19	0.0036
2.01-5.00	0	0.074	0.4	0.0047	0.0047	0	0.0031	0
> 5.00	0	0.007	0.078	0	0	0	0	0

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binalonan (in sq. km)							
	Poblacion	San Felipe Sur	Santa Maria Norte	Santiago	Santo Niño	Sumabnit	Tabuyoc	Vacante
0.03-0.20	0.97	0.029	0.38	0.38	0.02	0.94	1.37	1.85
0.21-0.50	0.33	0.002	0.24	0.24	0.000018	0.56	0.44	0.64
0.51-1.00	0.12	0	0.4	0.4	0	0.33	0.084	0.26
1.01-2.00	0.013	0	0.12	0.14	0	0.05	0.012	0.21
2.01-5.00	0	0	0.01	0.0002	0	0	0	0.36
> 5.00	0	0	0	0	0	0	0	0.018

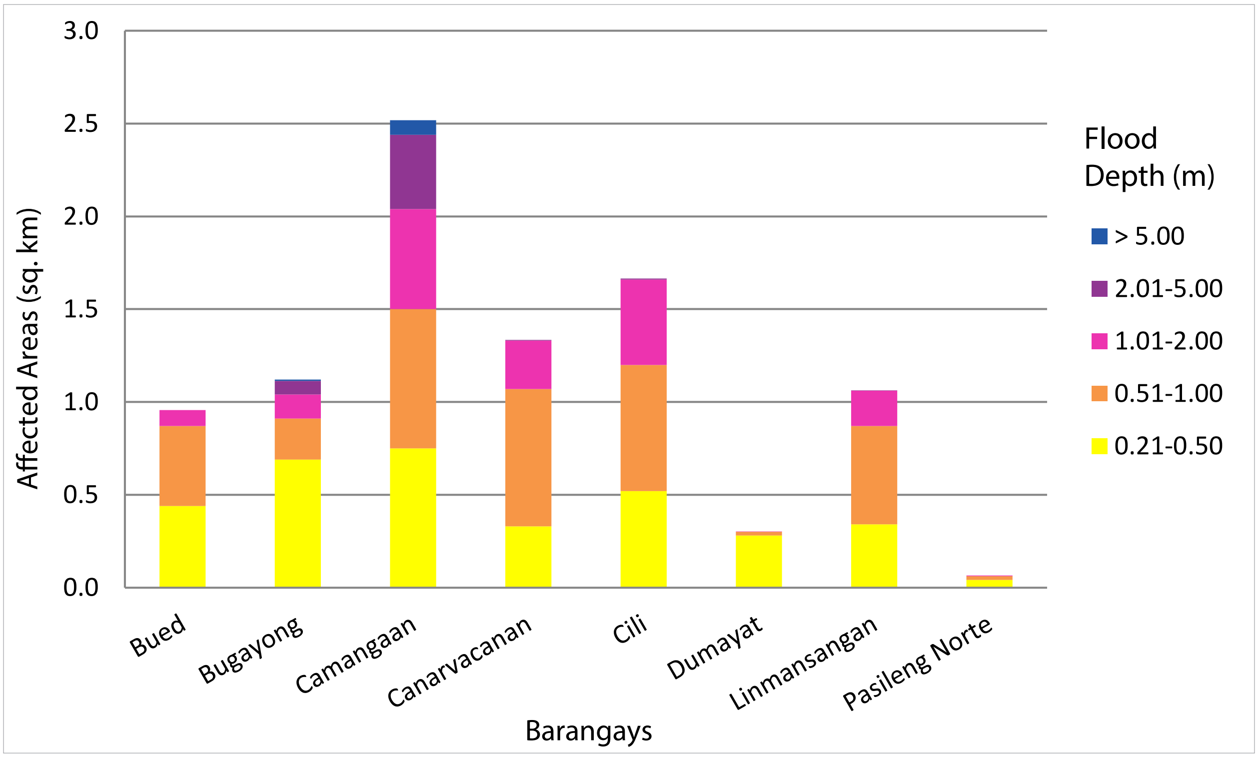


Figure 76. Affected Areas in Binalonan, Pangasinan during 5-Year Rainfall Return Period

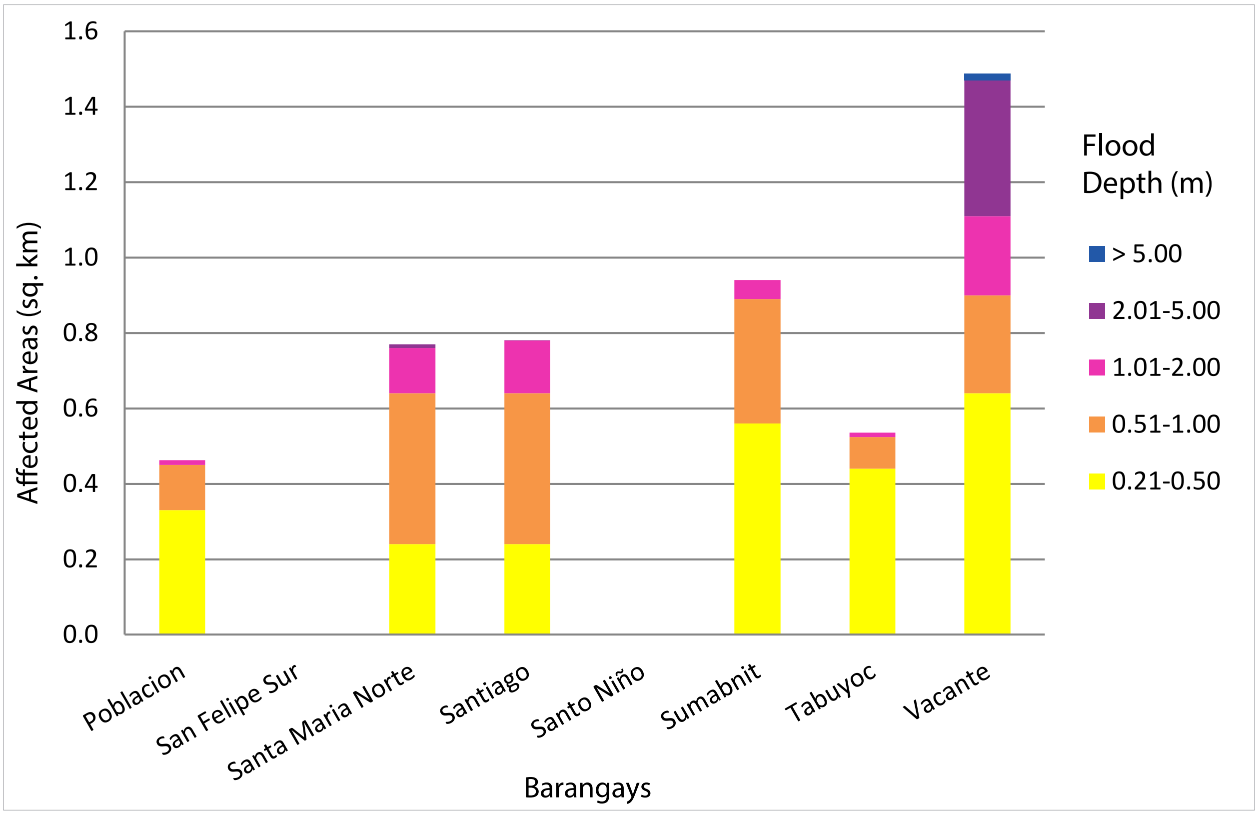


Figure 77. Affected Areas in Binalonan, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 0.84% of the municipality of Dagupan City with an area of 47.755696 sq. km. will experience flood levels of less than 0.20 meters. 0.25% of the area will experience flood levels of 0.21 to 0.50 meters while 0.54%, 1.13%, and 0.17% 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 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)
	Bonuan Binloc
0.03-0.20	0.4
0.21-0.50	0.12
0.51-1.00	0.26
1.01-2.00	0.54
2.01-5.00	0.082
> 5.00	0

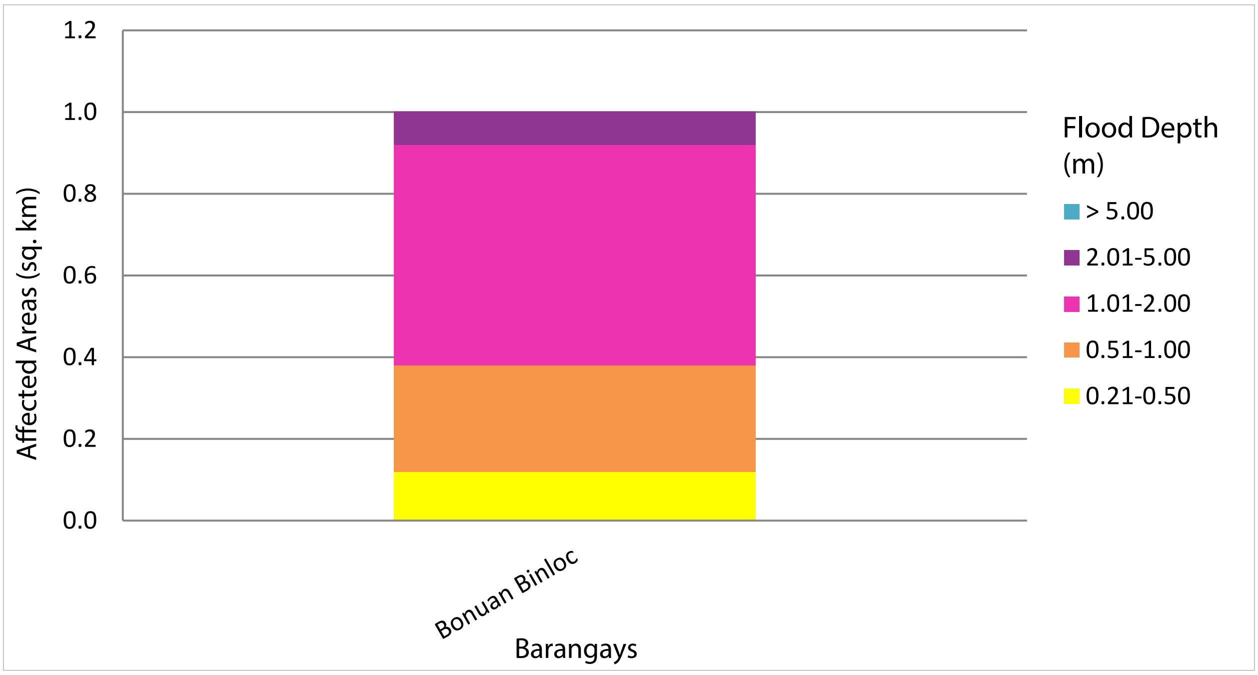


Figure 78. Affected Areas in Dagupan City, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 38.72% of the municipality of Laoac with an area of 40.697535 sq. km. will experience flood levels of less than 0.20 meters. 28.48% of the area will experience flood levels of 0.21 to 0.50 meters while 22.66%, 5.61%, 2.77%, and 1.06% 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 47. 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)										
	Anis	Balligi	Banuar	Botique	Caaringayan	Cabilaoan West	Cabulalaan	Calaoagan	Calmay	Casampagaan	Casanestebanan
0.03-0.20	0.79	0.86	0.19	0.65	0.84	1.41	0.64	0.15	0.18	2.18	0.19
0.21-0.50	0.23	0.55	0.28	0.36	0.95	0.99	0.33	0.12	0.6	1.09	0.47
0.51-1.00	0.18	0.048	0.41	0.3	1.23	0.42	0.3	0.11	0.9	0.55	0.93
1.01-2.00	0.025	0.0032	0.24	0.21	0.11	0.08	0.14	0.052	0.35	0.021	0.33
2.01-5.00	0	0.012	0.1	0.23	0	0	0.18	0.025	0.094	0	0.1
> 5.00	0	0.00018	0.017	0.055	0	0	0.067	0.024	0.037	0	0.029

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Laoac (in sq. km)										
	Casantiagoan	Domingo Alarcio	Inmanduyan	Lebueg	Maraboc	Nanbagatan	Panaga	Poblacion	Talogtog	Turko	Yatyat
0.03-0.20	0.64	0.68	1.19	0.86	0.6	0.72	0.39	0.42	0.17	0.92	1.09
0.21-0.50	0.29	0.23	0.36	0.83	0.36	1.15	0.43	0.4	0.21	0.68	0.68
0.51-1.00	0.22	0.044	0.36	0.16	0.47	1.01	0.18	0.39	0.29	0.33	0.39
1.01-2.00	0.0064	0.004	0.14	0.007	0.19	0.079	0.018	0.025	0.14	0.089	0.023
2.01-5.00	0.0000003	0	0.089	0	0.21	0.0025	0.008	0.014	0.048	0.013	0.0013
> 5.00	0	0	0.065	0	0.11	0	0.0097	0.004	0.01	0.0022	0

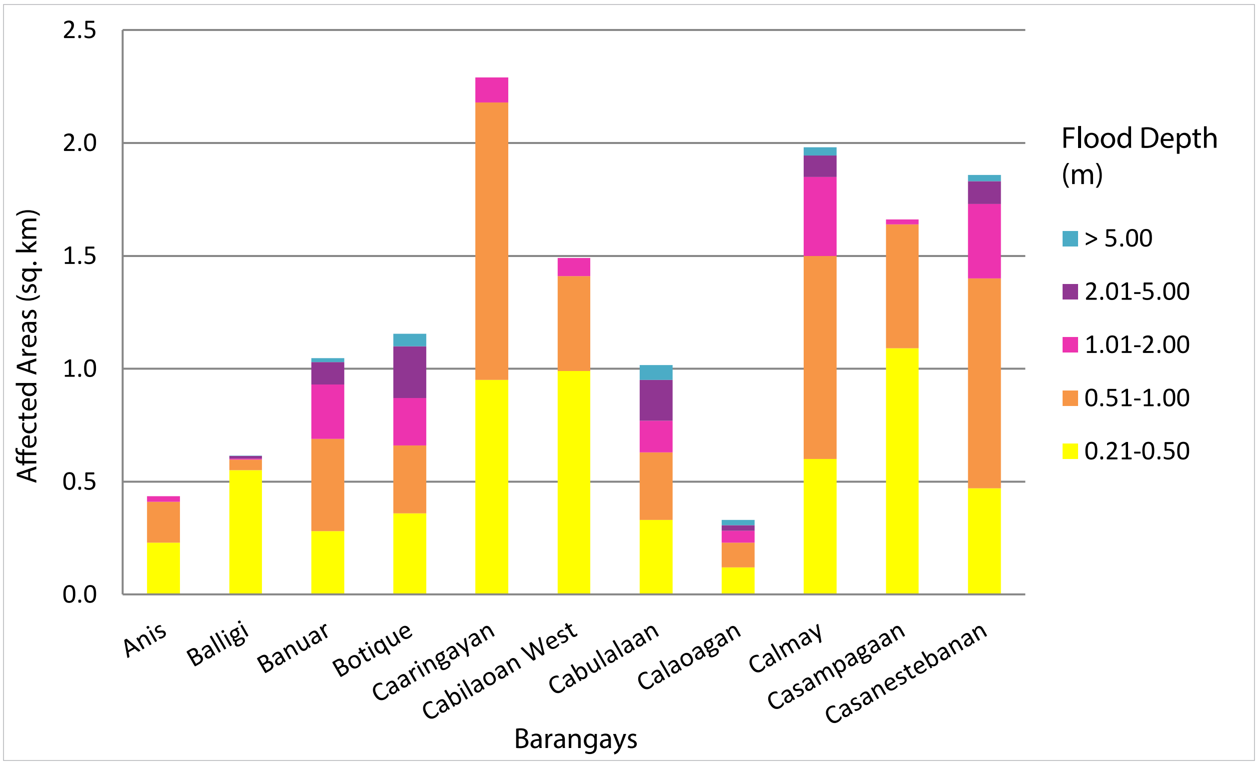


Figure 79. Affected Areas in Laoac, Pangasinan during 5-Year Rainfall Return Period

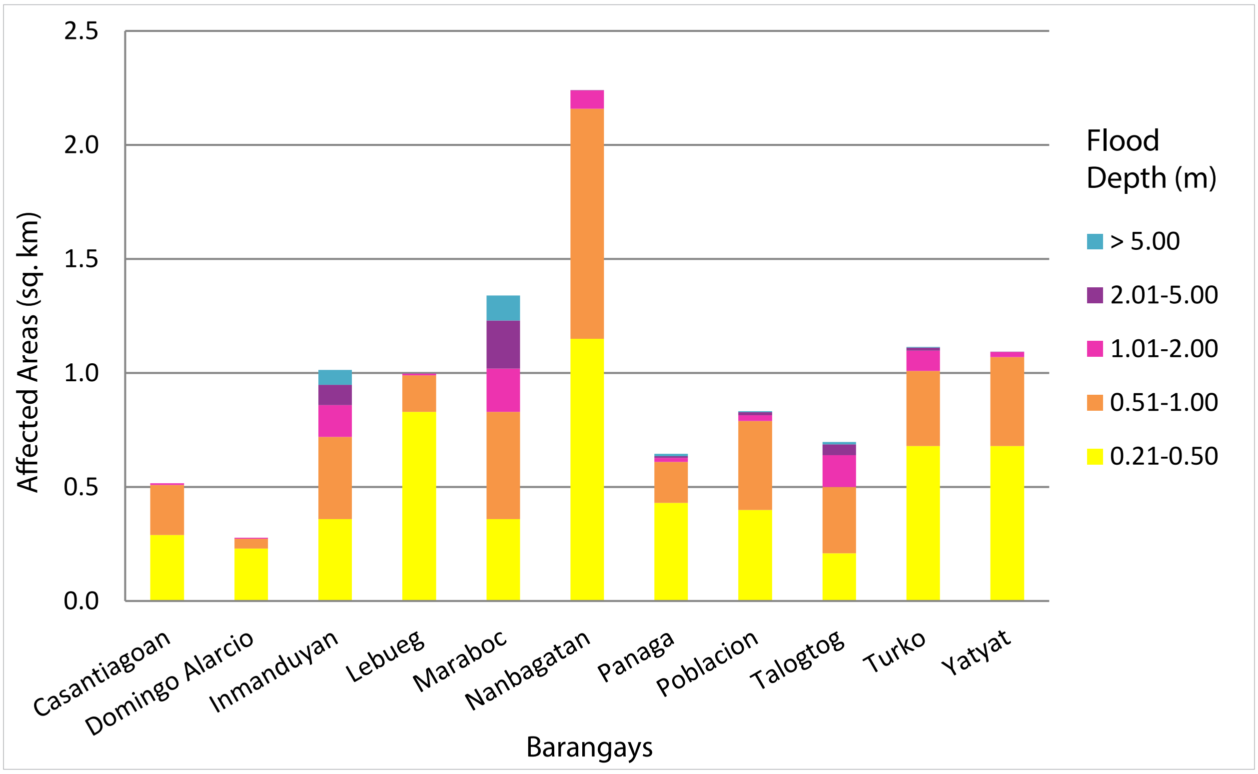


Figure 80. Affected Areas in Laoac, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 57.94% of the municipality of Manaoag with an area of 42.418932 sq. km. will experience flood levels of less than 0.20 meters. 14.09% of the area will experience flood levels of 0.21 to 0.50 meters while 11.95%, 7.28%, 4.42%, and 1.64% 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 48. 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)												
	Babasit	Baguinay	Baritao	Bisal	Bucao	Cabanbanan	Calaocan	Inamotan	Lelemaan	Licsi	Lipit Norte	Lipit Sur	Matolong
0.03-0.20	2.81	0.28	0.89	0.23	0.81	0.33	0.47	2.11	0.46	0.78	1.31	1.24	0.16
0.21-0.50	0.88	0.28	0.44	0.098	0.26	0.14	0.029	0.96	0.28	0.1	0.12	0.071	0.075
0.51-1.00	0.47	0.15	0.27	0.016	0.011	0.34	0.016	0.3	0.39	0.075	0.15	0.051	0.036
1.01-2.00	0.027	0.044	0.25	0	0	0.21	0.0084	0.03	0.46	0.029	0.42	0.052	0.0021
2.01-5.00	0.014	0.054	0.12	0	0	0.24	0.0047	0.0058	0.18	0.0094	0.37	0.11	0.0019
> 5.00	0	0.0048	0.089	0	0	0.073	0	0	0.042	0.021	0.11	0.058	0.0011

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Manaoag (in sq. km)												
	Mermer	Nalsian	Oraan East	Oraan West	Pantal	Pao	Parian	Poblacion	Pugaro	San Ramon	Santa Ines	Sapang	Tebuel
0.03-0.20	0.061	1.35	0.054	0.064	0.32	1.28	0.24	1.39	5.33	0.83	0.22	1.08	0.48
0.21-0.50	0.12	0.38	0.12	0.053	0.087	0.094	0.12	0.11	0.34	0.26	0.48	0.059	0.019
0.51-1.00	0.28	0.31	0.17	0.078	0.076	0.061	0.11	0.099	0.24	0.22	1.09	0.048	0.012
1.01-2.00	0.16	0.17	0.02	0.05	0.037	0.039	0.13	0.13	0.18	0.2	0.4	0.032	0.0096
2.01-5.00	0.23	0.088	0.008	0.021	0.0087	0.052	0.051	0.1	0.087	0.018	0.09	0.0092	0.0031
> 5.00	0.044	0.057	0.0029	0.017	0.022	0.091	0.016	0.0079	0	0.03	0.0079	0	0

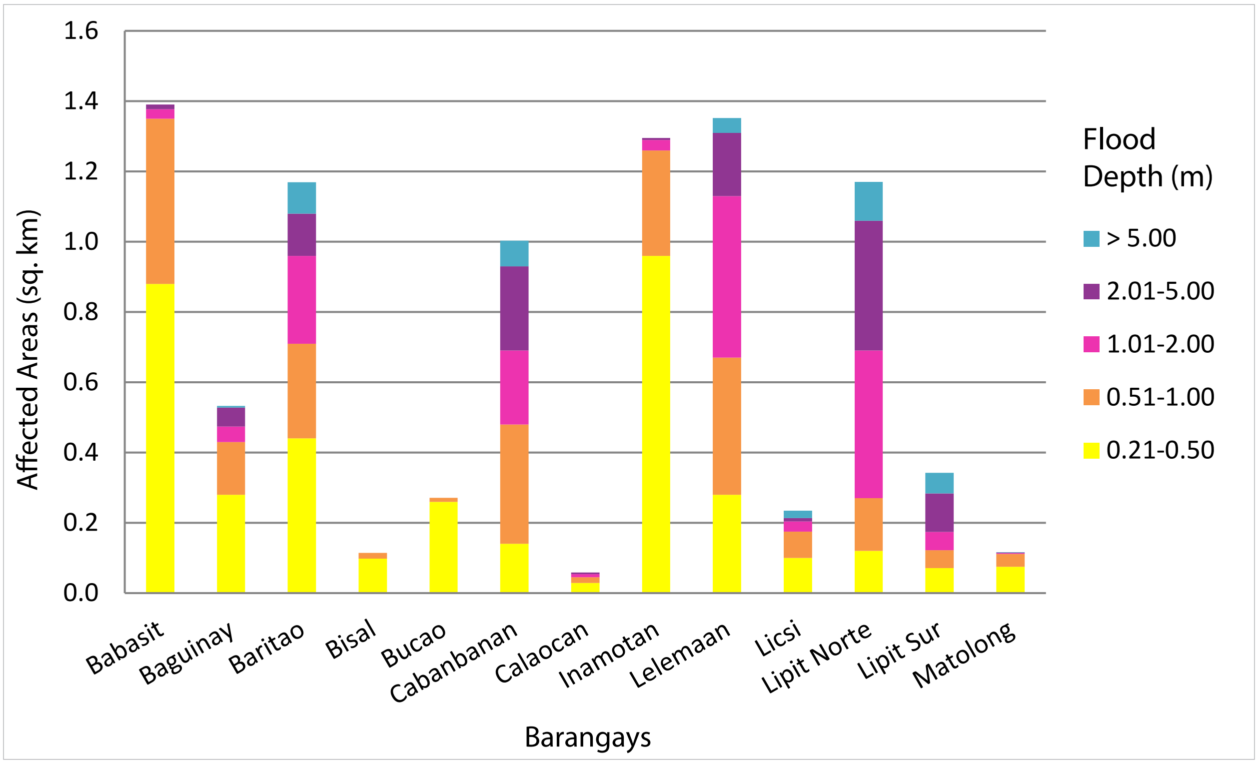


Figure 81. Affected Areas in Manaoag, Pangasinan during 5-Year Rainfall Return Period

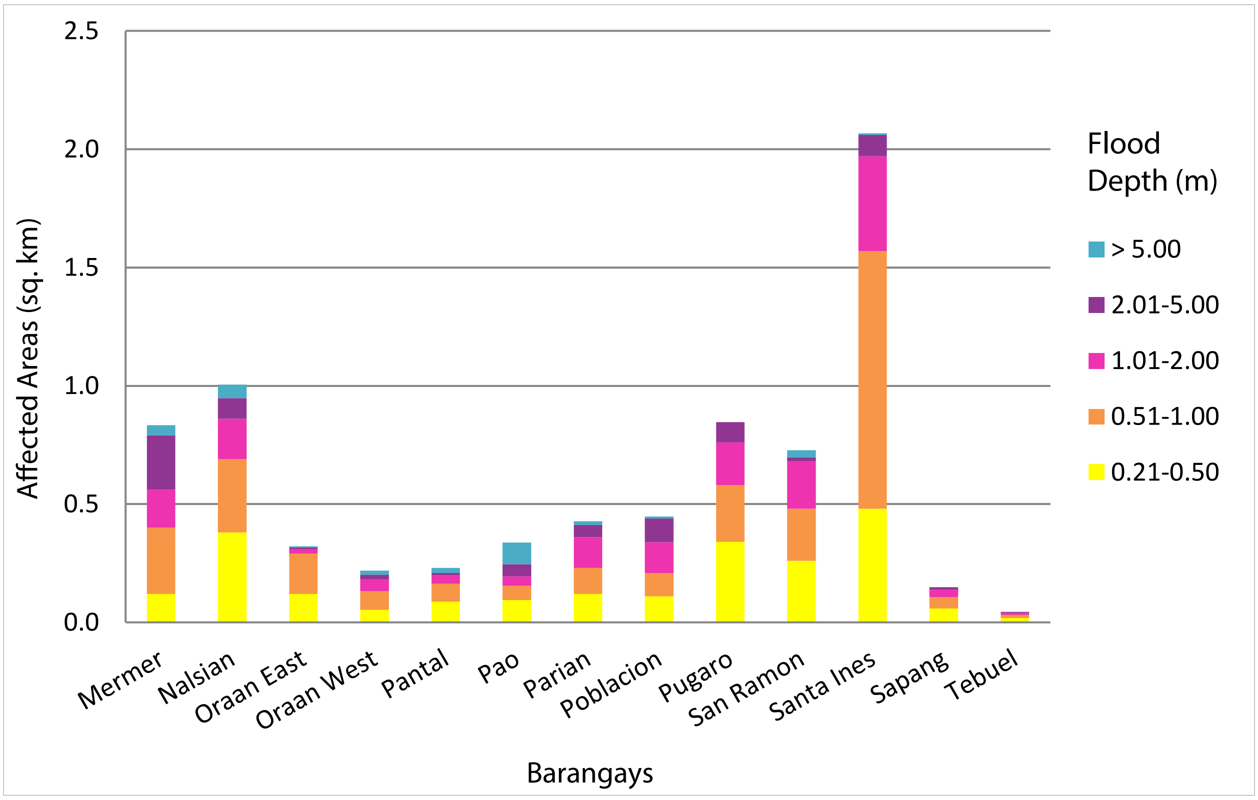


Figure 82. Affected Areas in Manaoag, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 1.09% of the municipality of Mangaldan with an area of 43.415808 sq. km. will experience flood levels of less than 0.20 meters. 0.97% of the area will experience flood levels of 0.21 to 0.50 meters while 1.71%, 5.74%, 3.14%, and 1.64% 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 49. 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)												
	Embarcadero	Guesang	Guiguilonen	Inlambo	Landas	Macayug	Navaluan	Nibaliw	Osiem	Palua	Pogo	Salaan	Tebag
0.03-0.20	0.01	0.15	0.003	0.0011	0.046	0.0032	0.0046	0.0047	0.078	0.084	0.076	0.0089	0.0031
0.21-0.50	0.019	0.036	0.0014	0.003	0.034	0.0034	0.012	0.0042	0.12	0.033	0.15	0.0039	0.002
0.51-1.00	0.088	0.032	0.018	0.028	0.038	0.06	0.022	0.017	0.26	0.02	0.081	0.053	0.025
1.01-2.00	0.54	0.018	0.019	0.65	0.056	0.58	0.0058	0.07	0.31	0.067	0.0046	0.13	0.042
2.01-5.00	0.59	0.073	0.024	0.18	0.091	0.062	0	0.023	0.23	0.0083	0	0.013	0.069
> 5.00	0.17	0.088	0.011	0.00002	0.045	0.037	0	0.069	0.097	0.051	0	0.089	0.056

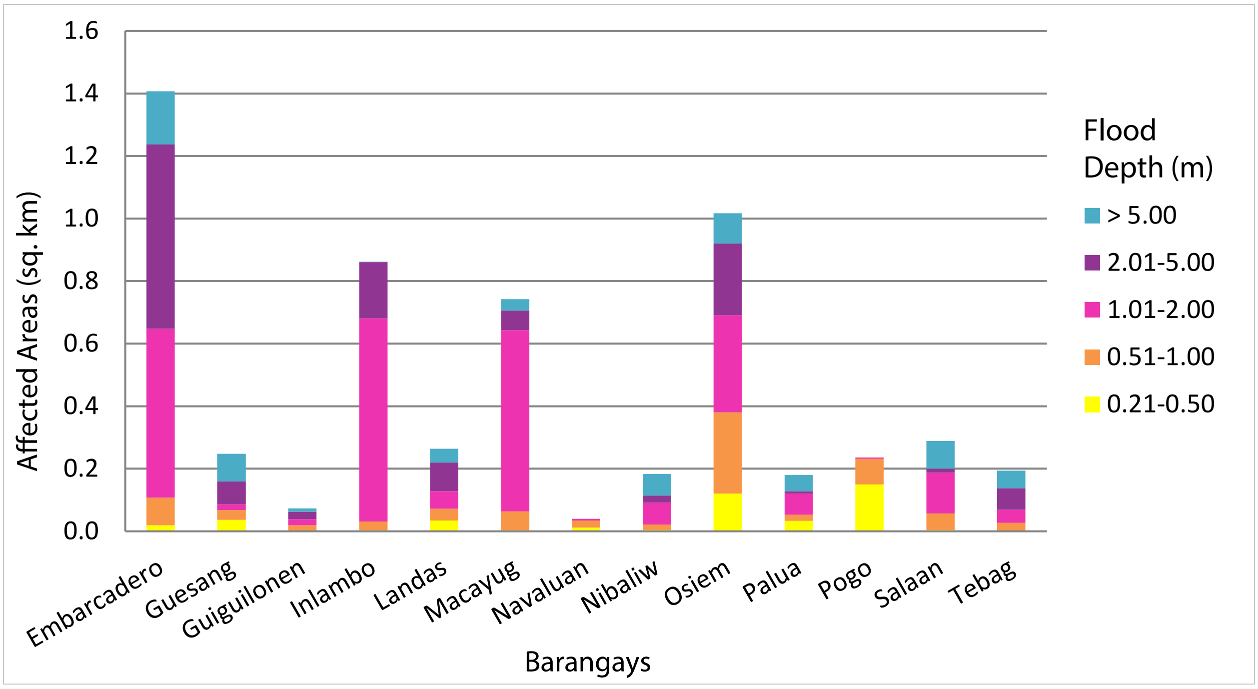


Figure 83. Affected Areas in Mangaldan, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 5.85% of the municipality of Mapandan with an area of 21.351923 sq. km. will experience flood levels of less than 0.20 meters. 3.49% of the area will experience flood levels of 0.21 to 0.50 meters while 5.14%, 5.13%, 5.38%, and 2.00% 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 50. 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)								
	Baloling	Coral	Jimenez	Luyan	Pias	Poblacion	Primicias	Santa Maria	Torres
0.03-0.20	0.69	0.017	0.024	0.28	0.036	0.041	0.0039	0.12	0.037
0.21-0.50	0.29	0.026	0.0082	0.14	0.065	0.054	0.0007	0.14	0.021
0.51-1.00	0.29	0.12	0.031	0.16	0.12	0.13	0.0088	0.23	0.0068
1.01-2.00	0.24	0.043	0.017	0.13	0.11	0.094	0.0082	0.45	0.0033
2.01-5.00	0.054	0.026	0.11	0.14	0.096	0.19	0.0023	0.4	0.13
> 5.00	0.015	0.028	0	0.066	0.088	0.079	0	0.15	0

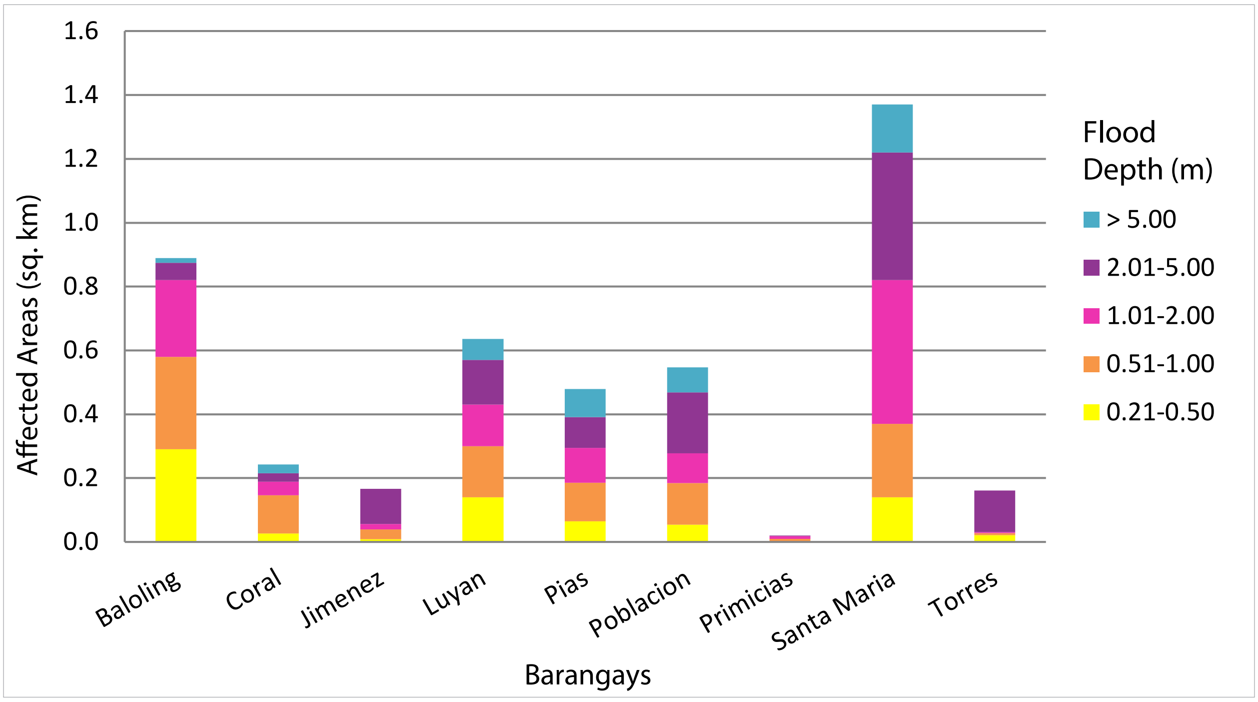


Figure 84. Affected Areas in Mapandan, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 64.59% of the municipality of Pozzorubio with an area of 74.749443 sq. km. will experience flood levels of less than 0.20 meters. 15.29% of the area will experience flood levels of 0.21 to 0.50 meters while 8.31%, 4.46%, 3.81%, and 0.23% 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 Pozzorubio, Pangasinan during 5-Year Rainfall Return Period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Pozzorubio (in sq. km)											
	Alipangpang	Amagbagan	Balacag	Banding	Bantugan	Batakil	Bobonan	Buneg	Cablong	Casanfernandoan	Castaño	Dilan
0.03-0.20	0.96	2.01	4.44	1.8	1.37	0.86	1.43	0.91	1.04	2.48	2.81	1.41
0.21-0.50	0.81	0.79	0.27	0.55	0.39	0.12	0.35	0.72	0.14	0.15	0.3	0.27
0.51-1.00	0.23	0.25	0.19	0.083	0.2	0.014	0.23	0.67	0.016	0.12	0.32	0.18
1.01-2.00	0.056	0.044	0.23	0.01	0.083	0.0001	0.19	0.045	0.0008	0.18	0.34	0.17
2.01-5.00	0	0.0002	1.23	0	0.0032	0	0.094	0.0023	0	0.41	0.11	0.33
> 5.00	0	0	0.083	0	0	0	0.0002	0	0	0	0	0.082

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Pozzorubio (in sq. km)										
	Don Benito	Haway	Imbalbalatong	Inoman	Laoac	Maambal	Malasin	Malokiat	Manaol	Nama	Nantangalan
0.03-0.20	1.5	2.47	2.6	1.11	1.53	1.15	0.37	1.34	0.19	1.22	4.07
0.21-0.50	0.085	0.17	0.27	0.33	0.3	0.069	0.23	0.15	0.27	0.24	0.4
0.51-1.00	0.055	0.12	0.046	0.3	0.18	0.069	0.11	0.17	0.2	0.15	0.29
1.01-2.00	0.051	0.016	0.054	0.22	0.013	0.041	0.11	0.16	0.21	0.22	0.32
2.01-5.00	0.037	0.0007	0.016	0.055	0.0002	0.029	0.099	0.1	0.038	0.085	0.2
> 5.00	0	0	0	0	0	0.0001	0.0035	0	0	0	0

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Pozzorubio (in sq. km)										
	Palacpalac	Palguyod	Poblacion I	Poblacion II	Poblacion III	Poblacion IV	Rosario	Sugcong	Talogtog	Tulnac	Villegas
0.03-0.20	0.44	0.72	0.18	0.17	0.58	0.31	2.53	0.95	0.71	1.68	0.94
0.21-0.50	0.19	0.27	0.071	0.033	0.18	0.2	2.05	0.038	0.46	0.38	0.18
0.51-1.00	0.19	0.43	0.0001	0.012	0.08	0.058	0.96	0.014	0.091	0.031	0.15
1.01-2.00	0.16	0.16	0	0.0019	0.058	0.028	0.097	0.0014	0.0063	0.0068	0.048
2.01-5.00	0	0.0032	0	0	0.00013	0.0011	0.0035	0	0	0	0.00036
> 5.00	0	0	0	0	0	0	0	0	0	0	0

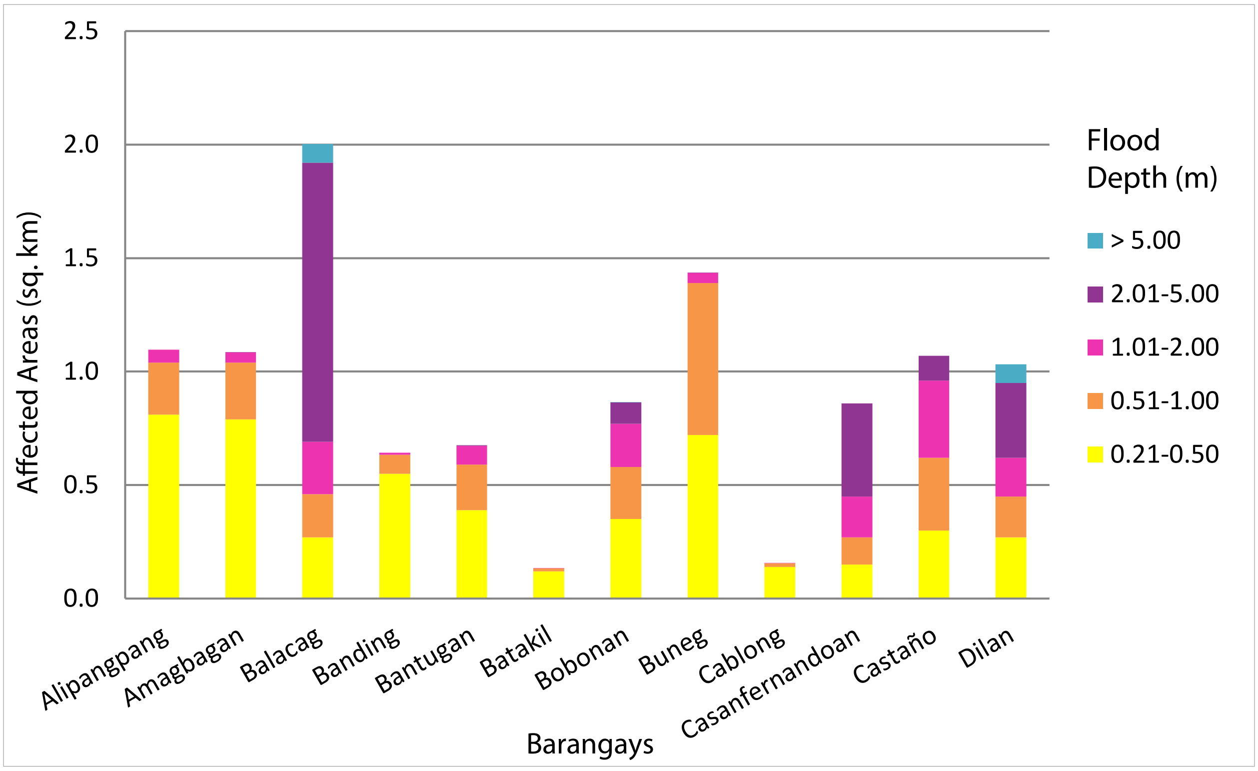


Figure 85. Affected Areas in Pozzorubio, Pangasinan during 5-Year Rainfall Return Period

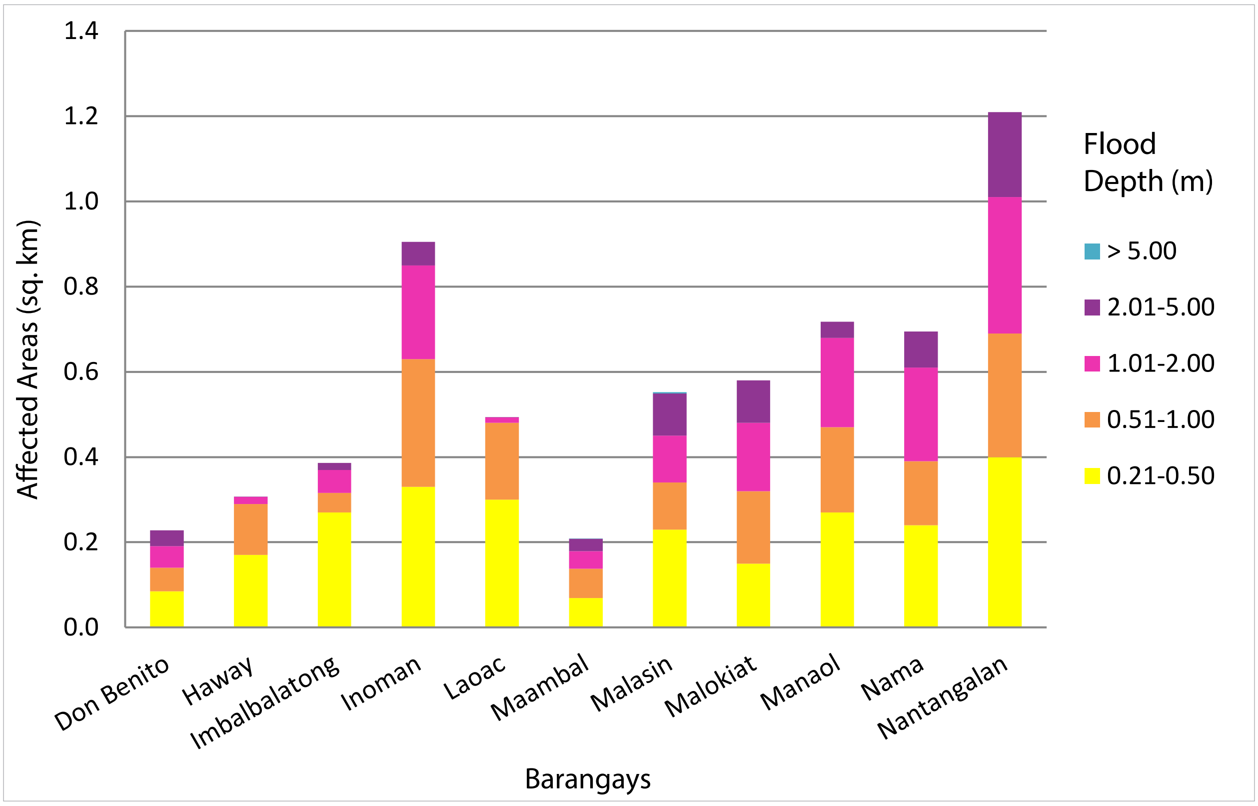


Figure 86. Affected Areas in Pozzorubio, Pangasinan during 5-Year Rainfall Return Period

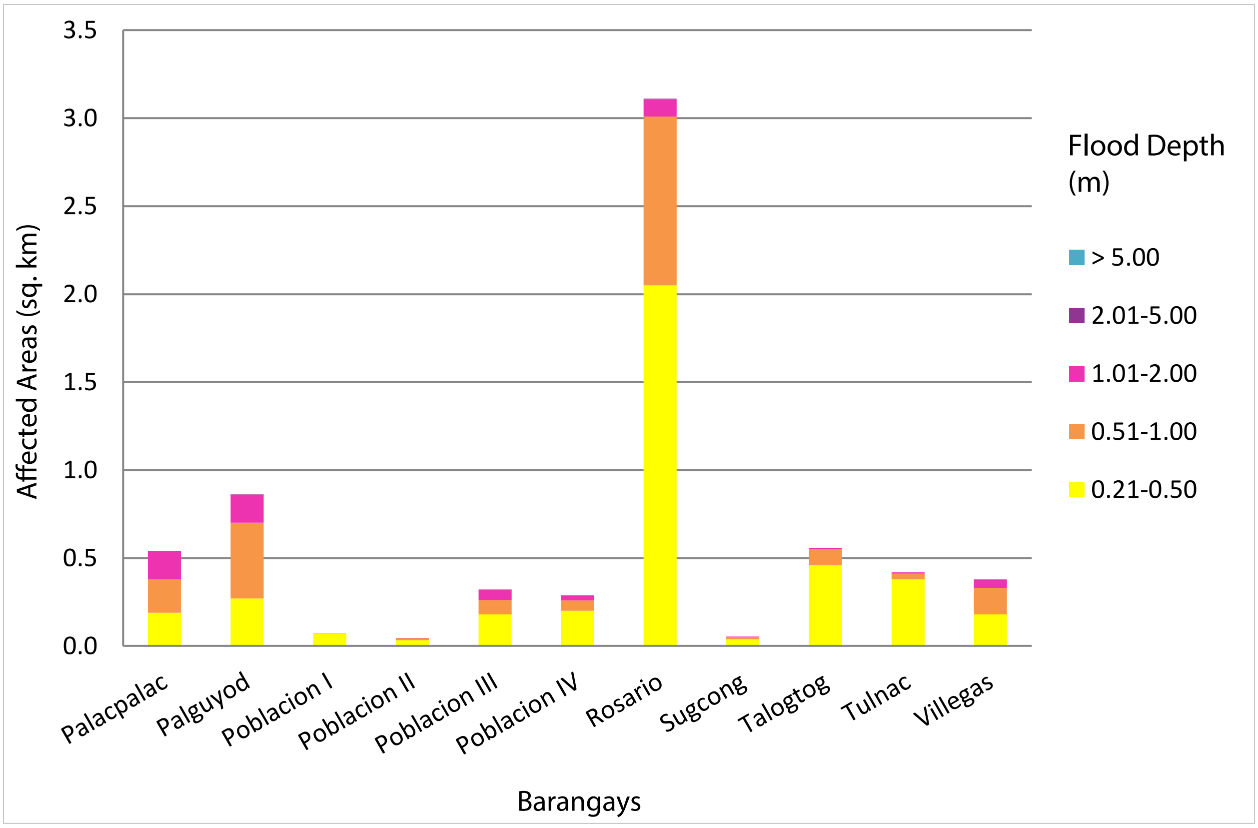


Figure 87. Affected Areas in Pozzorubio, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 27.20% of the municipality of San Fabian with an area of 69.270236 sq. km. will experience flood levels of less than 0.20 meters. 7.77% of the area will experience flood levels of 0.21 to 0.50 meters while 6.10%, 9.89%, 2.86%, 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 52. 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)												
	Ambalangan-Dalin	Angio	Anonang	Aramal	Binday	Bolasi	Cabaruan	Cayanga	Colisao	Lekep-Butao	Longos	Longos-Amangonan-Parac-Parac Fabrica	Tebag
0.03-0.20	0.37	2.15	1.93	1.9	1.6	1.07	0.21	0.17	0.64	2.57	0.27	0.011	0.0031
0.21-0.50	0.024	0.59	0.29	0.79	0.076	0.51	0.092	0.17	0.045	0.79	0.3	0.026	0.002
0.51-1.00	0.0094	0.1	0.018	0.13	0.044	0.087	0.13	0.24	0.019	0.74	0.47	0.23	0.025
1.01-2.00	0.0023	0.0021	0.0000078	0	0.038	0.001	0.57	0.43	0.00041	2.15	0.28	0.46	0.042
2.01-5.00	0.0002	0	0	0	0.018	0	0.079	0.18	0	0.61	0.16	0.043	0.069
> 5.00	0	0	0	0	0.006	0	0	0.059	0	0.11	0.04	0	0.056

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Fabian (in sq. km)												
	Longos Proper	Nibaliw Central	Nibaliw East	Nibaliw Magliba	Nibaliw Narvarte	Nibaliw Vidal	Palapad	Poblacion	Sagud-Bahley	Sobol	Tempra-Guilig	Tocok	Tebag
0.03-0.20	0.039	0.015	0.25	0.25	0.24	0.1	2.57	0.22	0.11	0.29	0.028	1.84	0.0031
0.21-0.50	0.022	0.036	0.14	0.035	0.062	0.0098	0.26	0.1	0.072	0.1	0.093	0.75	0.002
0.51-1.00	0.08	0.13	0.19	0.021	0.13	0.0074	0.14	0.08	0.073	0.1	0.27	0.79	0.025
1.01-2.00	0.075	0.19	0.24	0.0075	0.31	0.033	0.051	0.21	0.17	0.2	0.53	0.9	0.042
2.01-5.00	0.0051	0.088	0.028	0	0.019	0.006	0.018	0.079	0.057	0.0067	0.56	0.026	0.069
> 5.00	0.012	0	0	0	0	0	0	0	0	0	0	0	0.056

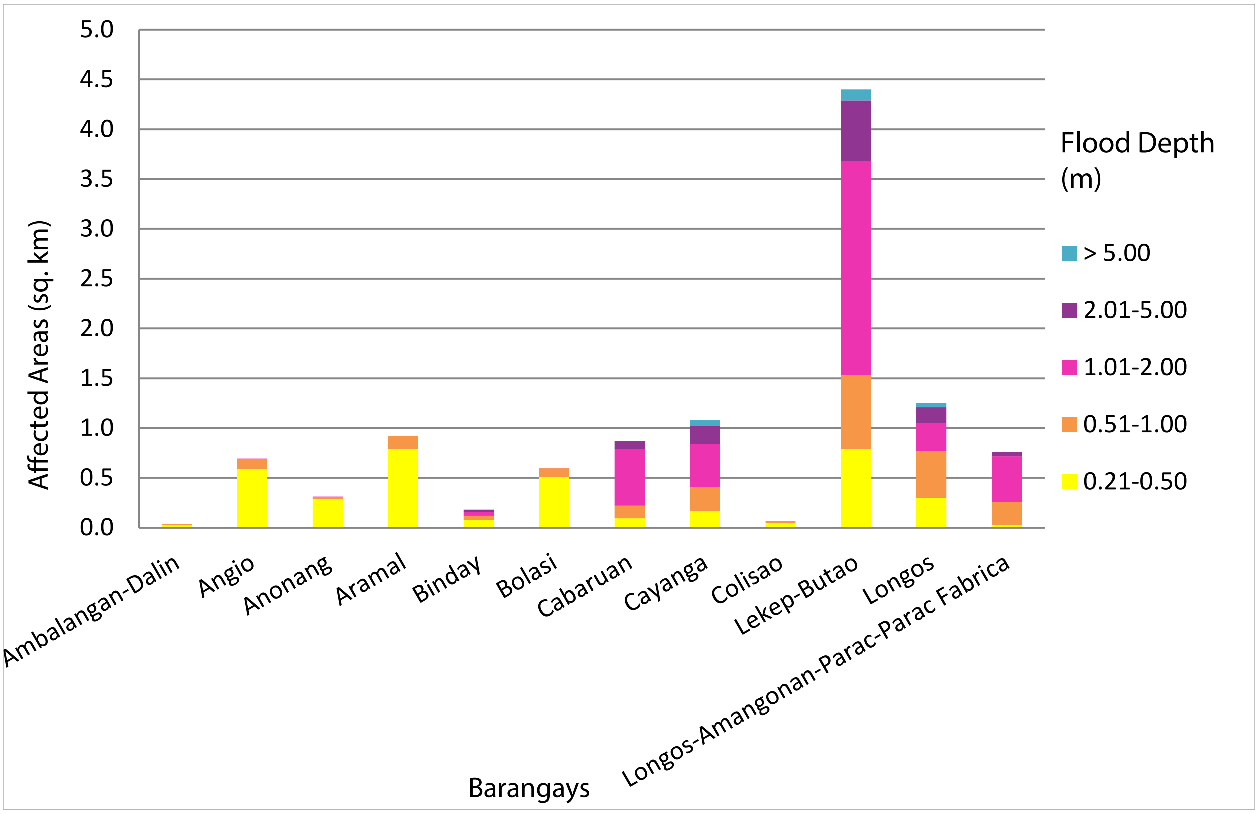


Figure 88. Affected Areas in San Fabian, Pangasinan during 5-Year Rainfall Return Period

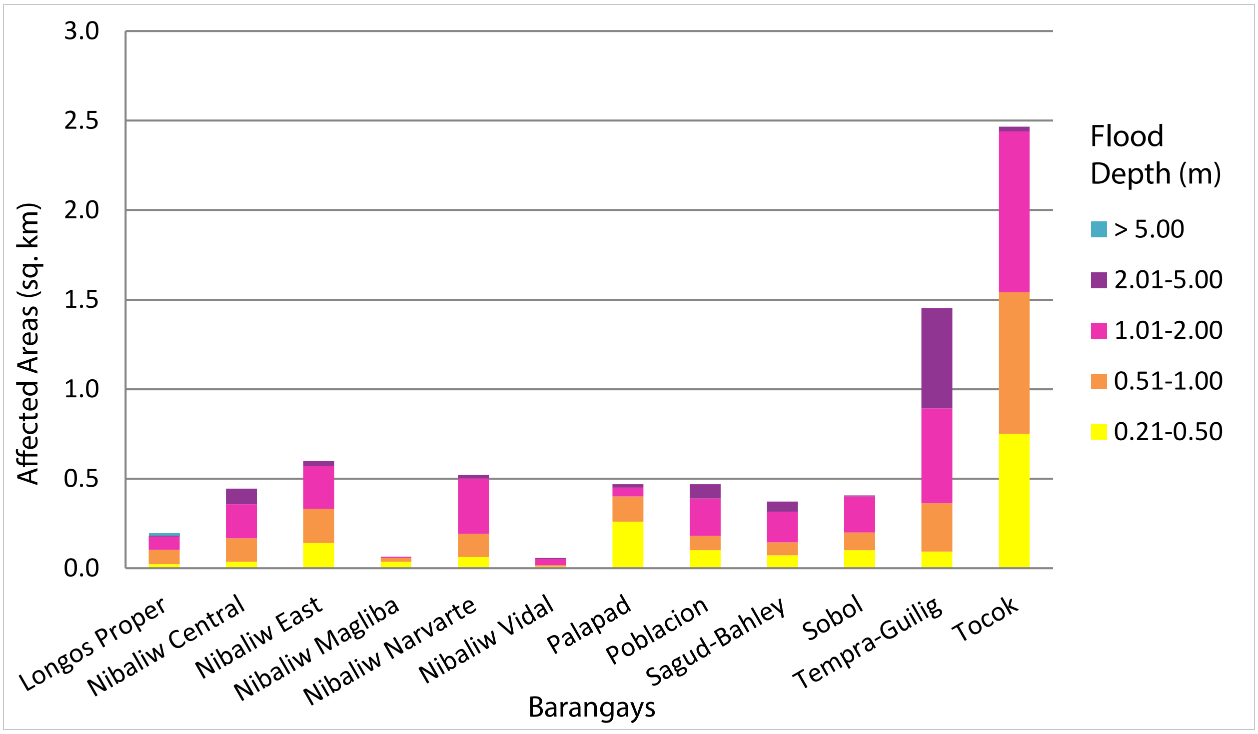


Figure 89. Affected Areas in San Fabian, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 42.72% of the municipality of San Jacinto with an area of 34.091828 sq. km. will experience flood levels of less than 0.20 meters. 10.07% of the area will experience flood levels of 0.21 to 0.50 meters while 10.31%, 19.34%, 12.36%, and 5.08% 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 53. Affected Areas in San Jacinto, Pangasinan during 5-Year Rainfall Return Period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Jacinto (in sq. km)									
	Awai	Bagong Pag-asa	Bolo	Capaoay	Casibong	Guibel	Imelda	Labney	Lobong	Macayug
0.03-0.20	2.84	0	0.34	0.013	0.0091	0.46	0.083	2.84	2.18	0.99
0.21-0.50	0.2	0	0.012	0.028	0.014	0.35	0.093	0.29	0.63	0.56
0.51-1.00	0.18	0.00057	0.025	0.095	0.05	0.7	0.07	0.18	0.32	0.66
1.01-2.00	0.12	0.036	0.18	0.16	0.41	1.74	0.0092	0.11	0.11	1.36
2.01-5.00	0.077	0.15	0.19	0.16	0.2	0.86	0	0.26	0.03	0.5
> 5.00	0	0.0033	0.069	0	0	0.0043	0	0.72	0.0098	0.27

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Jacinto (in sq. km)								
	Magsaysay	San Guillermo	San Jose	San Juan	San Roque	San Vicente	Santa Cruz	Santa Maria	Santo Tomas
0.03-0.20	0	0.0011	0.32	3.09	0.41	0.013	0.3	0.67	0.0056
0.21-0.50	0.000095	0.0054	0.11	0.39	0.2	0.0089	0.041	0.5	0.0021
0.51-1.00	0.007	0.013	0.11	0.24	0.32	0.034	0.0089	0.43	0.071
1.01-2.00	0.069	0.15	0.45	0.11	0.43	0.42	0.048	0.41	0.27
2.01-5.00	0.084	0.23	0.88	0.026	0.028	0.33	0.14	0	0.07
> 5.00	0.0012	0.0029	0.46	0	0	0.082	0.052	0	0.056

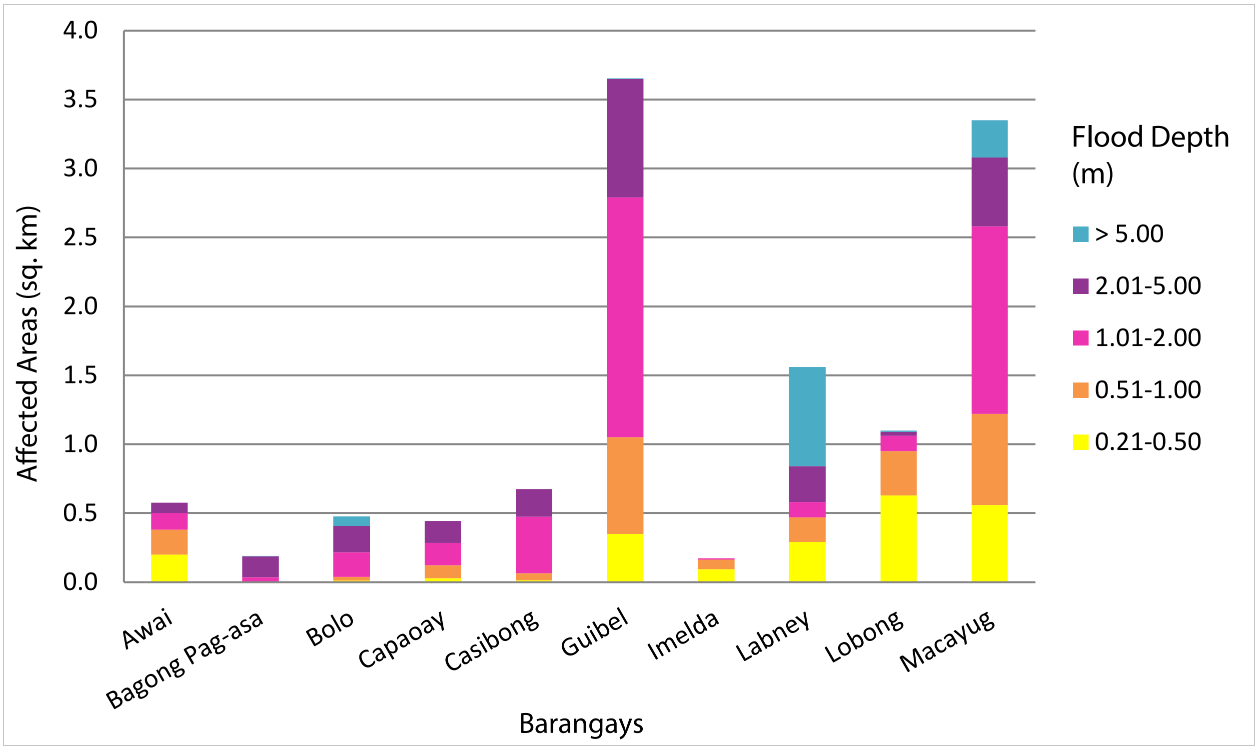


Figure 90. Affected Areas in San Jacinto, Pangasinan during 5-Year Rainfall Return Period

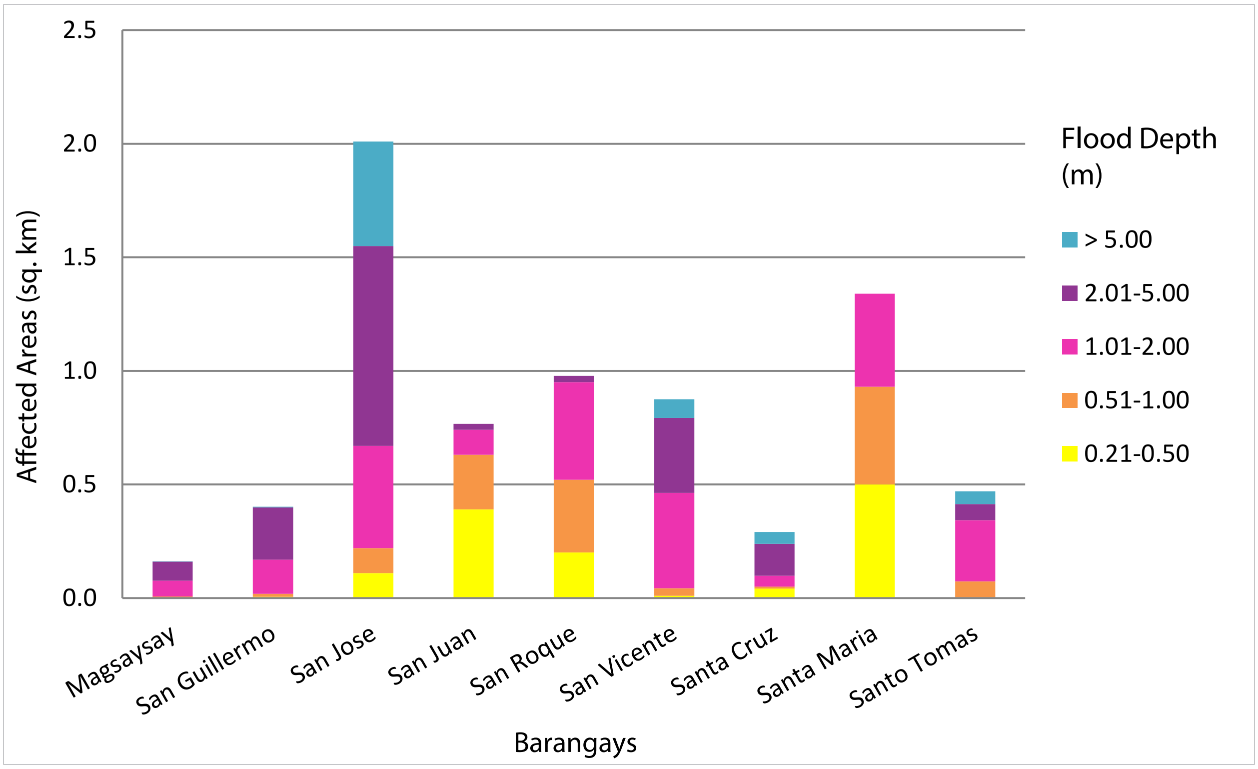


Figure 91. Affected Areas in San Jacinto, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 4.80% of the municipality of Sison with an area of 151.961994 sq. km. will experience flood levels of less than 0.20 meters. 0.81% of the area will experience flood levels of 0.21 to 0.50 meters while 0.79%, 0.58%, and 0.37% 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 54. Affected Areas in Sison, Pangasinan during 5-Year Rainfall Return Period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Sison (in sq. km)					
	Alibeng	Calunetan	Camangaan	Killo	Labayug	Tara-Tara
0.03-0.20	2.01	3.26	0.15	1.59	0.2	0.077
0.21-0.50	0.12	0.4	0.0076	0.68	0.026	0.0035
0.51-1.00	0.059	0.6	0.0006	0.53	0.011	0.00079
1.01-2.00	0.024	0.48	0	0.37	0.0017	0.0055
2.01-5.00	0.0093	0.14	0	0.21	0.007	0.19
> 5.00	0	0.0001	0	0.0003	0	0.0032

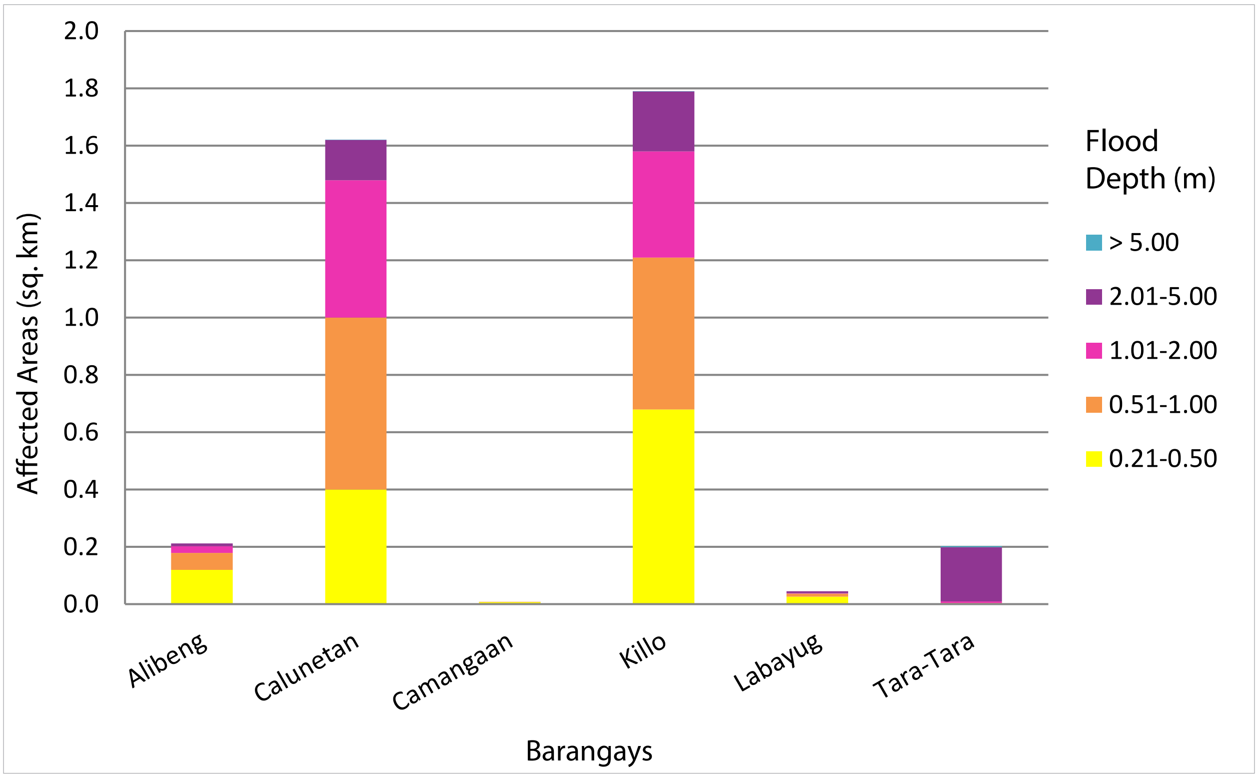


Figure 92. Affected Areas in Sison, Pangasinan during 5-Year Rainfall Return Period

For the 5-year return period, 1.84% of the municipality of Urdaneta City with an area of 107.789848 sq. km. will experience flood levels of less than 0.20 meters. 0.51% of the area will experience flood levels of 0.21 to 0.50 meters while 0.11%, 0.06%, and 0.04% 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 55. 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)			
	Camantiles	Cayambanan	Pinmaludpod	Tulong
0.03-0.20	1.27	0.0021	0.48	0.23
0.21-0.50	0.35	0.000024	0.14	0.059
0.51-1.00	0.074	0.000000038	0.042	0.0065
1.01-2.00	0.04	0	0.028	0.0000093
2.01-5.00	0.025	0	0.014	0
> 5.00	0	0	0.0001	0

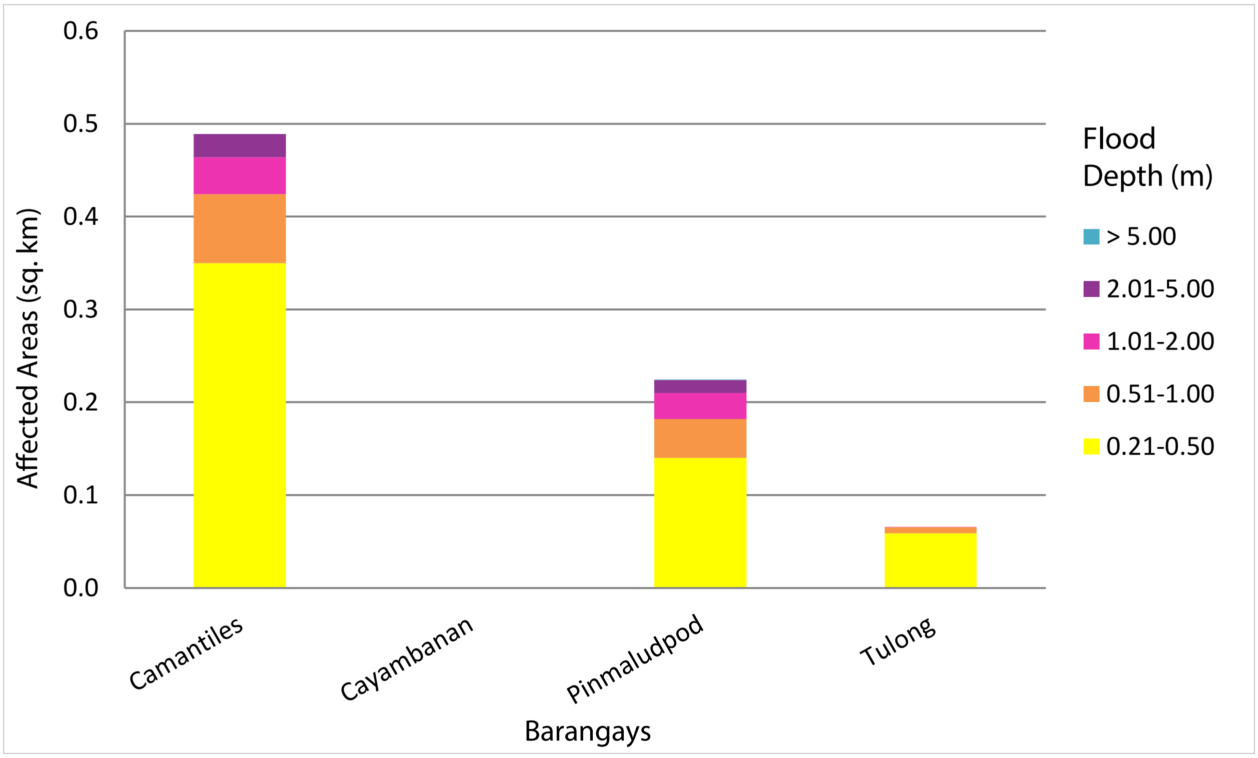


Figure 93. Affected Areas in Urdaneta City, Pangasinan during 5-Year Rainfall Return Period

For the 25-year return period, 15.06% of the municipality of Binalonan with an area of 78.537828 sq. km. will experience flood levels of less than 0.20 meters. 8.30% of the area will experience flood levels of 0.21 to 0.50 meters while 6.80%, 5.90%, 1.46%, and 0.25% 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 56. Affected Areas in Binalonan, Pangasinan during 25-Year Rainfall Return Period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binalonan (in sq. km)							
	Bued	Bugayong	Camangaan	Canarvacanan	Cili	Dumayat	Linmansangan	Pasileng Norte
0.03-0.20	0.27	1.87	2.68	0.26	1.31	0.52	0.28	0.07
0.21-0.50	0.36	1.02	0.94	0.2	0.55	0.38	0.25	0.046
0.51-1.00	0.54	0.37	0.95	0.54	0.5	0.069	0.57	0.035
1.01-2.00	0.3	0.22	0.67	0.76	0.88	0.0001	0.46	0.0078
2.01-5.00	0.0003	0.11	0.5	0.018	0.076	0	0.0069	0
> 5.00	0	0.0081	0.15	0	0	0	0	0

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binalonan (in sq. km)							
	Poblacion	San Felipe Sur	Santa Maria Norte	Santiago	Santo Niño	Sumabnit	Tabuyoc	Vacante
0.03-0.20	0.8	0.028	0.27	0.23	0.02	0.62	1.13	1.47
0.21-0.50	0.41	0.0027	0.17	0.2	0.00035	0.55	0.6	0.84
0.51-1.00	0.18	0	0.29	0.41	0	0.46	0.14	0.29
1.01-2.00	0.039	0	0.4	0.32	0	0.25	0.038	0.29
2.01-5.00	0	0	0.025	0.0039	0	0	0	0.41
> 5.00	0	0	0	0	0	0	0	0.037

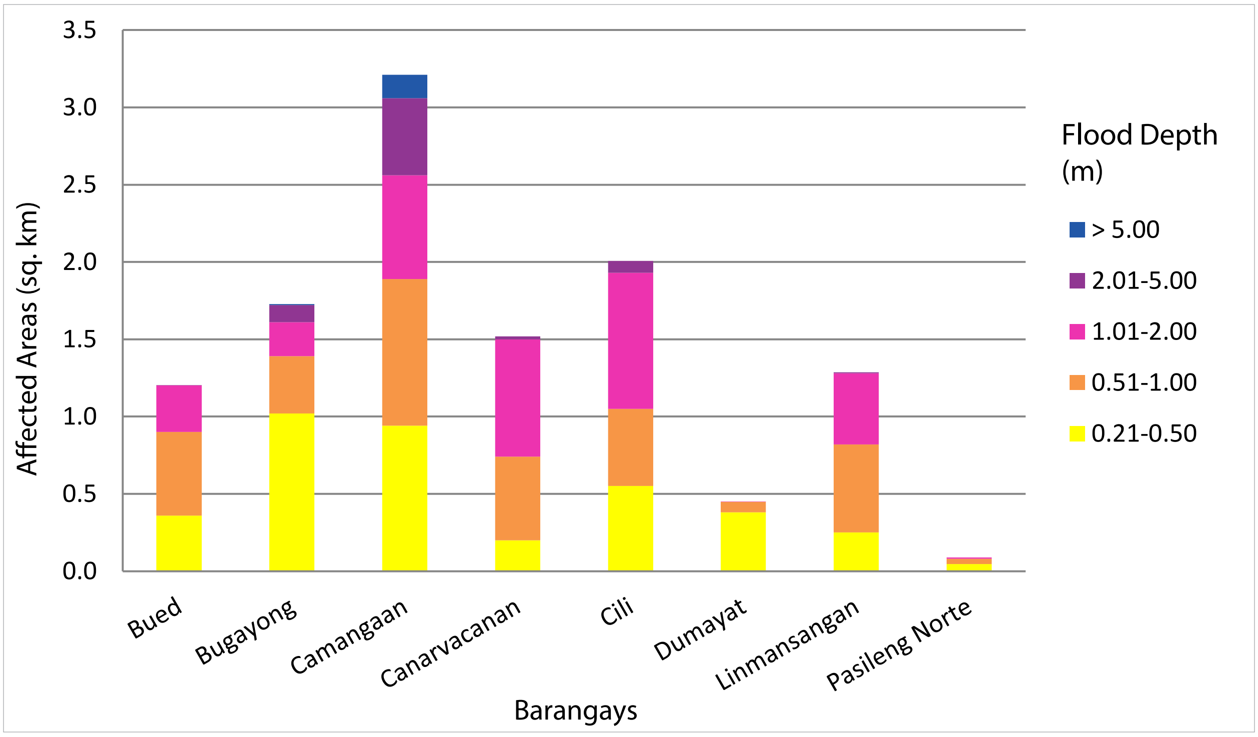


Figure 94. Figure 87. Affected Areas in Binalonan, Pangasinan during 25-Year Rainfall Return Period

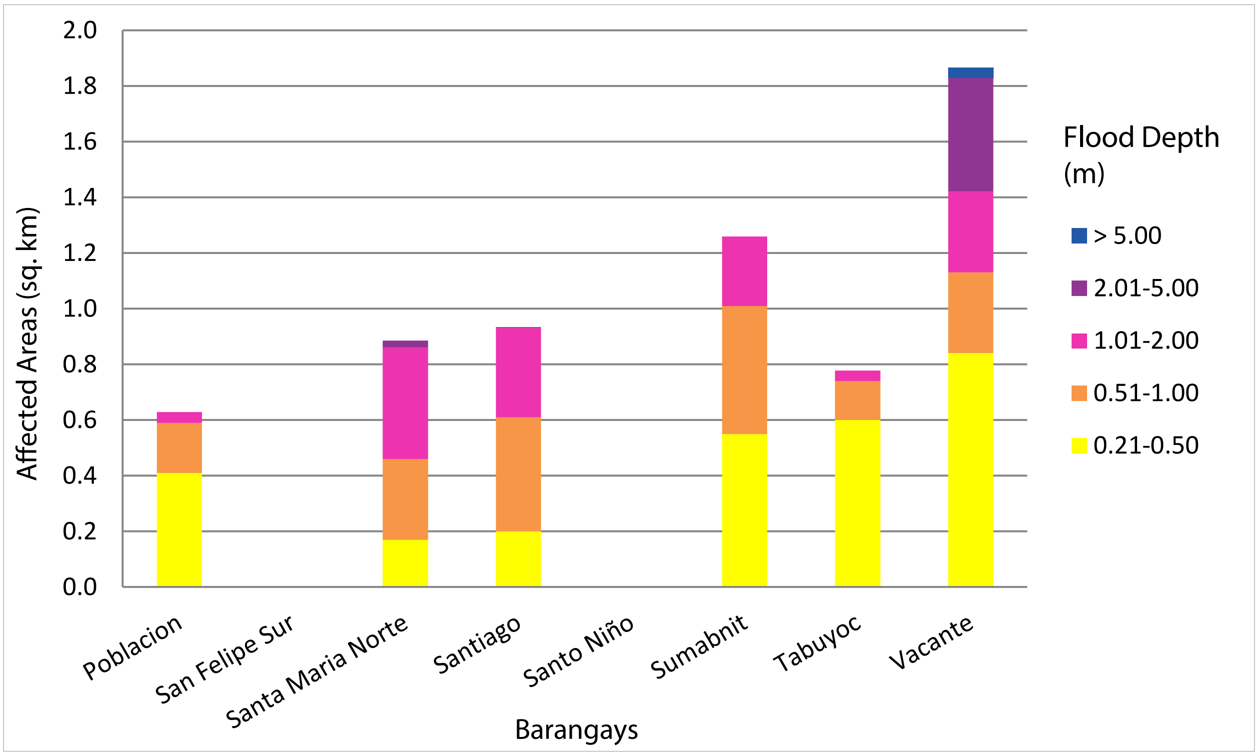


Figure 95. Figure 87. Affected Areas in Binalonan, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 0.69% of the municipality of Dagupan City with an area of 47.755696 sq. km. will experience flood levels of less than 0.20 meters. 0.23% of the area will experience flood levels of 0.21 to 0.50 meters while 0.40%, 1.40%, and 0.21% 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 57. 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)
	Bonuan Binloc
0.03-0.20	0.33
0.21-0.50	0.11
0.51-1.00	0.19
1.01-2.00	0.67
2.01-5.00	0.099
> 5.00	0

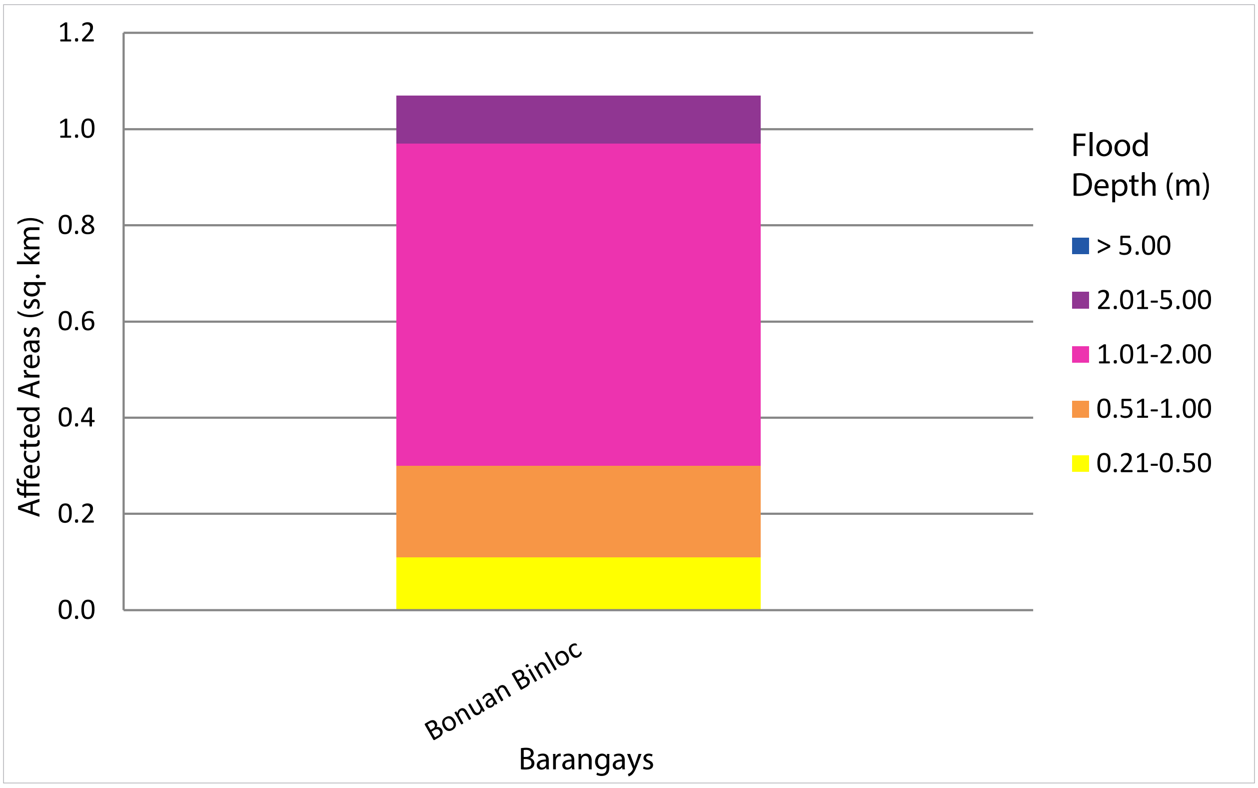


Figure 96. Affected Areas in Dagupan City, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 21.94% of the municipality of Laoac with an area of 40.697535 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 32.53%, 17.40%, 3.63%, and 1.38% 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 58. 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)										
	Anis	Balligi	Banuar	Botique	Caaringayan	Cabilaoan West	Cabulalaan	Calaoagan	Calmay	Casampagaan	Casanestebanan
0.03-0.20	0.59	0.59	0.13	0.39	0.41	0.86	0.44	0.1	0.014	1.53	0.053
0.21-0.50	0.3	0.72	0.22	0.33	0.74	0.92	0.22	0.11	0.071	1.22	0.11
0.51-1.00	0.24	0.14	0.42	0.4	1.5	0.88	0.39	0.13	0.73	0.95	0.92
1.01-2.00	0.11	0.0044	0.34	0.35	0.49	0.24	0.32	0.089	1.13	0.16	0.74
2.01-5.00	0	0.014	0.11	0.27	0.0005	0	0.22	0.027	0.17	0.0001	0.19
> 5.00	0	0.00029	0.017	0.066	0	0	0.073	0.024	0.044	0	0.035

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Laoac (in sq. km)										
	Casantiagoan	Domingo Alarcio	Inmanduyan	Lebueg	Maraboc	Nanbagatan	Panaga	Poblacion	Talogtog	Turko	Yatyat
0.03-0.20	0.42	0.51	0.75	0.53	0.16	0.33	0.074	0.21	0.12	0.23	0.49
0.21-0.50	0.29	0.33	0.26	0.65	0.19	0.5	0.38	0.32	0.13	0.51	0.66
0.51-1.00	0.29	0.11	0.41	0.65	0.4	1.66	0.46	0.52	0.25	1.02	0.77
1.01-2.00	0.15	0.011	0.58	0.029	0.8	0.46	0.099	0.19	0.3	0.23	0.26
2.01-5.00	0.00085	0.0001	0.11	0	0.23	0.011	0.0065	0.013	0.059	0.037	0.007
> 5.00	0	0	0.091	0	0.18	0	0.011	0.0049	0.013	0.0022	0

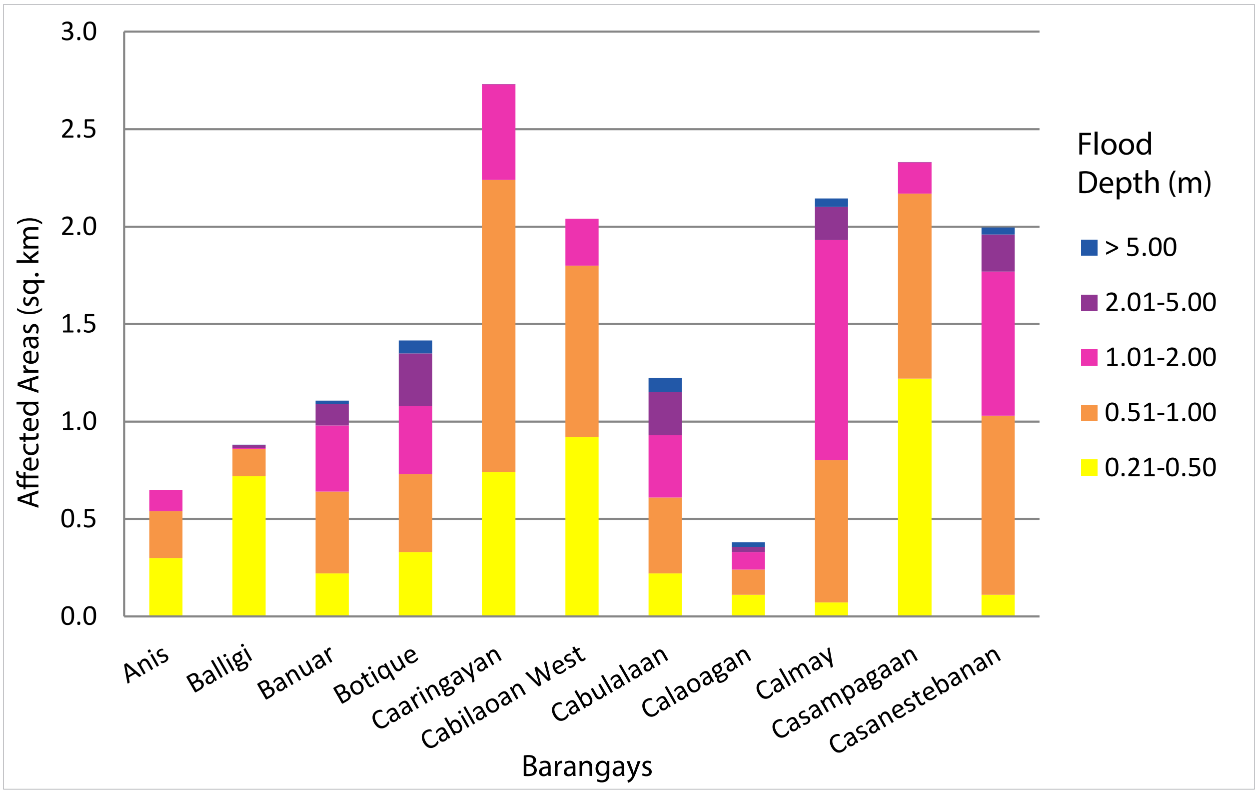


Figure 97. Affected Areas in Laoac, Pangasinan during 25-Year Rainfall Return Period

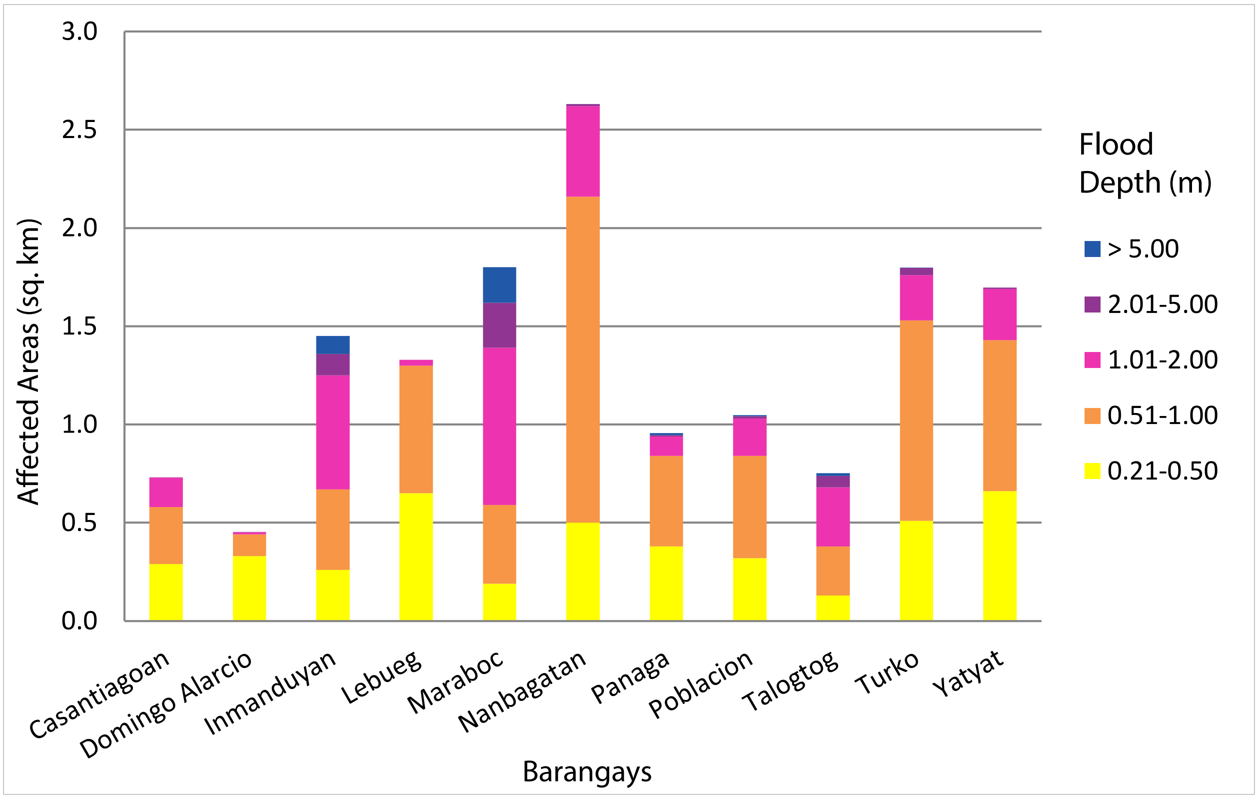


Figure 98. Affected Areas in Laoac, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 45.37% of the municipality of Manaoag with an area of 42.418932 sq. km. will experience flood levels of less than 0.20 meters. 11.30% of the area will experience flood levels of 0.21 to 0.50 meters while 13.80%, 16.60%, 7.93%, and 2.32% 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 59. 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)												
	Babasit	Baguinay	Baritao	Bisal	Bucao	Cabanbanan	Calaocan	Inamotan	Lelemaan	Licsi	Lipit Norte	Lipit Sur	Matolong
0.03-0.20	2.48	0.013	0.64	0.15	0.66	0.14	0.46	1.04	0.12	0.72	0.96	0.91	0.013
0.21-0.50	0.75	0.033	0.42	0.15	0.38	0.071	0.028	0.89	0.099	0.12	0.17	0.13	0.015
0.51-1.00	0.89	0.13	0.4	0.041	0.047	0.1	0.022	1.04	0.29	0.08	0.19	0.19	0.1
1.01-2.00	0.069	0.53	0.35	0	0	0.52	0.014	0.42	0.87	0.058	0.2	0.11	0.14
2.01-5.00	0.02	0.083	0.15	0	0	0.37	0.0072	0.022	0.37	0.011	0.77	0.15	0.0031
> 5.00	0.0001	0.021	0.095	0	0	0.12	0	0	0.059	0.022	0.2	0.094	0.0019

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Manaoag (in sq. km)												
	Mermer	Nalsian	Oraan East	Oraan West	Pantal	Pao	Parian	Poblacion	Pugaro	San Ramon	Santa Ines	Sapang	Tebuel
0.03-0.20	0.00084	1.09	0	0.000071	0.24	1.16	0.023	1.2	5.1	0.6	0.057	1	0.47
0.21-0.50	0.0029	0.36	0.0058	0.0014	0.066	0.11	0.035	0.15	0.41	0.23	0.086	0.059	0.021
0.51-1.00	0.1	0.36	0.036	0.039	0.094	0.082	0.22	0.14	0.27	0.29	0.63	0.057	0.015
1.01-2.00	0.46	0.35	0.31	0.16	0.12	0.075	0.22	0.16	0.25	0.36	1.23	0.055	0.011
2.01-5.00	0.28	0.11	0.025	0.058	0.012	0.067	0.15	0.17	0.16	0.052	0.26	0.058	0.0057
> 5.00	0.048	0.069	0.006	0.028	0.022	0.11	0.027	0.013	0.0001	0.031	0.017	0.000045	0

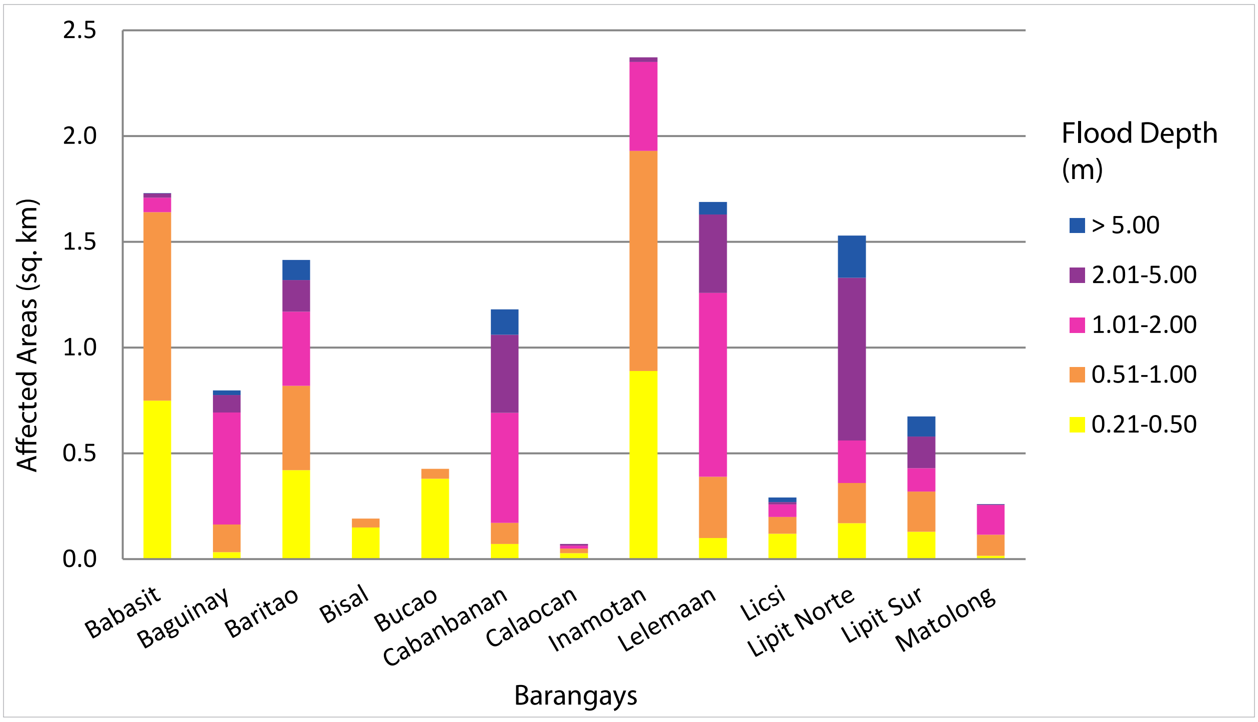


Figure 99. Affected Areas in Manaoag, Pangasinan during 25-Year Rainfall Return Period

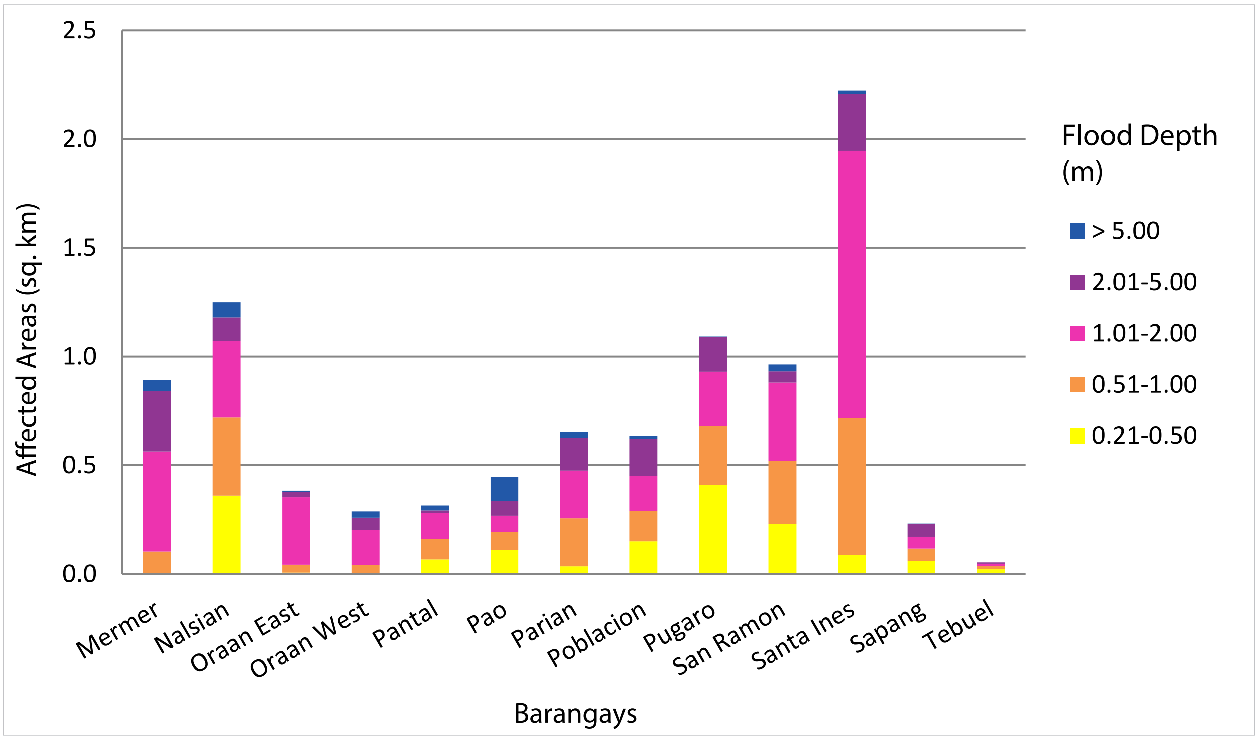


Figure 100. Affected Areas in Manaoag, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 0.53% of the municipality of Mangaldan with an area of 43.415808 sq. km. will experience flood levels of less than 0.20 meters. 0.66% of the area will experience flood levels of 0.21 to 0.50 meters while 1.34%, 4.38%, 5.63%, and 1.76% 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 60. 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)											
	Embarcadero	Guesang	Guiguilonen	Inlambo	Landas	Macayug	Navaluan	Nibaliw	Osiem	Palua	Pogo	Salaan	Tebag
0.03-0.20	0.004	0.12	0.0018	0	0.023	0.00072	0.00015	0.00054	0.01	0.039	0.023	0.0063	0.0015
0.21-0.50	0.0043	0.05	0.0013	0.0007	0.026	0.0013	0.0052	0.0044	0.041	0.067	0.079	0.0024	0.0018
0.51-1.00	0.036	0.044	0.0077	0.0041	0.042	0.0067	0.022	0.0074	0.18	0.015	0.2	0.0087	0.01
1.01-2.00	0.31	0.024	0.025	0.32	0.07	0.36	0.017	0.071	0.41	0.069	0.014	0.16	0.05
2.01-5.00	0.88	0.072	0.029	0.53	0.1	0.33	0	0.034	0.35	0.021	0	0.028	0.07
> 5.00	0.19	0.091	0.011	0.00002	0.048	0.038	0	0.07	0.11	0.052	0	0.09	0.063

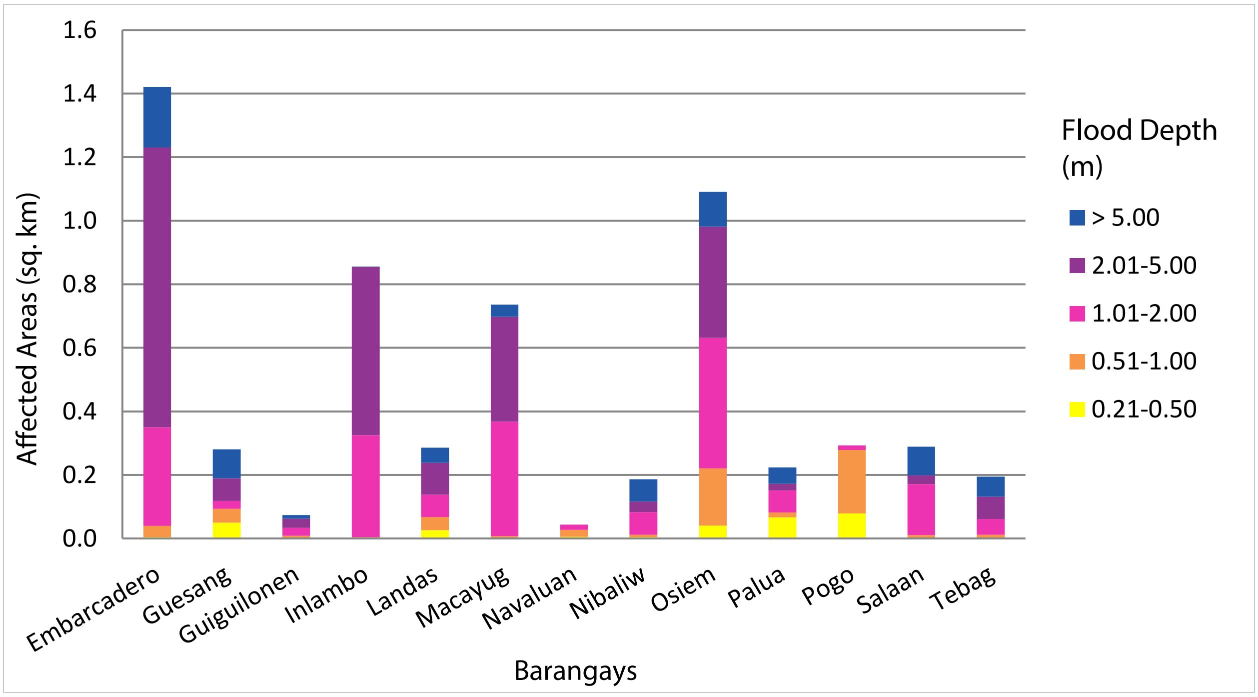


Figure 101. Affected Areas in Mangaldan, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 3.79% of the municipality of Mapandan with an area of 21.351923 sq. km. will experience flood levels of less than 0.20 meters. 2.06% of the area will experience flood levels of 0.21 to 0.50 meters while 4.61%, 7.41%, 7.02%, and 2.19% 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 61. 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)								
	Baloling	Coral	Jimenez	Luyan	Pias	Poblacion	Primicias	Santa Maria	Torres
0.03-0.20	0.52	0.0067	0.012	0.17	0.016	0.016	0.00028	0.054	0.014
0.21-0.50	0.22	0.0071	0.013	0.096	0.019	0.024	0.0029	0.04	0.018
0.51-1.00	0.31	0.043	0.024	0.16	0.098	0.11	0.0012	0.21	0.029
1.01-2.00	0.39	0.15	0.023	0.24	0.18	0.15	0.015	0.43	0.0047
2.01-5.00	0.11	0.025	0.12	0.17	0.12	0.21	0.0042	0.61	0.13
> 5.00	0.016	0.03	0	0.073	0.091	0.087	0	0.17	0

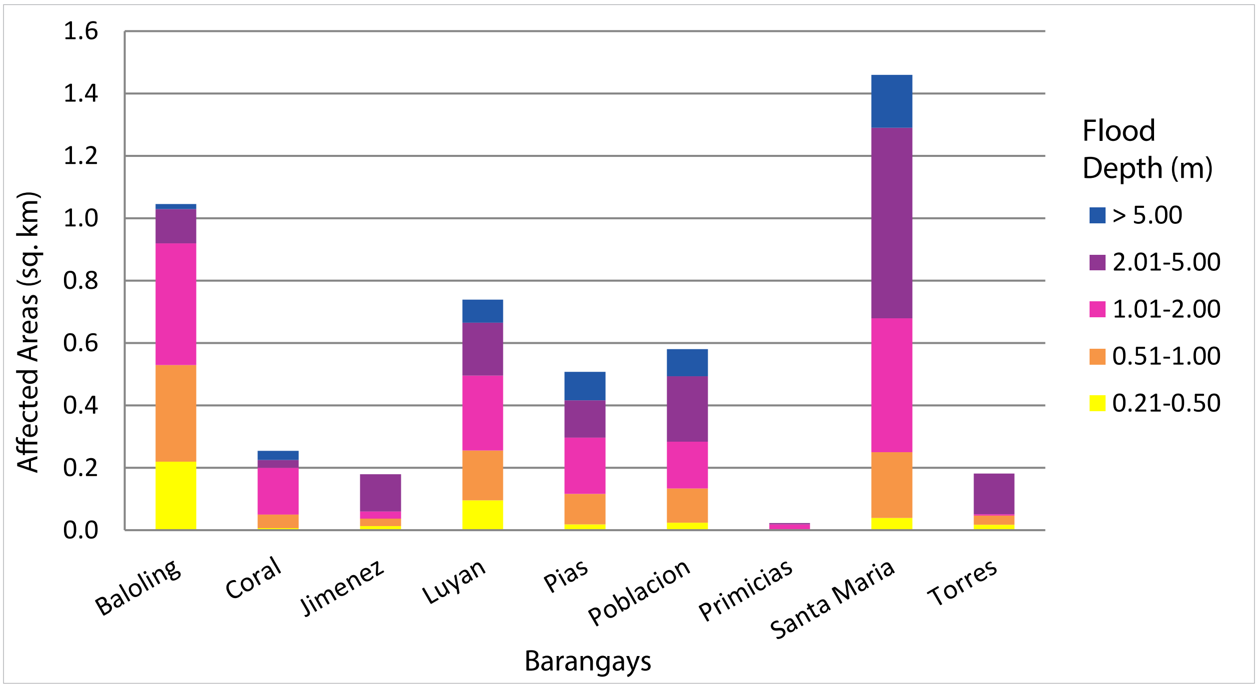


Figure 102. Affected Areas in Mapandan, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 53.79% of the municipality of Pozzorubio with an area of 74.749443 sq. km. will experience flood levels of less than 0.20 meters. 16.43% of the area will experience flood levels of 0.21 to 0.50 meters while 13.36%, 6.99%, 4.94%, and 1.22% 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 62. Affected Areas in Pozzorubio, Pangasinan during 25-Year Rainfall Return Period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Pozzorubio (in sq. km)											
	Alipangpang	Amagbagan	Balacag	Banding	Bantugan	Batakil	Bobonan	Buneg	Cablong	Casanfernandoan	Castaño	Dilan
0.03-0.20	0.62	1.45	4.27	1.32	0.97	0.8	1.2	0.66	0.91	2.38	2.6	1.05
0.21-0.50	0.74	0.97	0.28	0.75	0.51	0.17	0.4	0.4	0.27	0.15	0.25	0.22
0.51-1.00	0.61	0.58	0.22	0.34	0.26	0.026	0.3	1.06	0.024	0.12	0.38	0.18
1.01-2.00	0.1	0.091	0.16	0.02	0.26	0.0005	0.28	0.22	0.0019	0.11	0.34	0.36
2.01-5.00	0.0002	0.0036	0.84	0	0.047	0	0.13	0.0078	0	0.53	0.32	0.44
> 5.00	0	0	0.66	0	0	0	0.0004	0	0	0.034	0	0.19

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Pozzorubio (in sq. km)										
	Don Benito	Haway	Imbalbalatong	Inoman	Laoac	Maambal	Malasin	Malokiat	Manaol	Nama	Nantangalan
0.03-0.20	1.45	2.41	2.22	0.9	1.4	1.11	0.17	1.21	0.047	0.98	3.68
0.21-0.50	0.095	0.17	0.56	0.35	0.33	0.069	0.18	0.16	0.11	0.37	0.44
0.51-1.00	0.07	0.15	0.089	0.32	0.26	0.069	0.23	0.19	0.36	0.14	0.36
1.01-2.00	0.06	0.049	0.064	0.34	0.043	0.049	0.13	0.2	0.3	0.24	0.39
2.01-5.00	0.058	0.002	0.047	0.11	0.0002	0.055	0.19	0.17	0.096	0.18	0.41
> 5.00	0	0	0	0	0	0.003	0.02	0	0	0	0.0018

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Pozzorubio (in sq. km)										
	Palacpalac	Palguyod	Poblacion I	Poblacion II	Poblacion III	Poblacion IV	Rosario	Sugcong	Talogtog	Tulnac	Villegas
0.03-0.20	0.28	0.51	0.12	0.073	0.43	0.15	1.47	0.93	0.36	1.26	0.82
0.21-0.50	0.24	0.29	0.12	0.11	0.24	0.25	1.59	0.045	0.57	0.68	0.2
0.51-1.00	0.17	0.36	0.0013	0.022	0.13	0.16	2.14	0.023	0.31	0.15	0.18
1.01-2.00	0.27	0.43	0	0.008	0.094	0.046	0.41	0.0037	0.022	0.0096	0.12
2.01-5.00	0.0017	0.013	0	0.000087	0.0022	0.0024	0.025	0	0.00011	0	0.012
> 5.00	0	0	0	0	0	0	0	0	0	0	0

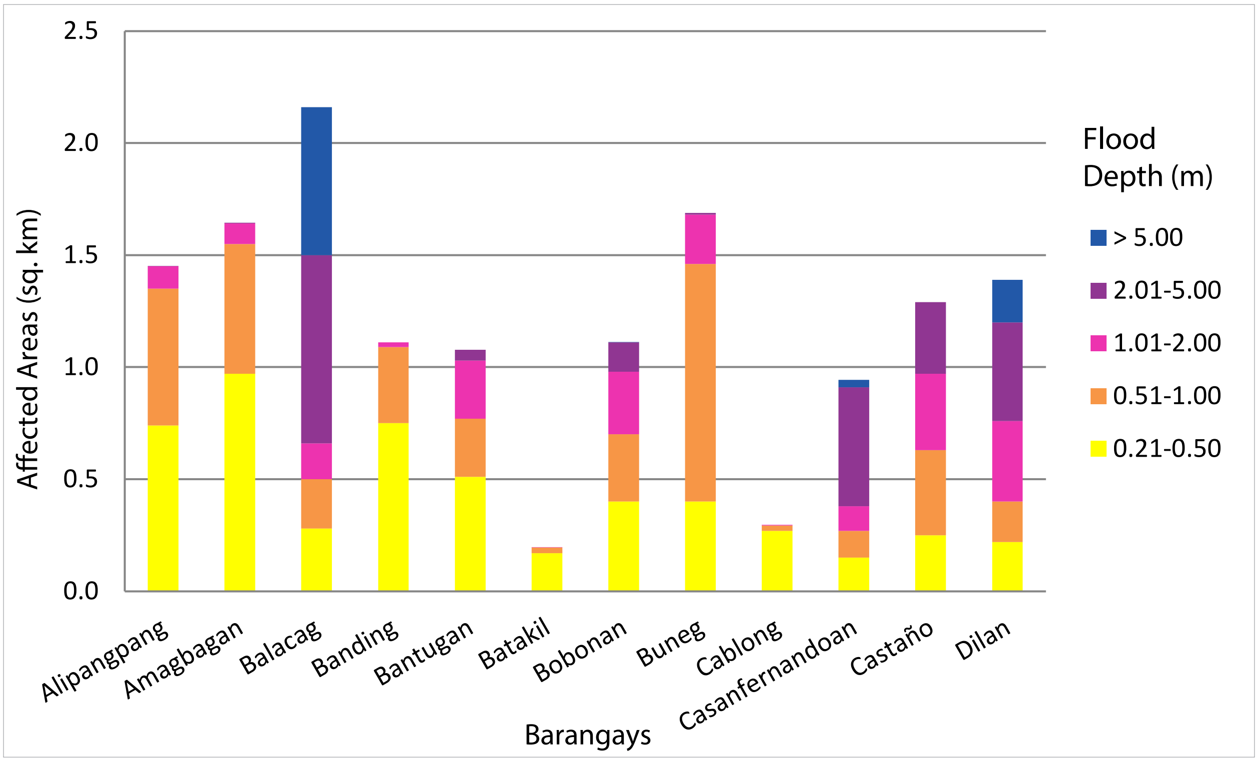


Figure 103. Affected Areas in Pozzorubio, Pangasinan during 25-Year Rainfall Return Period

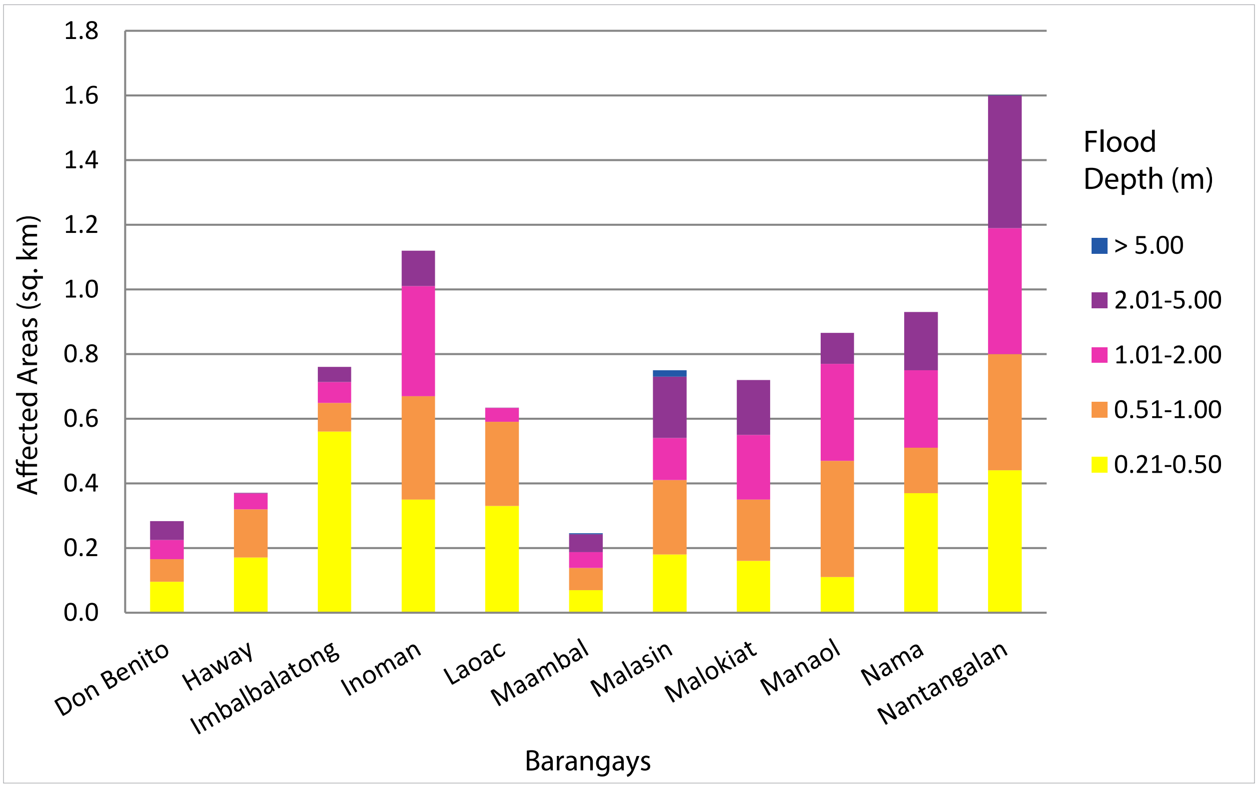


Figure 104. Affected Areas in Pozzorubio, Pangasinan during 25-Year Rainfall Return Period

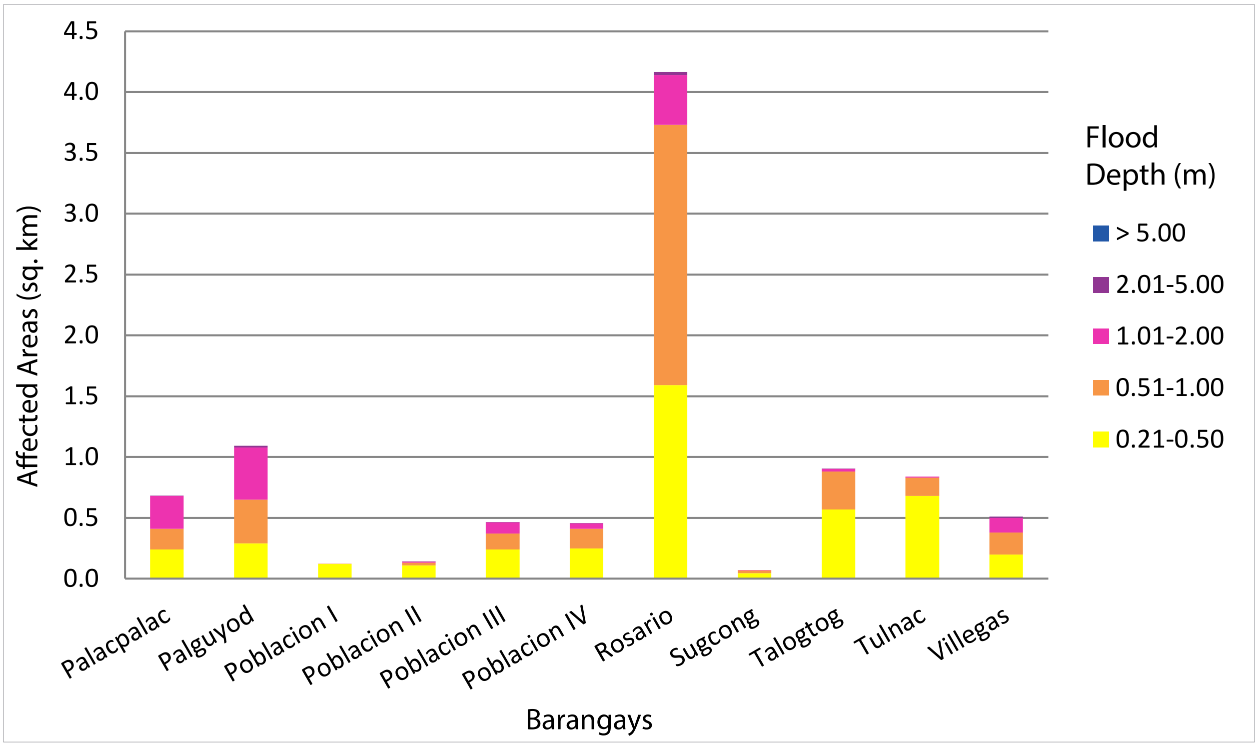


Figure 105. Affected Areas in Pozzorubio, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 17.01% of the municipality of San Fabian with an area of 69.270236 sq. km. will experience flood levels of less than 0.20 meters. 7.91% of the area will experience flood levels of 0.21 to 0.50 meters while 10.49%, 11.35%, 7.07%, and 0.39% 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 63. 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)												
	Ambalangan-Dalin	Angio	Anonang	Aramal	Binday	Bolasi	Cabaruan	Cayanga	Colisao	Lekep-Butao	Longos	Longos-Amangonan-Parac-Parac Fabrica	Tebag
0.03-0.20	0.37	0.98	1.03	0.57	1.57	0.73	0.0084	0.042	0.62	1.91	0.14	0.0053	0.0031
0.21-0.50	0.025	0.65	0.52	0.57	0.075	0.69	0.098	0.11	0.047	0.88	0.15	0.0053	0.002
0.51-1.00	0.015	0.97	0.63	1.1	0.052	0.24	0.16	0.29	0.031	0.73	0.55	0.077	0.025
1.01-2.00	0.0024	0.25	0.054	0.56	0.038	0.0071	0.24	0.39	0.0021	1.81	0.45	0.62	0.042
2.01-5.00	0.0007	0.0017	0.00011	0.0018	0.042	0	0.58	0.37	0	1.52	0.17	0.059	0.069
> 5.00	0	0	0	0	0.0073	0	0	0.06	0	0.12	0.07	0	0.056

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Fabian (in sq. km)												
	Longos Proper	Nibaliw Central	Nibaliw East	Nibaliw Magliba	Nibaliw Narvarte	Nibaliw Vidal	Palapad	Poblacion	Sagud-Bahley	Sobol	Tempra-Guilig	Tocok	Tebag
0.03-0.20	0.024	0.0024	0.093	0.15	0.19	0.061	2.45	0.0046	0.033	0.19	0.0004	0.61	0.0031
0.21-0.50	0.016	0.0047	0.11	0.084	0.066	0.031	0.26	0.047	0.016	0.1	0.0039	0.92	0.002
0.51-1.00	0.037	0.021	0.21	0.052	0.097	0.017	0.22	0.22	0.09	0.14	0.094	1.22	0.025
1.01-2.00	0.14	0.22	0.3	0.027	0.26	0.017	0.074	0.17	0.17	0.25	0.53	1.28	0.042
2.01-5.00	0.0077	0.21	0.14	0.00084	0.16	0.031	0.034	0.25	0.17	0.018	0.85	0.28	0.069
> 5.00	0.012	0	0	0	0	0	0.0003	0	0	0	0	0	0.056

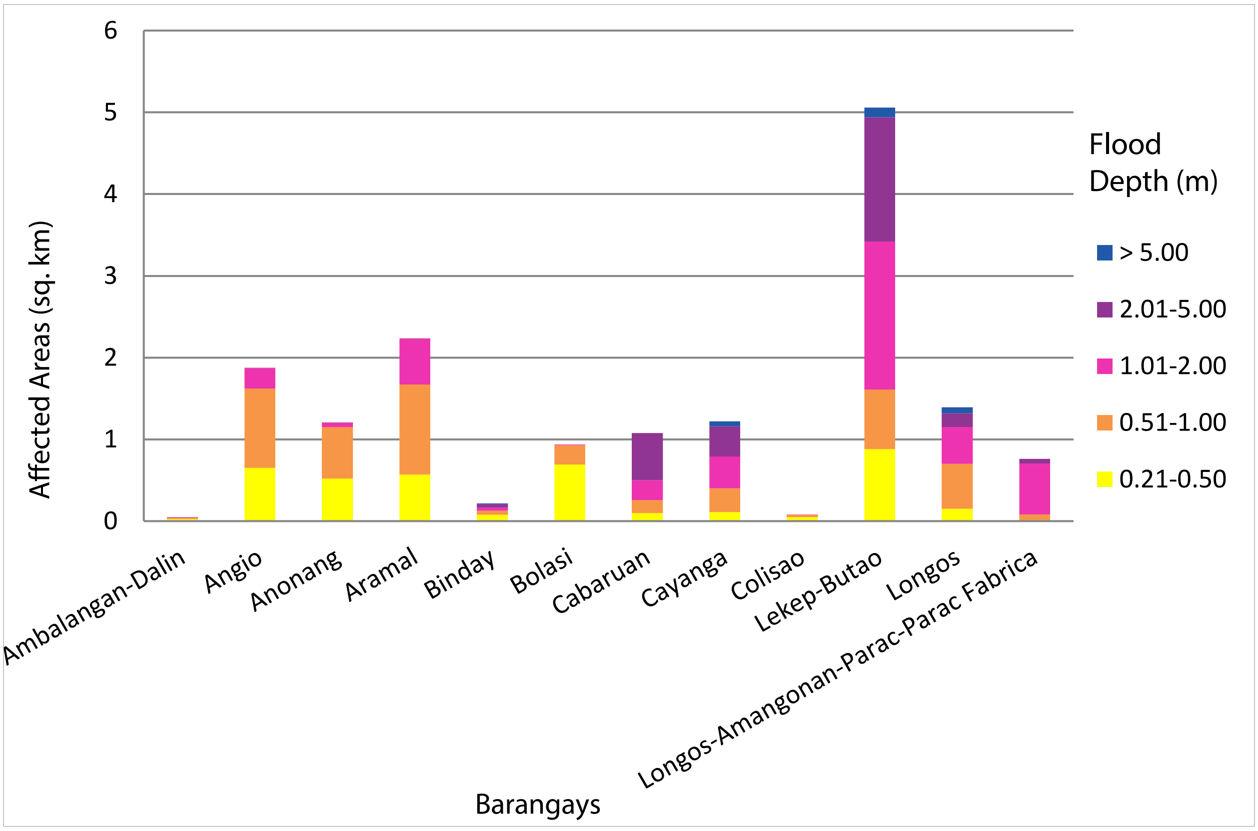


Figure 106. Affected Areas in San Fabian, Pangasinan during 25-Year Rainfall Return Period

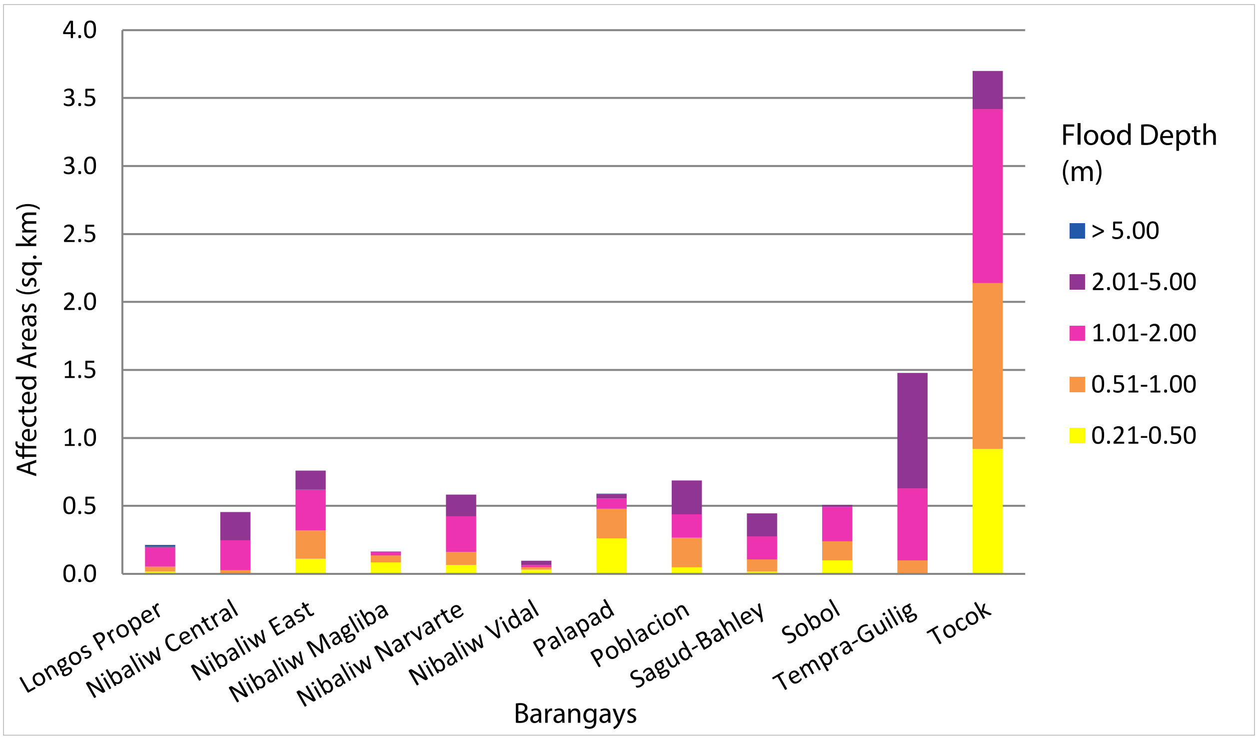


Figure 107. Affected Areas in San Fabian, Pangasinan during 25-Year Rainfall Return Period

For the 25-year return period, 33.38% of the municipality of San Jacinto with an area of 34.091828 sq. km. will experience flood levels of less than 0.20 meters. 7.64% of the area will experience flood levels of 0.21 to 0.50 meters while 10.72%, 17.75%, 24.33%, and 6.15% 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 64. Affected Areas in San Jacinto, Pangasinan during 25-Year Rainfall Return Period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Jacinto (in sq. km)									
	Awai	Bagong Pag-asa	Bolo	Capaoay	Casibong	Guibel	Imelda	Labney	Lobong	Macayug
0.03-0.20	2.76	0	0.12	0.0035	0.000099	0.19	0.019	2.41	1.81	0.46
0.21-0.50	0.19	0	0.036	0.0046	0.0016	0.12	0.05	0.3	0.61	0.39
0.51-1.00	0.19	0	0.15	0.028	0.021	0.36	0.082	0.38	0.57	0.66
1.01-2.00	0.17	0.0046	0.041	0.17	0.17	1.02	0.1	0.19	0.24	1.43
2.01-5.00	0.11	0.18	0.31	0.26	0.5	2.41	0.0016	0.25	0.046	1.11
> 5.00	0.0001	0.0053	0.15	0	0.0002	0.015	0	0.86	0.019	0.28

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Jacinto (in sq. km)								
	Magsaysay	San Guillermo	San Jose	San Juan	San Roque	San Vicente	Santa Cruz	Santa Maria	Santo Tomas
0.03-0.20	0	0	0.16	2.81	0.16	0.0077	0.2	0.27	0
0.21-0.50	0	0	0.063	0.37	0.17	0.0033	0.043	0.25	0.0046
0.51-1.00	0	0.0015	0.19	0.33	0.21	0.013	0.065	0.4	0.0056
1.01-2.00	0.031	0.039	0.29	0.29	0.58	0.19	0.045	0.81	0.24
2.01-5.00	0.13	0.36	1.11	0.057	0.27	0.58	0.16	0.29	0.16
> 5.00	0.0025	0.0043	0.52	0.0003	0	0.09	0.088	0	0.063

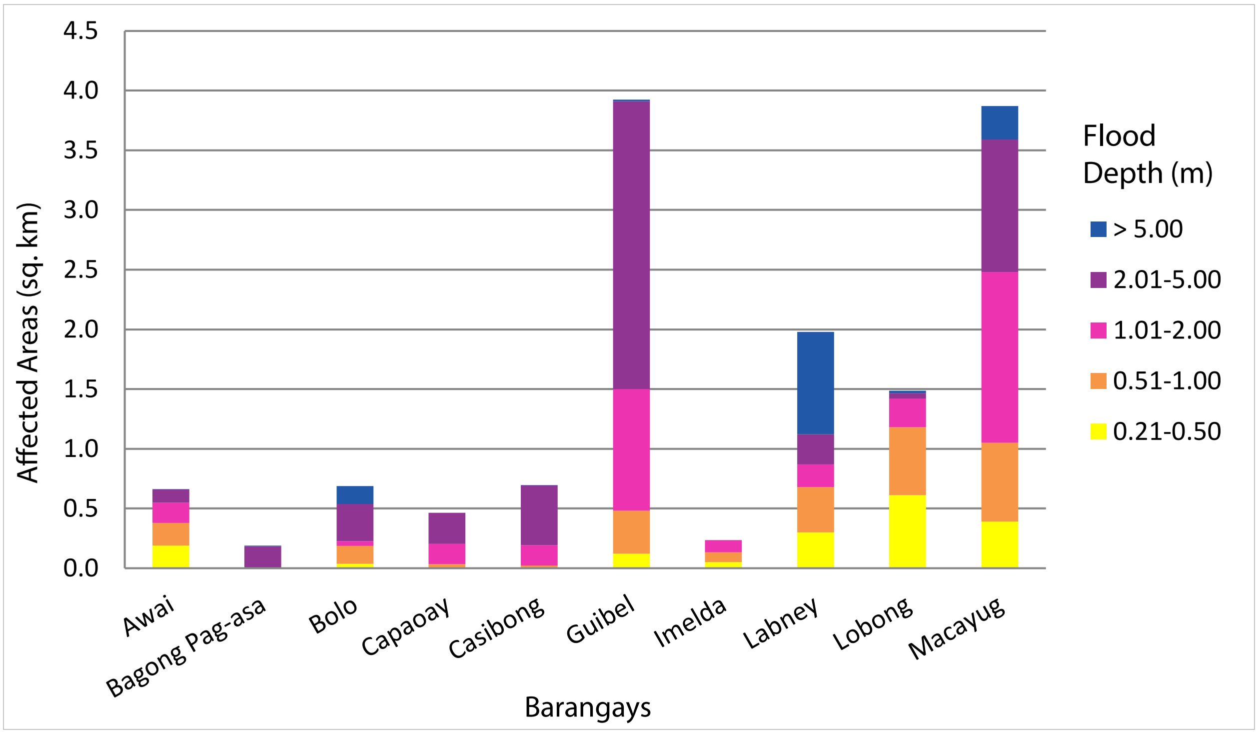


Figure 108. Affected Areas in San Jacinto, Pangasinan during 25-Year Rainfall Return Period

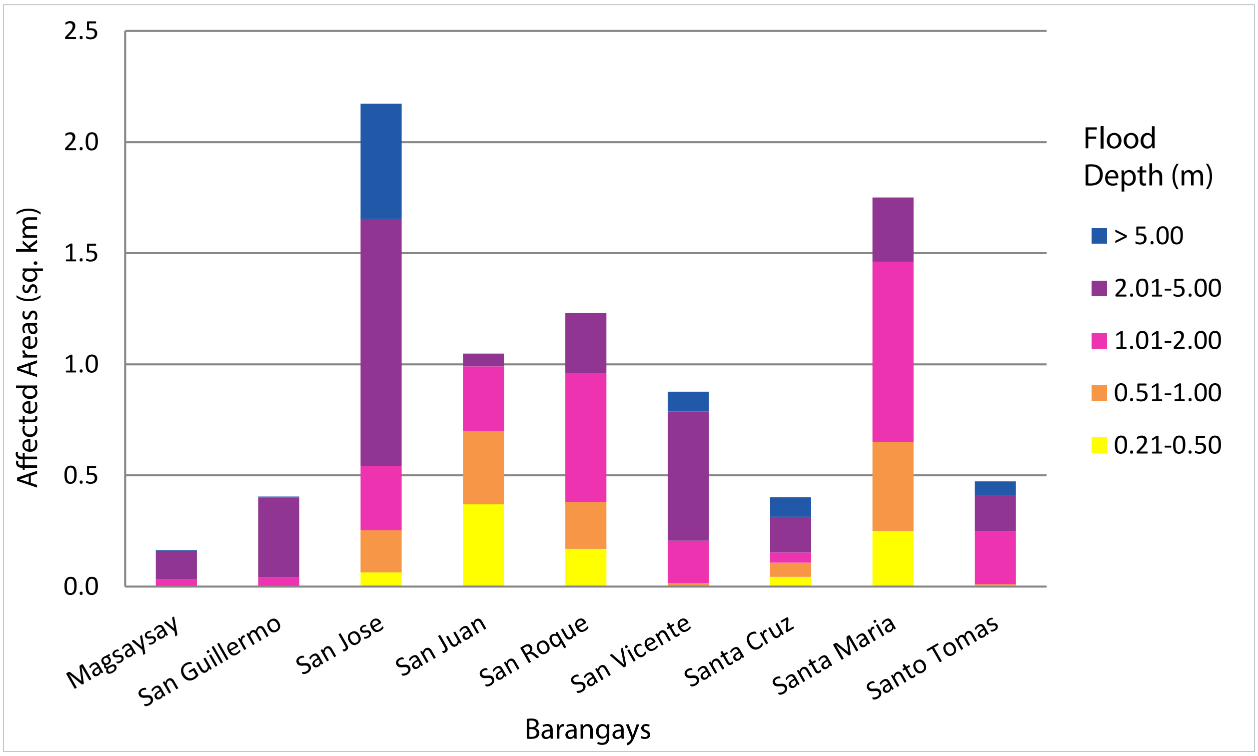


Figure 109. Affected Areas in San Jacinto, Pangasinan during 25-Year Rainfall Return Period

Table 65. For the 25-year return period, 4.44% of the municipality of Sison with an area of 151.961994 sq. km. will experience flood levels of less than 0.20 meters. 0.67% of the area will experience flood levels of 0.21 to 0.50 meters while 0.87%, 0.84%, 0.49%, and 0.05% 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 66. Affected Areas in Sison, Pangasinan during 25-Year Rainfall Return Period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Sison (in sq. km)					
	Alibeng	Calunetan	Camangaan	Killo	Labayug	Tara-Tara
0.03-0.20	1.95	3.04	0.15	1.35	0.19	0.07
0.21-0.50	0.15	0.3	0.0094	0.53	0.03	0.0031
0.51-1.00	0.077	0.52	0.002	0.71	0.015	0.0026
1.01-2.00	0.033	0.77	0	0.46	0.0053	0.0049
2.01-5.00	0.014	0.26	0	0.33	0.0072	0.13
> 5.00	0.0009	0.0014	0	0.0037	0	0.065

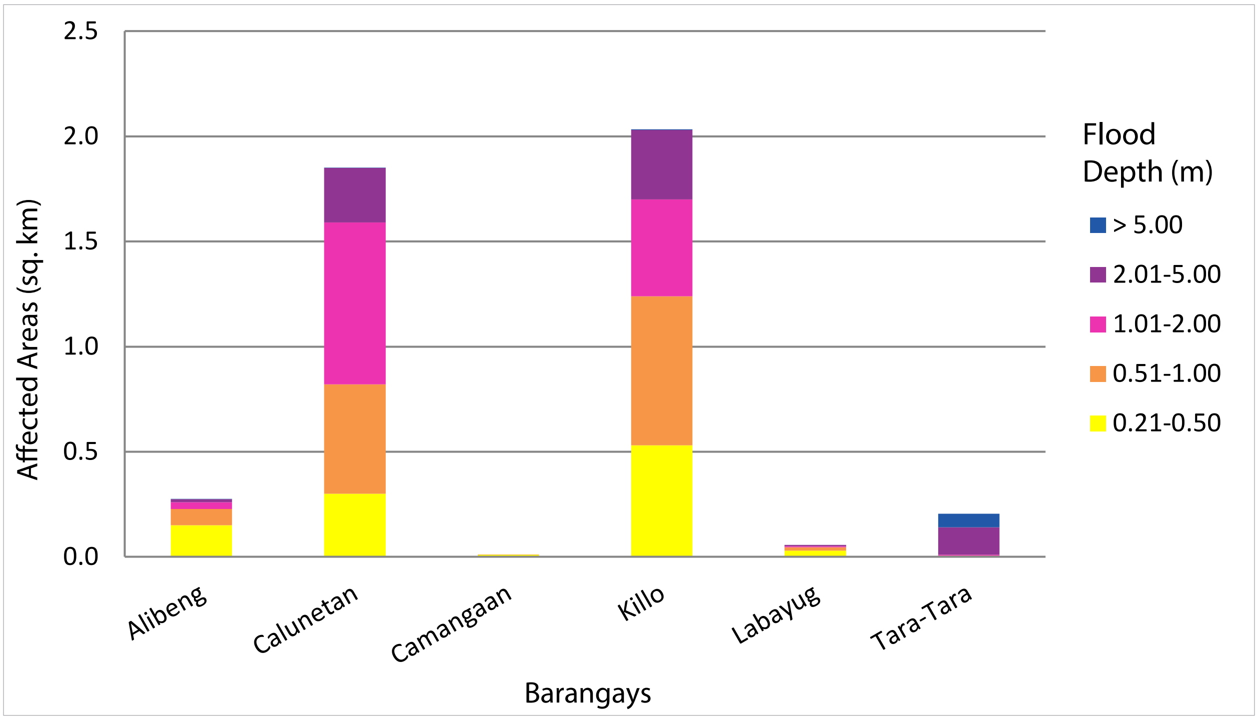


Figure 110. Affected Areas in Sison, Pangasinan during 5-Year Rainfall Return Period

For the 25-year return period, 1.16% of the municipality of Urdaneta City with an area of 107.789848 sq. km. will experience flood levels of less than 0.20 meters. 0.70% of the area will experience flood levels of 0.21 to 0.50 meters while 0.47%, 0.14%, and 0.06% 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 67. 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)			
	Camantiles	Cayambanan	Pinmaludpod	Tulong
0.03-0.20	0.9	0.0021	0.16	0.19
0.21-0.50	0.53	0.00000031	0.14	0.089
0.51-1.00	0.23	0.000024	0.27	0.011
1.01-2.00	0.056	0	0.098	0.000036
2.01-5.00	0.032	0	0.029	0
> 5.00	0.0001	0	0.00064	0

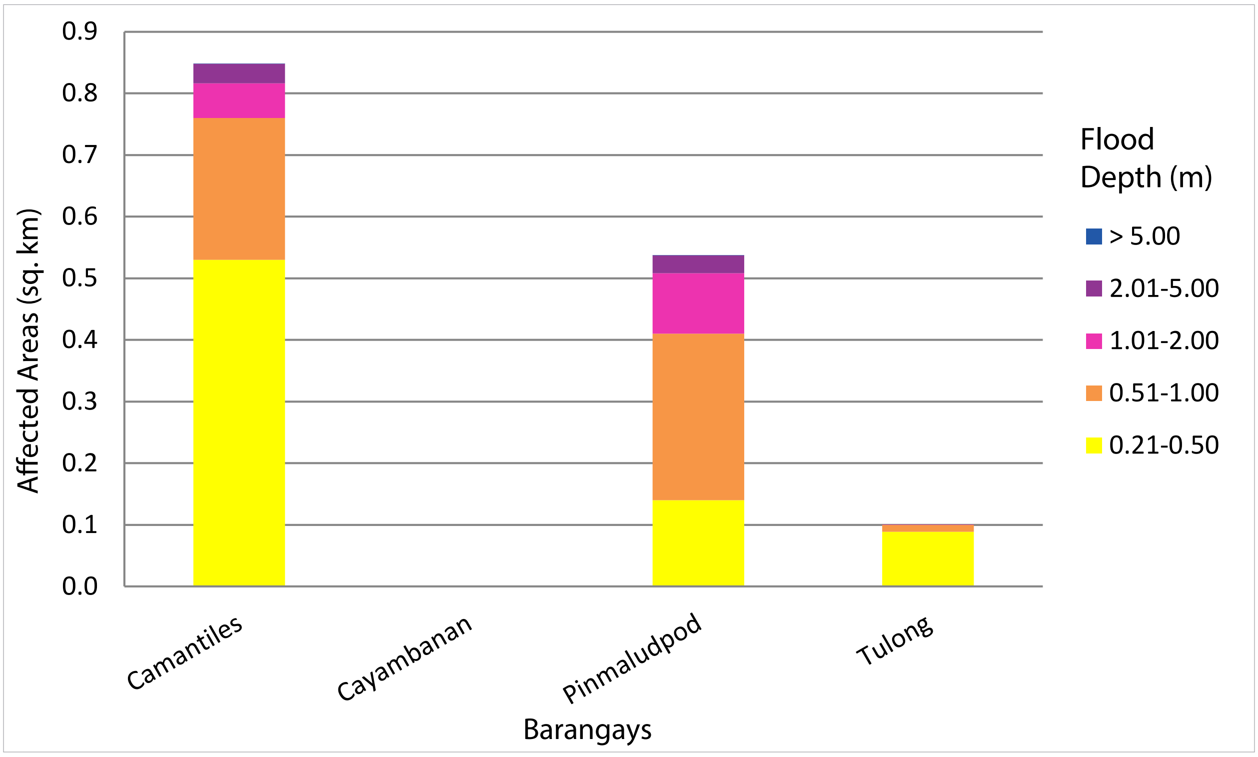


Figure 111. Affected Areas in Urdaneta City, Pangasinan during 25-Year Rainfall Return Period

For the 100-year return period, 11.79% of the municipality of Binalonan with an area of 78.537828 sq. km. will experience flood levels of less than 0.20 meters. 8.97% of the area will experience flood levels of 0.21 to 0.50 meters while 7.25%, 7.68%, 1.74%, and 0.35% 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 68. Affected Areas in Binalonan, Pangasinan during 100-Year Rainfall Return Period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binalonan (in sq. km)							
	Bued	Bugayong	Camangaan	Canarvacanan	Cili	Dumayat	Linmansangan	Pasileng Norte
0.03-0.20	0.18	1.32	2.04	0.19	1.09	0.43	0.19	0.06
0.21-0.50	0.29	1.22	1.15	0.16	0.61	0.42	0.19	0.041
0.51-1.00	0.54	0.58	1.17	0.42	0.45	0.12	0.51	0.045
1.01-2.00	0.47	0.3	0.77	0.98	1.03	0.0001	0.66	0.011
2.01-5.00	0.0009	0.16	0.57	0.029	0.13	0	0.014	0
> 5.00	0	0.012	0.19	0	0	0	0	0

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Binalonan (in sq. km)							
	Poblacion	San Felipe Sur	Santa Maria Norte	Santiago	Santo Niño	Sumabnit	Tabuyoc	Vacante
0.03-0.20	0.69	0.028	0.2	0.17	0.019	0.43	0.98	1.24
0.21-0.50	0.45	0.0035	0.17	0.19	0.00064	0.53	0.67	0.95
0.51-1.00	0.23	0	0.22	0.37	0	0.52	0.19	0.33
1.01-2.00	0.057	0	0.53	0.43	0	0.4	0.067	0.33
2.01-5.00	0	0	0.035	0.0065	0	0	0	0.42
> 5.00	0	0	0	0	0	0	0	0.069

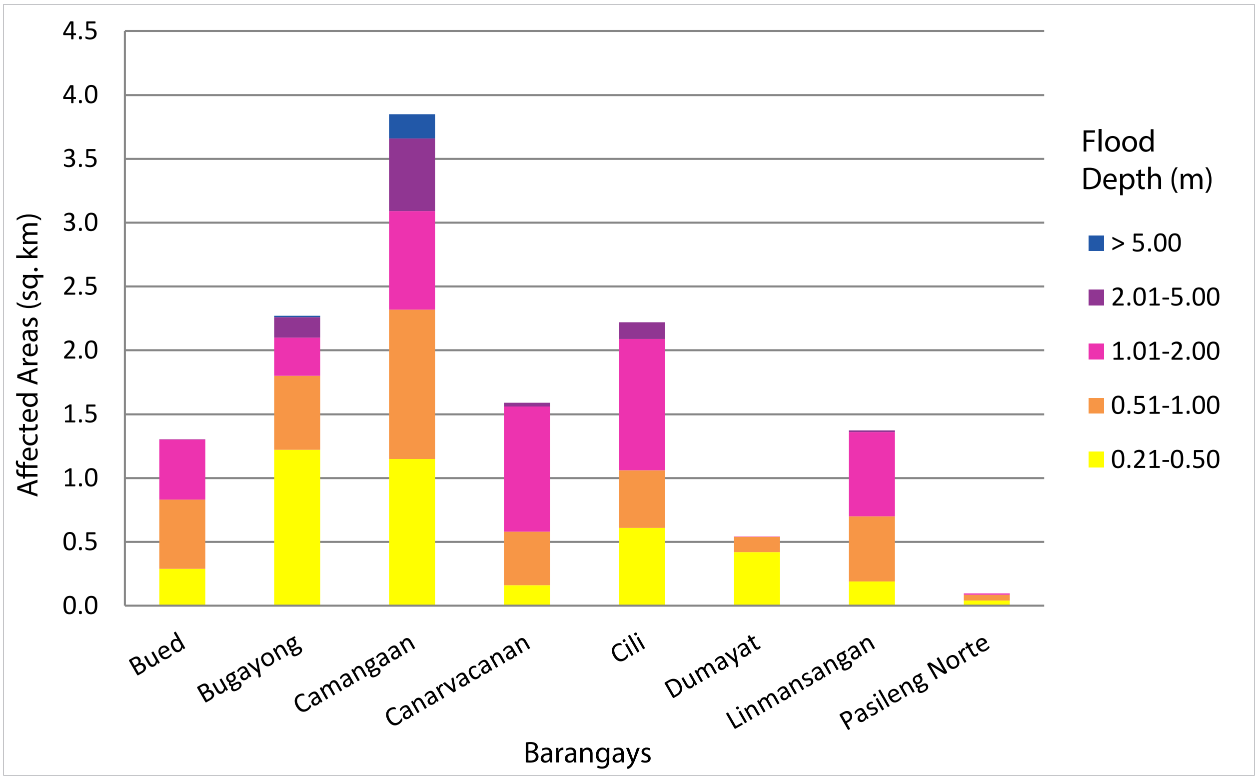


Figure 112. Affected Areas in Binalonan, Pangasinan during 100-Year Rainfall Return Period

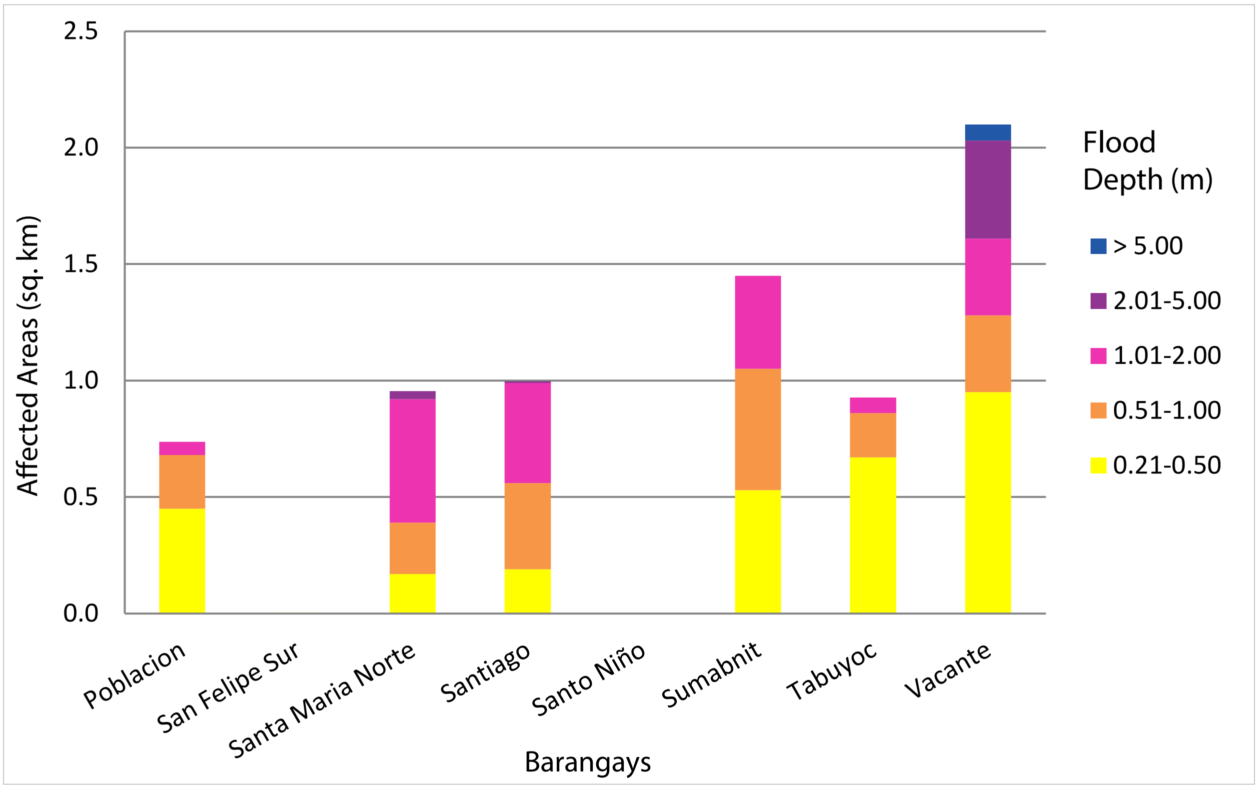


Figure 113. Affected Areas in Binalonan, Pangasinan during 100-Year Rainfall Return Period

For the 100-year return period, 0.59% of the municipality of Dagupan City with an area of 47.755696 sq. km. will experience flood levels of less than 0.20 meters. 0.20% of the area will experience flood levels of 0.21 to 0.50 meters while 0.40%, 1.49%, and 0.25% 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 69. 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)
	Bonuan Binloc
0.03-0.20	0.4
0.21-0.50	0.12
0.51-1.00	0.26
1.01-2.00	0.54
2.01-5.00	0.082
> 5.00	0

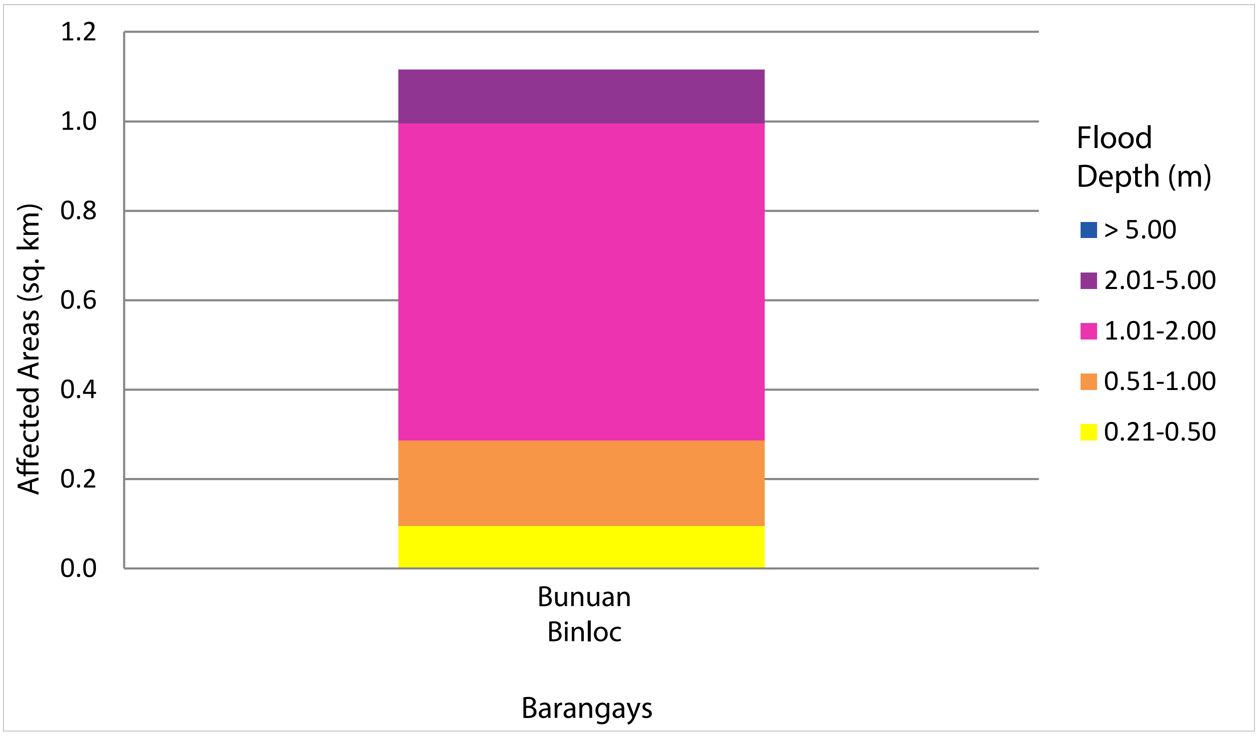


Figure 114. Affected Areas in Dagupan City, Pangasinan during 100-Year Rainfall Return Period

For the 100-year return period, 15.63% of the municipality of Laoac with an area of 40.697535 sq. km. will experience flood levels of less than 0.20 meters. 18.28% of the area will experience flood levels of 0.21 to 0.50 meters while 29.83%, 27.93%, 6.27%, and 1.55% 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 70. 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)										
	Anis	Balligi	Banuar	Botique	Caaringayan	Cabilaoan West	Cabulalaan	Calaoagan	Calmay	Casampagaan	Casanestebanan
0.03-0.20	0.47	0.43	0.099	0.28	0.25	0.67	0.34	0.071	0.003	1.18	0.02
0.21-0.50	0.33	0.75	0.18	0.28	0.6	0.85	0.19	0.084	0.0074	1.15	0.032
0.51-1.00	0.26	0.27	0.4	0.39	1.42	0.94	0.32	0.14	0.16	1.16	0.37
1.01-2.00	0.17	0.0065	0.43	0.48	0.86	0.44	0.5	0.13	1.5	0.35	1.24
2.01-5.00	0	0.015	0.12	0.3	0.001	0.0004	0.24	0.029	0.45	0.0001	0.35
> 5.00	0	0.00029	0.018	0.077	0	0	0.077	0.025	0.051	0	0.039

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Laoac (in sq. km)										
	Casantiagoan	Domingo Alarcio	Inmanduyan	Lebueg	Maraboc	Nanbagatan	Panaga	Poblacion	Talogtog	Turko	Yatyat
0.03-0.20	0.32	0.42	0.55	0.37	0.073	0.2	0.024	0.11	0.078	0.092	0.31
0.21-0.50	0.28	0.37	0.22	0.46	0.087	0.25	0.18	0.27	0.11	0.24	0.52
0.51-1.00	0.28	0.16	0.32	0.97	0.23	1.29	0.58	0.52	0.17	0.89	0.9
1.01-2.00	0.27	0.016	0.72	0.065	0.86	1.19	0.22	0.34	0.38	0.75	0.45
2.01-5.00	0.0018	0.0001	0.3	0	0.5	0.035	0.007	0.013	0.12	0.059	0.011
> 5.00	0	0	0.097	0	0.21	0	0.012	0.0052	0.017	0.0022	0

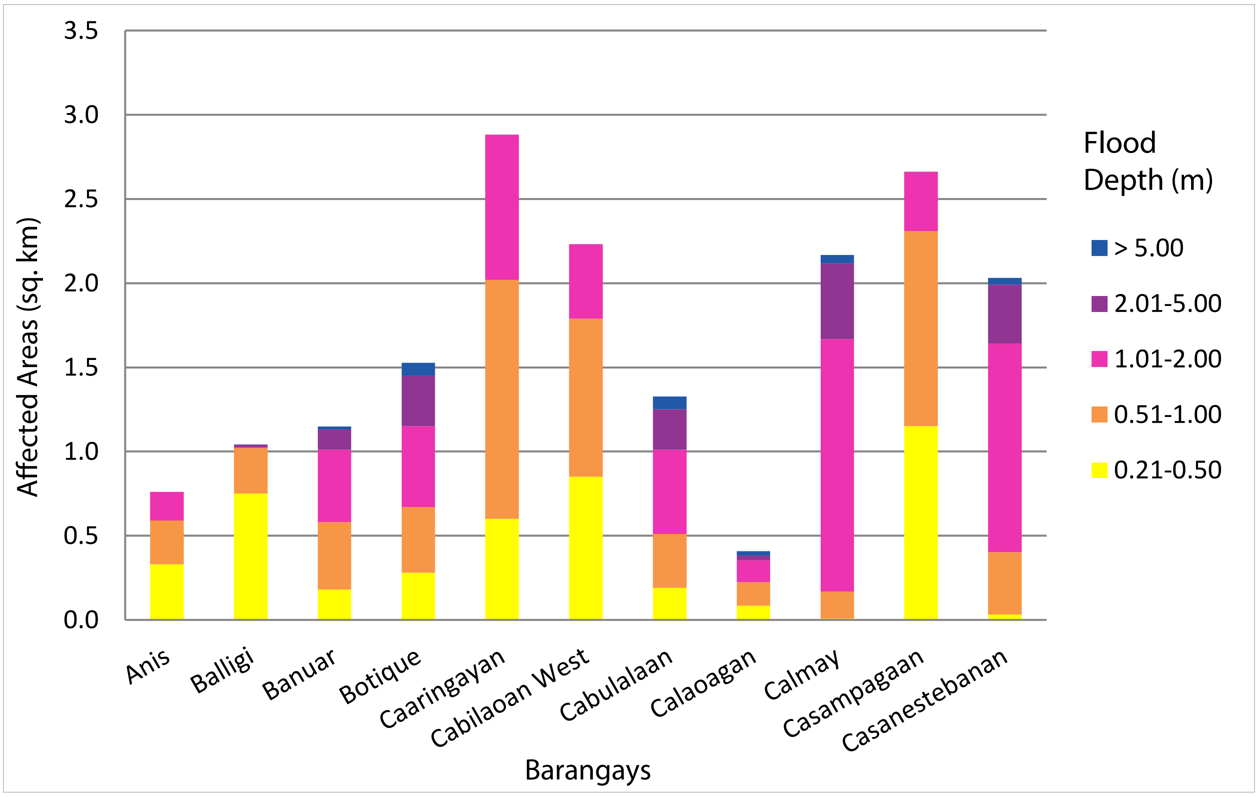


Figure 115. Affected Areas in Laoac, Pangasinan during 100-Year Rainfall Return Period

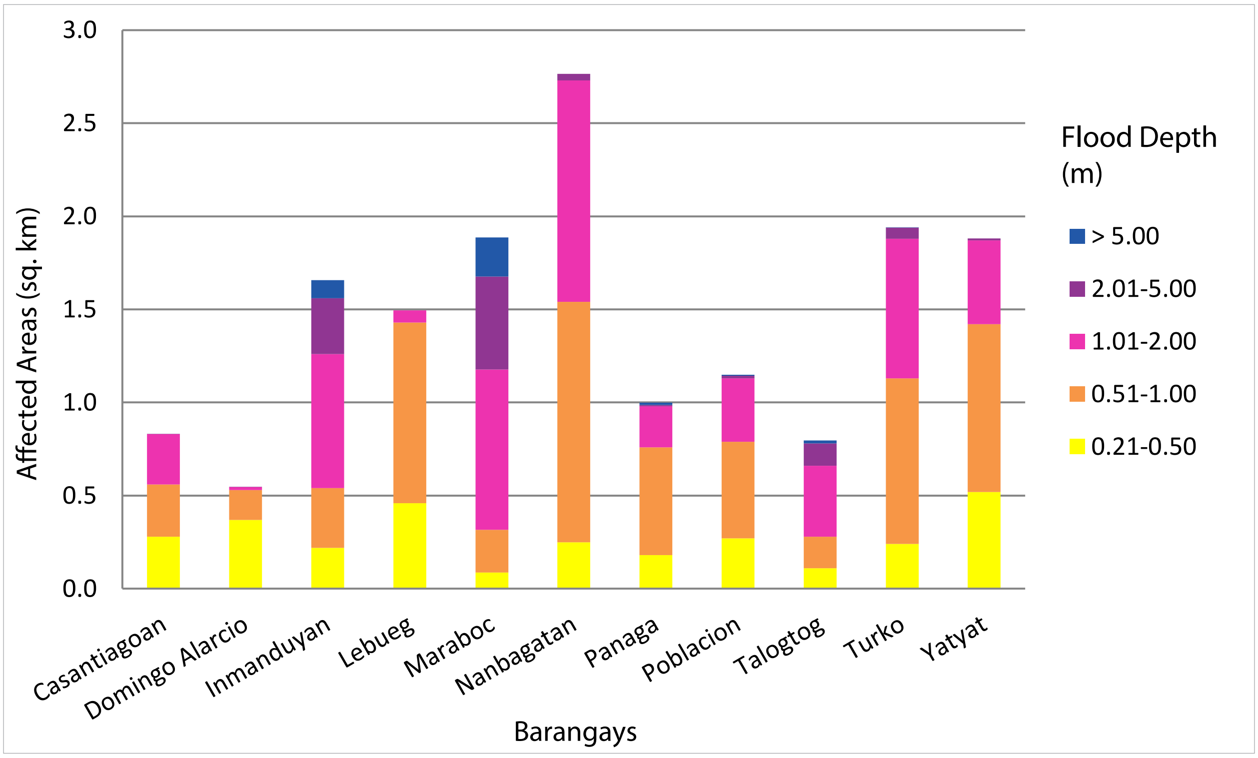


Figure 116. Affected Areas in Laoac, Pangasinan during 100-Year Rainfall Return Period

For the 100-year return period, 40.41% of the municipality of Manaoag with an area of 42.418932 sq. km. will experience flood levels of less than 0.20 meters. 9.94% of the area will experience flood levels of 0.21 to 0.50 meters while 12.07%, 18.49%, 13.58%, and 2.84% 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 71. 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)												
	Babasit	Baguinay	Baritao	Bisal	Bucao	Cabanbanan	Calaocan	Inamotan	Lelemaan	Licsi	Lipit Norte	Lipit Sur	Matolong
0.03-0.20	2.32	0.00027	0.55	0.11	0.56	0.061	0.45	0.69	0.014	0.68	0.67	0.85	0.0033
0.21-0.50	0.63	0.0013	0.39	0.15	0.41	0.042	0.03	0.54	0.057	0.13	0.23	0.073	0.0081
0.51-1.00	1.06	0.027	0.44	0.077	0.11	0.095	0.024	1.08	0.14	0.09	0.26	0.19	0.017
1.01-2.00	0.18	0.42	0.41	0.0012	0	0.3	0.017	0.99	0.64	0.072	0.26	0.21	0.19
2.01-5.00	0.019	0.33	0.17	0	0	0.68	0.01	0.095	0.89	0.012	0.78	0.16	0.056
> 5.00	0.0041	0.035	0.1	0	0	0.16	0.0005	0.000037	0.075	0.022	0.27	0.11	0.0021

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Manaoag (in sq. km)												
	Mermer	Nalsian	Oraan East	Oraan West	Pantal	Pao	Parian	Poblacion	Pugaro	San Ramon	Santa Ines	Sapang	Tebuel
0.03-0.20	0.00017	0.88	0	0	0.2	1.12	0.0078	1.1	4.91	0.5	0.013	0.98	0.47
0.21-0.50	0.00027	0.38	0	0.0000051	0.06	0.12	0.0091	0.13	0.48	0.23	0.029	0.063	0.023
0.51-1.00	0.0055	0.29	0.0065	0.0029	0.082	0.1	0.052	0.16	0.27	0.27	0.2	0.055	0.017
1.01-2.00	0.45	0.55	0.16	0.12	0.17	0.089	0.3	0.21	0.28	0.4	1.35	0.065	0.011
2.01-5.00	0.39	0.17	0.2	0.12	0.019	0.077	0.27	0.22	0.22	0.13	0.66	0.072	0.0089
> 5.00	0.061	0.076	0.0077	0.03	0.022	0.11	0.031	0.019	0.0088	0.032	0.027	0.00045	0

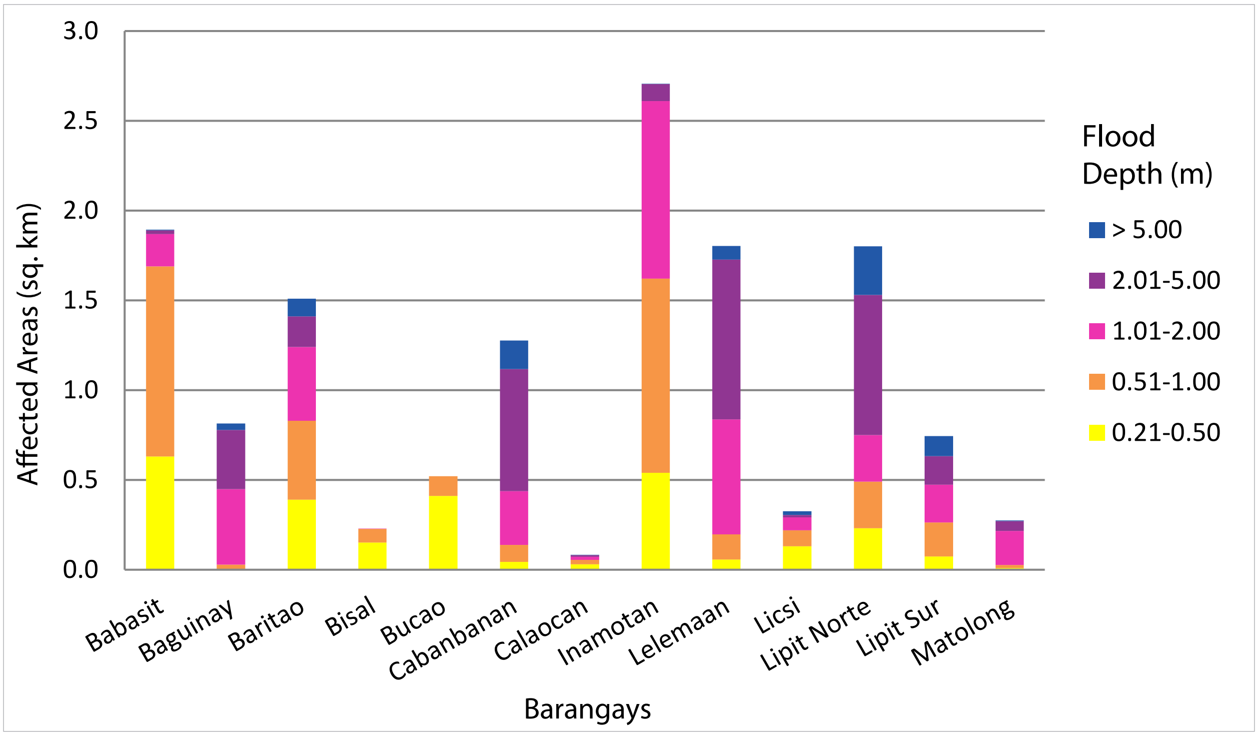


Figure 117. Affected Areas in Manaoag, Pangasinan during 100-Year Rainfall Return Period

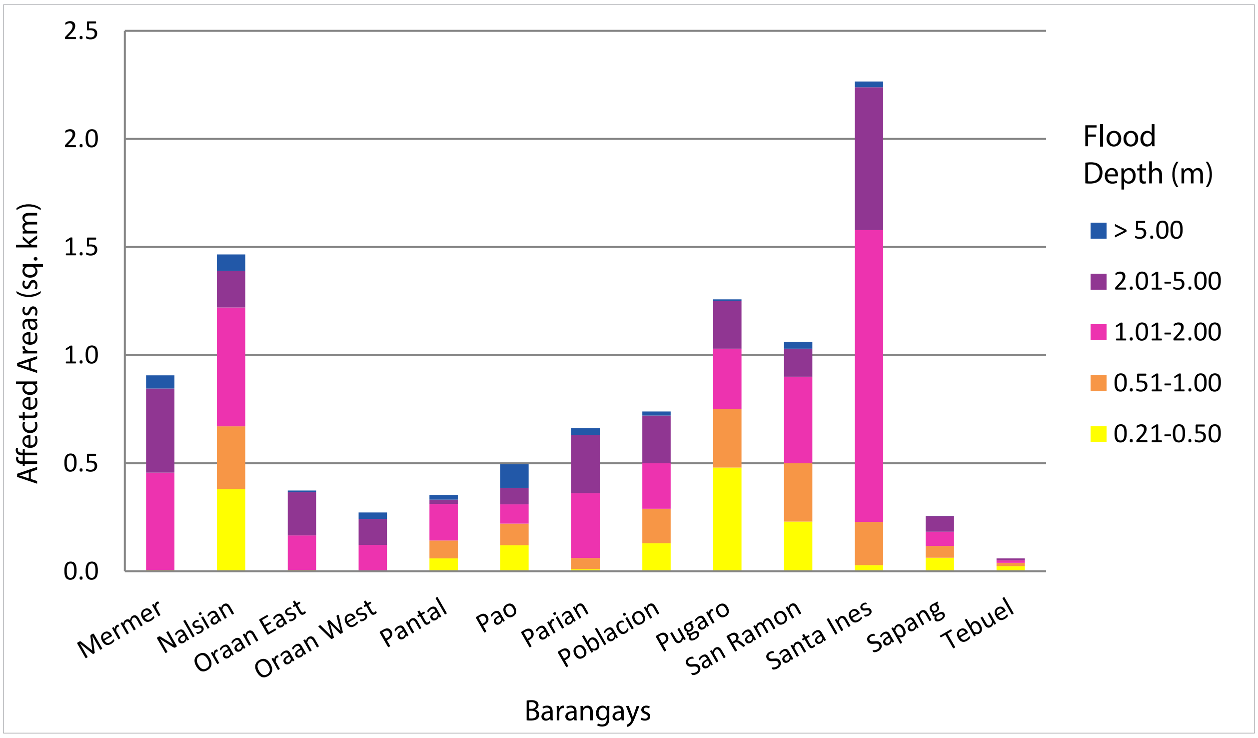


Figure 118. Affected Areas in Manaoag, Pangasinan during 100-Year Rainfall Return Period

For the 100-year return period, 0.39% of the municipality of Mangaldan with an area of 43.415808 sq. km. will experience flood levels of less than 0.20 meters. 0.57% of the area will experience flood levels of 0.21 to 0.50 meters while 1.26%, 3.64%, 6.66%, and 1.79% 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 72. 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)												
	Embarcadero	Guesang	Guiguilonen	Inlambo	Landas	Macayug	Navaluan	Nibaliw	Osiem	Palua	Pogo	Salaan	Tebag
0.03-0.20	0.0027	0.097	0.0016	0	0.013	0.0001	0	0.00014	0.004	0.025	0.018	0.0057	0.0007
0.21-0.50	0.0032	0.066	0.00093	0	0.025	0.0012	0.0033	0.0018	0.025	0.064	0.054	0.0016	0.0023
0.51-1.00	0.02	0.047	0.0043	0.0029	0.041	0.0031	0.019	0.0086	0.14	0.029	0.22	0.0067	0.0056
1.01-2.00	0.24	0.026	0.025	0.18	0.071	0.25	0.023	0.066	0.42	0.06	0.027	0.14	0.051
2.01-5.00	0.95	0.072	0.032	0.68	0.11	0.45	0	0.041	0.4	0.033	0	0.053	0.072
> 5.00	0.2	0.092	0.011	0.00002	0.05	0.039	0	0.07	0.11	0.052	0	0.09	0.065

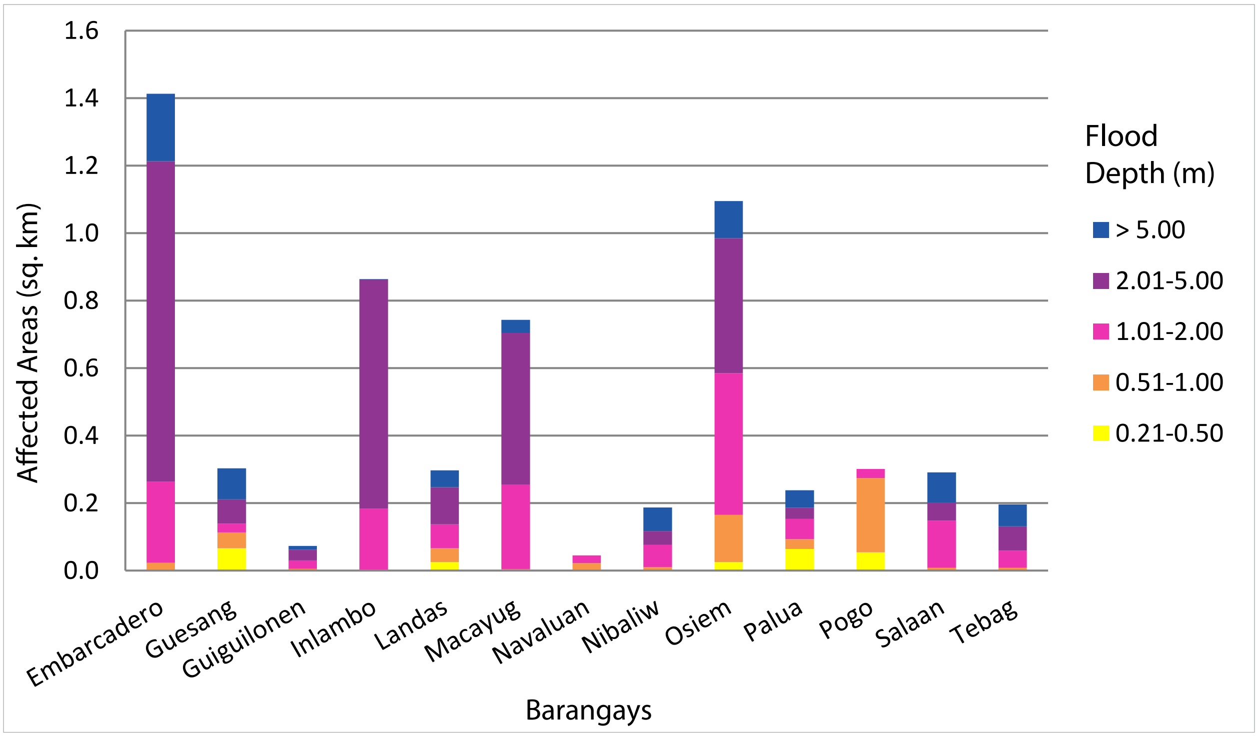


Figure 119. Affected Areas in Mangaldan, Pangasinan during 5-Year Rainfall Return Period

For the 100-year return period, 2.89% of the municipality of Mapandan with an area of 21.351923 sq. km. will experience flood levels of less than 0.20 meters. 2.04% of the area will experience flood levels of 0.21 to 0.50 meters while 3.74%, 8.29%, 7.69%, and 2.25% 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 73. 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)								
	Baloling	Coral	Jimenez	Luyan	Pias	Poblacion	Primicias	Santa Maria	Torres
0.03-0.20	0.44	0.004	0.0077	0.097	0.014	0.011	0	0.032	0.011
0.21-0.50	0.23	0.0064	0.014	0.12	0.01	0.015	0.0011	0.031	0.0086
0.51-1.00	0.29	0.023	0.023	0.12	0.086	0.086	0.0028	0.13	0.038
1.01-2.00	0.45	0.17	0.027	0.29	0.19	0.17	0.014	0.45	0.0088
2.01-5.00	0.14	0.026	0.12	0.2	0.13	0.21	0.0062	0.68	0.13
> 5.00	0.016	0.032	0	0.08	0.092	0.091	0	0.17	0

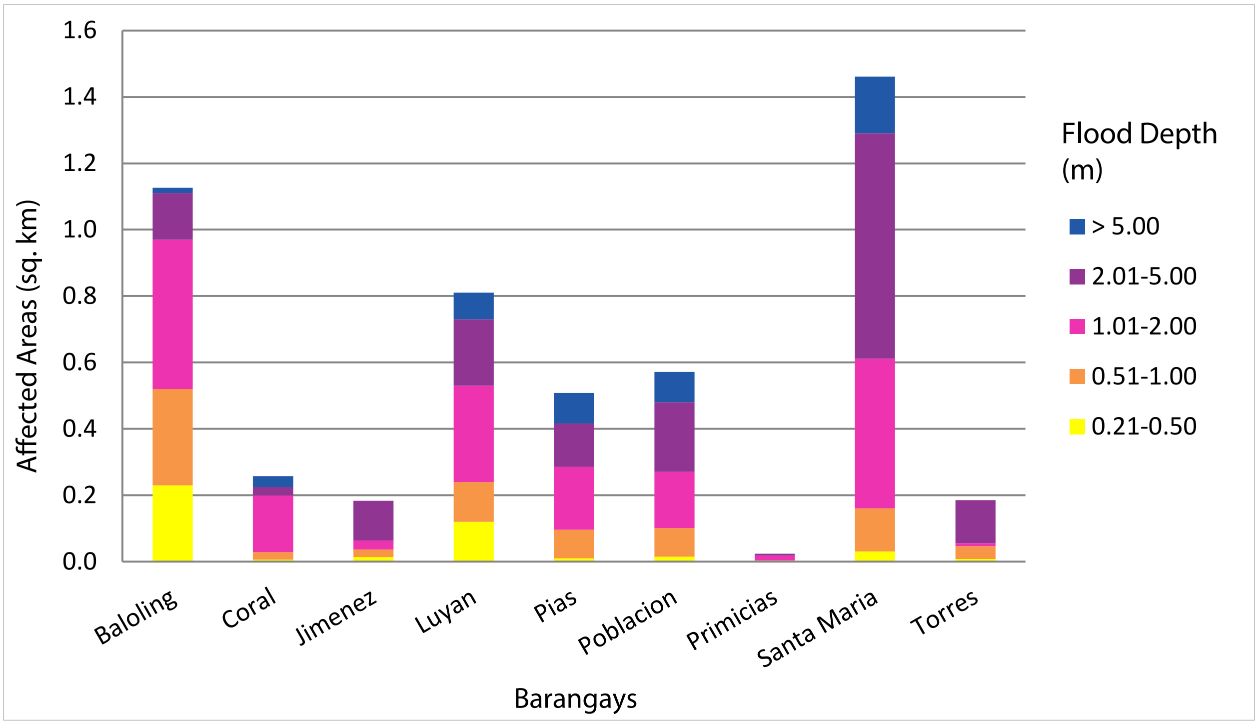


Figure 120. Affected Areas in Mapandan, Pangasinan during 5-Year Rainfall Return Period

For the 100-year return period, 48.20% of the municipality of Pozzorubio with an area of 74.749443 sq. km. will experience flood levels of less than 0.20 meters. 16.38% of the area will experience flood levels of 0.21 to 0.50 meters while 14.91%, 9.18%, 5.98%, and 2.03% 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 74. Affected Areas in Pozzorubio, Pangasinan during 100-Year Rainfall Return Period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Pozzorubio (in sq. km)											
	Alipangpang	Amagbagan	Balacag	Banding	Bantugan	Batakil	Bobonan	Buneg	Cablong	Casanfernandoan	Castaño	Dilan
0.03-0.20	0.47	1.19	4.14	1.06	0.81	0.75	1.05	0.56	0.8	2.31	2.51	0.78
0.21-0.50	0.62	0.92	0.28	0.82	0.48	0.21	0.43	0.33	0.37	0.16	0.23	0.28
0.51-1.00	0.83	0.81	0.23	0.51	0.26	0.038	0.33	0.85	0.033	0.13	0.27	0.21
1.01-2.00	0.15	0.17	0.2	0.045	0.29	0.0012	0.34	0.6	0.0032	0.092	0.43	0.26
2.01-5.00	0.0023	0.011	0.6	0	0.2	0	0.16	0.016	0	0.45	0.45	0.61
> 5.00	0	0	0.98	0	0.000027	0	0.0006	0	0	0.18	0.0001	0.29

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Pozzorubio (in sq. km)										
	Don Benito	Haway	Imbalbalatong	Inoman	Laoac	Maambal	Malasin	Malokiat	Manaol	Nama	Nantangalan
0.03-0.20	1.41	2.36	1.95	0.8	1.32	1.09	0.094	1.14	0.018	0.81	3.5
0.21-0.50	0.11	0.18	0.74	0.32	0.33	0.068	0.1	0.15	0.039	0.48	0.4
0.51-1.00	0.071	0.15	0.16	0.32	0.3	0.069	0.32	0.19	0.3	0.15	0.38
1.01-2.00	0.071	0.087	0.062	0.42	0.074	0.049	0.11	0.22	0.37	0.21	0.39
2.01-5.00	0.07	0.0049	0.068	0.16	0.0003	0.073	0.27	0.22	0.17	0.24	0.58
> 5.00	0	0	0	0	0	0.008	0.036	0.0002	0.0006	0.0002	0.023

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Pozzorubio (in sq. km)										
	Palacpalac	Palguyod	Poblacion I	Poblacion II	Poblacion III	Poblacion IV	Rosario	Sugcong	Talogtog	Tulnac	Villegas
0.03-0.20	0.2	0.4	0.089	0.041	0.36	0.096	1	0.92	0.25	1.01	0.74
0.21-0.50	0.25	0.26	0.15	0.13	0.25	0.22	1.38	0.05	0.52	0.8	0.19
0.51-1.00	0.19	0.35	0.0047	0.038	0.18	0.23	2.27	0.031	0.46	0.28	0.2
1.01-2.00	0.31	0.55	0	0.01	0.11	0.058	0.94	0.0065	0.041	0.02	0.17
2.01-5.00	0.018	0.025	0	0.00069	0.0043	0.004	0.04	0	0.00021	0	0.02
> 5.00	0	0	0	0	0	0	0.000074	0	0	0	0

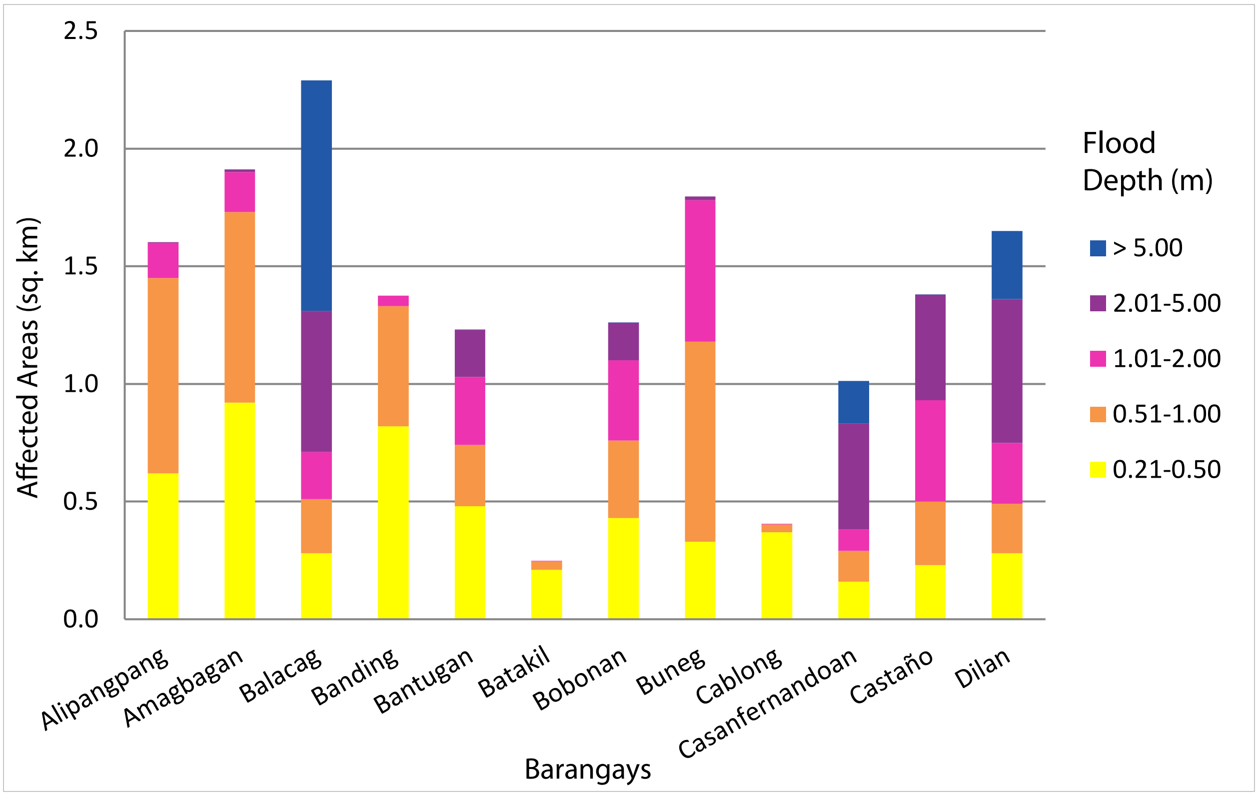


Figure 121. Affected Areas in Pozzorubio, Pangasinan during 100-Year Rainfall Return Period

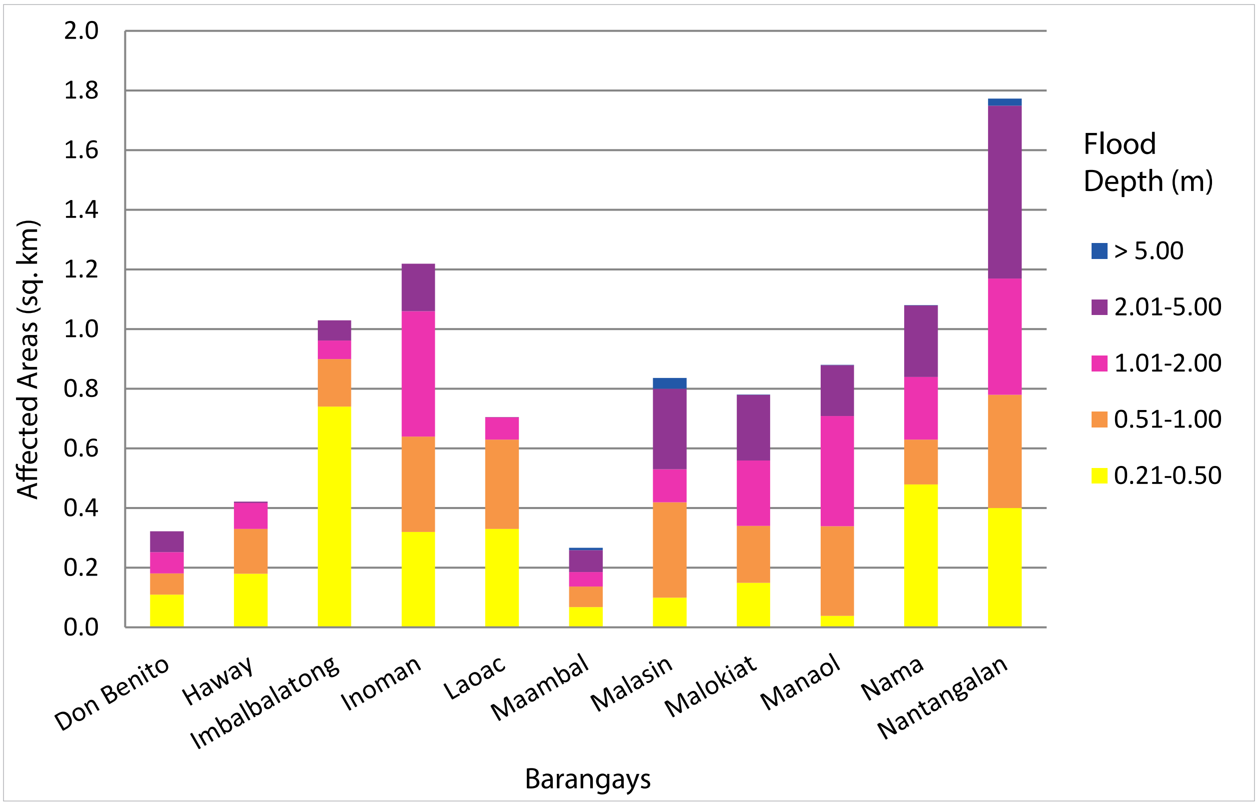


Figure 122. Affected Areas in Pozzorubio, Pangasinan during 100-Year Rainfall Return Period

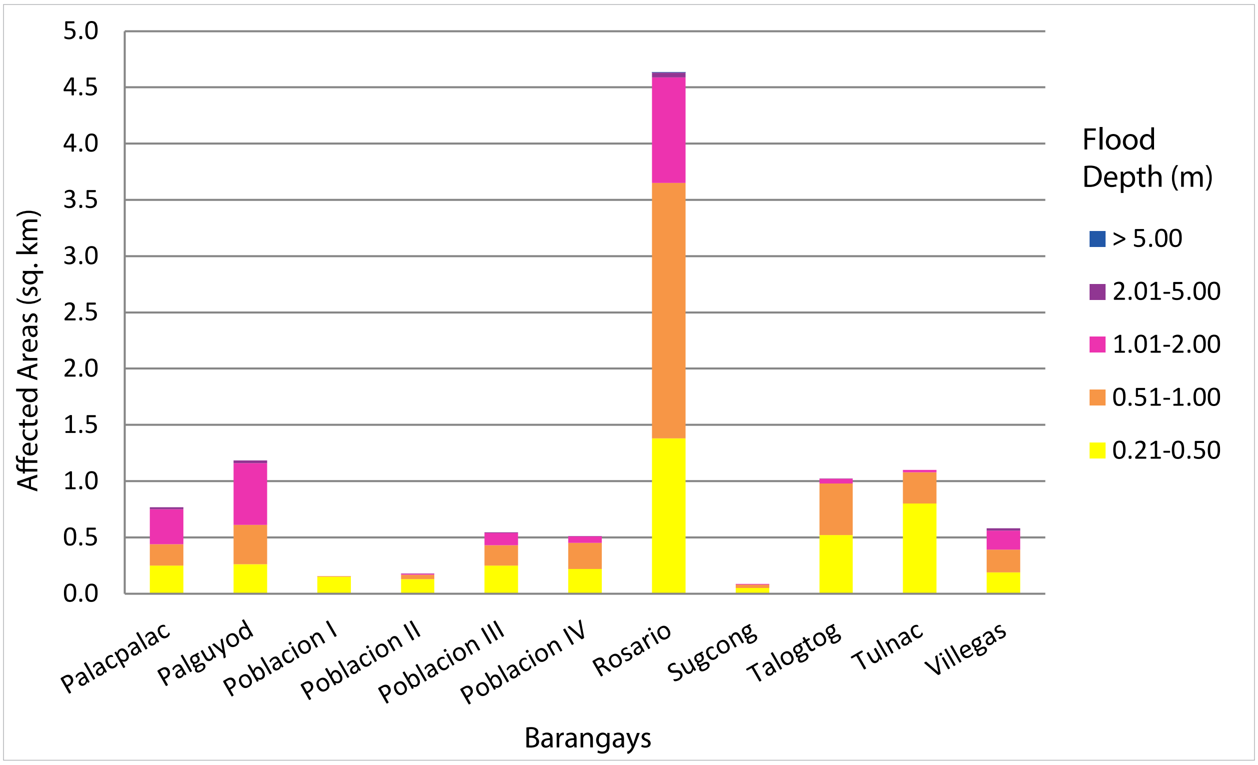


Figure 123. Affected Areas in Pozzorubio, Pangasinan during 100-Year Rainfall Return Period

For the 100-year return period, 13.55% of the municipality of San Fabian with an area of 69.270236 sq. km. will experience flood levels of less than 0.20 meters. 5.91% of the area will experience flood levels of 0.21 to 0.50 meters while 8.62%, 14.69%, 10.95%, and 0.41% 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 75. 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)												
	Ambalangan-Dalin	Angio	Anonang	Aramal	Binday	Bolasi	Cabaruan	Cayanga	Colisao	Lekep-Butao	Longos	Longos-Amangonan-Parac-Parac Fabrica	Tebag
0.03-0.20	0.36	0.75	0.78	0.18	1.54	0.51	0	0.028	0.62	1.54	0.09	0.0024	0.0031
0.21-0.50	0.025	0.48	0.46	0.21	0.08	0.71	0.0068	0.055	0.048	0.91	0.12	0.0047	0.002
0.51-1.00	0.017	0.67	0.48	0.85	0.058	0.4	0.12	0.21	0.037	0.81	0.48	0.028	0.025
1.01-2.00	0.0045	0.92	0.51	1.46	0.04	0.047	0.17	0.43	0.0041	1.67	0.57	0.62	0.042
2.01-5.00	0.00091	0.021	0.00021	0.1	0.053	0	0.79	0.47	0	1.92	0.18	0.12	0.069
> 5.00	0	0	0	0	0.009	0	0	0.061	0	0.12	0.08	0	0.056

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Fabian (in sq. km)												
	Longos Proper	Nibaliw Central	Nibaliw East	Nibaliw Magliba	Nibaliw Narvarte	Nibaliw Vidal	Palapad	Poblacion	Sagud-Bahley	Sobol	Tempra-Guilig	Tocok	Tebag
0.03-0.20	0.018	0.0015	0.014	0.1	0.14	0.029	2.38	0	0.024	0.049	0	0.23	0.0031
0.21-0.50	0.012	0.00069	0.063	0.064	0.063	0.039	0.26	0.0021	0.0075	0.1	0	0.37	0.002
0.51-1.00	0.029	0.0066	0.16	0.1	0.089	0.033	0.26	0.066	0.033	0.16	0.004	0.87	0.025
1.01-2.00	0.14	0.14	0.37	0.041	0.24	0.019	0.098	0.3	0.19	0.21	0.3	1.68	0.042
2.01-5.00	0.015	0.31	0.24	0.0025	0.24	0.037	0.046	0.32	0.22	0.18	1.17	1.15	0.069
> 5.00	0.013	0	0	0	0	0	0.0006	0	0	0	0	0	0.056

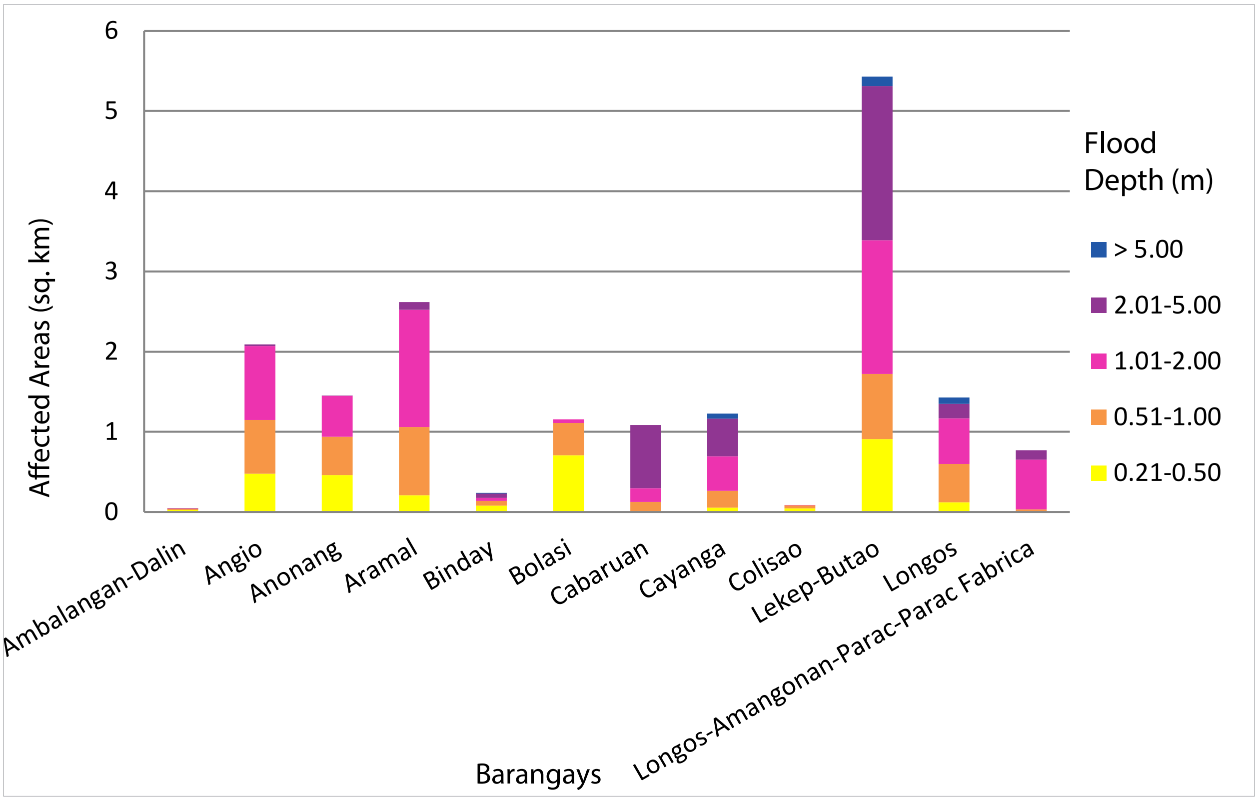


Figure 124. Affected Areas in San Fabian, Pangasinan during 100-Year Rainfall Return Period

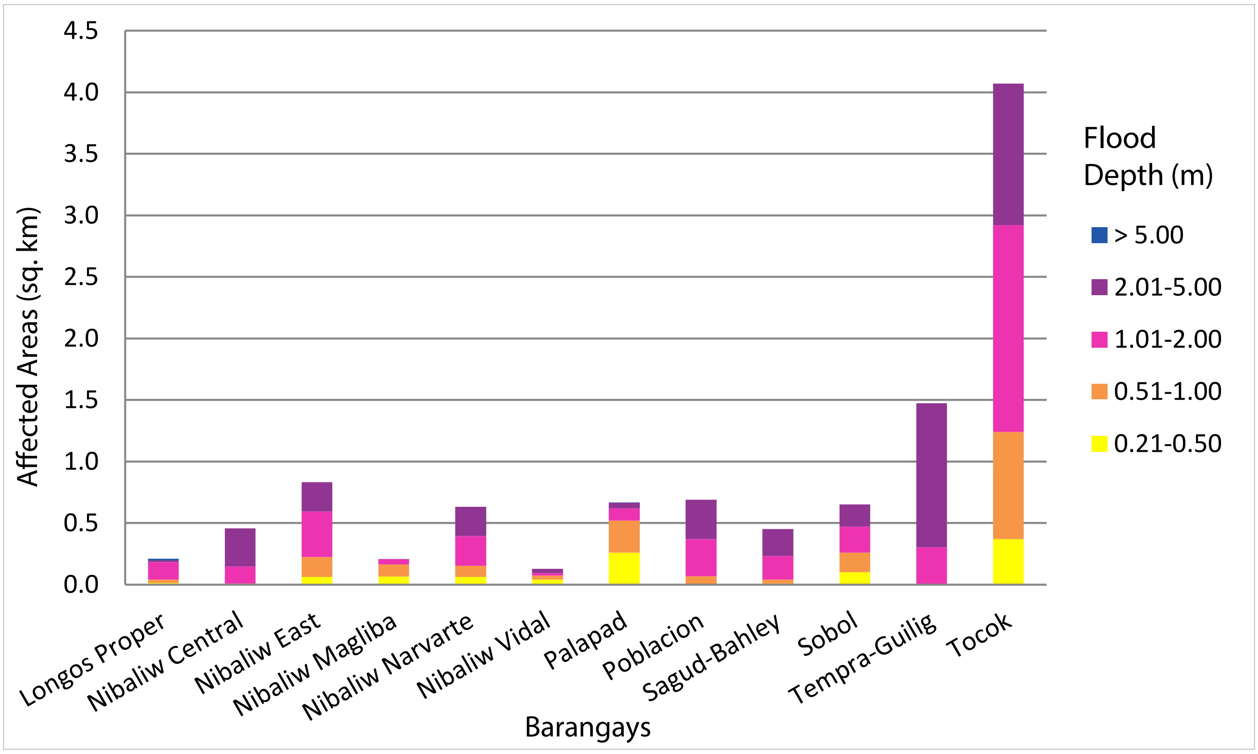


Figure 125. Affected Areas in San Fabian, Pangasinan during 100-Year Rainfall Return Period

For the 100-year return period, 30.07% of the municipality of San Jacinto with an area of 34.091828 sq. km. will experience flood levels of less than 0.20 meters. 6.07% of the area will experience flood levels of 0.21 to 0.50 meters while 10.18%, 18.00%, 28.99%, and 6.71% 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 76. Affected Areas in San Jacinto, Pangasinan during 100-Year Rainfall Return Period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Jacinto (in sq. km)									
	Awai	Bagong Pag-asa	Bolo	Capaoay	Casibong	Guibel	Imelda	Labney	Lobong	Macayug
0.03-0.20	2.71	0	0.096	0.0015	0	0.13	0.0023	2.24	1.62	0.25
0.21-0.50	0.17	0	0.017	0.0023	0.00056	0.08	0.017	0.26	0.54	0.29
0.51-1.00	0.2	0	0.061	0.0091	0.015	0.25	0.087	0.38	0.7	0.65
1.01-2.00	0.21	0.00067	0.17	0.15	0.1	0.75	0.13	0.34	0.33	1.46
2.01-5.00	0.13	0.18	0.27	0.3	0.57	2.89	0.021	0.28	0.073	1.4
> 5.00	0.0012	0.0068	0.2	0	0.0002	0.024	0	0.9	0.022	0.29

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in San Jacinto (in sq. km)								
	Magsaysay	San Guillermo	San Jose	San Juan	San Roque	San Vicente	Santa Cruz	Santa Maria	Santo Tomas
0.03-0.20	0	0	0.12	2.67	0.083	0.0073	0.17	0.15	0
0.21-0.50	0	0	0.059	0.32	0.14	0.0016	0.018	0.15	0.0027
0.51-1.00	0	0.0000041	0.16	0.35	0.21	0.0093	0.033	0.35	0.0045
1.01-2.00	0.015	0.022	0.31	0.4	0.53	0.12	0.12	0.79	0.19
2.01-5.00	0.14	0.37	1.16	0.12	0.42	0.65	0.12	0.58	0.21
> 5.00	0.0043	0.0068	0.53	0.0007	0	0.094	0.14	0	0.067

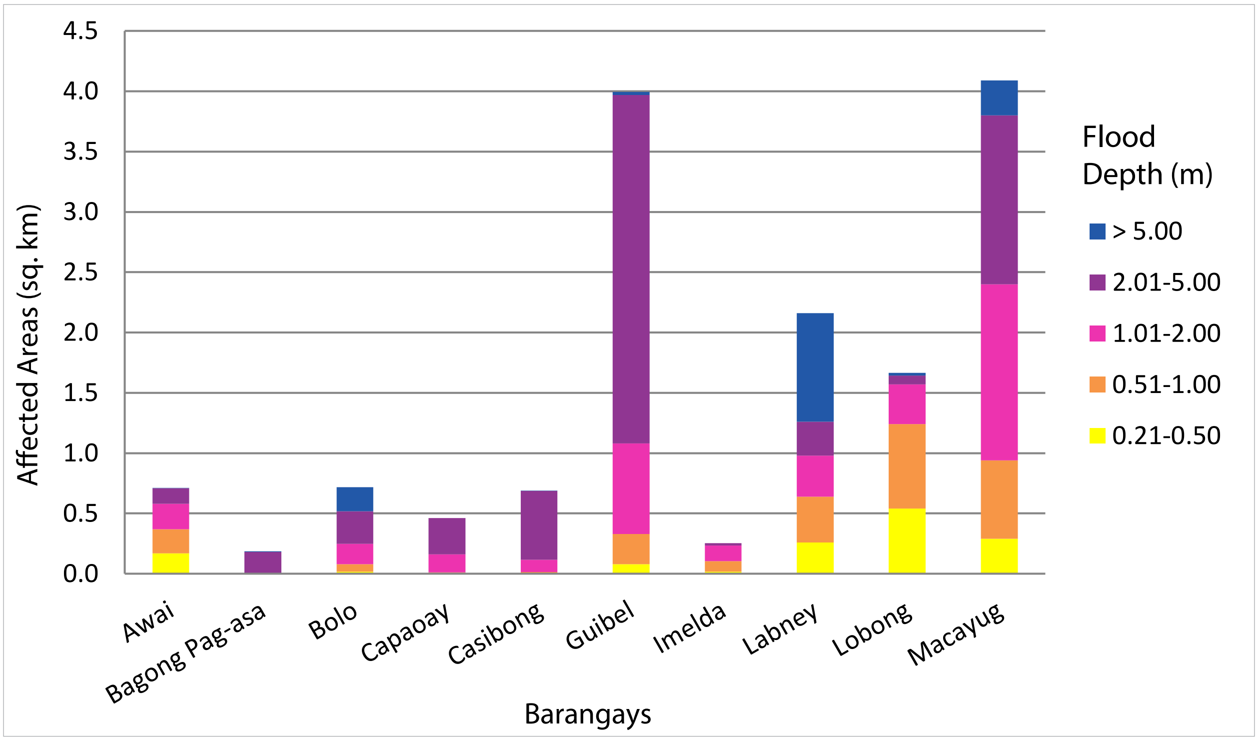
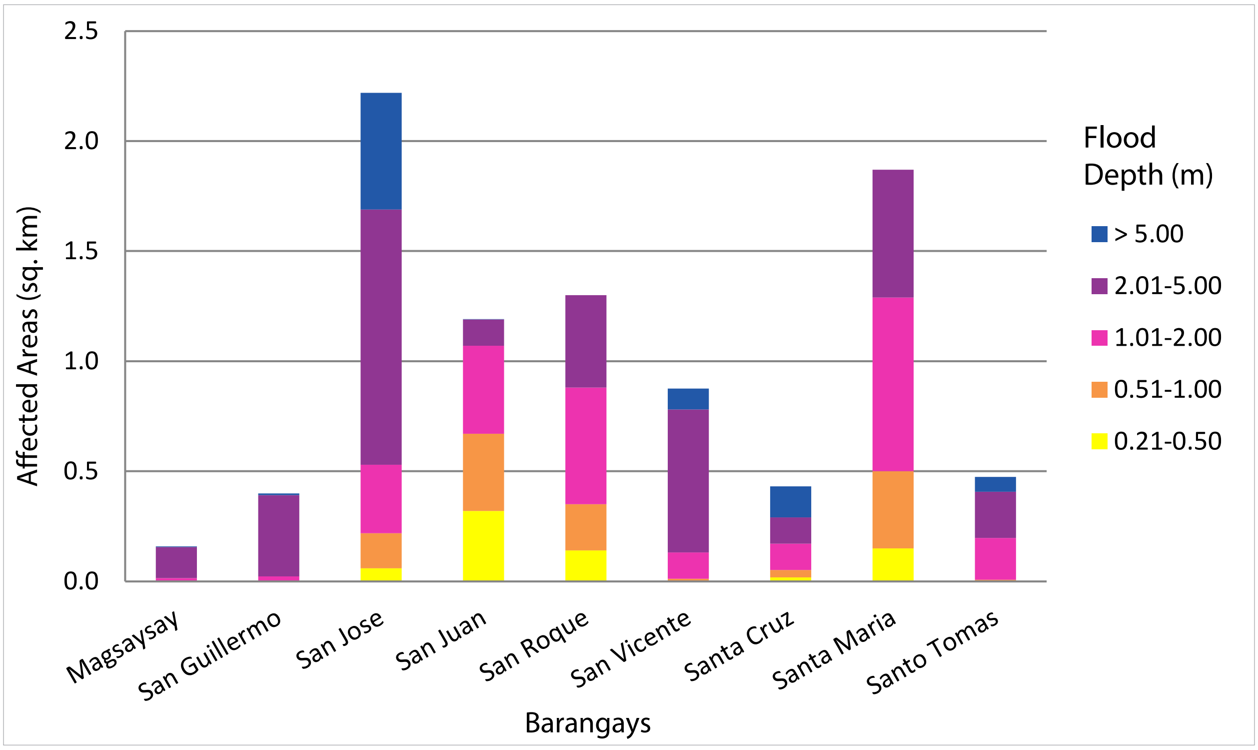


Figure 126. Affected Areas in San Jacinto, Pangasinan during 100-Year Rainfall Return Period



For the 100-year return period, 4.22% of the municipality of Sison with an area of 151.961994 sq. km. will experience flood levels of less than 0.20 meters. 0.61% of the area will experience flood levels of 0.21 to 0.50 meters while 0.84%, 0.98%, 0.56%, and 0.14% 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 77. Affected Areas in Sison, Pangasinan during 100-Year Rainfall Return Period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Sison (in sq. km)					
	Alibeng	Calunetan	Camangaan	Killo	Labayug	Tara-Tara
0.03-0.20	1.91	2.91	0.14	1.22	0.18	0.051
0.21-0.50	0.16	0.31	0.01	0.42	0.029	0.0003
0.51-1.00	0.093	0.37	0.0038	0.79	0.019	0.00079
1.01-2.00	0.04	0.9	0.0019	0.53	0.0088	0.0034
2.01-5.00	0.018	0.4	0.000056	0.41	0.0074	0.023
> 5.00	0.0013	0.0032	0	0.0081	0	0.2

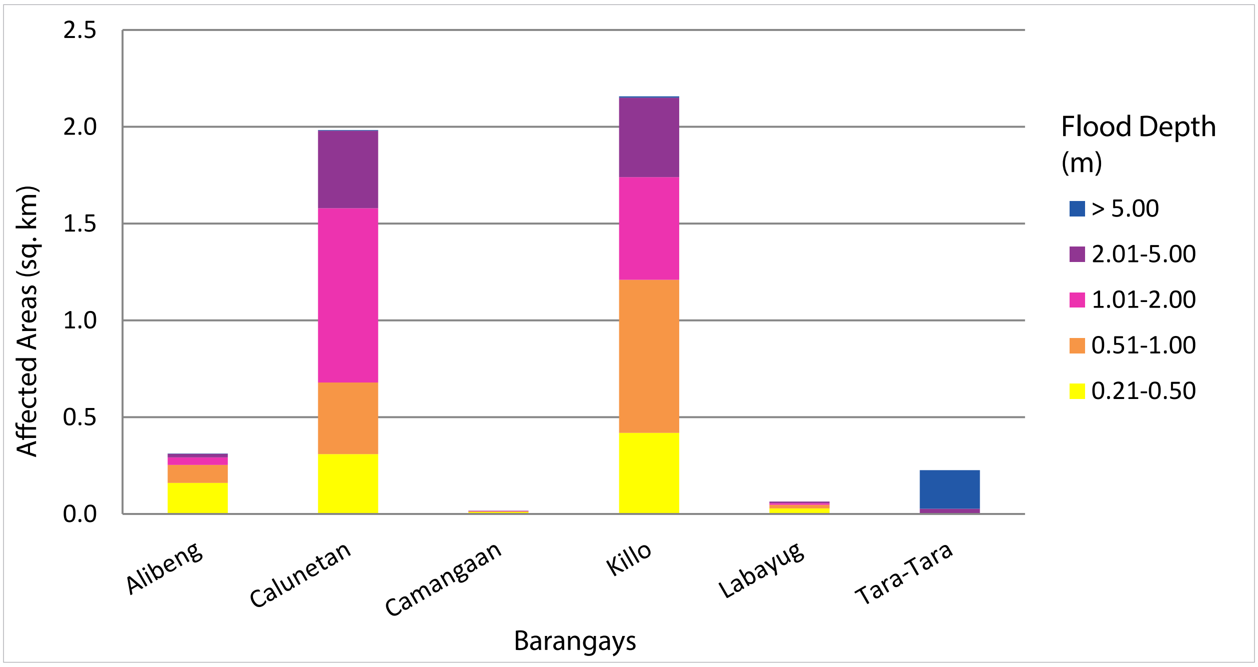


Figure 127. Affected Areas in Sison, Pangasinan during 100-Year Rainfall Return Period

For the 5-year return period, 1.84% of the municipality of Urdaneta City with an area of 107.789848 sq. km. will experience flood levels of less than 0.20 meters. 0.51% of the area will experience flood levels of 0.21 to 0.50 meters while 0.11%, 0.06%, and 0.04% 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 78. 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)			
	Camantiles	Cayambanan	Pinmaludpod	Tulong
0.03-0.20	0.64	0.002	0.041	0.16
0.21-0.50	0.39	0.00006	0.04	0.11
0.51-1.00	0.5	0.000024	0.11	0.023
1.01-2.00	0.18	0	0.43	0.000032
2.01-5.00	0.042	0	0.07	0.0000036
> 5.00	0	0	0.0025	0

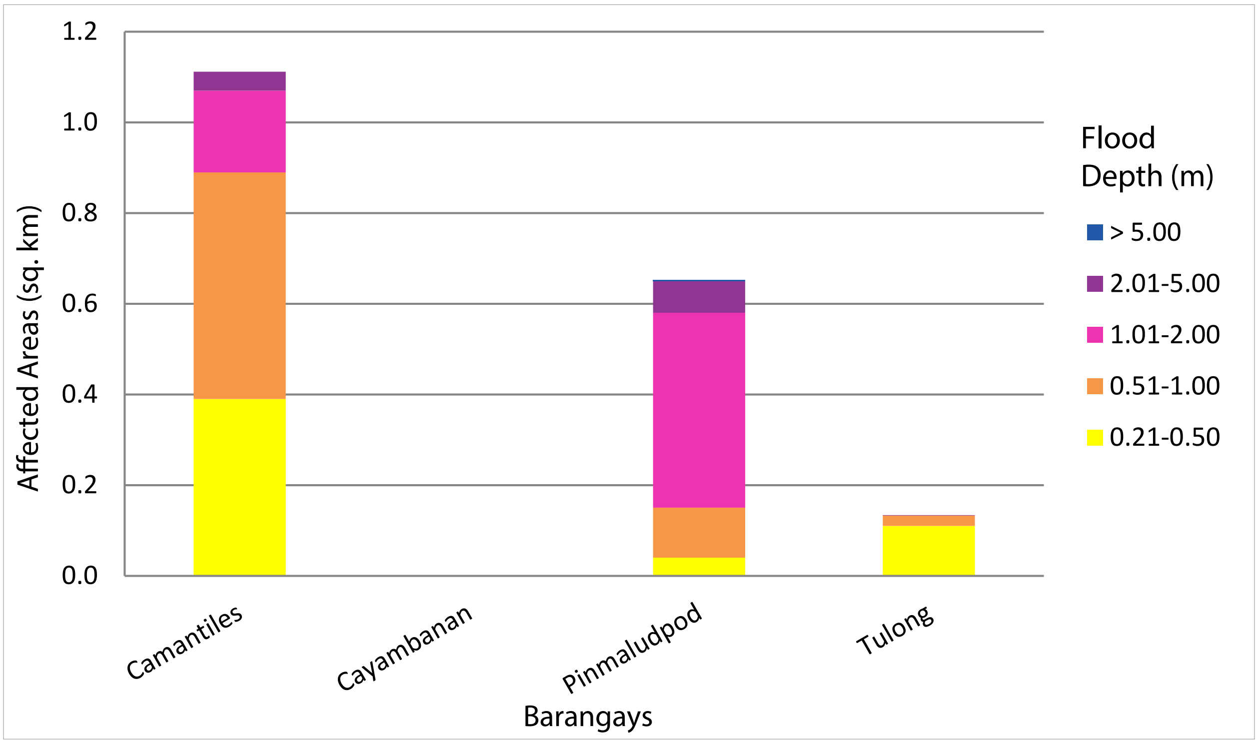


Figure 128. Affected Areas in Urdaneta City, Pangasinan during 100-Year Rainfall Return Period

Among the barangays in the municipality of Binalonan in Pangasinan, Camangaan is projected to have the highest percentage of area that will experience flood levels at 7.50%. Meanwhile, Bugayong posted the second highest percentage of area that may be affected by flood depths at 4.57%.

Brgy. Bonuan Binloc is the only barangay affected in the municipality of Dagupan City in Pangasinan. The barangay is projected to experience flood in 1.78% of the municipality.

Among the barangays in the municipality of Laoac in Pangasinan, Casampagaan is projected to have the highest percentage of area that will experience flood levels at 4.89%. Meanwhile, Caaringayan posted the second highest percentage of area that may be affected by flood depths at 3.99%.

Among the barangays in the municipality of Manaoag in Pangasinan, Pugaro is projected to have the highest percentage of area that will experience flood levels at 7.85%. Meanwhile, Babasit posted the second highest percentage of area that may be affected by flood depths at 5.36%.

Among the barangays in the municipality of Mangaldan in Pangasinan, Embarcadero is projected to have the highest percentage of area that will experience flood levels at 1.80%. Meanwhile, Osiem posted the second highest percentage of area that may be affected by flood depths at 1.40%.

Among the barangays in the municipality of Mapandan in Pangasinan, Baloling is projected to have the highest percentage of area that will experience flood levels at 1.99%. Meanwhile, Santa Maria posted the second highest percentage of area that may be affected by flood depths at 1.90%.

Among the barangays in the municipality of Pozzorubio in Pangasinan, Balacag is projected to have the highest percentage of area that will experience flood levels at 8.19%. Meanwhile, Rosario posted the second highest percentage of area that may be affected by flood depths at 7.17%.

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 8.87%. Meanwhile, Tocok posted the second highest percentage of area that may be affected by flood depths at 5.48%.

Among the barangays in the municipality of San Jacinto in Pangasinan, Labney is projected to have the highest percentage of area that will experience flood levels at 5.60%. Meanwhile, Macayug posted the second highest percentage of area that may be affected by flood depths at 5.53%.

Among the barangays in the municipality of Sison in Pangasinan, Calunetan is projected to have the highest percentage of area that will experience flood levels at 6.23%. Meanwhile, Killo posted the second highest percentage of area that may be affected by flood depths at 4.30%.

Among the barangays in the municipality of Urdaneta City in Pangasinan, Camantiles is projected to have the highest percentage of area that will experience flood levels at 2.23%. Meanwhile, Pinmaludpod posted the second highest percentage of area that may be affected by flood depths at 0.88%.

Moreover, the generated flood hazard maps for the Patalan 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 79. 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	47.94	44.24	40.05
Medium	55.24	76.95	81.25
High	33.07	51.08	66.74
Total	**136.25**	**172.27**	**188.04**

Of the 770 identified educational institutions in Patalan Floodplain, one hundred sixty two (162) school buildings were discovered exposed to low-level flooding while one hundred fifty four (154) school buildings were found exposed to medium-level flooding, both during a 5-year scenario. In the same scenario, twenty one (21) school buildings were discovered exposed to high-level flooding.

For the 25-year scenario, one hundred forty one (141) school buildings were discovered exposed to low-level flooding while one hundred sixty (160) school buildings were found exposed to medium-level flooding. In the same scenario, sixty (60) school buildings were discovered exposed to high-level flooding.

For the 100-year scenario, one hundred forty eight (148) school buildings were discovered exposed to low-level flooding while one hundred fifty eight (158) school buildings were found exposed to medium-level flooding. In the same scenario, one hundred twenty two (122) school buildings were discovered exposed to high-level flooding.

Of the 22 buildings of Medical Institutions in Patalan Floodplain, one (1) building was discovered exposed to low-level flooding while two (2) buildings were found exposed to medium-level flooding, both during a 5-year scenario. In the same scenario, one (1) building was discovered exposed to high-level flooding.

For the 25-year scenario, four (4) buildings were discovered exposed to low-level flooding while six (6) buildings were found exposed to medium-level flooding. In the same scenario, one (1) building was discovered exposed to high-level flooding.

For the 100-year scenario, four (4) buildings were discovered exposed to low-level flooding while six (6) buildings were found exposed to medium-level flooding. In the same scenario, two (2) buildings were discovered exposed to high-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 will gather data regarding the actual flood level in each location. Data gathering was done through a local DRRM office to obtain maps or situation reports about the past flooding events or interview some residents with knowledge of or have had experienced flooding in a particular area.

After which, the actual data from the field were 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 Patalan Floodplain. It has an RMSE value of 0.3. The validation points are found in Annex 11.

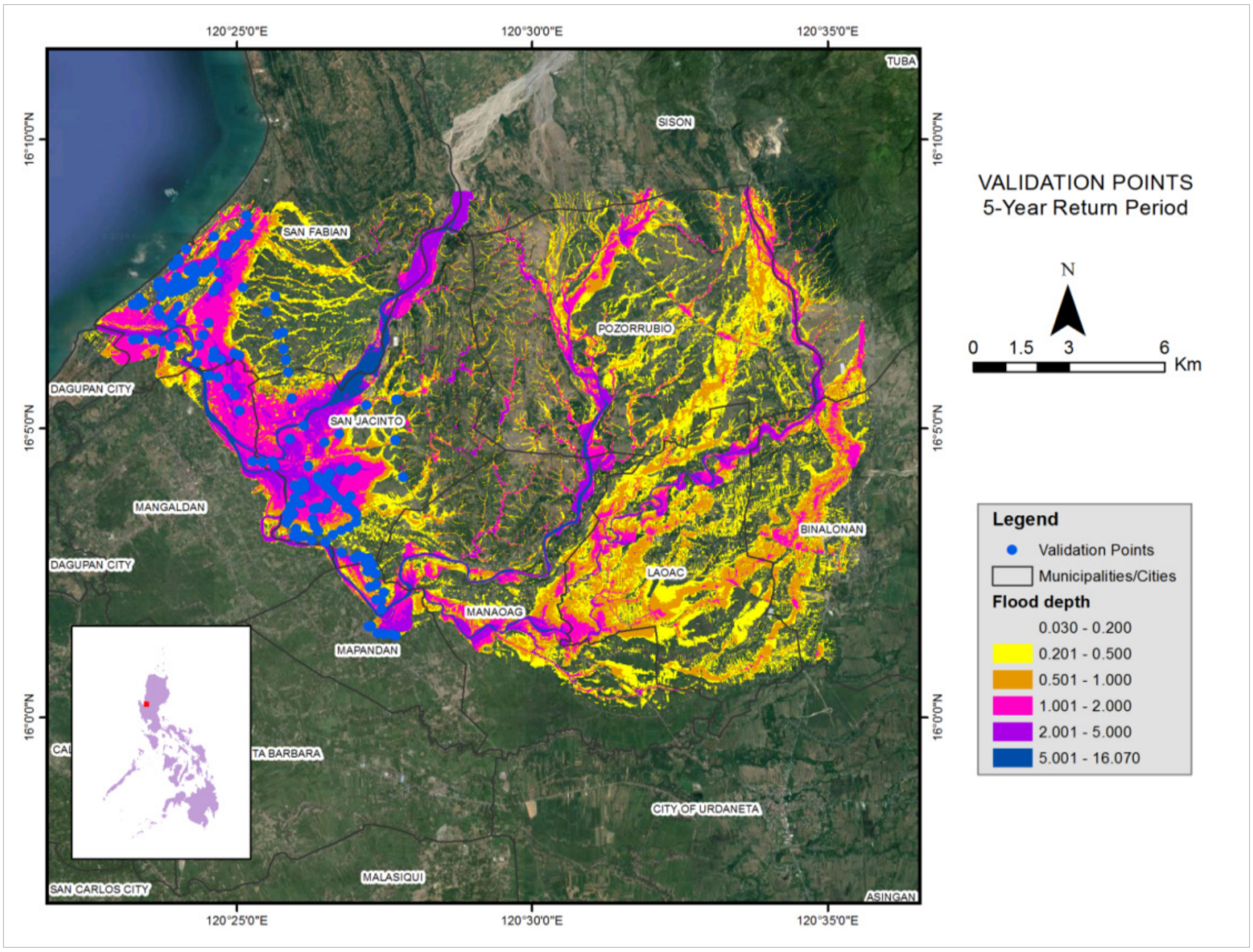


Figure 129. Validation points for 5-year Flood Depth Map of Patalan Floodplain

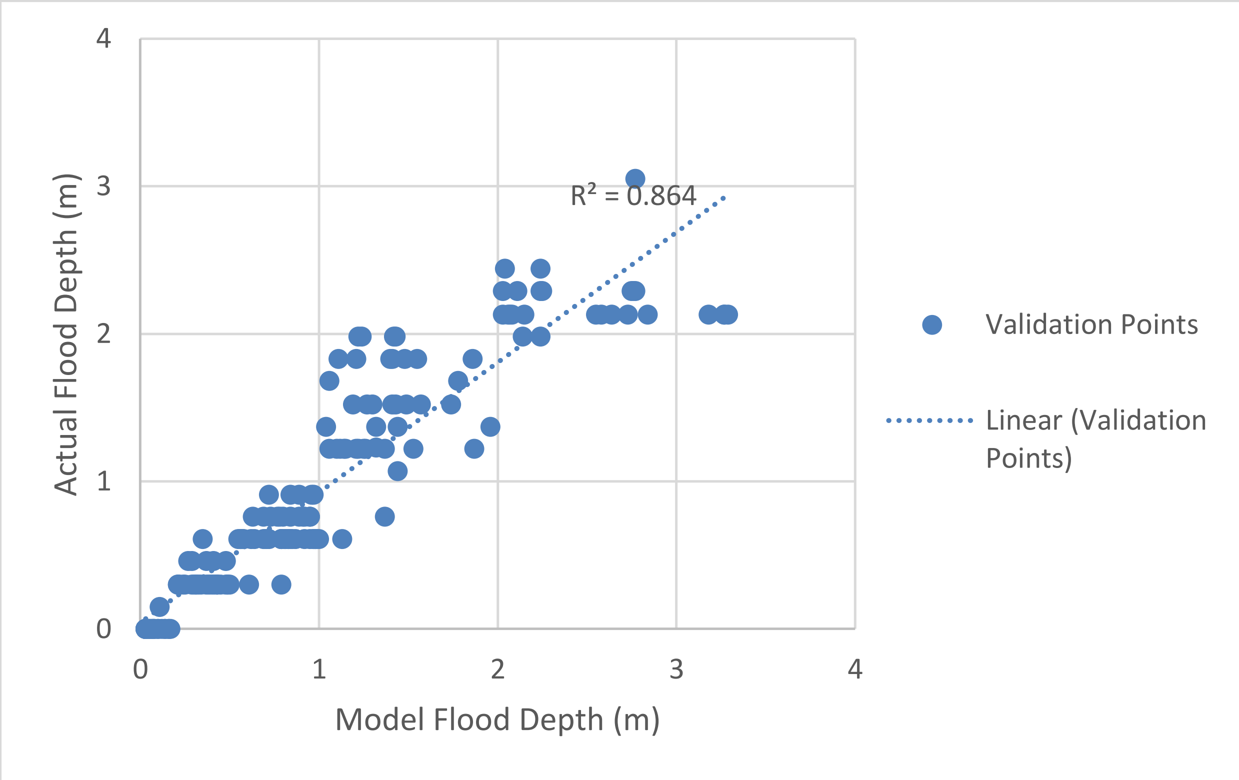


Figure 130. Model flood depth vs actual flood depth

Table 80. Actual Flood Depth vs Simulated Flood Depth in Patalan

Actual Flood Depth (m)	MODELED FLOOD DEPTH (m)						
	0-0.20	0.21-0.50	0.51-1.00	1.01-2.00	2.01-5.00	> 5.00	Total
0-0.20	30	0	0	0	0	0	30
0.21-0.50	0	31	2	0	0	0	33
0.51-1.00	0	1	49	2	0	0	52
1.01-2.00	0	0	0	39	2	0	41
2.01-5.00	0	0	0	0	24	0	24
> 5.00	0	0	0	0	0	0	0
Total	30	32	51	41	26	0	180

The overall accuracy generated by the flood model is estimated at 96.11% with 173 points correctly matching the actual flood depths. In addition, there were 6 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 1 point was underestimated in the modelled flood depths of Patalan.

Table 81. Summary of Accuracy Assessment in Patalan River Basin Survey

	No. of Points	%
Correct	173	96.11
Overestimated	6	3.33
Underestimated	1	0.56
Total	**180**	**100.00**

REFERENCES

Ang M.O., Paringit E.C., et al. 2014. *DREAM Data Processing Component Manual.* Quezon City, Philippines: UP Training Center for Applied Geodesy and Photogrammetry.

Balicanta L.P., Paringit E.C., et al. 2014. *DREAM Data Validation Component Manual.* Quezon City, Philippines: UP Training Center for Applied Geodesy and Photogrammetry.

Brunner, G. H. 2010a. HEC-RAS River Analysis System Hydraulic Reference Manual. Davis, CA: U.S. Army Corps of Engineers, Institute for Water Resources, Hydrologic Engineering Center

Lagmay A.F., Paringit E.C., et al. 2014. *DREAM Flood Modeling Component Manual.* Quezon City, Philippines: UP Training Center for Applied Geodesy and Photogrammetry.

Paringit E.C, Balicanta L.P., Ang, M.O., Sarmiento, C. 2017. *Flood Mapping of Rivers in the Philippines Using Airborne Lidar: Methods.* Quezon City, Philippines: UP Training Center for Applied Geodesy and Photogrammetry.

Sarmiento C., Paringit E.C., et al. 2014. *DREAM Data Acquisition Component Manual.* Quezon City, Philippines: UP Training Center for Applied Geodesy and Photogrammetry.

UP TCAGP 2016, *Acceptance and Evaluation of Synthetic Aperture Radar Digital Surface Model (SAR DSM) and Ground Control Points (GCP).* Quezon City, Philippines: UP Training Center for Applied Geodesy and Photogrammetry.

www.rappler.com, 2016. http://www.rappler.com/nation/special-coverage/weather-alert/149647-20161019-super-typhoon-lawin-pagasa-forecast-2pm

ANNEX

ANNEX 1. Technical Specifications of the LIDAR Sensors used in the Patalan Floodplain Survey

1. Aquarius Sensor

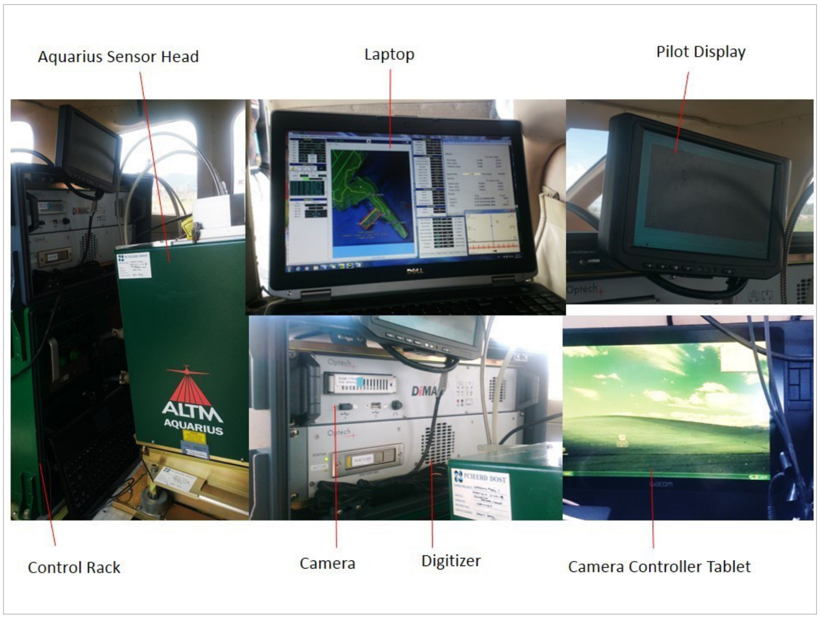


Figure A-1.1 Aquarius Sensor

Table A-1.1 Parameters and Specifications 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 altitiude	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

2. Pegasus Sensor

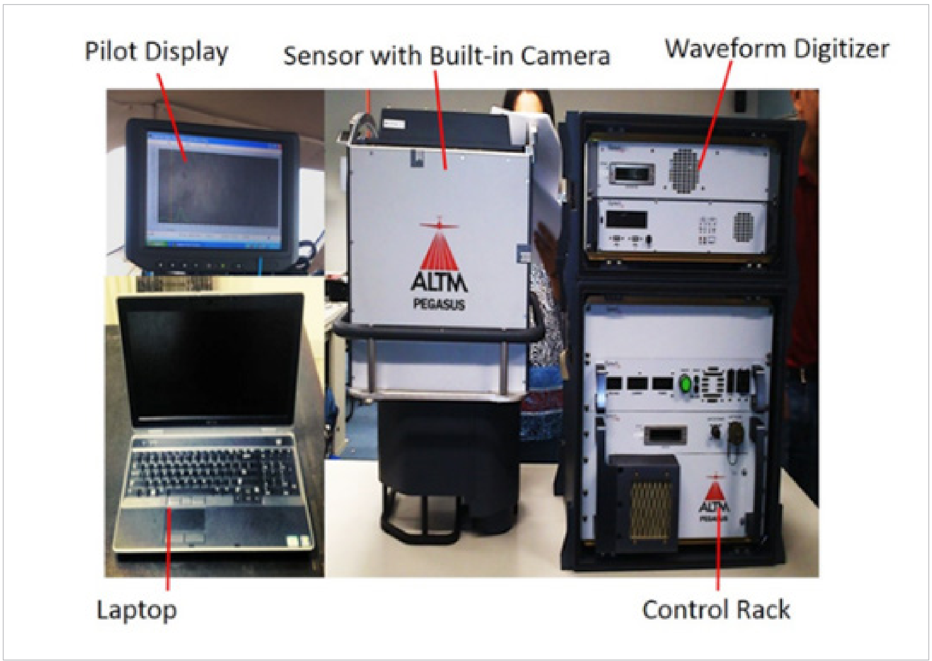


Figure A-1.2 Pegasus Sensor

Table A-1.2 Parameters and Specifications of Pegasus 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

3. Gemini Sensor

Figure A-1.3 Gemini Sensor

Table A-1.2 Parameters and Specifications 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

1. TRC-1

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

March 04, 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: **LA UNION**
Station Name: **LUN-72**
Order: **2nd**

Island: **LUZON** Municipality: **AGOO**		Barangay: **SAN AGUSTIN NORTE**
	PRS92 Coordinates	
Latitude: **16° 20' 15.54801"**	Longitude: **120° 21' 50.41723"**	Ellipsoidal Hgt: **18.53200 m.**
	WGS84 Coordinates	
Latitude: **16° 20' 9.68411"**	Longitude: **120° 21' 55.16713"**	Ellipsoidal Hgt: **55.39600 m.**
	PTM Coordinates	
Northing: **1806913.636 m.**	Easting: **432043.416 m.**	Zone: **3**
	UTM Coordinates	
Northing: **1,807,998.48**	Easting: **218,361.13**	Zone: **51**

Location Description

LUN-72

From Agoo Mun. Hall, travel towards San Fernando, about 1 km. after passing the first bridge. Travel for about 200 m. and turn left. Continue traveling for about 80 m. where the station is located. Station is situated in the right edge of the road and is about 20 m. SW of the San Agustin Norte Day Care Center.

Mark is the head of a 4 in. copper nail centered and embedded in a 30 cm. x 30 cm. cement putty, with inscriptions "LUN-72 2007 NAMRIA".

Requesting Party: **UP-DREAM**
Pupose: **Reference**
OR Number: **8795470 A**
T.N.: **2014-452**

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

9 9 0 3 0 4 2 0 1 4 1 6 1 1 1 3

CERTIFICATION INTERNATIONAL ISO 9001:2000
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

Figure A-2.1 TRC-1

2. LUN-72

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

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www.namria.gov.ph

Figure A-2.2.LUN-72

3. LUN-3047

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

March 04, 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: **LA UNION**
Station Name: **LUN-3047**
Order: **4th**

Island: **LUZON**
Municipality: **AGOO**
Barangay: **NAZARENO**

PRS92 Coordinates

Latitude: **16° 20' 55.96430"**	Longitude: **120° 21' 47.08672"**	Ellipsoidal Hgt: **43.62100 m.**

WGS84 Coordinates

Latitude: **16° 20' 50.09786"**	Longitude: **120° 21' 51.83567"**	Ellipsoidal Hgt: **80.44800 m.**

PTM Coordinates

Northing: **1808156.256 m.**	Easting: **431948.446 m.**	Zone: **3**

UTM Coordinates

Northing: **1,809,242.68**	Easting: **218,278.33**	Zone: **51**

Location Description

LUN-3047

It is located at Barangay Nazareno, Agoo, La Union.

Mark in the head of a 3 inches concrete nail embedded and centered on a 30 cm x 30 cm x 100 cm standard concrete monument protruding by about 20 cm, with the inscription LUN-3047 PRS-92 DENR-FNSP R-1.

Requesting Party: **UP-DREAM**
Pupose: **Reference**
OR Number: **8795470 A**
T.N.: **2014-454**

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

9 9 0 3 0 4 2 0 1 4 1 6 1 3 0 4

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

Figure A-2.3.LUN-3047

4. NEJ-110

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

January 23, 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: **NUEVA ECIJA**
Station Name: **NEJ-110**
Order: **2nd**

Island: **LUZON**
Municipality: **CUYAPO**
Barangay: **BALOY**

	PRS92 Coordinates	
Latitude: **15° 48' 19.61644"**	Longitude: **120° 46' 25.11917"**	Ellipsoidal Hgt: **88.30300 m.**
	WGS84 Coordinates	
Latitude: **15° 48' 13.90421"**	Longitude: **120° 46' 29.91195"**	Ellipsoidal Hgt: **127.76900 m.**
	PTM Coordinates	
Northing: **1747933.483 m.**	Easting: **475749.671 m.**	Zone: **3**
	UTM Coordinates	
Northing: **1,748,571.11**	Easting: **261,514.85**	Zone: **51**

Location Description

NEJ-110
Is located in the brgy. plaza, N of Baloy Elem. School. It is situated on top of an elevated platform, about 7 m. high, which is between the stage and the basketball court of the said plaza. It is also 1 m. from the E steel railing of the platform. Mark is the head of a 4 in. copper nail centered on a 25 cm. x 25 cm. cement putty, with inscriptions "NEJ-110 2007 NAMRIA".

Requesting Party: **UP-DREAM**
Pupose: **Reference**
OR Number: **8795198 A**
T.N.: **2014-136**

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

9 9 0 1 2 3 2 0 1 4 1 5 2 6 3 3

CERTIFICATION INTERNATIONAL ISO 9001:2008
ACCREDITED
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

Figure A-2.4. NEJ-110

5. NEJ-121

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

January 23, 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: **NUEVA ECIJA**
Station Name: **NEJ-121**
Order: **2nd**

Island: **LUZON**
Municipality: **TALAVERA**
Barangay: **TAGAYTAY**

		PRS92 Coordinates			
Latitude:	**15° 40' 5.06624"**	Longitude:	**120° 57' 24.22624"**	Ellipsoidal Hgt:	**65.19400 m.**
		WGS84 Coordinates			
Latitude:	**15° 39' 59.39965"**	Longitude:	**120° 57' 29.02968"**	Ellipsoidal Hgt:	**105.51500 m.**
		PTM Coordinates			
Northing:	**1732721.141 m.**	Easting:	**495361.169 m.**	Zone:	**3**
		UTM Coordinates			
Northing:	**1,733,169.16**	Easting:	**280,987.12**	Zone:	**51**

Location Description

NEJ-121
From Cabanatuan, travel along the nat'l. road going to Talavera until reaching the Y-road going to Talavera and Rizal at Brgy. Pinagpanaan. Turn left to the road going to Talavera. Follow the road until reaching Sicsican Bridge. From the bridge, travel straight ahead for about 1.5 km. until reaching a dirt road going to the right. Follow the road until reaching the welcome sign of Brgy. Tagaytay. Station is located near the SE footing of the said welcome sign, about 0.7 m. E of the said footing. It is about 5 m. SE from the road centerline. The welcome sign is the boundary between Brgys. Basang Hamog and Tagaytay. Mark is the head of a 4 in. copper nail centered on a 30 cm. x 30 cm. concrete monument protruding 20 cm. above the ground surface, with inscriptions "NEJ-121 2007 NAMRIA".

Requesting Party: **UP-DREAM**
Pupose: **Reference**
OR Number: **8795198 A**
T.N.: **2014-135**

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

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Figure A-2.5. NEJ-121

6. PNG-56

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

April 18, 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: **PANGASINAN**
Station Name: **PNG-56**
Order: **2nd**

Island: **LUZON**
Municipality: **STO. TOMAS**
Barangay: **POBLACION**

	PRS92 Coordinates	
Latitude: **15° 52' 46.68500"**	Longitude: **120° 34' 54.80152"**	Ellipsoidal Hgt: **30.68000 m.**
	WGS84 Coordinates	
Latitude: **15° 52' 40.94082"**	Longitude: **120° 34' 59.58898"**	Ellipsoidal Hgt: **69.45900 m.**
	PTM Coordinates	
Northing: **1756173.446 m.**	Easting: **455222.371 m.**	Zone: **3**
	UTM Coordinates	
Northing: **1,757,009.80**	Easting: **241,058.87**	Zone: **51**

Location Description

PNG-56

From Urdaneta, travel S until reaching Villasis then pass the Carmen Bridge. Then turn right until reaching Sto. Tomas Mun. Hall, about 2 km. from the intersection of Brgy. Carmen. Station is located in the town plaza fronting the mun. hall. It is situated 8.6 m. from the NE column of the waiting shed and 8.2 m. from the S entrance road. Mark is a 30 cm. x 30 cm. x 1 m. concrete monument, with inscriptions "PNG-56 2007 NAMRIA".

Requesting Party:	**UP DREAM/ Melchor Nery**
Pupose:	**Reference**
OR Number:	**3943540 B**
T.N.:	**2013-0309**

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Director, Mapping and Geodesy Department

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Figure A-2.6. PNG-56

7. PNG-3235

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: **PANGASINAN**
Station Name: **PNG-3235**
Order: **4th**

Island: **LUZON**
Municipality: **SAN CARLOS CITY**
Barangay: **MAPINIT**

	PRS92 Coordinates	
Latitude: **15° 54' 53.39177"**	Longitude: **120° 22' 37.60736"**	Ellipsoidal Hgt: **14.36100 m.**
	WGS84 Coordinates	
Latitude: **15° 54' 47.62346"**	Longitude: **120° 22' 42.39285"**	Ellipsoidal Hgt: **52.53700 m.**
	PTM Coordinates	
Northing: **1760122.49 m.**	Easting: **433302.82 m.**	Zone: **3**
	UTM Coordinates	
Northing: **1,761,170.53**	Easting: **219,166.89**	Zone: **51**

Location Description

PNG-3235
To reach the station travel 10-20 minutes eastward routing to Malasiqui beginning at San Carlos city proper. Turn right after reaching the junction going to Brgy. Mapinit. The station is located near the barangay hall. It is about 15 m E of the said hall and 3 m W from the centerline of the road. Station mark is the head of a 4" copper nail on a 0.40 m x 0.40 m concrete monument with inscription PNG-3235, PRS-92, 2008, DENR-LMS R-1.

Requesting Party: **Christopher Cruz**
Pupose: **Reference**
OR Number: **3943636B**
T.N.: **2013-0419**

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CIP/4701/12/09/814

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Figure A-2.7. PNG-3235

8. 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

9905292014124521

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Figure A-2.8. TRC-3008

9. TRC-3013

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-3013**
Order: **3rd**

Island: **LUZON**
Municipality: **LA PAZ**
Barangay: **LA PURISIMA**

	PRS92 Coordinates	
Latitude: **15° 29' 16.12939"**	Longitude: **120° 42' 38.37207"**	Ellipsoidal Hgt: **23.34200 m.**
	WGS84 Coordinates	
Latitude: **15° 29' 10.48416"**	Longitude: **120° 42' 43.19205"**	Ellipsoidal Hgt: **63.60100 m.**
	PTM Coordinates	
Northing: **1712797.124 m.**	Easting: **468953.912 m.**	Zone: **3**
	UTM Coordinates	
Northing: **1,713,487.51**	Easting: **254,385.82**	Zone: **51**

Location Description

TRC-3013
From La Purisima Elementary School, travel SW to La Purisima Purok II Plaza. Mark is located inside the plaza, E of basketball court and in front of the second concrete bench from the gate. 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-3013 2007 NAMRIA.

Requesting Party: **UP-DREAM**
Pupose: **Reference**
OR Number: **8796226 A**
T.N.: **2014-1183**

RUEL DM. BELEN, MNSA
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CIP/4701/12/09/814

Figure A-2.9. TRC-3013

10. BLN-58

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: **BULACAN**
Station Name: **BLN-58**
Order: **2nd**

Island: **LUZON**
Municipality: **SAN ILDEFONSO**
Barangay: **POBLACION**

PRS92 Coordinates

Latitude: **15° 4' 50.28672"**	Longitude: **120° 56' 35.59715"**	Ellipsoidal Hgt: **24.21800 m.**

WGS84 Coordinates

Latitude: **15° 4' 44.75323"**	Longitude: **120° 56' 40.45054"**	Ellipsoidal Hgt: **66.23600 m.**

PTM Coordinates

Northing: **1667726.854 m.**	Easting: **493895.954 m.**	Zone: **3**

UTM Coordinates

Northing: **1,668,175.07**	Easting: **278,919.72**	Zone: **51**

Location Description

BLN-58
The station is located in San Ildefonso Elementary School North District, about 10 m S of Gusaling Gabaldon and about 6 m NE of the SW corner of Math area. Mark is the head of a 4" copper nail centered on a 0.30 m x 0.30 m x 1 m concrete monument flushed on the ground with inscriptions BLN-58 2007 NAMRIA.

Requesting Party: **UP-DREAM**
Pupose: **Reference**
OR Number: **8796226 A**
T.N.: **2014-1187**

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CIF/4701/12/09/814

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Figure A-2.10. BLN-58

11. 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: **210,862.36**	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. labove ground surface, with inscriptions "PNG-66 2007 NAMRIA".

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

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Figure A-2.11. PNG-66

12. NEJ-138

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: **NUEVA ECIJA**	
	Station Name: **NEJ-138**	
Island: **LUZON**	Order: **2nd**	Barangay: **SAN FRANCISCO**
Municipality: **SAN ANTONIO**		
	PRS92 Coordinates	
Latitude: **15° 21' 17.34481"**	Longitude: **120° 50' 30.87881"**	Ellipsoidal Hgt: **18.43200 m.**
	WGS84 Coordinates	
Latitude: **15° 21' 11.74037"**	Longitude: **120° 50' 35.70940"**	Ellipsoidal Hgt: **59.40200 m.**
	PTM Coordinates	
Northing: **1698067.598 m.**	Easting: **483026.389 m.**	Zone: **3**
	UTM Coordinates	
Northing: **1,698,622.77**	Easting: **268,325.74**	Zone: **51**

Location Description

NEJ-138
From San Antonio Mun. Hall, travel along the road going to Zaragoza until reaching the Y-road going to Along-Along River and San Francisco at Brgy. Papaya. Turn right to the road going to San Francisco. Then turn right to the road junction until reaching San Francisco Brgy. Hall. Station is located along the ESE side of the multipurpose concrete pavement, about 18 m. SE of the brgy. hall, about 3 m. SSW of the ENE corner of the pavement and approx. 8 m. NNE of the shed. Mark is the head of a 4 in. copper nail centered on a 30 cm. x 30 cm. concrete monument protruding 40 cm. above the ground surface, with inscriptions "NEJ-138 2007 NAMRIA".

Requesting Party:	**UP-DREAM**
Pupose:	**Reference**
OR Number:	**8796226 A**
T.N.:	**2014-1184**

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

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Figure A-2.12. NEJ-138

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

1. WWC-2

Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
PNG56__ --- WCC 2 (B1)	PNG56__	WCC 2	Fixed	0.004	0.016	359°42'47"	19432.713	11.398

Acceptance Summary

Processed	Passed	Flag	Fail
1	1	0	0

Vector Components (Mark to Mark)

From:	PNG56__				
Grid		Local		Global	
Easting	241202.850 m	Latitude	N15°52'40.94078"	Latitude	N15°52'40.94078"
Northing	1756938.752 m	Longitude	E120°34'59.58895"	Longitude	E120°34'59.58895"
Elevation	27.865 m	Height	69.457 m	Height	69.457 m

To:	WCC 2				
Grid		Local		Global	
Easting	241331.135 m	Latitude	N16°03'13.12892"	Latitude	N16°03'13.12892"
Northing	1776379.358 m	Longitude	E120°34'56.31340"	Longitude	E120°34'56.31340"
Elevation	39.198 m	Height	80.855 m	Height	80.855 m

Vector					
ΔEasting	128.284 m	NS Fwd Azimuth	359°42'47"	ΔX	2797.844 m
ΔNorthing	19440.606 m	Ellipsoid Dist.	19432.713 m	ΔY	-4542.698 m
ΔElevation	11.333 m	ΔHeight	11.398 m	ΔZ	18686.228 m

Figure A-3.1 WWC-2

2. AAC-1

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

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

Figure A-3.2 AAC-1

ANNEX 4. The LiDAR Survey Team Composition

Table A-4.1. LiDAR Survey Team Composition

Data Acquisition Component Sub-Team	Designation	Name	Agency / Affiliation
PHIL-LIDAR 1	Program Leader	ENRICO C. PARINGIT, D.ENG	UP-TCAGP
Data Acquisition Component Leader	Data Component Project Leader – I	ENGR. CZAR JAKIRI SARMIENTO	
Survey Supervisor	Chief Science Research Specialist (CSRS)	ENGR. CHRISTOPHER CRUZ	
	Supervising Science Research Specialist (Supervising SRS)	LOVELY GRACIA ACUÑA	
		LOVELYN ASUNCION	
FIELD TEAM			
LiDAR Operation	**Senior Science Research Specialist (SSRS)**	LOVELY GRACIA ACUÑA	UP-TCAGP
		JULIE PEARL MARS	
		MARK GREGORY ANO	
		ENGR. GEROME HIPOLITO	
	Research Associate (RA)	MARY CATHERINE ELIZABETH BALIGUAS	
		ENGR. LARAH KRISELLE PARAGASA	
		MA. VERLINA TONGA	
		PAULINE JOANNE ARCEO	
Ground Survey, Data Download and Transfer	RA	ENGR. IRO NIEL ROXAS	UP-TCAGP
		ENGR. KENNETH QUISADO	
		ENGR. JAMES WILBERT BELTRAN	
		ENGR. FRANK NICOLAS ILEJAY	
LiDAR Operation	Airborne Security	SSG.DIOSCORO SOBERANO	PHILIPPINE AIR FORCE (PAF)
		SSG. OLIVER SACLOT	
	Pilot	CAPT. JAMAAL CLEMENTE	ASIAN AEROSPACE CORPORATION (AAC)
		CAPT. LAWRENCE MADAYAG	
		CAPT. MARK TANGONAN	
		CAPT. GRAIUS DELA CRUZ	
		CAPT. NEIL AGAWIN	
		CAPT. FRANCO JESUS PEPITO	
		CAPT. RAUL CZ SAMAR II	
		CAPT. JOHN BRYAN DONGUINES	

ANNEX 5. Data Transfer Sheet Patalan Floodplain

DATA TRANSFER FILE CHECKLIST
February 08, 2013

Date	Flight No.	Operator	Mission Name	Description (Loc)	Sensor	RAW LAS	LOGS	POS	RAW IMAGES	MISSION LOG FILE	RANGE	DIGITIZER	BASE STATION	SERVER LOCATION
04/feb/2013	122	Iro Neil Roxas	2AGN6B035A	PANGASINAN	GEMINI	N/A	445 KB	182 MB	23.5 GB	188 KB	11.7 GB	NO DIGITIZER	8.59 MB	\\FREENAS\DAC\122G
04/feb/2013	124	Jasmine Alviar	1AGN5P035B	PANGASINAN	PEGASUS	150 MB	714 KB	110 MB	-	1 KB	16.3 GB	74.2 GB	8.59 MB	\\FREENAS\DAC\124P
04/feb/2013	125	Lovely Acuna	2AGN6B035A 5N035B	PANGASINAN	GEMINI	N/A	332 KB	126 MB	16.5 GB	1KB/146 KB	7.17 GB	NO DIGITIZER	8.59 MB	\\FREENAS\DAC\125G

RECEIVED FROM:
NAME: CHRISTOPHER JOAQUIN
POSITION: RA
SIGNATURE:
DATE TRANSFERRED: Feb 8, 2013

RECEIVED BY:
NAME: Jojo F. Prieto
POSITION: SSRS
SIGNATURE:
DATE TRANSFERRED: 02/08/2013

Figure A-5.1. Transfer Sheet for Patalan Floodplain (A)

DATA TRANSFER FILE CHECKLIST
February 05, 2013

Date	Flight No.	Operator	Mission Name	Description (Loc)	Sensor	RAW LAS	LOGS	POS	RAW IMAGES	MISSION LOG FILE	RANGE	DIGITIZER	BASE STATION	SERVER LOCATION
05/feb/2013	126		2AGN6A036A		GEMINI	N/A	453 KB	164 MB	20.5 GB	149 KB	12.1 GB	NO DIGITIZER	11.3 MB	\\FREENAS\DAC\02062013\0205201
05/feb/2013	127		1AGN5M036A		PEGASUS	191 MB	926 KB	126 MB	28 GB	216 KB	16.1 GB	79.9 GB	11.3 MB	\\FREENAS\DAC\02062013\0205201
05/feb/2013	128	-	2AGN5O036B		GEMINI	N/A	394 KB	154 MB	19.7 GB	171 KB	9.57 GB	NO DIGITIZER	11.3 MB	\\FREENAS\DAC\02062013\0205201
06/feb/2013	129		2AGN5E037A		GEMINI	N/A	611 KB	184 MB	20.5 GB	-	10.5 GB	NO DIGITIZER	6.21 MB	\\FREENAS\DAC\02062013\129G
06/feb/2013	130		1AGN5L037A		PEGASUS	104 MB	1.35 MB	153 MB	33 GB	44KB/210KB	2.96 GB/1 2.9 GB	64.7 GB	6.21 MB	\\FREENAS\DAC\02062013\130P
06/feb/2013	131		2AGN5D037B		GEMINI	N/A	515 KB	159 MB	43.8 GB	133KB/6KB/3KB/25KB	9.67 GB	NO DIGITIZER	6.21 MB	\\FREENAS\DAC\02062013\131G
09/feb/2013	136		1AGN5J040A		PEGASUS	104 MB	757 KB	124 MB	26.1 GB	208 KB	325 MB	82.8 GB	-	\\FREENAS\DAC\136P ~~no kan...~~

RECEIVED FROM:
NAME: CHRISTOPHER JOAQUIN
POSITION: RA
SIGNATURE:
DATE TRANSFERRED: FEB 11, 2013

RECEIVED BY:
NAME: Joida F. Prieto
POSITION: SSRS
SIGNATURE:
DATE TRANSFERRED: 02/11/2013

Figure A-5.2. Transfer Sheet for Patalan Floodplain (B)

Sheet1

DATA TRANSFER SHEET
01/21/13

DATE	FLIGHT NO.	OPERATOR	MISSION NAME	DESCRIPTION (LOC)	SENSOR	RAW LAS	LOGS	POS	RAW IMAGES	MISSION LOG FILE	RANGE	DIGITIZER	BASE STATION(S)	OPERATOR COMMENTS (DPC LOGS)	FLIGHT PLAN	HARDRIVE LOCATION	SERVER LOCATION
Jan 16, 2013	093	Aubrey Matira	1D016B - TEST	DAVAO FLOODPLAIN	PEGASUS	404 MB	215 KB	51.3 MB	NO IMAGE DATA (TEST IMAGES ONLY. 814 MB)	832 bytes	3.05 GB	11.4 GB	TEST: 1.80 MB	OK	OK	SEAGATE:\DAC\2013 FLIGHTS\MINDANAO\01162013\93P	\\Freenas\dac\93p
Jan 17, 2013	094	Jasmine Alviar	1DV017B	DAVAO FLOODPLAIN	PEGASUS	304 MB	1.79 MB	206 MB	59.2 GB	566 KB	32.3 GB	154 GB	DVS-1: 9.61 MB	OK	OK	SEAGATE:\DAC\2013 FLIGHTS\MINDANAO\01172013\94P	\\Freenas\dac\94p
Jan 18, 2013	095	Mark Gregory Año	1CV018A	COMPOSTELA VALLEY	PEGASUS	201 MB	1.69 MB	250 MB	74 GB	552 KB	16.2 GB	94 GB	DVS-1: 8.45 MB DVC-BASE-CV&DAVAO: 10.7MB		OK	SEAGATE:\DAC\2013 FLIGHTS\MINDANAO\01182013\95P	\\Freenas\dac\95p
Jan 18, 2013	096	Jasmine Alviar	1DV018B	DAVAO FLOODPLAIN	PEGASUS	175 MB	678 KB	140 MB	26.9 GB	318 KB	18.6 GB	49.6 GB	DVS-1: 8.45 MB DVC-BASE-CV&DAVAO: 10.7MB	OK	OK	SEAGATE:\DAC\2013 FLIGHTS\MINDANAO\01182013\96P	\\Freenas\dac\96p
Jan 21, 2013	097	Iro Neil Roxas	2AG6P021_A	PANGASINAN	GEMINI	N/A	803 KB	470 MB	49.8 GB/ 1.02 GB	378 KB/ 6KB	15.1 GB	102 GB	5.79 MB	OK	OK	ENGG_CRU Z:\01212013\97G	\\Freenas\dac\97g
Jan 21, 2013	098	Lovely Acuna	2AGO021B	PANGASINAN	GEMINI	N/A	714 KB	178 MB	44.8 GB	377 KB	12.3 GB	No data	5.79 MB	OK	OK	ENGG_CRU Z:\01212013\98G	\\Freenas\dac\98g
Jan 22, 2013	099	Iro Neil Roxas	AGNO12_A	PANGASINAN	GEMINI	N/A	855 KB	208 MB	56.4 GB	430 KB/ 6KB/ 1KB	14.6 GB	No data	2.97 MB	OK	OK	ENGG_CRU Z:\01222013\99G	\\Freenas\dac\99g

Received from:
Name: Patricia alcantara
Position: RA
Signature: Palcantara
Data Transferred: 01/23/13

Received by: Joida F. Prieto
Name:
Position: SSRS
Signature: [signature]
Data transferred: 01/23/2013

Figure A-5.3. Transfer Sheet for Patalan Floodplain (C)

DATA TRANSFER SHEET CHECKLIST

MARCH 01, 2013

DATE	FLIGHT NO.	MISSION NAME	LAS	LOGS	POS	RAW IMAGE	LOG FILE	RANGE	BASE	LOCATION
0207	132 G	2AGN5F038A	N/A	775 KB	194.9 MB	57.2 GB	396.2 KB	13.5 GB	8 MB	FREENAS
0208	133 G	2AGN5E039A	N/A	672 KB	229.3 MB	45.9 GB	302.2 KB / 526B	15.4 GB	—	FREENAS (020813 FOLDER)
0208	134 G	2AGN5B039B	N/A	442.7 KB	199.3 MB	281 GB	186.6 KB	11.3 GB	—	FREENAS (020813 FOLDER)
	136 P	1Agno 5J	OTHER FILES ON DVC WS02					NEW RANGE (20.1 GB)		

DPC 4 HD

DATE	FLIGHT NO.	MISSION NAME	LAS	LOGS	POS	RAW IMAGE	LOG FILE	RANGE	BASE	LOCATION
0226	168 P	1AGN6BS057A	157.6 MB	685.6 KB	113.4 MB	24.7 GB	173.1 KB	16.4 GB	5.8 MB	FREENAS (022613 FOLDER)
022 13	169 G	2A50Q057B	N/A	97.7 KB	75.8 MB	1.8 GB	17.5 KB / 2.8 KB	1.5 GB	5.8 MB	FREENAS (022613 FOLDER)
022 13	170 P	1AGN6C5057B	136.4 MB	988.8 KB	115.3 MB	2.5 GB / 16.0 GB	—	13.7 GB	5.8 MB	FREENAS (022613 FOLDER)
022 13	171 G	2P3P058A	N/A	1.1 MB	359.4 MB	62.2 GB	462.8 KB	24.1 GB	10.1 MB	FREENAS (022713 FOLDER)
022 13	172 P	1P3C558A	5.6 MB	216 KB	78.3 MB	1.9 GB	149 KB	5.6 GB	10.1 MB	"
022 13	173 G	2P3B058B	N/A	570.7 KB	265.5 MB	28 GB	229.9 KB	13.6 GB	10.1 MB	FREENAS (022713
022 13	174 P	1P3A558B	310.7 MB	1.4 MB	205.8 MB	40.4 GB	351.9 KB	27.7 GB	10.1 MB	"

HD

DATE	FLIGHT NO.	MISSION NAME	LAS	LOGS	POS	RAW IMAGE	LOG FILE	RANGE	BASE	LOCATION
021 13	145 G	2P7A2045A	N/A	519.2 KB	269.2 MB	26.2 GB	577 B / 183.2 KB	14.6 GB	7.2 MB	FREENAS (0214 FOLDER)
021 13	148 P	2P7B2045B	N/A	~~580.9 KB~~ 585 KB	288.5 MB	29.3 GB	228 KB / 424 B	16.1 GB	7.2 MB	"
021 13	152 P	1P7E047A	~~210 MB~~ 242.6 MB	1.4 MB	199.8 MB	48.4 GB	424 B / 424 B / 552 KB	34.4 GB	4.8 MB	Freenas (021
021 13	154 P	1P7G049A	248.3 MB	1.4 MB	200.9 MB	49.2 GB	358.2 KB	33.1 GB	11.4 MB	FREENAS (0214
021 13	155 G	2A10D049A	N/A	799.8 KB	274.5 MB	47.2 GB	300.5 / 2.4 / 73.7 KB	15.7 GB	11.4 MB	"
021 13	156 P	1P7C049B	210.2 MB	12.5 KB / 1.1 MB	169.7 MB	27.4 GB	211.9 KB	17.8 GB	11.4 MB	"
* 021 13	153 P	1P7G049B	—	—	—	8.4 GB	58.3 KB	4.5 GB	4.8 MB	FREENAS (0216 13
021 13	157 G	2A6A050A	N/A	307.3 KB	169.9 MB	16 GB	117 KB	7.9 GB	—	FREENAS (02 17
13	158 P	1A6Q050A	158.5 MB	777.2 KB	114.7 MB	18.1 GB	138.2 KB	12.1 GB	—	"

12-22

Figure A-5.4. Transfer Sheet for Patalan Floodplain (D)

(CLA UNION)

DATA TRANSFER SHEET
Mar 17, 2014

DATE	FLIGHT NO.	MISSION NAME	SENSOR	RAW LAS		LOGS	POS	RAW IMAGES	MISSION LOG FILE	RANGE	DIGITIZER	BASE STATION(S)		OPERATOR LOGS (OPLOG)	FLIGHT PLAN		SERVER LOCATION
				Output LAS	KML (swath)							BASE STATION(S)	Base Info (.txt)		Actual	KML	
2/25/2014	1151P	1BLK10A056A	PEGASUS	3.03GB	NA	12.3MB	229MB	N/A	N/A	19.8	N/A	6.5	1KB	459B	35	NA	X:\Airborne_Raw\1151P
2/25/2014	1153P	1BLK10AS056B	PEGASUS	836MB	NA	3.57MB	84.5MB	N/A	N/A	8.02	N/A	6.51	1KB	244B	38	N/A	X:\Airborne_Raw\1153P
2/26/2014	1155P	1BLK10C057A	PEGASUS	2.64GB	NA	11MB	220MB	33.1GB	289KB	26.4	N/A	6.95	1KB	610B	44	N/A	X:\Airborne_Raw\1155P
2/26/2014	1157P	1BLK10B057B	PEGASUS	1.85GB	NA	6.62MB	129MB	25.6GB	229KB	17.4	N/A	6.95	1KB	485B	45	N/A	X:\Airborne_Raw\1157P
2/27/2014	1159P	1BLK10GD058A	PEGASUS	2.76GB	NA	11.4MB	221MB	4.7GB	148KB	27.9	N/A	6.55	1KB	669B	29	N/A	X:\Airborne_Raw\1159P
2/27/2014	1161P	1BLK10DS058B	PEGASUS	1.28GB	NA	7.08MB	152MB	22.3GB	186KB	15.6	N/A	6.55	1KB	474B	50	N/A	X:\Airborne_Raw\1161P
2/28/2014	1163P	1BLK10F059A	PEGASUS	3.42GB	NA	12MB	216MB	53.2GB	416KB	31.7	N/A	6.05	1KB	328B	31	N/A	X:\Airborne_Raw\1163P
2/28/2014	1165P	1BLK10E059B	PEGASUS	1.41GB	NA	7.12MB	143MB	25.6GB	208KB	16.7	N/A	6.05	1KB	502B	n/a	N/A	X:\Airborne_Raw\1165P
3/1/2014	1167P	1BLK10H060A	PEGASUS	831MB	NA	7.42MB	170MB	17.5GB	145KB	8.66	N/A	6.64	1KB	318B	20	N/A	X:\Airborne_Raw\1167P
3/1/2014	1169P	1BLK10ES060B	PEGASUS	2.05GB	NA	7.17MB	133MB	28.6GB	224KB	19.1	N/A	6.64	1KB	304B	45	N/A	X:\Airborne_Raw\1169P
3/2/2014	1171P	1BLK10CDS061A	PEGASUS	1.72GB	NA	9.73MB	206MB	21GB	170KB	17	N/A	7.08	1KB	310B	32	N/A	X:\Airborne_Raw\1171P
3/2/2014	1173P	1BLK10DS061B	PEGASUS	1.52GB	NA	5.95MB	116MB	20.3GB	169KB	14.5	N/A	7.08	1KB	481B	50	N/A	X:\Airborne_Raw\1173P
3/3/2014	1175P	1BLK10BS062A	PEGASUS	3.14GB	NA	11.8MB	214MB	43.1GB	341KB	29.5	N/A	6.74	1KB	305B	38	N/A	X:\Airborne_Raw\1175P
3/3/2014	1177P	1BLK10CS062B	PEGASUS	1.18GB	NA	8.31MB	157MB	30GB	254KB	11.3	N/A	6.74	1KB	741B	42	N/A	X:\Airborne_Raw\1177P
Mar 4, 2014	1179P	1BLK27B063A	PEGASUS	3.54GB	NA	14MB	260MB	39.3GB	361KB	34.5	N/A	5.86	1KB	1KB	38	N/A	X:\Airborne_Raw\1179P
Mar 5, 2014	1183P	1BLK12AC064A	PEGASUS	1.5GB	NA	10.3MB	206MB	35.6GB	304KB	22.5GB	N/A	5.94	1KB	1KB	42/38/33/4234	N/A	X:\Airborne_Raw\1183P
Mar 5, 2014	1185P	1BLK10D064B	PEGASUS	1.18GB	NA	5.86MB	151MB	16.4GB	142KB	11.7GB	N/A	5.94	1KB	1KB	n/a	N/A	X:\Airborne_Raw\1185P
Mar 6, 2014	1187P	1BLK12DS065A	PEGASUS	2.34GB	NA	11MB	212MB	35.3GB	302KB	24.4GB	N/A	6.62	1KB	1KB	36	N/A	X:\Airborne_Raw\1187P
Mar 6, 2014	1189P	1BLK12CS065B	PEGASUS	2.06GB	NA	8.08MB	151MB	37.7GB	332KB	19.7GB	N/A	6.62	1KB	1KB	42	N/A	X:\Airborne_Raw\1189P
Mar 8, 2014	1195P	1BLK27ABS067A	PEGASUS	915MB	NA	4.91MB	110MB	16.1GB	130KB	10.2GB	N/A	From Ilocos	1KB	1KB	36	N/A	X:\Airborne_Raw\1195P
Mar 8, 2014	1197P	1BLK10CGS067B	PEGASUS	714MB	NA	4.95MB	112MB	14.5GB	131KB	8.16GB	N/A	1.44MB	1KB	1KB	27	N/A	X:\Airborne_Raw\1197P

Received from

Name CHRIS JOAQUIN
Position RA
Signature

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Name JOIDA F. PRIETO
Position SSRS
Signature

Figure A-5.5. Transfer Sheet for Patalan Floodplain (E)

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

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Name [illegible]
Position RA
Signature

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Name JOIDA PRIETO
Position SSRS
Signature 5/29/14

Figure A-5.6. Transfer Sheet for Patalan Floodplain (F)

DATA TRANSFER SHEET
5/22/2014(PAMPANGA REFLIGHTS)

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	
5/16/2014	7253GC	2PAMS1S3136A	GEMINI	na	140	350	228	NA	NA	10.8	NA	11.7	1KB	1KB	93	30	Z:\Airborne_Raw\7253GC
5/17/2014	7254GC	2BLK15S1S2137A	GEMINI	na	59.7	141	191	NA	NA	5.17	NA	7.17	1KB	1KB	40	NA	Z:\Airborne_Raw\7254GC
5/17/2014	7255GC	2PAMS2137B	GEMINI	na	78.4	167	121	NA	NA	6.45	NA	7.17	1KB	1KB	53	5	Z:\Airborne_Raw\7255GC
5/18/2014	7256GC	2PAMS5138A	GEMINI	na	245	486	227	NA	NA	18.9	NA	18.7	1KB	1KB	216	NA	Z:\Airborne_Raw\7256GC
5/18/2014	7257GC	2PAMS7138B & 2NEJS1138B	GEMINI	na	318	197	146	NA	NA	6.22	NA	18.7	1KB	1KB	216	32	Z:\Airborne_Raw\7257GC
5/20/2014	7260GC	2BLK17S1140A	GEMINI	na	209	301	183	NA	NA	14.5	NA	10.7	1KB	1KB	241	NA	Z:\Airborne_Raw\7260GC

Received from

Name C. Joaquin
Position RA
Signature

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Name JOIDA F. PRIETO
Position SSRS
Signature 5/26/2014

Figure A-5.7. Transfer Sheet for Patalan Floodplain (G)

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 [illegible]
Position
Signature [illegible]

Received by

Name AC Bongat 2/12/15
Position SSRS
Signature ACBongat

Figure A-5.8. Transfer Sheet for Patalan Floodplain (H)

DATA TRANSFER SHEET
NUEVA ECIJA FLIGHTS

DATE	FLIGHT NO.	MISSION NAME	SENSOR	RAW LAS		LOGS	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	
January 20, 2014	1009P	1NEJA020A	PEGASUS	3.49	2.07	9.13	241	41.8	722	31.2	149	5.57	1KB	1KB	42/47	NA	Z:\DAC\RAW DATA
January 21, 2014	1011P	1NEJ1B021A	PEGASUS	NA	88	8.56	185	15.3	NA	18.5	93.4	8.24	1KB	1KB	NA	NA	Z:\DAC\RAW DATA
January 22, 2014	1015P	1LMSCAM022A	PEGASUS	NA	NA	6.96	237	56.2	NA	16.7	48.7	17.3	1KB	1KB	29/25	NA	Z:\DAC\RAW DATA

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Name R. PUNTO
Position RA
Signature

Received by

Name JOIDA PRIETO
Position SSRS
Signature

Figure A-5.9. Transfer Sheet for Patalan Floodplain (I)

DATA TRANSFER SHEET
6/17/2014 (Missing Flights - NEJ, CAG, Arayat)

DATE	FLIGHT NO.	MISSION NAME	SENSOR	RAW LAS		LOGS	POS	RAW IMAGES	MISSION LOG FILE	RANGE	DIGITIZER	BASE STATION(S)		OPERATOR LOGS (OPLOG)	FLIGHT PLAN		SERVER LOCATION
				Output LAS	KML (swath)							BASE STATION(S)	Base Info (.txt)		Actual	KML	
Oct 21, 2013	669G	2CAG161BC294A	GEMINI	NA	NA	NA	161MB	38.9	64/139	20	79.3	7.33	1KB	1KB	5	NA	X:\Airborne_Raw\669G
Jan 20, 2014	1009P	1NEJA020A	PEGASUS	3.49	NA	9.13	241	41.8	361	31.2	149	5.57	1KB	1KB	42/47	NA	X:\Airborne_Raw\1009P
Jan 21, 2014	1011P	1NEJ1B021A	PEGASUS	NA	88	8.56	185	15.3	NA	18.5	93.4	8.24	1KB	1KB	36	NA	X:\Airborne_Raw\1011P
Jan 21, 2014	1013P	1NEJ1B021B	PEGASUS	NA	NA	6.13	150	NA	NA	11.3	53.8	8.24	1KB	1KB	NA	NA	X:\Airborne_Raw\1013P
Jan 26, 2014	7032G	2NEJ1C026A	GEMINI	NA	122	NA	158	NA	NA	9.77	NA	8.03	1KB	1KB	5	NA	X:\Airborne_Raw\7032G
Jan 28, 2014	7036G	2NEJ1CS028A	GEMINI	NA	259	262	185	NA	NA	11.1	NA	2.56	1KB	1KB	5	NA	X:\Airborne_Raw\7036G
Jan 29, 2014	7038G	2NEJFG029A	GEMINI	NA	TO FOLLOW					8.65	NA	3.77	1KB	1KB		NA	X:\Airborne_Raw\7038G
Feb 2, 2014	7047G	2MtAS033A	GEMINI	NA	105	188	138	30.4(casi)	NA	3.64	NA	2.42	1KB	1KB	4	NA	X:\Airborne_Raw\7047G

Received from

Name C. JOAQUIN
Position RA
Signature

Received by

Name JOIDA PRIETO
Position SSRS
Signature

6/17/2014

Figure A-5.10. Transfer Sheet for Patalan Floodplain (J)

DATA TRANSFER SHEET
Mar 19, 2014

DATE	FLIGHT NO.	MISSION NAME	SENSOR	RAW LAS		LOGS	POS	RAW IMAGES	MISSION LOG FILE	RANGE	DIGITIZER	BASE STATION(S)		OPERATOR LOGS (OPLOG)	FLIGHT PLAN		SERVER LOCATION
				Output LAS	KML (swath)							BASE STATION(S)	Base Info (.txt)		Actual	KML	
Jan 15, 2014	989P	1PAMS015A	PEGASUS	1.02MB	NA	5.85MB	168MB	NA	NA	9.2GB	N/A	11MB	1KB	1KB	NA	N/A	X:\Airborne_Raw\989P
Jan 21, 2014	1004A	3PNG1AB021A	AQUARIUS	NA	NA	620KB	209MB	23.4GB	194KB	10.6GB	47.7GB	8.24MB	1KB	2KB	7/114/114KB	389/16KN	X:\Airborne_Raw\1004A
Jan 21, 2014	1006A	3PNG1ABS021B	AQUARIS	NA	NA	214KB	128MB	6.78GB	65KB	4.08GB	15.5GB	8.24MB	1KB	1KB	16/46/7KB	124KB	X:\Airborne_Raw\1006A
Jan 22, 2014	1008A	3PNG1AS022A	AQUARIUS	NA	NA	482KB	204MB	26.3GB	209KB	8.14GB	33.1GB	10.6MB	1KB	1KB	1/7/101KB	281KB	X:\Airborne_Raw\1008A
Feb 21, 2014	1128A	3BLK29I52A	AQUARIUS	NA	NA	1.34MB	269MB	6.32GB	1/672KB	16.1GB	NA	12.3MB	1KB	1KB	6/303KB	854KB	X:\Airborne_Raw\1128A
Feb 22, 2014	1132A	3BLK29IS53A/3BLK29H53A	AQUARIUS	NA	NA	1.62MB	276MB	34.3GB	251/1/326KB	16.1GB	83.7GB	13.4MB	1KB	1KB	432KB	383/506/320/384KB	(DREAMPC30) C:\DAC Back up\OCC MINDORO FLIGHTS\1132A
Feb 22, 2014	1134A	3BLK29MS53B/3BLK29MR53B	AQUARIUS	NA	NA	1.08MB	144MB	27.8GB	105/28/1/30/55/44KB	4.99GB	12.6GB	13.4MB	1KB	1KB	102KB	131KB	(DREAMPC30) C:\DAC Back up\OCC MINDORO FLIGHTS\1134A
Feb 23, 2014	1136A	3BLK29HS54A/3BLK29HB54A	AQUARIUS	NA	NA	1.37MB	256MB	86.5GB	227/337/61KB	15GB	NA	15.8MB	1KB	1KB	268KB	265/265/520/36KB	(DREAMPC30) C:\DAC Back up\OCC MINDORO FLIGHTS\1136A
Feb 23, 2014	1138A	3BLK29E54B	AQUARIUS	NA	NA	833KB	196MB	50.4GB	408KB	8.89GB	42.6GB	15.8MB	1KB	1KB	172KB	500KB	(DREAMPC30) C:\DAC Back up\OCC MINDORO FLIGHTS\1138A
Feb 24, 2014	1140A	3BLK29ES55A/3BLK29G55A	AQUARIUS	NA	NA	961KB	241MB	53.3GB	401KB	9.99GB	40.8GB	12.1MB	1KB	1KB	367KB	244/264KB	(DREAMPC30) C:\DAC Back up\OCC MINDORO FLIGHTS\1140A
Feb 24, 2014	1142A	3BLK29P55B	AQUARIUS	NA	NA	2.04MB	228MB	61.7GB	56/490KB	12.4GB	64.2GB	12.1MB	1KB	1KB	709KB	247KB	(DREAMPC30) C:\DAC Back up\OCC MINDORO FLIGHTS\1142A

TRANSFERRED IN FREENAS.

Received from

Name CHRIS JOAQUIN

Position RA

Signature

Received by

Name JOIDA PRIETO

Position SSRS

Signature

Figure A-5.11. Transfer Sheet for Patalan Floodplain (K)

DATA TRANSFER SHEET
Clark 4/12/16

DATE	FLIGHT NO.	MISSION NAME	SENSOR	RAW LAS		LOGS	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	
3/28/2016	8411AC	3PAMS1088A	Aquarius	NA	151	359 KB	162	NA	NA	6.7GB	54.1GB	93.8MB	1KB	NA	27KB	NA	Z:\DAC\RAW DATA
3/29/2016	8412AC	3PAMS1089A	Aquarius	NA	384	5.67MB	230	51.3	246KB	10 GB	79.9 GB	144MB	1KB	1KB	28KB	NA	Z:\DAC\RAW DATA
3/31/2016	8416AC	3NEJS1091A	Aquarius	NA	145	313 KB	210	26.3	84KB	6.85 GB	44.0 GB	146MB	1KB	1KB	28KB	NA	Z:\DAC\RAW DATA
4/1/2016	8418AC	3TRCD1092A	Aquarius	NA	NA	22.1KB	180	22 GB	270KB	NA	NA	149MB	1KB	NA	4KB	NA	Z:\DAC\RAW DATA
4/1/2016	8419AC	3TRCD2092B	Aquarius	NA	NA	19.2KB	195	43.3 GB	270KB	NA	NA	149MB	1KB	1KB	4KB	NA	Z:\DAC\RAW DATA
4/2/2016	8420AC	3TRCD2093A	Aquarius	NA	NA	27.3B	133	20.3GB	239KB	NA	NA	101MB	1KB	1KB	4KB	NA	Z:\DAC\RAW DATA
4/2/2016	8421AC	3TRCD1093B	Aquarius	NA	NA	61.4KB	144	28.7GB	239KB	NA	NA	101MB	1KB	1KB	4KB	NA	Z:\DAC\RAW DATA

Received from

Name Millie Shane Reyes
Position RA
Signature

Received by

Name AC Bongat
Position SSRS
Signature 4/22/16

Figure A-5.12. Transfer Sheet for Patalan Floodplain (L)

ANNEX 6. FLIGHT LOGS

1. Flight Log for 1BLK10F059A Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 1165P

1 LiDAR Operator: R. PUNTO	2 ALTM Model: PEG	3 Mission Name: 1BLK10F059A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9022
7 Pilot: M. TANGONAN	8 Co-Pilot: N. AGAWIN	9 Route: LA UNION			
10 Date: FEB. 28, 2014	12 Airport of Departure (Airport, City/Province): SAN FERNANDO, LA UNION		12 Airport of Arrival (Airport, City/Province): SAN FERNANDO, LA UNION		
13 Engine On: 0853	14 Engine Off: 1240	15 Total Engine Time: 3 + 47	16 Take off:	17 Landing:	18 Total Flight Time: 3 + 37
19 Weather					
20 Remarks: SUCCESSFUL FLIGHT					

21 Problems and Solutions:

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

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

Pilot-in-Command
M. TANGONAN
Signature over Printed Name

Lidar Operator
R. PUNTO
Signature over Printed Name

DREAM
Disaster Risk and Exposure Assessment for Mitigation

Figure A-5.11. Transfer Sheet for Patalan Floodplain (K)

2. Flight Log for 1BLK10E059B Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 1165P

1 LiDAR Operator: F. SABLE	2 ALTM Model: PEG	3 Mission Name: 1BLK10E059B	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9022
7 Pilot: M. TANGONAN	8 Co-Pilot: N. AGAWIN	9 Route: LA UNION			
10 Date: FEB. 28, 2014	12 Airport of Departure (Airport, City/Province): SAN FERNANDO, LA UNION		12 Airport of Arrival (Airport, City/Province): SAN FERNANDO, LA UNION		
13 Engine On: 1321	14 Engine Off: 1608	15 Total Engine Time: 2+47	16 Take off:	17 Landing:	18 Total Flight Time: 2+37
19 Weather					
20 Remarks: SUCCESSFUL FLIGHTS					

21 Problems and Solutions:

Acquisition Flight Approved by

LOVELY ACUNA

Signature over Printed Name
(End User Representative)

Acquisition Flight Certified by

OLIVER SPEROT

Signature over Printed Name
(PAF Representative)

Pilot-in-Command

M. C. TANGONAN

Signature over Printed Name

Lidar Operator

Signature over Printed Name

DREAM
Disaster Risk and Exposure Assessment for Mitigation

Figure A-6.2. Flight Log for 1BLK10E059B Mission

3. Flight Log for 1BLK10H060A Mission

DREAM Data Acquisition Flight Log — **Flight Log No.:** 1169P

1 LiDAR Operator: R. PUNTO	2 ALTM Model: PEG	3 Mission Name: 1BLK10H060A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9022
7 Pilot: M. TANGONAN	8 Co-Pilot: N. AGAWIN	9 Route: LA UNION			
10 Date: MAR. 1, 2014	12 Airport of Departure (Airport, City/Province): SAN FERNANDO, LA UNION		12 Airport of Arrival (Airport, City/Province): SAN FERNANDO, LA UNION		
13 Engine On: 0910	14 Engine Off: 1205	15 Total Engine Time: 2+59	16 Take off:	17 Landing:	18 Total Flight Time: 2+49
19 Weather					
20 Remarks: SUCCESSFUL FLIGHT					

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
LOVELY ACUNA	OLIVER SACLOT	M. TANGONAN	R. PUNTO
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

DREAM
Disaster Risk and Exposure Assessment for Mitigation

Figure A-6.3. Flight Log for 1BLK10H060A Mission

4. Flight Log for 1BLK10ES060B Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 1169P

1 LiDAR Operator: F. SABLE	2 ALTM Model: PEG	3 Mission Name: 1BLK10ES60B	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: 9022
7 Pilot: M. TANGONAN	8 Co-Pilot: N. ADAWIN	9 Route: LA UNION			
10 Date: MAR. 1, 2014	12 Airport of Departure (Airport, City/Province): SAN FERNANDO, LA UNION		12 Airport of Arrival (Airport, City/Province): SAN FERNANDO, LA UNION		
13 Engine On: 1253	14 Engine Off: 1534	15 Total Engine Time: 2+41	16 Take off:	17 Landing:	18 Total Flight Time: 2+31
19 Weather					
20 Remarks: SUCCESSFUL FLIGHT					

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
LOVELY ACUNA	OLIVER SACLOT	M.L. TANGONAN	
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

DREAM
Disaster Risk and Exposure Assessment for Mitigation

Figure A-6.4. Flight Log for 1BLK10ES060B Mission

5. Flight Log for 2PAMS7138B Mission

DREAM Data Acquisition Flight Log — Flight Log No.: 7257

1 LiDAR Operator: MV Tonga	2 ALTM Model: Gemini	3 Mission Name: 2PAMS7138B	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-C9322
7 Pilot: R Samar II	8 Co-Pilot: F de Ocampo	9 Route: RPLC – PAMS7 RPLC			
10 Date: 5-18-14	12 Airport of Departure (Airport, City/Province): RPLC		12 Airport of Arrival (Airport, City/Province): RPLC		
13 Engine On: 1638 H	14 Engine Off: 1913H	15 Total Engine Time: 2+35	16 Take off: 1642H	17 Landing: 1909H	18 Total Flight Time: 2+27
19 Weather					
20 Remarks: NO CASI. Surveyed 5 lines on Plan Pams7 and mission completed on plan NEJSI					
21 Problems and Solutions:					

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Pearl Mars	Sg Dascoro Sabagano PAF	R. SAMAR II	MVE Tonga
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

Figure A-6.5. Flight Log for 2PAMS7138B Mission

6. Flight Log for 2PAMS8144A Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 7268

1 LiDAR Operator: MVE Tonga	2 ALTM Model:	3 Mission Name:	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: 9322
7 Pilot: Samar II	8 Co-Pilot: K. Kawai	9 Route:			
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 CASI)

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Pearl Mars	Sg Dioscoro Sabarno PAF	R. Samar II	MVE Tonga
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

Figure A-6.6. Flight Log for 2PAMS8144A Mission

7. Flight Log for 2AGN6L024A Mission

DREAM Data Acquisition Flight Log — **Flight Log No.: 103**

1 LiDAR Operator: IRO ROXAS	2 ALTM Model: GEM	3 Mission Name: 2AGL024A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-C9122
7 Pilot: F. CADENAS	8 Co-Pilot: J. CLEMENTE	9 Route: CIA - BINANGONAN - CIA			
10 Date: 24 JAN '13	12 Airport of Departure (Airport, City/Province): CIA		12 Airport of Arrival (Airport, City/Province): CIA		
13 Engine On: 0752H	14 Engine Off: 0552H	15 Total Engine Time: 2h59m	16 Take off: 0615 0651 1018	17 Landing: 0643 1104 1048	18 Total Flight Time: 28m 1h13m 30m 2h11m
19 Weather	Clear				

20 Remarks:

- No digitizer
- LINES 8, 6, 4, 2, 3
- missed line 5, Operator has an exam

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
	SSgt Procerio B Sabanao PAF		IRO ROXAS
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Figure A-6.7. Flight Log for 2AGN6L024A Mission

8. Flight Log for 2AGN6K025A Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 105

1 LiDAR Operator: Lovely Acuña	2 ALTM Model: Gemini	3 Mission Name: 2AGNCK025A + lines(AGNCL)	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: RP-C9122
7 Pilot: Capt. F- Cardenas	8 Co-Pilot: J- Clemente	9 Route: Clark to Pangasinan			
10 Date: 01/25/2013	12 Airport of Departure (Airport, City/Province): Clark		12 Airport of Arrival (Airport, City/Province): Clark		
13 Engine On: 0852 H	14 Engine Off: 1255H	15 Total Engine Time: 4+03	16 Take off: 0905 H	17 Landing: 0935 H	18 Total Flight Time: 30 mins
19 Weather			0948 H	1208 H	2+20
			1220H	1250H	30 mins

20 Remarks:

- Completed the survey mission. :)
- No digitizer data

21 Problems and Solutions:

No problem.

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
LOVELY GRACIA ACUNA	SSg Dioscoro D Sotomayo PAF		LOVELY GRACIA ACUNA
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Figure A-6.8. Flight Log for 2AGN6K025A Mission

9. Flight Log for 2AGN5N035B Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 125

1 LiDAR Operator: Lovely Acuña	2 ALTM Model: Gemini	3 Mission Name: 2AGN5N035B	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-C9122
7 Pilot: Capt. F. Cadenas	8 Co-Pilot: G. dela Cruz	9 Route: Clark → Pangasinan			
10 Date: 02/04/2013	12 Airport of Departure (Airport, City/Province): Clark		12 Airport of Arrival (Airport, City/Province): Clark		
13 Engine On: 1510H	14 Engine Off: 1800H	15 Total Engine Time: 2+50H	16 Take off: 1525H	17 Landing: 1755H	18 Total Flight Time: 2+30
19 Weather: Good					
20 Remarks: Successful Missed lines 2 8 3					

21 Problems and Solutions:

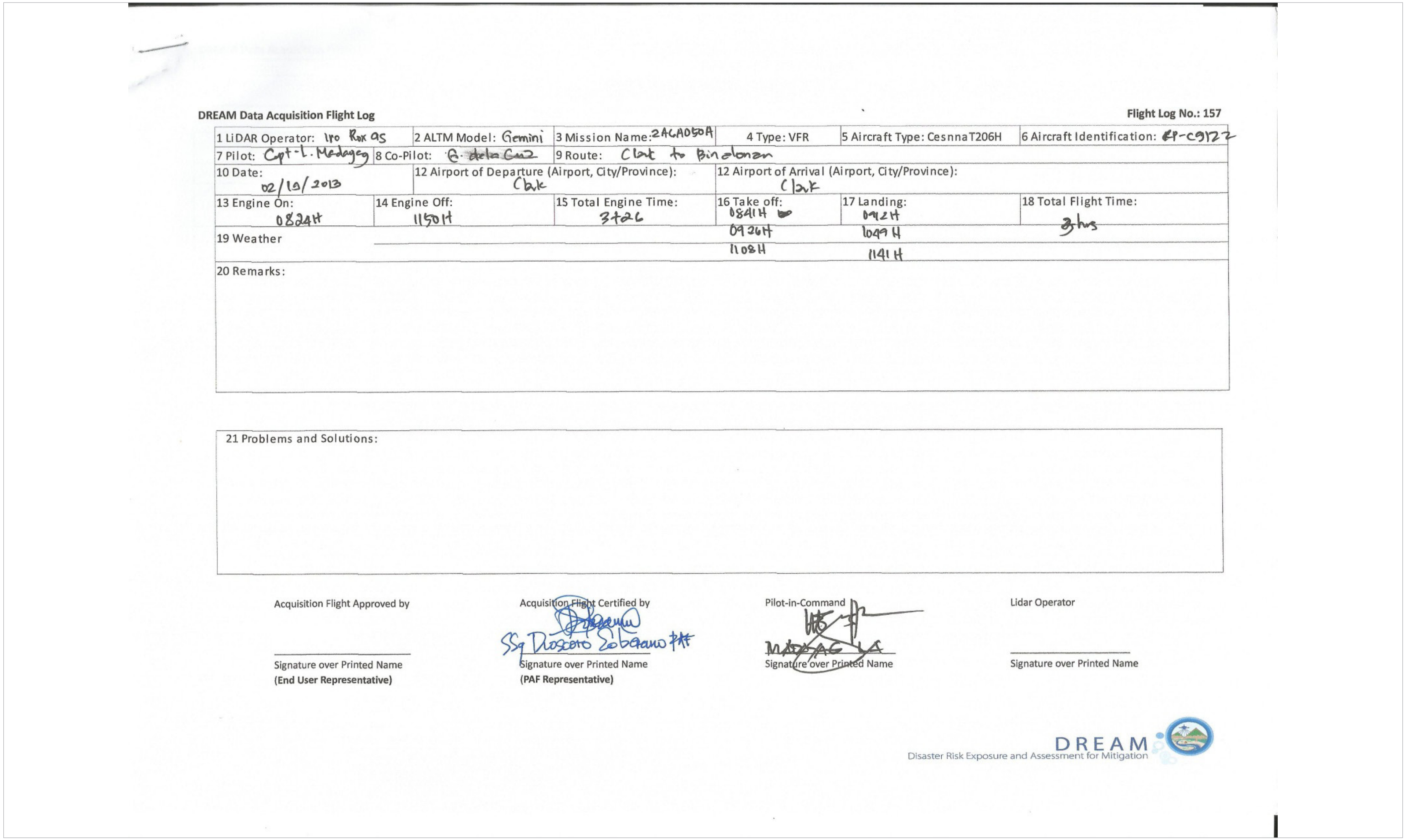
IMU Failure at the start / Restarted the system

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Christopher Cruz	SSg Droscoro Sobegano PAF	F. Cadenas	Lovely Acuña
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Figure A-6.9. Flight Log for 2AGN5N035B Mission

10. Flight Log for 2AGN6A050A Misison



DREAM Data Acquisition Flight Log

Flight Log No.: 157

1 LiDAR Operator: Iro Roxas	2 ALTM Model: Gemini	3 Mission Name: 2AGA050A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-C9122
7 Pilot: Cpt. L. Madayag	8 Co-Pilot: G. dela Cruz	9 Route: Clark to Binalonan			
10 Date: 02/19/2013	12 Airport of Departure (Airport, City/Province): Clark		12 Airport of Arrival (Airport, City/Province): Clark		
13 Engine On: 0824H	14 Engine Off: 1150H	15 Total Engine Time: 3+26	16 Take off: 0841H / 0926H / 1108H	17 Landing: 0912H / 1049 H / 1141 H	18 Total Flight Time: 3 hrs
19 Weather					
20 Remarks:					

21 Problems and Solutions:

Acquisition Flight Approved by

Signature over Printed Name
(End User Representative)

Acquisition Flight Certified by

SSg Dioscoro Zobayano PAF
Signature over Printed Name
(PAF Representative)

Pilot-in-Command

MADAYAG LA
Signature over Printed Name

Lidar Operator

Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Figure A-6.10. Flight Log for 2AGN6A050A Misison

11. Flight Log for 2AGN5OQ059B Mission

DREAM Data Acquisition Flight Log | **Flight Log No.: 175**

1 LiDAR Operator: ROJAS	2 ALTM Model: GEM	3 Mission Name: 2AS0Q59B	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-C9122
7 Pilot: A. BASCAN	8 Co-Pilot:	9 Route: RIA - PANG - CIA			
10 Date: 26 Feb 13	12 Airport of Departure (Airport, City/Province): CIA		12 Airport of Arrival (Airport, City/Province): CIA		
13 Engine On: 1430H	14 Engine Off: 1820H	15 Total Engine Time: 4+00	16 Take off: 1450H	17 Landing: ~~[illegible]~~ 1812H	18 Total Flight Time: 3+32
19 Weather: clear					

20 Remarks:

, Refflight , AGN5Q + AGN5O

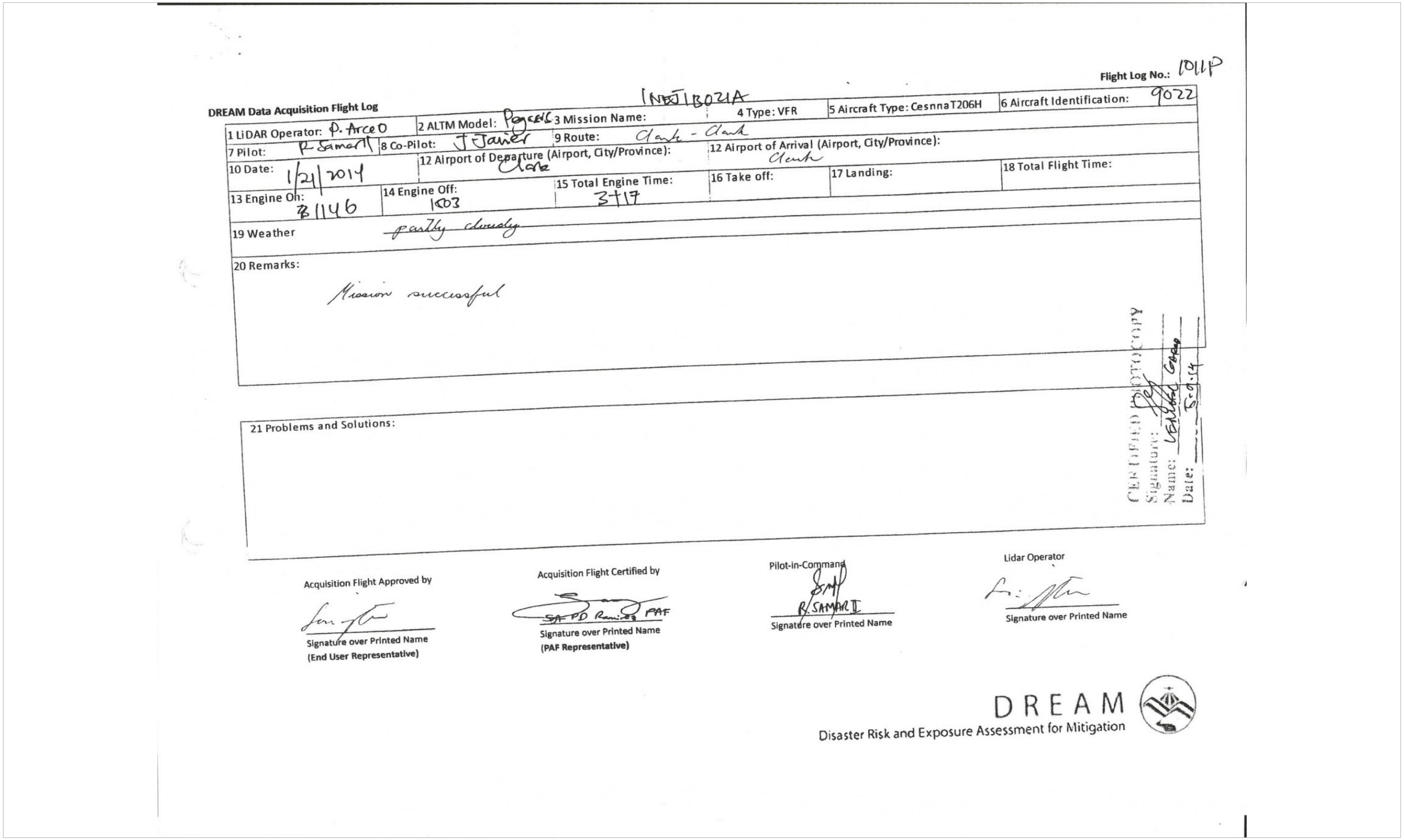
21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
			IRO ROJAS
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Figure A-6.11. Flight Log for 2AGN5OQ059B Mission

12. Flight Log for 1NEJ1B021A Mission


Flight Log No.: 1011P

DREAM Data Acquisition Flight Log

1 LiDAR Operator: P. Arceo	2 ALTM Model: Pegasus	3 Mission Name: 1NEJ1B021A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9022
7 Pilot: R. Samar II	8 Co-Pilot: J. Javier	9 Route: Clark - Clark			
10 Date: 1/24/2014	12 Airport of Departure (Airport, City/Province): Clark		12 Airport of Arrival (Airport, City/Province): Clark		
13 Engine On: 1146	14 Engine Off: 1503	15 Total Engine Time: 3+17	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: partly cloudy					

20 Remarks:

Mission successful

21 Problems and Solutions:

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

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

Pilot-in-Command
R. SAMAR II
Signature over Printed Name

Lidar Operator
Signature over Printed Name

CERTIFIED PHOTOCOPY
Signature:
Name: Ventura
Date: 5-9-14

DREAM
Disaster Risk and Exposure Assessment for Mitigation

Figure A-6.12. Flight Log for 1NEJ1B021A Mission

13. Flight Log for 3PNG1AB021A Mission

DREAM Data Acquisition Flight Log 3PNGAB021A Flight Log No.: 1004

1 LiDAR Operator: Balgues / Paraggas	2 ALTM Model: AQUA	3 Mission Name:	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9122
7 Pilot:	8 Co-Pilot:	9 Route:			
10 Date: 21 Jan 2014	12 Airport of Departure (Airport, City/Province):		12 Airport of Arrival (Airport, City/Province):		
13 Engine On: 1147	14 Engine Off: 1528	15 Total Engine Time: 3+41	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather					

20 Remarks:

completed some lines of PNGAB

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
J. Alviar	Sgt. PD Ramirez PAF	Jackson Rhod S. Javier	
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

Figure A-6.13. Flight Log for 3PNG1AB021A Mission

14. Flight Log for 3PNG1AB021B Mission

DREAM Data Acquisition Flight Log — Flight Log No.: 1406

1 LiDAR Operator: Baligues + Paragas	2 ALTM Model: AQUA	3 Mission Name: 3PNG1AB021B	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9122
7 Pilot:	8 Co-Pilot:	9 Route:			
10 Date: 21 Jan 2014	12 Airport of Departure (Airport, City/Province):		12 Airport of Arrival (Airport, City/Province):		
13 Engine On: 1622	14 Engine Off: 1845	15 Total Engine Time: 2T23	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather					

20 Remarks:

Completed lines in Area PN6AB

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
J. Alvian	Sgt PD Ramirez PAF	Jackson Rhod S. Javier	
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

Figure A-6.14. Flight Log for 3PNG1AB021B Mission

15. Flight Log for 3PNG1AB022A Mission

DREAM Data Acquisition Flight Log Flight Log No.: 1008

1 LiDAR Operator: Baligues	2 ALTM Model: AQUA	3 Mission Name: 3PNG1AS022A	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: 9122
7 Pilot:	8 Co-Pilot:	9 Route:			
10 Date: 22 Jan 2014	12 Airport of Departure (Airport, City/Province):		12 Airport of Arrival (Airport, City/Province):		
13 Engine On: 1141	14 Engine Off: 1516	15 Total Engine Time: 3+35	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather					

20 Remarks:

Completed lines in PNG1AS

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
J. Alviar	Sgt PDRamirez PAF	Jackson Rhod S. Vanier	
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

Figure A-6.15. Flight Log for 3PNG1AB022A Mission

16. Flight Log for 1NEJ1B021A Mission

Flight Log No.: 1011P

DREAM Data Acquisition Flight Log

1 LiDAR Operator: P. Arceo	2 ALTM Model: Pegasus	3 Mission Name: 1NEJ1B021A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9022
7 Pilot: R. Samaniego	8 Co-Pilot: J. Javier	9 Route: Clark - Clark			
10 Date: 1/21/2014	12 Airport of Departure (Airport, City/Province): Clark		12 Airport of Arrival (Airport, City/Province): Clark		
13 Engine On: 1146	14 Engine Off: 1503	15 Total Engine Time: 3+17	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: partly cloudy					

20 Remarks:

Mission successful

21 Problems and Solutions:

CERTIFIED PHOTOCOPY
Signature:
Name: Ventura Gray
Date: 5-9-14

Acquisition Flight Approved by

Signature over Printed Name
(End User Representative)

Acquisition Flight Certified by

SA PD Ramirez PAF
Signature over Printed Name
(PAF Representative)

Pilot-in-Command

R. SAMAR II
Signature over Printed Name

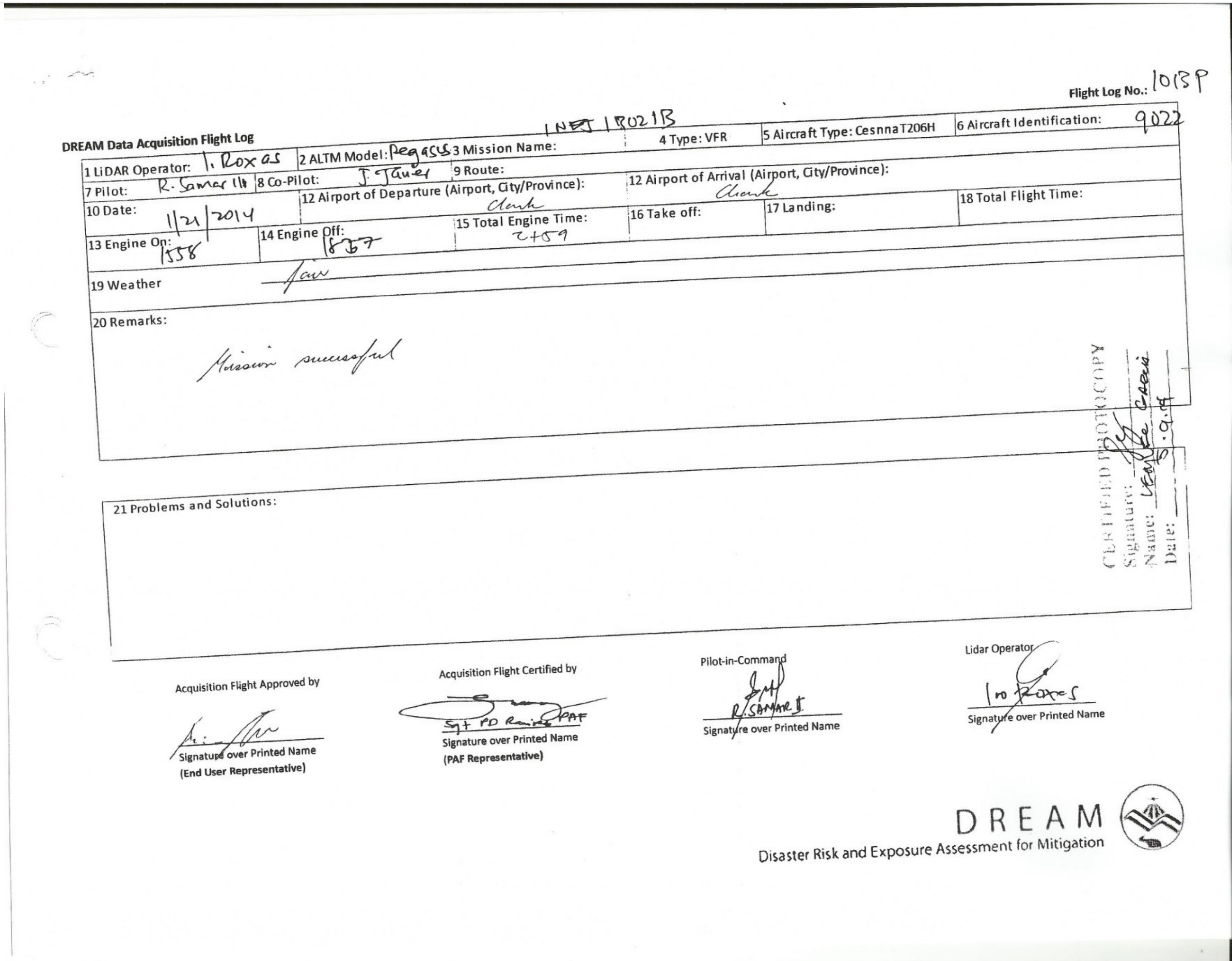
Lidar Operator

Signature over Printed Name

DREAM
Disaster Risk and Exposure Assessment for Mitigation

Figure A-6.16. Flight Log for 1NEJ1B021A Mission

17. Flight Log for 1NEJ1B021B Mission



Flight Log No.: 1013P

DREAM Data Acquisition Flight Log

1 LiDAR Operator: I. Roxas	2 ALTM Model: Pegasus	3 Mission Name: 1NEJ1B021B	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9022
7 Pilot: R. Samar III	8 Co-Pilot: J. Jaurez	9 Route:		12 Airport of Arrival (Airport, City/Province): Clark	
10 Date: 1/21/2014		12 Airport of Departure (Airport, City/Province): Clark		16 Take off:	17 Landing:
13 Engine On: 1558	14 Engine Off: 1857	15 Total Engine Time: 2+59			18 Total Flight Time:
19 Weather	fair				

20 Remarks:

Mission successful

21 Problems and Solutions:

Acquisition Flight Approved by

Signature over Printed Name
(End User Representative)

Acquisition Flight Certified by

Sgt PD Ramirez PAF
Signature over Printed Name
(PAF Representative)

Pilot-in-Command

R. SAMAR III
Signature over Printed Name

Lidar Operator

I. Roxas
Signature over Printed Name

CERTIFIED PHOTOCOPY
Signature:
Name: Ley Garcia
Date: 5.9.14

DREAM
Disaster Risk and Exposure Assessment for Mitigation

Figure A-6.17. Flight Log for 1NEJ1B021B Mission

18. Flight Log for 2NEJ1C026A Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 7032

1 LiDAR Operator: MCE Balicuas	2 ALTM Model: Gemini + CASI	3 Mission Name: 2NEJ1C026A	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: 9322
7 Pilot: R. Samak III	8 Co-Pilot: C. Alfonso III	9 Route: Clark - Nueva Ecija - Clark			
10 Date: Jan. 24, 2014	12 Airport of Departure (Airport, City/Province): Clark		12 Airport of Arrival (Airport, City/Province): Clark		
13 Engine On: 1300	14 Engine Off: 1553	15 Total Engine Time: 2+53	16 Take off:	17 Landing:	18 Total Flight Time: 2+43
19 Weather: Partly Cloudy					

20 Remarks:

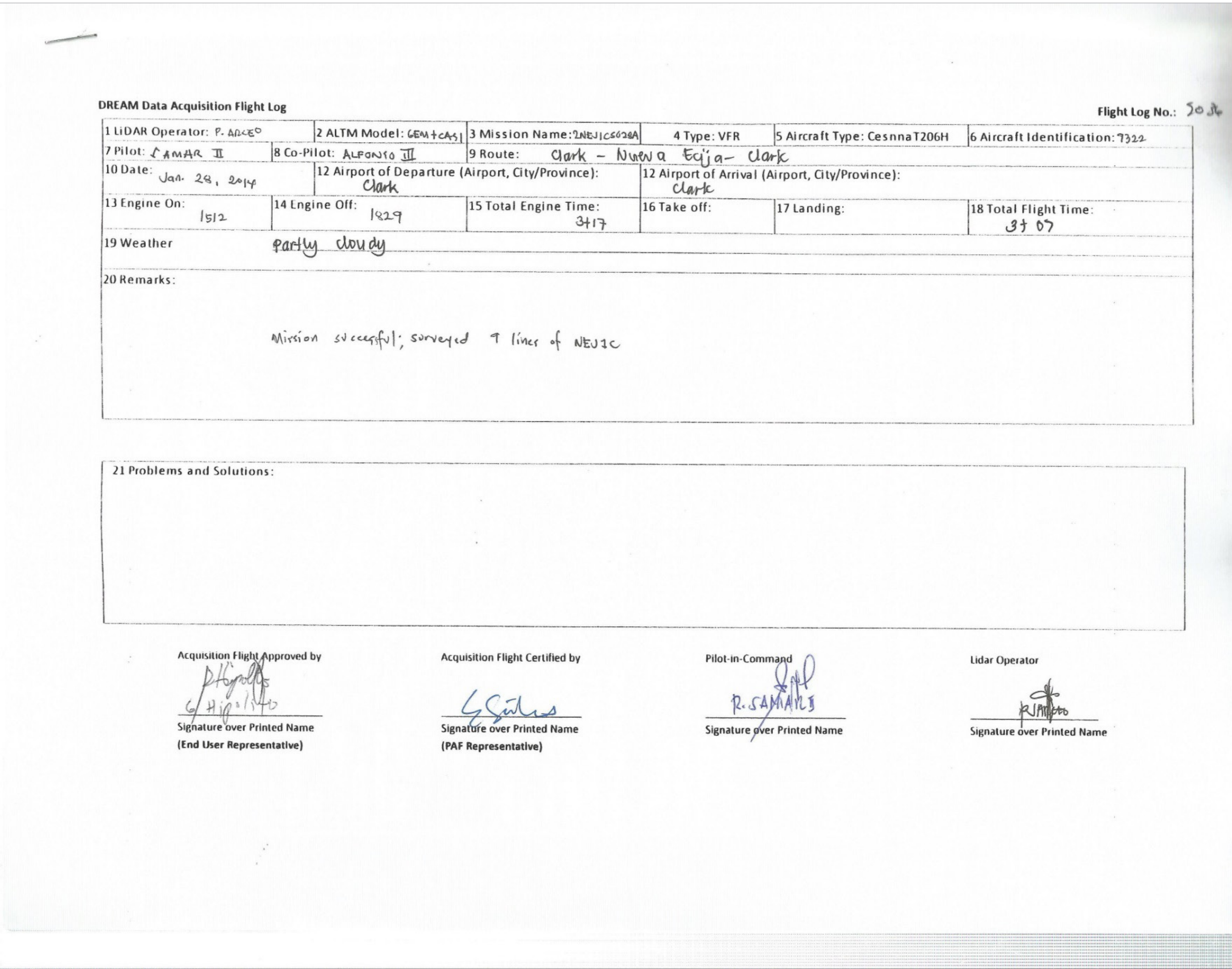
Mission successful (without CASI); surveyed eight (8) lines.

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
G. Hipolito		R. Samak III	
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

Figure A-6.18. Flight Log for 2NEJ1C026A Mission

19. Flight Log for 2NEJ1CS028A Mission



DREAM Data Acquisition Flight Log

Flight Log No.: 5036

1 LiDAR Operator: P. ARCEO	2 ALTM Model: GEM+CAS1	3 Mission Name: 2NEJ1CS028A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9322
7 Pilot: SAMAR II	8 Co-Pilot: ALFONSO III	9 Route: Clark - Nueva Ecija - Clark			
10 Date: Jan. 28, 2014	12 Airport of Departure (Airport, City/Province): Clark		12 Airport of Arrival (Airport, City/Province): Clark		
13 Engine On: 1512	14 Engine Off: 1829	15 Total Engine Time: 3+17	16 Take off:	17 Landing:	18 Total Flight Time: 3+07
19 Weather: partly cloudy					

20 Remarks:

Mission successful; surveyed 9 lines of NEJ1C

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
G. Hipolito		R. SAMAR II	
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

Figure A-6.19. Flight Log for 2NEJ1CS028A Mission

ANNEX 7. Flight Status Reports

Table A-7.1. Flight Status Report

Flight No	Area	Mission	Operator	Date Flown	Remarks
1163P	BLOCK 10F	1BLK10F059A	R. PUNTO	February 28, 2014	Finished survey; renamed from 1161P
1165P	BLOCK 10E	1BLK10E059B	F. SABLE	February 28, 2014	Survey Block 10E; renamed from 1163P
1167P	BLOCK 10H	1BLK10H060A	R. PUNTO	March 1, 2014	Survey Block 10h but with data voids due to high terrain and clouds; renamed from 1165P
1169P	BLOCK 10E	1BLK10ES060B	F. SABLE	March 1, 2014	Supplementary flight for Block 10E; renamed from 1167P
7257G	BLK 15S	2PAMS7138B	VERLINA TONGA	5-18-2014	Completed 10 lines of PAMS7 and NEJS1 at 850m
7268G	PAMS8	2PAMS8144A	VERLINA TONGA	5-24-2014	Completed 10 lines at 1000m
100G	AGNO	2A6023A	IRO ROXAS	11 JAN 13	Successful survey over AGNO
102G	AGNL	2A6L023B	L.ACUNA	11 JAN 13	Successful survey over AGNL
103G	AGNL	2AGN6L024A	I. ROXAS	24 JAN 13	Supplementary flight over AGNL
105G	AGNK	2AGN6K025A	I.ROXAS	25 JAN 13	Successful survey over AGNK
125G	AGNK	2AGN5N035B	I.ROXAS	4 FEB 13	Supplementary flight over AGNK
158P	AGNQ	1A6Q050A	CHRISTOPHER JOAQUIN	19 FEB 13	Successful survey over AGNQ
175G	AGNO	2A5OQ59B	LOVELY ACUNA	28 FEB 13	Supplementary flight over AGNO
1011P	NEJB	1NEJ1B021A	P.ARCEO	21 JAN 14	Successful Mission
1013P	NEJB	1NEJ1B021B	I.ROXAS	21 JAN 14	Successful Mission
1004A	PNGA	3PNG1AB021A	C.BALIGUAS	21 JAN 14	Completed seven lines over PNGA
1006A	PNGB	3PNG1AB021B	L.PARAGAS	21 JAN 14	Completed lines over PNGB
1015P	NEJC	1LMSCAM022A	P.ARCEO	22 JAN 14	Successful survey and calibration
1008A	PNGA	3PNG1AB022A	C. BALIGUAS	22 JAN 14	Completed lines in PNGA

Flight No	Area	Mission	Operator	Date Flown	Remarks
1019P	NEJC	1NEJ1C023A	I.ROXAS	23 JAN 14	Successful Mission
7032GC	NEJC	2NEJ1C026A	C. BALIGUAS	26 JAN 14	Successful Mission
7036GC	NEJC	2NEJ1CS028A	P.ARCEO	28 JAN 14	Successful Mission

Flight No. 1163P
Area: CAG 10F
Mission Name: 1BLK10F059A
Parameters:
Altitude: 1200m;
Scan Frequency: 30;
Scan Angle: 25

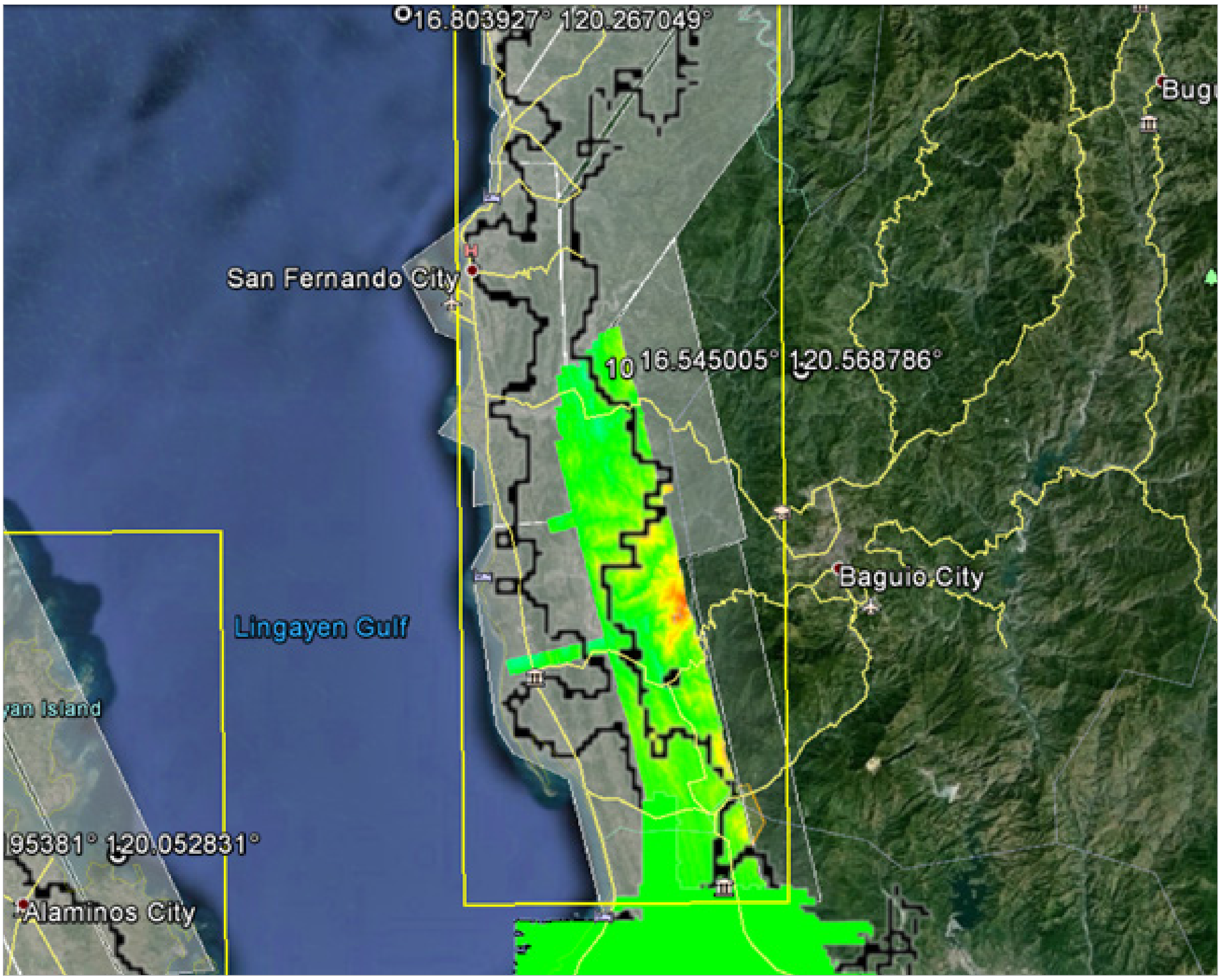


Figure A-7.1. Swath Coverage of Mission 1BLK10F059A

Flight No. : 1165P
Area: 10E
Mission Name: 1BLK10E059B
Parameters:
Altitude: 1200m;
Scan Frequency: 30;
Scan Angle: 25

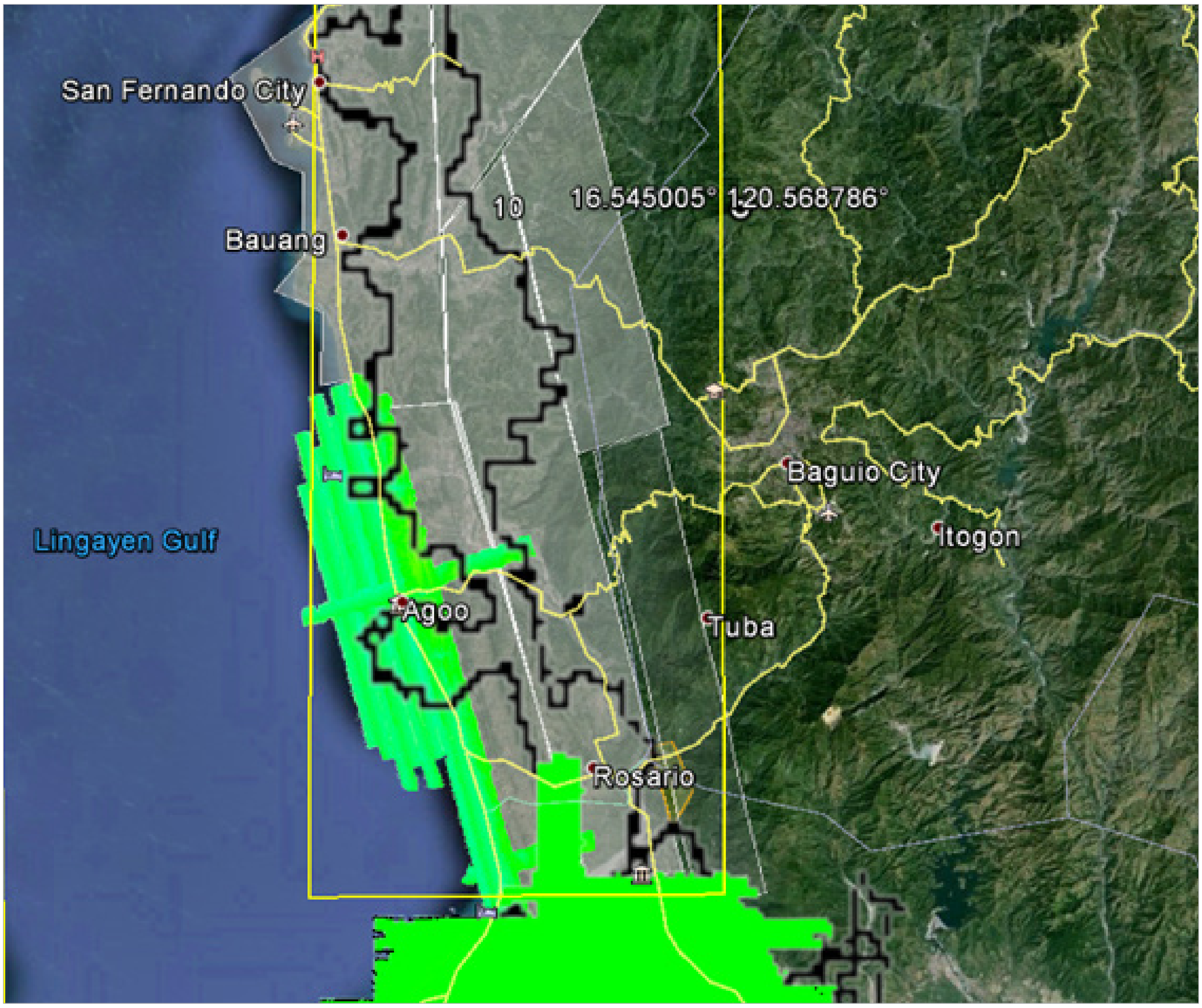


Figure A-7.2. Swath Coverage of Mission 1BLK10E059B

Flight No.: 1167P
Area: 10H
Mission Name: 1BLK10H060A
Parameters:
Altitude: 1700m;
Scan Frequency: 30;
Scan Angle: 25

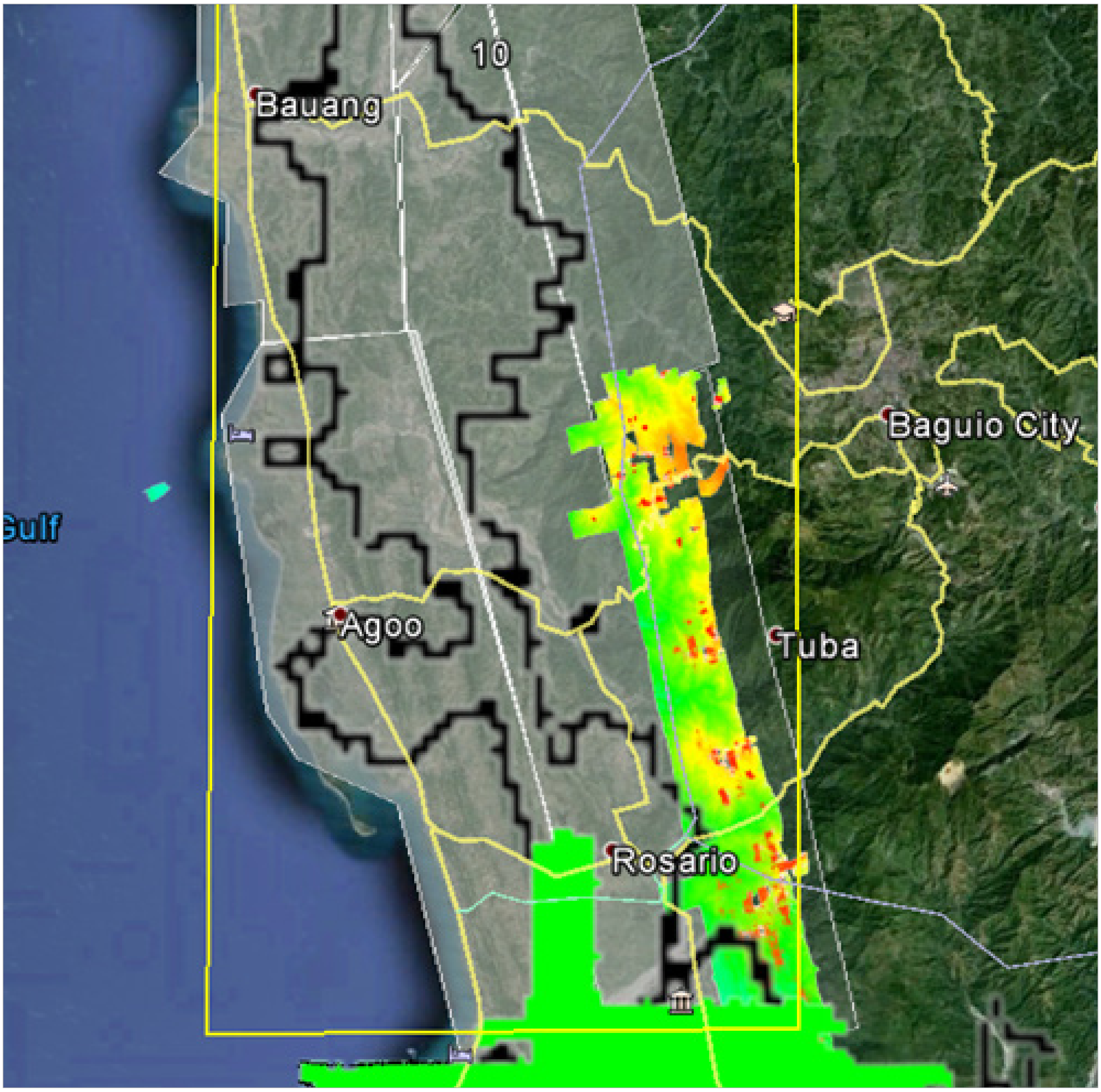


Figure A-7.3. Swath Coverage of Mission 1BLK10H060A

Flight No.: 1169P
Area: 10E
Mission Name: 1BLK10H060A
Parameters:
Altitude: 1700m;
Scan Frequency: 30;
Scan Angle: 25

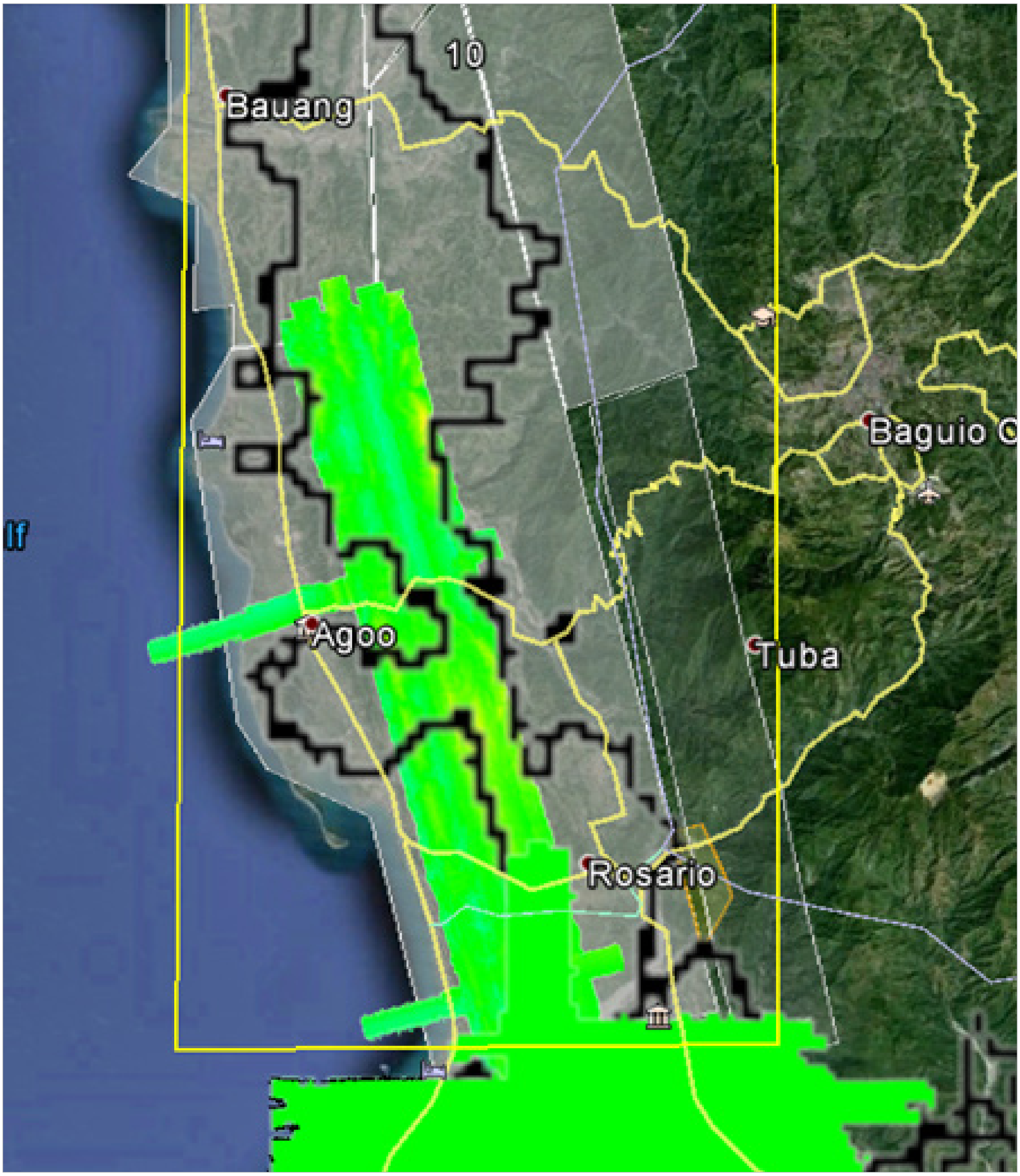


Figure A-7.4. Swath Coverage of Mission 1BLK10ES060B

Flight No. : 7257 G
Area: PAMS7, NEJS1
Mission name: 2PAMS7138B
Parameters:
Altitude: 850;
Scan Frequency: 50;
Scan Angle: 20;
Overlap: 30 %
Area covered: 49.597 sq.km.

Figure A-7.5. Swath Coverage for 2PAMS7138B Mission

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

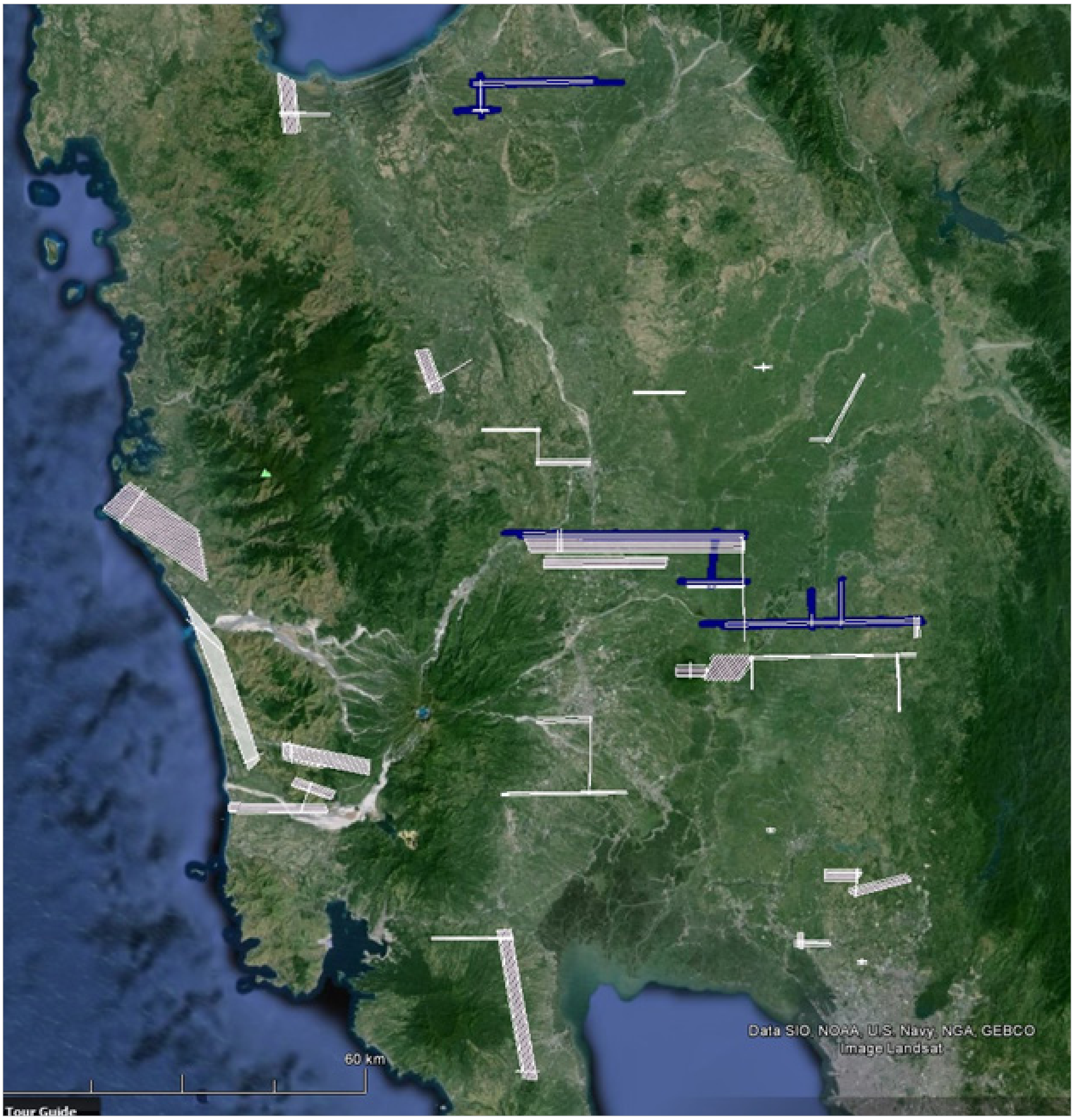


Figure A-7.6. Swath Coverage for 2PAMS8144B Mission

Flight No. : 2298A
Mission name: 3NEJV345A
Parameters:
Altitude: 600;
Scan Frequency: 45;
Scan Angle: 18;
Overlap: 60 %

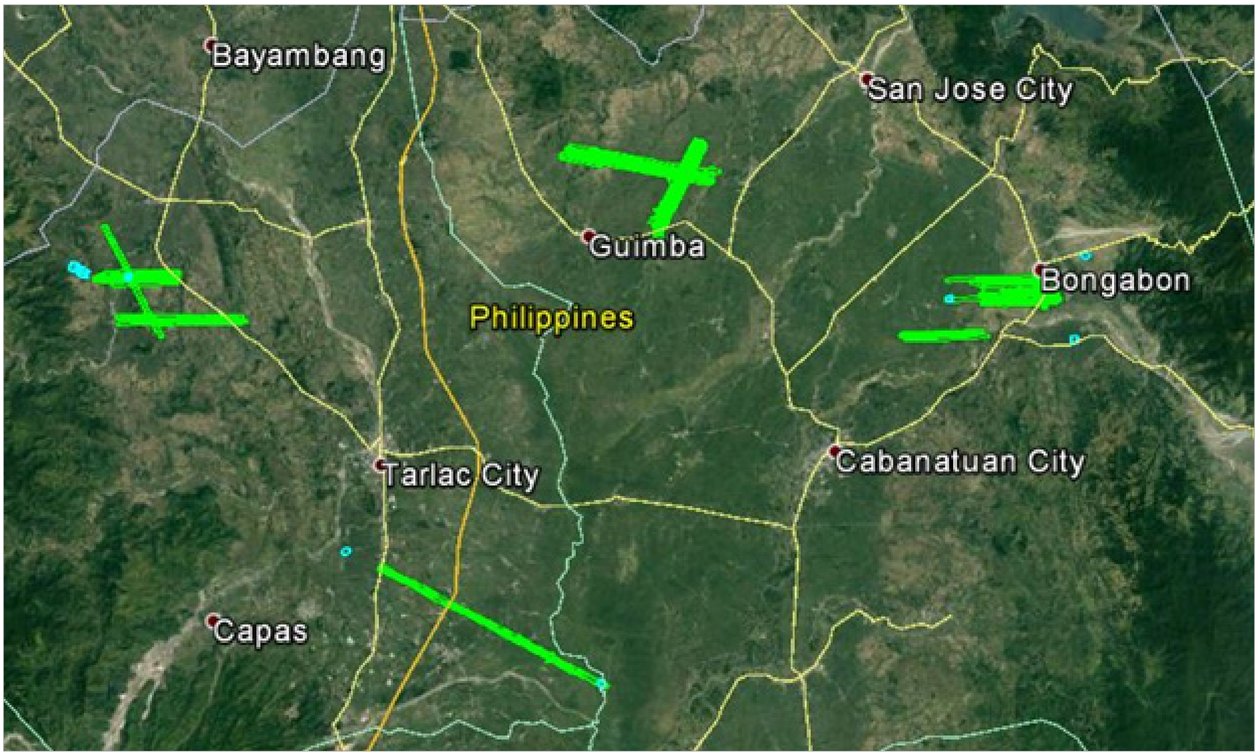


Figure A-7.7. Swath Coverage for3NEJV345A Mission

Flight No. : 8416AC
Mission name: 3NEJS1091A
Parameters:
Altitude: 500;
Scan Frequency: 45;
Scan Angle: 18;
Overlap: 50 %

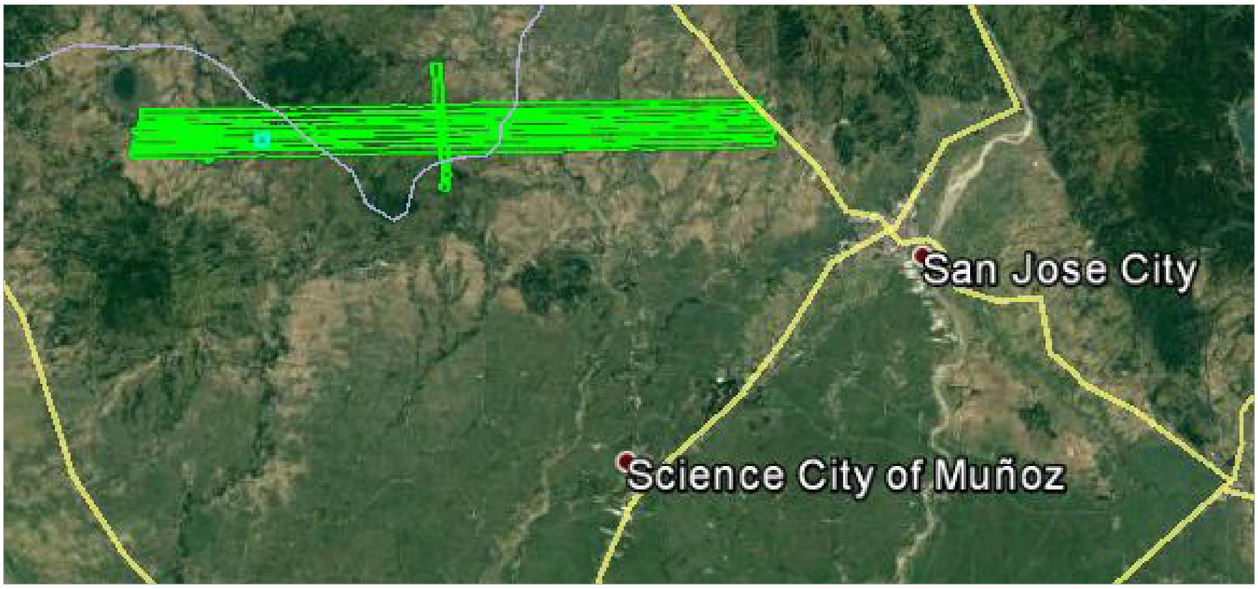


Figure A-7.8. Swath Coverage for 3NEJS1091A Mission

Flight No. : 7032GC
Mission name: 2NEJ1C026A
Parameters:
Altitude: 1000;
Scan Frequency: 50;
Scan Angle: 20;
Overlap: 30 %

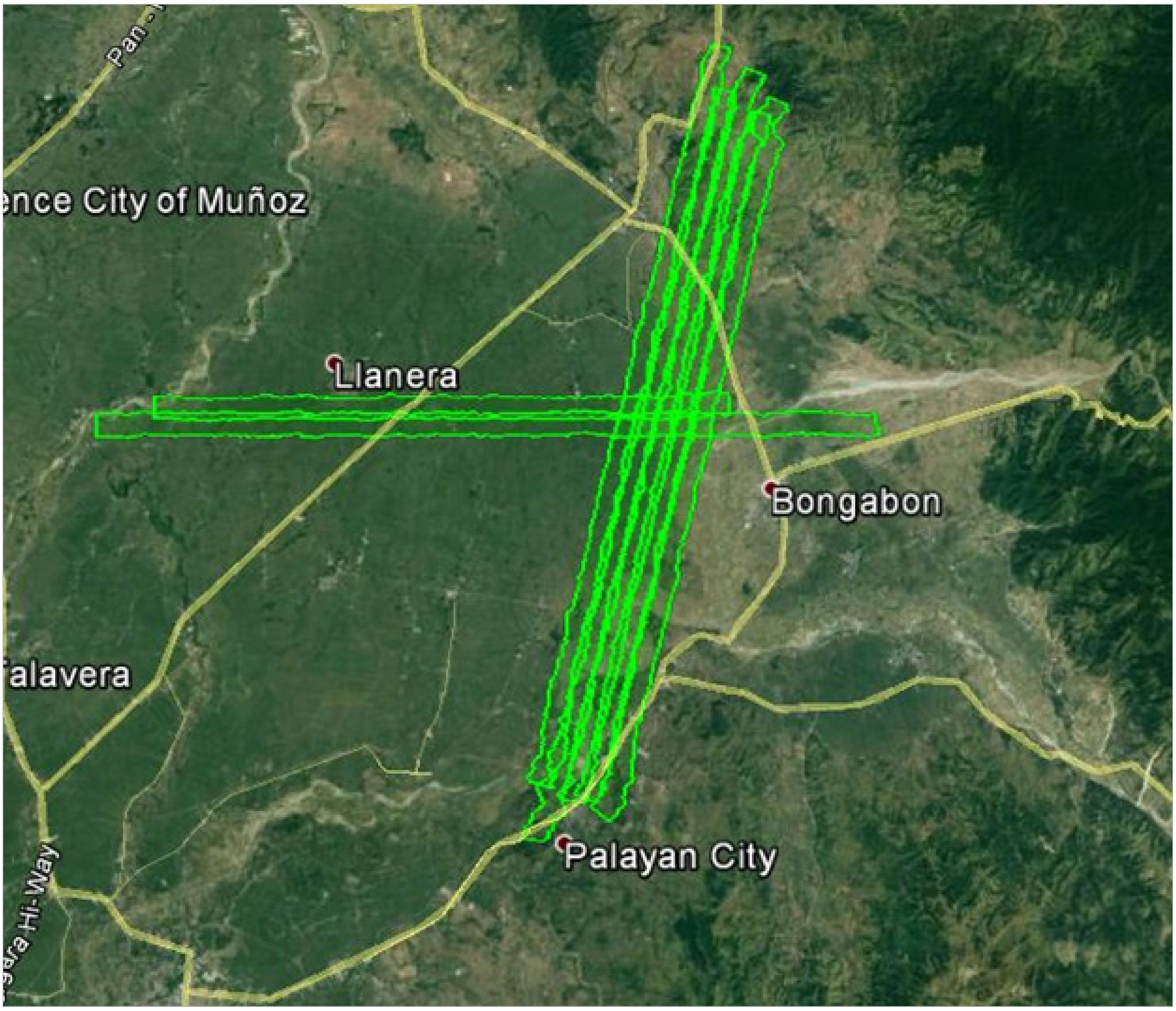


Figure A-7.9. Swath Coverage for 2NEJ1C026A Mission

Flight No. : 7036GC
Mission name: 2NEJ1CS028A
Parameters:
Altitude: 1200;
Scan Frequency: 40;
Scan Angle: 20;
Overlap: 30 %

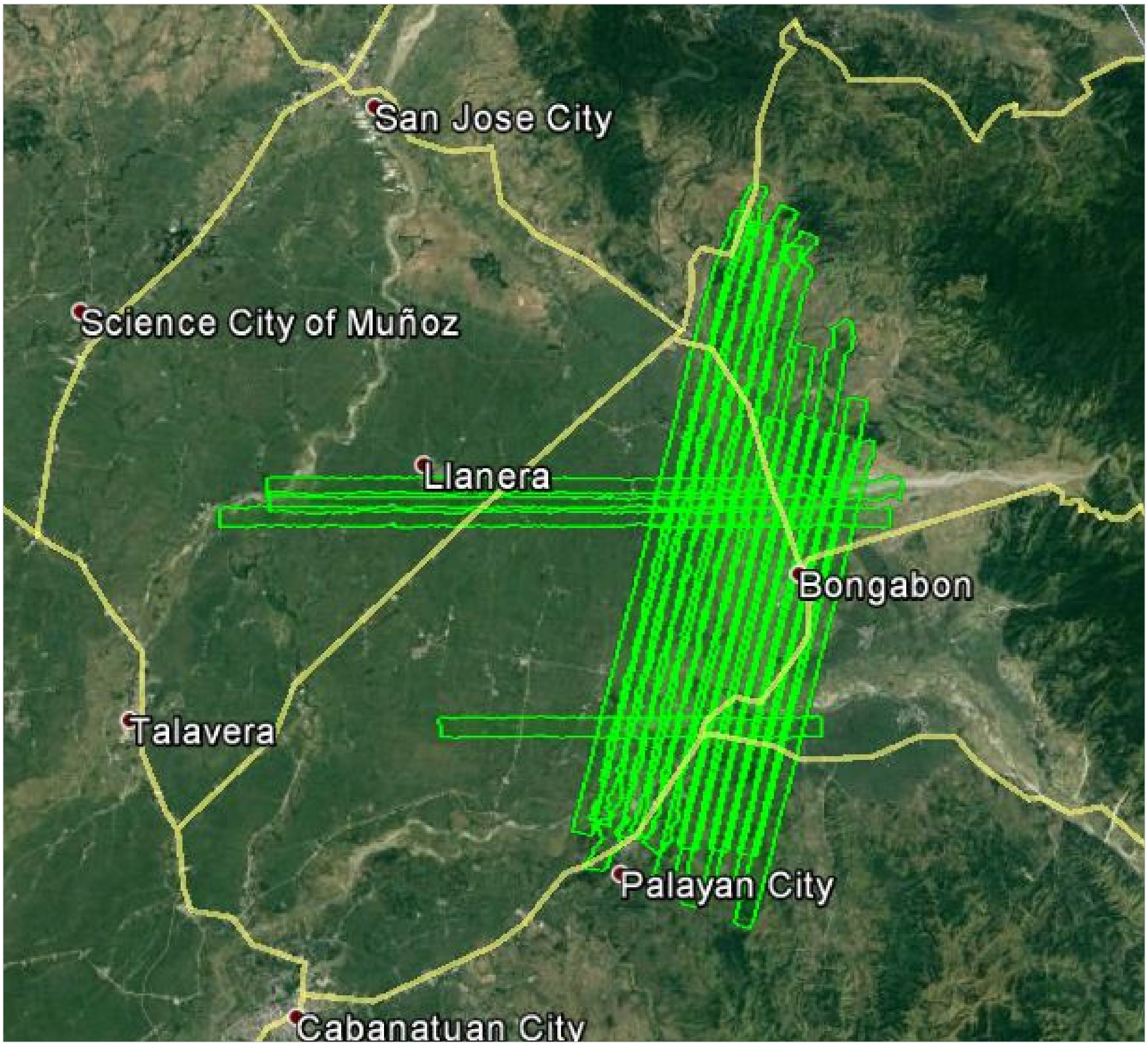


Figure A-7.10. Swath Coverage for 2NEJ1CS028A Mission

Flight No. : 1011P
Mission name: 1NEJ1B021A
Parameters:
 Altitude: 1200;
 Scan Frequency: 30;
 Scan Angle: 25;
 Overlap: 30 %

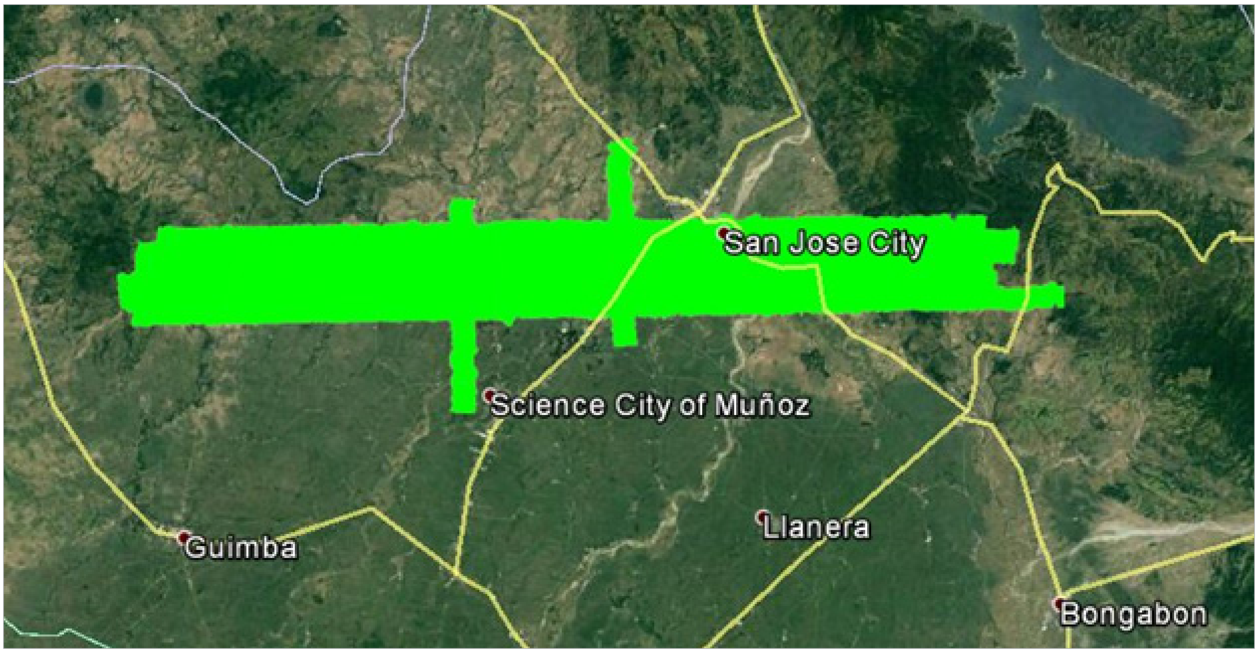


Figure A-7.11. Swath Coverage for 1NEJ1B021A Mission

Flight No. : 1013P
Mission name: 1NEJ1B021B
Parameters:
Altitude: 900;
Scan Frequency: 30;
Scan Angle: 25;
Overlap: 30 %

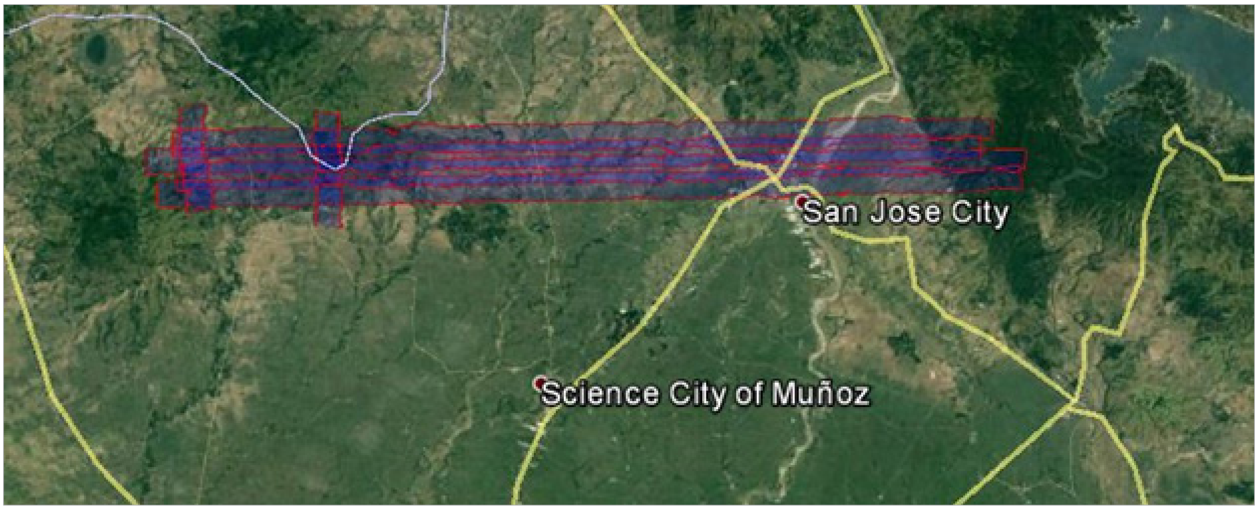


Figure A-7.12. Swath Coverage for 1NEJ1B021B Mission

Flight No. : 1015P
Mission name: 1NEJ1B021B
Parameters:
Altitude: 1200;
Scan Frequency: 30;
Scan Angle: 25;
Overlap: 30 %

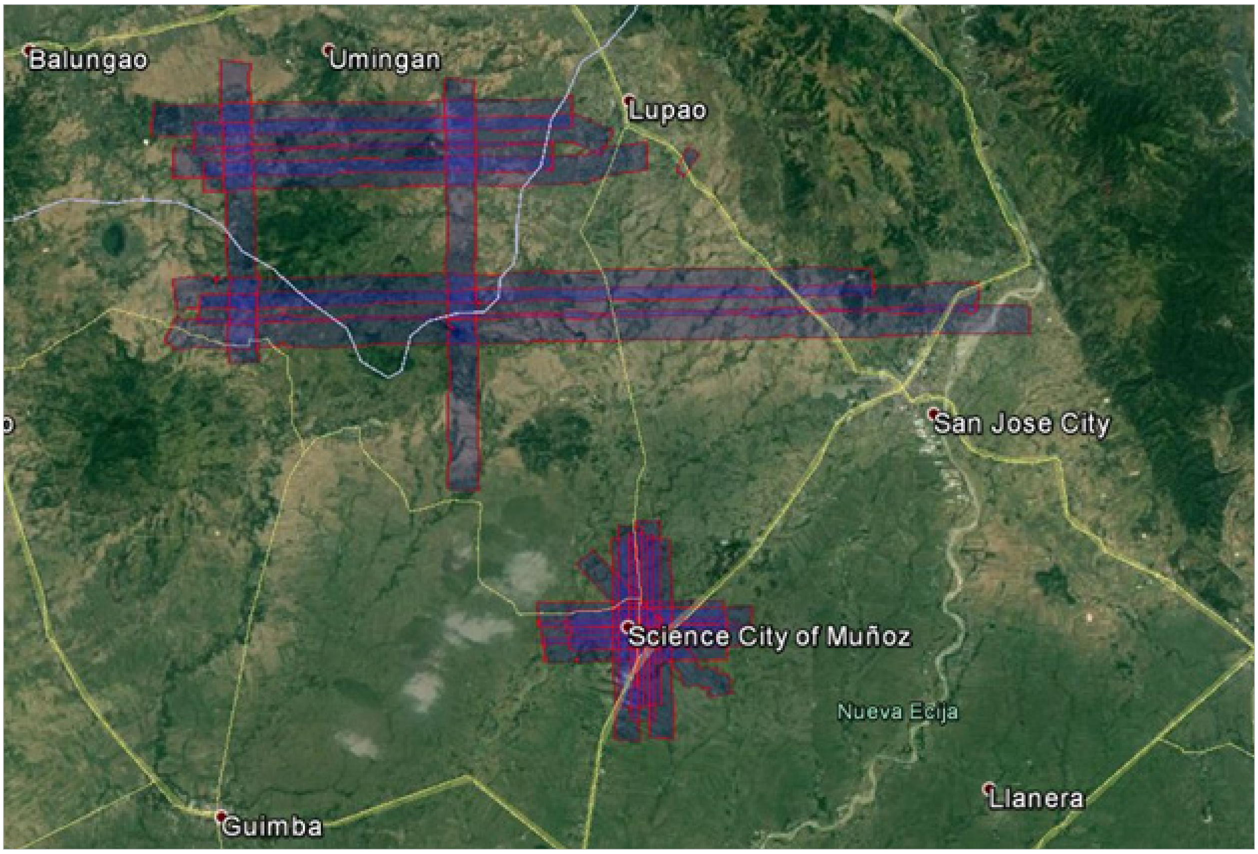


Figure A-7.13. Swath Coverage for 1LMSCAM022A Mission

Flight No. : 1019P
Mission name: 1NEJ1C023A
Parameters:
Altitude: 800;
Scan Frequency: 30;
Scan Angle: 25;
Overlap: 30 %

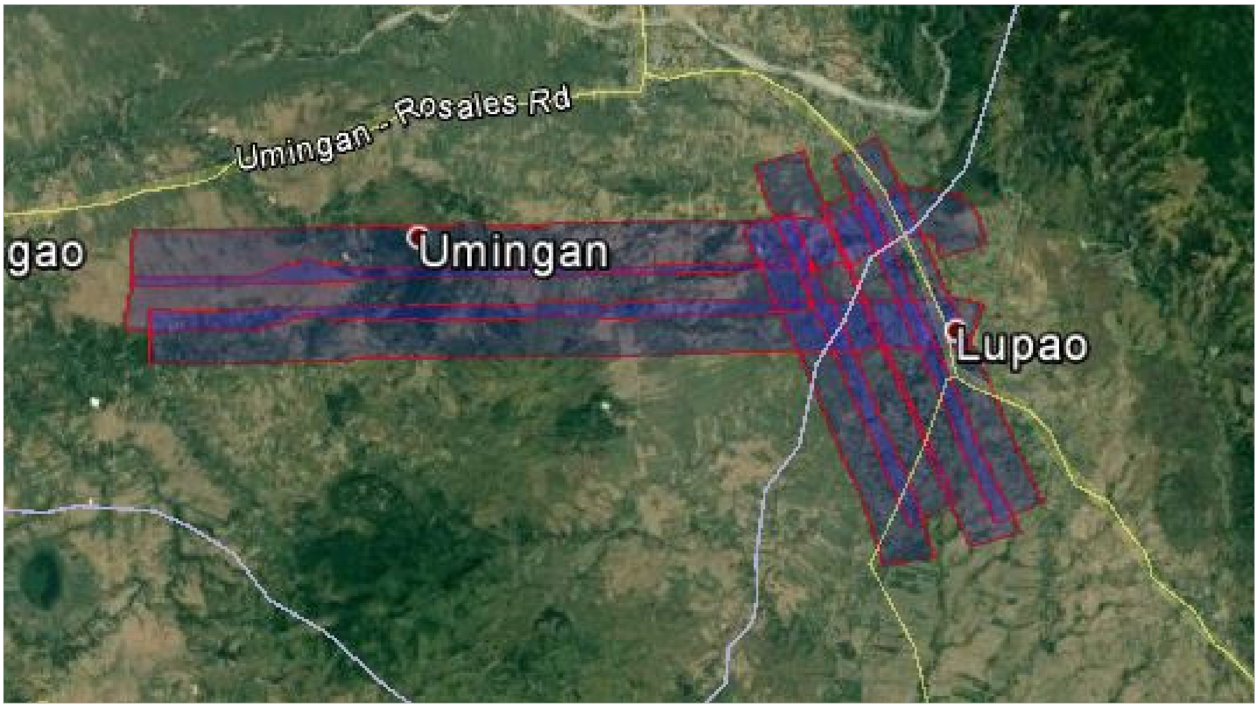


Figure A-7.14. Swath Coverage for 1NEJ1C023A Mission

Flight No. : 1008A
Mission name: 3PNG1AB022A
Parameters:
- Altitude: 600;
- Scan Frequency: 45;
- Scan Angle: 18;
- Overlap: 60 %

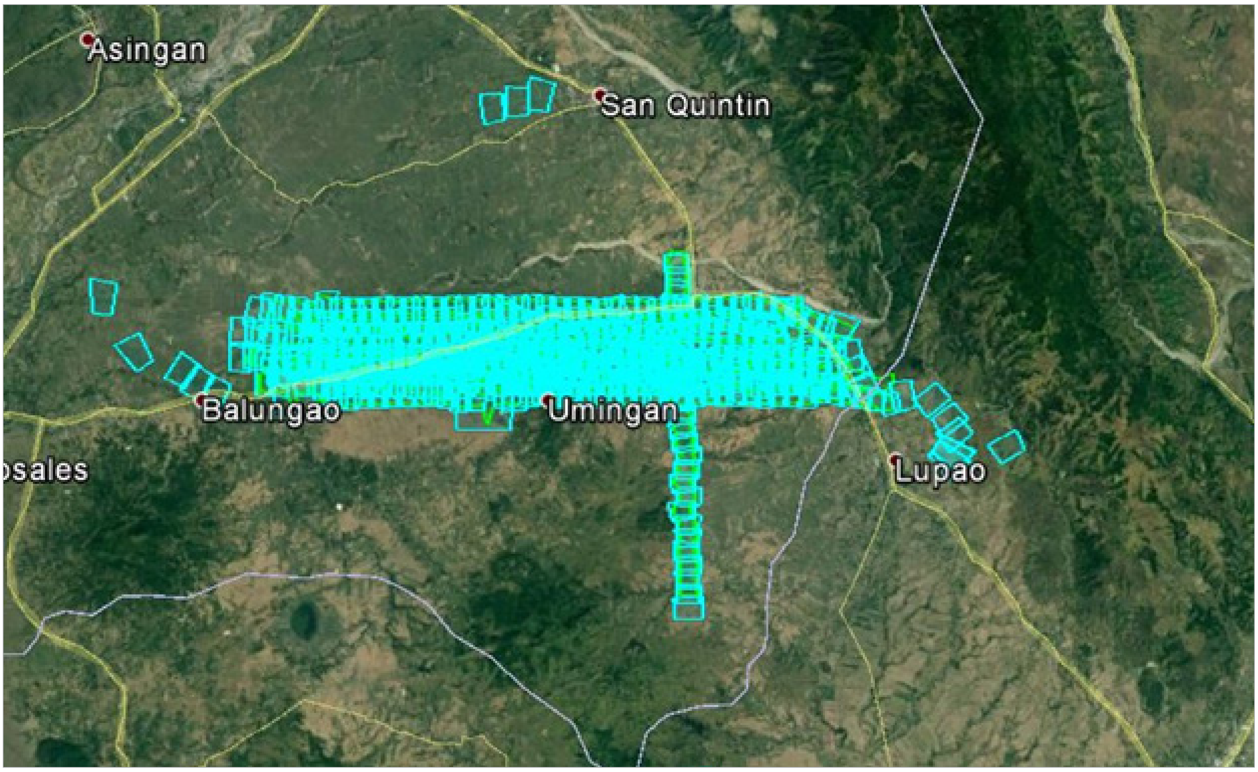


Figure A-7.15. Swath Coverage for 3PNG1AB022A Mission

Flight No. : 1004A
Mission name: 3PNG1AB022A
Parameters:
Altitude: 700;
Scan Frequency: 45;
Scan Angle: 18;
Overlap: 60 %

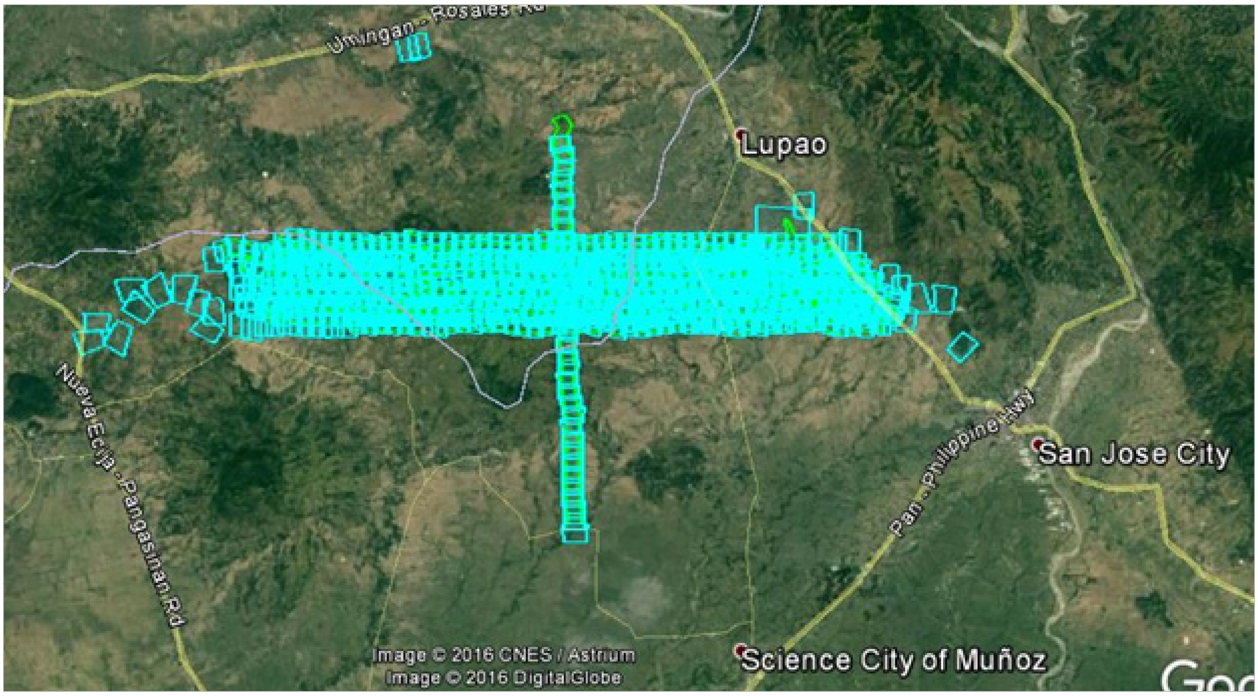


Figure A-7.16. Swath Coverage for 3PNG1AB021A Mission

Flight No. : 1006A
Mission name: 3PNG1AB021B
Parameters:
Altitude: 600;
Scan Frequency: 45;
Scan Angle: 18;
Overlap: 60 %

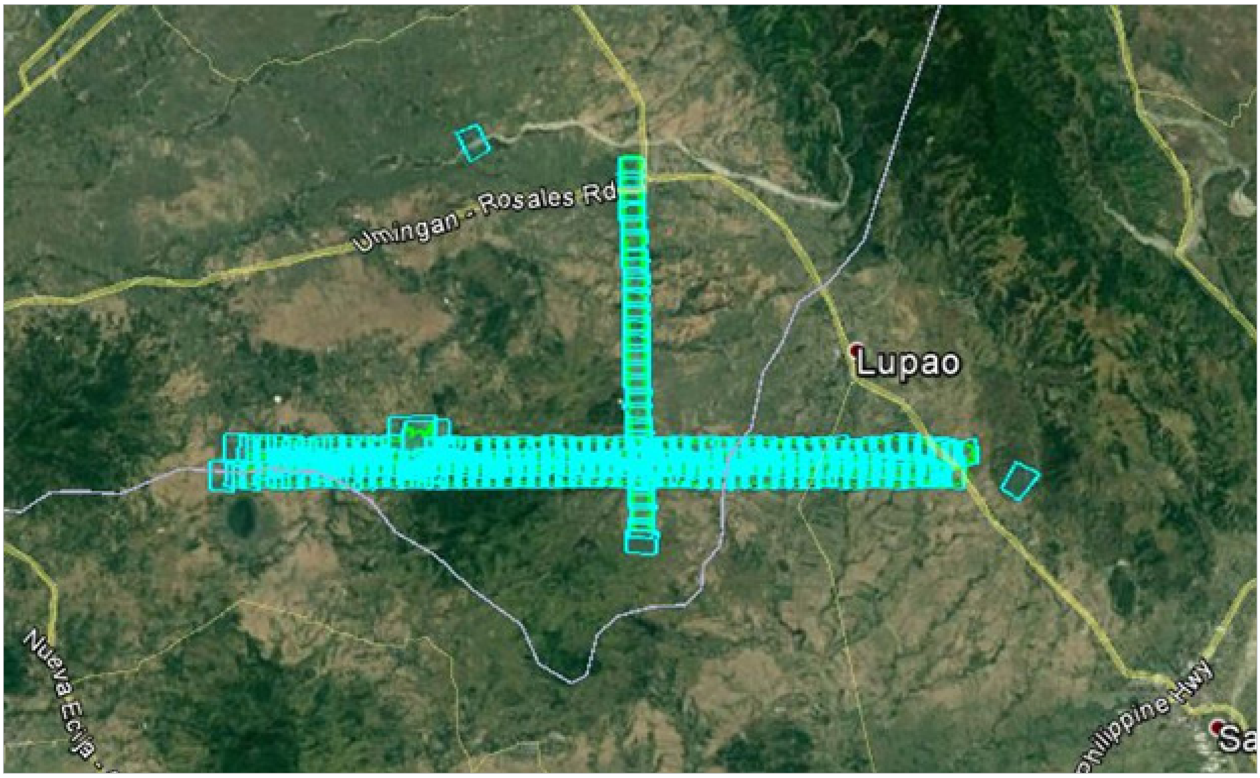


Figure A-7.17. Swath Coverage for 3PNG1AB021B Mission

Flight No. : 175G
Mission name: 2A5OQ59B
Parameters:
Altitude: 1000;
Scan Frequency: 50;
Scan Angle: 20;
Overlap: 30 %

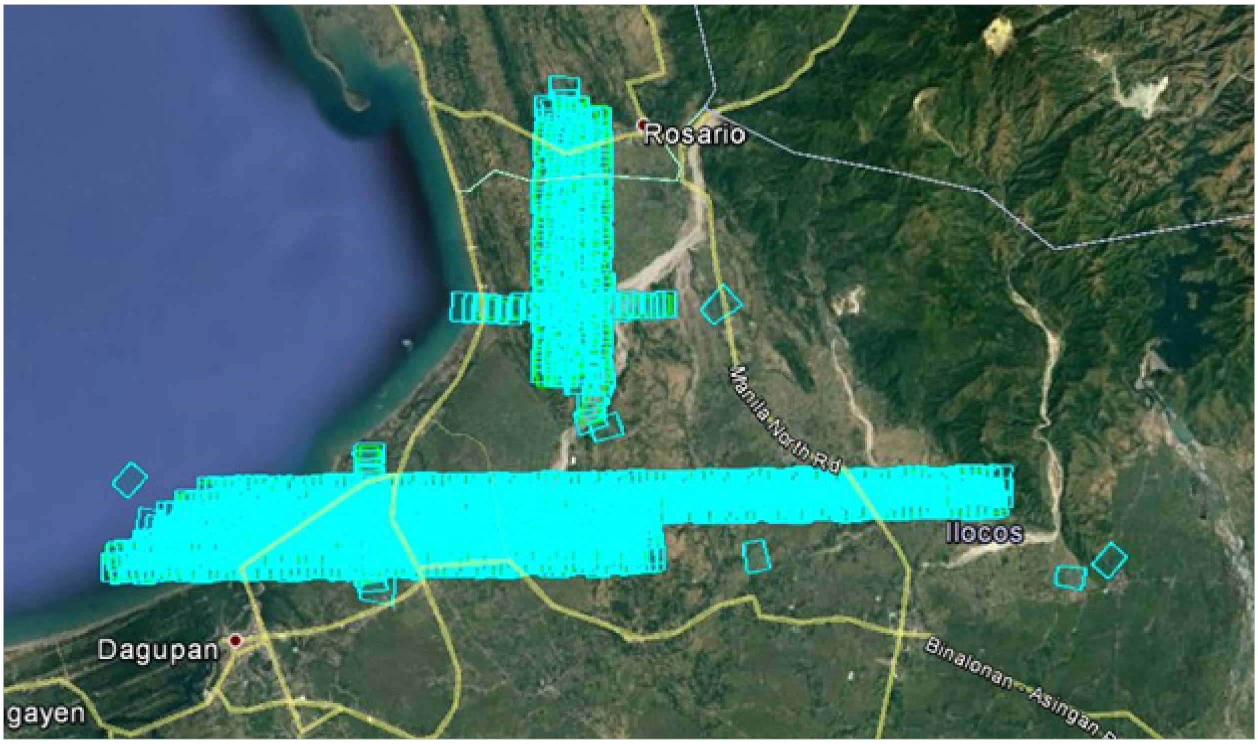


Figure A-7.18. Swath Coverage for 2A5OQ59B Mission

Flight No. : 125G
Mission name: 2AGN5N035B
Parameters:
Altitude: 1200;
Scan Frequency: 60;
Scan Angle: 26;
Overlap: 45 %

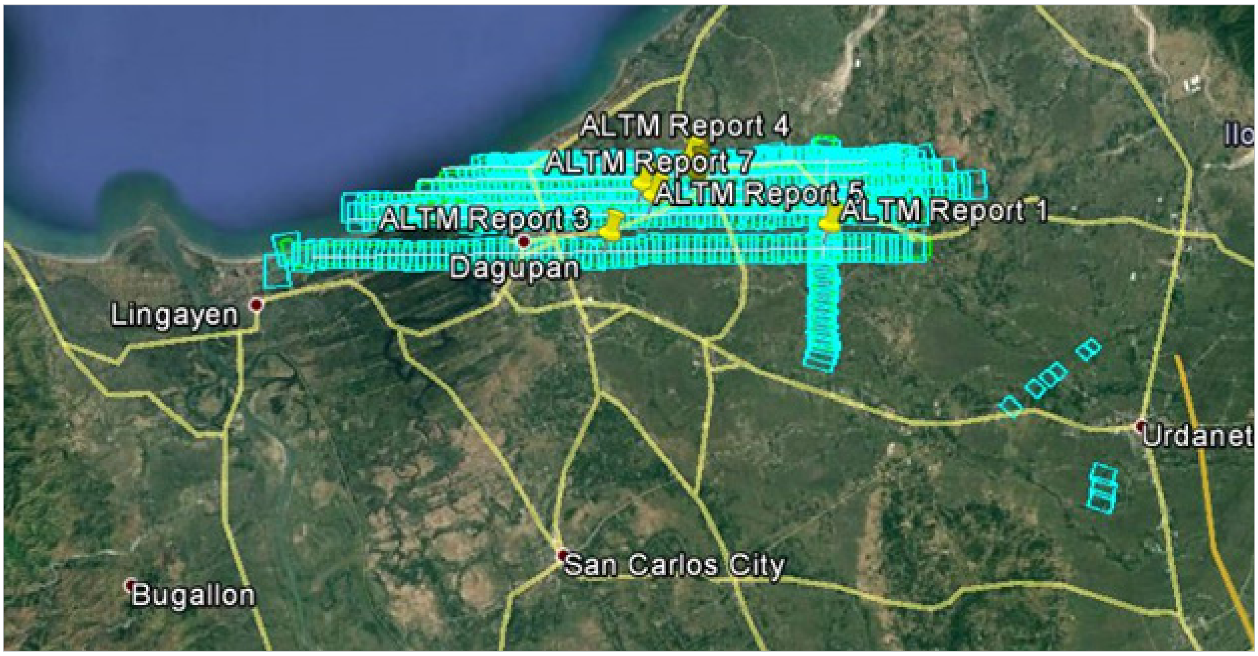


Figure A-7.19. Swath Coverage for 2AGN5N035B Mission

Flight No. : 102G
Mission name: 2A6L023B
Parameters:
Altitude: 1200;
Scan Frequency: 60;
Scan Angle: 26;
Overlap: 45 %

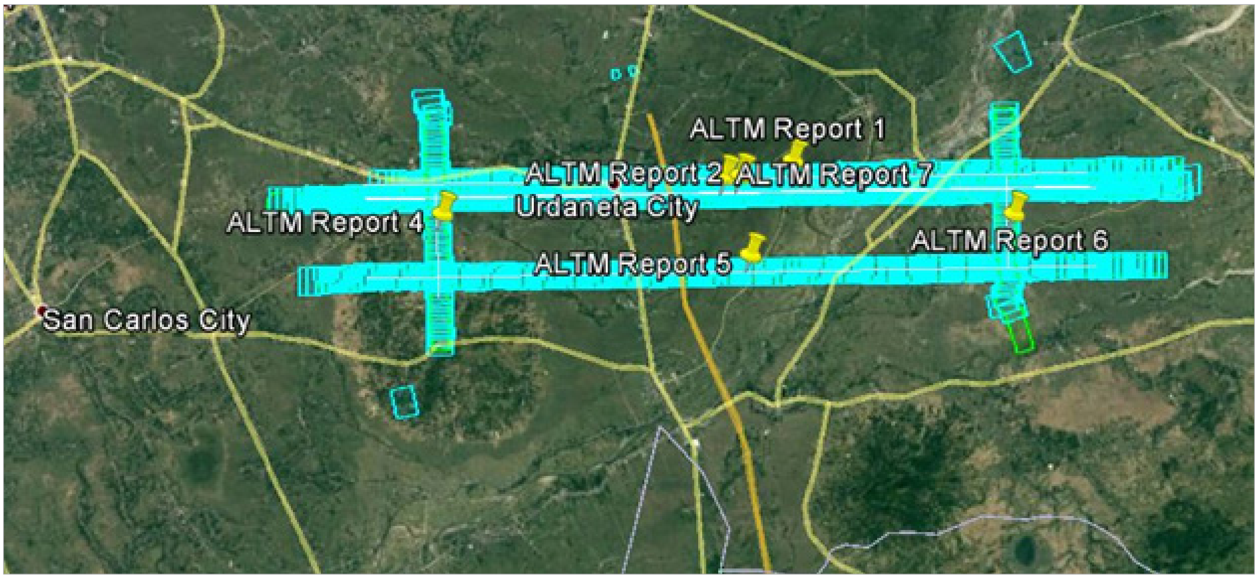


Figure A-7.20. Swath Coverage for 2A6L023B Mission

Flight No. : 103G
Mission name: 2AGN6L024A
Parameters:
Altitude: 1200;
Scan Frequency: 60;
Scan Angle: 26;
Overlap: 45 %

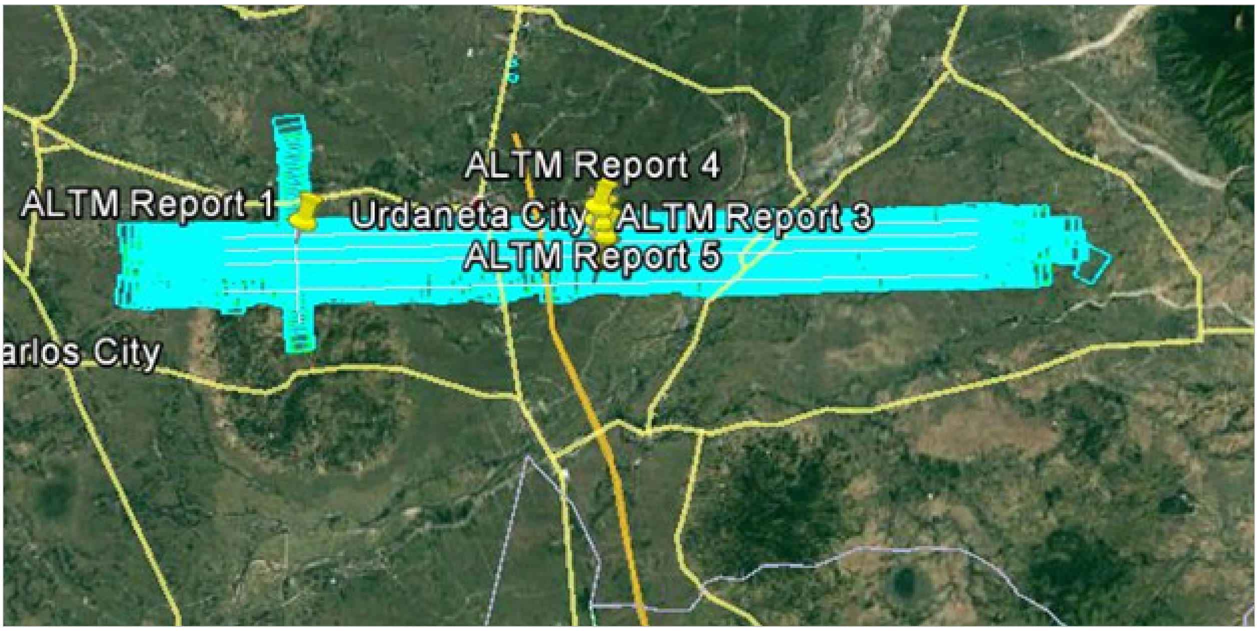


Figure A-7.21. Swath Coverage for 2AGN6L024A Mission

Flight No. : 105G
Mission name: 2AGN6K025A
Parameters:
Altitude: 1200;
Scan Frequency: 60;
Scan Angle: 26;
Overlap: 45 %

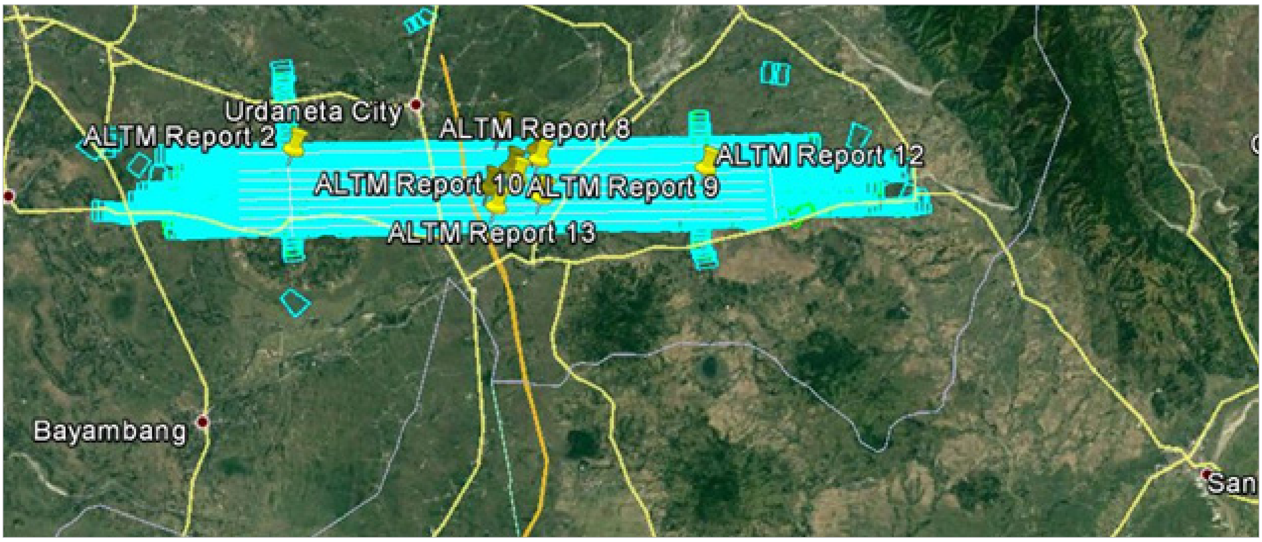


Figure A-7.22. Swath Coverage for 2AGN6K025A Mission

Flight No. : 100G
Mission name: 2A6023A
Parameters:
Altitude: 1200;
Scan Frequency: 60;
Scan Angle: 26;
Overlap: 45 %

Figure A-7.23. Swath Coverage for 2A6023A Mission

ANNEX 8. Mission Summary Reports

Table A-8.1. Mission Summary Report for Mission Blk10H

Flight Area	La Union
Mission Name	Blk10H
Inclusive Flights	1167P
Range data size	8.66 GB
Base data size	MB
POS	170 MB
Image	17.5 GB
Transfer date	March 01, 2014
Solution Status	
Number of Satellites (>6)	No
PDOP (<3)	Yes
Baseline Length (<30km)	No
Processing Mode (<=1)	No
Smoothed Performance Metrics (in cm)	
RMSE for North Position (<4.0 cm)	0.9
RMSE for East Position (<4.0 cm)	1.168
RMSE for Down Position (<8.0 cm)	2.32
Boresight correction stdev (<0.001deg)	0.000524
IMU attitude correction stdev (<0.001deg)	0.019693
GPS position stdev (<0.01m)	0.0279
Minimum % overlap (>25)	33.92%
Ave point cloud density per sq.m. (>2.0)	1.78
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	165
Maximum Height	1,257.47 m
Minimum Height	101.57 m
Classification (# of points)	
Ground	36,203,988
Low vegetation	14,356,792
Medium vegetation	58,381,757
High vegetation	105,073,591
Building	1,657,874
Orthophoto	YES
Processed By	Victoria Rejuso, Engr. Harmond Santos, Engr. Jeffrey Delica

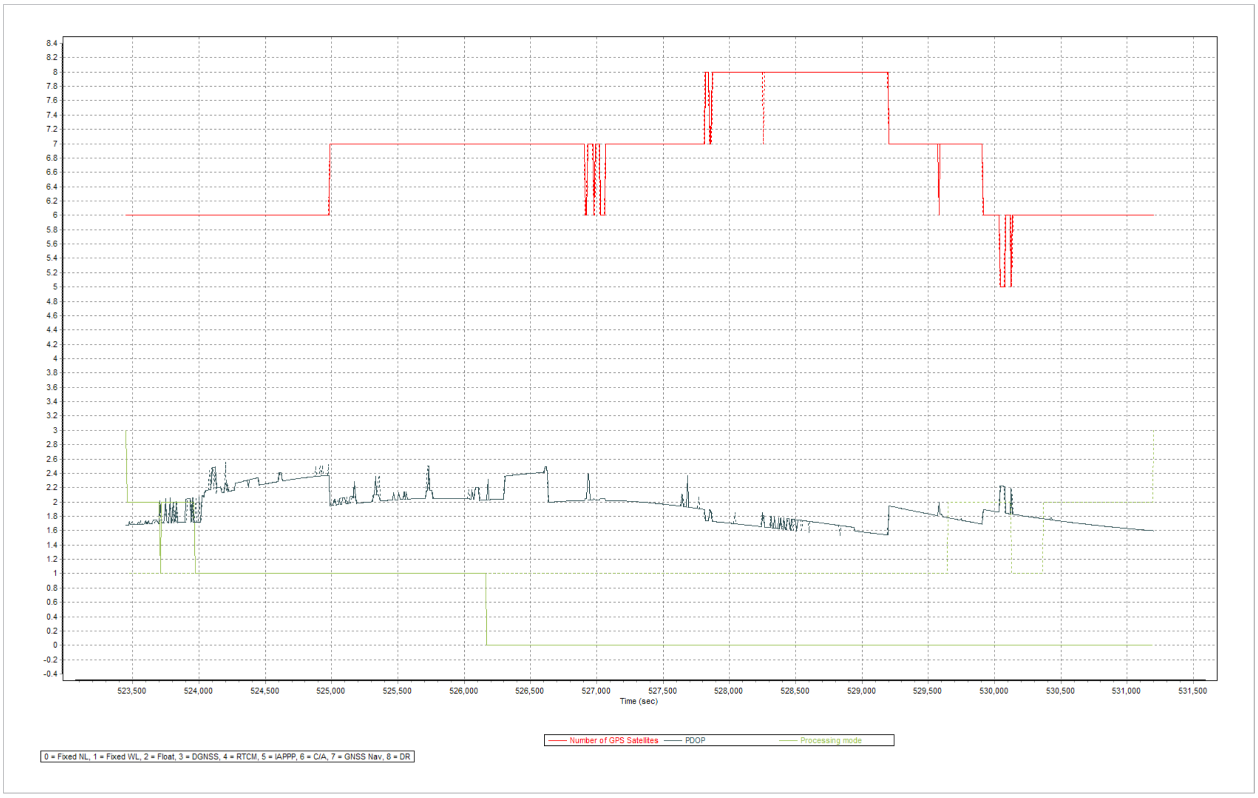


Figure 1.1.1 Solution Status

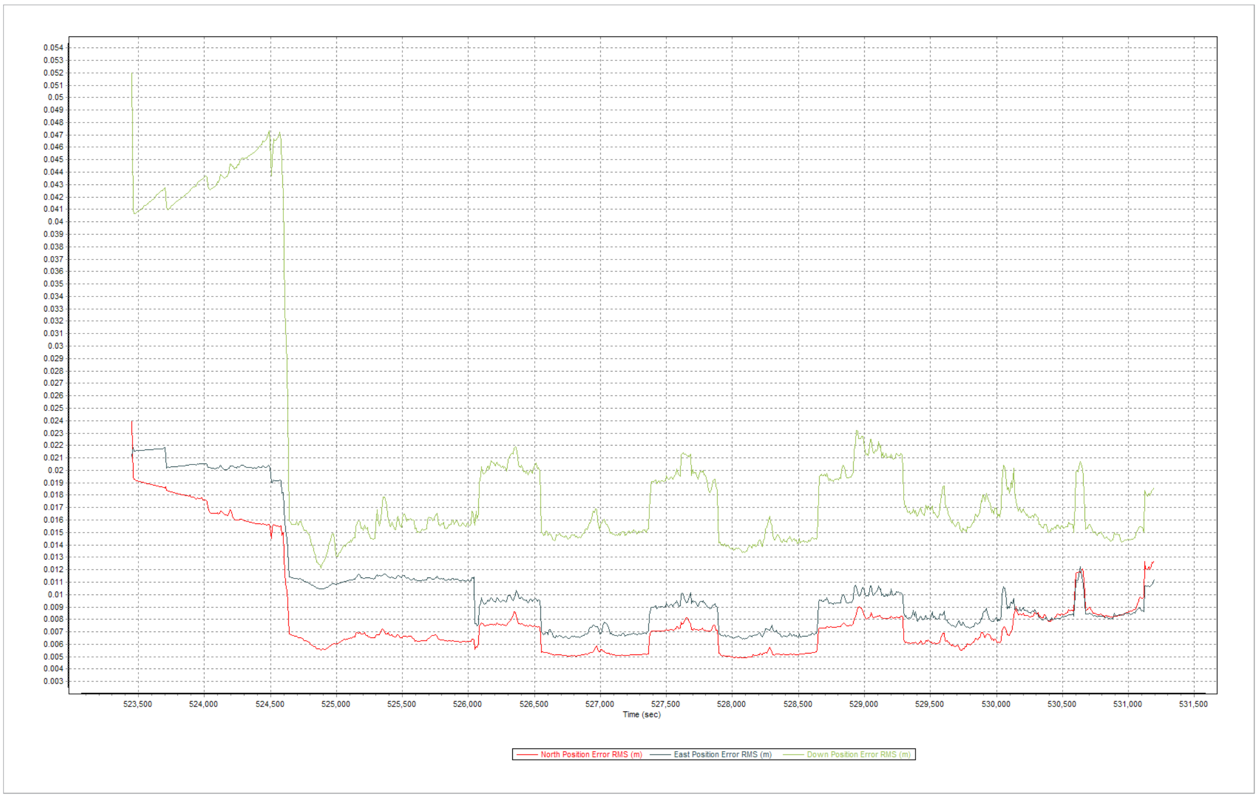


Figure 1.1.2 Smoothed Performance Metric Parameters

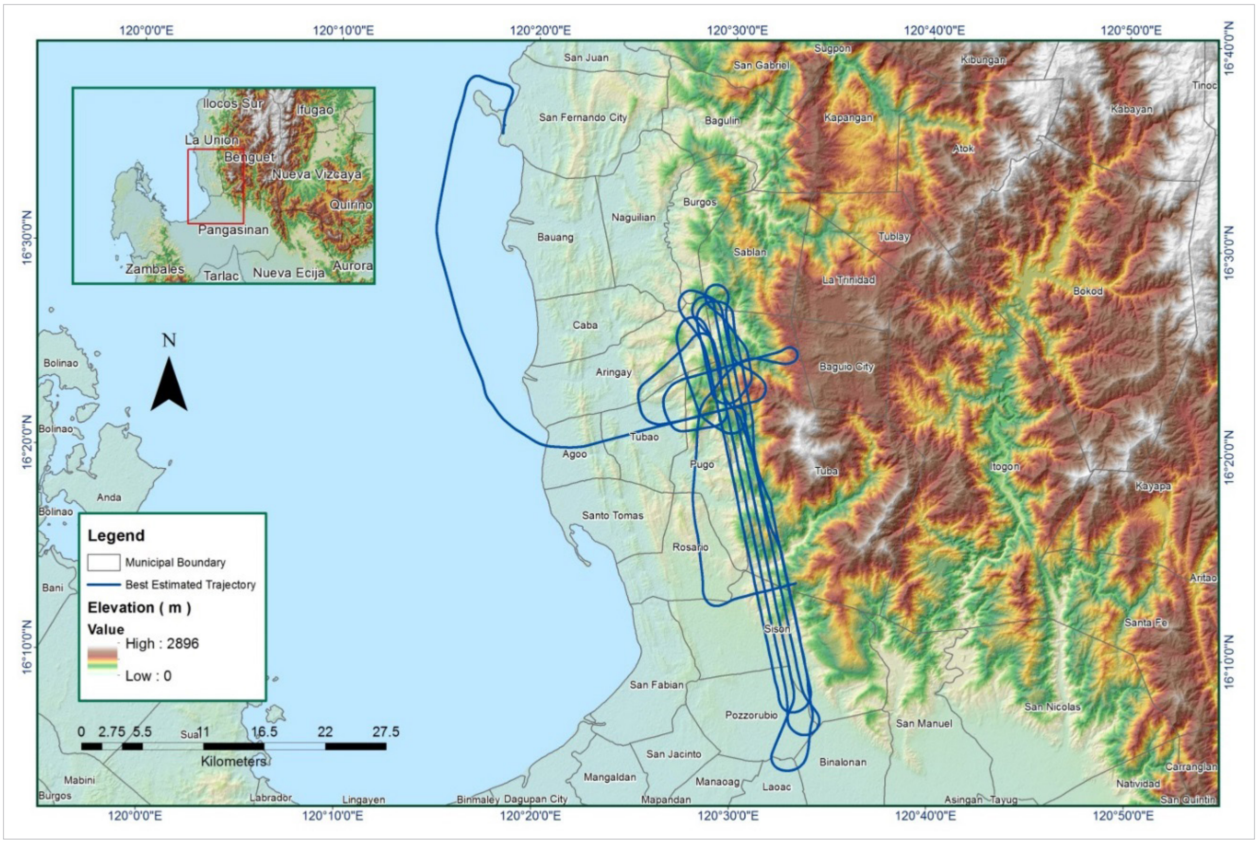


Figure 1.1.3 Best Estimated Trajectory

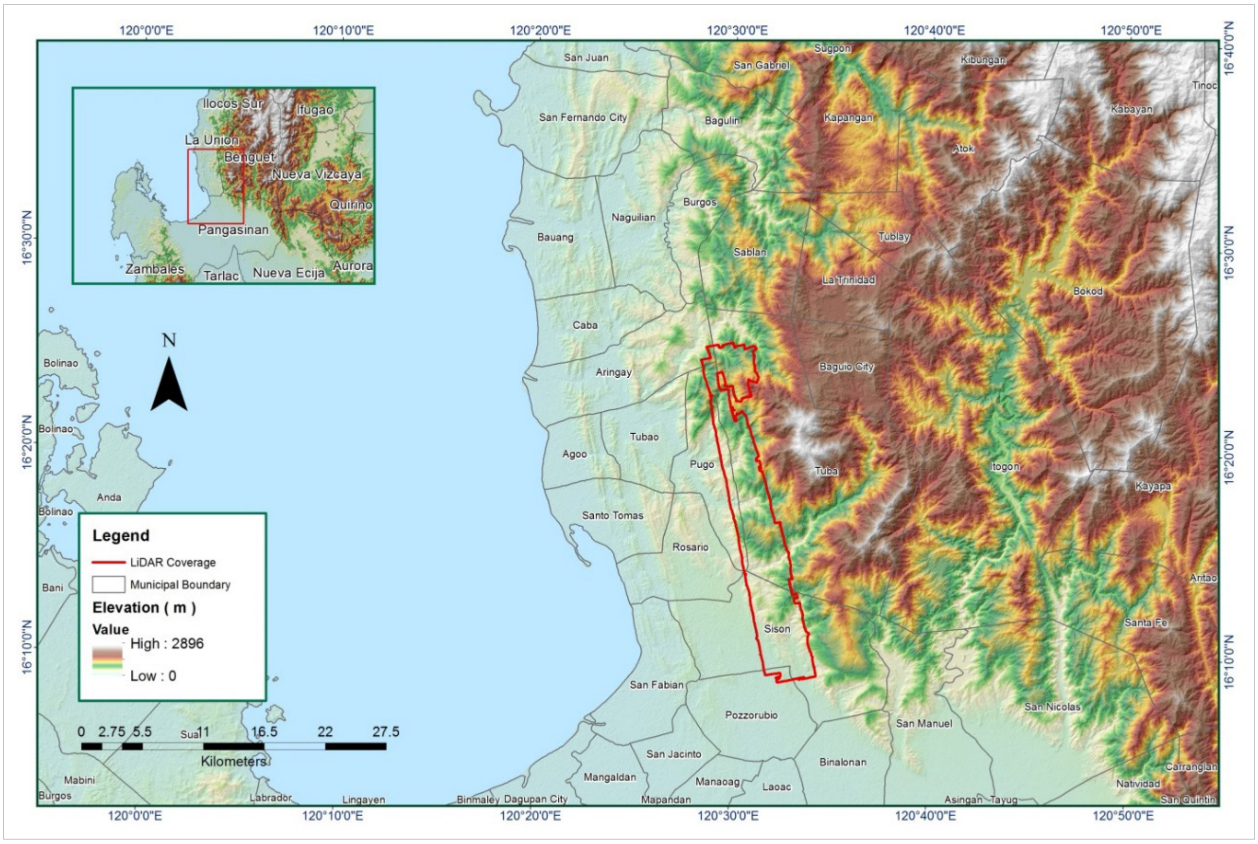


Figure 1.1.4 Coverage of LIDAR data

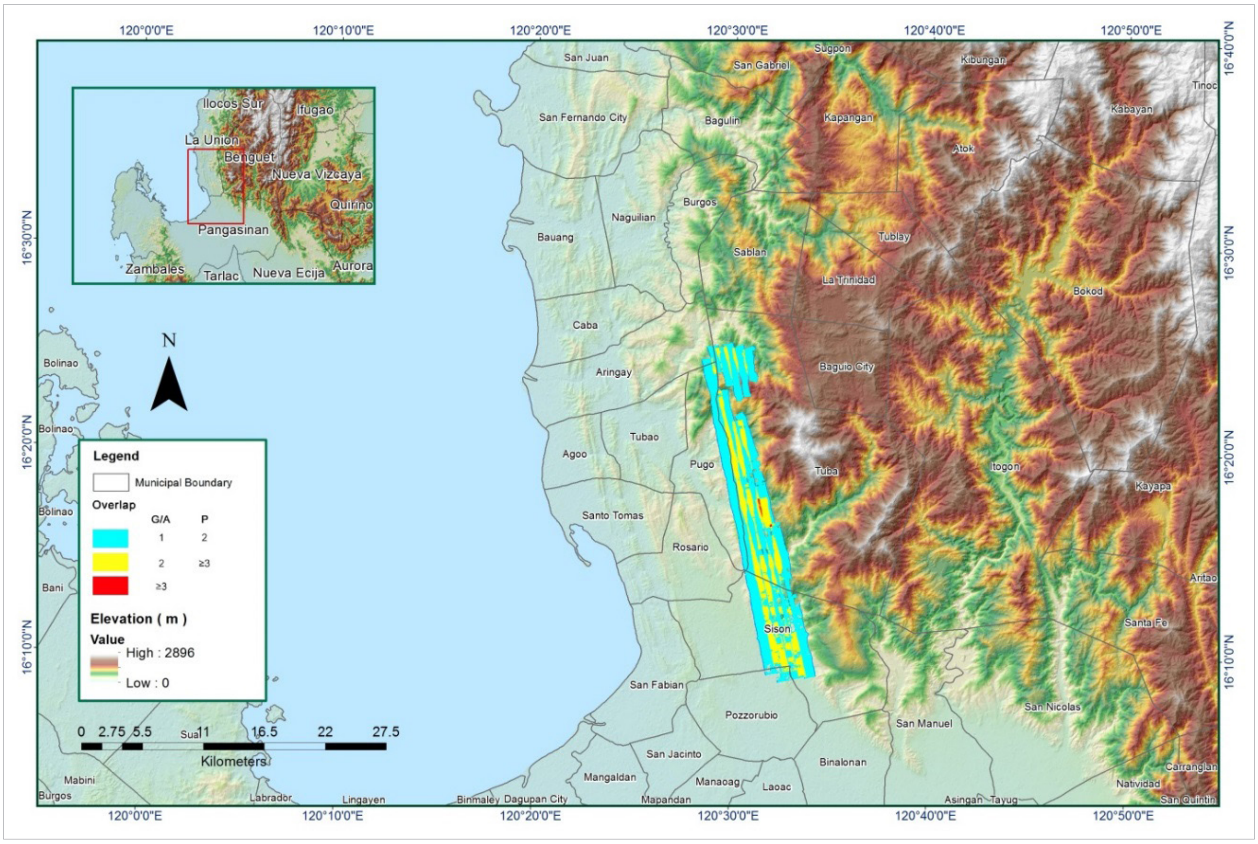


Figure 1.1.5 Image of Data Overlap

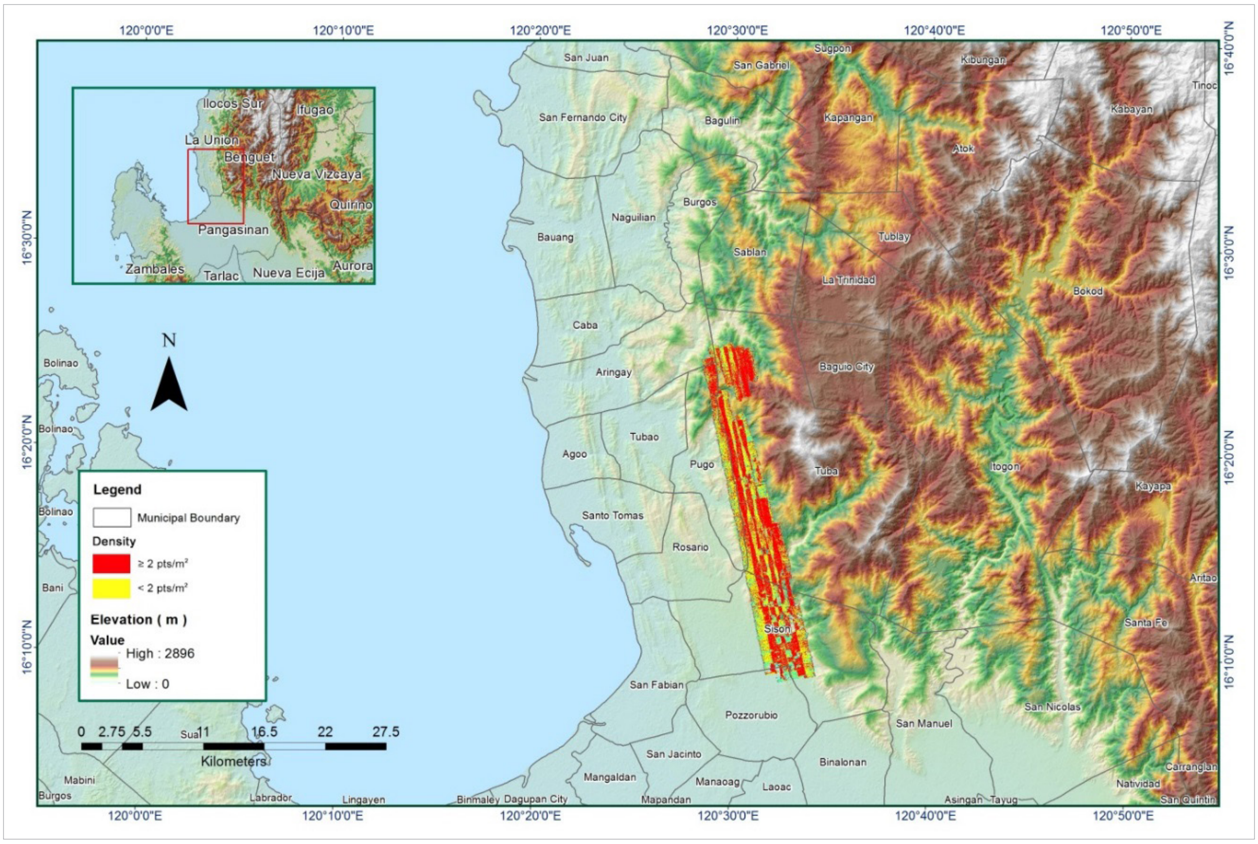


Figure 1.1.6 Density map of merged LIDAR data

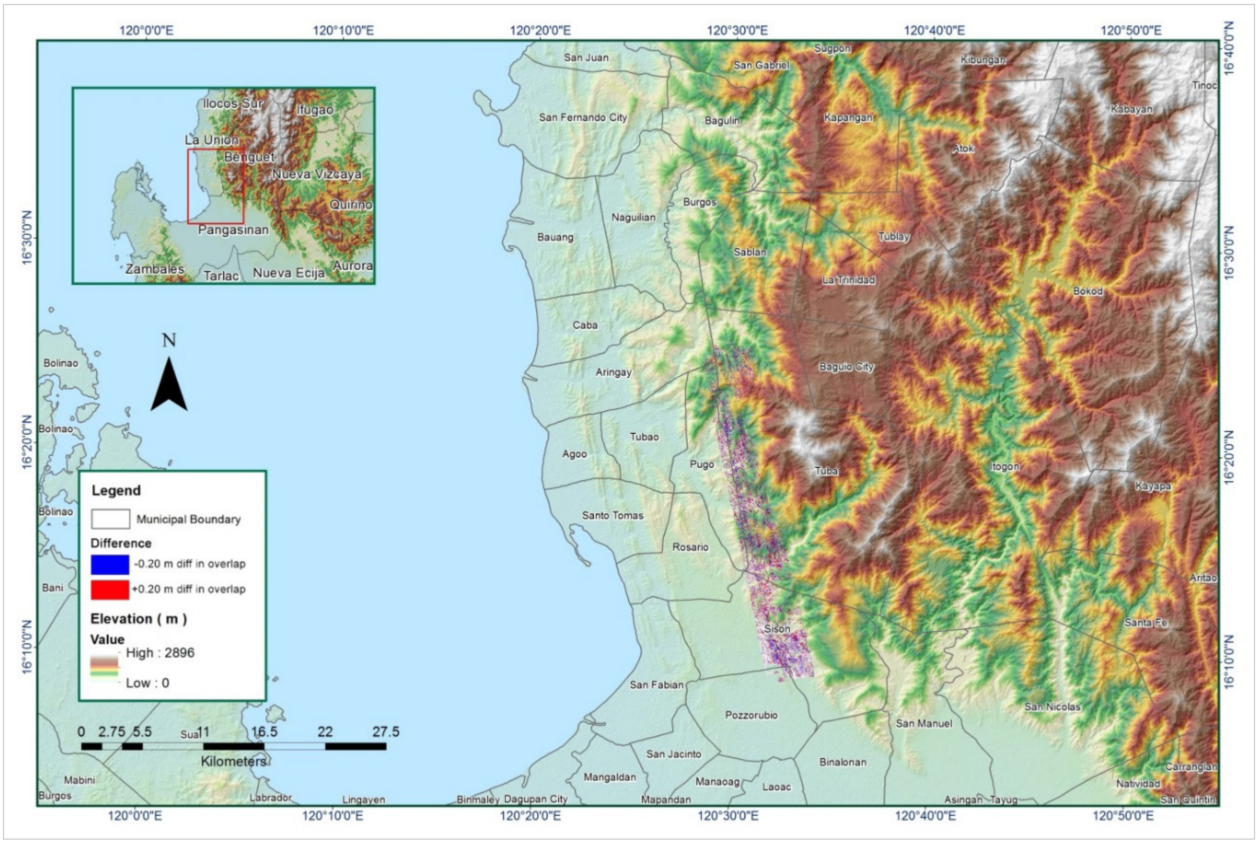


Figure 1.1.7 Elevation difference between flight lines

Table A-8.2. Mission Summary Report for Mission Blk10F

Flight Area	La Union
Mission Name	Blk10F
Inclusive Flights	1163P
Range data size	31.7 GB
Base data size	MB
POS	216 MB
Image	26.6 GB
Transfer date	February 28, 2014
Solution Status	
Number of Satellites (>6)	No
PDOP (<3)	Yes
Baseline Length (<30km)	No
Processing Mode (<=1)	No
Smoothed Performance Metrics (in cm)	
RMSE for North Position (<4.0 cm)	4.0
RMSE for East Position (<4.0 cm)	1.7
RMSE for Down Position (<8.0 cm)	4.55
Boresight correction stdev (<0.001deg)	0.000412
IMU attitude correction stdev (<0.001deg)	0.001085
GPS position stdev (<0.01m)	0.0015
Minimum % overlap (>25)	51.30%
Ave point cloud density per sq.m. (>2.0)	2.89
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	397
Maximum Height	917.14
Minimum Height	54.72
Classification (# of points)	
Ground	313,178,442
Low vegetation	207,472,770
Medium vegetation	359,082,600
High vegetation	352,450,264
Building	16,826,260
Orthophoto	
Processed By	Engr. Irish Cortez, Engr. Edgardo Gubatanga Jr., Simonette Lat

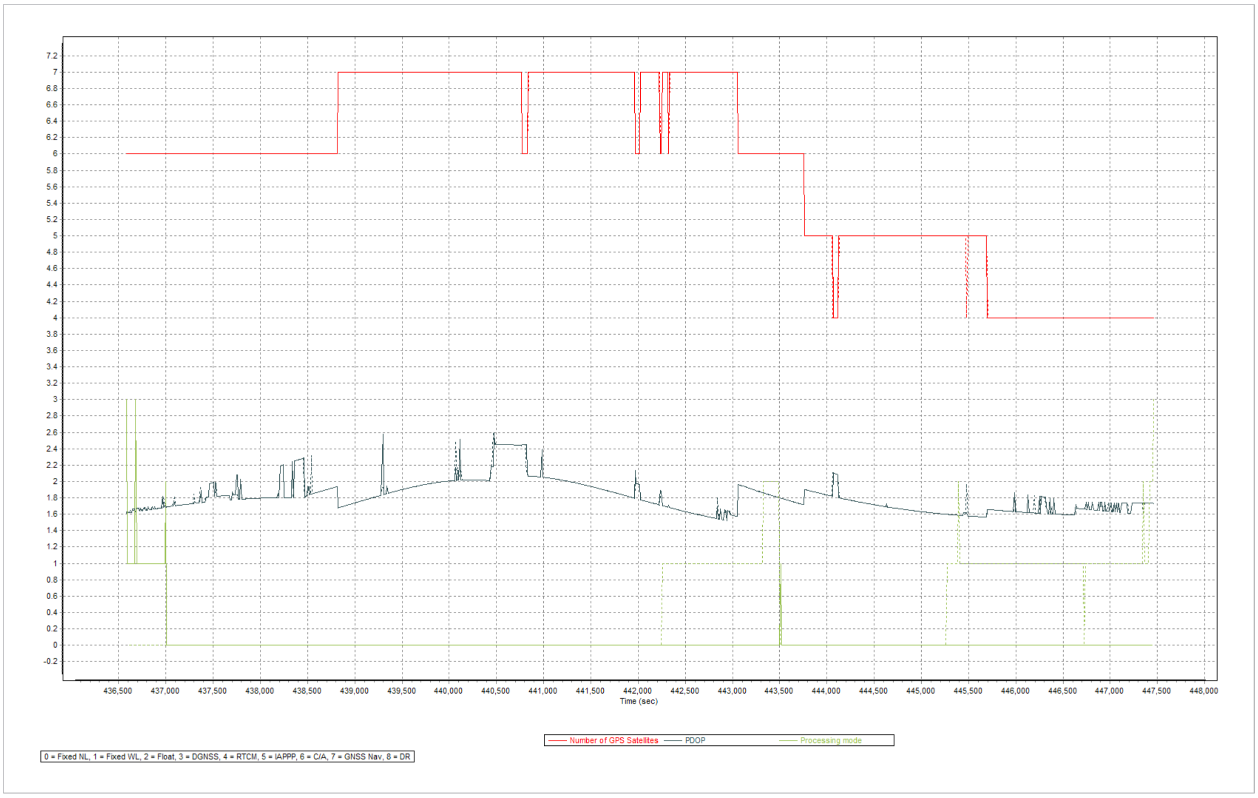


Figure 1.2.1 Solution Status

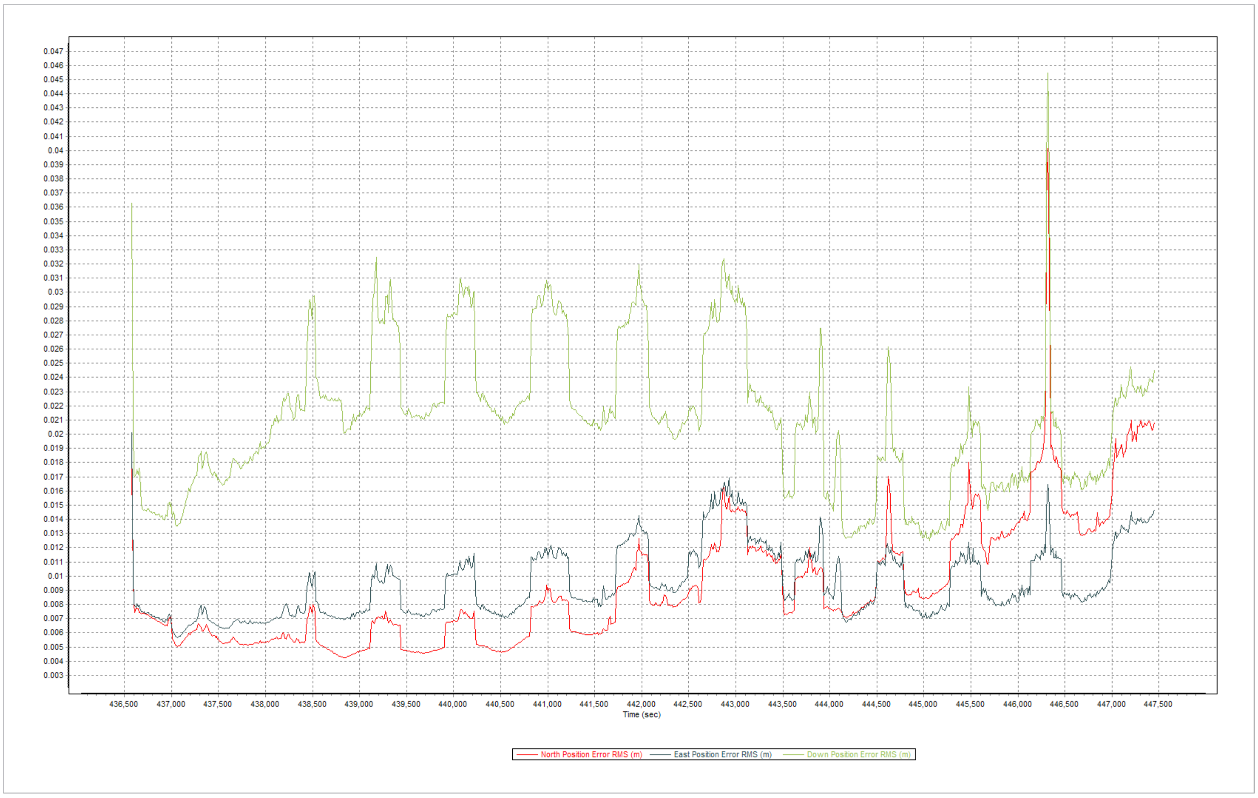


Figure 1.2.2 Smoothed Performance Metric Parameters

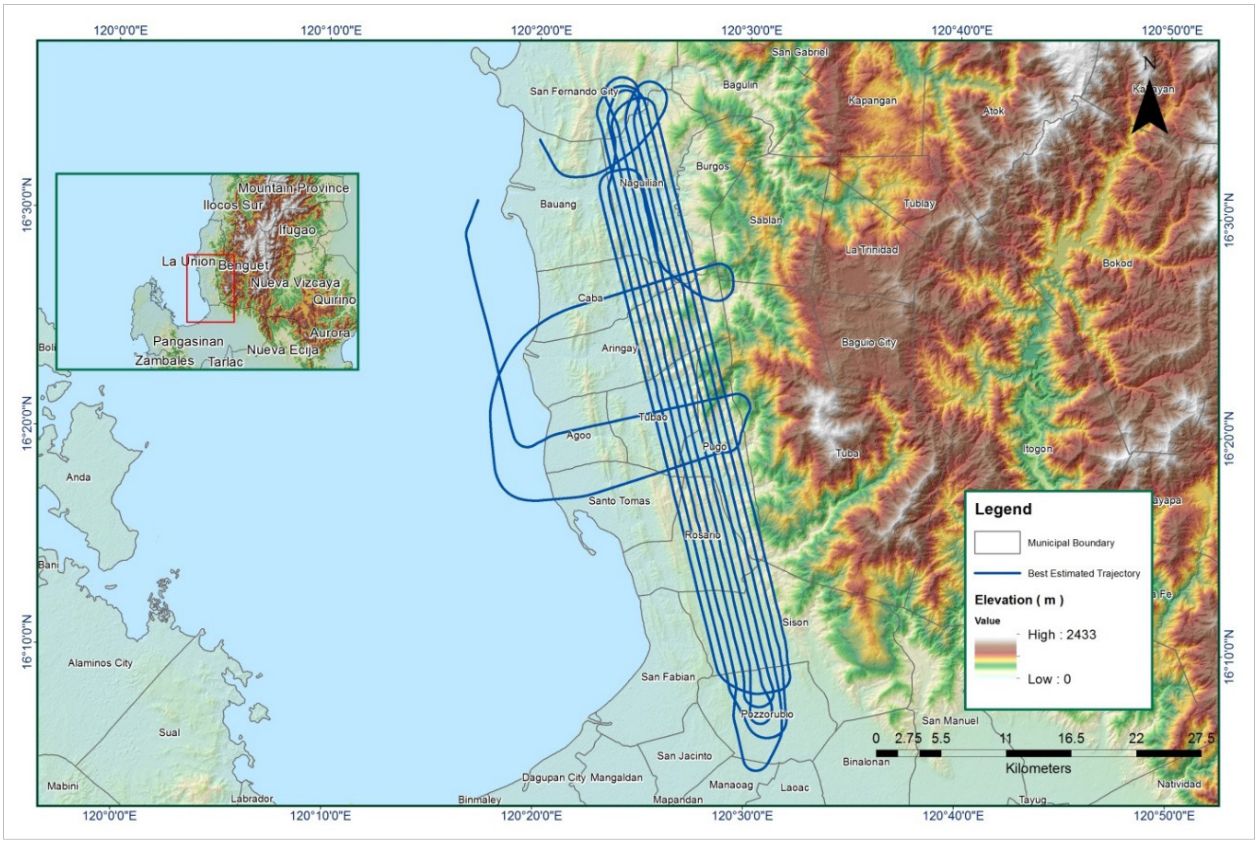


Figure 1.2.3 Best Estimated Trajectory

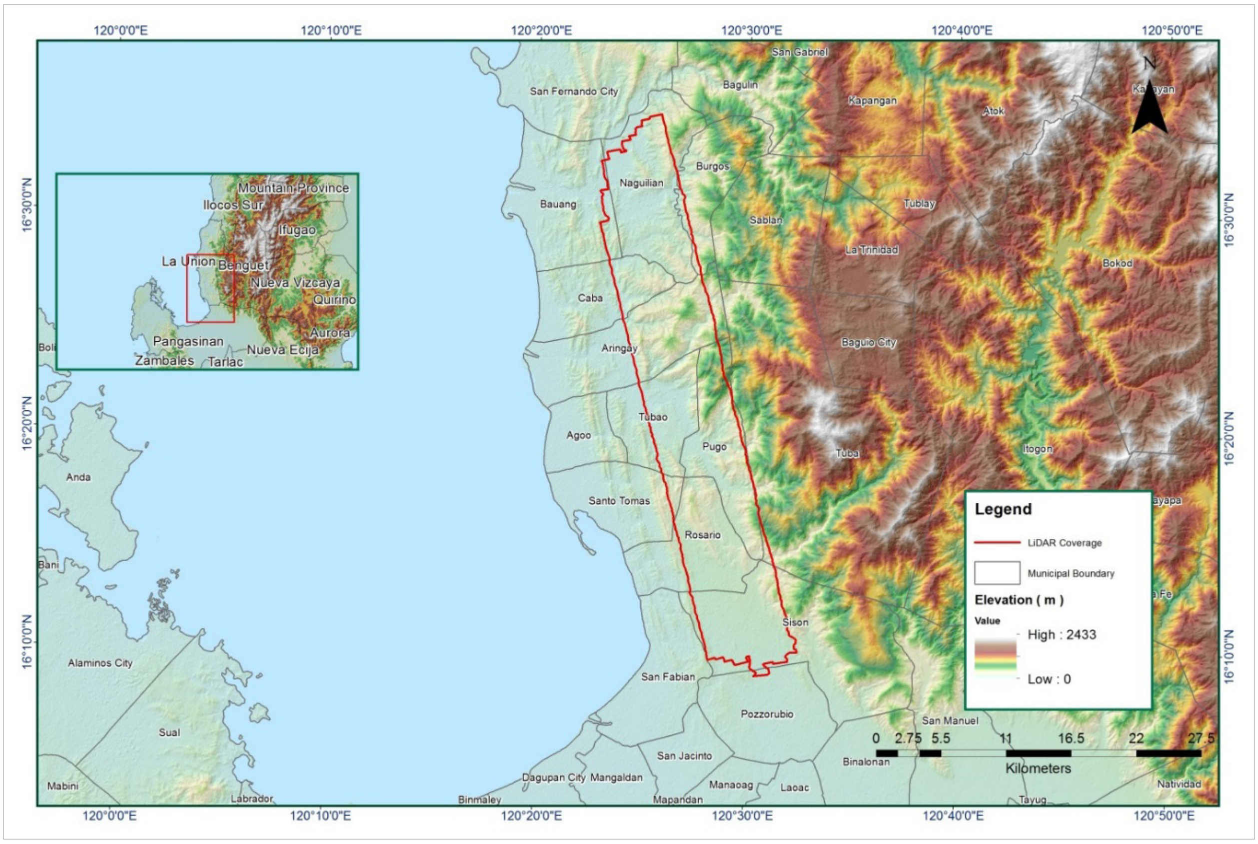


Figure 1.2.4 Coverage of LIDAR data

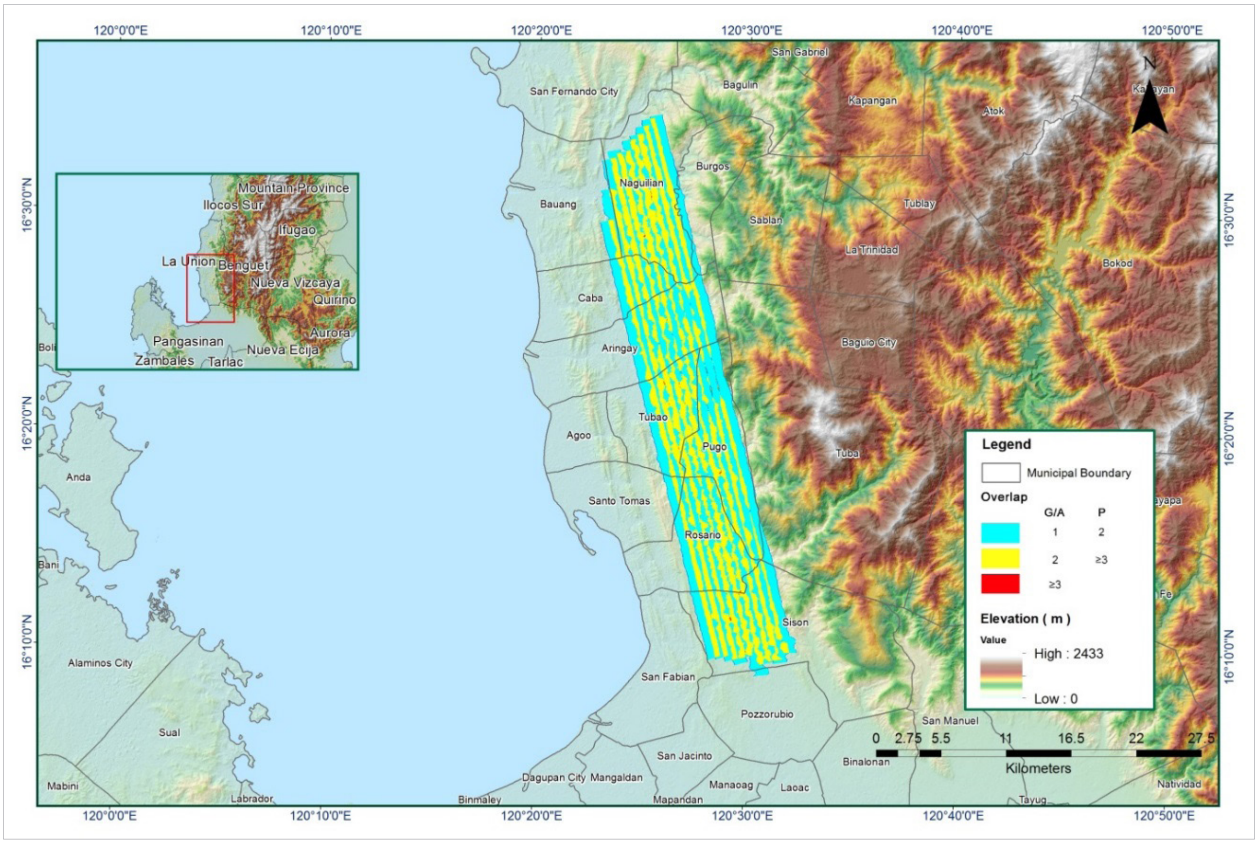


Figure 1.2.5 Image of Data Overlap

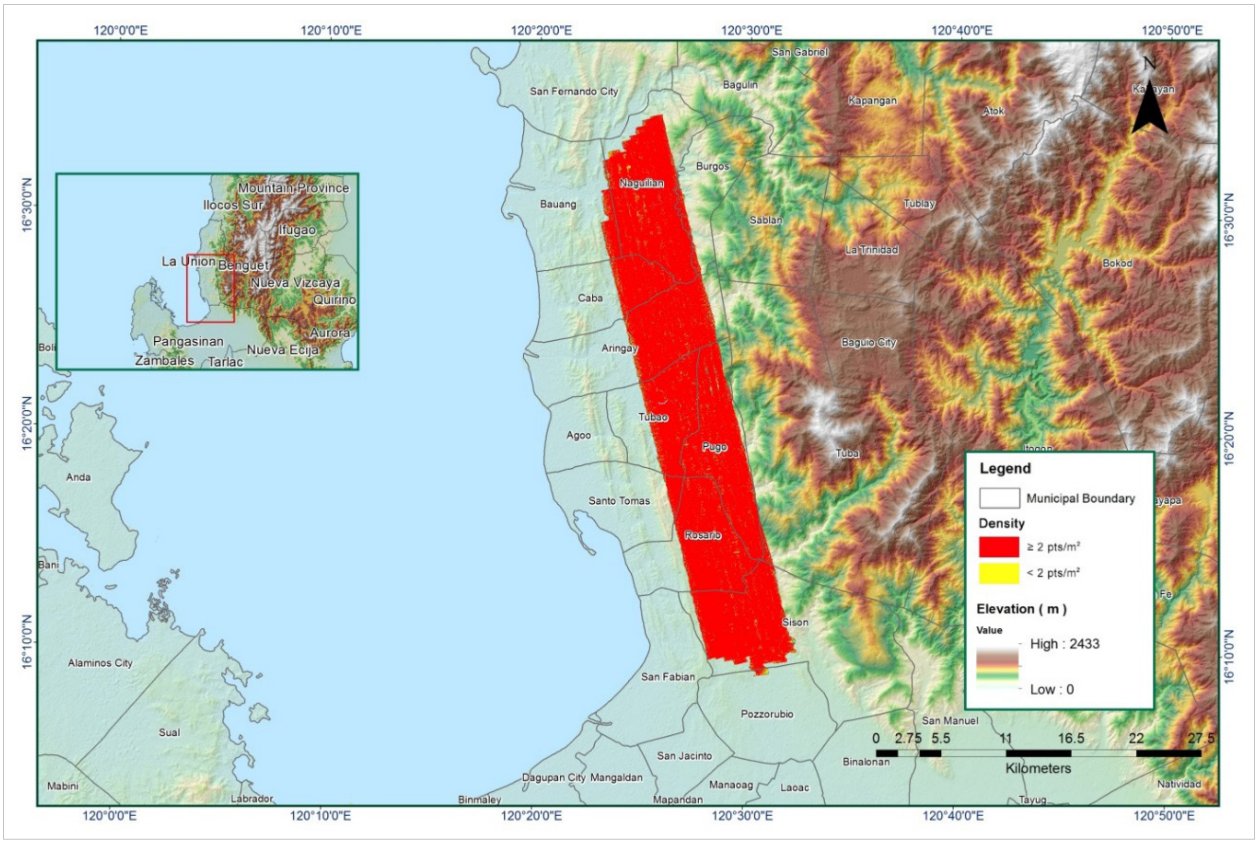


Figure 1.2.6 Density map of merged LIDAR data

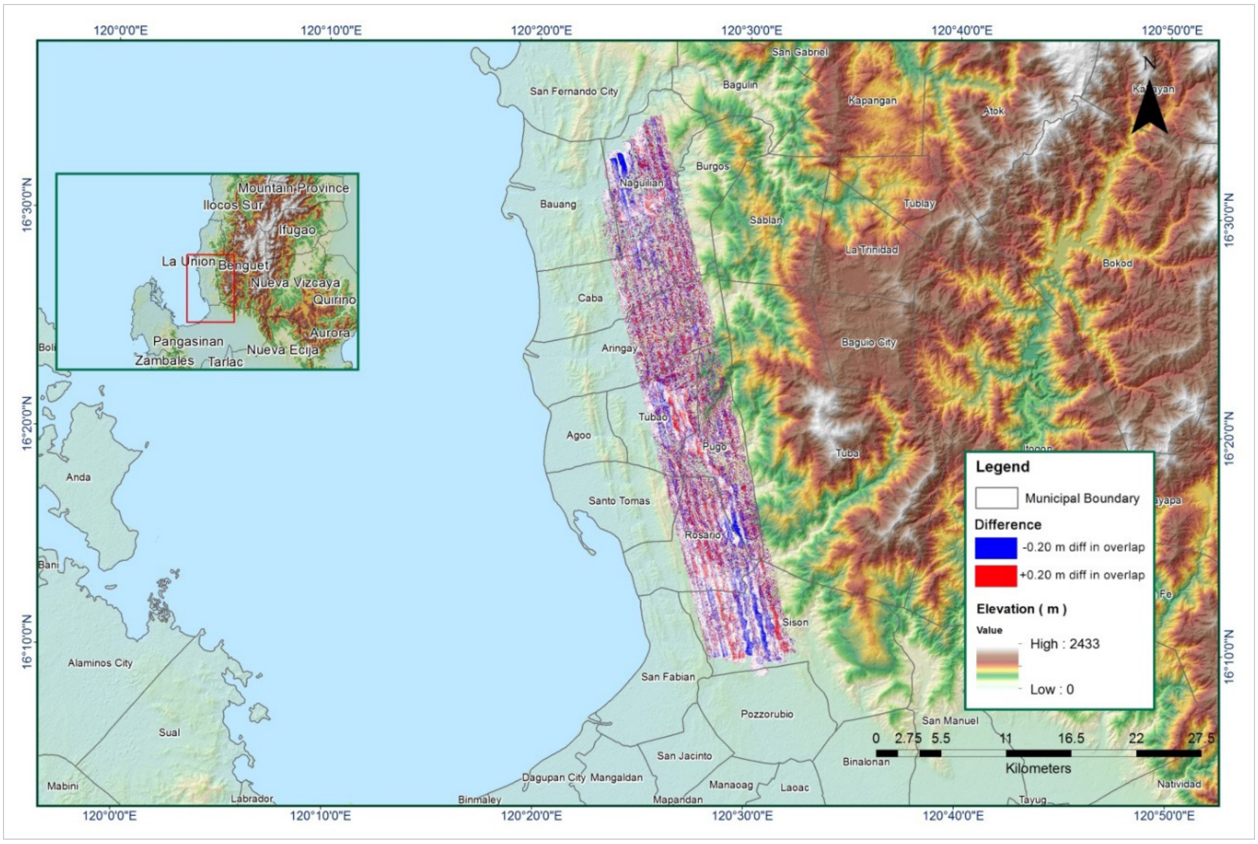


Figure 1.2.7 Elevation difference between flight lines

Table A-8.3. Mission Summary Report for Mission Blk10E

Flight Area	La Union
Mission Name	Blk10E
Inclusive Flights	1165P
Range data size	16.7 GB
Base data size	MB
POS	143 MB
Image	25.6 GB
Transfer date	February 28, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	Yes
Processing Mode (<=1)	No
Smoothed Performance Metrics (in cm)	
RMSE for North Position (<4.0 cm)	1.47
RMSE for East Position (<4.0 cm)	3.55
RMSE for Down Position (<8.0 cm)	5.8
Boresight correction stdev (<0.001deg)	0.00063
IMU attitude correction stdev (<0.001deg)	0.00176
GPS position stdev (<0.01m)	0.0285
Minimum % overlap (>25)	33.94%
Ave point cloud density per sq.m. (>2.0)	1.83
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	254
Maximum Height	511.11
Minimum Height	36.61
Classification (# of points)	
Ground	159,587,429
Low vegetation	116,400,476
Medium vegetation	97,848,898
High vegetation	80,131,631
Building	12,300,219
Orthophoto	
Processed By	Engr. Benjamin Jonah Magallon, Engr. Merven Matthew Natino, Engr. Jeffrey Delica

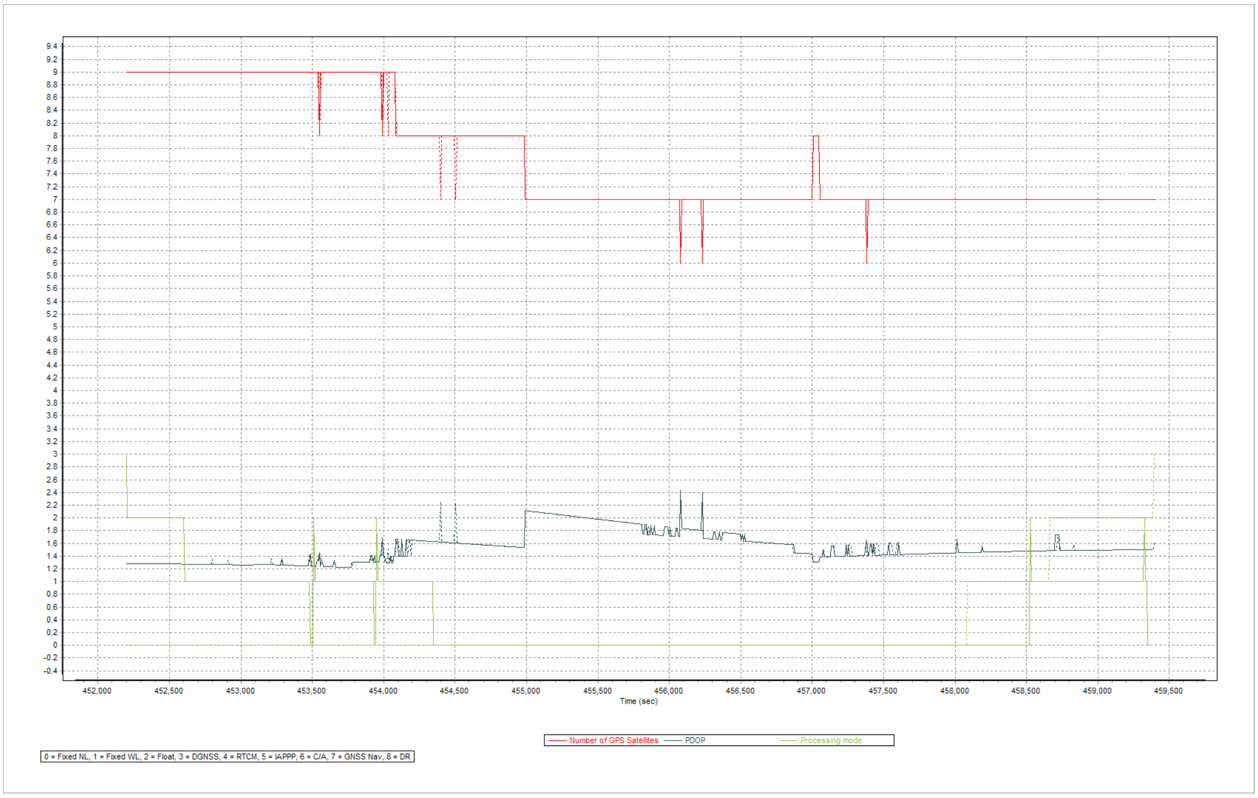


Figure 1.3.1 Solution Status

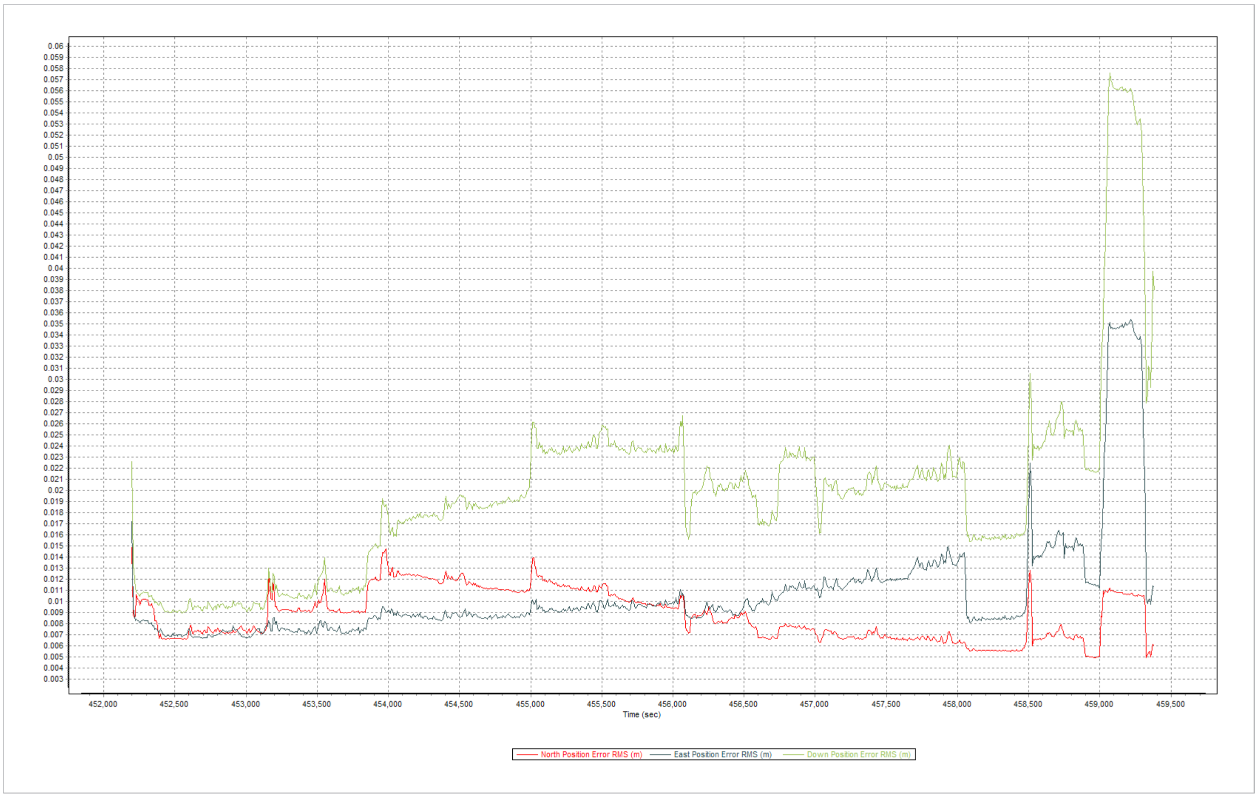


Figure 1.3.2 Smoothed Performance Metric Parameters

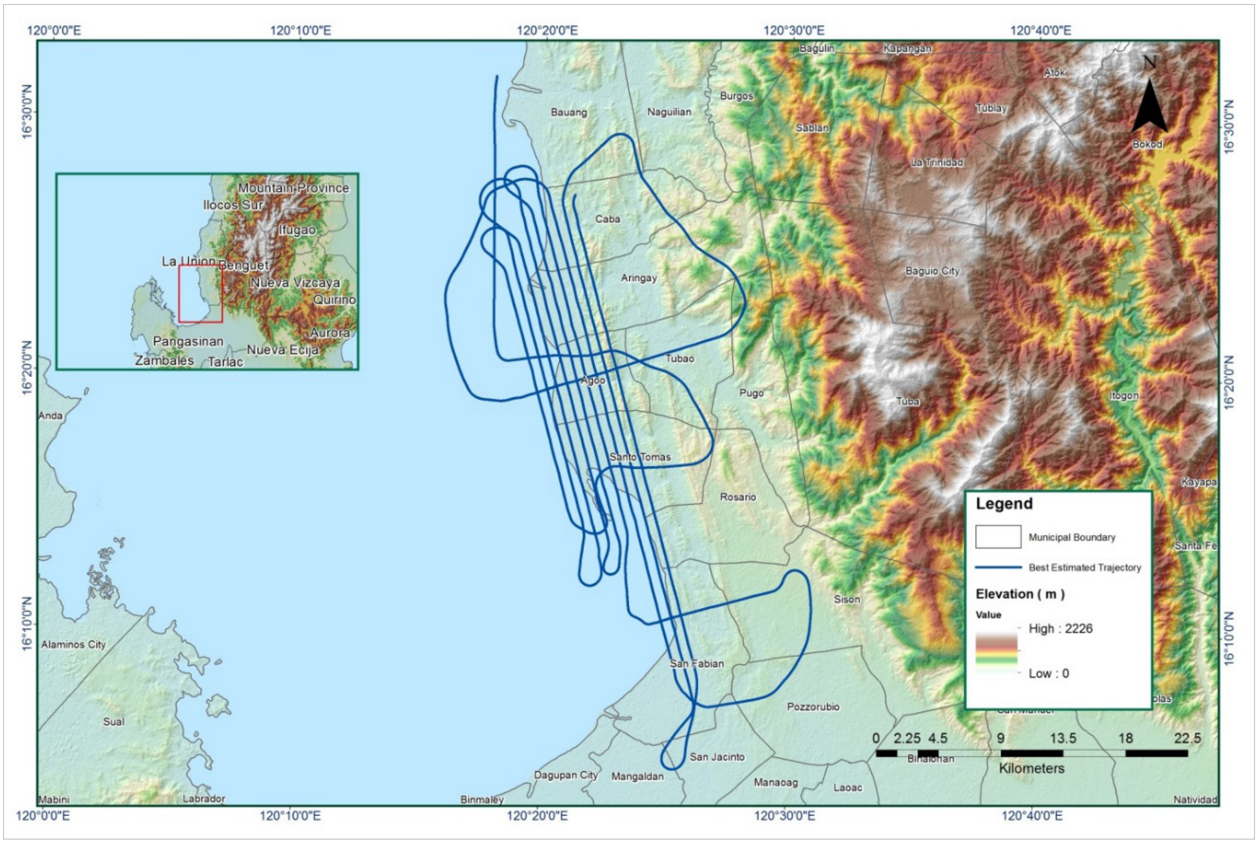


Figure 1.3.3 Best Estimated Trajectory

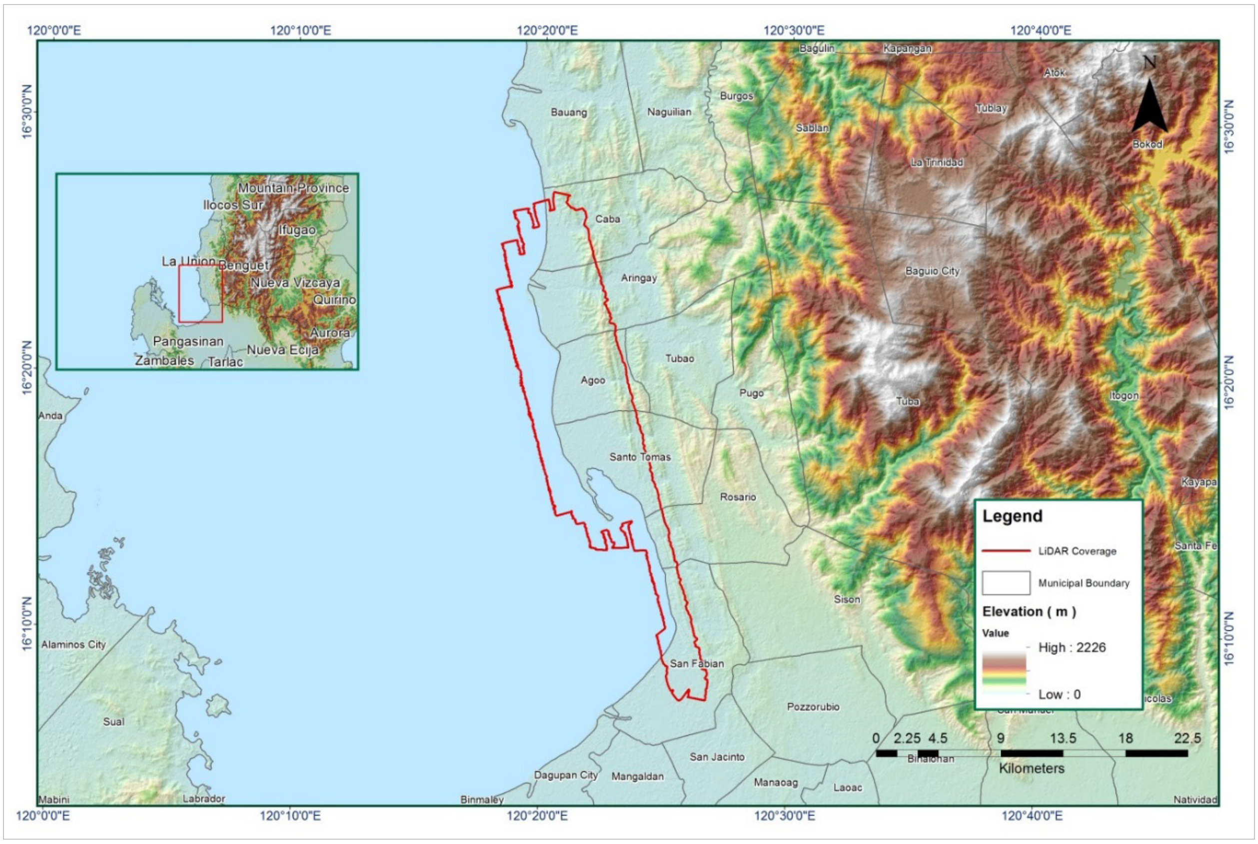


Figure 1.3.4 Coverage of LIDAR data

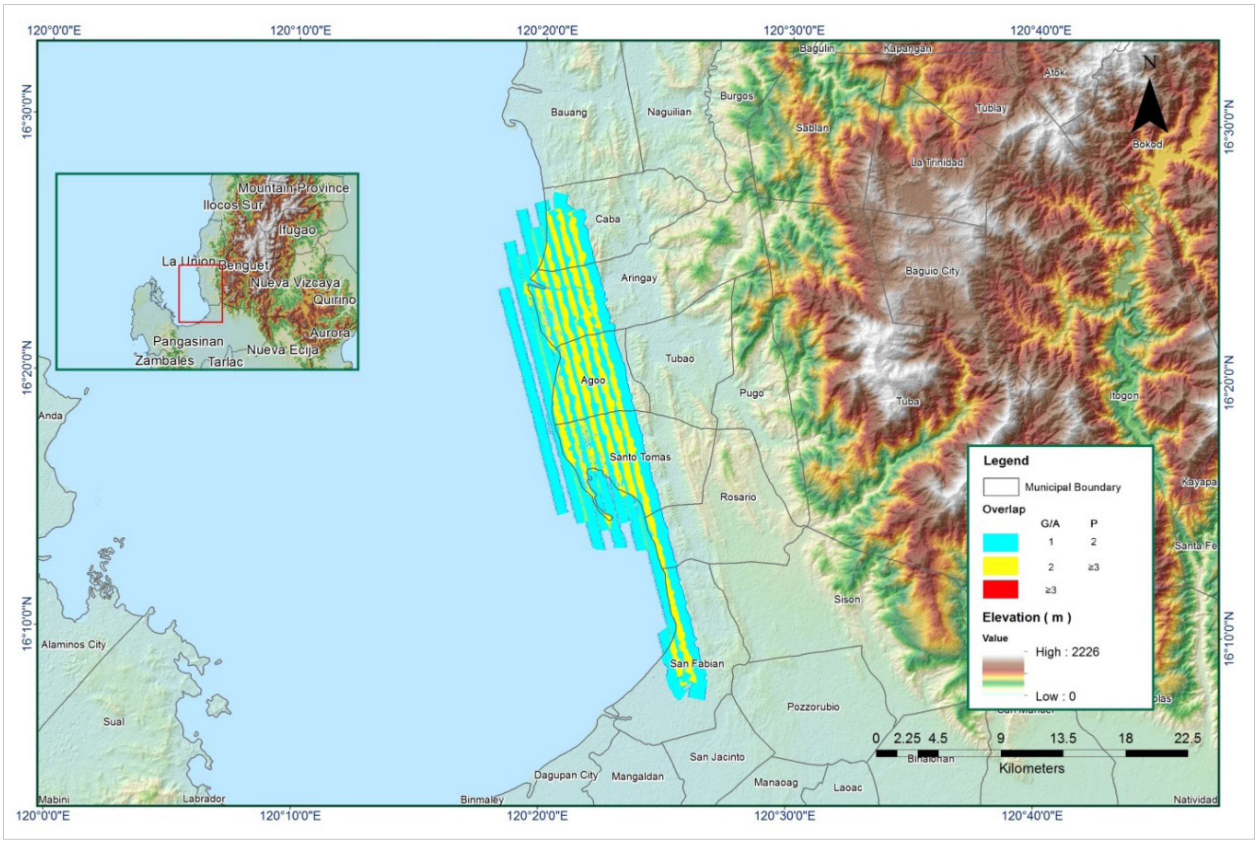


Figure 1.3.5 Image of Data Overlap

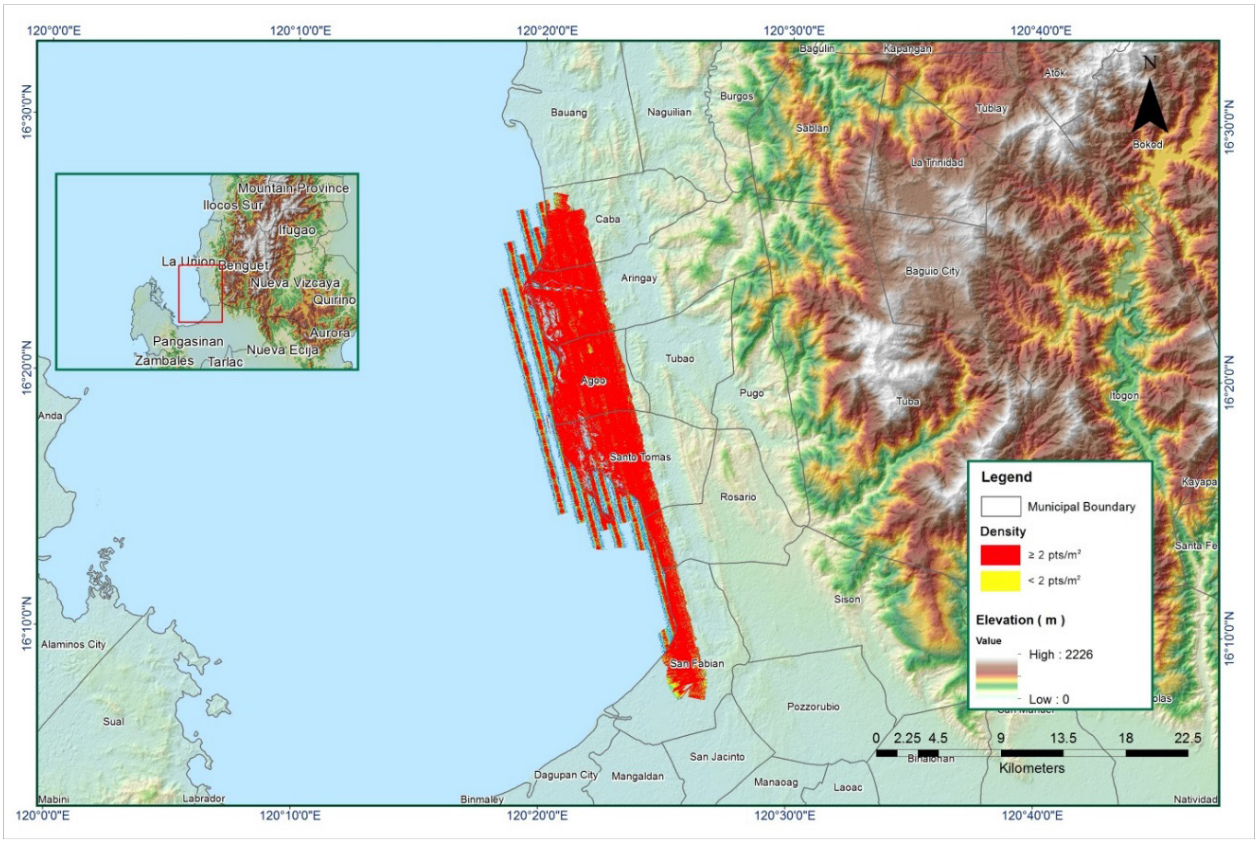


Figure 1.3.6 Density map of merged LIDAR data

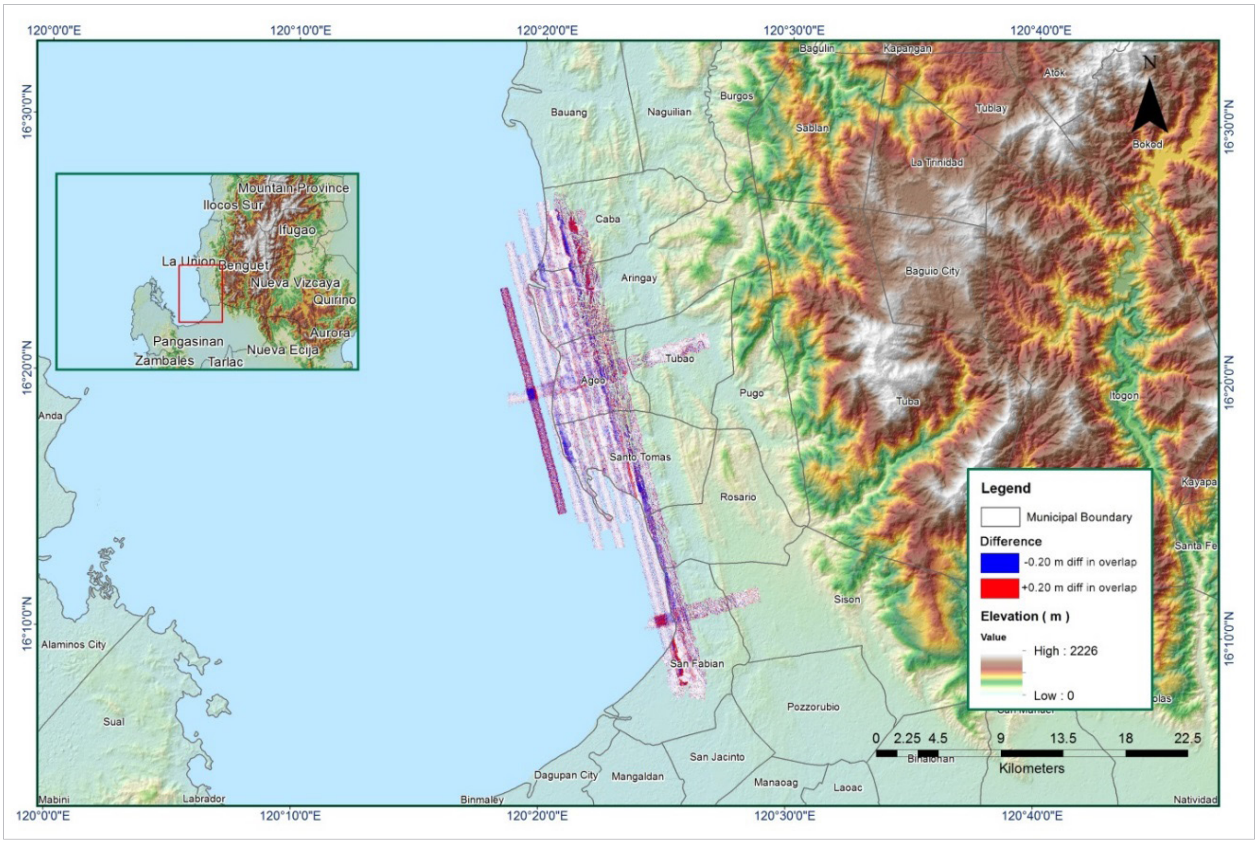


Figure 1.3.7 Elevation difference between flight lines

Table A-8.4. Mission Summary Report for Mission Blk10E_additional

Flight Area	La Union
Mission Name	Blk10E_additional
Inclusive Flights	1169P
Range data size	19.1 GB
Base data size	MB
POS	133 MB
Image	28.6 GB
Transfer date	March 01, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	Yes
Processing Mode (<=1)	No
Smoothed Performance Metrics (in cm)	
RMSE for North Position (<4.0 cm)	1.28
RMSE for East Position (<4.0 cm)	1.12
RMSE for Down Position (<8.0 cm)	2.46
Boresight correction stdev (<0.001deg)	0.000564
IMU attitude correction stdev (<0.001deg)	0.000694
GPS position stdev (<0.01m)	0.0096
Minimum % overlap (>25)	43.46%
Ave point cloud density per sq.m. (>2.0)	2.42
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	262
Maximum Height	517.13
Minimum Height	44.11
Classification (# of points)	
Ground	192,742,973
Low vegetation	118,975,893
Medium vegetation	202,541,674
High vegetation	162,966,316
Building	8,351,163
Orthophoto	
Processed By	Engr. Benjamin Jonah Magallon, Engr. Mark Joshua Salvacion, Engr. Melissa Fernandez

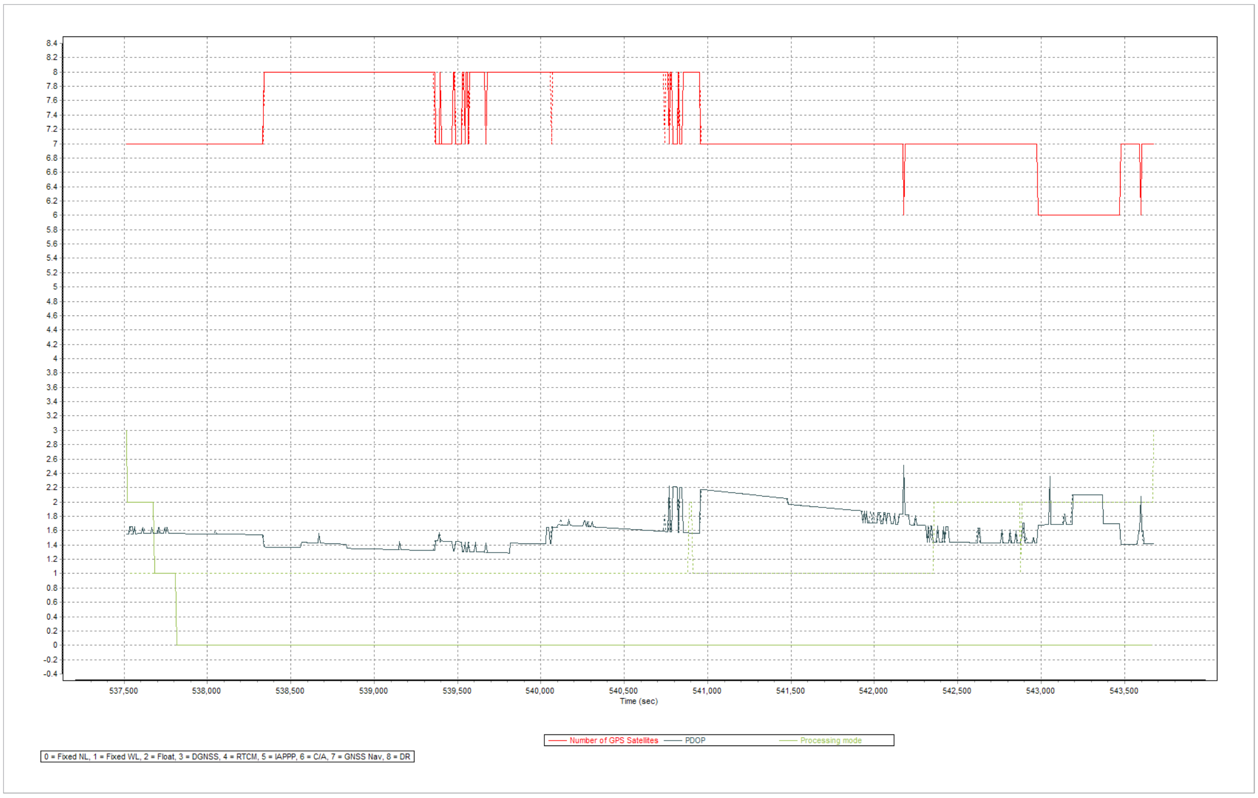


Figure 1.4.1 Solution Status

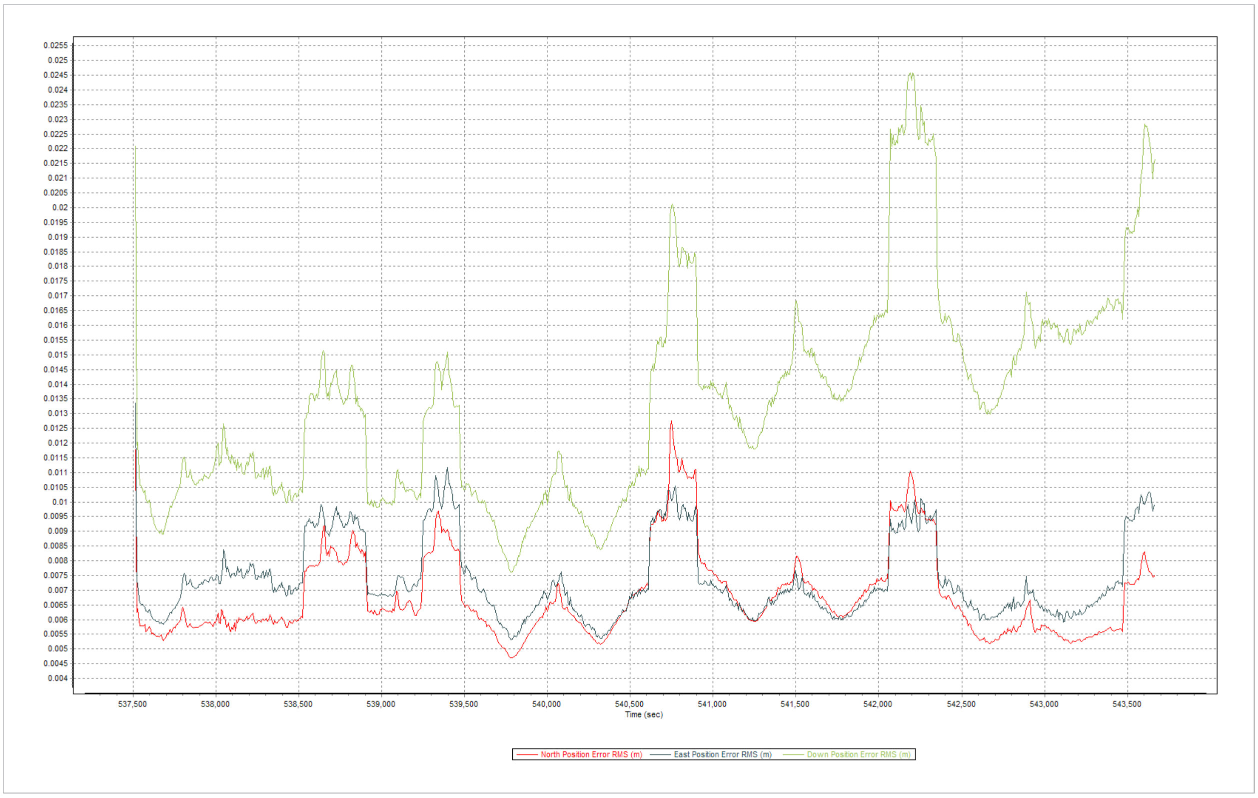


Figure 1.4.2 Smoothed Performance Metric Parameters

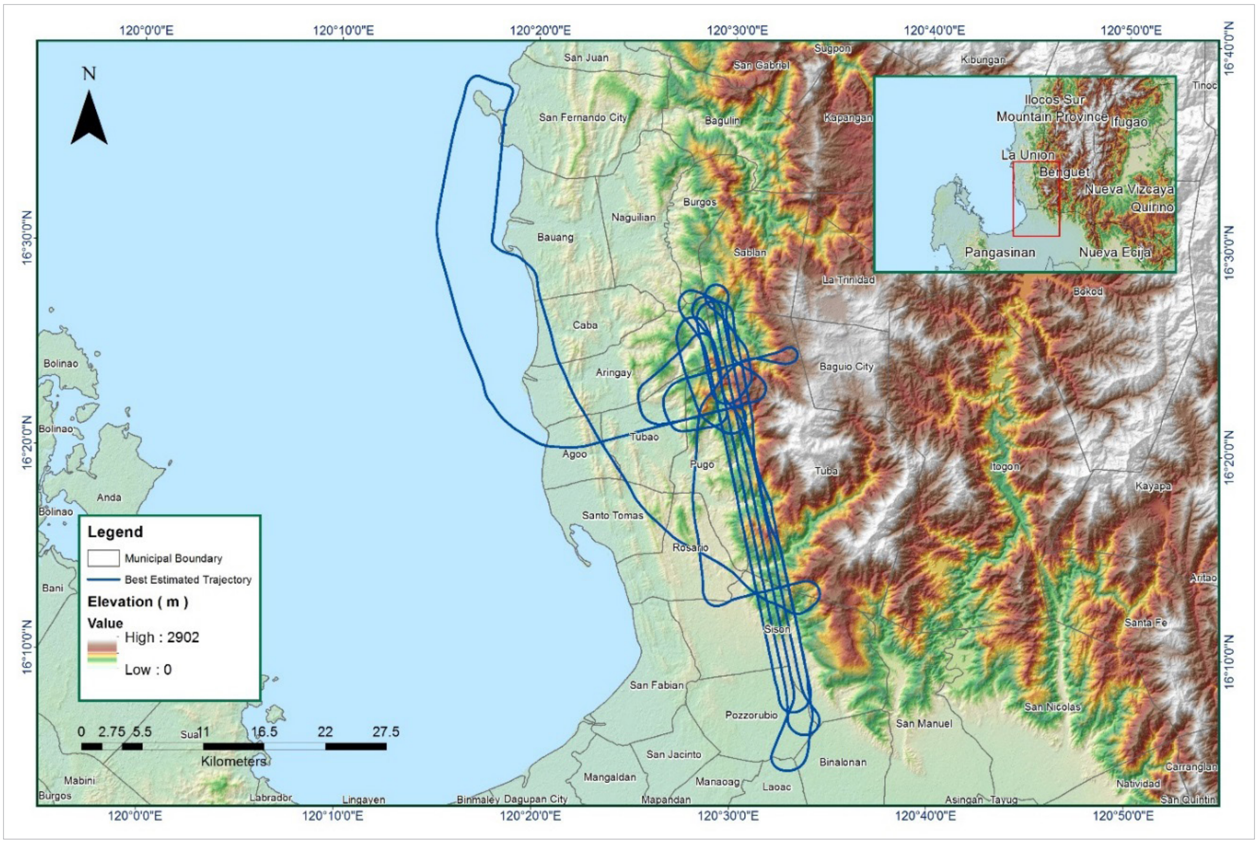


Figure 1.4.3 Best Estimated Trajectory

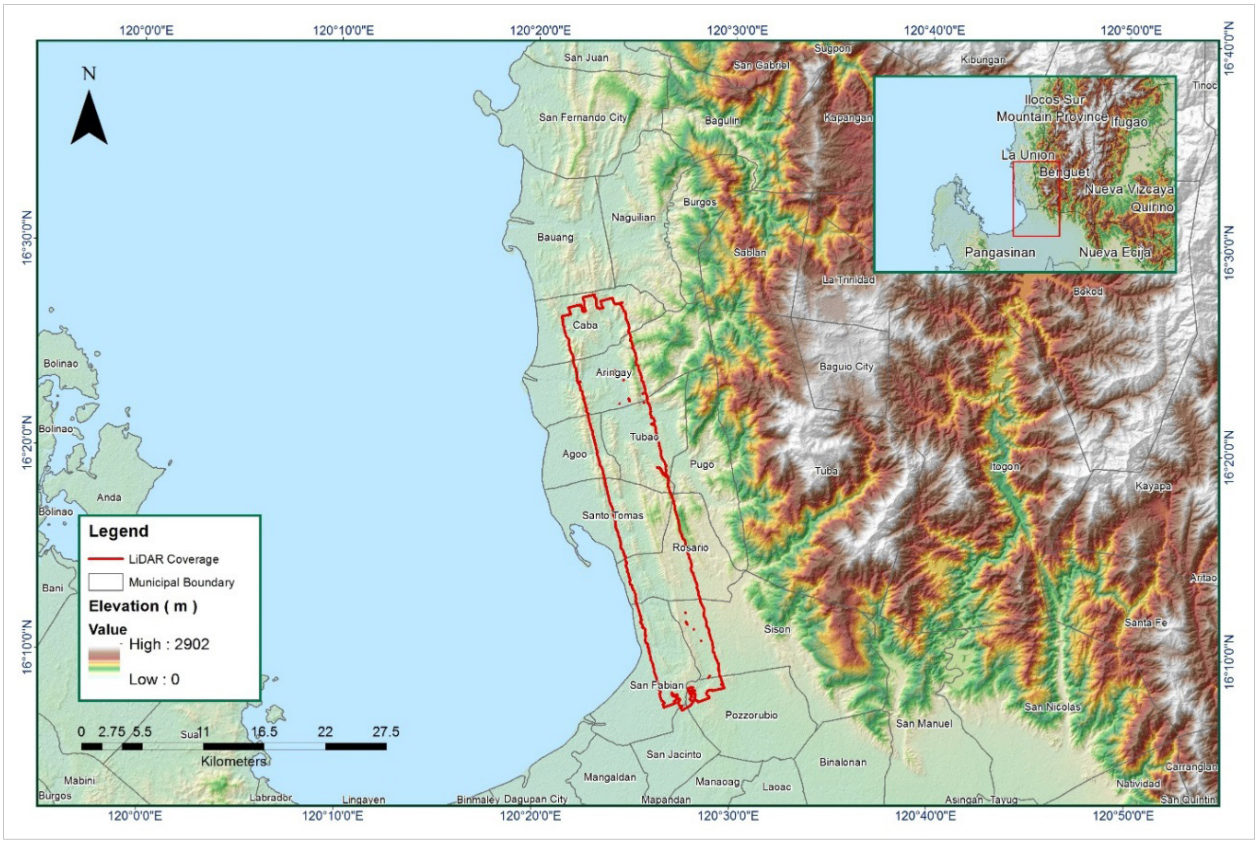


Figure 1.4.4 Coverage of LIDAR data

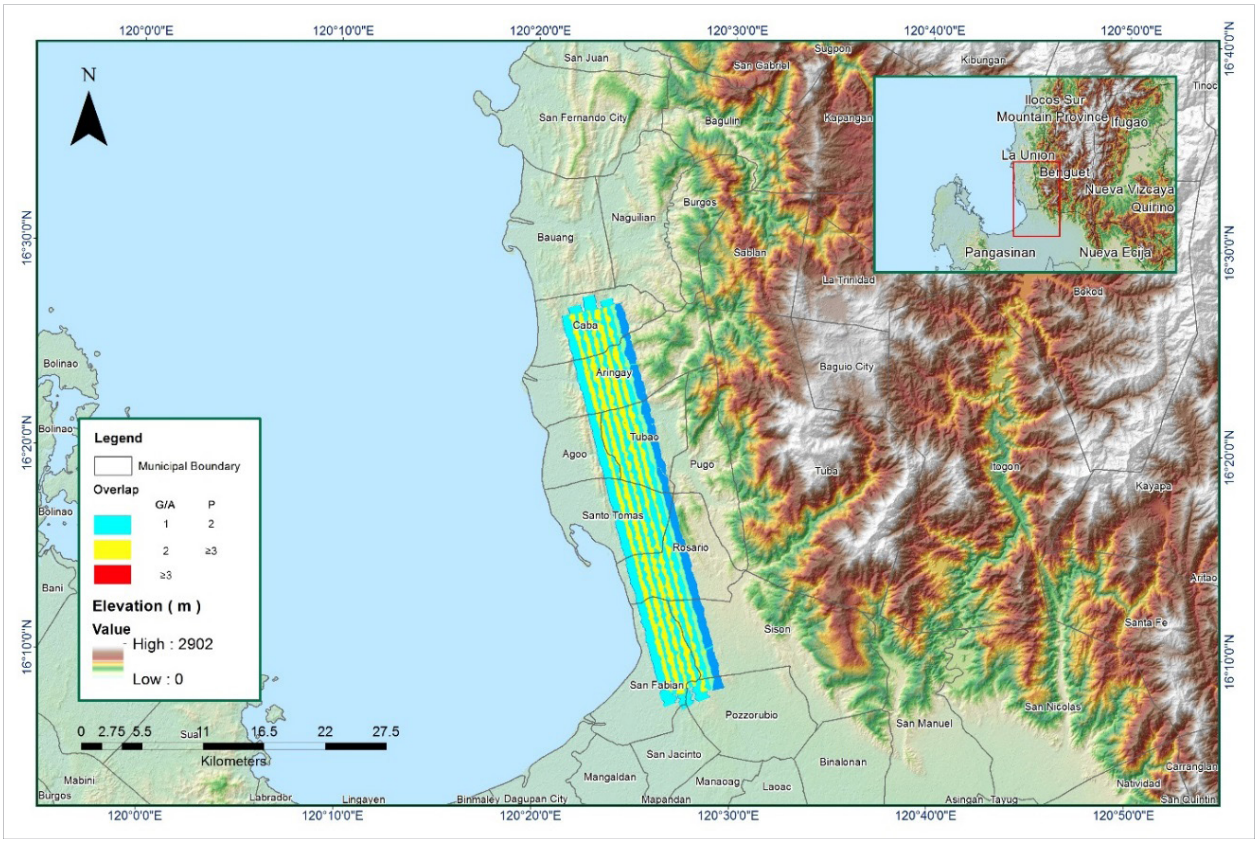


Figure 1.4.5 Image of Data Overlap

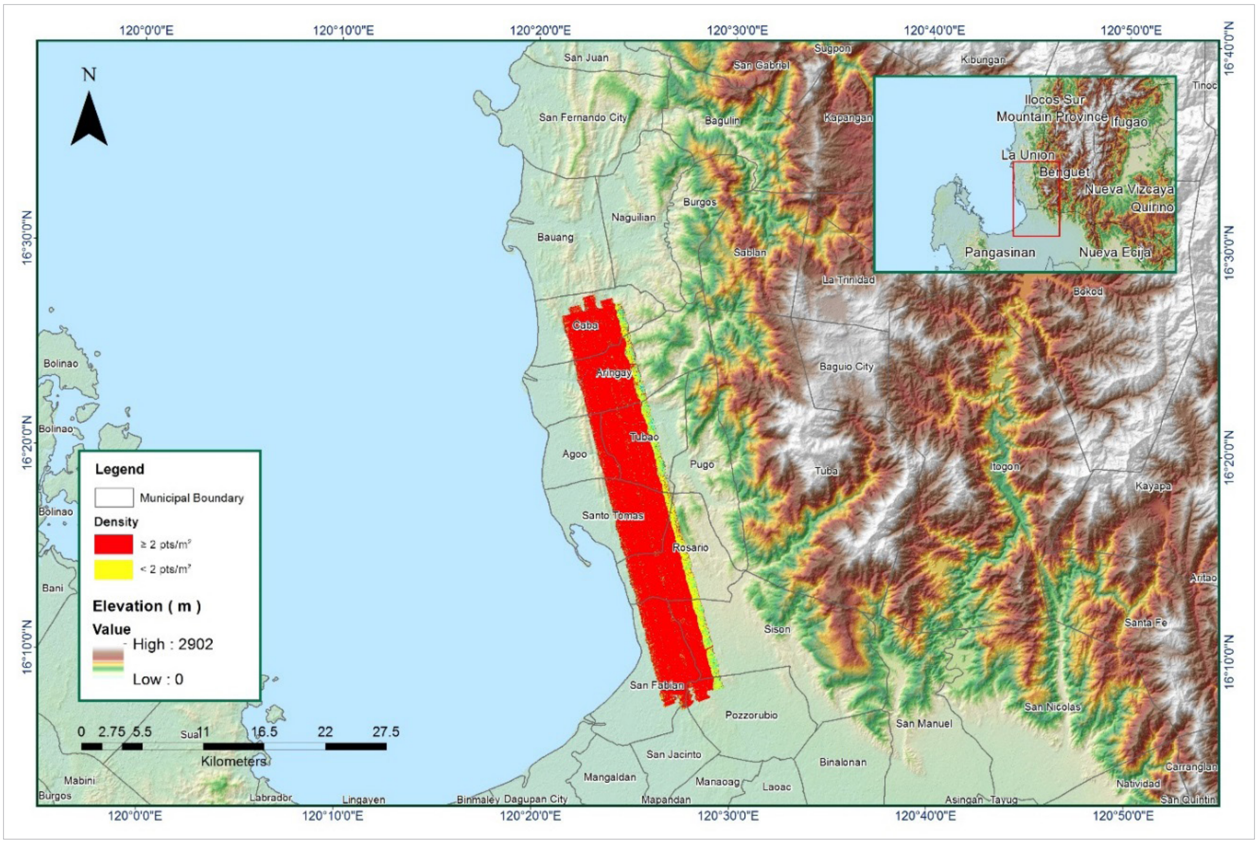


Figure 1.4.6 Density map of merged LIDAR data

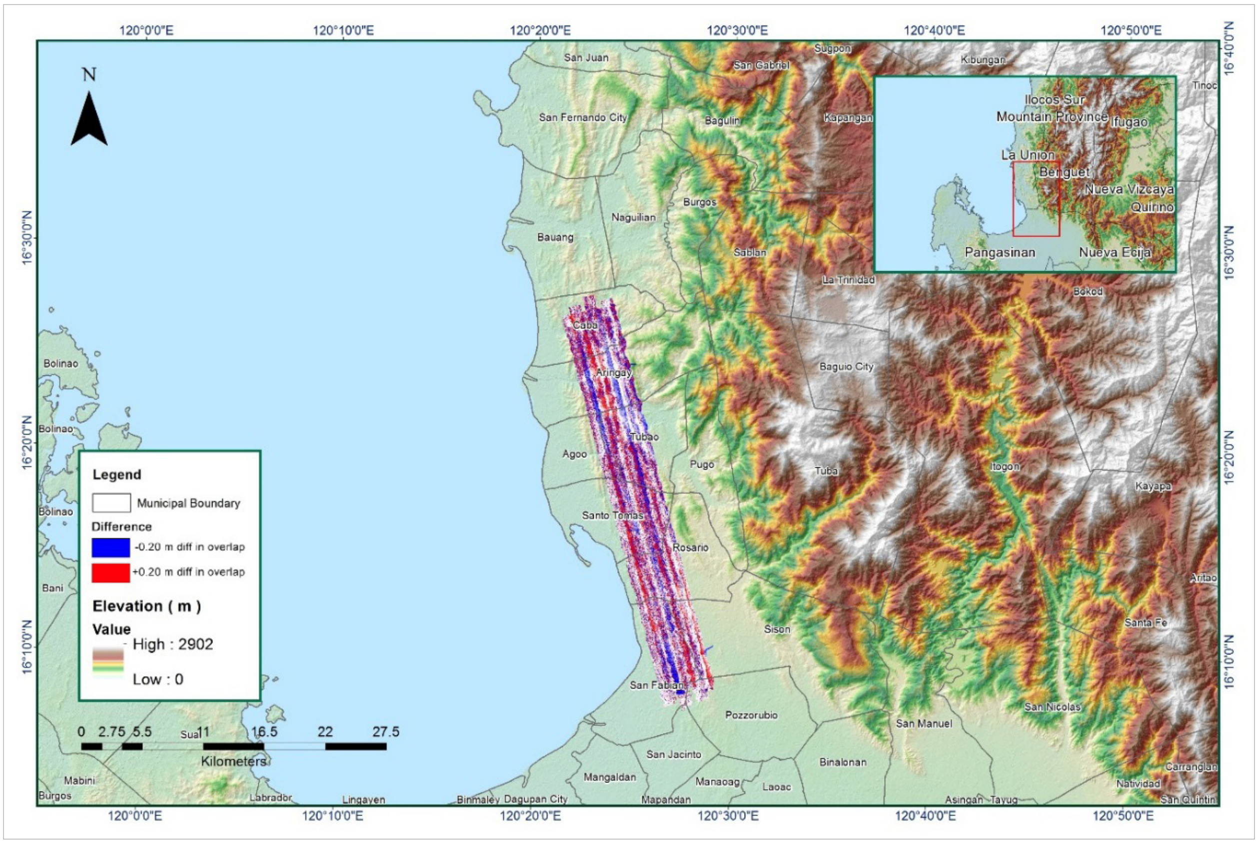


Figure 1.4.7 Elevation difference between flight lines

Table A-8.5. Mission Summary Report for Mission Blk10H

Flight Area	Clark Reflights
Mission Name	Agno6B_additional
Inclusive Flights	2298A
Range data size	8.18 GB
Base data size	19.3 MB
POS	216 MB
Image	NA
Transfer date	February 12, 2015
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)	1.4278
RMSE for East Position (<4.0 cm)	2.3149
RMSE for Down Position (<8.0 cm)	4.7563
Boresight correction stdev (<0.001deg)	0.000494
IMU attitude correction stdev (<0.001deg)	0.001187
GPS position stdev (<0.01m)	0.0095
Minimum % overlap (>25)	43.07%
Ave point cloud density per sq.m. (>2.0)	3.24
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	26
Maximum Height	125.55 m
Minimum Height	3.55 m
Classification (# of points)	
Ground	10,841,036
Low vegetation	15,562,872
Medium vegetation	4,109,095
High vegetation	947,413
Building	212,547
Orthophoto	Yes
Processed by	Engr. Jommer Medina, Engr. Melanie Hingpit, Engr. Gladys Mae Apat

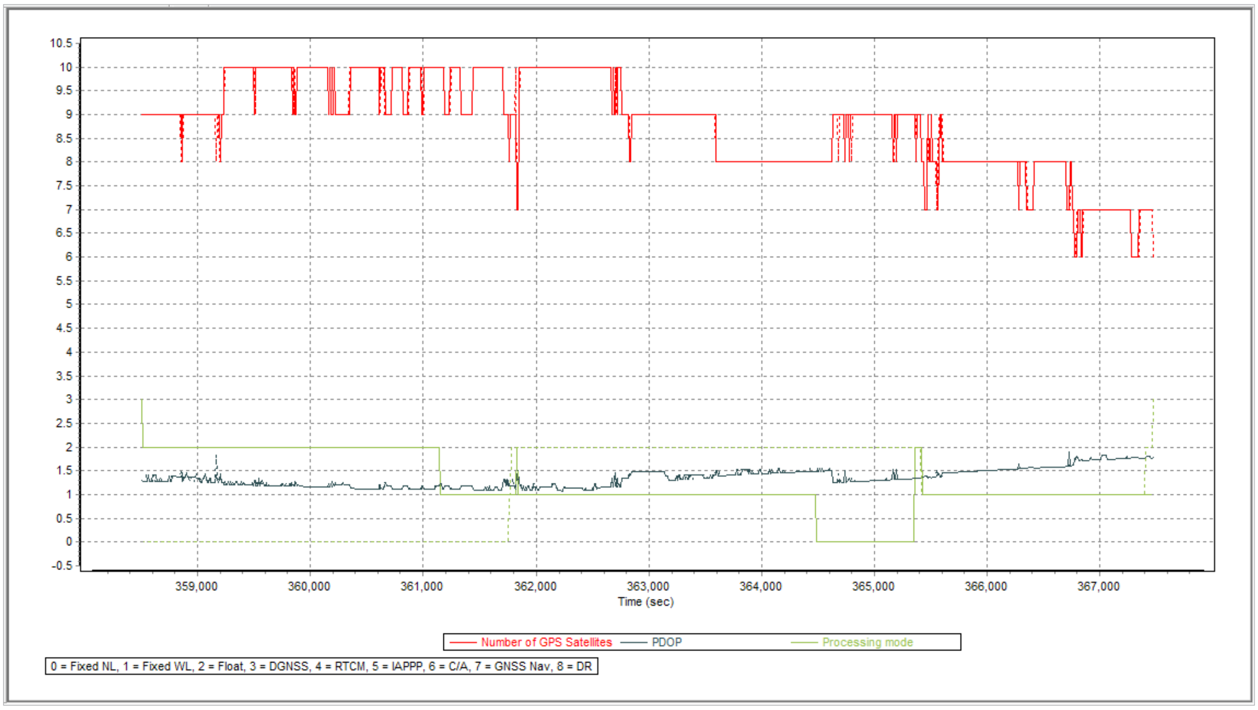


Figure 1.5.1 Solution Status

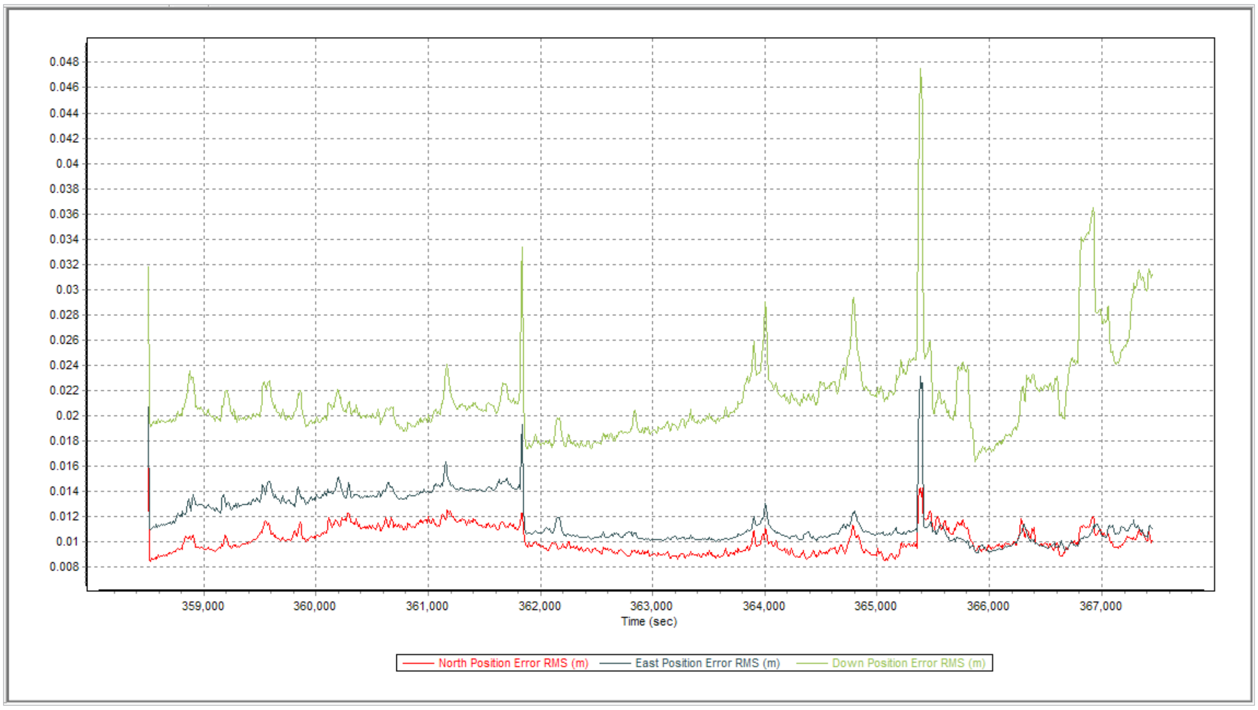


Figure 1.5.2 Smoothed Performance Metric Parameters

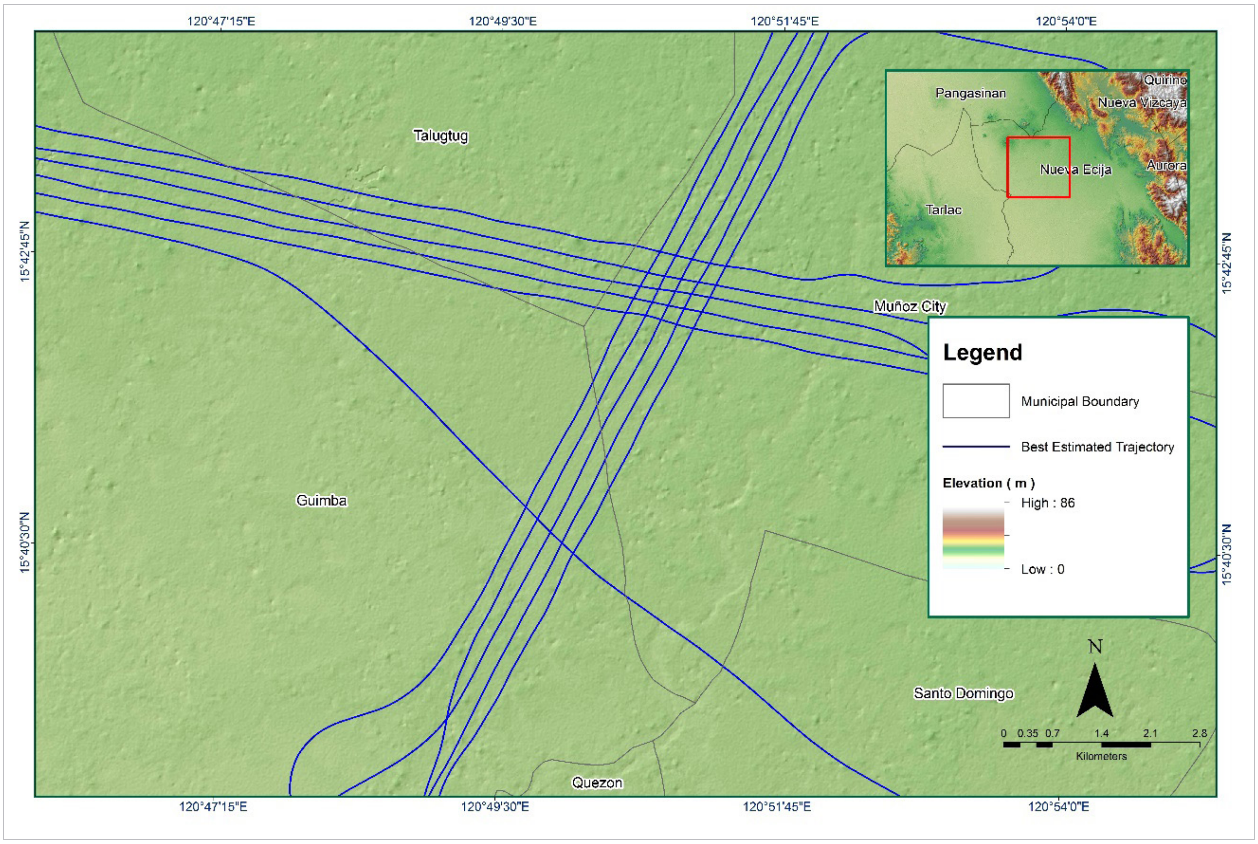


Figure 1.5.3 Best Estimated Trajectory

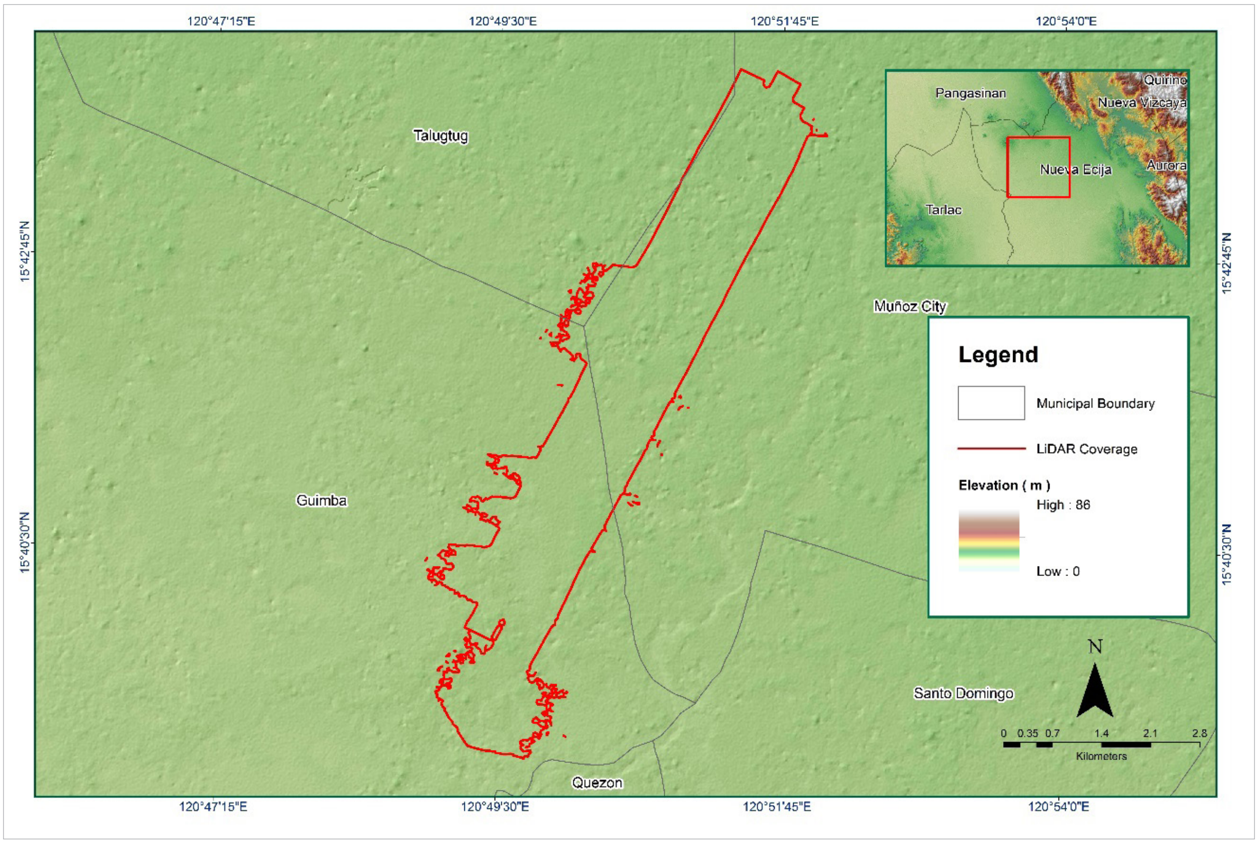


Figure 1.5.4 Coverage of LIDAR data

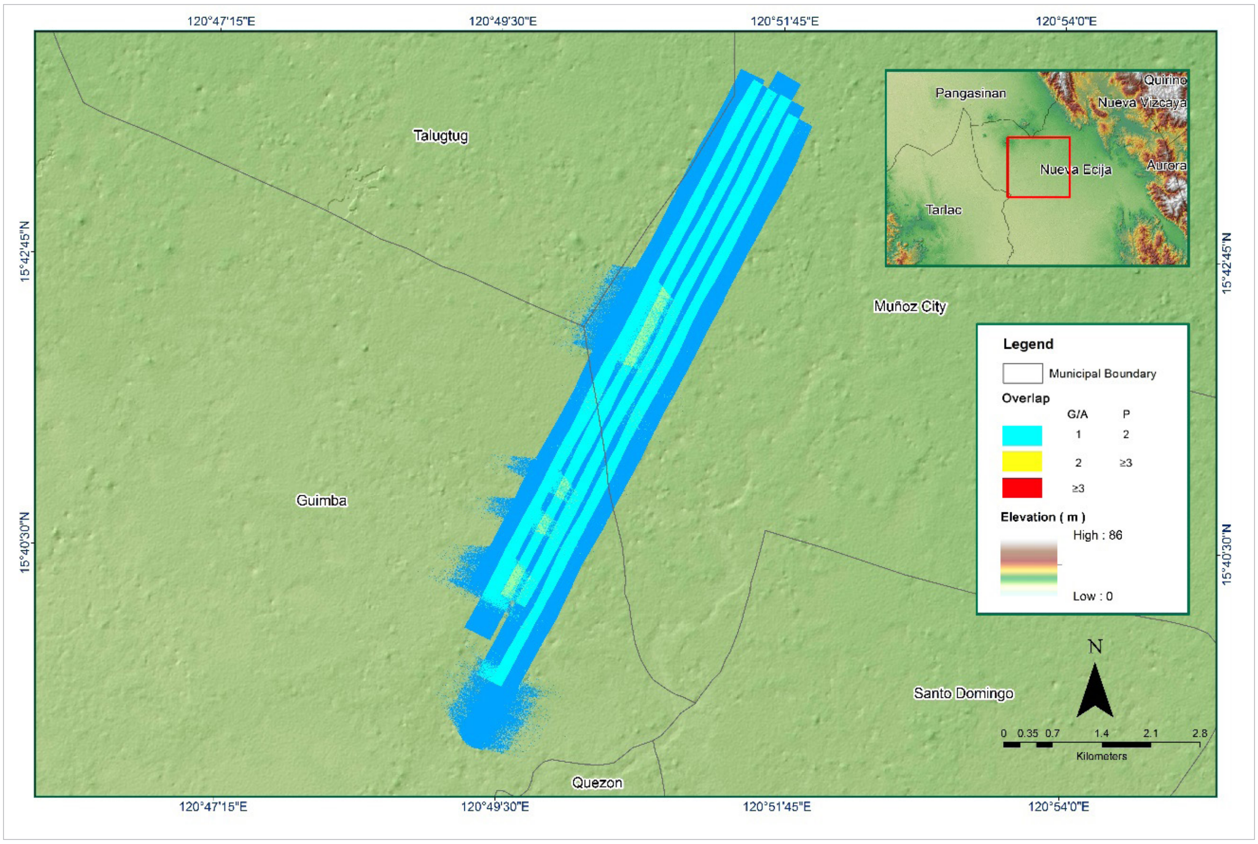


Figure 1.5.5 Image of Data Overlap

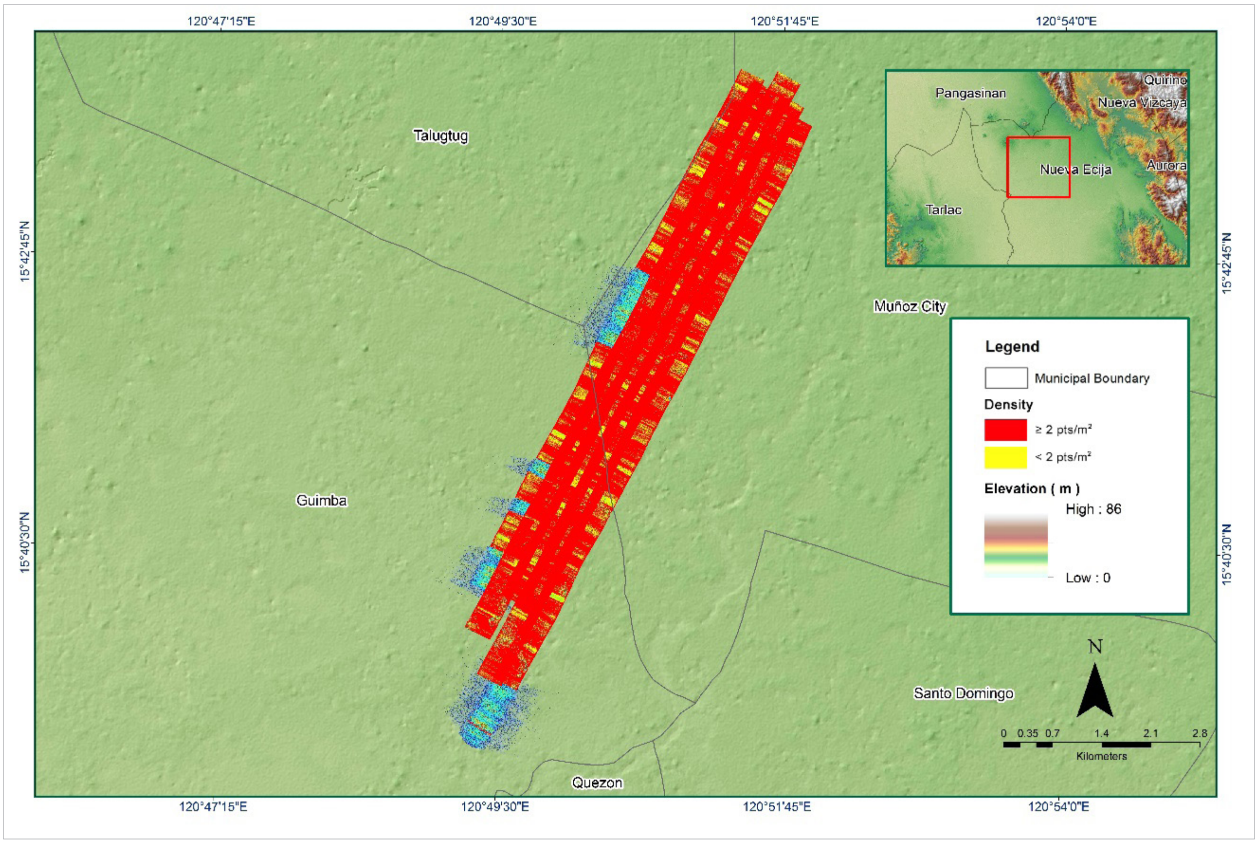


Figure 1.5.6 Density map of merged LIDAR data

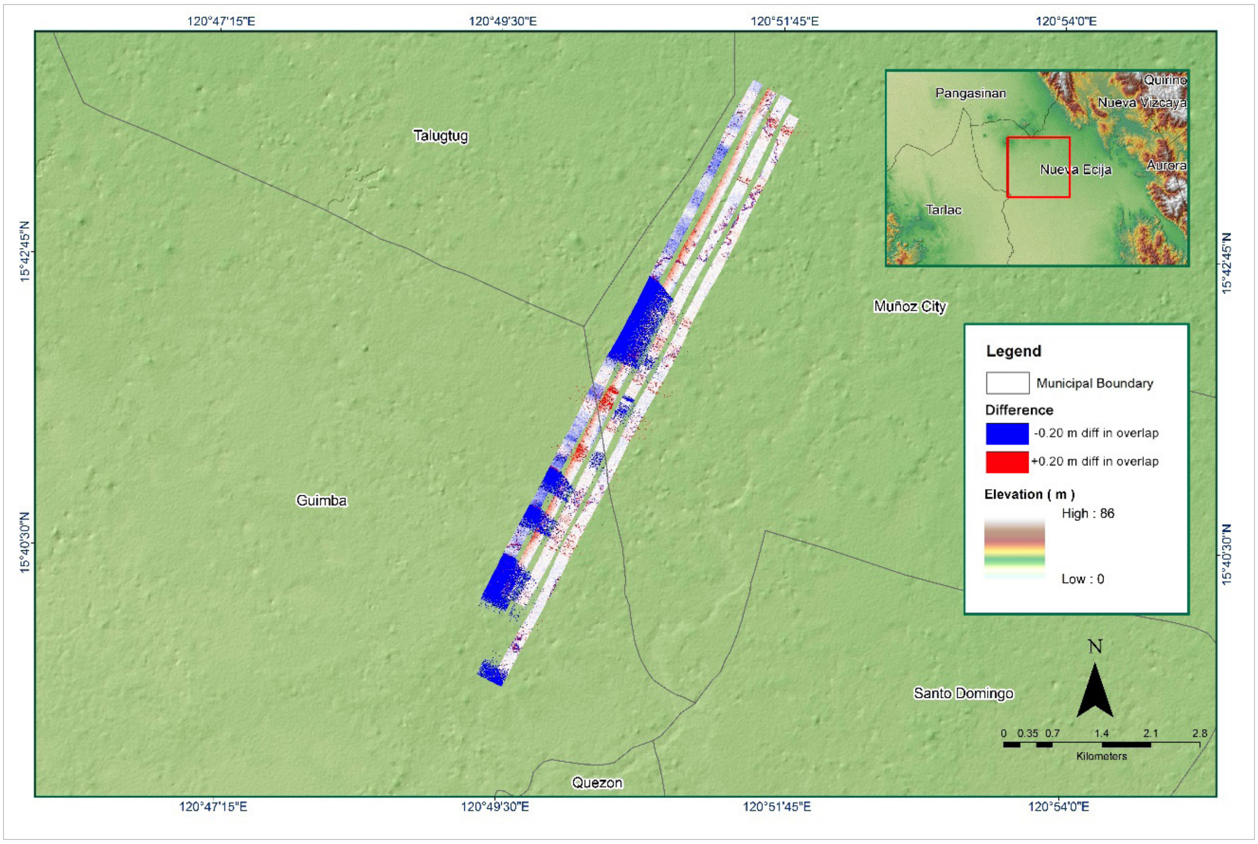


Figure 1.5.7 Elevation difference between flight lines

Table A-8.6. Mission Summary Report for Mission Agno6C_additional

Flight Area	Clark Reflights
Mission Name	Agno6C_additional
Inclusive Flights	2298A
Range data size	8.18 GB
POS data size	216 MB
Base data size	19.3 MB
Image	NA
Transfer date	February 12, 2015
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)	1.4278
RMSE for East Position (<4.0 cm)	2.3149
RMSE for Down Position (<8.0 cm)	4.7563
Boresight correction stdev (<0.001deg)	0.000494
IMU attitude correction stdev (<0.001deg)	0.001187
GPS position stdev (<0.01m)	0.0095
Minimum % overlap (>25)	48.06%
Ave point cloud density per sq.m. (>2.0)	3.327008
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	40
Maximum Height	122.22 m
Minimum Height	81.88 m
Classification (# of points)	
Ground	16,341,019
Low vegetation	23,033,794
Medium vegetation	8,231,584
High vegetation	1,890,299
Building	230,684
Orthophoto	No
Processed By	Engr. Jommer Medina, Engr. Harmond Santos, Engr. Gladys Mae Apat

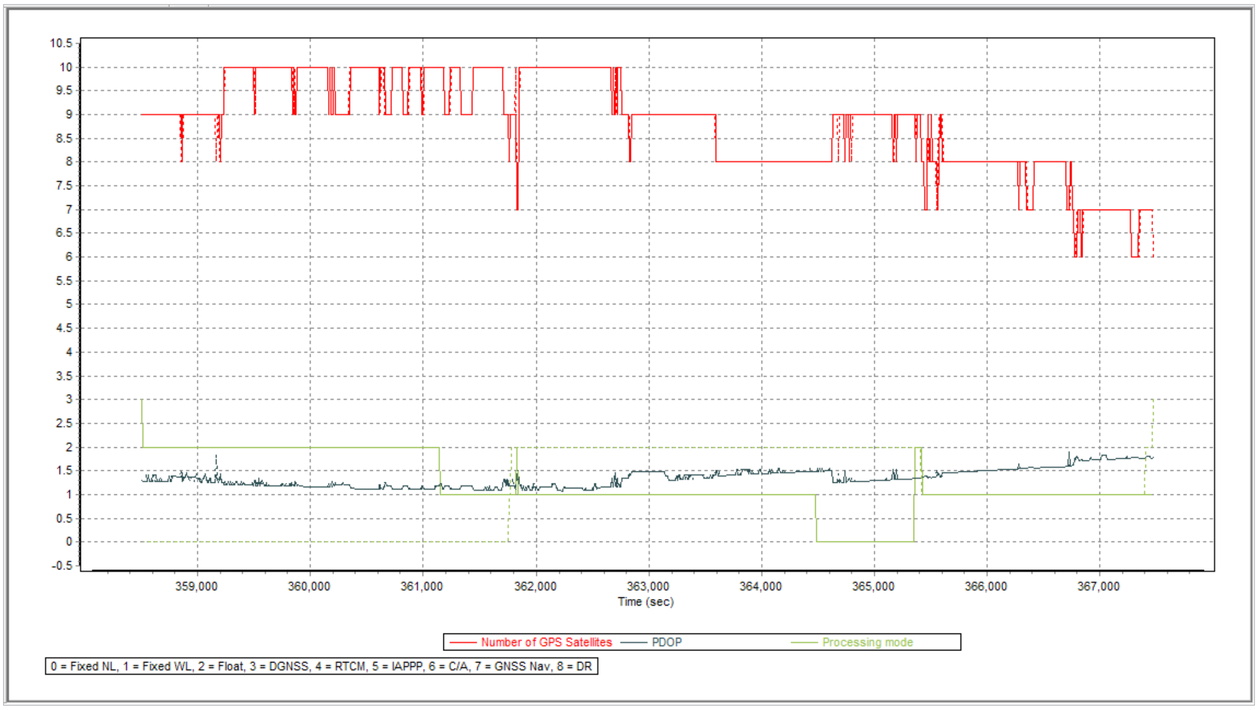


Figure 1.6.1 Solution Status

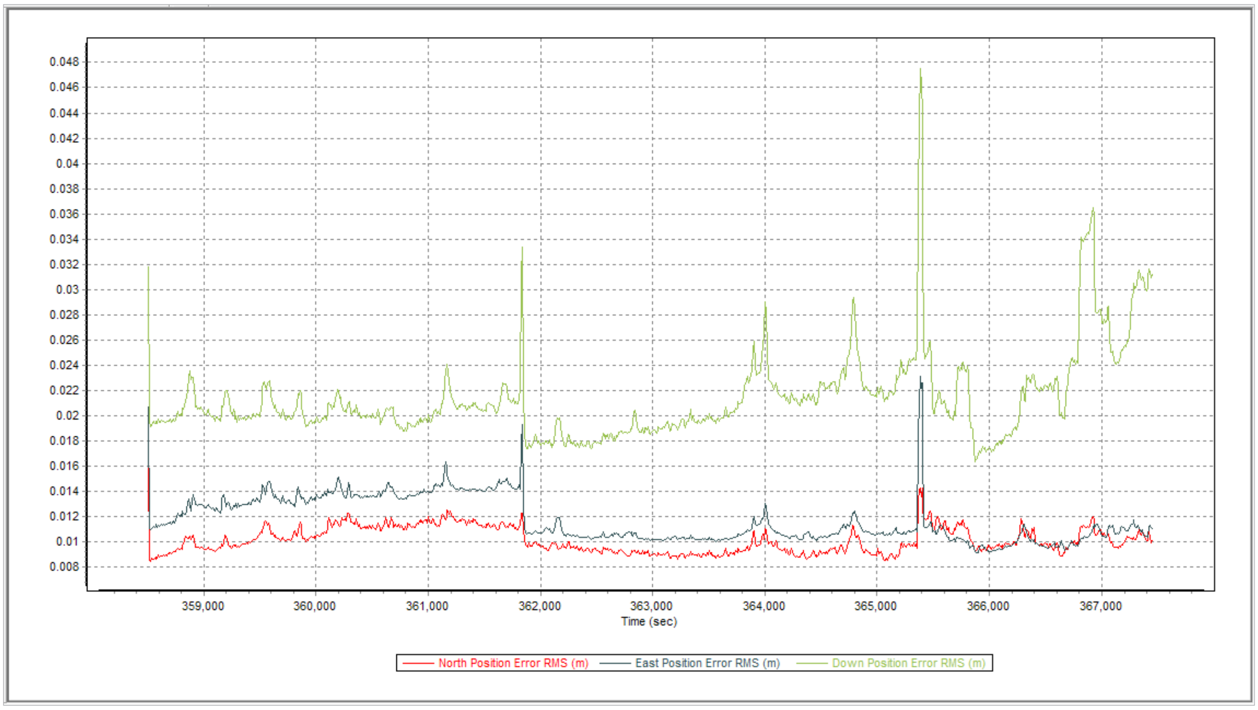


Figure 1.6.2 Smoothed Performance Metric Parameters

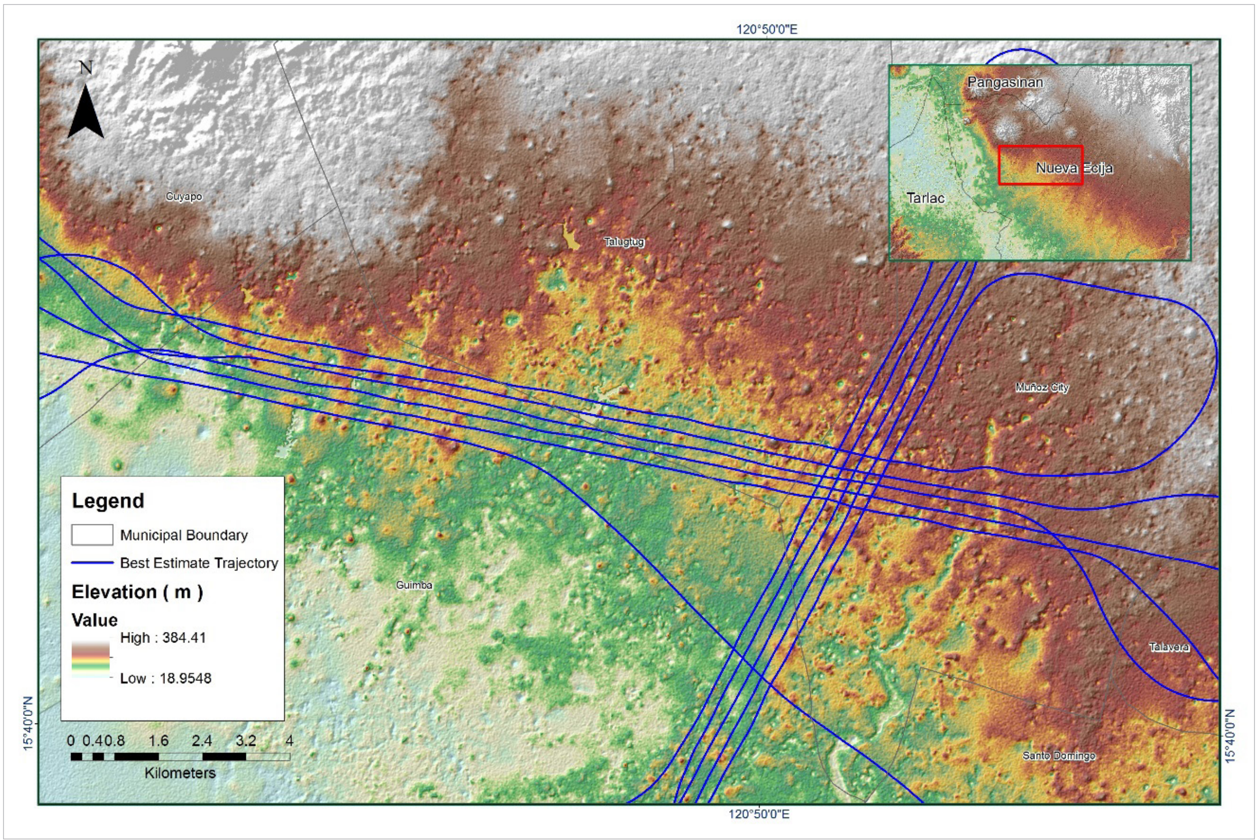


Figure 1.6.3 Best Estimated Trajectory

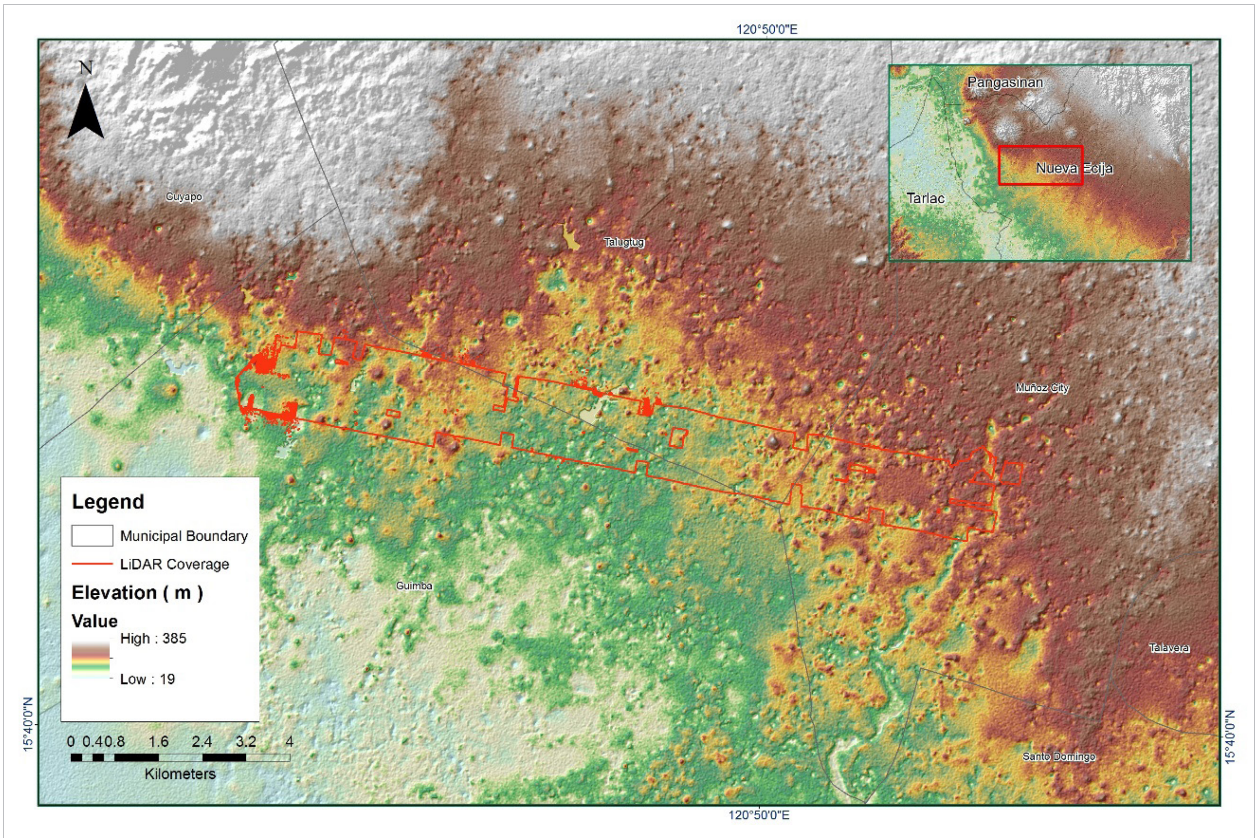


Figure 1.6.4 Coverage of LIDAR data

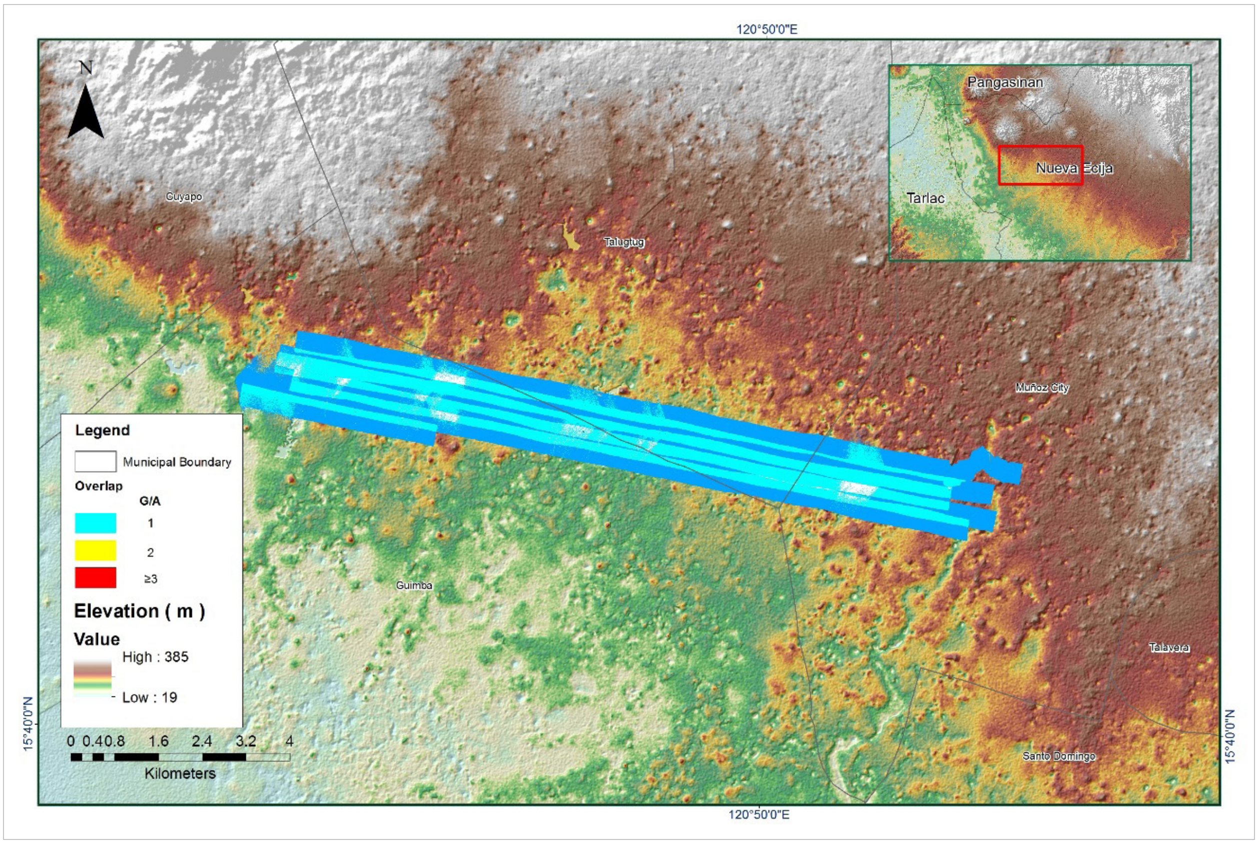


Figure 1.6.5 Image of Data Overlap

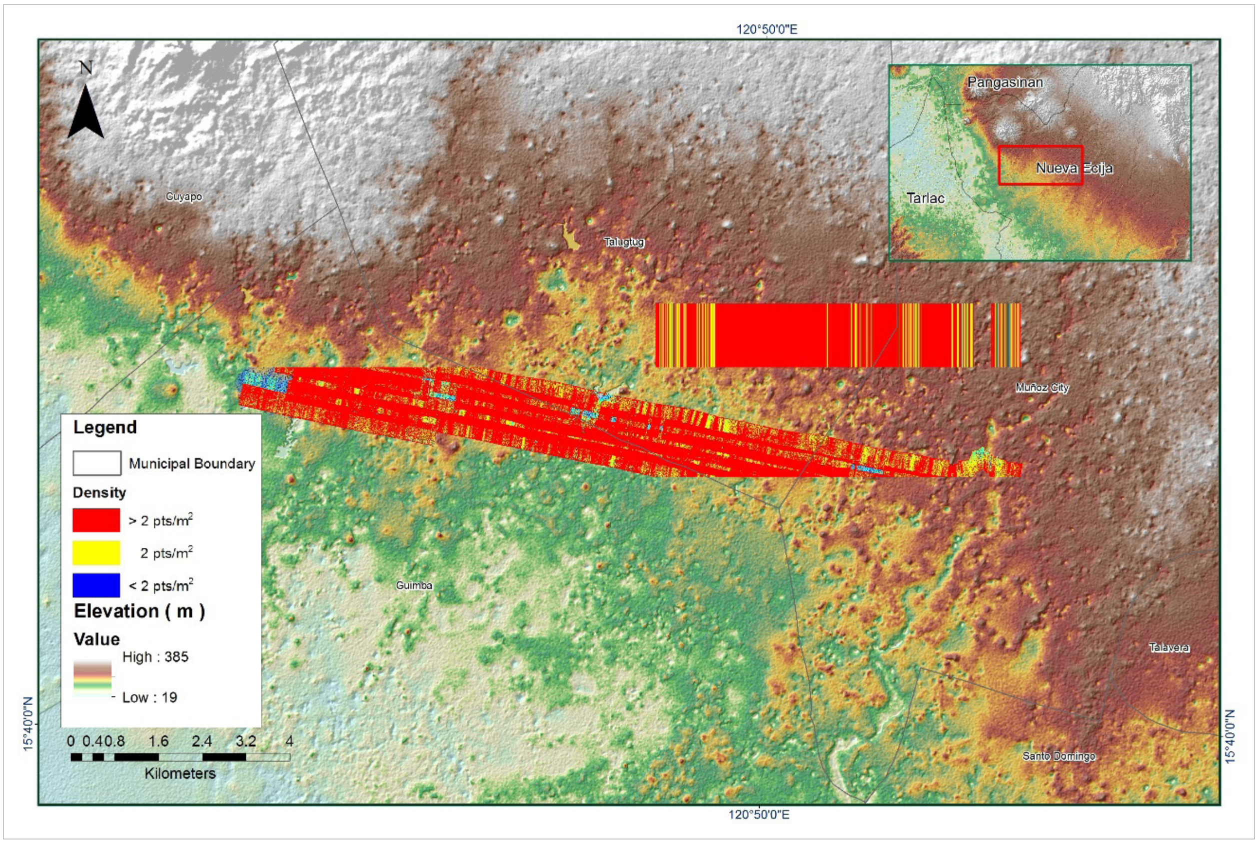


Figure 1.6.6 Density map of merged LIDAR data

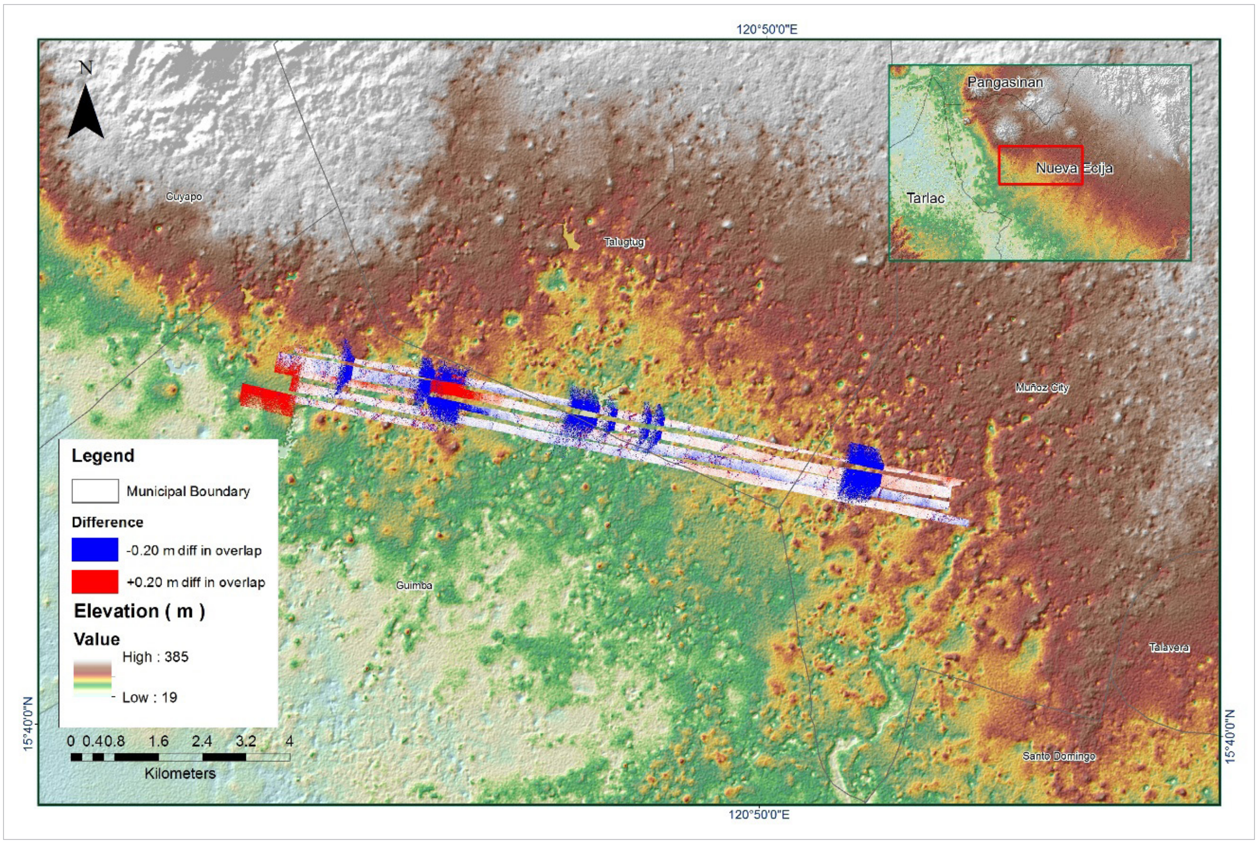


Figure 1.6.7 Elevation difference between flight lines

Table A-8.7. Mission Summary Report for Pam_Nej_reflights_Blk1B

Flight Area	Pam_Nej Reflights
Mission Name	Pam_Nej_reflights_Blk1B
Inclusive Flights	8416AC
Mission Name	3NEJS1091A
Range data size	6.85 GB
Base data size	146 MB
POS	210 MB
Image	26.3 GB
Transfer date	April 22, 2016
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)	1.0009
RMSE for East Position (<4.0 cm)	1.1108
RMSE for Down Position (<8.0 cm)	2.4128
Boresight correction stdev (<0.001deg)	0.000245
IMU attitude correction stdev (<0.001deg)	0.000539
GPS position stdev (<0.01m)	0.0099
Minimum % overlap (>25)	23.80%
Ave point cloud density per sq.m. (>2.0)	4.17
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	74
Maximum Height	325.04 m
Minimum Height	107.27 m
Classification (# of points)	
Ground	45,354,091
Low vegetation	54,538,681
Medium vegetation	28,028,986
High vegetation	19,680,709
Building	675,521
Orthophoto	No
Processed by	Engr. Analyn Naldo, Aljon Rie Araneta, Vincent Louise Azucena

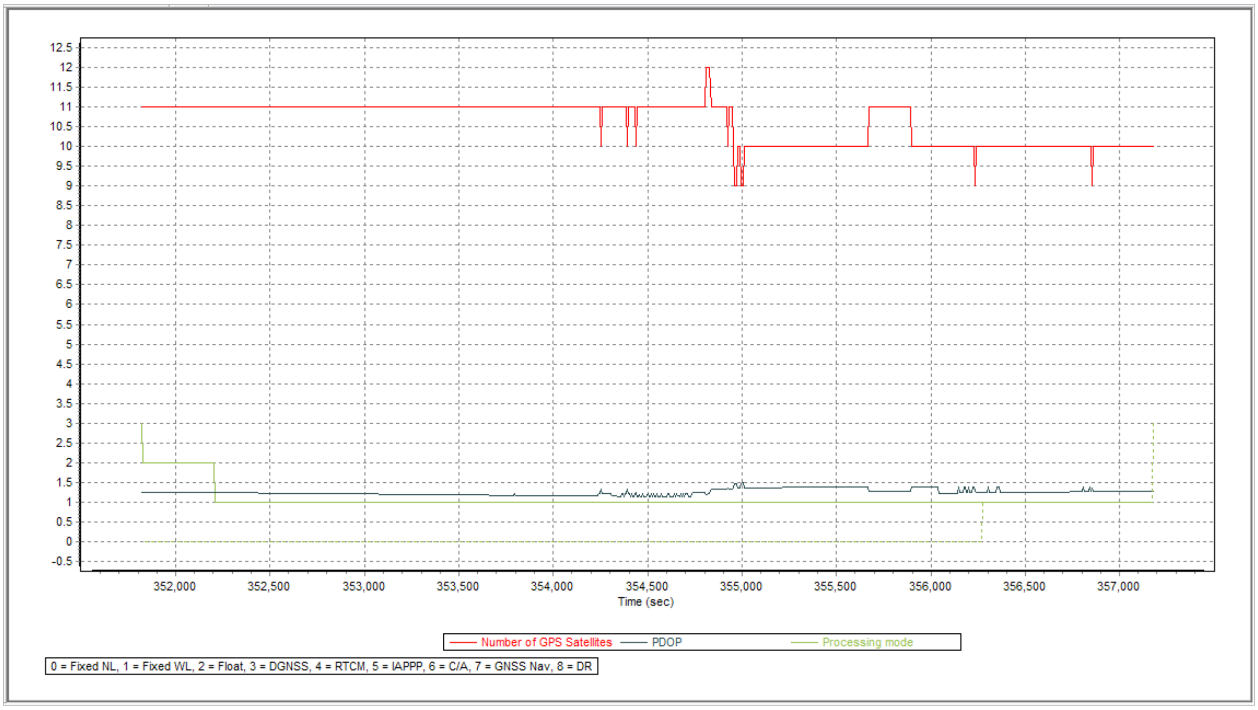


Figure 1.7.1 Solution Status

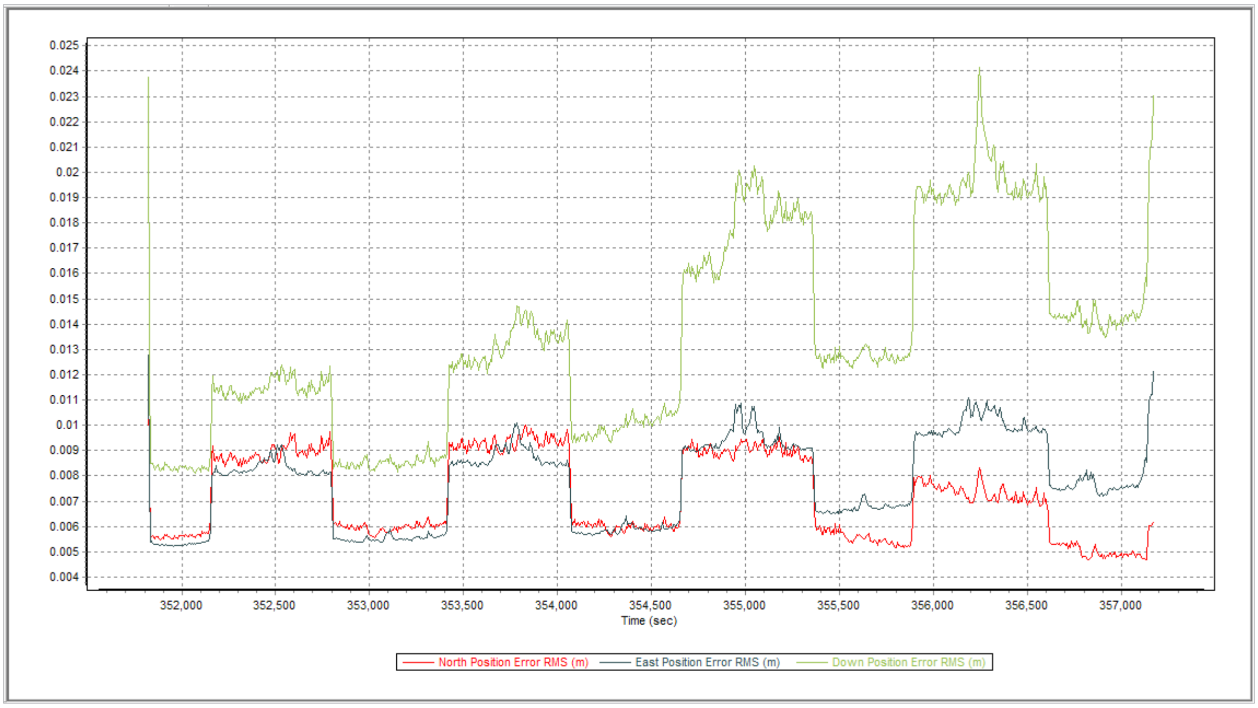


Figure 1.7.2 Smoothed Performance Metric Parameters

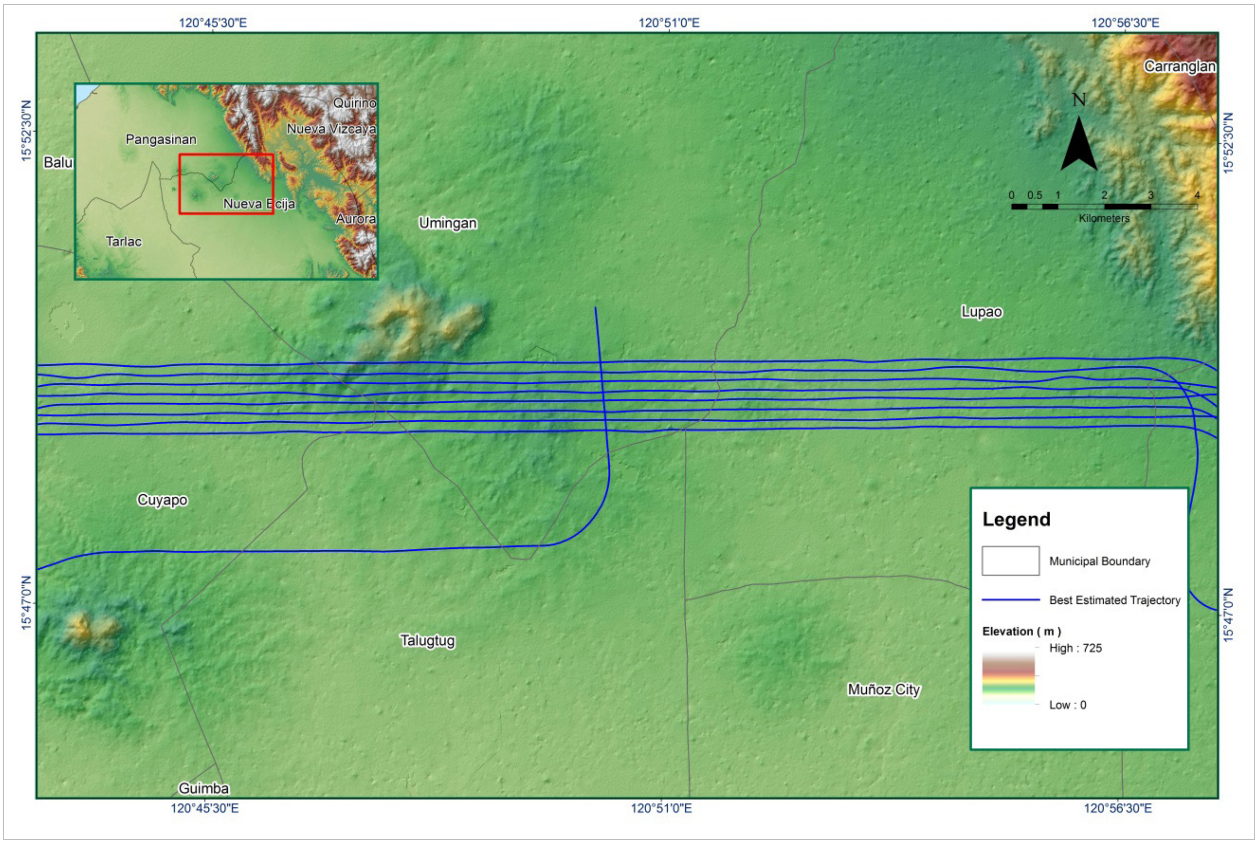


Figure 1.7.3 Best Estimated Trajectory

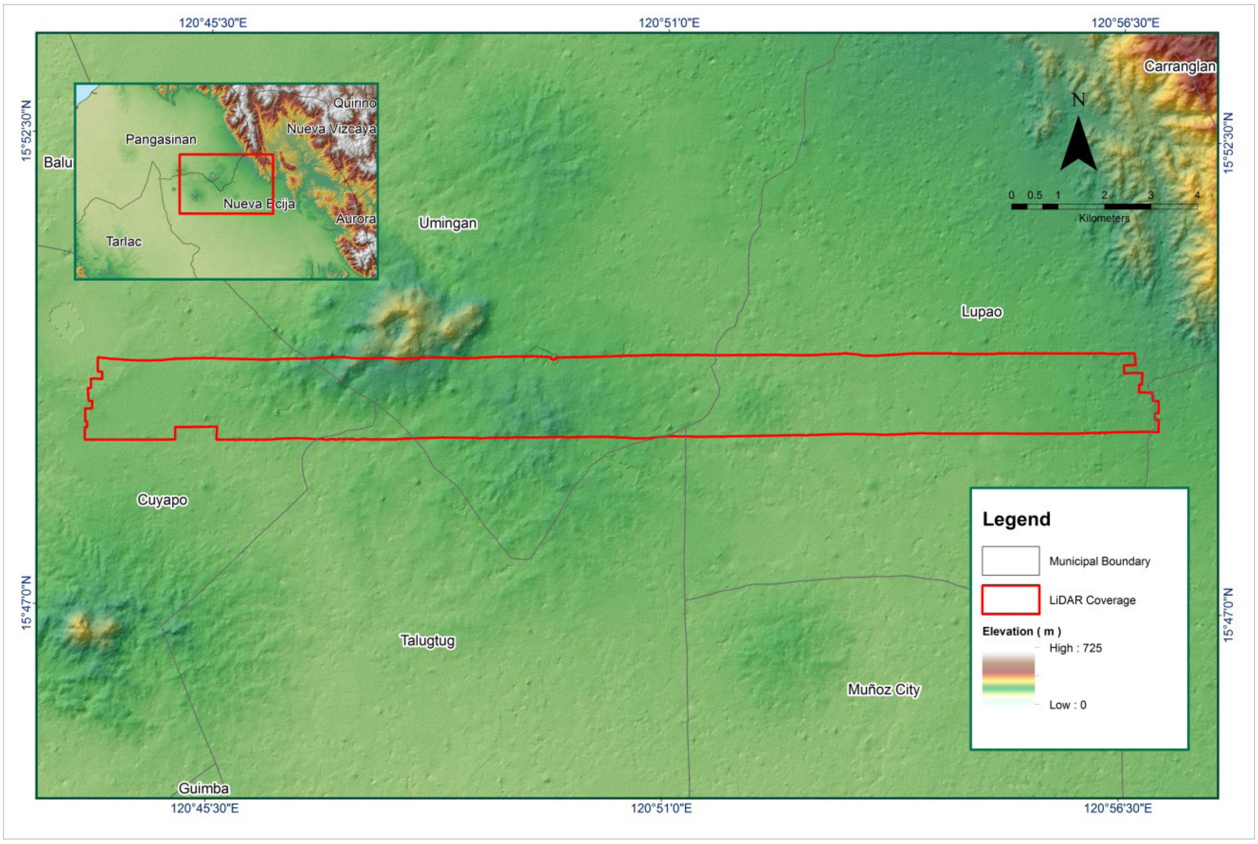


Figure 1.7.4 Coverage of LIDAR data

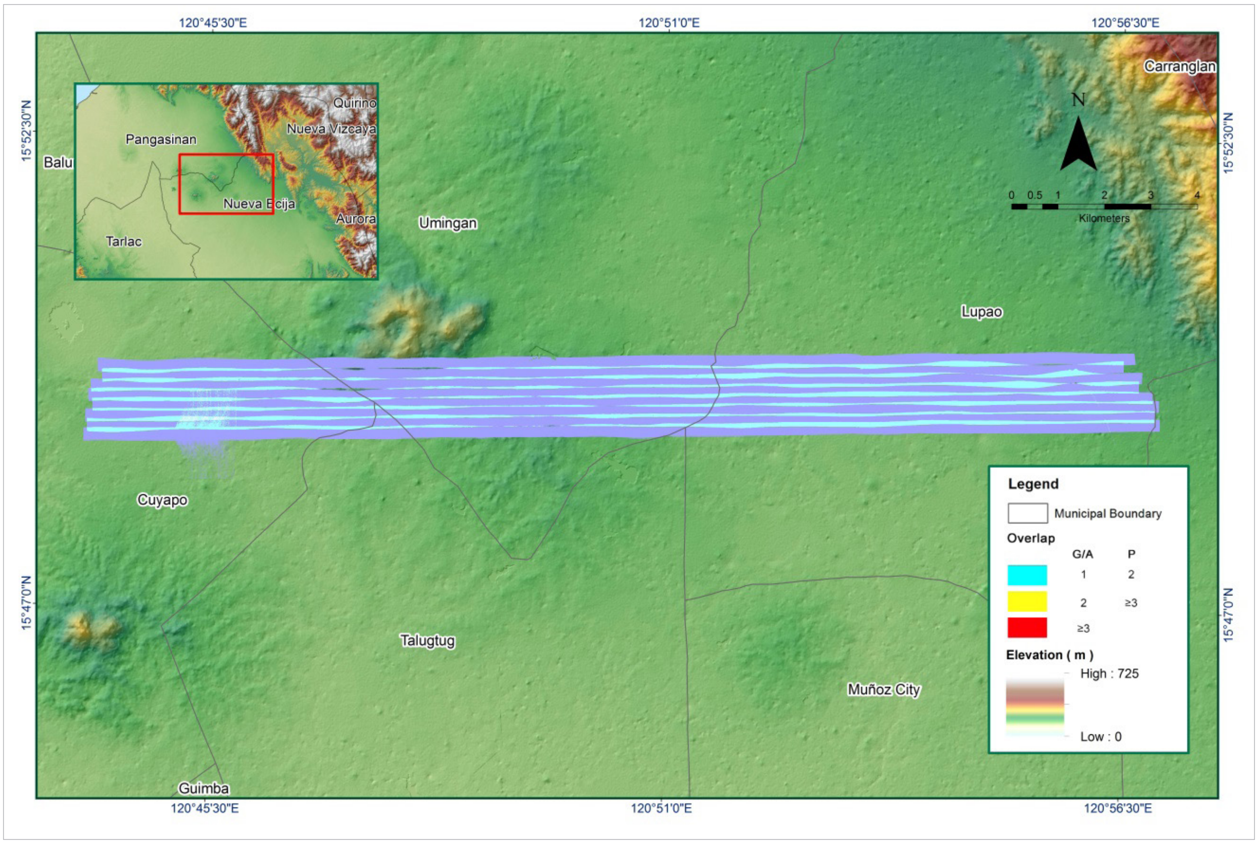


Figure 1.7.5 Image of Data Overlap

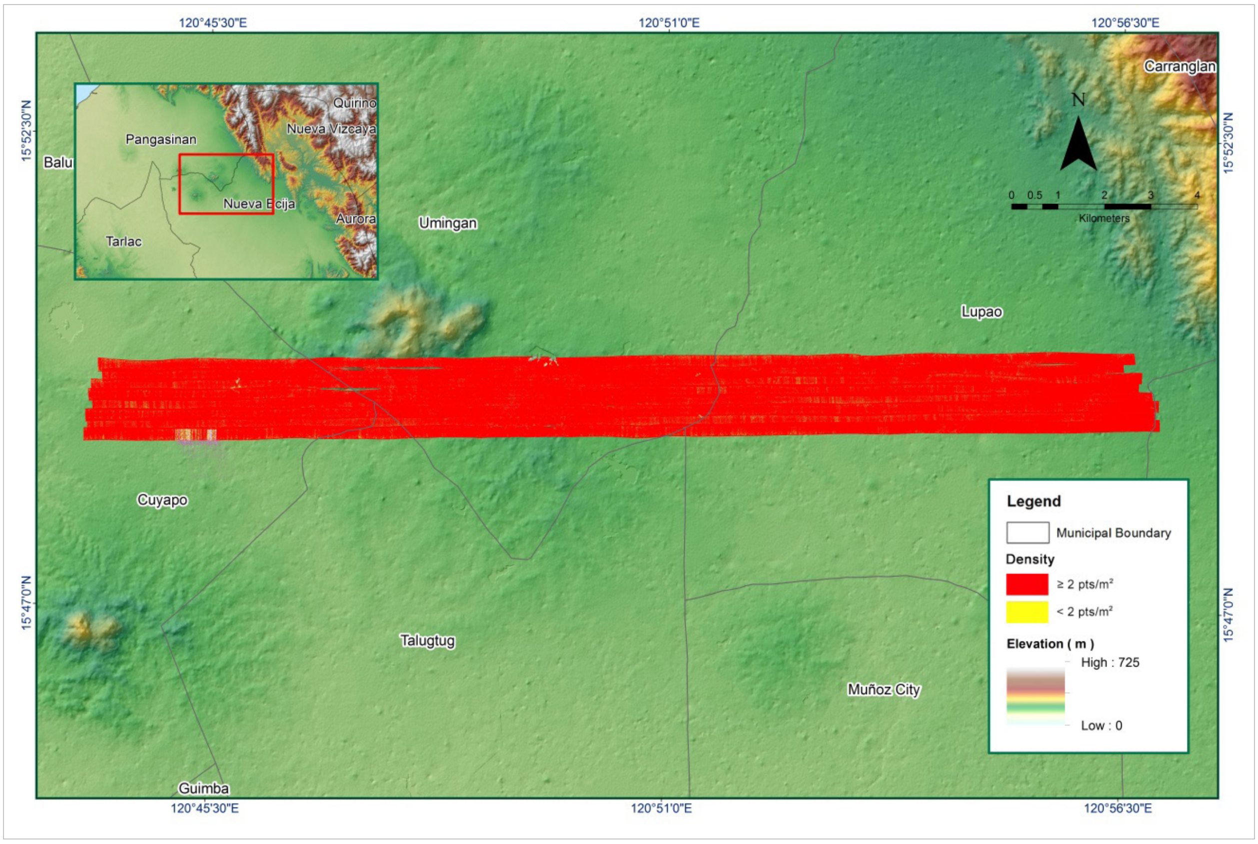


Figure 1.7.6 Density map of merged LIDAR data

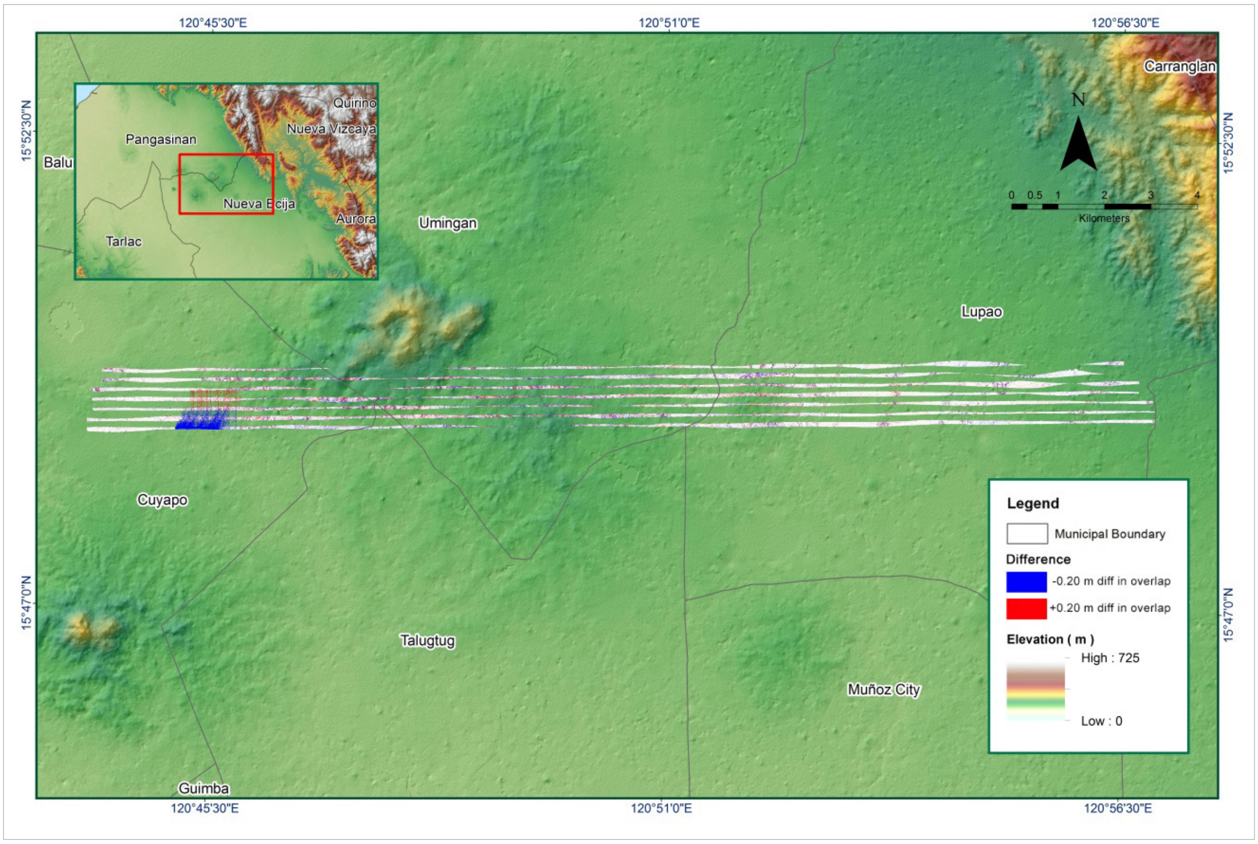


Figure 1.7.7 Elevation difference between flight lines

Table A-8.8. Mission Summary Report for Agno_Blk6I_reflight

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)	3.1666
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

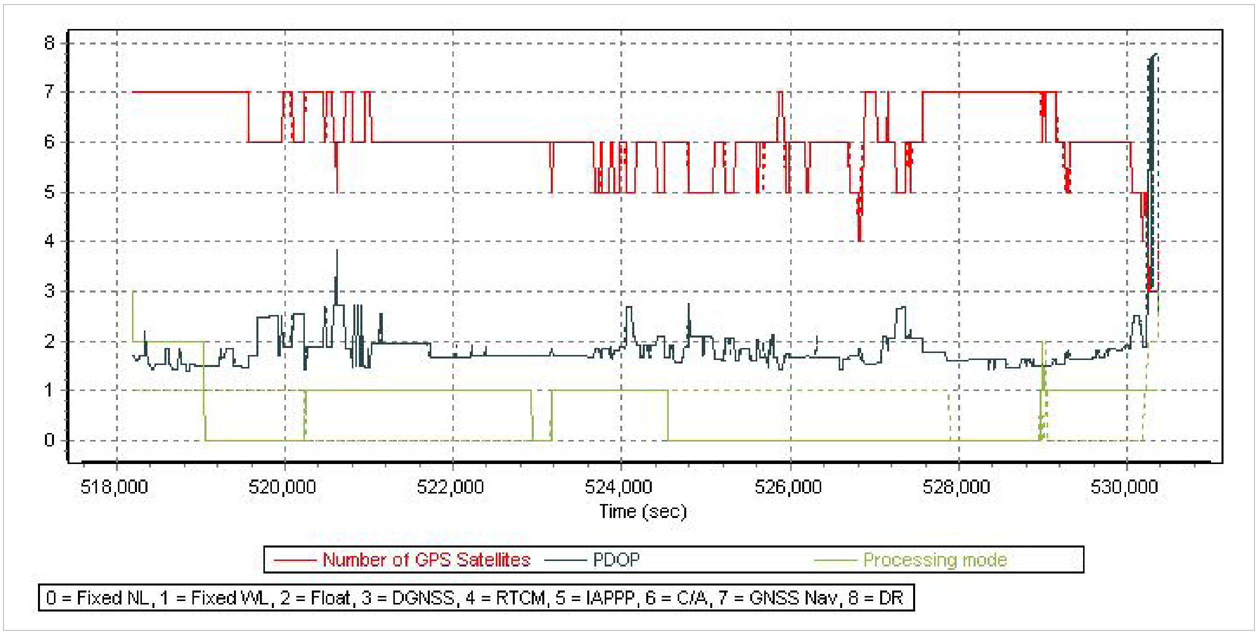


Figure 1.8.1 Solution Status

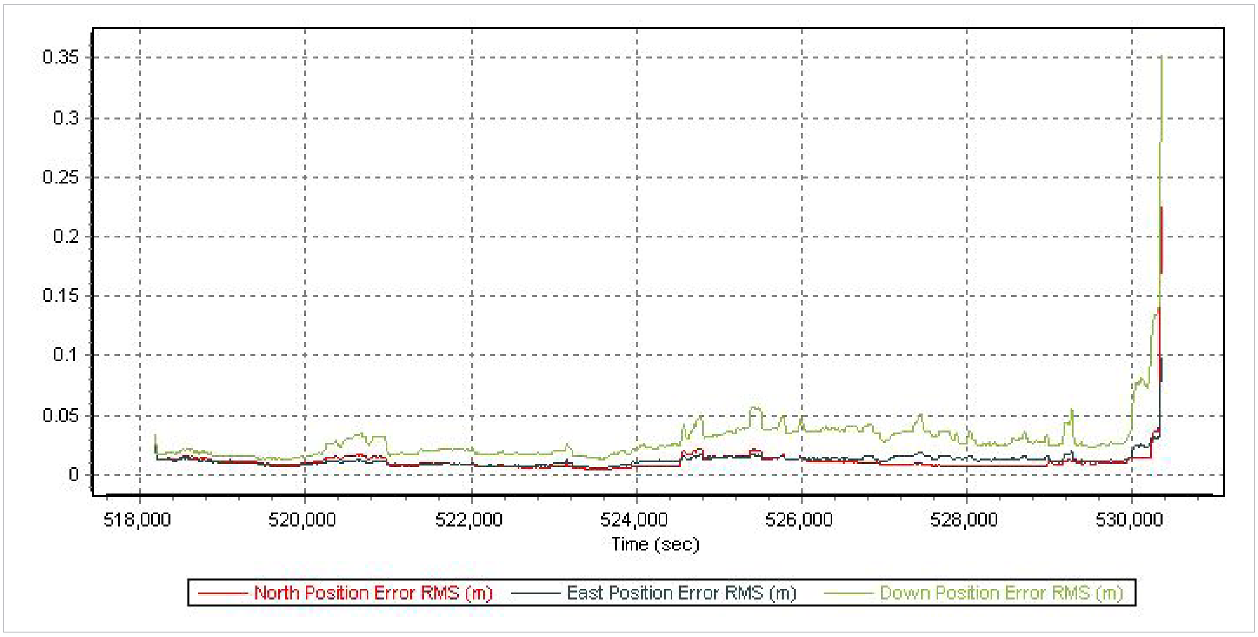


Figure 1.8.2 Smoothed Performance Metric Parameters

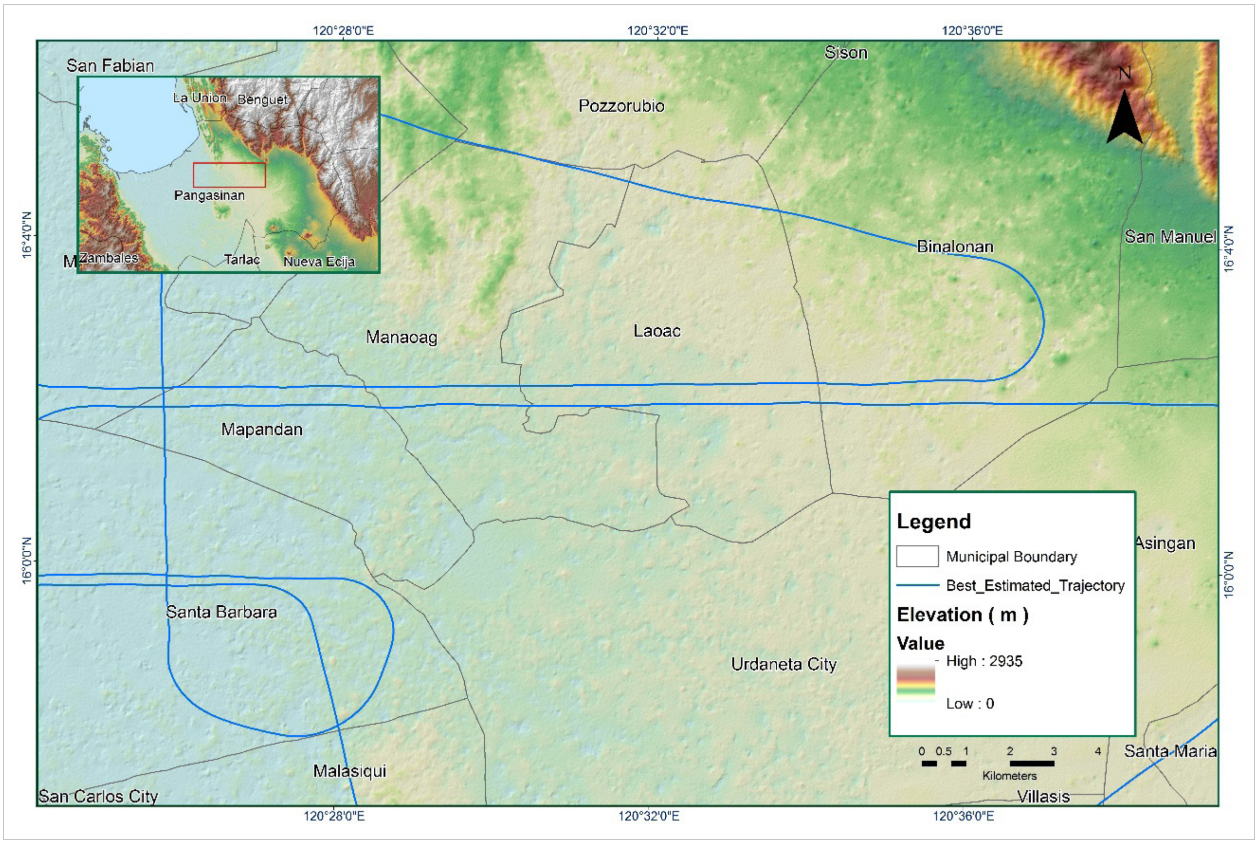


Figure 1.8.3 Best Estimated Trajectory

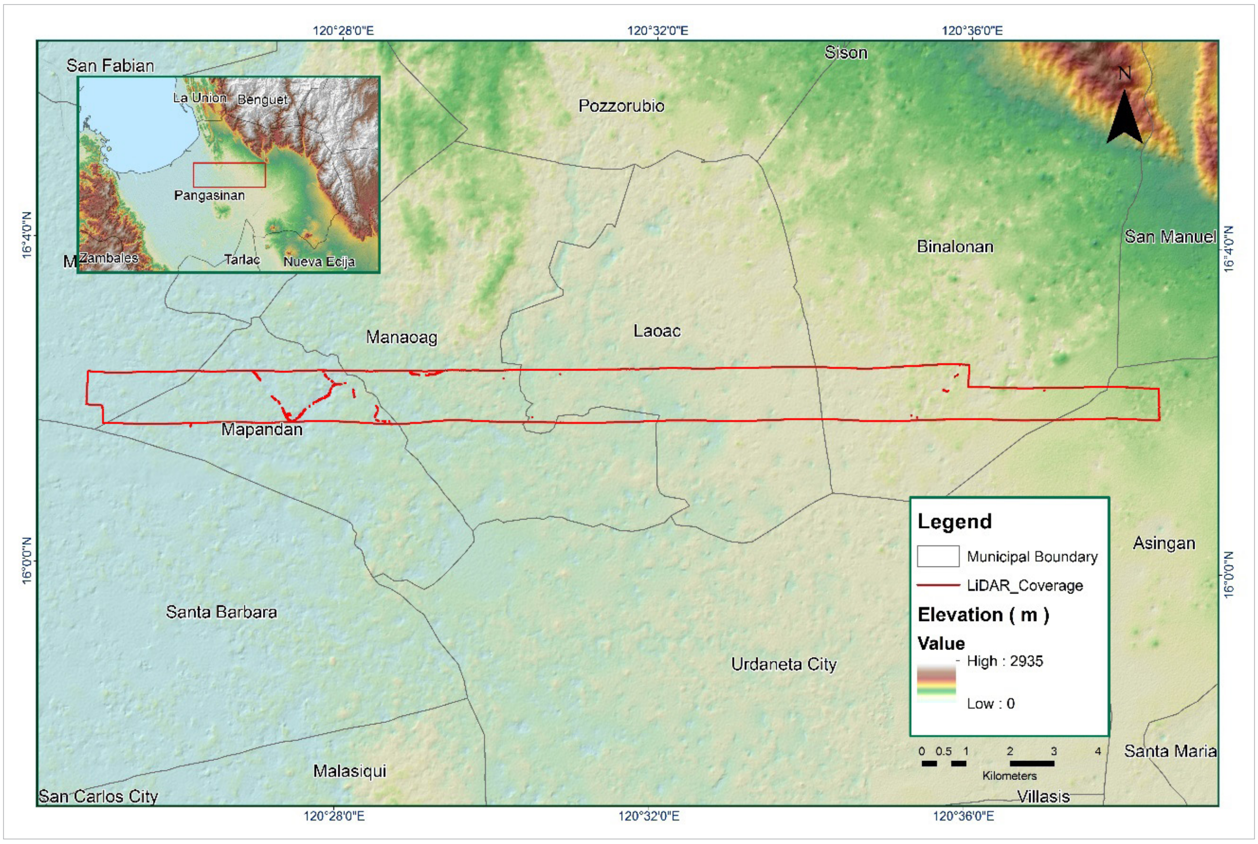


Figure 1.8.4 Coverage of LIDAR data

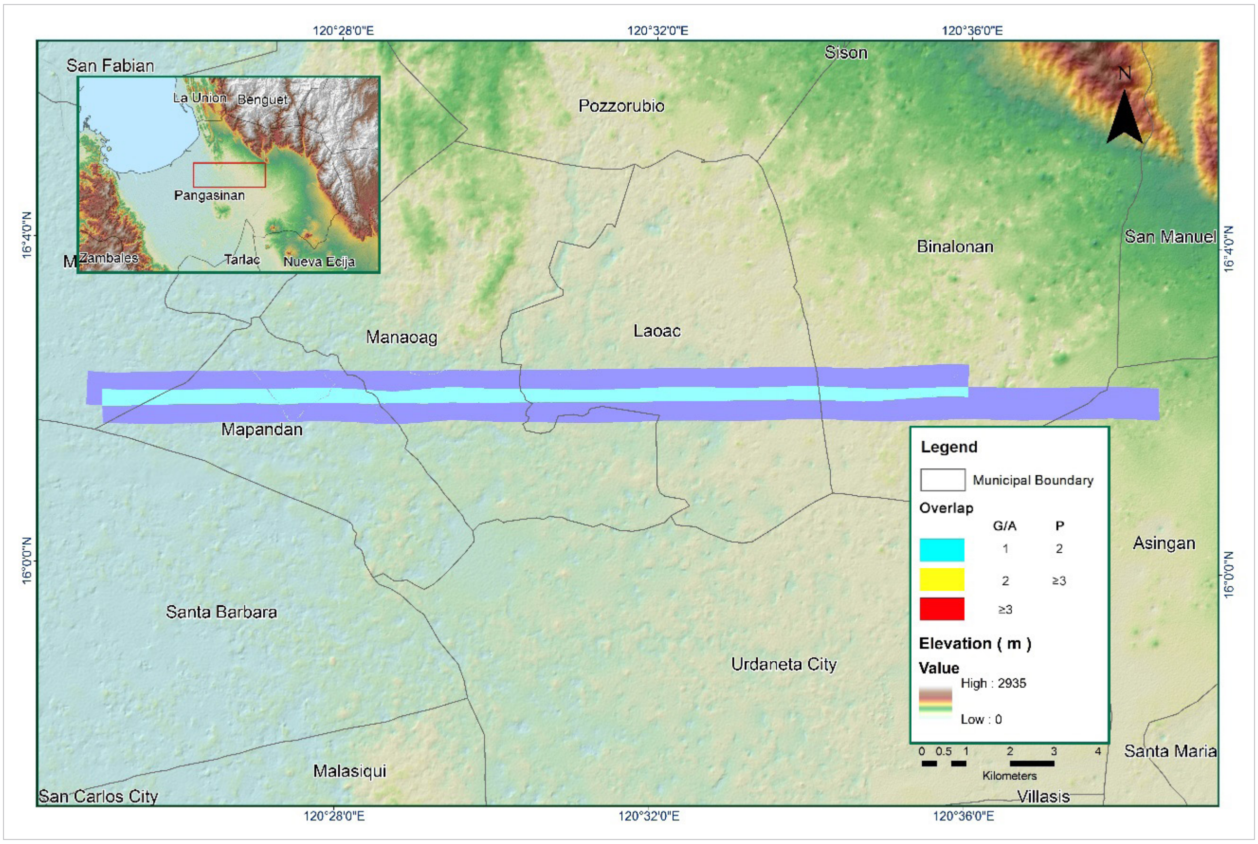


Figure 1.8.5 Image of Data Overlap

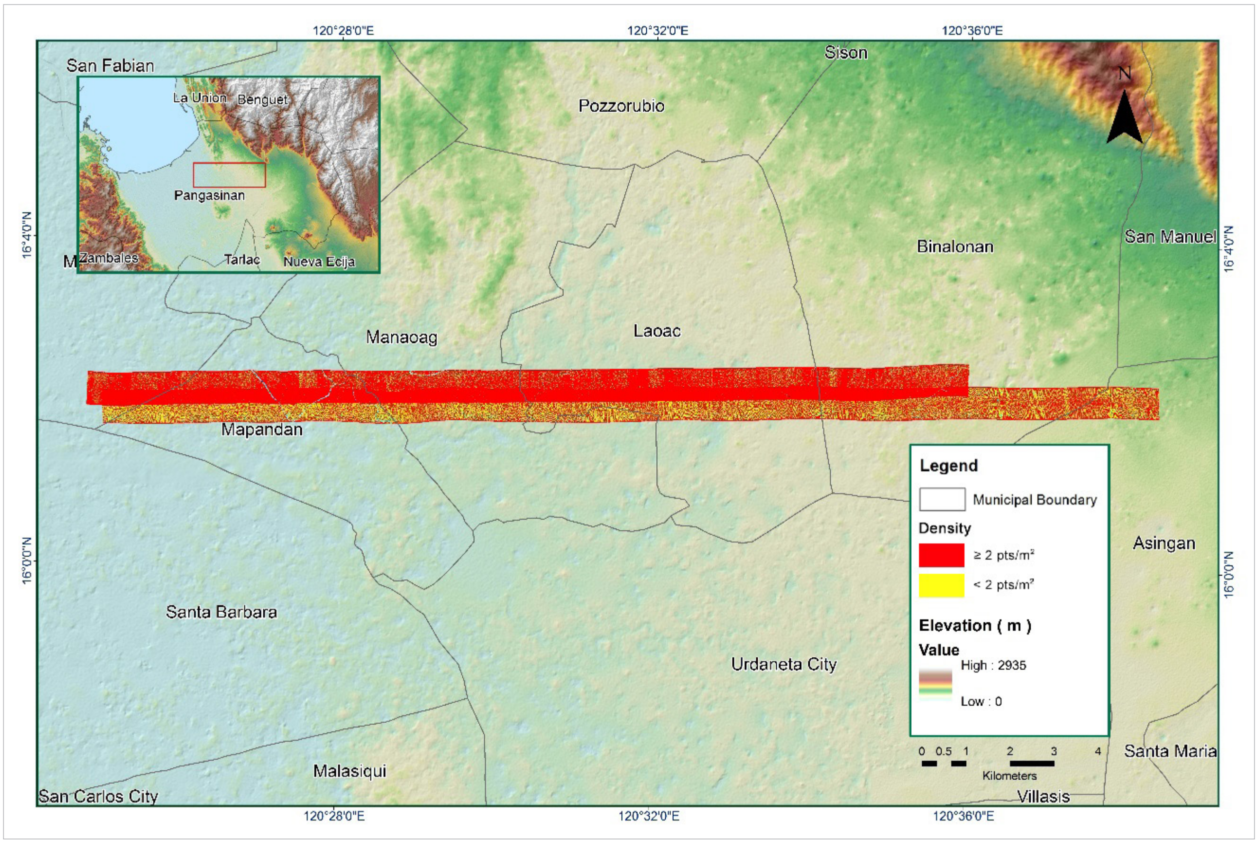


Figure 1.8.6 Density map of merged LIDAR data

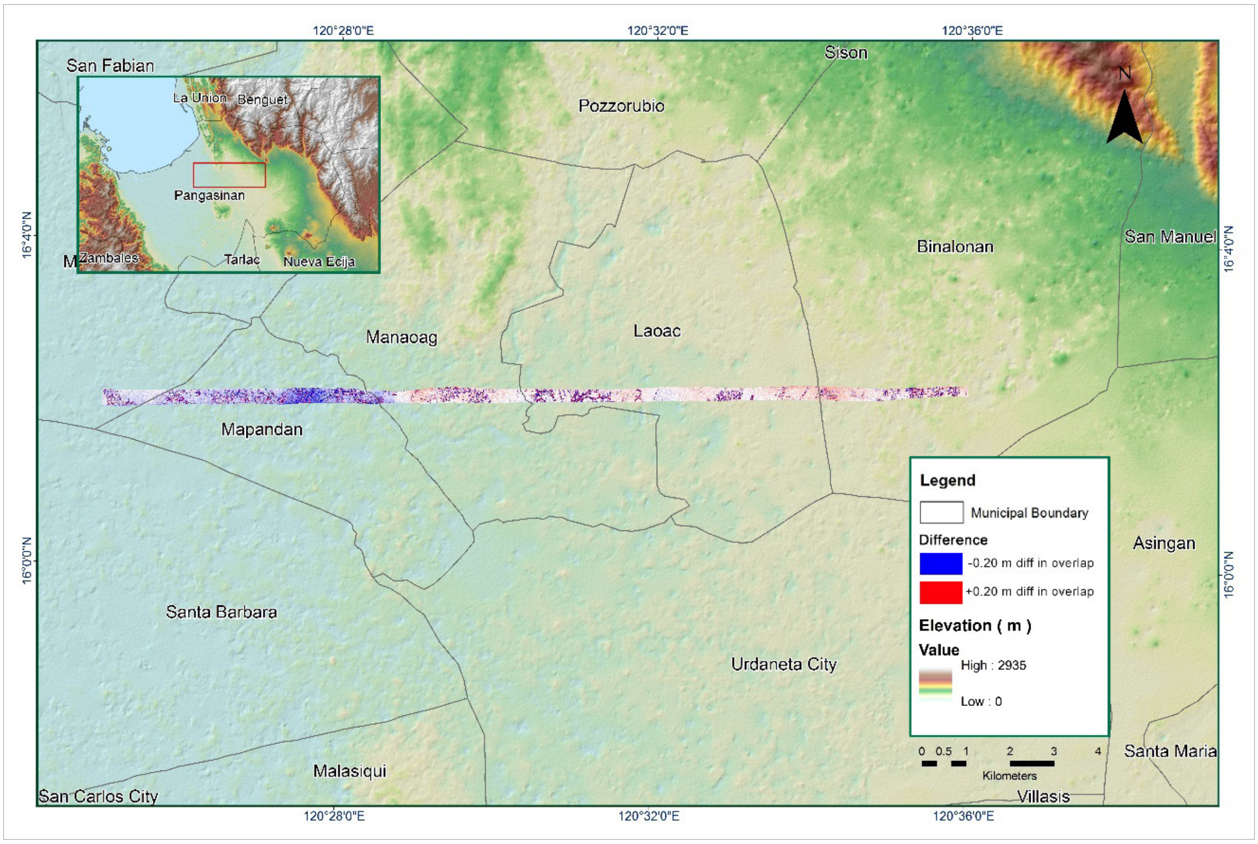


Figure 1.8.7 Elevation difference between flight lines

Table A-8.9. Mission Summary Report for Mission Pam3J_reflights

Flight Area	Pam_Agno Reflights
Mission Name	Pam3J_reflights
Inclusive Flights	7257G
Range data size	6.22 GB
Base data size	18.7 MB
POS	146 MB
Image	NA
Transfer date	May 26, 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)	1.0148
RMSE for East Position (<4.0 cm)	1.3362
RMSE for Down Position (<8.0 cm)	1.6004
Boresight correction stdev (<0.001deg)	0.000637
IMU attitude correction stdev (<0.001deg)	0.002830
GPS position stdev (<0.01m)	0.0166
Minimum % overlap (>25)	14.11%
Ave point cloud density per sq.m. (>2.0)	3.03
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	62
Maximum Height	156.83 m
Minimum Height	61.26 m
Classification (# of points)	
Ground	19,529,093
Low vegetation	29,901,700
Medium vegetation	9,774,573
High vegetation	4,903,198
Building	688,452
Orthophoto	Yes
Processed by	Engr. Jommer Medina, Engr. Harmond Santos, Engr. Melissa Fernandez

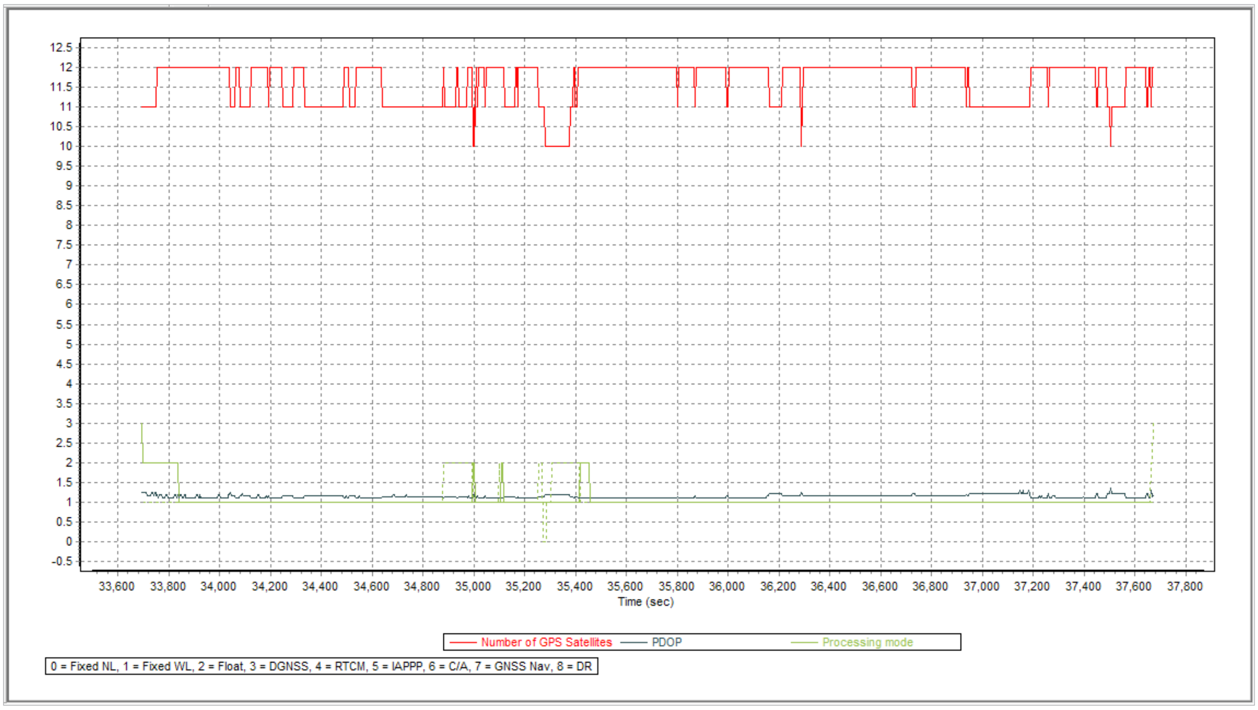


Figure 1.9.1 Solution Status

Figure 1.9.2 Smoothed Performance Metric Parameters

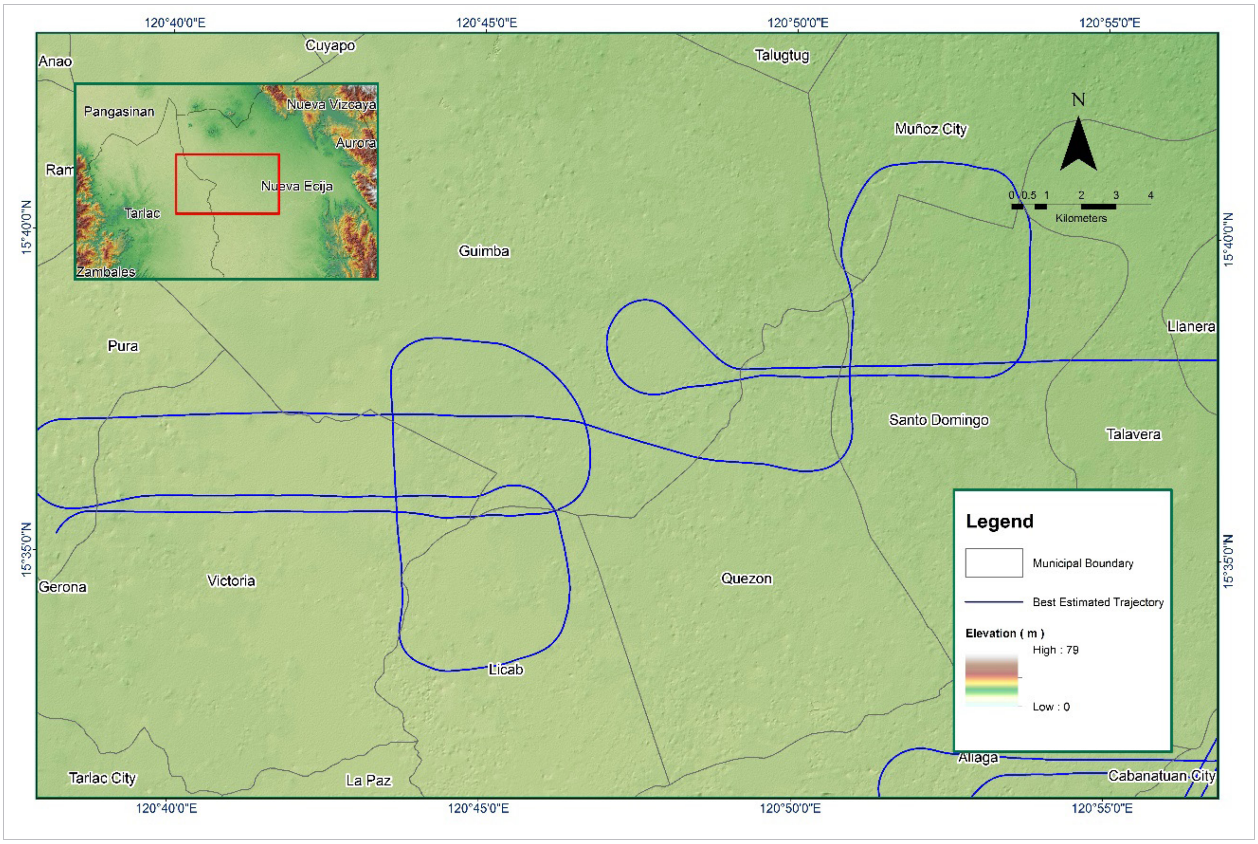


Figure 1.9.3 Best Estimated Trajectory

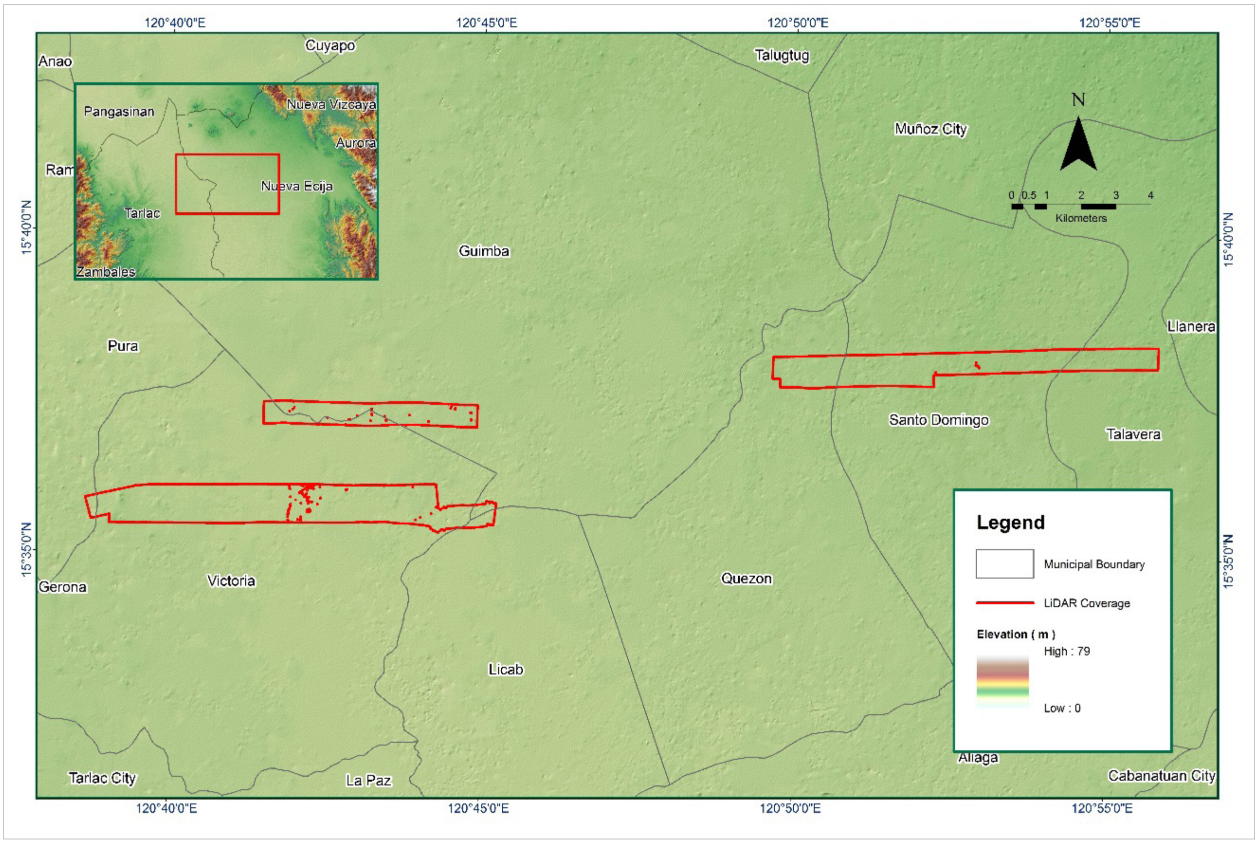


Figure 1.9.4 Coverage of LIDAR data

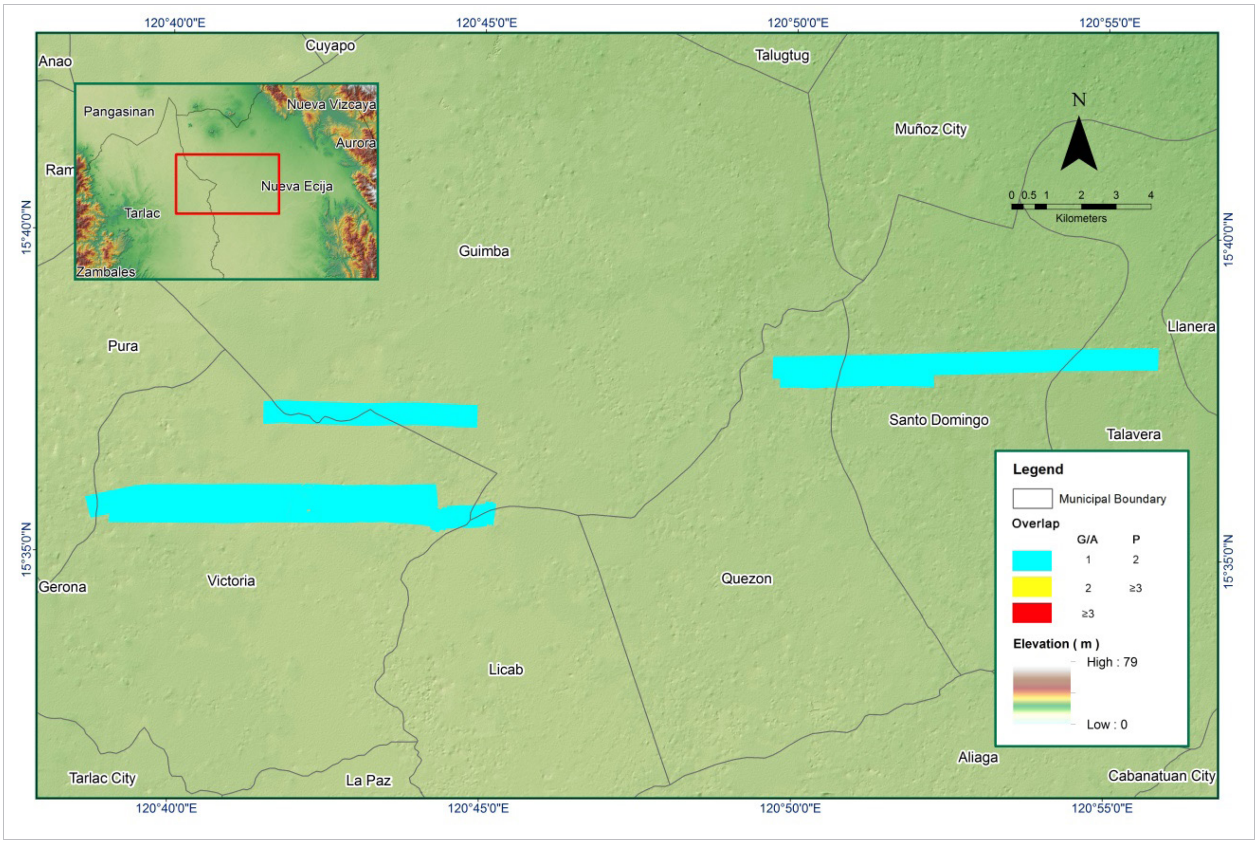


Figure 1.9.5 Image of Data Overlap

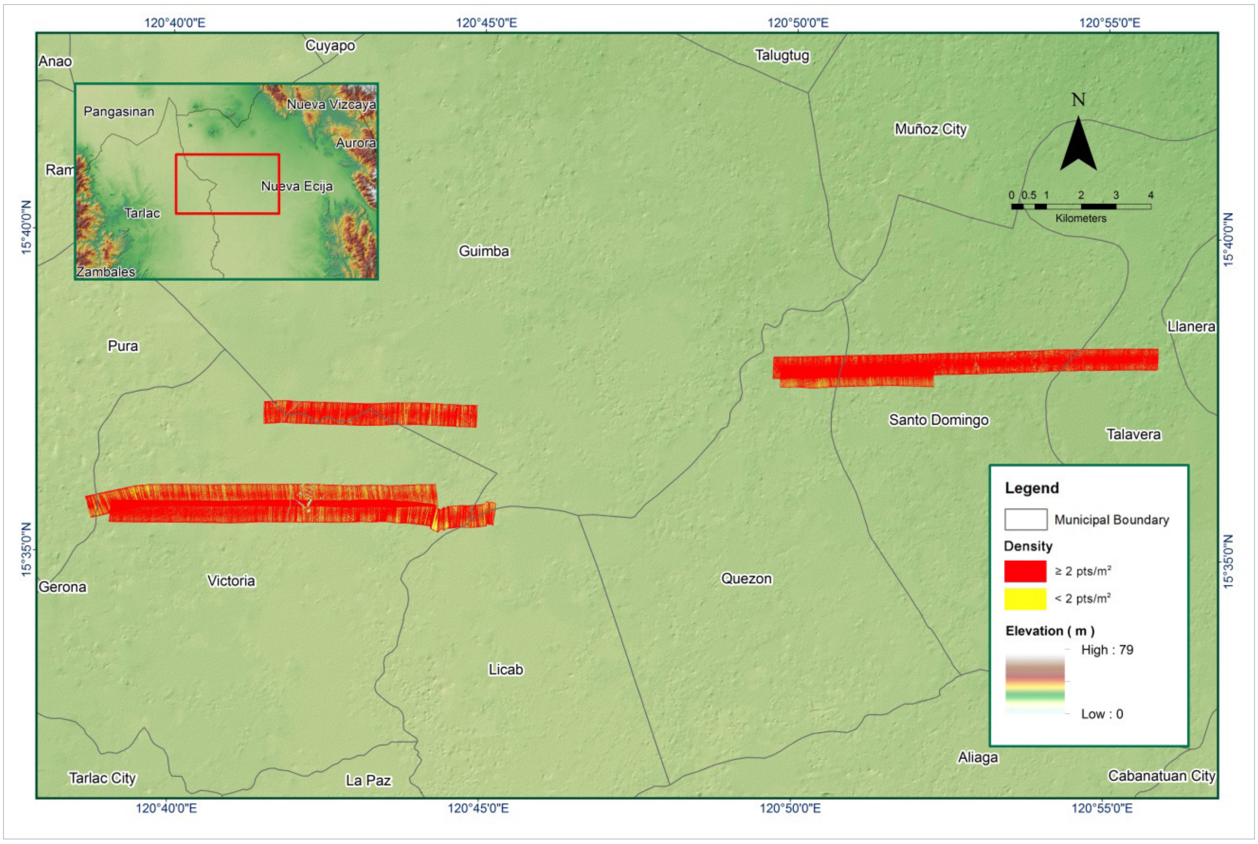


Figure 1.9.6 Density map of merged LIDAR data

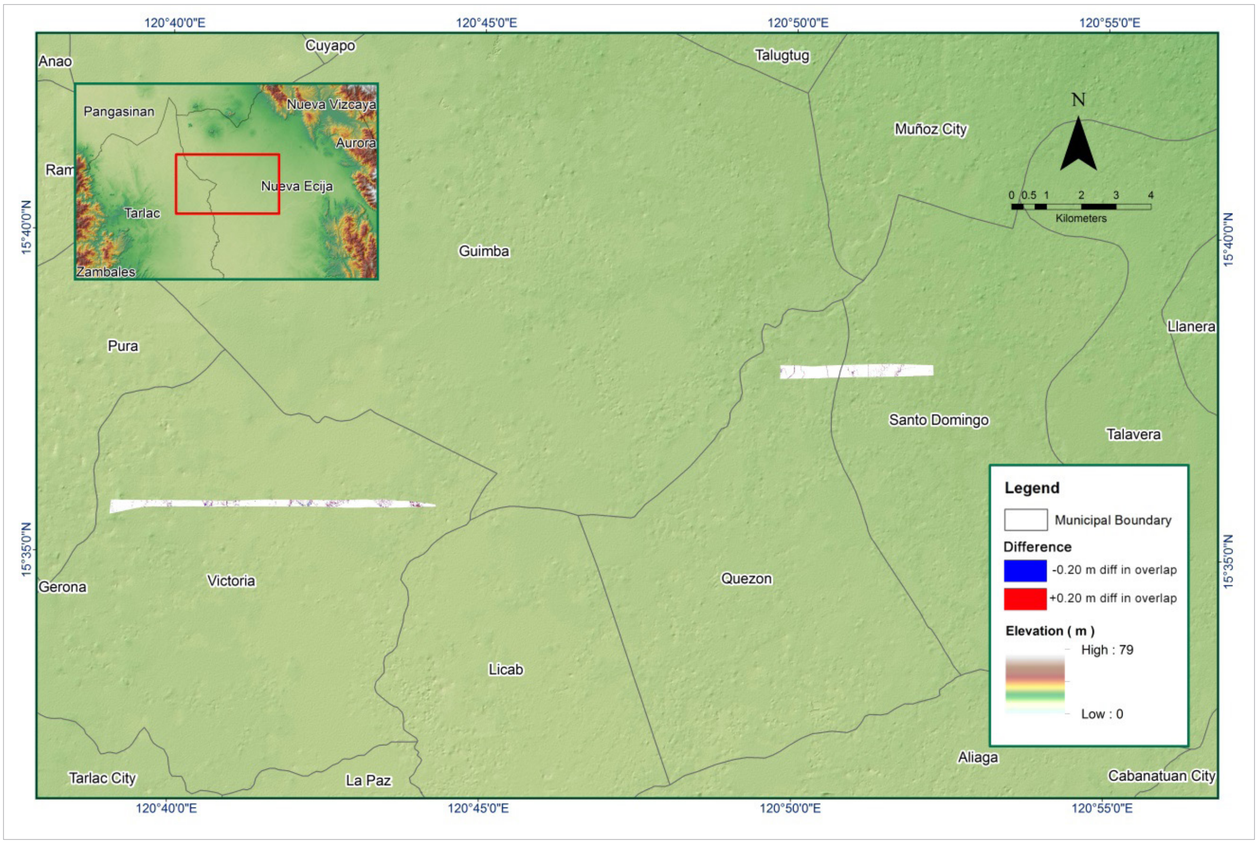


Figure 1.9.7 Elevation difference between flight lines

Table A-8.10. Mission Summary Report for Mission Pam3H_reflights

Flight Area	Pam_Agno Reflights
Mission Name	Pam3H_reflights
Inclusive Flights	7257G
Mission Name	2PAMS7138B, 2NEJS1138B
Range data size	6.22 GB
Base data size	18.7 MB
POS	146 MB
Image	NA
Transfer date	May 26, 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)	1.0148
RMSE for East Position (<4.0 cm)	1.3362
RMSE for Down Position (<8.0 cm)	1.6004
Boresight correction stdev (<0.001deg)	0.0148
IMU attitude correction stdev (<0.001deg)	0.000845
GPS position stdev (<0.01m)	0.002159
Minimum % overlap (>25)	21.56%
Ave point cloud density per sq.m. (>2.0)	3.20
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	49
Maximum Height	146.8 m
Minimum Height	70.72 m
Classification (# of points)	
Ground	17,460,390
Low vegetation	29,159,535
Medium vegetation	10,479,127
High vegetation	2,848,427
Building	881,156
Orthophoto	No
Processed by	Engr. Jommer Medina, Engr. Mark Joshua Salvacion, Engr. Ma. Ailyn Olanda

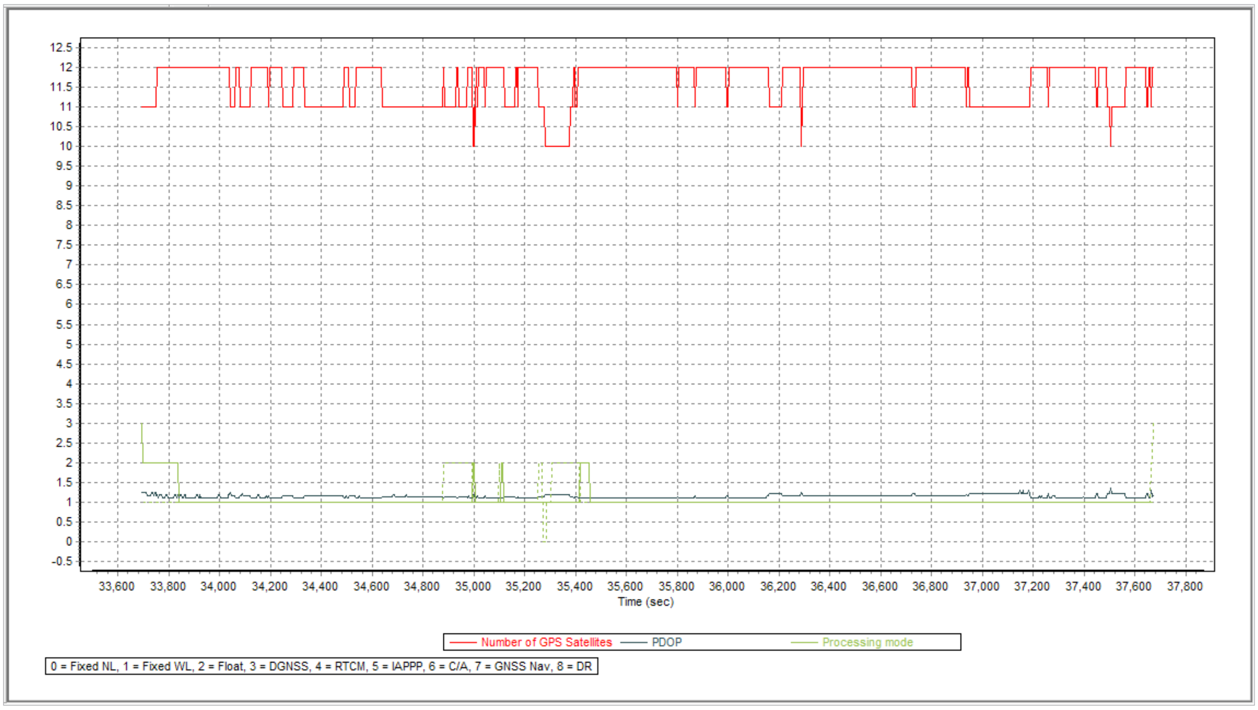


Figure 1.10.1 Solution Status

Figure 1.10.2 Smoothed Performance Metric Parameters

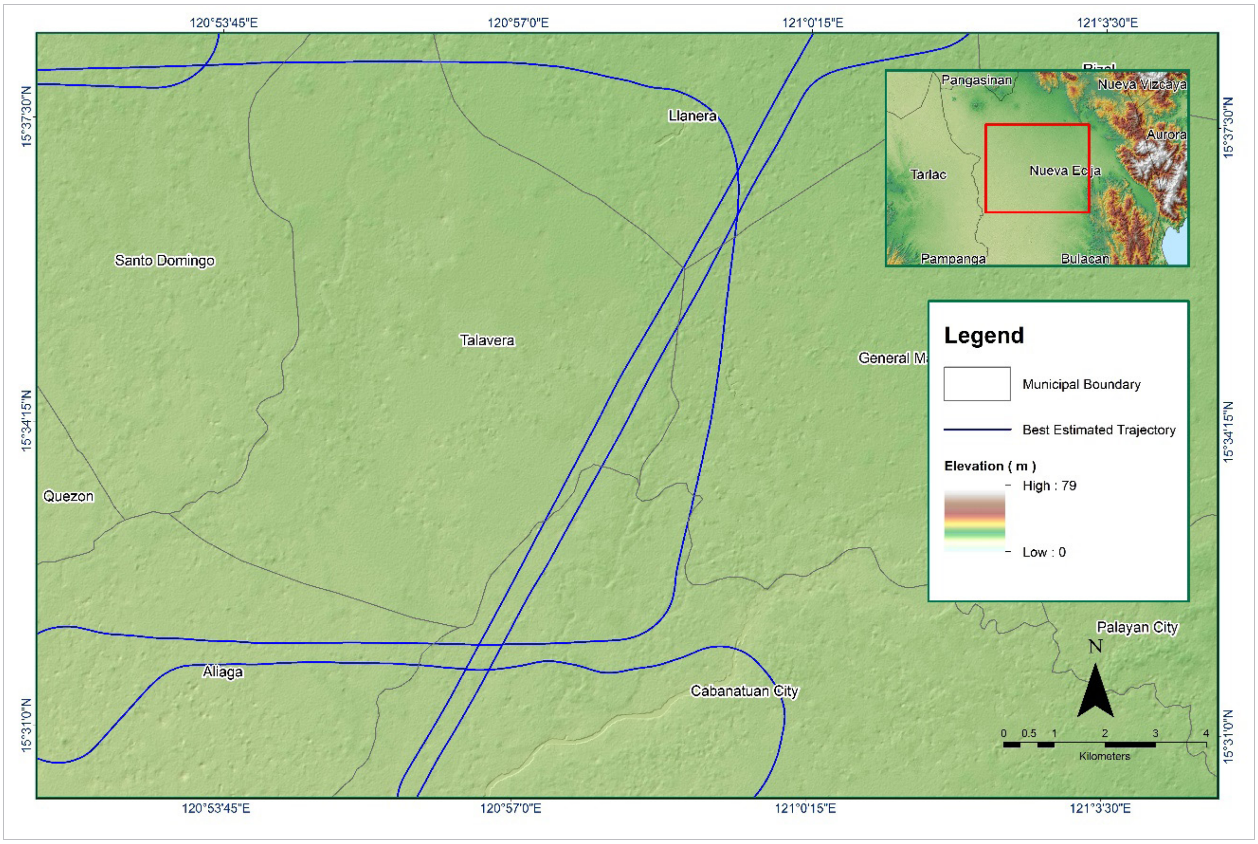


Figure 1.10.3 Best Estimated Trajectory

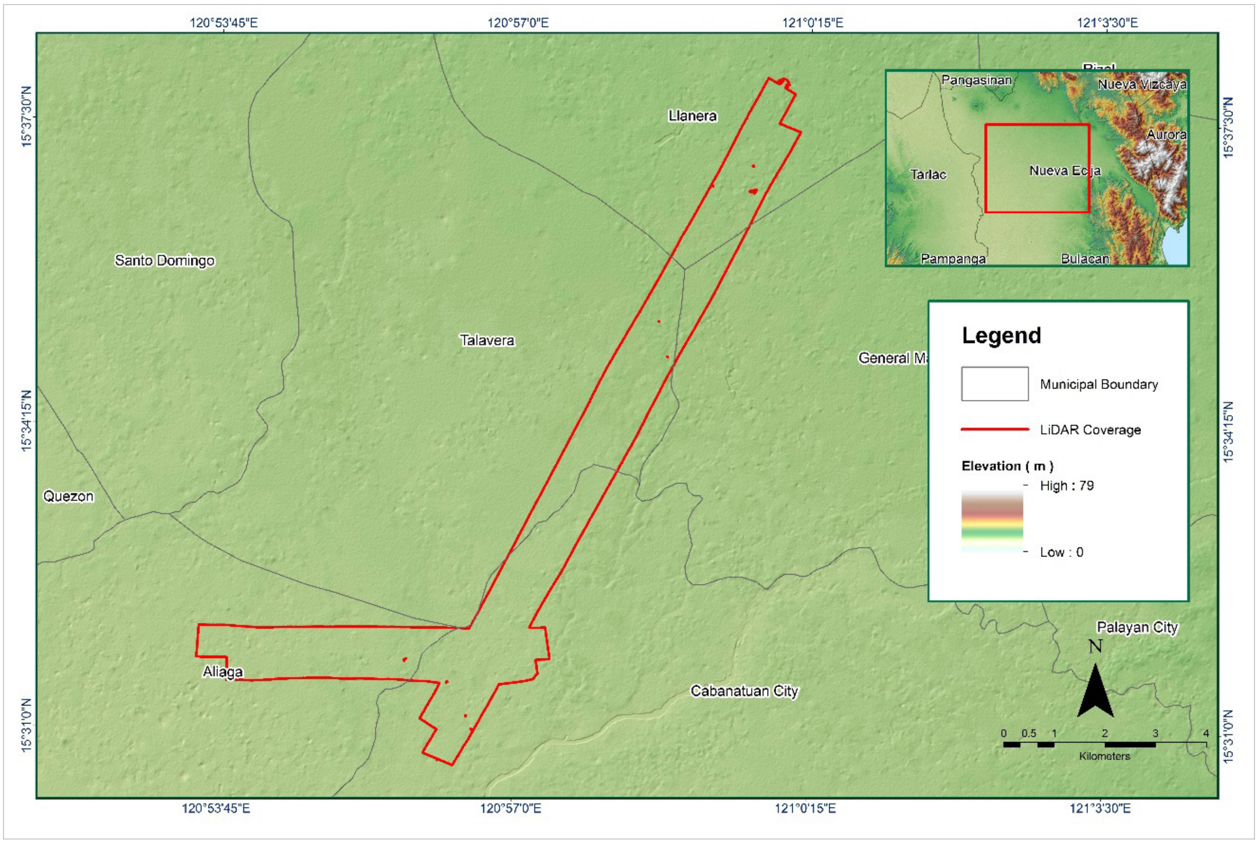


Figure 1.10.4 Coverage of LIDAR data

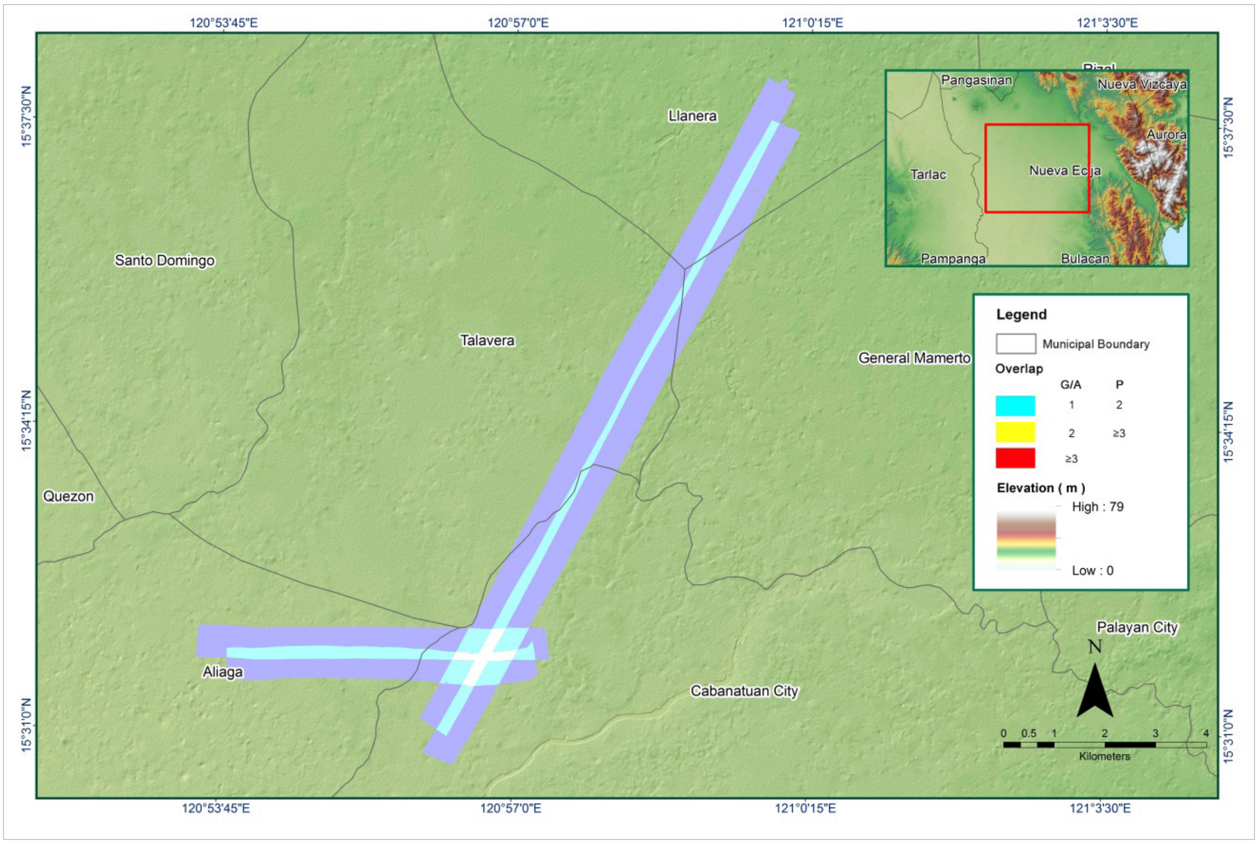


Figure 1.10.5 Image of Data Overlap

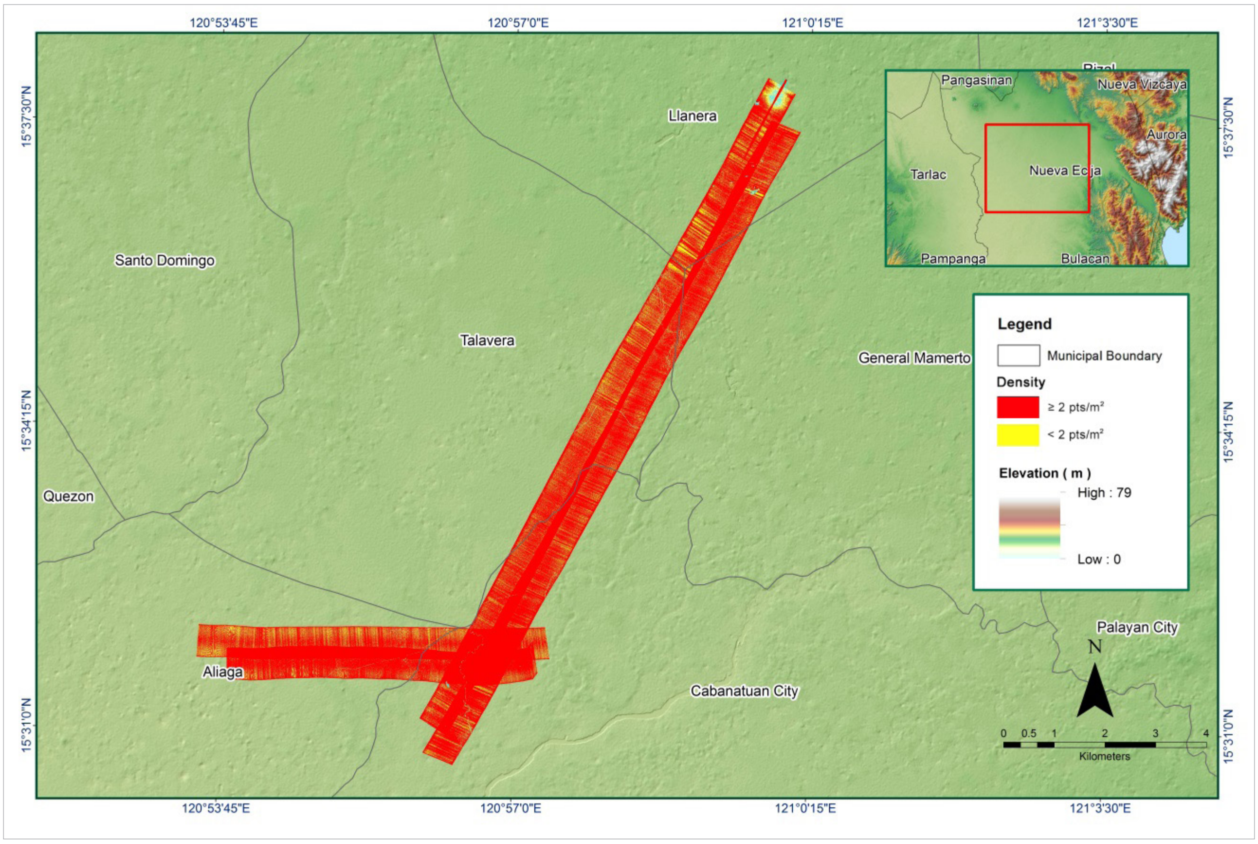


Figure 1.10.6 Density map of merged LIDAR data

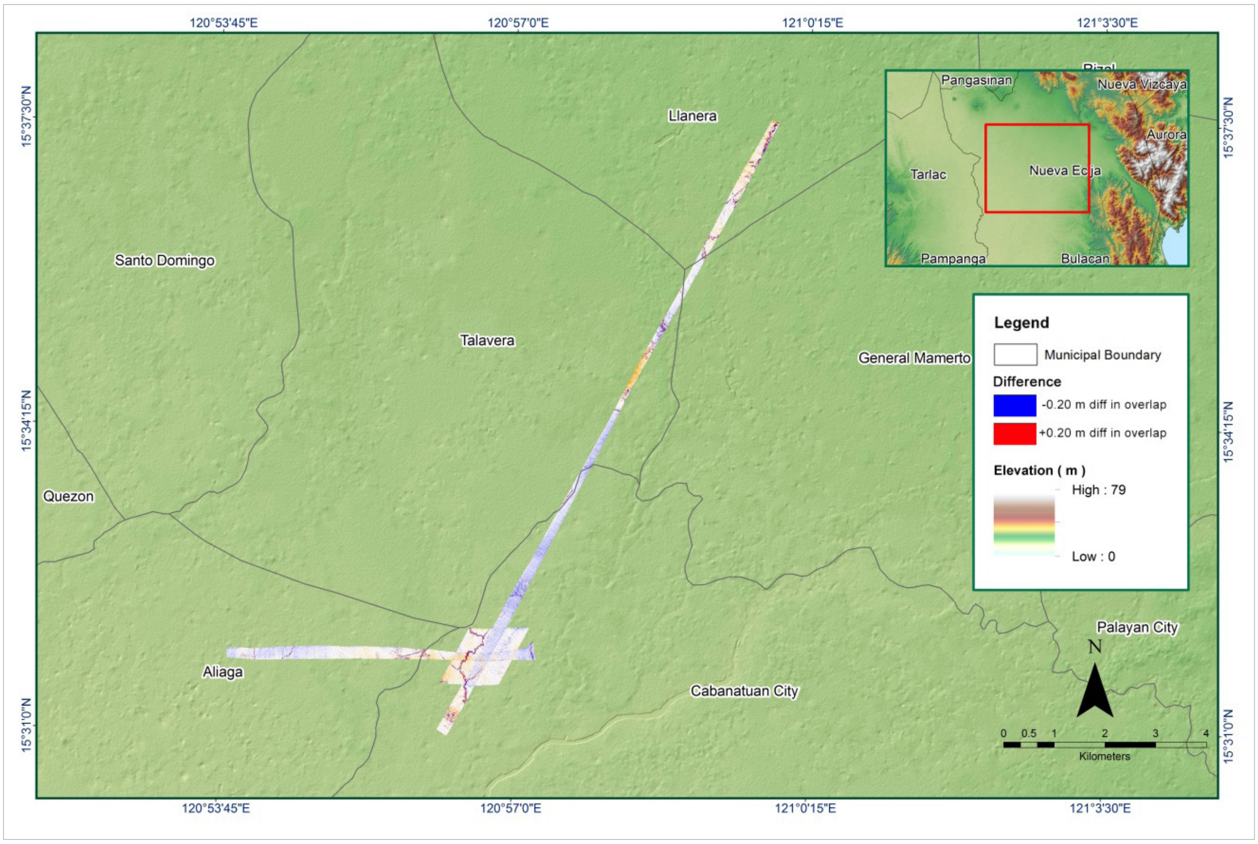


Figure 1.10.7 Elevation difference between flight lines

Table A-8.11. Mission Summary Report

Flight Area	Nueva Ecija
Mission Name	NA
Inclusive Flights	1017P
Range data size	14.0 GB
Base data size	MB
POS	98.8 MB
Image	27.6 GB
Transfer date	NA
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	Yes
Processing Mode (<=1)	Yes
Smoothed Performance Metrics (in cm)	
RMSE for North Position (<4.0 cm)	3.531
RMSE for East Position (<4.0 cm)	1.860
RMSE for Down Position (<8.0 cm)	5.075
Boresight correction stdev (<0.001deg)	0.000498
IMU attitude correction stdev (<0.001deg)	0.004964
GPS position stdev (<0.01m)	0.0083
Minimum % overlap (>25)	39.88
Ave point cloud density per sq.m. (>2.0)	2.35
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	361
Maximum Height	342.54 m
Minimum Height	342.54 m
Classification (# of points)	
Ground	555490395
Low vegetation	348925082
Medium vegetation	122439055
High vegetation	45500310
Building	15411146
Orthophoto	Yes
Processed By	Engr. Jennifer Saguran, Celina Rosete, Jovy Narisma, Engr. Ma. Ailyn Olanda

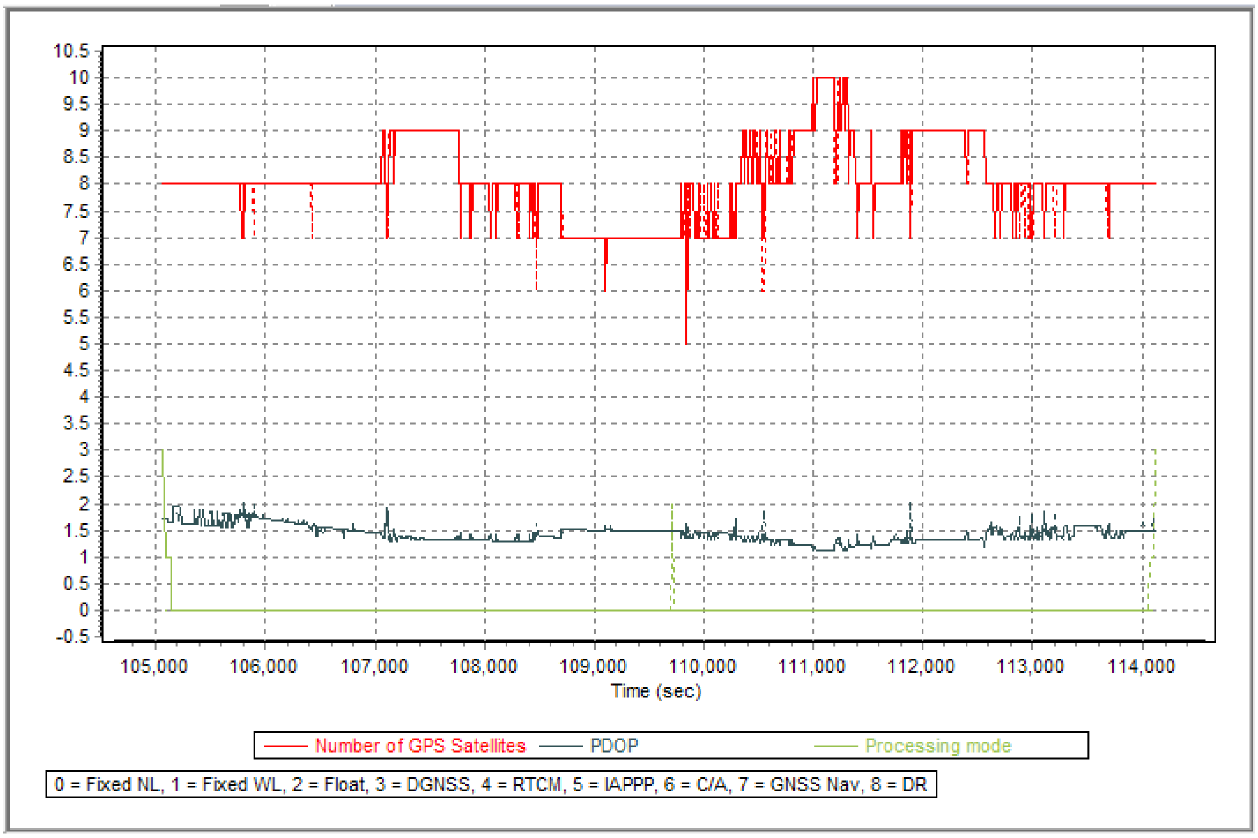


Figure 1.11.1 Solution Status

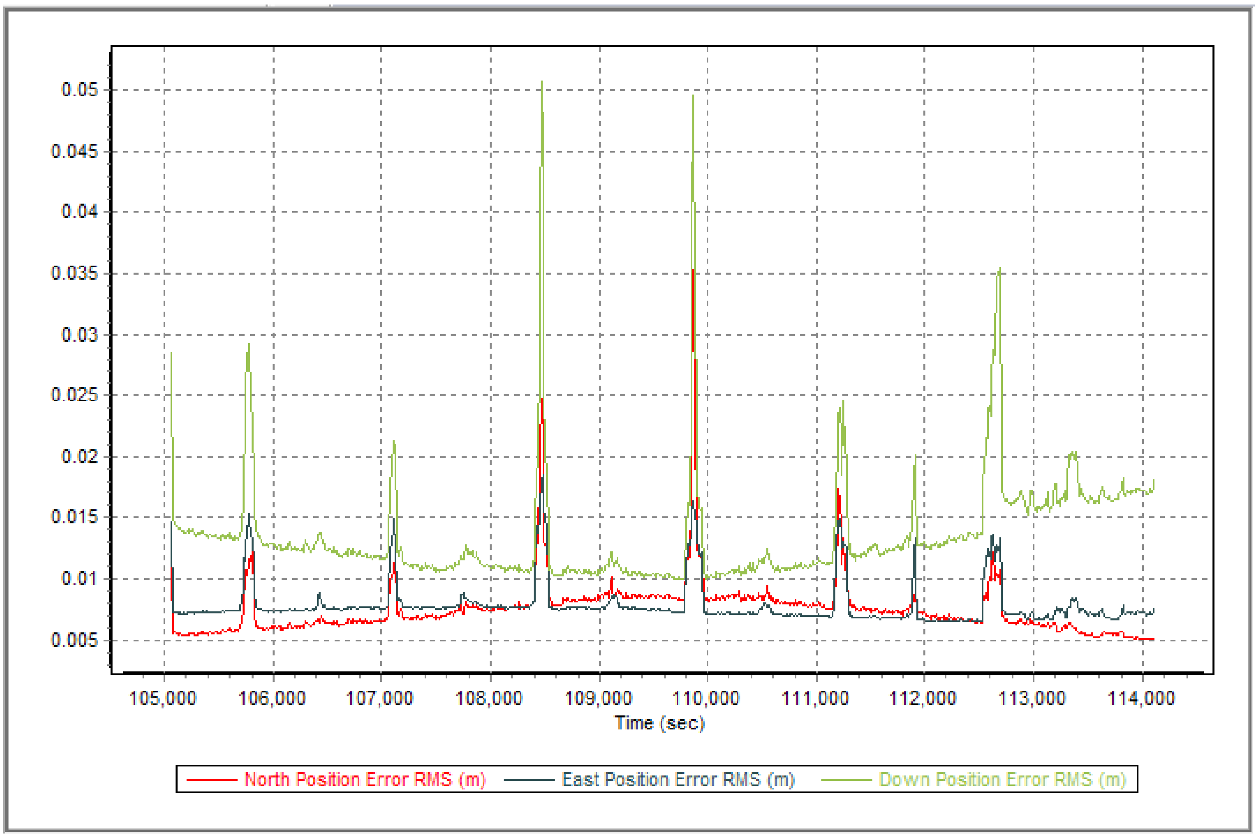


Figure 1.11.2 Smoothed Performance Metric Parameters

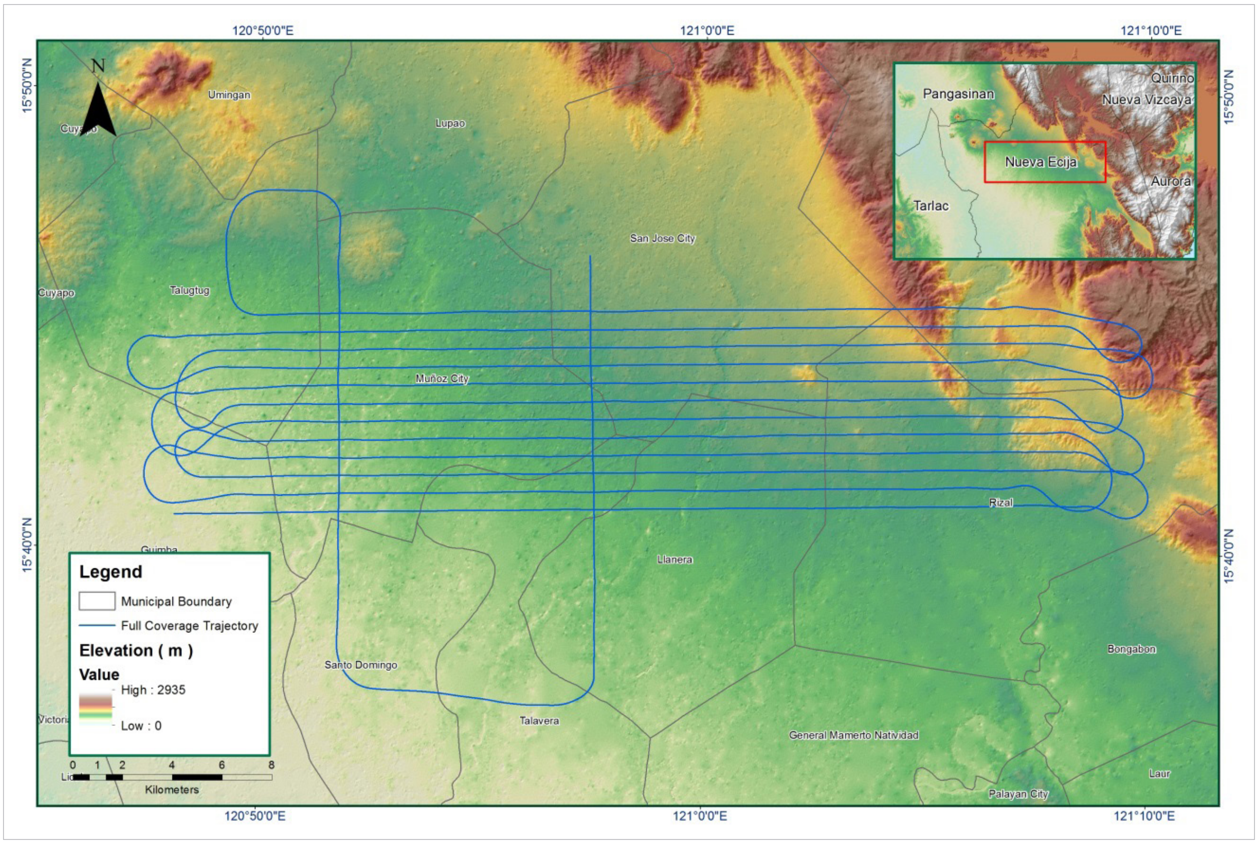


Figure 1.11.3 Best Estimated Trajectory

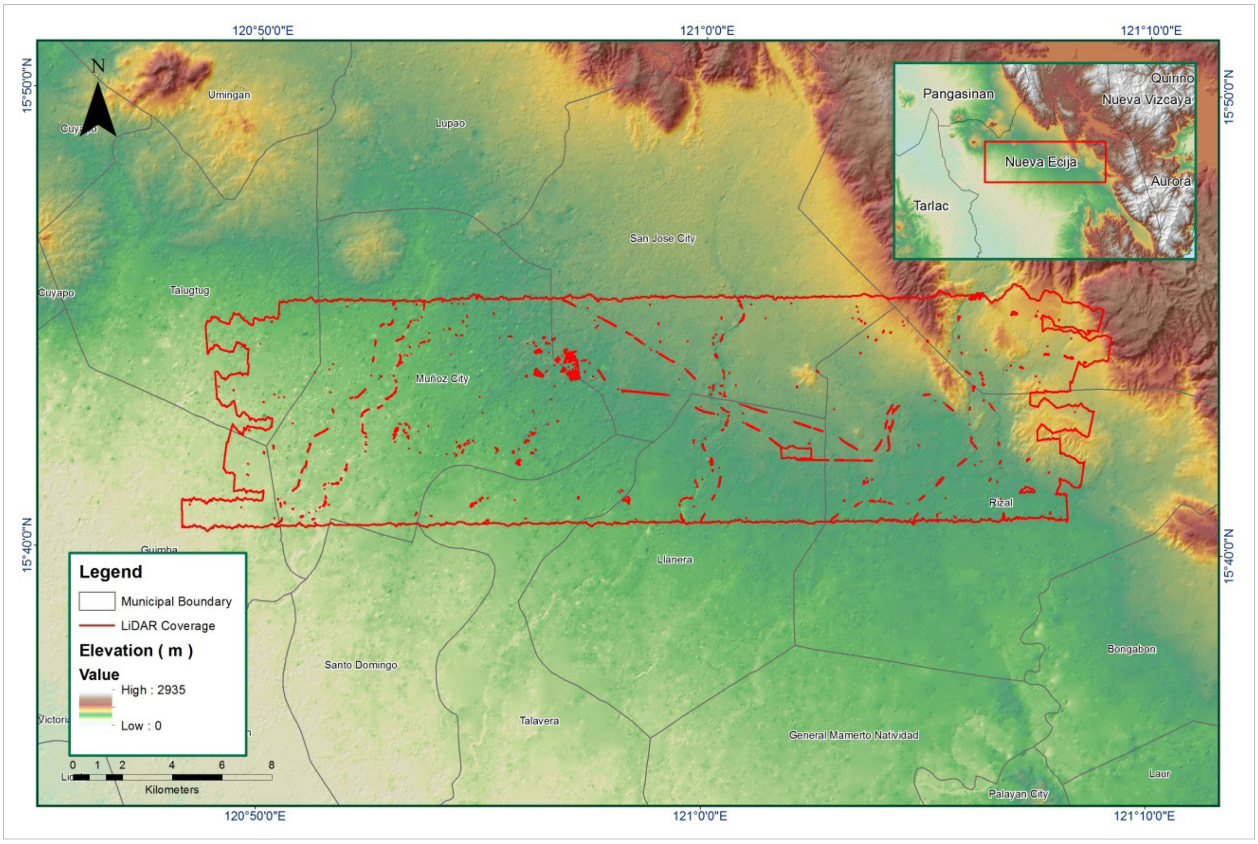


Figure 1.11.4 Coverage of LIDAR data

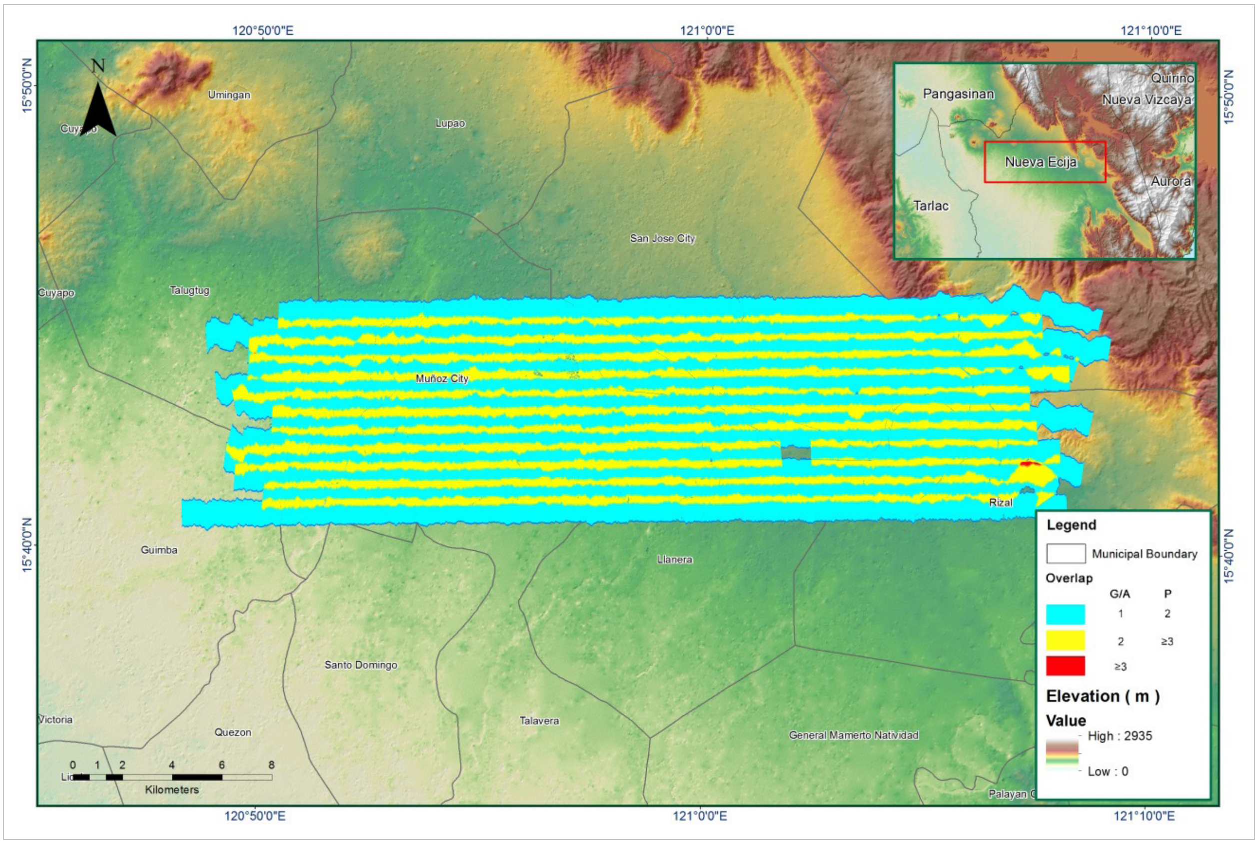


Figure 1.11.5 Image of Data Overlap

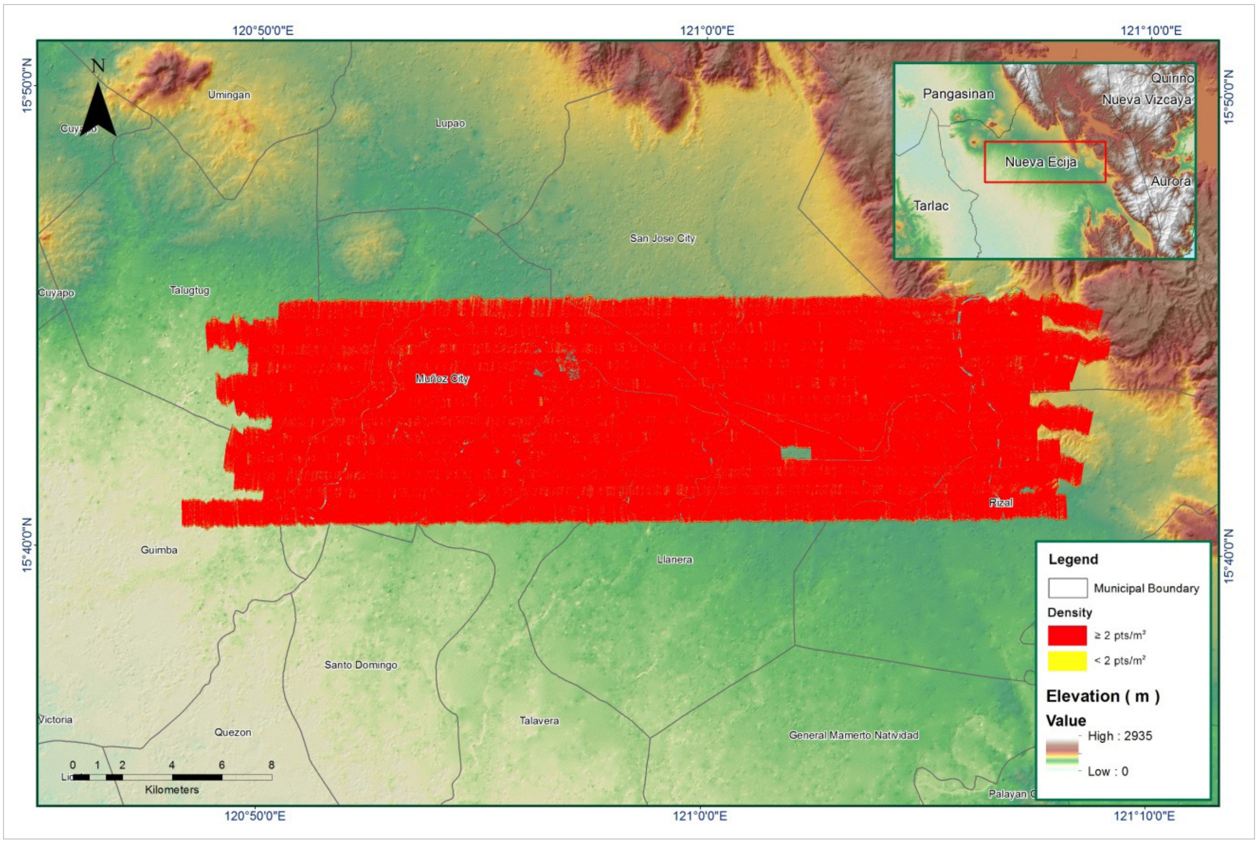


Figure 1.11.6 Density map of merged LIDAR data

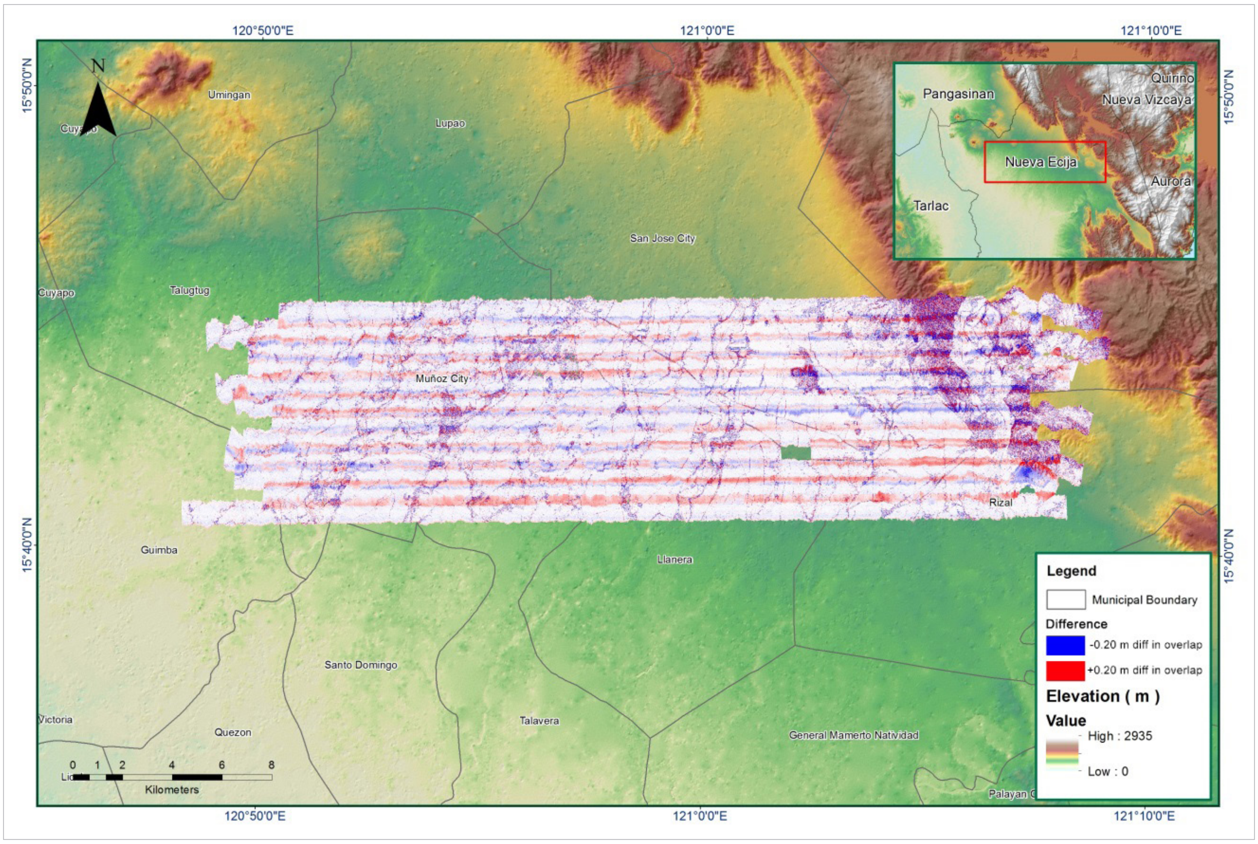


Figure 1.11.7 Elevation difference between flight lines

Table A-8.12. Mission Summary Report

Flight Area	Nueva Ecija
Mission Name	NA
Inclusive Flights	7032GC
Range data size	9.77 GB
Base data size	MB
POS	158 MB
Image	NA
Transfer date	June 17, 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)	3.723
RMSE for East Position (<4.0 cm)	4.916
RMSE for Down Position (<8.0 cm)	7.296
Boresight correction stdev (<0.001deg)	0.000297
IMU attitude correction stdev (<0.001deg)	0.000438
GPS position stdev (<0.01m)	0.0060
Minimum % overlap (>25)	18.71
Ave point cloud density per sq.m. (>2.0)	2.87
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	103
Maximum Height	241.53 m
Minimum Height	84 m
Classification (# of points)	
Ground	54236859
Low vegetation	66930131
Medium vegetation	33382595
High vegetation	14465868
Building	1616942
Orthophoto	No
Processed By	Engr. Kenneth Solidum,Engr. Christy Lubiano, Engr. Gladys Mae Apat

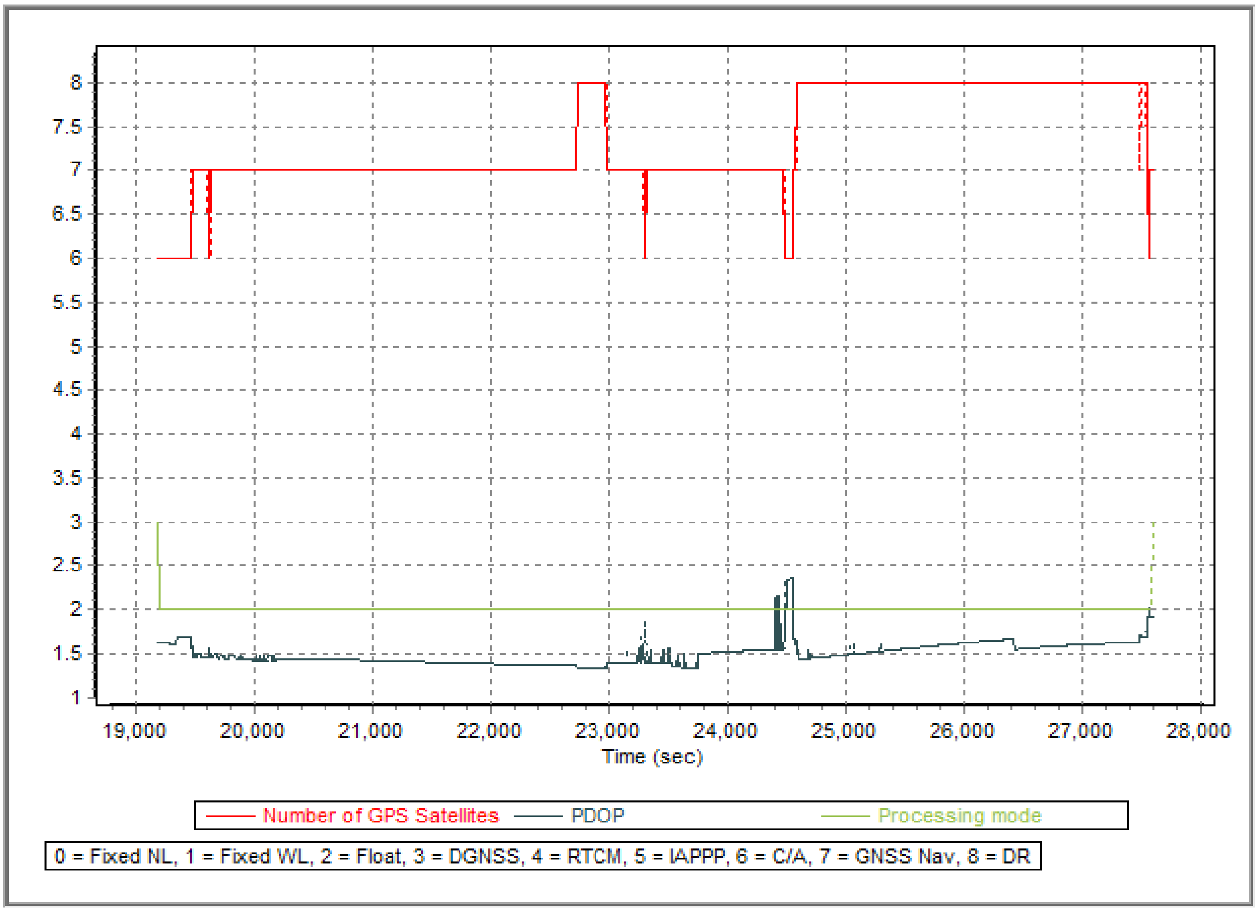


Figure 1.12.1 Solution Status

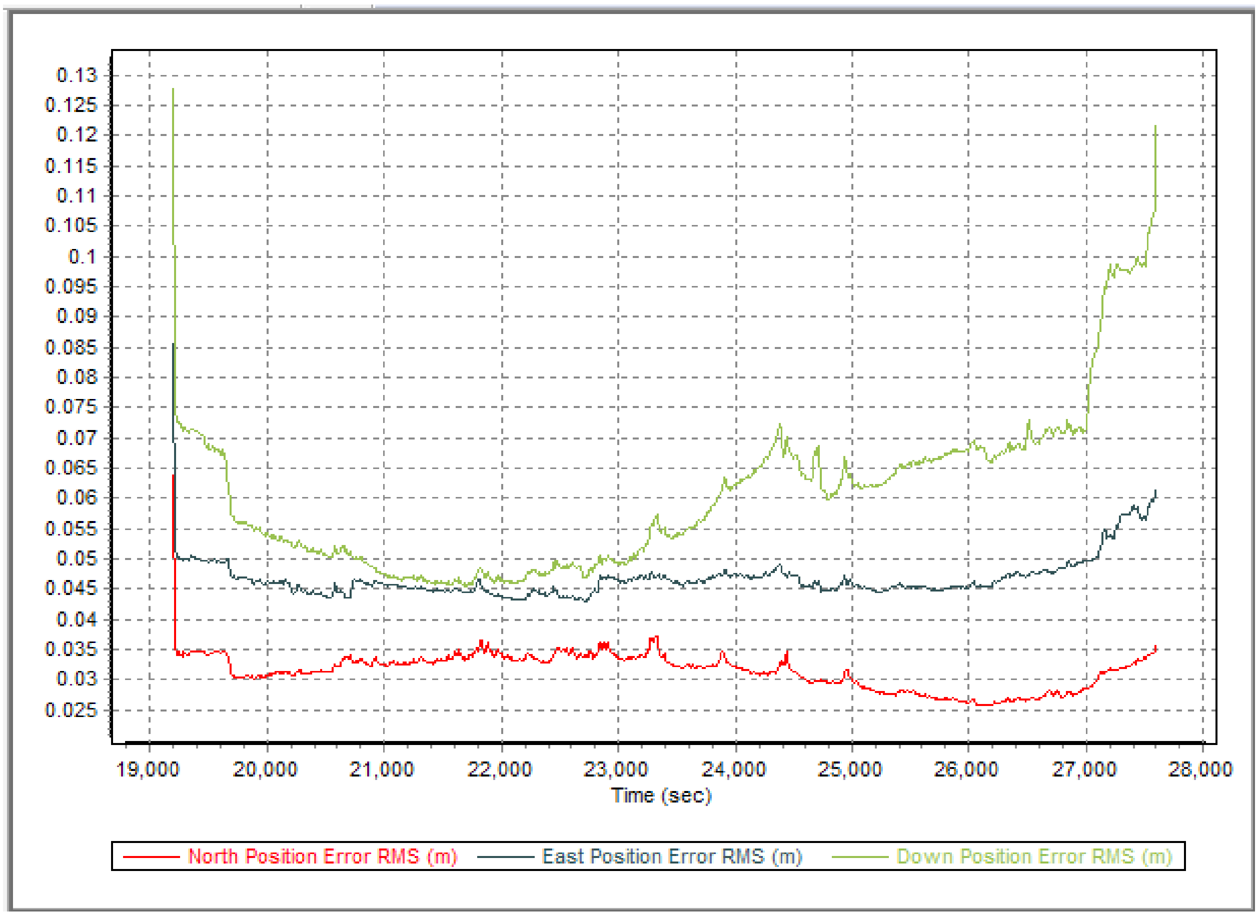


Figure 1.12.2 Smoothed Performance Metric Parameters

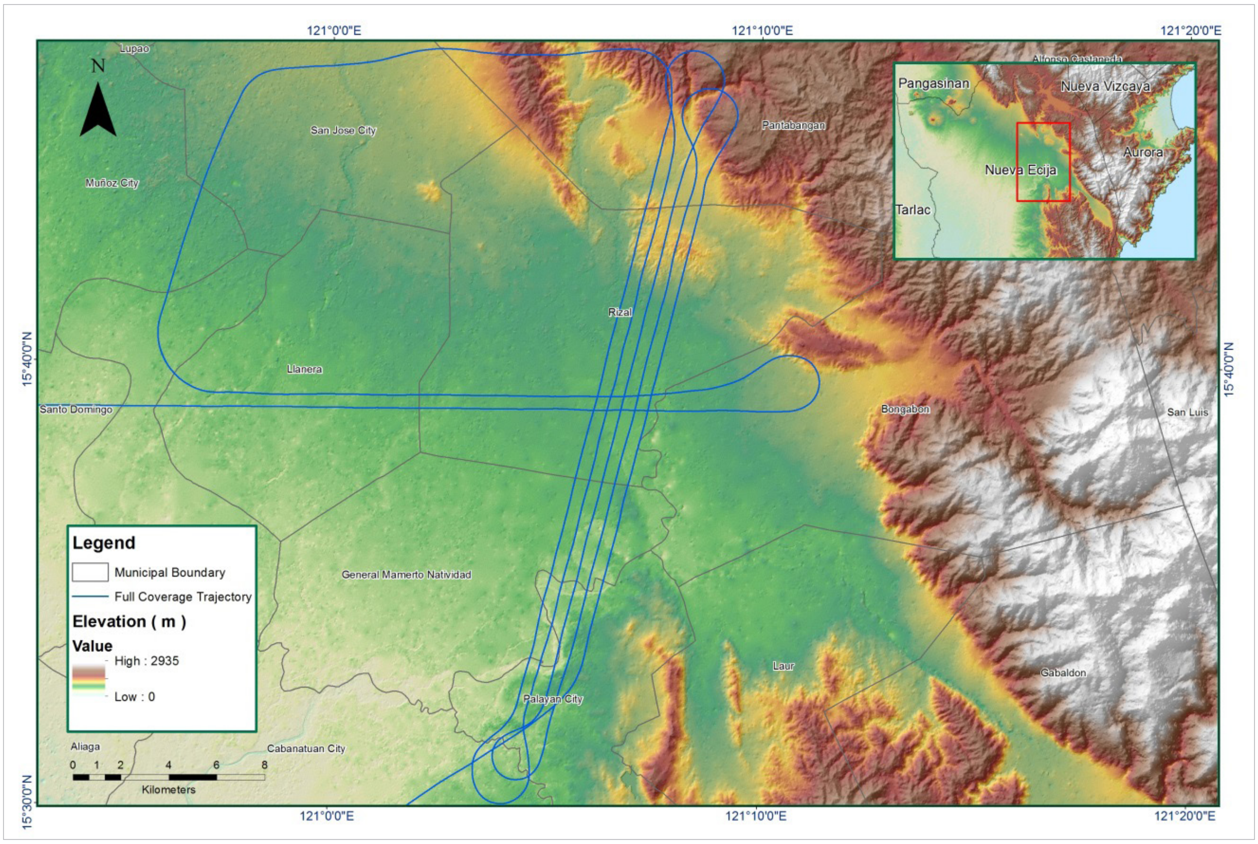


Figure 1.12.3 Best Estimated Trajectory

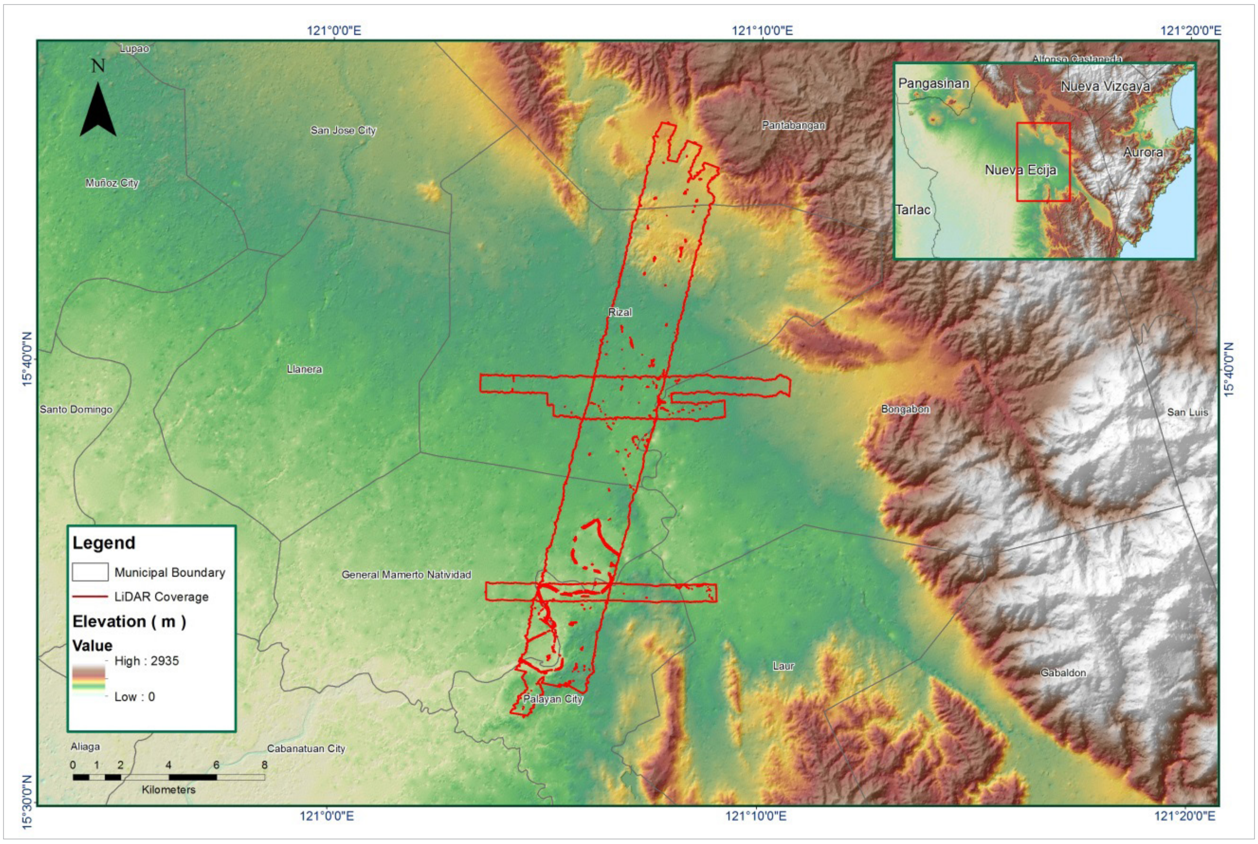


Figure 1.12.4 Coverage of LIDAR data

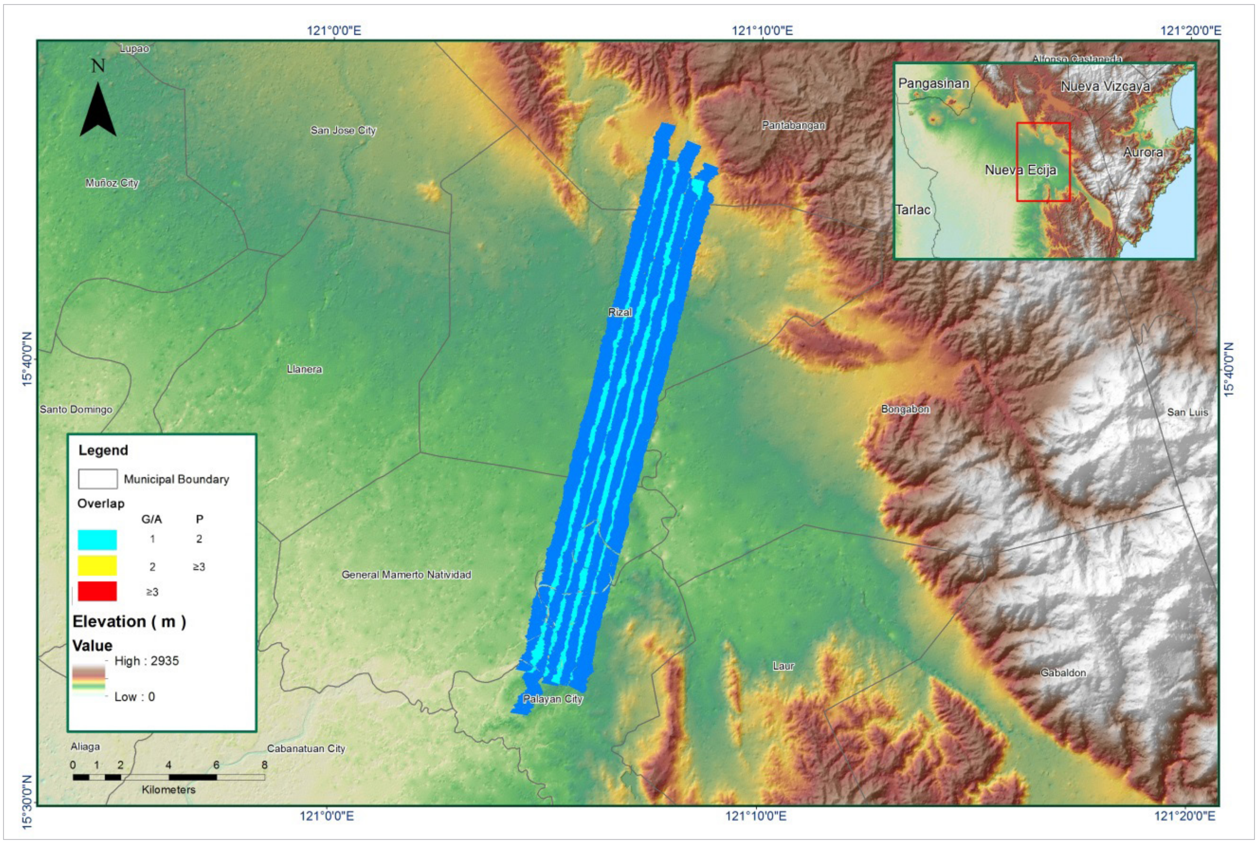


Figure 1.12.5 Image of Data Overlap

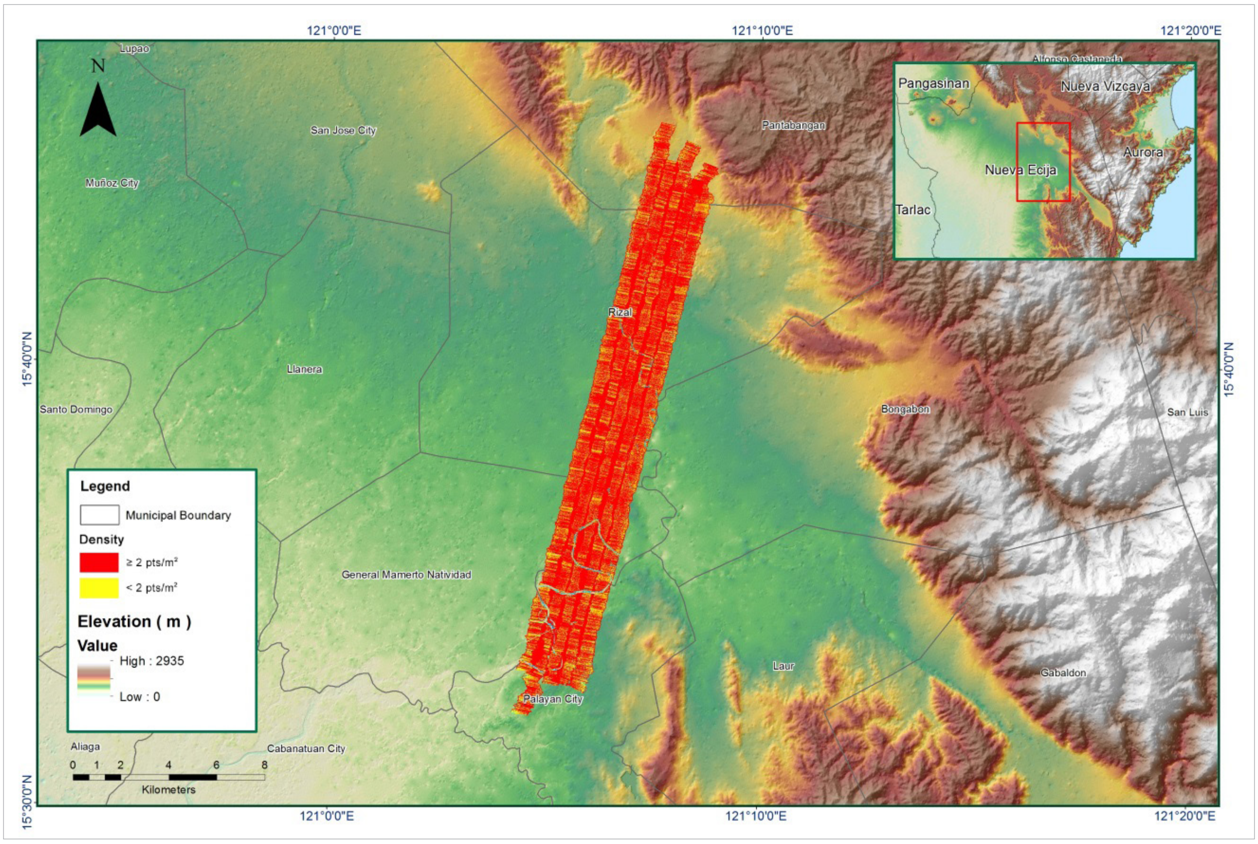


Figure 1.12.6 Density map of merged LIDAR data

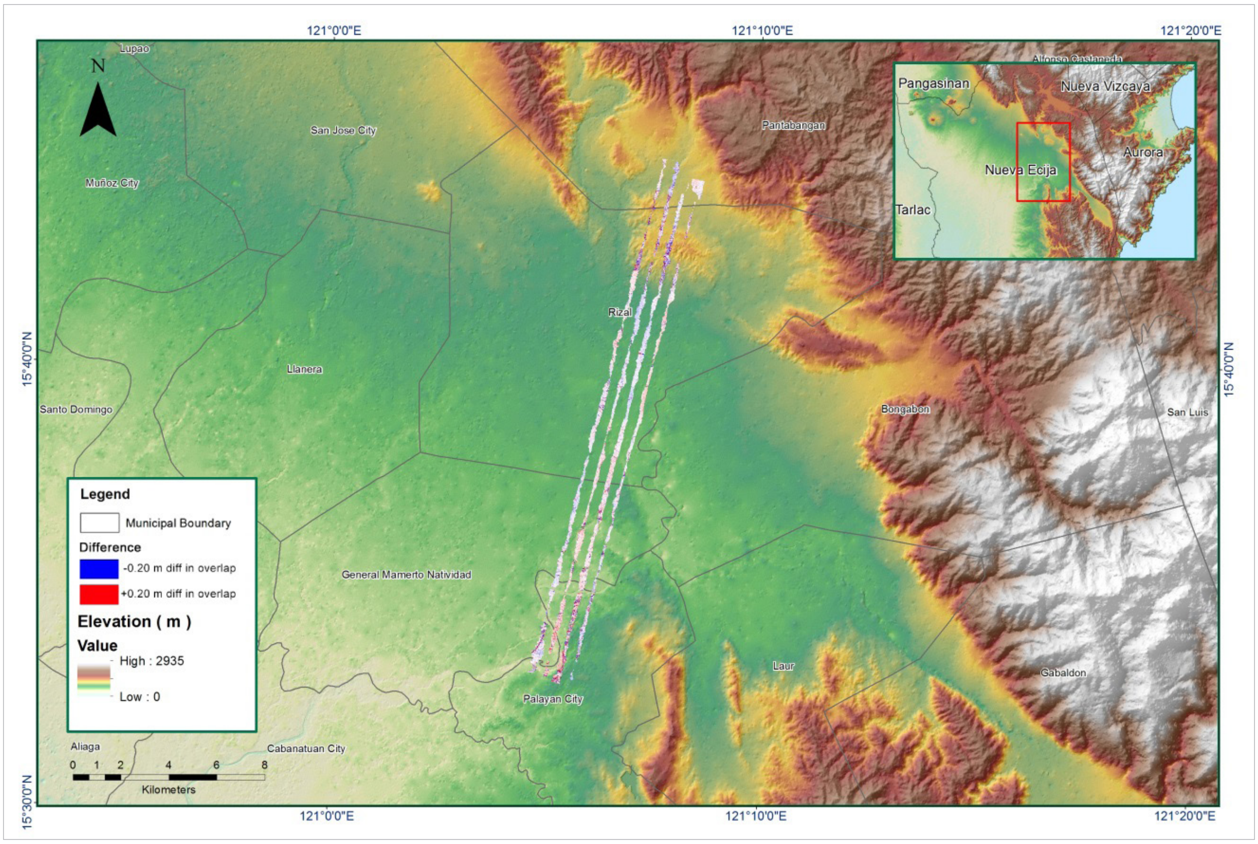


Figure 1.12.7 Elevation difference between flight lines

Table A-8.13. Mission Summary Report

Flight Area	Nueva Ecija
Mission Name	NA
Inclusive Flights	7036GC
Range data size	11.1 GB
Base data size	MB
POS	185 MB
Image	NA
Transfer date	June 17, 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)	2.658
RMSE for East Position (<4.0 cm)	4.014
RMSE for Down Position (<8.0 cm)	4.825
Boresight correction stdev (<0.001deg)	0.000318
IMU attitude correction stdev (<0.001deg)	0.000524
GPS position stdev (<0.01m)	0.0067
Minimum % overlap (>25)	16.19
Ave point cloud density per sq.m. (>2.0)	2.72
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	161
Maximum Height	351.22 m
Minimum Height	83.62 m
Classification (# of points)	
Ground	69769144
Low vegetation	83550741
Medium vegetation	42344200
High vegetation	18942742
Building	2903183
Orthophoto	No
Processed By	Engr. Kenneth Solidum, Engr. Melanie Hingpit, Engr. Gladys Mae Apat

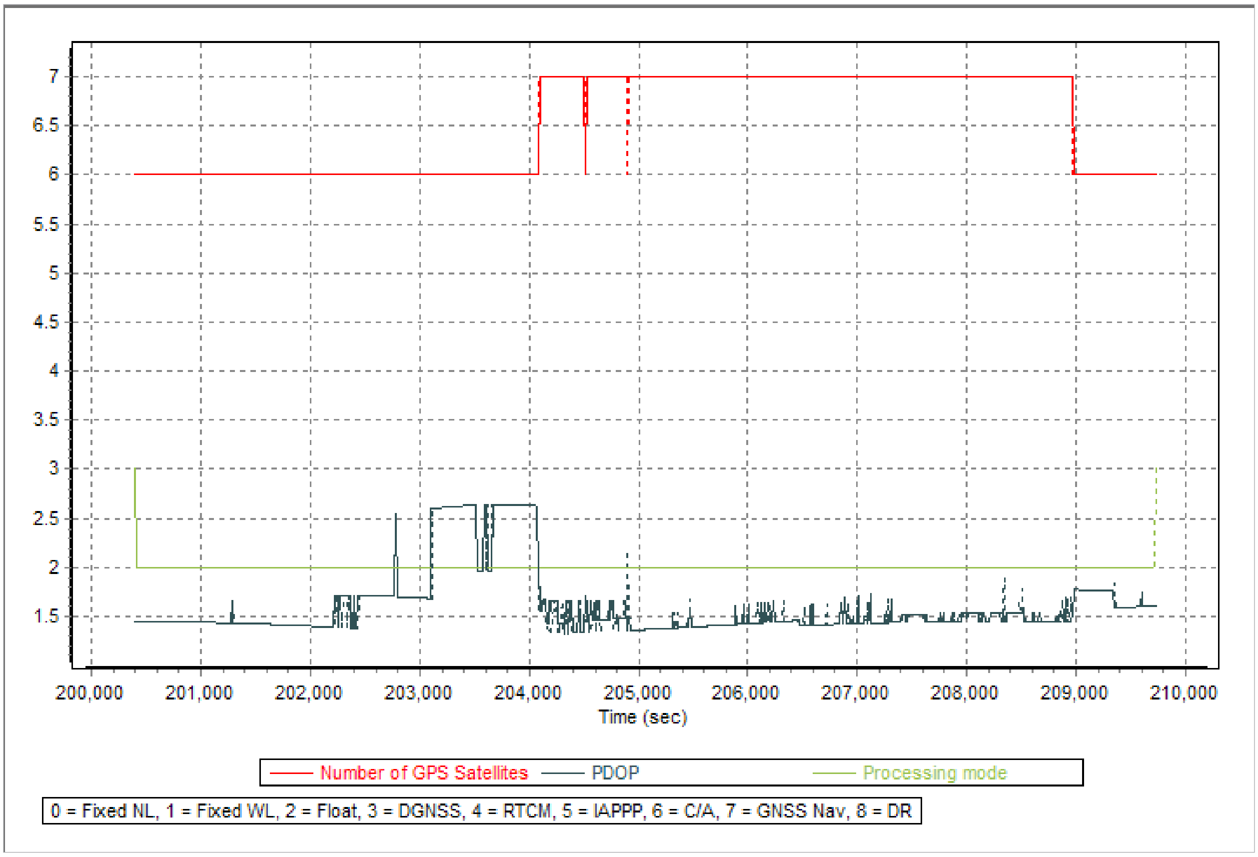


Figure 1.13.1 Solution Status

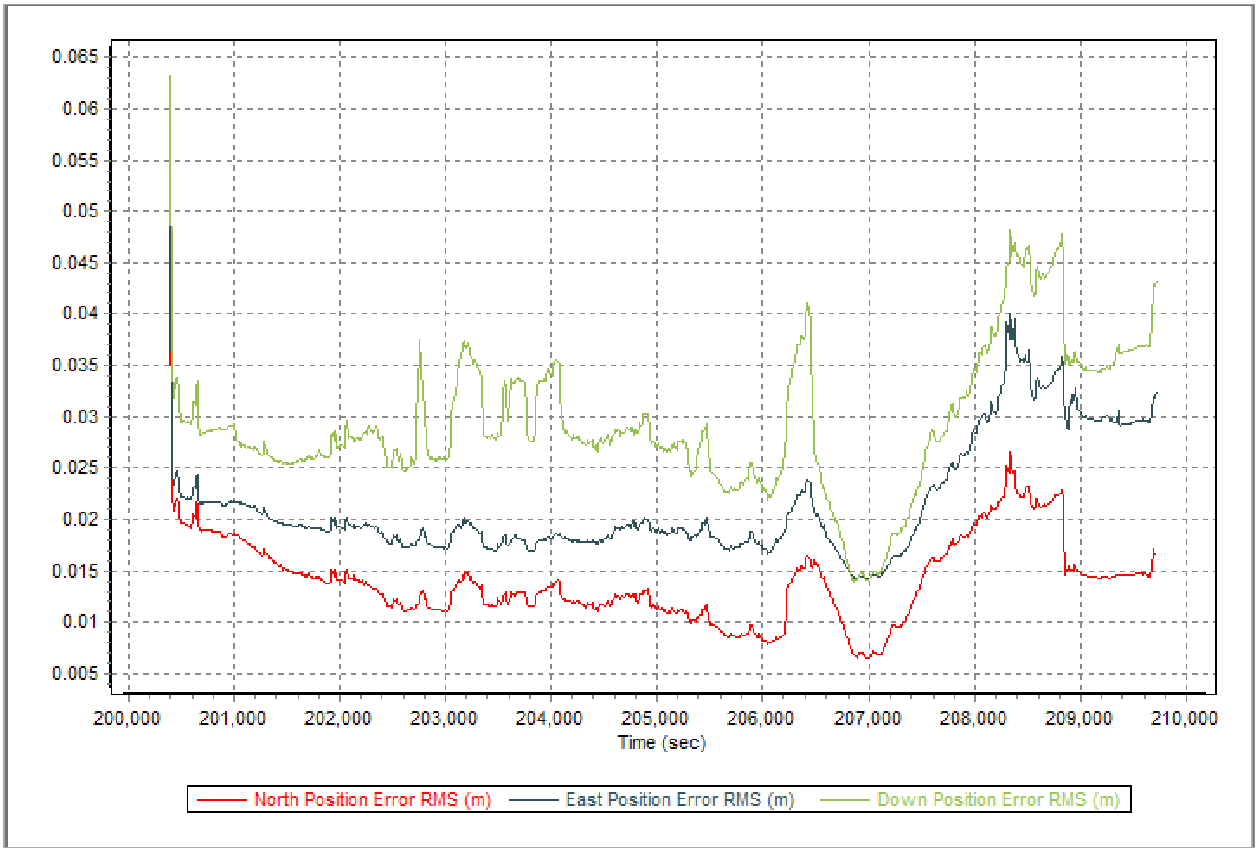


Figure 1.13.2 Smoothed Performance Metric Parameters

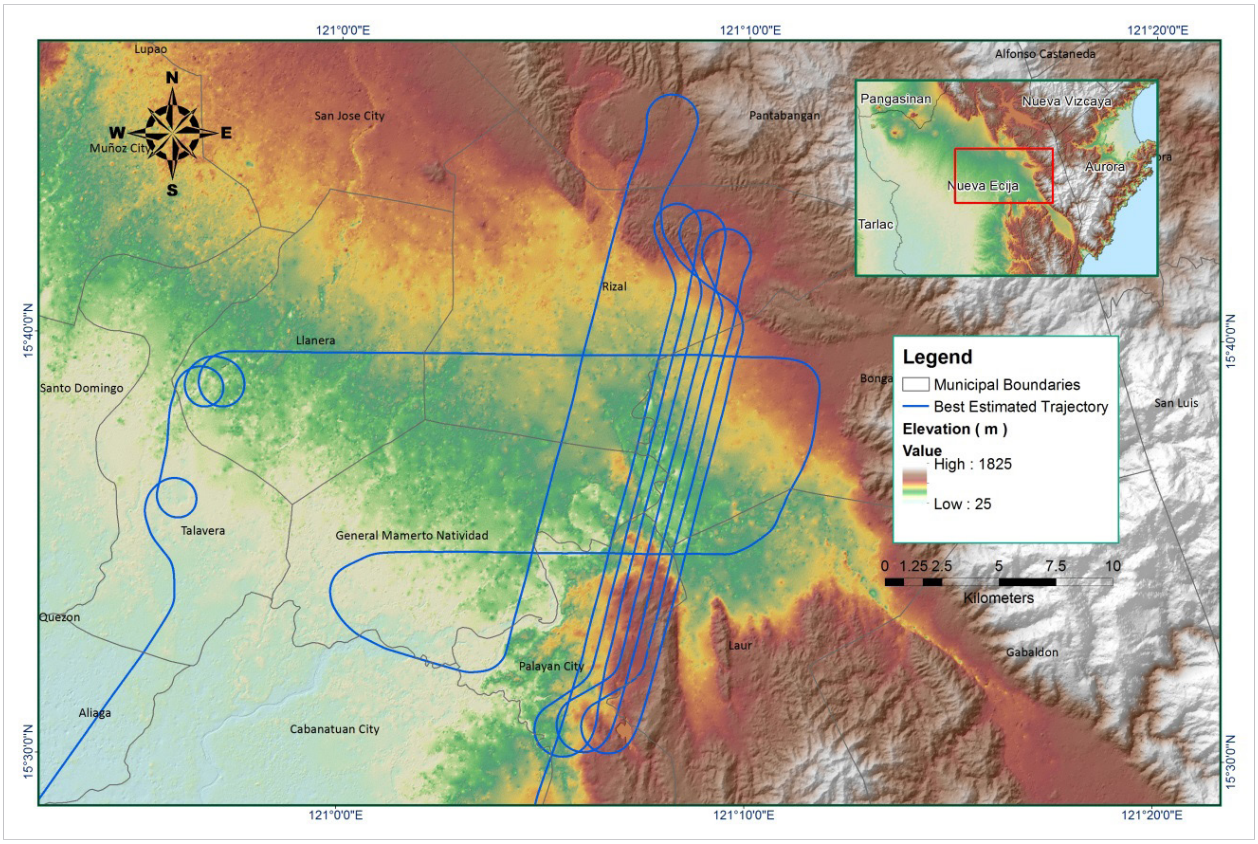


Figure 1.13.3 Best Estimated Trajectory

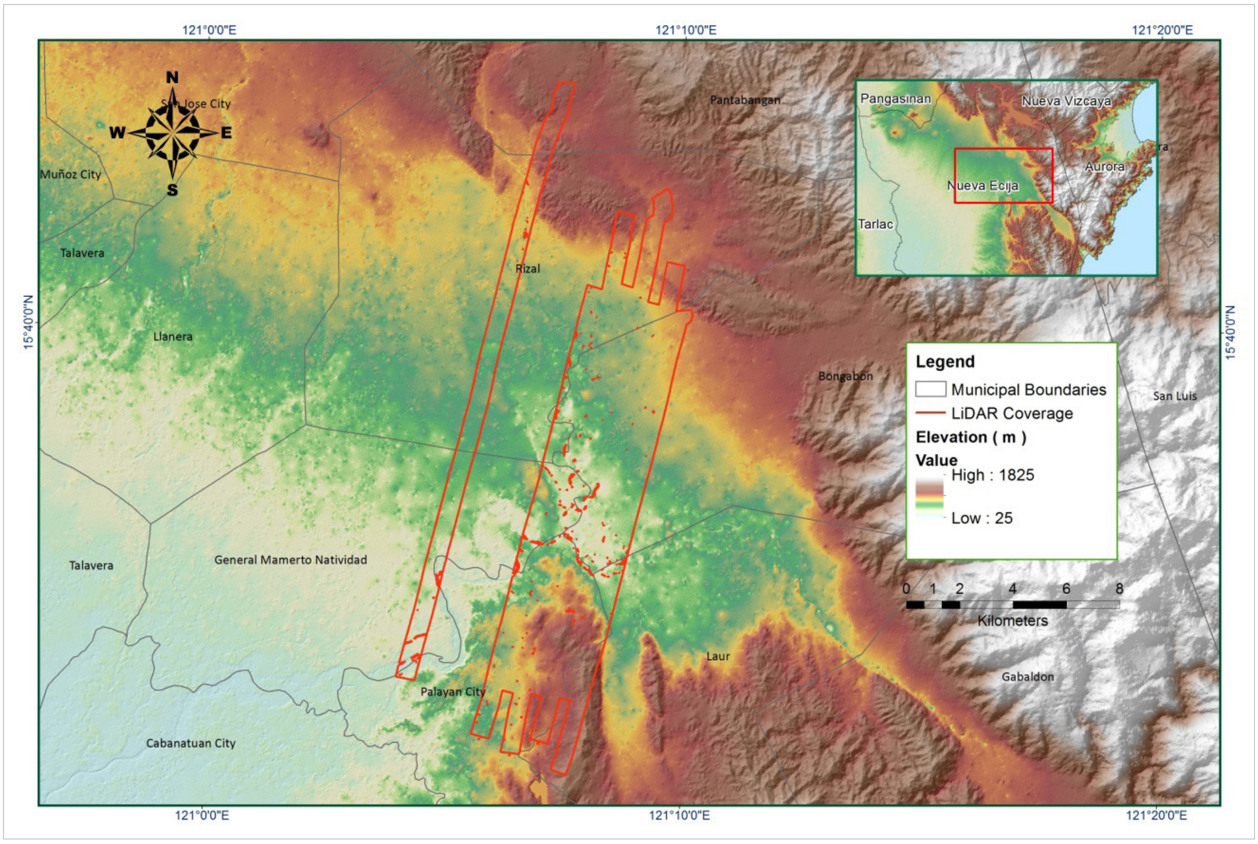


Figure 1.13.4 Coverage of LIDAR data

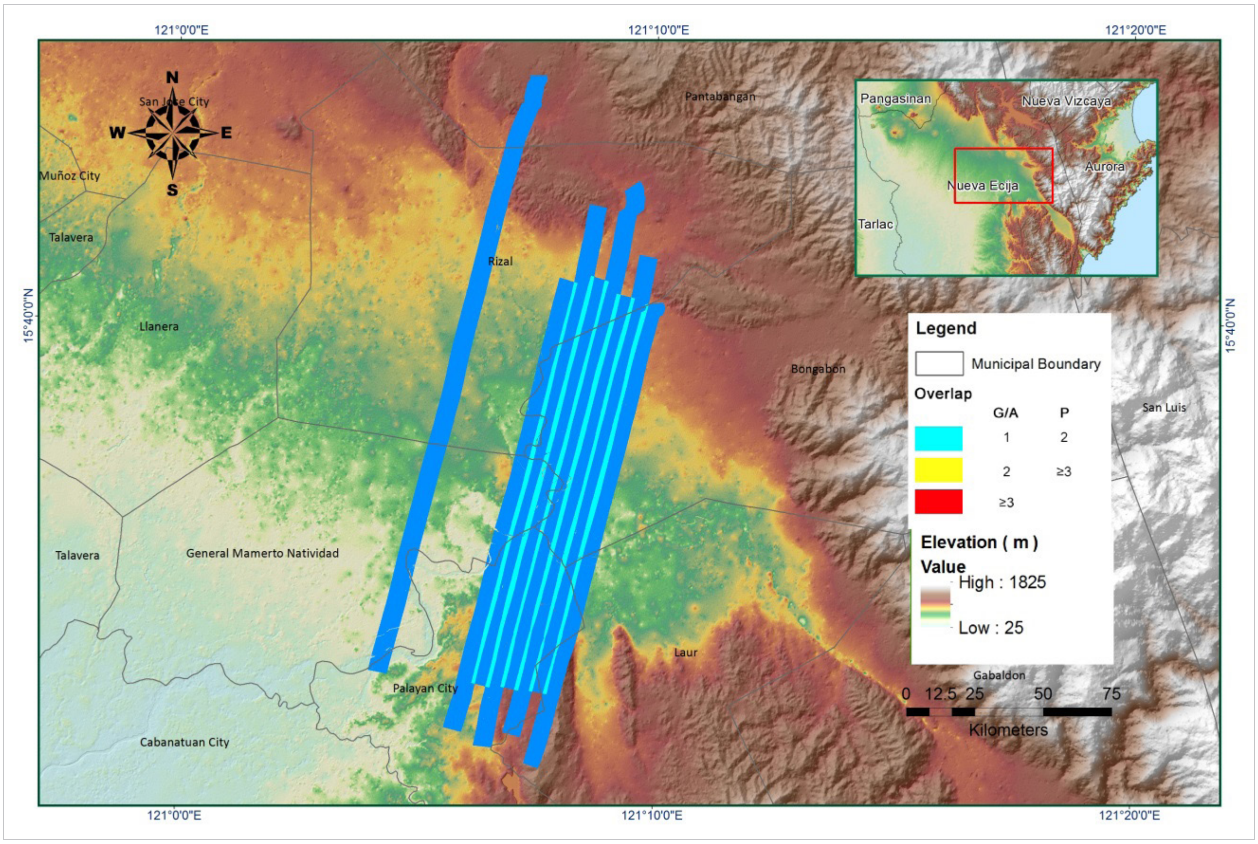


Figure 1.13.5 Image of Data Overlap

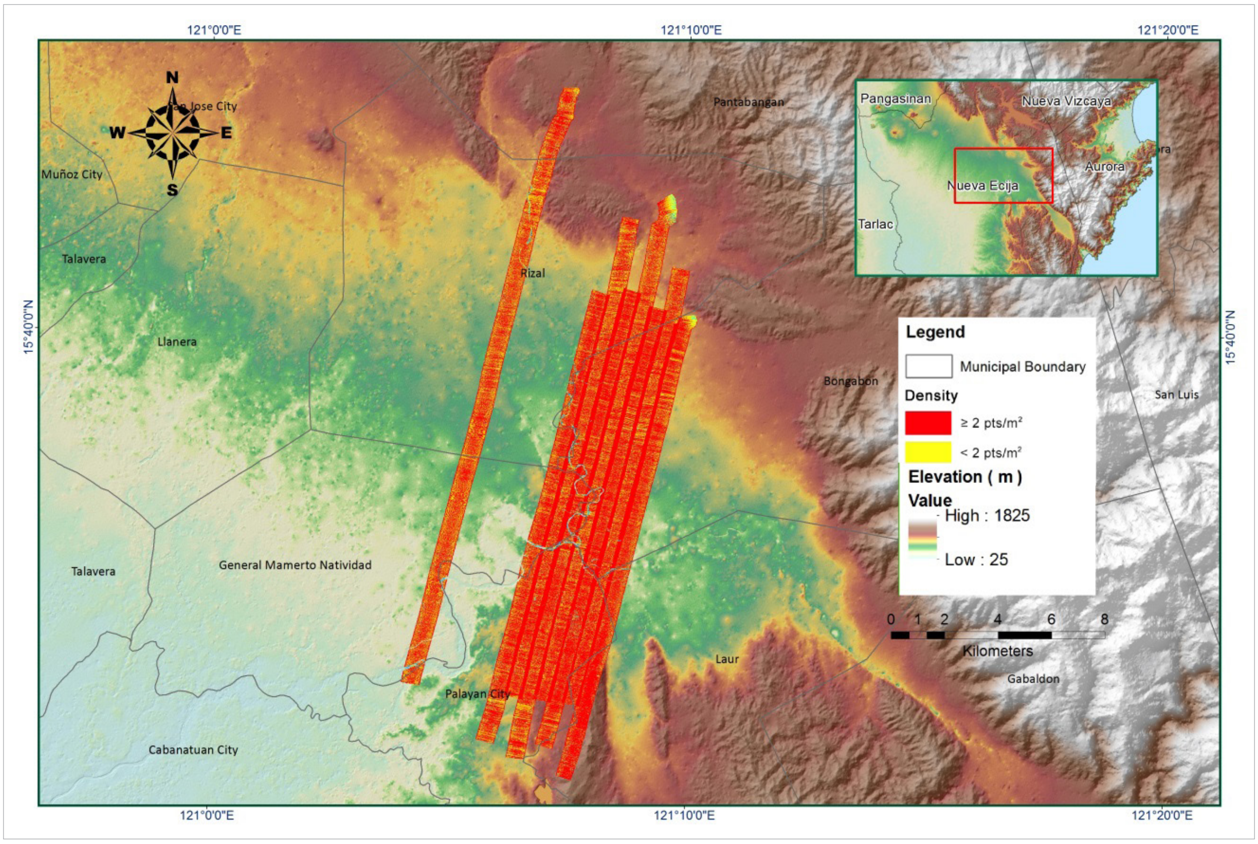


Figure 1.13.6 Density map of merged LIDAR data

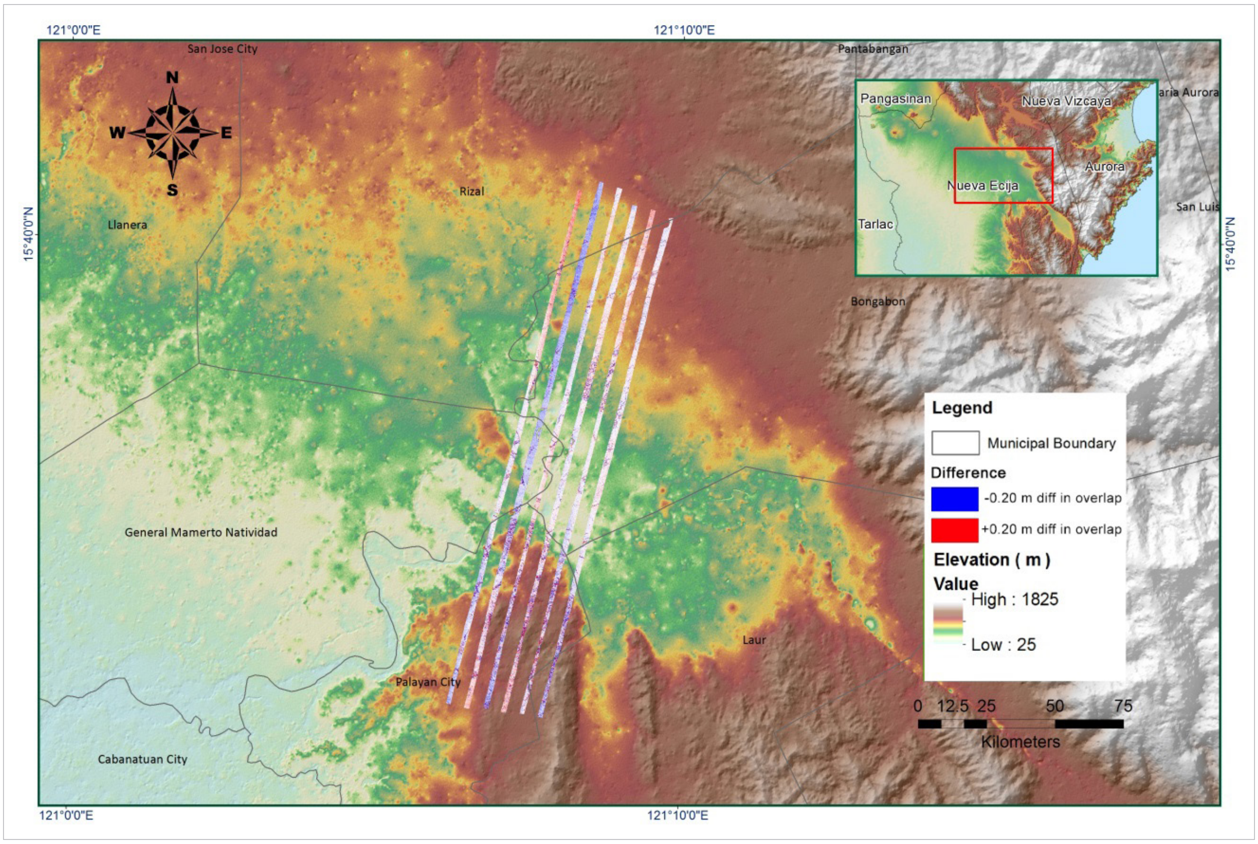


Figure 1.13.7 Elevation difference between flight lines

Table A-8.14. Mission Summary Report for Mission NEJ1B

Flight Area	Nueva Ecija
Mission Name	NEJ1B
Inclusive Flights	1011P, 1013P
Range data size	29.8 GB
Base data size	MB
POS	335 MB
Image	15.3 GB
Transfer date	
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)	3.162
RMSE for East Position (<4.0 cm)	4.614
RMSE for Down Position (<8.0 cm)	9.852
Boresight correction stdev (<0.001deg)	0.000288
IMU attitude correction stdev (<0.001deg)	0.000624
GPS position stdev (<0.01m)	0.0068
Minimum % overlap (>25)	12.91
Ave point cloud density per sq.m. (>2.0)	2.28
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	324
Maximum Height	534.7 m
Minimum Height	90.82 m
Classification (# of points)	
Ground	568356129
Low vegetation	411103218
Medium vegetation	284753470
High vegetation	134543333
Building	17053804
Orthophoto	No
Processed By	Engr. Jennifer Saguran, Engr. Mark Joshua Salvacion, Engr. Jeffrey Delica

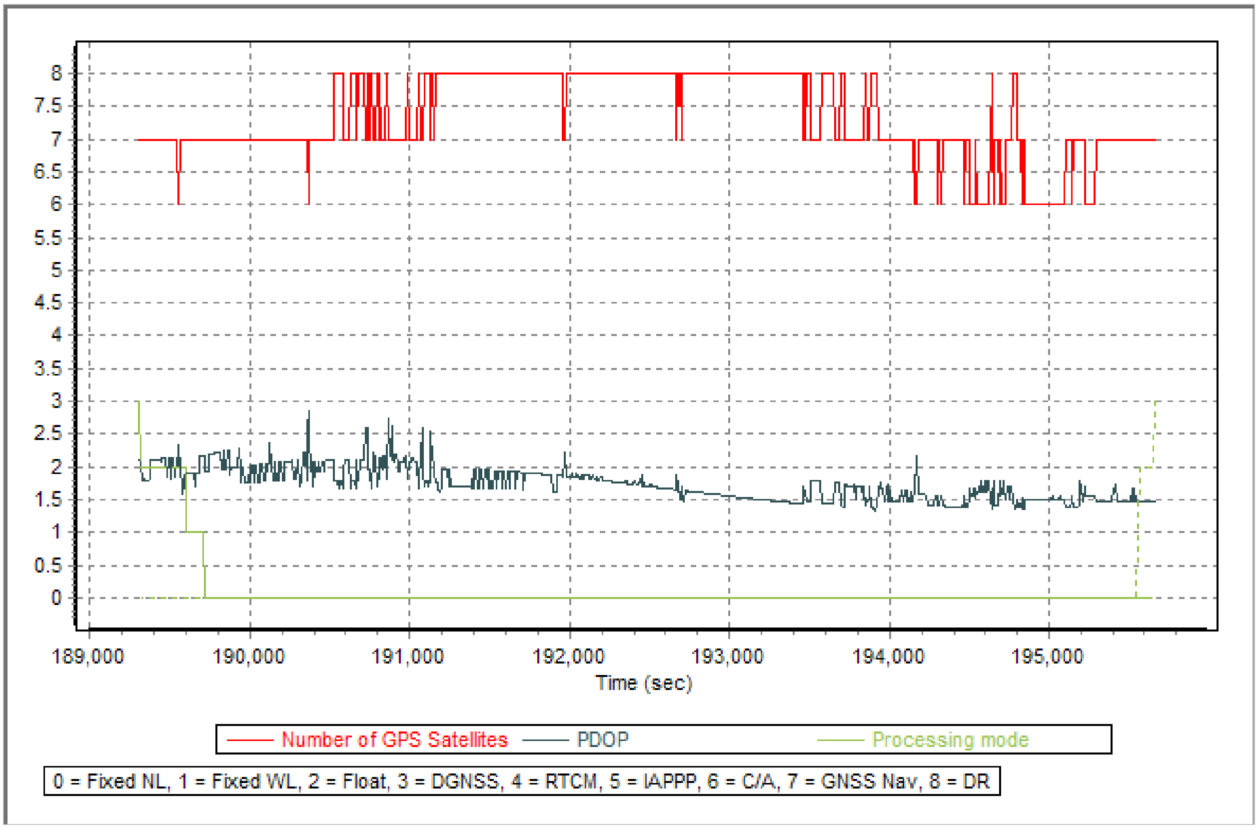


Figure 1.14.1 Solution Status

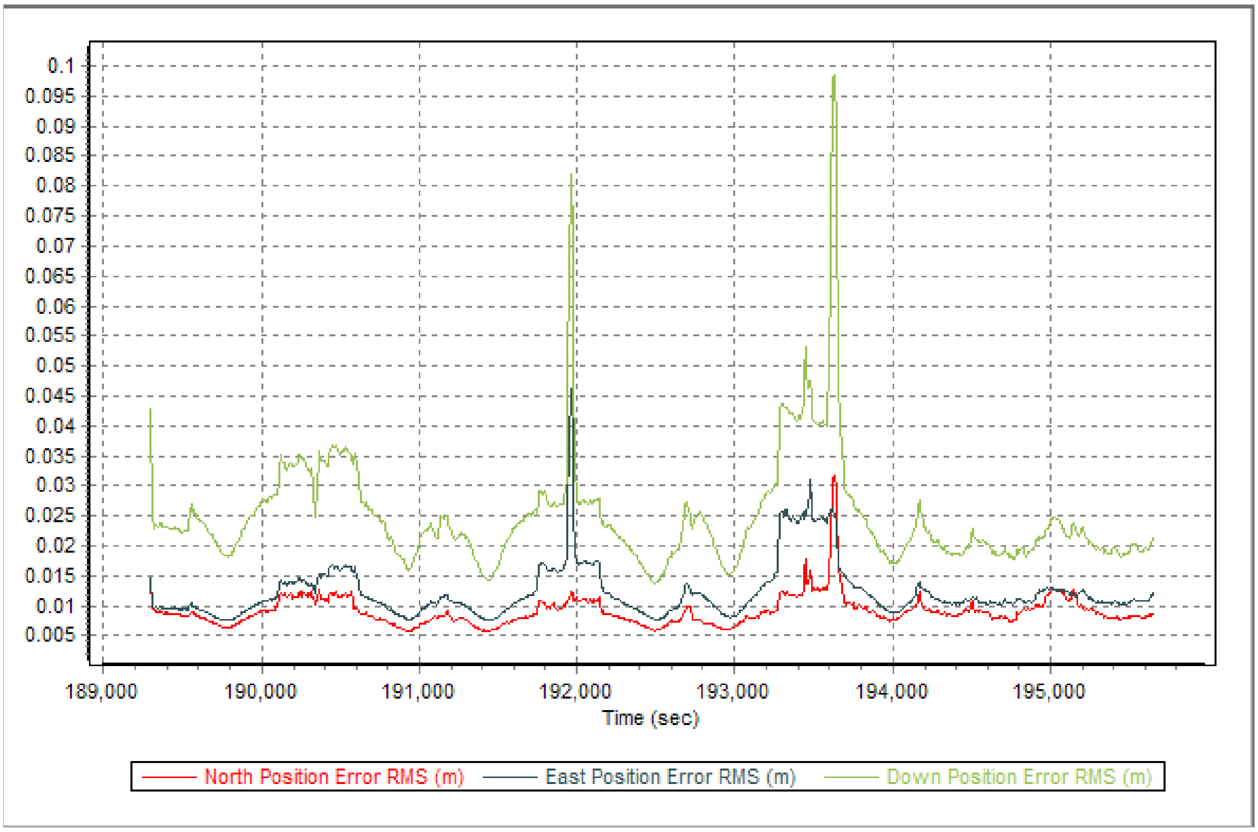


Figure 1.14.2 Smoothed Performance Metric Parameters

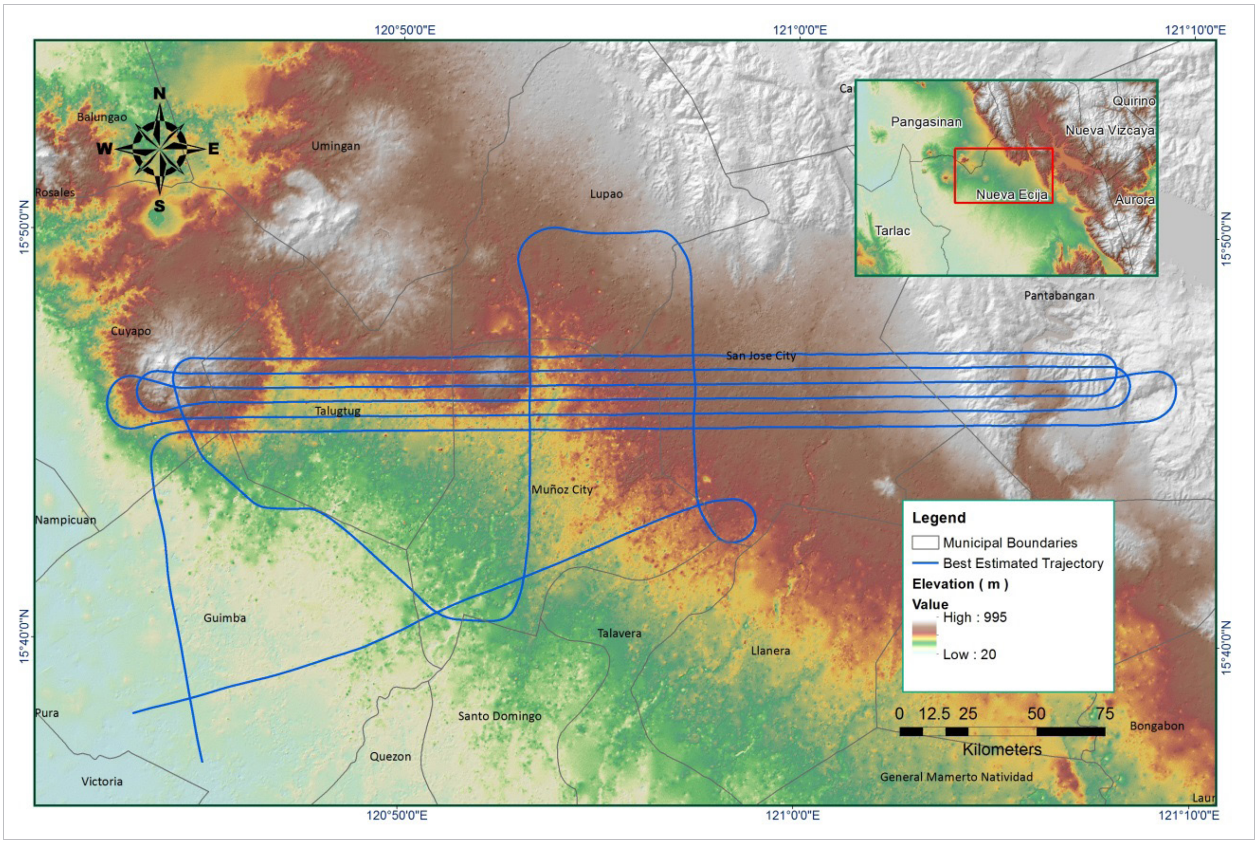


Figure 1.14.3 Best Estimated Trajectory

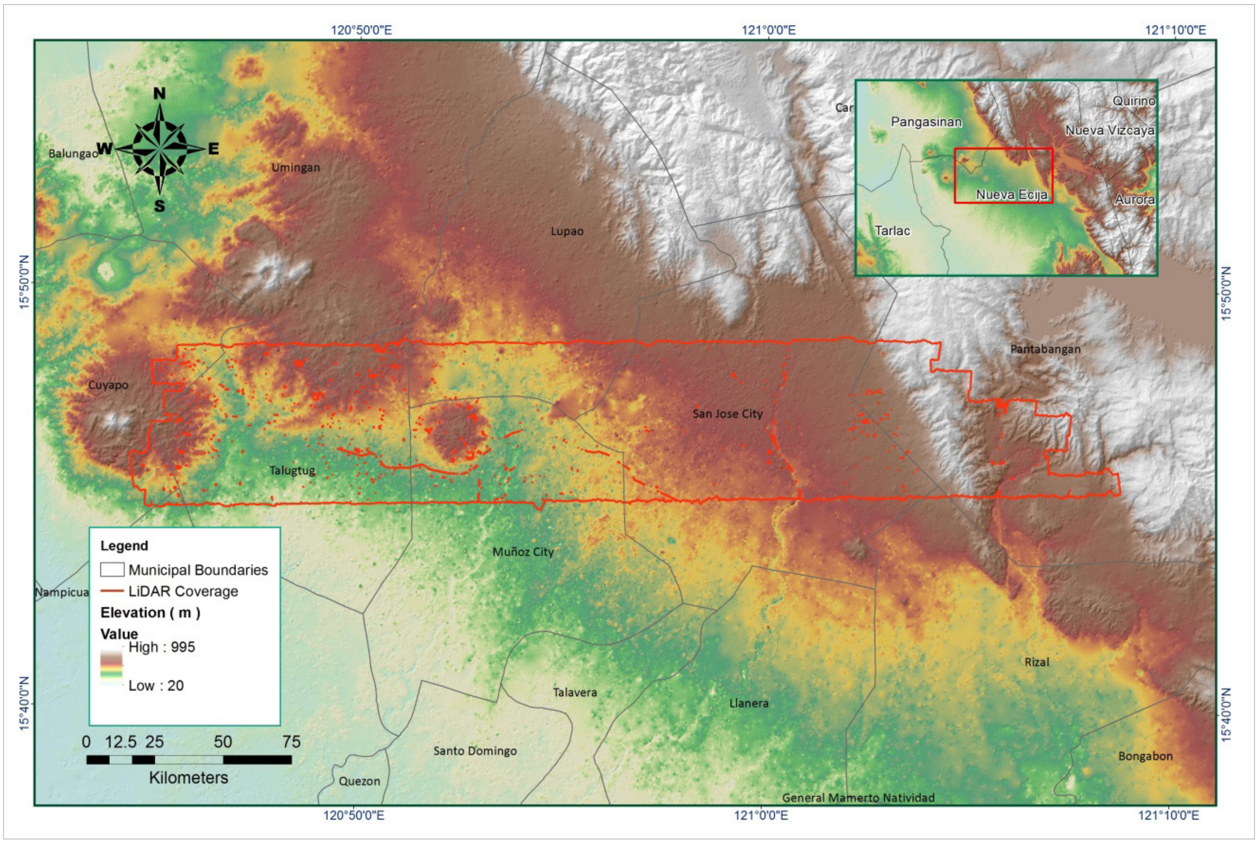


Figure 1.14.4 Coverage of LIDAR data

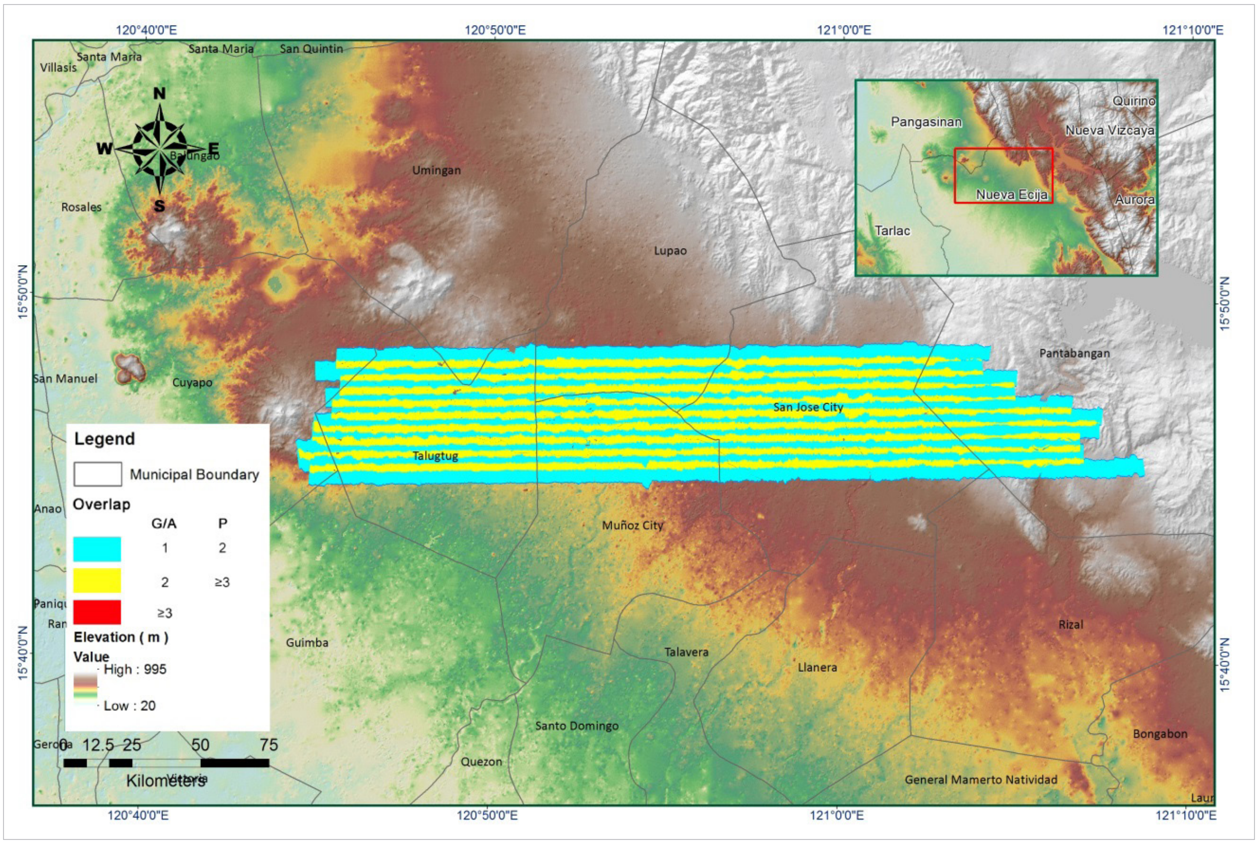


Figure 1.14.5 Image of Data Overlap

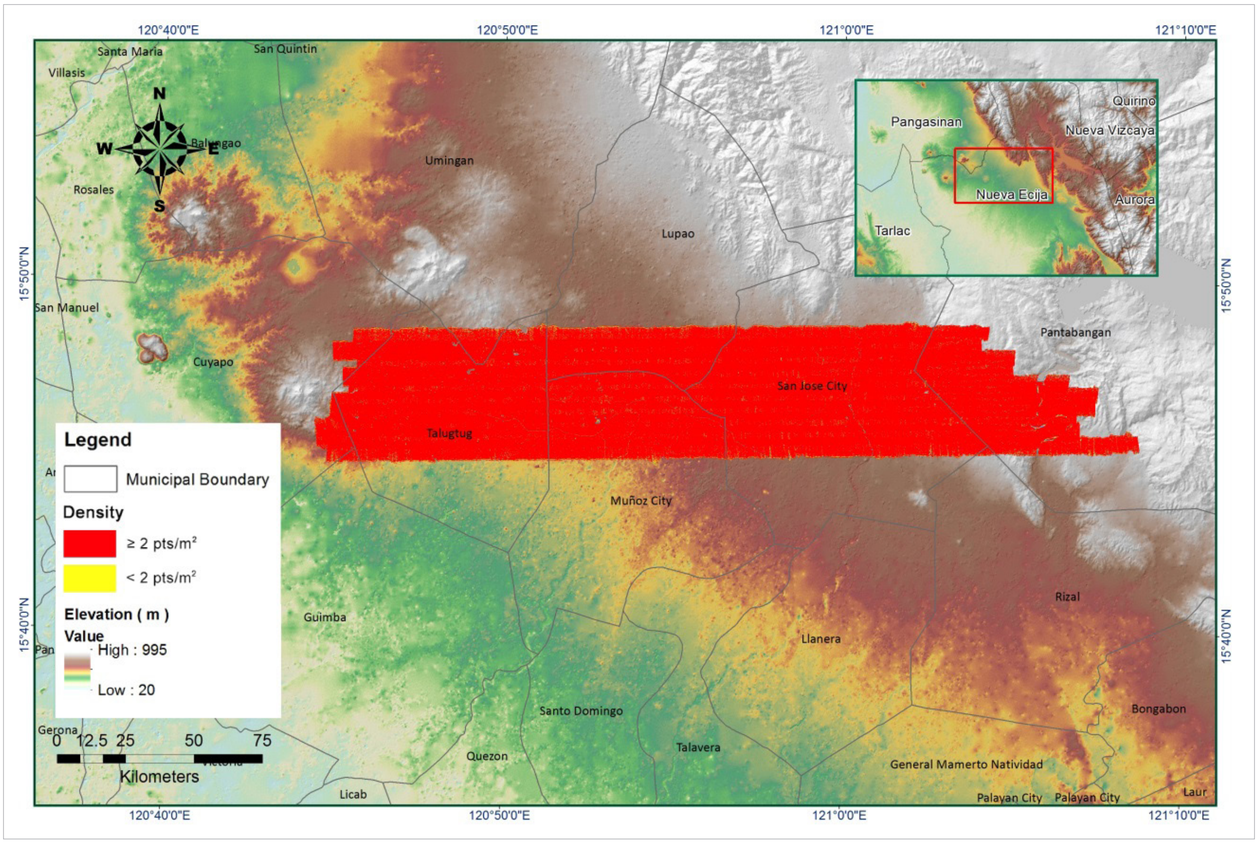


Figure 1.14.6 Density map of merged LIDAR data

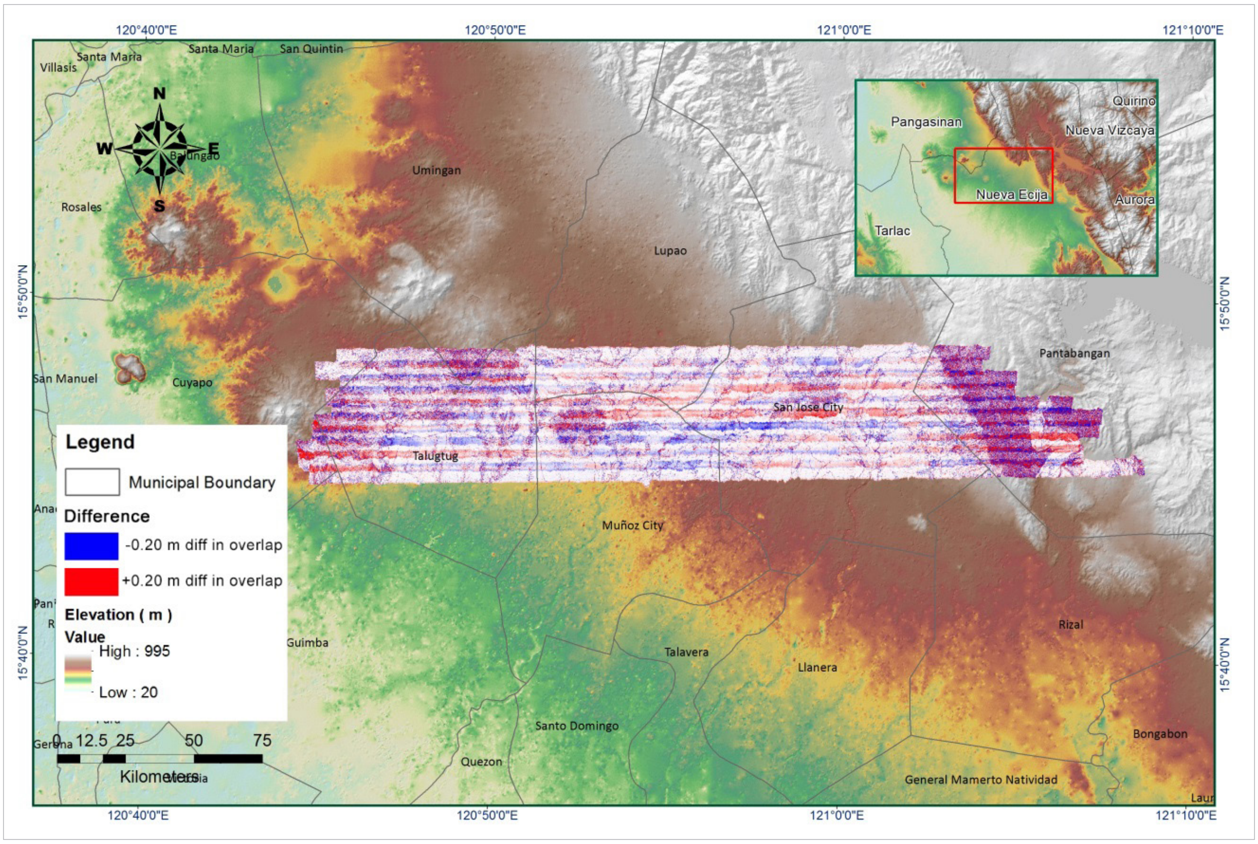


Figure 1.14.7 Elevation difference between flight lines

Table A-8.15. Mission Summary Report for Mission NEJ_1015P_1019P

Flight Area	Nueva Ecija
Mission Name	NEJ_1015P_1019P
Inclusive Flights	1015P, 1019P
Range data size	23.0 GB
Base data size	MB
POS	329 MB
Image	64.79 GB
Transfer date	
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)	5.935
RMSE for East Position (<4.0 cm)	2.158
RMSE for Down Position (<8.0 cm)	9.074
Boresight correction stdev (<0.001deg)	0.000292
IMU attitude correction stdev (<0.001deg)	0.000920
GPS position stdev (<0.01m)	0.0067
Minimum % overlap (>25)	48.87
Ave point cloud density per sq.m. (>2.0)	2.59
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	258
Maximum Height	362.01 m
Minimum Height	92.27 m
Classification (# of points)	
Ground	310561671
Low vegetation	190449451
Medium vegetation	146905721
High vegetation	38365153
Building	5217138
Orthophoto	Yes
Processed By	Engr. Jennifer Saguran, Engr. Edgardo Gubatanga Jr., Engr. Melissa Fernandez

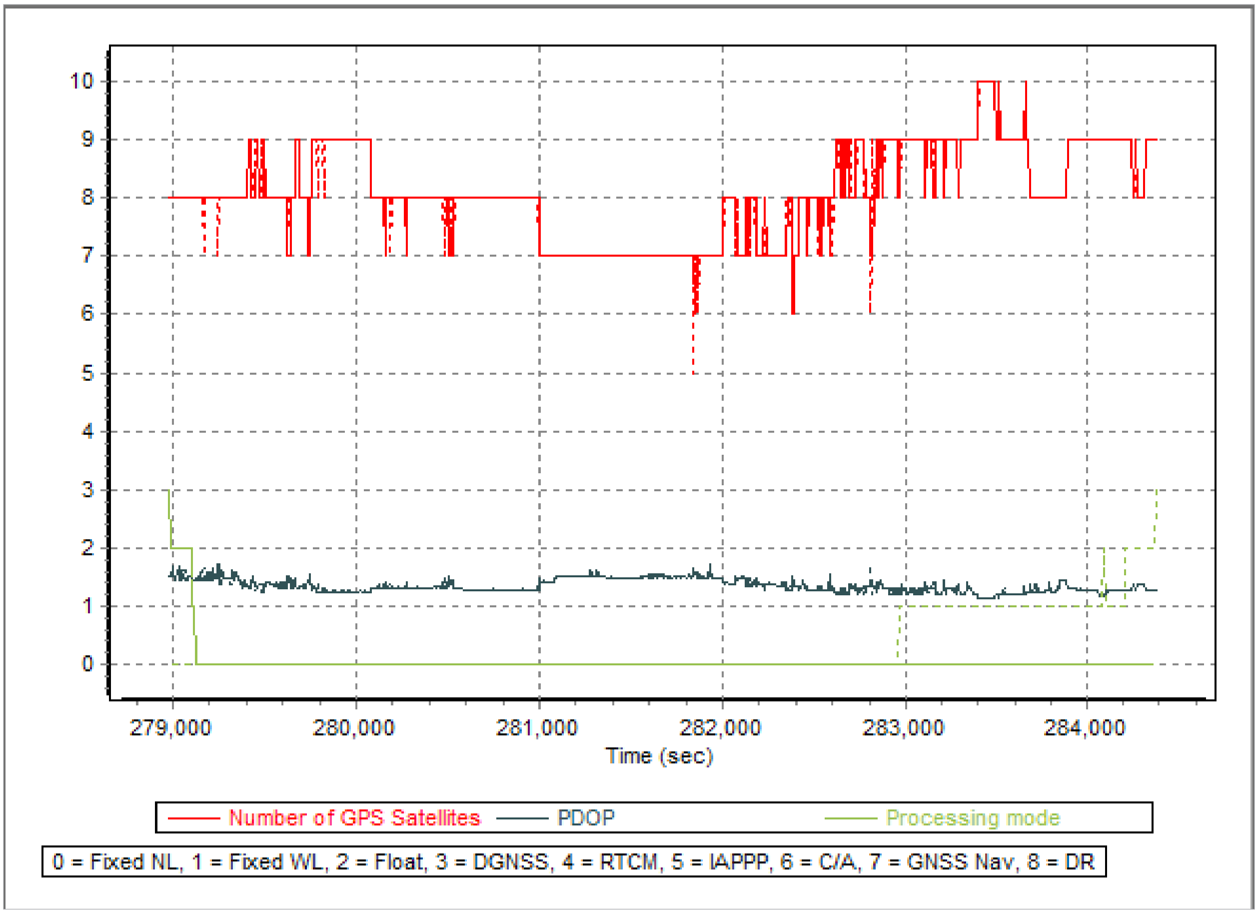


Figure 1.15.1 Solution Status

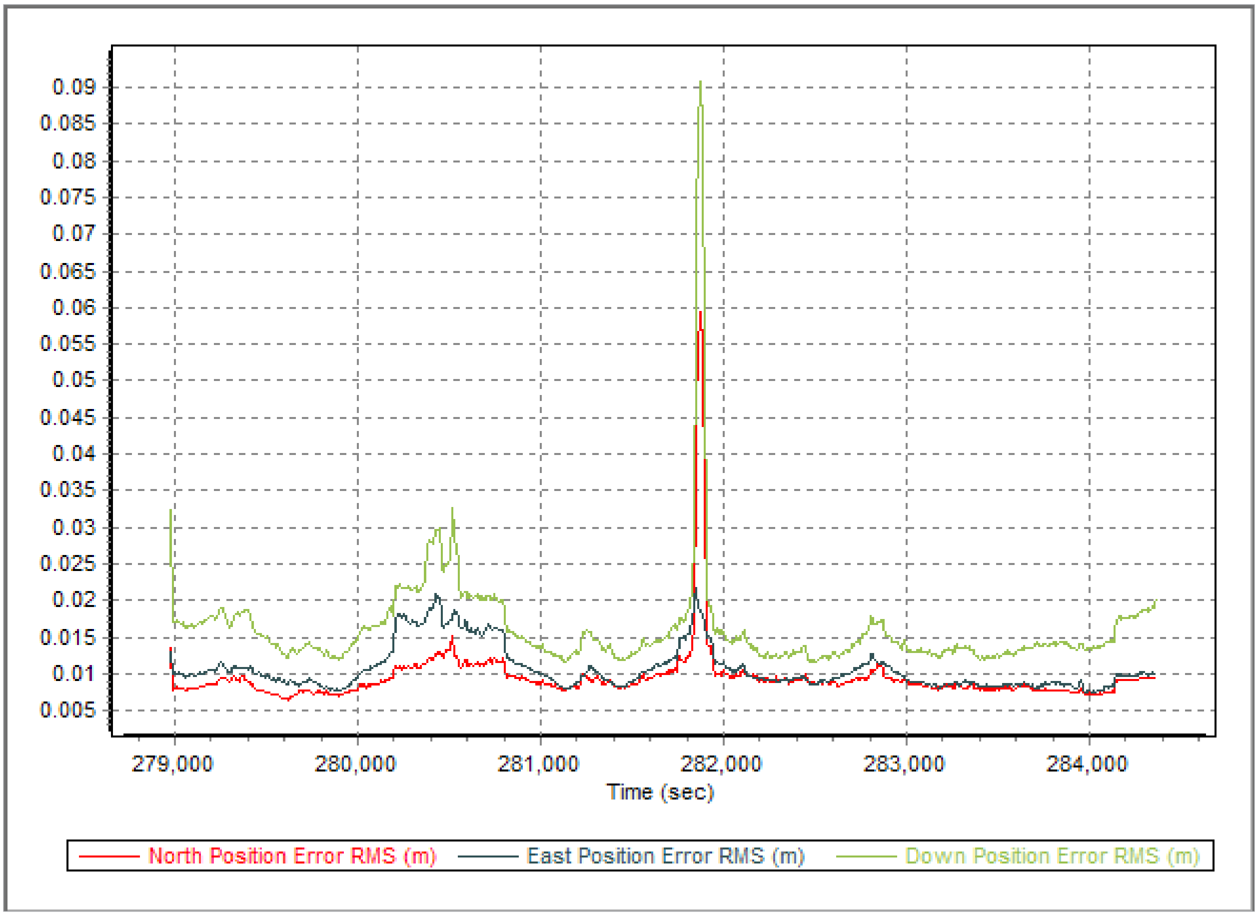


Figure 1.15.2 Smoothed Performance Metric Parameters

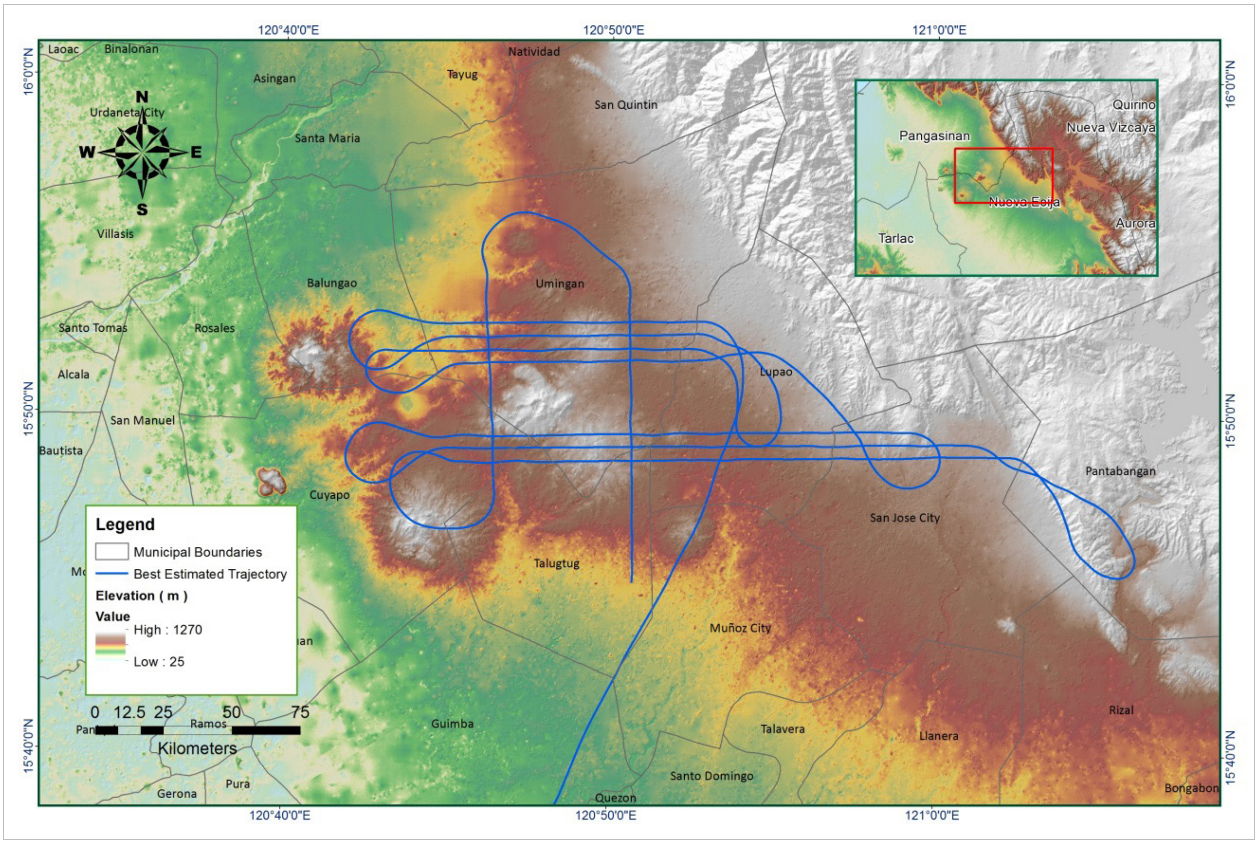


Figure 1.15.3 Best Estimated Trajectory

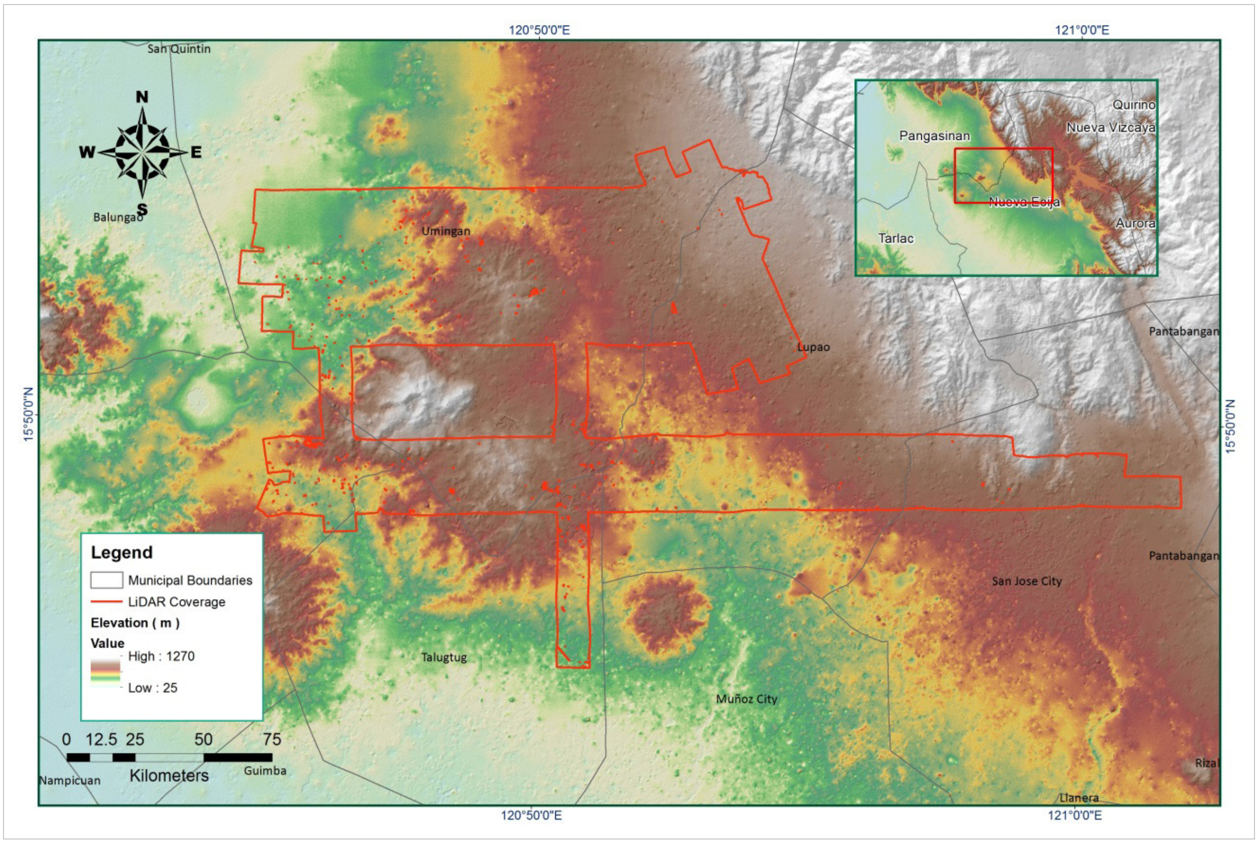


Figure 1.15.4 Coverage of LIDAR data

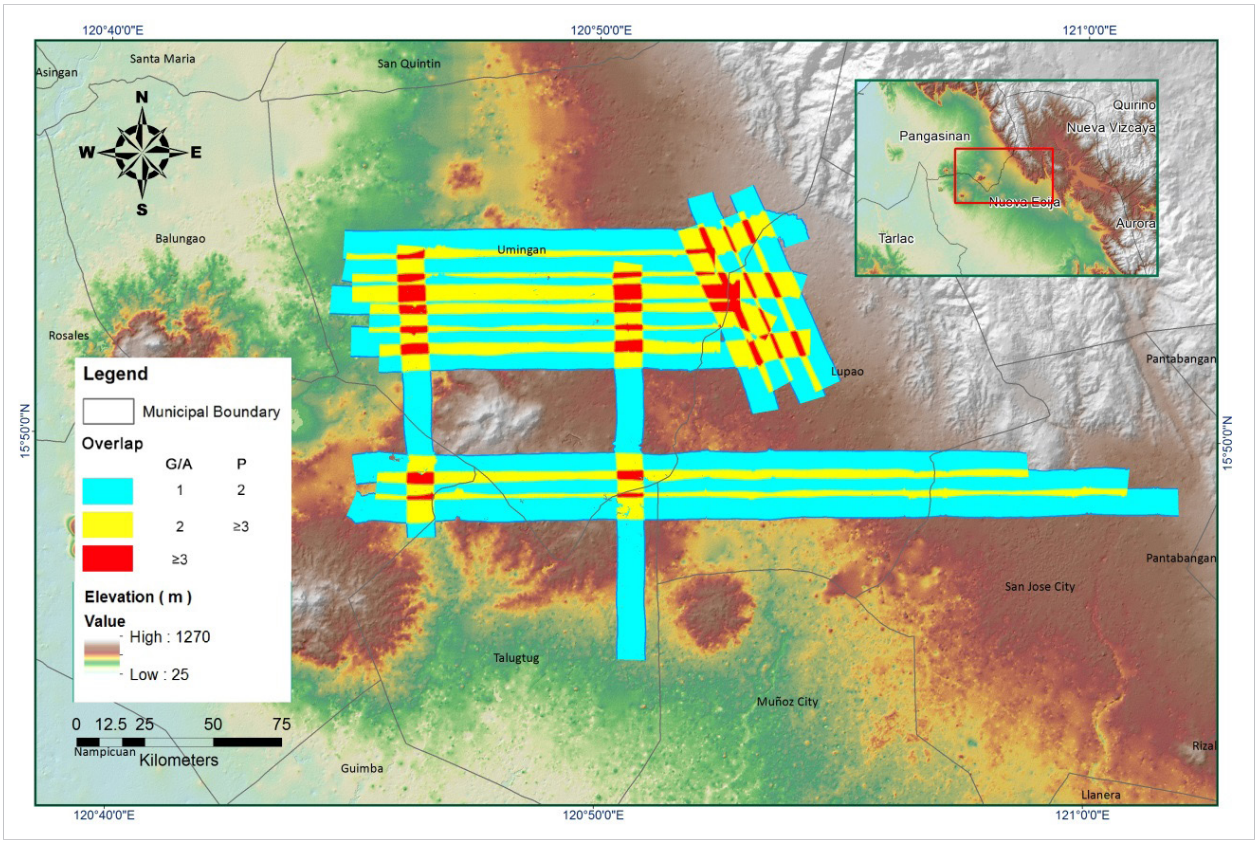


Figure 1.15.5 Image of Data Overlap

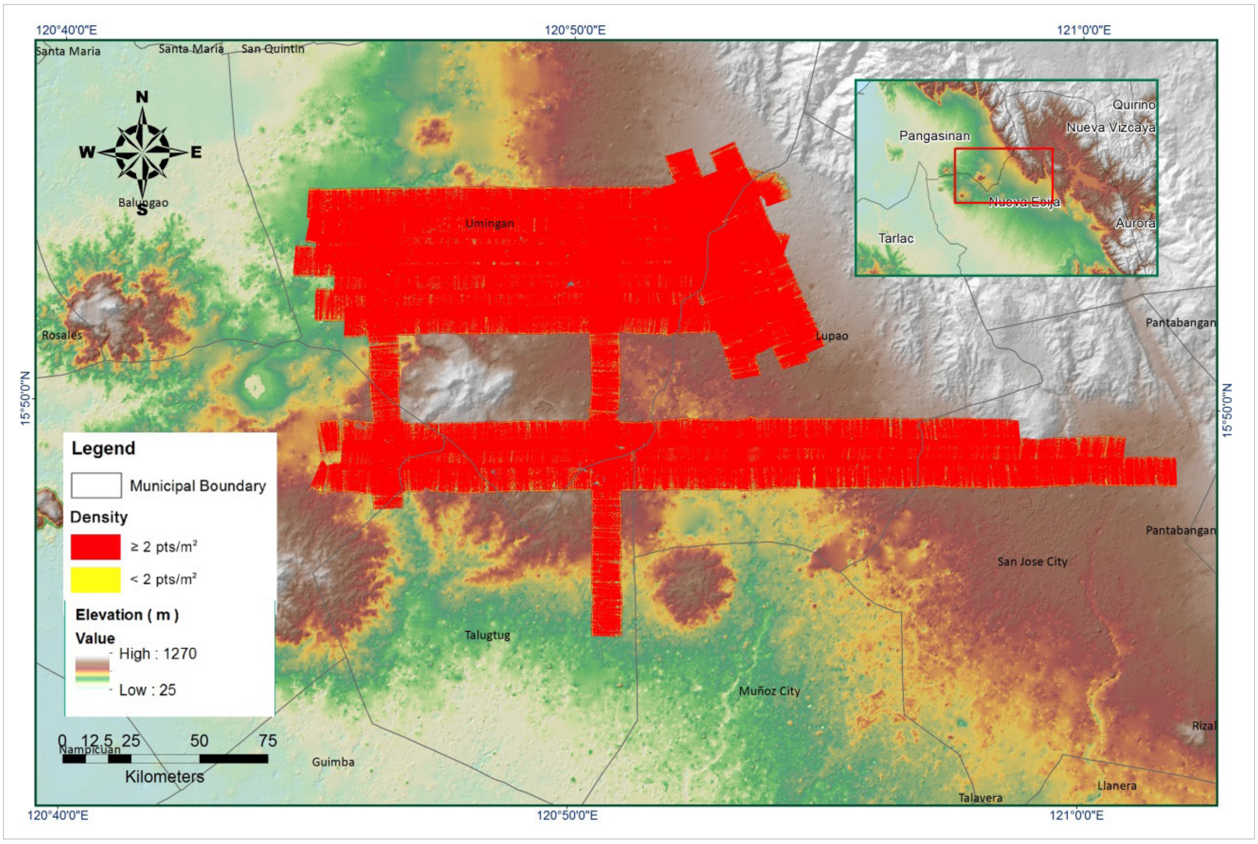


Figure 1.15.6 Density map of merged LIDAR data

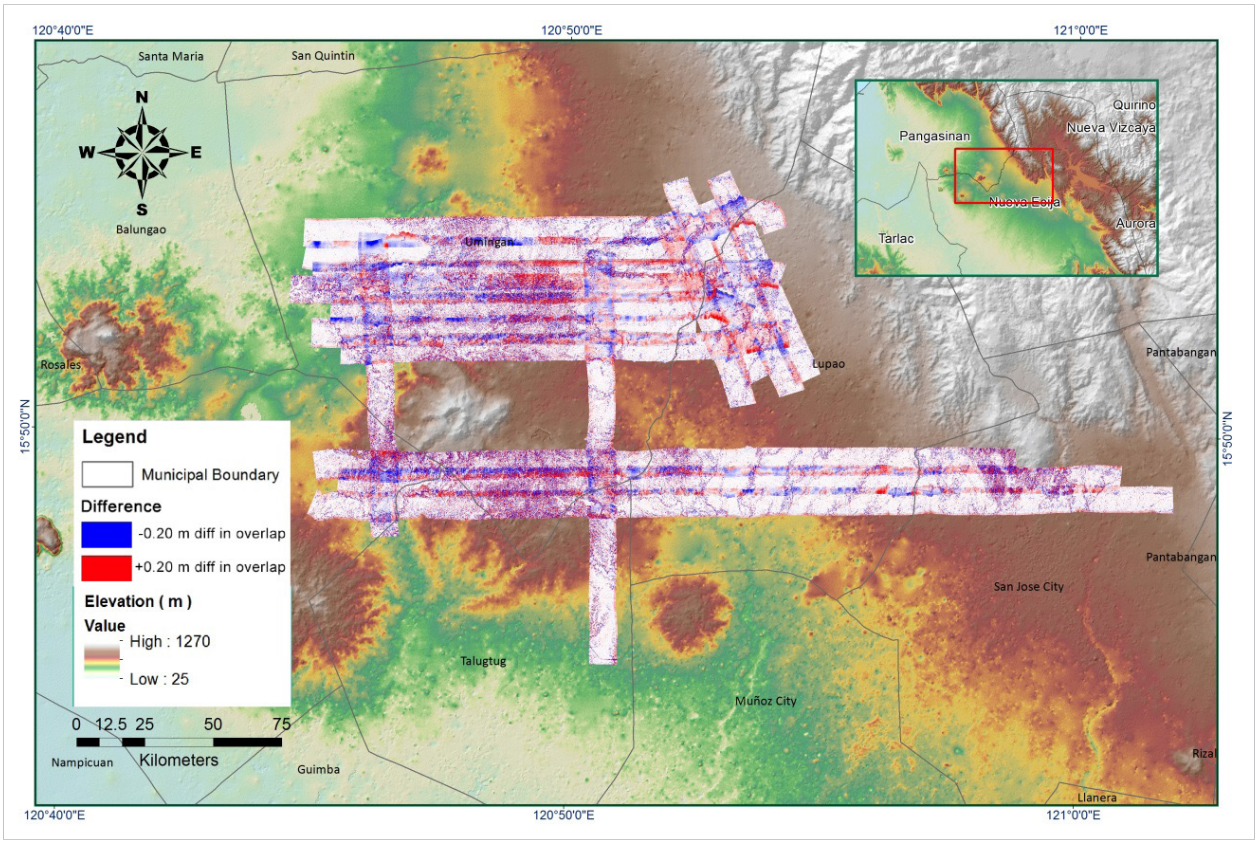


Figure 1.15.7 Elevation difference between flight lines

Table A-8.16. Mission Summary Report for Mission NEJ_additional

Flight Area	Nueva Ecija
Mission Name	NEJ_additional
Inclusive Flights	7032GC
Range data size	9.77 GB
Base data size	MB
POS	158 MB
Image	NA
Transfer date	
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)	3.7
RMSE for East Position (<4.0 cm)	6.2
RMSE for Down Position (<8.0 cm)	12.2
Boresight correction stdev (<0.001deg)	0.000369
IMU attitude correction stdev (<0.001deg)	0.000574
GPS position stdev (<0.01m)	0.0065
Minimum % overlap (>25)	12.91
Ave point cloud density per sq.m. (>2.0)	2.61
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	91
Maximum Height	162.49 m
Minimum Height	91.48 m
Classification (# of points)	
Ground	36776606
Low vegetation	49990467
Medium vegetation	22528600
High vegetation	5244303
Building	1217280
Orthophoto	No
Processed By	Engr. Kenneth Solidum, Engr. Chelou Prado, Engr. Melissa Fernandez

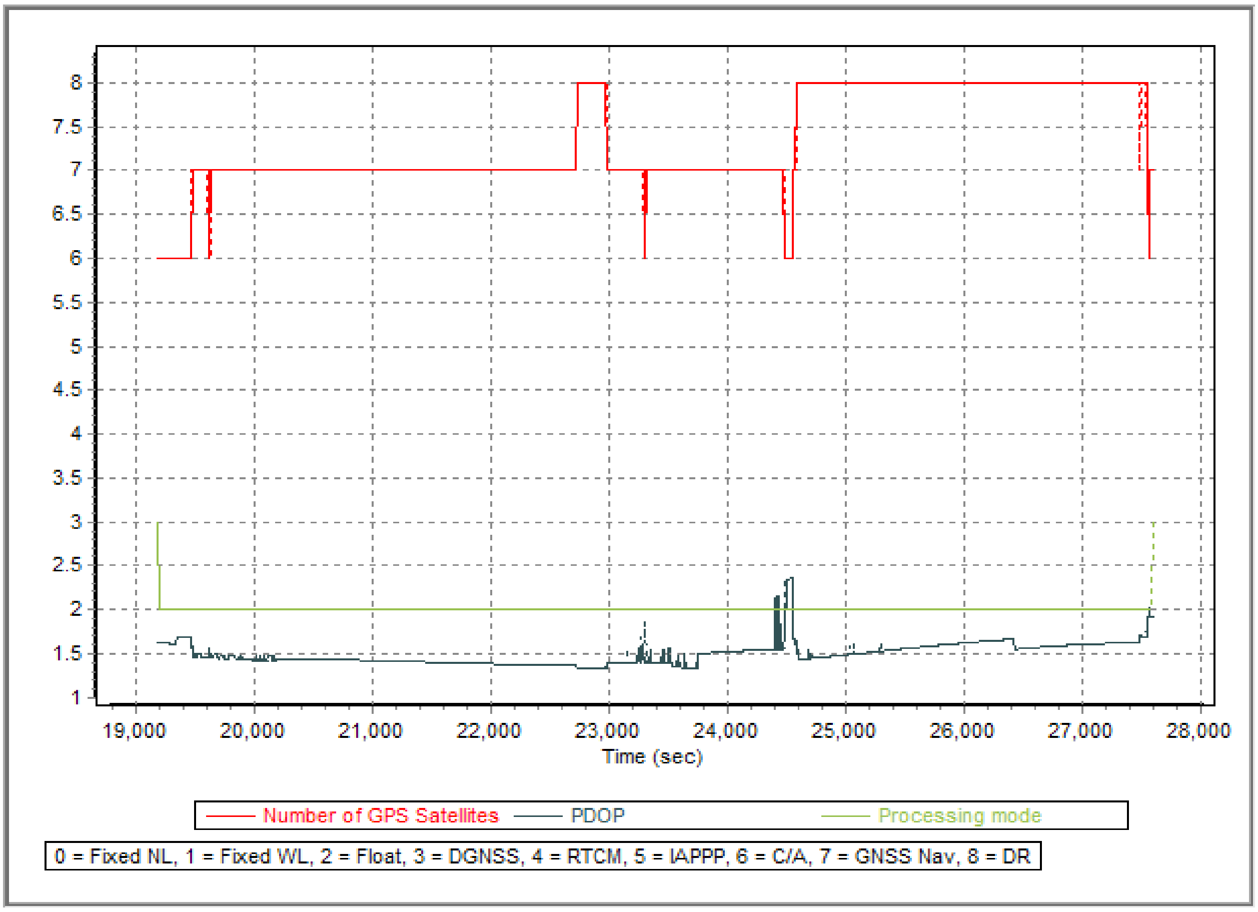


Figure 1.16.1 Solution Status

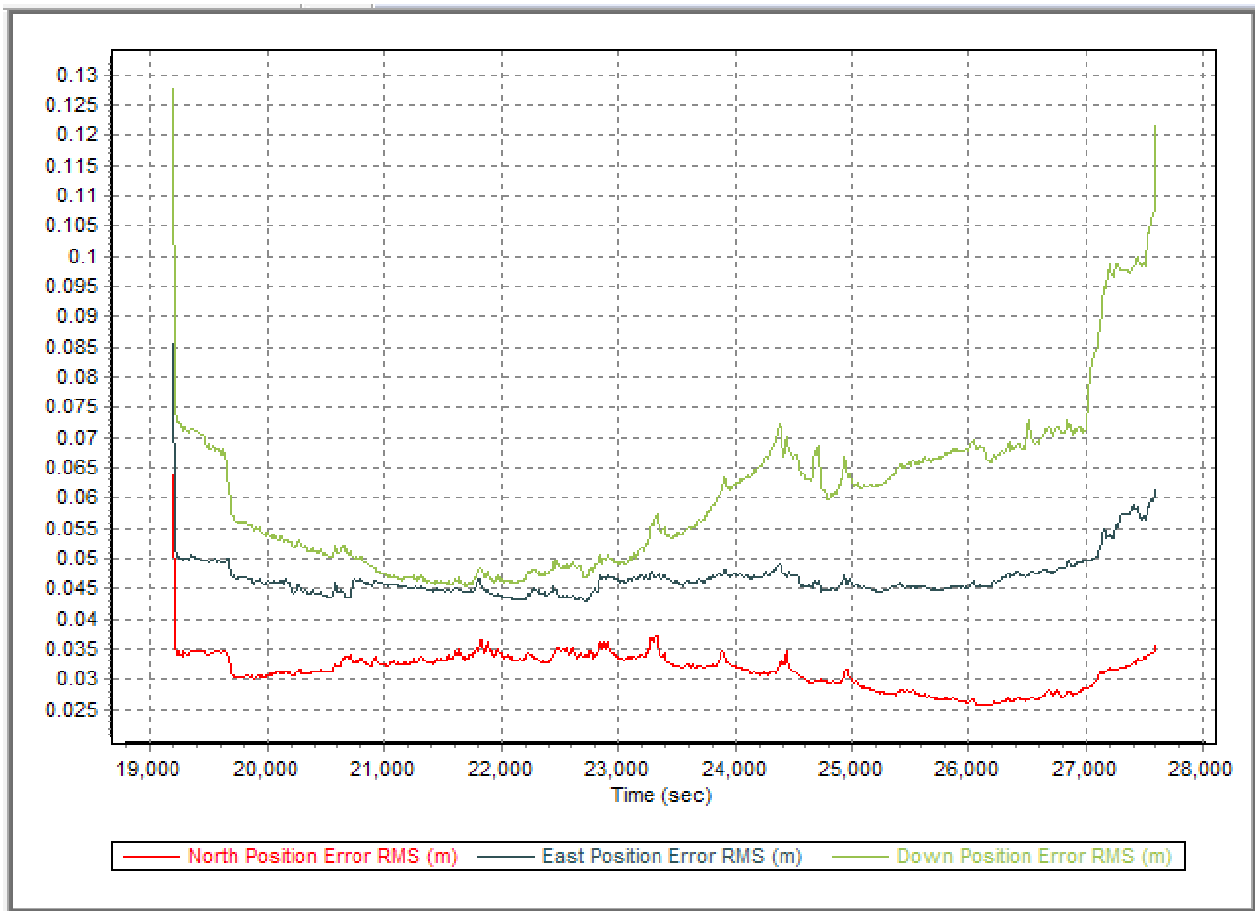


Figure 1.16.2 Smoothed Performance Metric Parameters

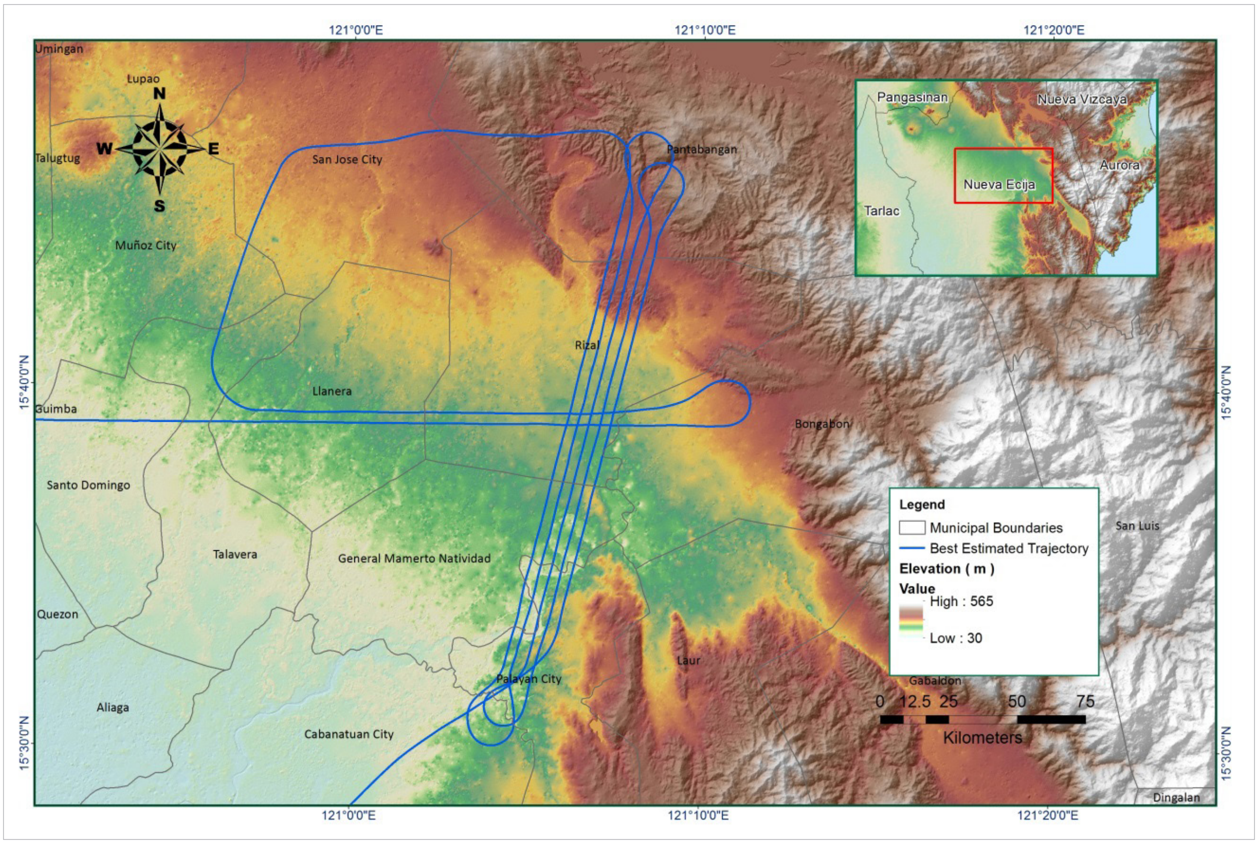


Figure 1.16.3 Best Estimated Trajectory

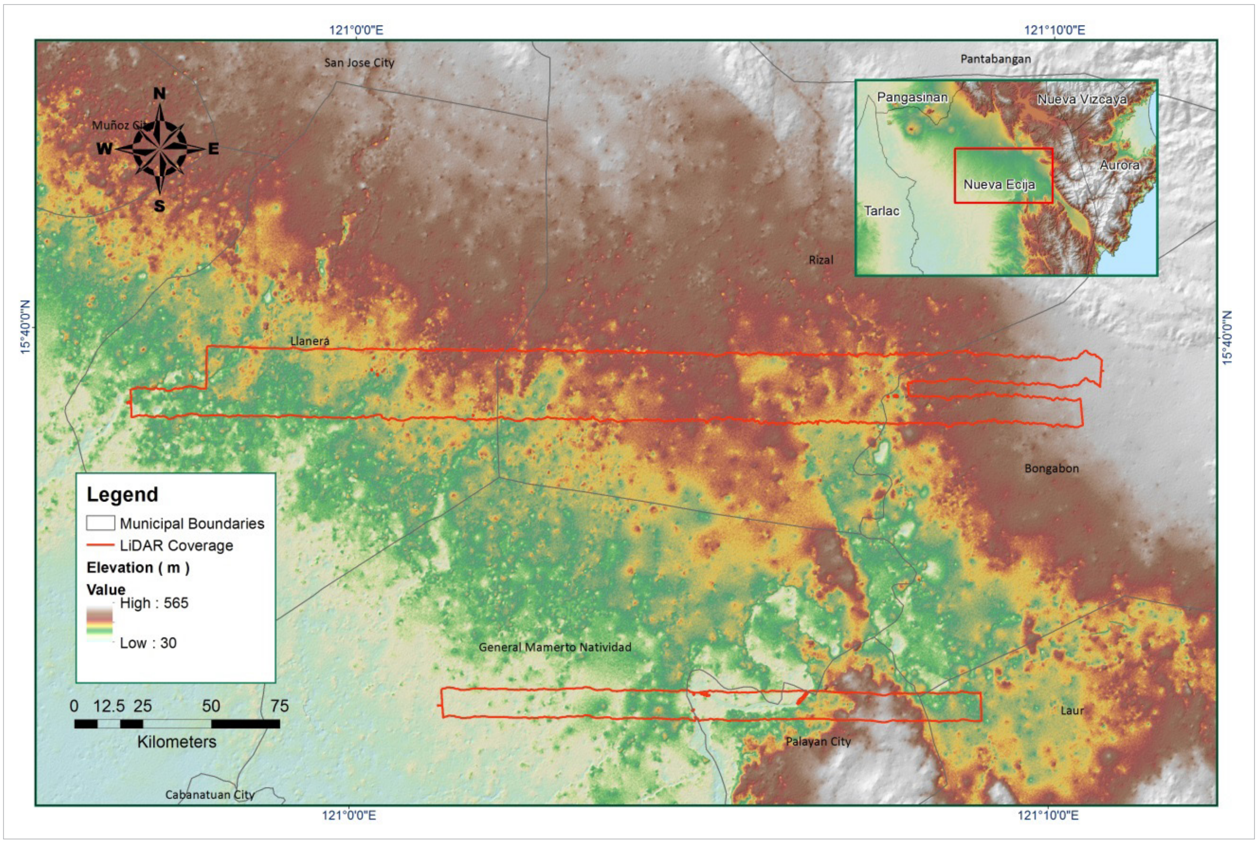


Figure 1.16.4 Coverage of LIDAR data

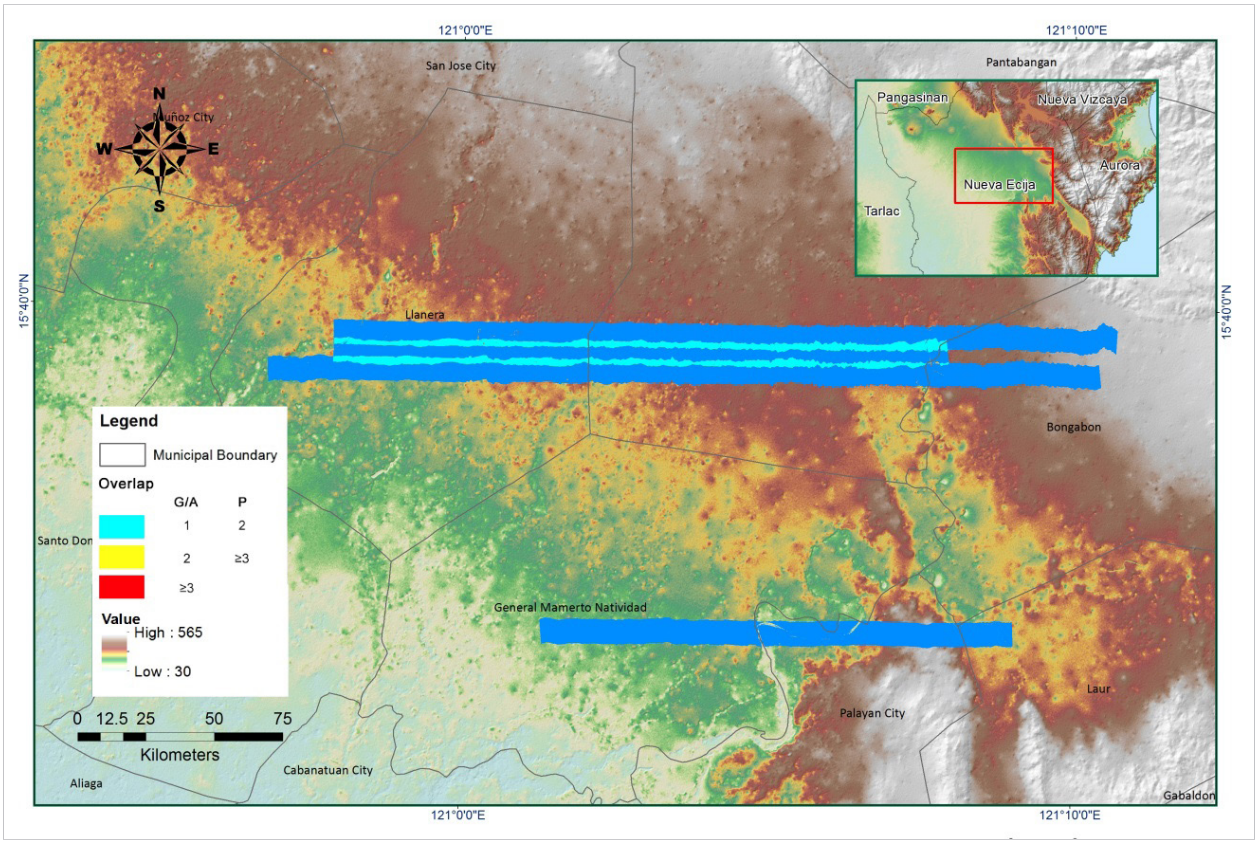


Figure 1.16.5 Image of Data Overlap

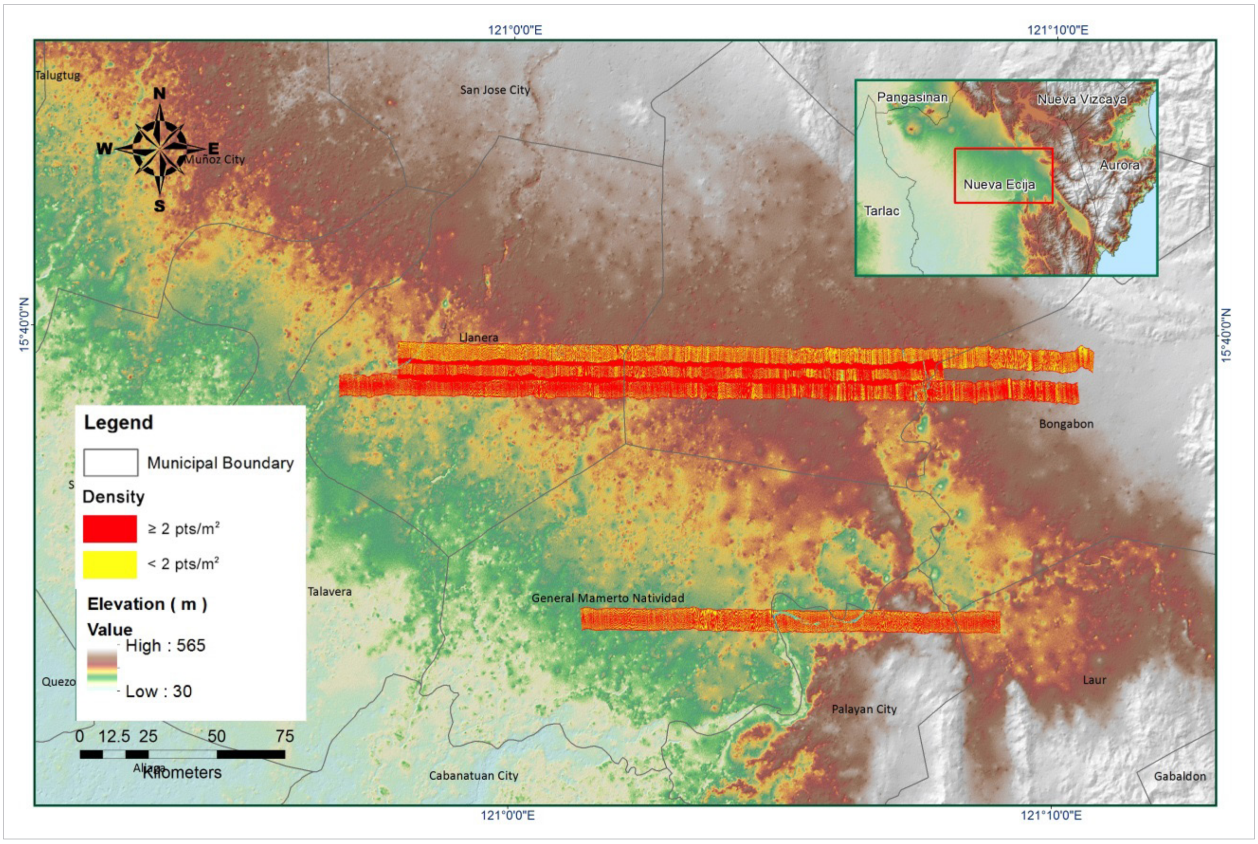


Figure 1.16.6 Density map of merged LIDAR data

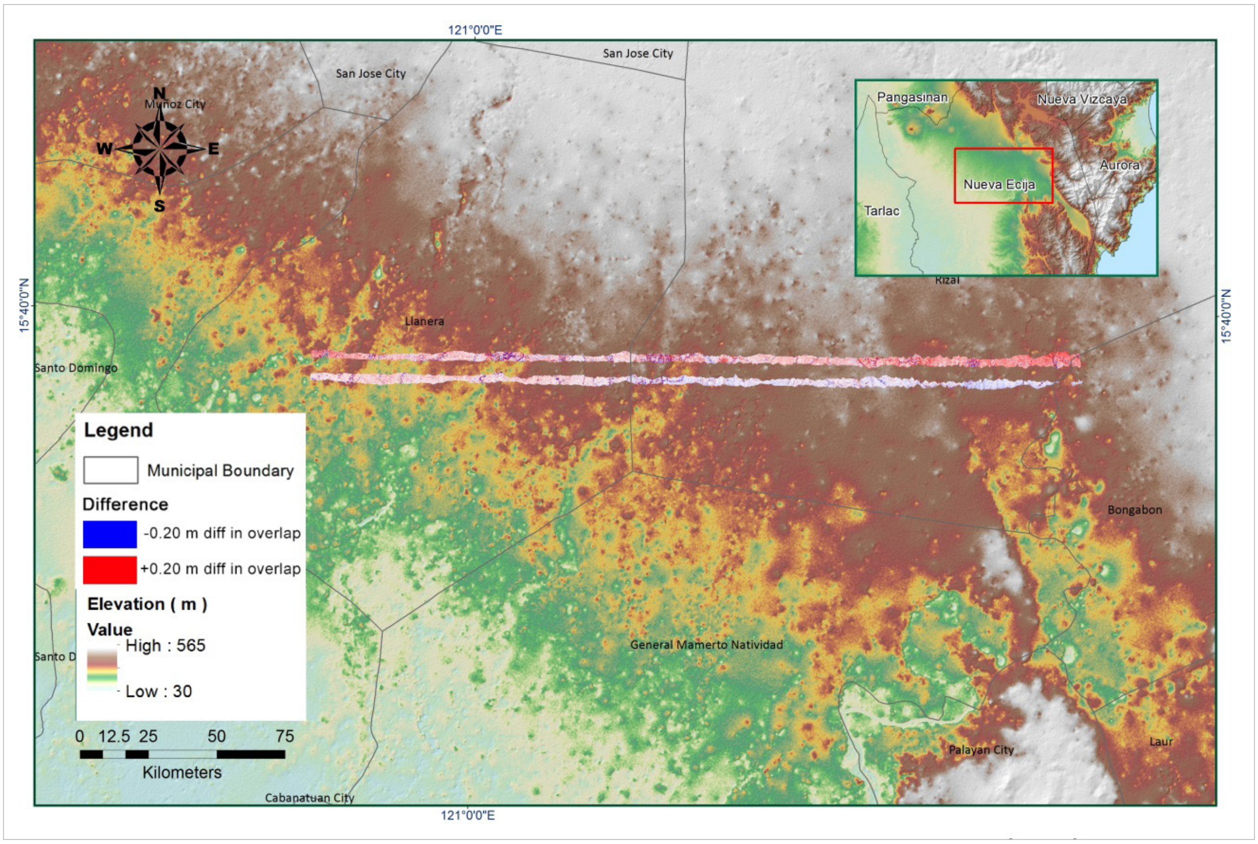


Figure 1.16.7 Elevation difference between flight lines

ANNEX 9. Patalan Model Basin Parameters

Table A-9.1. Patalan Model Basin Parameters

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recess56n Basef36w				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (cms)	Recession Constant	Threshold Type	Ratio to Peak
W2750	0.5966	89.986	0	1.1977	1.223	Discharge	7.3573	0.83013	Ratio to Peak	0.52806
W2760	0.34515	99	0	1.5627	2.54	Discharge	3.1495	0.8479	Ratio to Peak	0.54206
W2770	0.3283	99	0	2.1999	1.4129	Discharge	1.138	0.52176	Ratio to Peak	1
W2780	0.6944	99	0	0.96737	0.45852	Discharge	1.9389	0.80123	Ratio to Peak	0.54394
W2790	0.12904	99	0	9.9647	7.5315	Discharge	2.1391	0.63139	Ratio to Peak	0.23476
W2800	0.15283	99	0	6.1269	4.5563	Discharge	4.1149	0.42396	Ratio to Peak	0.37162
W2810	0.6095	99	0	1.5137	0.29252	Discharge	0.14759	0.84757	Ratio to Peak	0.54666
W2820	0.73666	99	0	0.62521	1.5264	Discharge	1.9299	0.80105	Ratio to Peak	0.55487
W2830	0.12789	99	0	16.397	5.0941	Discharge	4.64	0.8579	Ratio to Peak	0.16296
W2840	0.0900845	99	0	6.4857	5.8237	Discharge	2.2277	0.62862	Ratio to Peak	0.81529
W2850	0.3439	99	0	15.103	0.84573	Discharge	5.1881	0.54695	Ratio to Peak	0.53229
W2860	0.15905	99	0	11.167	14.632	Discharge	2.7441	0.84082	Ratio to Peak	0.5073
W2870	0.0887467	99	0	6.4065	8.1536	Discharge	0.8169	0.59453	Ratio to Peak	0.1597
W2880	0.0967111	99	0	8.253	7.3459	Discharge	1.3429	0.80453	Ratio to Peak	0.23476
W2890	0.0824059	99	0	10.268	3.8702	Discharge	2.1319	0.64105	Ratio to Peak	0.23956
W2900	0.35354	99	0	2.6594	0.23718	Discharge	0.61303	0.49833	Ratio to Peak	0.81596
W2910	0.0666252	99	0	10.599	9.6511	Discharge	1.8792	0.80586	Ratio to Peak	0.3451
W2920	0.0526064	99	0	13.182	6.0711	Discharge	2.5858	0.84446	Ratio to Peak	0.3451

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recess56n Basef36w				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (cms)	Recession Constant	Threshold Type	Ratio to Peak
W2930	0.0873772	99	0	1.826	3.9521	Discharge	0.26177	0.78531	Ratio to Peak	0.81666
W2940	0.32156	99	0	1.4841	0.2026	Discharge	0.11561	0.49833	Ratio to Peak	0.83668
W2950	0.084492	99	0	13.481	6.2573	Discharge	3.0708	0.81107	Ratio to Peak	0.3451
W2960	0.0827614	99	0	13.929	8.1089	Discharge	1.4512	0.82516	Ratio to Peak	0.3451
W2970	0.0942136	99	0	12.693	7.132	Discharge	2.6991	1	Ratio to Peak	0.35933
W2980	0.0775928	99	0	10.285	8.1722	Discharge	1.7293	0.82461	Ratio to Peak	0.3451
W2990	0.15066	99	0	12.407	9.6425	Discharge	3.0405	0.86962	Ratio to Peak	0.35331
W3000	0.0701472	99	0	10.564	10.431	Discharge	7.1471	0.86953	Ratio to Peak	0.35327
W3010	0.14222	99	0	16.033	7.9745	Discharge	1.7888	0.84914	Ratio to Peak	0.79564
W3020	0.26688	99	0	1.3827	4.3064	Discharge	0.32854	0.83013	Ratio to Peak	0.81457
W3030	0.74832	99	0	3.5643	2.2823	Discharge	2.0938	0.4929	Ratio to Peak	0.83552
W3040	0.15968	99	0	10.673	15.042	Discharge	1.9089	0.87923	Ratio to Peak	0.52822
W3050	0.66844	99	0	2.8909	1.8455	Discharge	0.72989	0.79311	Ratio to Peak	0.5551
W3060	0.0655012	99	0	12.398	6.6013	Discharge	2.2524	0.8278	Ratio to Peak	0.51987
W3070	0.63814	99	0	5.6197	3.3125	Discharge	0.52331	0.79463	Ratio to Peak	0.83262
W3080	0.15749	99	0	11.411	8.8445	Discharge	1.6882	0.90357	Ratio to Peak	0.35323
W3090	0.36386	99	0	1.9373	2.5549	Discharge	0.6805	0.58472	Ratio to Peak	0.64171
W3100	0.11777	99	0	27.439	3.0637	Discharge	2.6457	0.9002	Ratio to Peak	0.5073
W3110	0.11308	99	0	13.917	6.881	Discharge	6.2697	0.87516	Ratio to Peak	0.51931

ANNEX 10. Patalan Model Reach Parameters

Table A-10.1. Patalan Model Reach Parameters

Reach Number	Muskingum Cunge Channel Routing						
	Time Step Method	Length (m)	Slope	Manning's n	Shape	Width	Side Slope
R2410	Automatic Fixed Interval	2959.6	0.011957	0.013333	Trapezoid	50.63	1
R2420	Automatic Fixed Interval	796.92	0.007278	0.004958	Trapezoid	45.74	1
R2470	Automatic Fixed Interval	1182.6	0.000219	0.045778	Trapezoid	21.08	1
R2500	Automatic Fixed Interval	1809.2	0.002557	0.040139	Trapezoid	61.6	1
R2510	Automatic Fixed Interval	4182.1	0.003361	0.060559	Trapezoid	37.57	1
R2530	Automatic Fixed Interval	2174.9	0.002919	0.040907	Trapezoid	25.17	1
R2540	Automatic Fixed Interval	1154.5	0.002272	0.089971	Trapezoid	28.46	1
R2560	Automatic Fixed Interval	9481.1	0.005248	0.007644	Trapezoid	72.17	1
R2580	Automatic Fixed Interval	2916.8	0.001980	0.090116	Trapezoid	60.92	1
R2610	Automatic Fixed Interval	12933	0.001975	0.004958	Trapezoid	32.02	1
R2630	Automatic Fixed Interval	1398.5	0.001470	0.054827	Trapezoid	24.93	1
R2650	Automatic Fixed Interval	8320.7	0.001232	0.059669	Trapezoid	40.48	1
R2660	Automatic Fixed Interval	3331.2	0.001352	0.061287	Trapezoid	43.98	1
R2680	Automatic Fixed Interval	1428.7	0.000605	0.017514	Trapezoid	47	1
R2700	Automatic Fixed Interval	2669.6	0.000979	0.016850	Trapezoid	21.46	1
R2710	Automatic Fixed Interval	5043.3	0.001053	0.009145	Trapezoid	18.43	1
R2720	Automatic Fixed Interval	4656	0.000871	0.038010	Trapezoid	30.59	1
R2730	Automatic Fixed Interval	4333	0.001362	0.062082	Trapezoid	16.23	1

ANNEX 11. Patalan Field Validation

Table A-11.1. Patalan Field Validation

Point Number	Validation Coordinates		Model Var (m)	Validation Points (m)	Error (m)	Event/Date	Rain Return/ Scenario
	Lat	Long					
1	16.052591	120.443878	0.03	0	-0.03	TS Lando	5 -Year
2	16.072416	120.436826	0.03	0	-0.03	TS Lando	5 -Year
3	16.036063	120.458226	0.03	0	-0.03	TS Lando	5 -Year
4	16.037560	120.454256	0.03	0	-0.03	TS Lando	5 -Year
5	16.023976	120.458312	0.03	0	-0.03	TS Lando	5 -Year
6	16.045926	120.450042	0.03	0	-0.03	TS Lando	5 -Year
7	16.047530	120.446349	0.03	0	-0.03	TS Lando	5 -Year
8	16.050607	120.441760	0.03	0	-0.03	TS Lando	5 -Year
9	16.052125	120.435403	0.03	0	-0.03	TS Lando	5 -Year
10	16.046116	120.452385	0.03	0	-0.03	TS Lando	5 -Year
11	16.052314	120.432937	0.04	0	-0.04	TS Lando	5 -Year
12	16.051064	120.437985	0.04	0	-0.04	TS Lando	5 -Year
13	16.042064	120.453598	0.04	0	-0.04	TS Lando	5 -Year
14	16.044052	120.455074	0.04	0	-0.04	TS Lando	5 -Year
15	16.058654	120.430844	0.05	0	-0.05	TS Lando	5 -Year
16	16.033954	120.456028	0.05	0	-0.05	TS Lando	5 -Year
17	16.044546	120.453201	0.06	0	-0.06	TS Lando	5 -Year
18	16.058497	120.450464	0.07	0	-0.07	TS Lando	5 -Year
19	16.056221	120.430830	0.07	0	-0.07	TS Lando	5 -Year
20	16.024289	120.456552	0.08	0	-0.08	TS Lando	5 -Year
21	16.026296	120.454020	0.08	0	-0.08	TS Lando	5 -Year
22	16.056236	120.450409	0.1	0	-0.1	TS Lando	5 -Year
23	16.023566	120.461592	0.1	0	-0.1	TS Lando	5 -Year
24	16.059737	120.449418	0.11	0.15	0.04	TS Lando	5 -Year
25	16.051914	120.433904	0.12	0	-0.12	TS Lando	5 -Year
26	16.072511	120.427334	0.14	0	-0.14	TS Lando	5 -Year
27	16.046483	120.451244	0.14	0	-0.14	TS Lando	5 -Year
28	16.062266	120.447590	0.16	0	-0.16	TS Lando	5 -Year
29	16.045891	120.453931	0.16	0	-0.16	TS Lando	5 -Year
30	16.054921	120.448396	0.17	0	-0.17	TS Lando	5 -Year
31	16.023927	120.460576	0.21	0.3	0.09	TS Lando	5 -Year
32	16.067529	120.441293	0.21	0.3	0.09	TS Lando	5 -Year
33	16.066600	120.442056	0.22	0.3	0.08	TS Lando	5 -Year
34	16.060913	120.431837	0.24	0.3	0.06	TS Lando	5 -Year

Point Number	Validation Coordinates		Model Var (m)	Validation Points (m)	Error (m)	Event/Date	Rain Return/ Scenario
	Lat	Long					
35	16.079933	120.461499	0.25	0.3	0.05	TS Lando	5 -Year
36	16.041493	120.455974	0.27	0.46	0.19	TS Lando	5 -Year
37	16.091668	120.461748	0.29	0.3	0.01	TS Lando	5 -Year
38	16.053775	120.439714	0.29	0.46	0.17	TS Lando	5 -Year
39	16.055142	120.438755	0.3	0.3	0	TS Lando	5 -Year
40	16.060662	120.448383	0.31	0.3	-0.01	TS Lando	5 -Year
41	16.060537	120.447642	0.31	0.3	-0.01	TS Lando	5 -Year
42	16.138697	120.410278	0.32	0.3	-0.02	TS Lando	5 -Year
43	16.081796	120.445598	0.33	0.3	-0.03	TS Lando	5 -Year
44	16.066210	120.435890	0.34	0.3	-0.04	TS Lando	5 -Year
45	16.038286	120.456101	0.35	0.61	0.26	TS Lando	5 -Year
46	16.079256	120.441516	0.37	0.46	0.09	TS Lando	5 -Year
47	16.069252	120.463693	0.37	0.3	-0.07	TS Lando	5 -Year
48	16.060182	120.448850	0.38	0.3	-0.08	TS Lando	5 -Year
49	16.033765	120.457402	0.39	0.3	-0.09	TS Lando	5 -Year
50	16.089991	120.453254	0.4	0.3	-0.1	TS Lando	5 -Year
51	16.058638	120.432748	0.41	0.3	-0.11	TS Lando	5 -Year
52	16.103050	120.430531	0.41	0.46	0.05	TS Lando	5 -Year
53	16.080287	120.431652	0.42	0.3	-0.12	TS Lando	5 -Year
54	16.026348	120.454645	0.43	0.3	-0.13	TS Lando	5 -Year
55	16.056908	120.431198	0.43	0.3	-0.13	TS Lando	5 -Year
56	16.121428	120.427595	0.43	0.3	-0.13	TS Lando	5 -Year
57	16.065730	120.443460	0.45	0.3	-0.15	TS Lando	5 -Year
58	16.061916	120.442305	0.48	0.46	-0.02	TS Lando	5 -Year
59	16.053977	120.446281	0.48	0.3	-0.18	TS Lando	5 -Year
60	16.063898	120.448786	0.49	0.3	-0.19	TS Lando	5 -Year
61	16.054461	120.433496	0.49	0.3	-0.19	TS Lando	5 -Year
62	16.068917	120.440157	0.5	0.3	-0.2	TS Lando	5 -Year
63	16.066856	120.435942	0.55	0.61	0.06	TS Lando	5 -Year
64	16.091953	120.432261	0.56	0.61	0.05	TS Lando	5 -Year
65	16.116851	120.425179	0.56	0.61	0.05	TS Lando	5 -Year
66	16.108460	120.395553	0.56	0.61	0.05	TS Lando	5 -Year
67	16.106228	120.430022	0.57	0.61	0.04	TS Lando	5 -Year
68	16.124273	120.394416	0.57	0.61	0.04	TS Lando	5 -Year
69	16.119586	120.390256	0.58	0.61	0.03	TS Lando	5 -Year
70	16.135021	120.402390	0.61	0.3	-0.31	TS Lando	5 -Year
71	16.062576	120.446454	0.62	0.61	-0.01	TS Lando	5 -Year
72	16.063612	120.444894	0.63	0.76	0.13	TS Lando	5 -Year

Point Number	Validation Coordinates		Model Var (m)	Validation Points (m)	Error (m)	Event/Date	Rain Return/ Scenario
	Lat	Long					
73	16.113648	120.408764	0.64	0.61	-0.03	TS Lando	5 -Year
74	16.110924	120.429793	0.69	0.61	-0.08	TS Lando	5 -Year
75	16.123869	120.418446	0.69	0.76	0.07	TS Lando	5 -Year
76	16.116044	120.394895	0.7	0.61	-0.09	TS Lando	5 -Year
77	16.108929	120.393096	0.71	0.61	-0.1	TS Lando	5 -Year
78	16.114884	120.397431	0.72	0.61	-0.11	TS Lando	5 -Year
79	16.129722	120.408963	0.72	0.91	0.19	TS Lando	5 -Year
80	16.109143	120.389029	0.73	0.76	0.03	TS Lando	5 -Year
81	16.110296	120.428375	0.77	0.76	-0.01	TS Lando	5 -Year
82	16.128298	120.411569	0.78	0.76	-0.02	TS Lando	5 -Year
83	16.107387	120.405949	0.79	0.61	-0.18	TS Lando	5 -Year
84	16.124867	120.403713	0.79	0.61	-0.18	TS Lando	5 -Year
85	16.129805	120.404601	0.79	0.61	-0.18	TS Lando	5 -Year
86	16.132033	120.400158	0.79	0.3	-0.49	TS Lando	5 -Year
87	16.122809	120.410073	0.8	0.76	-0.04	TS Lando	5 -Year
88	16.118584	120.400244	0.81	0.61	-0.2	TS Lando	5 -Year
89	16.130166	120.398816	0.81	0.61	-0.2	TS Lando	5 -Year
90	16.119432	120.389322	0.83	0.61	-0.22	TS Lando	5 -Year
91	16.104433	120.417272	0.83	0.61	-0.22	TS Lando	5 -Year
92	16.113486	120.398239	0.84	0.91	0.07	TS Lando	5 -Year
93	16.125099	120.399556	0.84	0.76	-0.08	TS Lando	5 -Year
94	16.107034	120.397946	0.84	0.61	-0.23	TS Lando	5 -Year
95	16.108845	120.387442	0.85	0.61	-0.24	TS Lando	5 -Year
96	16.102324	120.405282	0.87	0.61	-0.26	TS Lando	5 -Year
97	16.116386	120.398996	0.89	0.76	-0.13	TS Lando	5 -Year
98	16.128214	120.407525	0.89	0.91	0.02	TS Lando	5 -Year
99	16.125448	120.394657	0.91	0.76	-0.15	TS Lando	5 -Year
100	16.068211	120.440693	0.92	0.61	-0.31	TS Lando	5 -Year
101	16.099451	120.431317	0.92	0.76	-0.16	TS Lando	5 -Year
102	16.110194	120.407175	0.95	0.76	-0.19	TS Lando	5 -Year
103	16.123819	120.402216	0.95	0.76	-0.19	TS Lando	5 -Year
104	16.118797	120.388636	0.95	0.61	-0.34	TS Lando	5 -Year
105	16.098589	120.408814	0.96	0.91	-0.05	TS Lando	5 -Year
106	16.069468	120.439527	0.97	0.91	-0.06	TS Lando	5 -Year
107	16.104934	120.415991	0.97	0.61	-0.36	TS Lando	5 -Year
108	16.125308	120.401126	0.97	0.61	-0.36	TS Lando	5 -Year
109	16.064975	120.443763	0.98	0.61	-0.37	TS Lando	5 -Year
110	16.065327	120.434357	0.98	0.61	-0.37	TS Lando	5 -Year

Point Number	Validation Coordinates		Model Var (m)	Validation Points (m)	Error (m)	Event/Date	Rain Return/ Scenario
	Lat	Long					
111	16.124081	120.398690	0.98	0.61	-0.37	TS Lando	5 -Year
112	16.094830	120.414222	0.99	0.61	-0.38	TS Lando	5 -Year
113	16.057067	120.438171	1	0.61	-0.39	TS Lando	5 -Year
114	16.139007	120.419827	1.04	1.37	0.33	TS Lando	5 -Year
115	16.139326	120.418163	1.06	1.22	0.16	TS Lando	5 -Year
116	16.122766	120.399523	1.06	1.68	0.62	TS Lando	5 -Year
117	16.088504	120.417457	1.1	1.22	0.12	TS Lando	5 -Year
118	16.139858	120.418609	1.11	1.83	0.72	TS Lando	5 -Year
119	16.131104	120.400234	1.12	1.22	0.1	TS Lando	5 -Year
120	16.128744	120.403028	1.13	0.61	-0.52	TS Lando	5 -Year
121	16.141773	120.420006	1.14	1.22	0.08	TS Lando	5 -Year
122	16.118988	120.387490	1.15	1.22	0.07	TS Lando	5 -Year
123	16.120731	120.389134	1.19	1.52	0.33	TS Lando	5 -Year
124	16.133602	120.413910	1.21	1.22	0.01	TS Lando	5 -Year
125	16.128457	120.406602	1.21	1.83	0.62	TS Lando	5 -Year
126	16.138005	120.416275	1.22	1.98	0.76	TS Lando	5 -Year
127	16.144678	120.419470	1.22	1.22	0	TS Lando	5 -Year
128	16.121436	120.395350	1.24	1.98	0.74	TS Lando	5 -Year
129	16.139218	120.417592	1.25	1.22	-0.03	TS Lando	5 -Year
130	16.130565	120.407952	1.26	1.22	-0.04	TS Lando	5 -Year
131	16.125465	120.395308	1.27	1.52	0.25	TS Lando	5 -Year
132	16.124510	120.395746	1.3	1.52	0.22	TS Lando	5 -Year
133	16.136428	120.416272	1.32	1.37	0.05	TS Lando	5 -Year
134	16.125228	120.404297	1.32	1.23	-0.09	TS Lando	5 -Year
135	16.092965	120.416208	1.37	0.76	-0.61	TS Lando	5 -Year
136	16.060486	120.440052	1.37	1.22	-0.15	TS Lando	5 -Year
137	16.122482	120.398193	1.4	1.83	0.43	TS Lando	5 -Year
138	16.122818	120.397403	1.41	1.83	0.42	TS Lando	5 -Year
139	16.124752	120.402503	1.41	1.52	0.11	TS Lando	5 -Year
140	16.135849	120.413491	1.42	1.98	0.56	TS Lando	5 -Year
141	16.135503	120.414105	1.43	1.52	0.09	TS Lando	5 -Year
142	16.126911	120.399767	1.43	1.98	0.55	TS Lando	5 -Year
143	16.133483	120.413011	1.44	1.37	-0.07	TS Lando	5 -Year
144	16.060393	120.439219	1.44	1.07	-0.37	TS Lando	5 -Year
145	16.123082	120.398109	1.48	1.83	0.35	TS Lando	5 -Year
146	16.135350	120.415362	1.49	1.52	0.03	TS Lando	5 -Year
147	16.031212	120.457596	1.53	1.22	-0.31	TS Lando	5 -Year
148	16.127307	120.404755	1.55	1.83	0.28	TS Lando	5 -Year

Point Number	Validation Coordinates		Model Var (m)	Validation Points (m)	Error (m)	Event/Date	Rain Return/ Scenario
	Lat	Long					
149	16.125614	120.403698	1.57	1.52	-0.05	TS Lando	5 -Year
150	16.131237	120.409842	1.74	1.52	-0.22	TS Lando	5 -Year
151	16.124678	120.398802	1.78	1.68	-0.1	TS Lando	5 -Year
152	16.124287	120.411047	1.86	1.83	-0.03	TS Lando	5 -Year
153	16.066570	120.433994	1.87	1.22	-0.65	TS Lando	5 -Year
154	16.103096	120.412142	1.96	1.37	-0.59	TS Lando	5 -Year
155	16.073823	120.421097	2.03	2.29	0.26	TS Lando	5 -Year
156	16.109759	120.398853	2.03	2.13	0.1	TS Lando	5 -Year
157	16.117721	120.394489	2.04	2.44	0.4	TS Lando	5 -Year
158	16.073879	120.426746	2.06	2.13	0.07	TS Lando	5 -Year
159	16.073546	120.423952	2.07	2.13	0.06	TS Lando	5 -Year
160	16.123575	120.401511	2.08	2.13	0.05	TS Lando	5 -Year
161	16.066845	120.433097	2.11	2.29	0.18	TS Lando	5 -Year
162	16.105532	120.410335	2.14	1.98	-0.16	TS Lando	5 -Year
163	16.066971	120.442003	2.15	2.13	-0.02	TS Lando	5 -Year
164	16.103798	120.410001	2.24	1.98	-0.26	TS Lando	5 -Year
165	16.063163	120.432930	2.24	2.44	0.2	TS Lando	5 -Year
166	16.071163	120.449291	2.24	2.29	0.05	TS Lando	5 -Year
167	16.060213	120.438416	2.25	2.29	0.04	TS Lando	5 -Year
168	16.069073	120.442203	2.55	2.13	-0.42	TS Lando	5 -Year
169	16.068580	120.439930	2.58	2.13	-0.45	TS Lando	5 -Year
170	16.071941	120.449984	2.64	2.13	-0.51	TS Lando	5 -Year
171	16.069445	120.442569	2.73	2.13	-0.6	TS Lando	5 -Year
172	16.060130	120.441759	2.75	2.29	-0.46	TS Lando	5 -Year
173	16.084168	120.435645	2.76	2.29	-0.47	TS Lando	5 -Year
174	16.071167	120.448833	2.77	3.05	0.28	TS Lando	5 -Year
175	16.098049	120.411471	2.77	2.29	-0.48	TS Lando	5 -Year
176	16.070376	120.443149	2.84	2.13	-0.71	TS Lando	5 -Year
177	16.061511	120.434603	3.18	2.13	-1.05	TS Lando	5 -Year
178	16.067835	120.435408	3.27	2.13	-1.14	TS Lando	5 -Year
179	16.071304	120.446166	3.27	2.13	-1.14	TS Lando	5 -Year
180	16.072185	120.450486	3.29	2.13	-1.16	TS Lando	5 -Year

ANNEX 12. Educational Institutions affected by flooding in Patalan Floodplain

Table A-12.1. Educational Institutions Affected by Flooding in the Patalan Floodplain

Pangasinan				
Binalonan				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
PANAGA-TABAO INTEGRATED ELEMENTARY	Bugayong	Low		
PANAGA-TABAO INTEGRATED ELEMENTARY 2	Bugayong			
PANAGA-TABAO INTEGRATED ELEMENTARY 3	Bugayong			
PANAGA-TABAO INTEGRATED ELEMENTARY 4	Bugayong	Low		
PANAGA-TABAO INTEGRATED ELEMENTARY 5	Bugayong			Low
PANAGA-TABAO INTEGRATED ELEMENTARY 6	Bugayong	Low		Low
PANAGA-TABAO INTEGRATED ELEMENTARY 7	Bugayong	Low		
ROSARIO HIGH SCHOOL 1	Bugayong	Low	Low	Medium
ROSARIO HIGH SCHOOL 2	Bugayong			Low
ROSARIO HIGH SCHOOL 3	Bugayong	Low	Low	Medium
ROSARIO HIGH SCHOOL 4	Bugayong			Low
ROSARIO HIGH SCHOOL 5	Bugayong			Low
ROSARIO HIGH SCHOOL 6	Bugayong		Low	Medium
ROSARIO HIGH SCHOOL 7	Bugayong	Low	Low	Low
ROSARIO HIGH SCHOOL 3	Camangaan	Low	Low	Medium
ROSARIO HIGH SCHOOL 4	Camangaan			Low
STA. MARIA ELEMENTARY 11	Canarvacanan		Low	Low
STA. MARIA ELEMENTARY 12	Canarvacanan			
STA. MARIA ELEMENTARY 13	Canarvacanan			
STA. MARIA ELEMENTARY 14	Canarvacanan			Low
STA. MARIA ELEMENTARY 16	Canarvacanan			
STA. MARIA ELEMENTARY 17	Canarvacanan		Low	Low
STA. MARIA ELEMENTARY 18	Canarvacanan	Low		
STA. MARIA ELEMENTARY 2	Canarvacanan			
STA. MARIA ELEMENTARY 3	Canarvacanan			
STA. MARIA ELEMENTARY 4	Canarvacanan			
STA. MARIA ELEMENTARY 5	Canarvacanan			
STA. MARIA ELEMENTARY 8	Canarvacanan			
STA. MARIA ELEMENTARY 9	Canarvacanan			
CAMANGAAN ELEMENTARY	Cili			
CAMANGAAN ELEMENTARY 2	Cili			
CAMANGAAN ELEMENTARY 3	Cili			Low

Pangasinan				
Binalonan				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
CAMANGAAN ELEMENTARY 4	Cili			
CAMANGAAN ELEMENTARY 5	Cili		Low	Low
CAMANGAAN ELEMENTARY 6	Cili	Low	Low	Low
DUMAYAT ELEMENTARY 2	Dumayat	Low	Low	Low
DUMAYAT ELEMENTARY 3	Dumayat	Low	Low	Low
BINALONAN NAZARENE CHRISTIAN ACADEMY 1	Poblacion	Low	Low	Low
JUAN G MACARAEG NATIONAL HIGH SCHOOL 1	Poblacion	Low	Low	Low
JUAN G MACARAEG NATIONAL HIGH SCHOOL 12	Poblacion	Low	Low	Low
JUAN G MACARAEG NATIONAL HIGH SCHOOL 14	Poblacion		Low	Low
JUAN G MACARAEG NATIONAL HIGH SCHOOL 15	Poblacion	Low	Medium	Medium
JUAN G MACARAEG NATIONAL HIGH SCHOOL 16	Poblacion	Low	Low	Medium
JUAN G MACARAEG NATIONAL HIGH SCHOOL 17	Poblacion	Low	Medium	Medium
JUAN G MACARAEG NATIONAL HIGH SCHOOL 18	Poblacion	Low	Low	Low
JUAN G MACARAEG NATIONAL HIGH SCHOOL 19	Poblacion			
JUAN G MACARAEG NATIONAL HIGH SCHOOL 2	Poblacion	Low	Medium	Medium
JUAN G MACARAEG NATIONAL HIGH SCHOOL 21	Poblacion	Low	Low	Low
JUAN G MACARAEG NATIONAL HIGH SCHOOL 22	Poblacion			
JUAN G MACARAEG NATIONAL HIGH SCHOOL 23	Poblacion		Low	Low
JUAN G MACARAEG NATIONAL HIGH SCHOOL 3	Poblacion	Low	Medium	Medium
JUAN G MACARAEG NATIONAL HIGH SCHOOL 4	Poblacion	Low	Low	Low
JUAN G MACARAEG NATIONAL HIGH SCHOOL 5	Poblacion	Low	Medium	Medium
JUAN G MACARAEG NATIONAL HIGH SCHOOL 6	Poblacion	Medium	Medium	Medium
JUAN G MACARAEG NATIONAL HIGH SCHOOL 7	Poblacion	Low	Low	Low
JUAN G MACARAEG NATIONAL HIGH SCHOOL 8	Poblacion	Low	Low	Low

Pangasinan				
Binalonan				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
JUAN G MACARAEG NATIONAL HIGH SCHOOL 9	Poblacion	Low	Low	Low
PHILIPPINE DARAKBANG THEOLOGICAL COLLEGE 1	Poblacion			
PHILIPPINE DARAKBANG THEOLOGICAL COLLEGE 2	Poblacion			
STA. FE LEARNING CENTER	Poblacion	Low	Low	Low
UNIVERSITY OF EASTERN PANGASINAN 1	Poblacion			
UNIVERSITY OF EASTERN PANGASINAN 2	Poblacion			
UNIVERSITY OF EASTERN PANGASINAN 3	Poblacion			
CILI ELEMENTARY SCHOOL 1	Santa Maria Norte	Medium	Medium	Medium
CILI ELEMENTARY SCHOOL 2	Santa Maria Norte	Medium	Medium	Medium
CILI ELEMENTARY SCHOOL 3	Santa Maria Norte	Medium	Medium	Medium
CILI ELEMENTARY SCHOOL 4	Santa Maria Norte	Medium	Medium	Medium
CILI ELEMENTARY SCHOOL 5	Santa Maria Norte	Medium	Medium	Medium
CILI ELEMENTARY SCHOOL 6	Santa Maria Norte	Medium	Medium	Medium
CILI ELEMENTARY SCHOOL 7	Santa Maria Norte	Medium	Medium	Medium
LINMANSANGAN ELEMENTARY SCHOOL 1	Santiago			
LINMANSANGAN ELEMENTARY SCHOOL 10	Santiago			Low
LINMANSANGAN ELEMENTARY SCHOOL 12	Santiago		Low	Low
LINMANSANGAN ELEMENTARY SCHOOL 13	Santiago		Low	Low
LINMANSANGAN ELEMENTARY SCHOOL 14	Santiago		Low	Medium
LINMANSANGAN ELEMENTARY SCHOOL 2	Santiago			
LINMANSANGAN ELEMENTARY SCHOOL 3	Santiago		Low	Medium
LINMANSANGAN ELEMENTARY SCHOOL 5	Santiago			
LINMANSANGAN ELEMENTARY SCHOOL 6	Santiago	Low	Medium	Medium
LINMANSANGAN ELEMENTARY SCHOOL 7	Santiago			
LINMANSANGAN ELEMENTARY SCHOOL 8	Santiago			Low
LINMANSANGAN ELEMENTARY SCHOOL 9	Santiago	Low	Medium	Medium
SANTIAGO ELEMENTARY	Sumabnit	Low	Low	Low
SANTIAGO ELEMENTARY 2	Sumabnit	Medium	Low	Medium
SANTIAGO ELEMENTARY 3	Sumabnit	Medium	Low	Medium
SANTIAGO ELEMENTARY 4	Sumabnit	Low	Low	Medium
SANTIAGO ELEMENTARY 5	Sumabnit	Low	Low	Low
SANTIAGO ELEMENTARY 6	Sumabnit	Low	Low	Low
MANANTAN INSTITUTE OF SCIENCE AND TECHNOLOGY 1	Tabuyoc		Low	Low
MANANTAN INSTITUTE OF SCIENCE AND TECHNOLOGY 2	Tabuyoc	Low	Low	Medium
MANANTAN INSTITUTE OF SCIENCE AND TECHNOLOGY 3	Tabuyoc	Low	Low	Medium

Pangasinan				
Binalonan				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
MANANTAN INSTITUTE OF SCIENCE AND TECHNOLOGY 4	Tabuyoc	Low	Low	Medium
SUMABNIT ELEMENTARY SCHOOL 1	Tabuyoc			
SUMABNIT ELEMENTARY SCHOOL 10	Tabuyoc			
SUMABNIT ELEMENTARY SCHOOL 2	Tabuyoc			
SUMABNIT ELEMENTARY SCHOOL 3	Tabuyoc			
SUMABNIT ELEMENTARY SCHOOL 4	Tabuyoc			
SUMABNIT ELEMENTARY SCHOOL 5	Tabuyoc			
SUMABNIT ELEMENTARY SCHOOL 6	Tabuyoc		Low	Low
SUMABNIT ELEMENTARY SCHOOL 7	Tabuyoc			
SUMABNIT ELEMENTARY SCHOOL 8	Tabuyoc			
SUMABNIT ELEMENTARY SCHOOL 9	Tabuyoc			Low
BUGAYONG INTEGRATED SCHOOL 2	Vacante	Low	Low	Medium
BUGAYONG INTEGRATED SCHOOL 3	Vacante			Low
VACANTE ELEMENTARY	Vacante			
VACANTE ELEMENTARY 2	Vacante			
VACANTE ELEMENTARY 3	Vacante	Low	Low	Low
VACANTE ELEMENTARY 4	Vacante			
VACANTE ELEMENTARY 5	Vacante			

Table A-12.2. Educational Institutions Affected in Laoac

Pangasinan				
Laoac				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
ANIS DAYCARE CENTER	Anis			
QUEVEDO-ANISCA ELEMENTARY	Anis			
QUEVEDO-ANISCA ELEMENTARY 10	Anis			
QUEVEDO-ANISCA ELEMENTARY 3	Anis			
QUEVEDO-ANISCA ELEMENTARY 4	Anis			
QUEVEDO-ANISCA ELEMENTARY 8	Anis			
CABU-CALA ELEMENTARY	Banuar	Low	Low	Low
CABU-CALA ELEMENTARY 2	Banuar	Medium	Medium	Medium
CABU-CALA ELEMENTARY 3	Banuar	Medium	Medium	Medium
CABU-CALA ELEMENTARY 5	Banuar	Low	Medium	Medium
CABU-CALA ELEMENTARY 6	Banuar	Low	Low	Low
BOTIGUE ELEMENTARY	Botique		Low	Low
BOTIGUE ELEMENTARY 2	Botique	Low	Low	Low
BOTIGUE ELEMENTARY 3	Botique	Low	Low	Medium

Pangasinan				
Laoac				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
BOTIGUE ELEMENTARY 5	Botique			
QUEVEDO-ANISCA ELEMENTARY 3	Caaringayan			
QUEVEDO-ANISCA ELEMENTARY 4	Caaringayan			
QUEVEDO-ANISCA ELEMENTARY 5	Caaringayan			
QUEVEDO-ANISCA ELEMENTARY 6	Caaringayan			
QUEVEDO-ANISCA ELEMENTARY 7	Caaringayan			
CABILAOAN AGRO-INDUSTRIAL HIGHSCHOOL	Cabilaoan West			
CABILAOAN AGRO-INDUSTRIAL HIGHSCHOOL 3	Cabilaoan West			
CABILAOAN AGRO-INDUSTRIAL HIGHSCHOOL 4	Cabilaoan West			
CABILAOAN AGRO-INDUSTRIAL HIGHSCHOOL 5	Cabilaoan West			
CABILAOAN ELEMENTARY	Cabilaoan West			
CABILAOAN ELEMENTARY 2	Cabilaoan West			
CABILAOAN ELEMENTARY 3	Cabilaoan West			
CABILAOAN ELEMENTARY 4	Cabilaoan West			
CABILAOAN ELEMENTARY 5	Cabilaoan West			
CABILAOAN ELEMENTARY 6	Cabilaoan West			
CABILAOAN ELEMENTARY 7	Cabilaoan West	Low		
CABILAOAN ELEMENTARY 9	Cabilaoan West			
NANBAGATAN ELEMENTARY 2	Cabilaoan West	Low	Medium	Medium
NANBAGATAN ELEMENTARY 3	Cabilaoan West	Medium	Medium	Medium
NANBAGATAN ELEMENTARY 4	Cabilaoan West	Medium	Medium	Medium
LIMOS-TURKO ELEMENTARY	Cabulalaan			
LIMOS-TURKO ELEMENTARY 2	Cabulalaan			
LIMOS-TURKO ELEMENTARY 3	Cabulalaan			
LIMOS-TURKO ELEMENTARY 4	Cabulalaan			
LIMOS-TURKO ELEMENTARY 5	Cabulalaan	Low	Low	Low
LIMOS-TURKO ELEMENTARY 6	Cabulalaan	Low	Low	Low
LIMOS-TURKO ELEMENTARY 7	Cabulalaan			
FULL OF GRACE MONTESSORI AND HIGHSCHOOL	Casampagaan			Low
FULL OF GRACE MONTESSORI AND HIGHSCHOOL 3	Casampagaan	Low	Low	Low
FULL OF GRACE MONTESSORI AND HIGHSCHOOL 4	Casampagaan	Low	Low	Low
FULL OF GRACE MONTESSORI AND HIGHSCHOOL 5	Casampagaan	Low	Low	Medium
RUFINO LEAL TORALBA ELEMENTARY	Casanestebanan			Low
RUFINO LEAL TORALBA ELEMENTARY 2	Casanestebanan			Low
RUFINO LEAL TORALBA ELEMENTARY 3	Casanestebanan			Low
RUFINO LEAL TORALBA ELEMENTARY 4	Casanestebanan			Low
RUFINO LEAL TORALBA ELEMENTARY 5	Casanestebanan			Low

Pangasinan				
Laoac				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
RUFINO LEAL TORALBA ELEMENTARY 6	Casanestebanan		Low	Medium
RUFINO LEAL TORALBA ELEMENTARY 7	Casanestebanan		Low	Medium
LEBUEG ELEMENTARY	Casantiagoan			
LEBUEG ELEMENTARY 2	Casantiagoan			
LEBUEG ELEMENTARY 3	Casantiagoan		Low	Low
LEBUEG ELEMENTARY 4	Casantiagoan			Low
LEBUEG ELEMENTARY 5	Casantiagoan			
LEBUEG ELEMENTARY 6	Casantiagoan	Low	Low	Low
LEBUEG ELEMENTARY 7	Casantiagoan			
LEBUEG ELEMENTARY 8	Casantiagoan			
PAO ELEMENTARY SCHOOL 1	Inmanduyan			
PAO ELEMENTARY SCHOOL 10	Inmanduyan	Low	Low	Low
PAO ELEMENTARY SCHOOL 11	Inmanduyan	Low	Low	Low
PAO ELEMENTARY SCHOOL 2	Inmanduyan	Low	Low	Low
PAO ELEMENTARY SCHOOL 4	Inmanduyan			Low
PAO ELEMENTARY SCHOOL 5	Inmanduyan			
PAO ELEMENTARY SCHOOL 6	Inmanduyan			
PAO ELEMENTARY SCHOOL 7	Inmanduyan			
PAO ELEMENTARY SCHOOL 8	Inmanduyan			
PAO ELEMENTARY SCHOOL 9	Inmanduyan			
OUR LADY OF FATIMA DAY CARE CENTER	Talogtog			

Table A-12.3. Educational Institutions Affected in Manaoag

Pangasinan				
Manaoag				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
BABASIT ELEMENTARY SCHOOL 1	Baritao		Low	Low
BABASIT ELEMENTARY SCHOOL 2	Baritao		Low	Low
BABASIT ELEMENTARY SCHOOL 3	Baritao		Low	Low
BABASIT ELEMENTARY SCHOOL 4	Baritao	Low	Medium	Medium
BABASIT ELEMENTARY SCHOOL 5	Baritao	Low	Medium	Medium
BABASIT ELEMENTARY SCHOOL 6	Baritao	Low	Low	Low
BABASIT ELEMENTARY SCHOOL 7	Baritao	Low	Low	Low
BABASIT ELEMENTARY SCHOOL 8	Baritao			
BISAL-BUCAO ELEMENTARY	Baritao			
BISAL-BUCAO ELEMENTARY 2	Baritao			
BISAL-BUCAO ELEMENTARY 3	Baritao			

Pangasinan				
Manaoag				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
BISAL-BUCAO ELEMENTARY 4	Baritao		Low	Low
BISAL-BUCAO ELEMENTARY 5	Baritao			Low
DAYCARE CENTER	Baritao			
REILAND CHRISTIAN SCHOOL	Baritao		Medium	Medium
DAYCARE CENTER	Bisal	Low		
SAINT CAMILLUS COLLEGE OF MANAOAG 4	Cabanbanan			
SAINT CAMILLUS COLLEGE OF MANAOAG 6	Cabanbanan			
SAINT CAMILLUS COLLEGE OF MANAOAG 7	Cabanbanan			
SAINT CAMILLUS COLLEGE OF MANAOAG 8	Cabanbanan			
DO	Inamotan			
CABANBANAN ELEMENTARY SCHOOL 1	Lelemaan		Low	Medium
CABANBANAN ELEMENTARY SCHOOL 3	Lelemaan		Medium	Medium
CABANBANAN ELEMENTARY SCHOOL 4	Lelemaan	Low	Medium	Medium
CABANBANAN ELEMENTARY SCHOOL 5	Lelemaan	Low	Medium	Medium
CABANBANAN ELEMENTARY SCHOOL 6	Lelemaan	Low	Medium	Medium
CABANBANAN NATIONAL HIGH SCHOOL 10	Lelemaan	Low	Medium	Medium
CABANBANAN NATIONAL HIGH SCHOOL 11	Lelemaan	Low	Medium	Medium
CABANBANAN NATIONAL HIGH SCHOOL 12	Lelemaan	Low	Medium	Medium
CABANBANAN NATIONAL HIGH SCHOOL 13	Lelemaan	Low	Medium	Medium
CABANBANAN NATIONAL HIGH SCHOOL 3	Lelemaan	Low	Medium	Medium
CABANBANAN NATIONAL HIGH SCHOOL 4	Lelemaan	Low	Medium	Medium
CABANBANAN NATIONAL HIGH SCHOOL 5	Lelemaan	Low	Medium	Medium
CABANBANAN NATIONAL HIGH SCHOOL 6	Lelemaan		Medium	Medium
CABANBANAN NATIONAL HIGH SCHOOL 7	Lelemaan		Medium	Medium
CABANBANAN NATIONAL HIGH SCHOOL 9	Lelemaan	Low	Medium	Medium
COLEGIO DE SAN JUAN DE LETRAN 1	Licsi			
COLEGIO DE SAN JUAN DE LETRAN 2	Licsi			
COLEGIO DE SAN JUAN DE LETRAN 3	Licsi			
COLEGIO DE SAN JUAN DE LETRAN 4	Licsi			
COLEGIO DE SAN JUAN DE LETRAN 5	Licsi			
COLEGIO DE SAN JUAN DE LETRAN 6	Licsi	Low	Low	Low
FAMILY CHILD DEVELOPMENT SCHOOL 3	Licsi			
FAMILY CHILD DEVELOPMENT SCHOOL 4	Licsi			
FAMILY CHILD DEVELOPMENT SCHOOL 5	Licsi			
GOLDEN SEEDS GUIDANCE MONTESORRI AND HIGH SCHOOL 1	Licsi			
GOLDEN SEEDS GUIDANCE MONTESORRI AND HIGH SCHOOL 2	Licsi			
GOLDEN SEEDS GUIDANCE MONTESORRI AND HIGH SCHOOL 3	Licsi			

Pangasinan				
Manaoag				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
GOLDEN SEEDS GUIDANCE MONTESORRI AND HIGH SCHOOL 4	Licsi			
GOLDEN SEEDS GUIDANCE MONTESORRI AND HIGH SCHOOL 5	Licsi			
MANAOAG CENTRAL SCHOOL 1	Licsi			
MANAOAG CENTRAL SCHOOL 10	Licsi			
MANAOAG CENTRAL SCHOOL 11	Licsi			
MANAOAG CENTRAL SCHOOL 12	Licsi			
MANAOAG CENTRAL SCHOOL 14	Licsi			
MANAOAG CENTRAL SCHOOL 15	Licsi			
MANAOAG CENTRAL SCHOOL 16	Licsi			
MANAOAG CENTRAL SCHOOL 2	Licsi			
MANAOAG CENTRAL SCHOOL 3	Licsi			
MANAOAG CENTRAL SCHOOL 4	Licsi	Low	Low	Low
MANAOAG CENTRAL SCHOOL 5	Licsi			
MANAOAG CENTRAL SCHOOL 6	Licsi			
MANAOAG CENTRAL SCHOOL 7	Licsi			
MANAOAG CENTRAL SCHOOL 9	Licsi			
MANAOAG NATIONAL HIGHSCHOOL	Licsi			
MANAOAG NATIONAL HIGHSCHOOL 10	Licsi			
MANAOAG NATIONAL HIGHSCHOOL 2	Licsi			
MANAOAG NATIONAL HIGHSCHOOL 3	Licsi			
OUR LADY OF MANAOAG INTEGRATED SCHOOL 1	Licsi			
OUR LADY OF MANAOAG INTEGRATED SCHOOL 3	Licsi	Medium		
OUR LADY OF MANAOAG INTEGRATED SCHOOL 4	Licsi	Low	Low	Medium
OUR LADY OF MANAOAG INTEGRATED SCHOOL 6	Licsi			
NALSIAN ELEMENTARY 6	Nalsian			Low
NALSIAN ELEMENTARY SCHOOL 1	Nalsian			
NALSIAN ELEMENTARY SCHOOL 10	Nalsian		Low	Low
NALSIAN ELEMENTARY SCHOOL 11	Nalsian			Low
NALSIAN ELEMENTARY SCHOOL 2	Nalsian			
NALSIAN ELEMENTARY SCHOOL 3	Nalsian	Low	Low	Low
NALSIAN ELEMENTARY SCHOOL 4	Nalsian	Low	Low	Low
NALSIAN ELEMENTARY SCHOOL 5	Nalsian			
NALSIAN ELEMENTARY SCHOOL 6	Nalsian	Low		
NALSIAN ELEMENTARY SCHOOL 7	Nalsian	Low	Low	Low
NALSIAN ELEMENTARY SCHOOL 8	Nalsian		Low	Low
SAINT CAMILLUS COLLEGE 2	Nalsian	Low		Low
SAINT CAMILLUS COLLEGE OF MANAOAG 2	Nalsian			
SAINT CAMILLUS COLLEGE OF MANAOAG 3	Nalsian			
SAINT CAMILLUS COLLEGE OF MANAOAG 4	Nalsian			

Pangasinan				
Manaoag				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
SAINT CAMILLUS COLLEGE OF MANAOAG 5	Nalsian			
SAINT CAMILLUS COLLEGE OF MANAOAG 6	Nalsian			
SAINT CAMILLUS COLLEGE OF MANAOAG 8	Nalsian			
SAINT CAMILLUS COLLEGE OF MANAOAG 9	Nalsian			
ORAAN WEST ELEMENTARY	Oraan East	Low	Medium	High
ORAAN WEST ELEMENTARY 2	Oraan East	Low	Medium	High
ORAAN WEST ELEMENTARY 3	Oraan East	Low	Medium	High
ORAAN WEST ELEMENTARY 4	Oraan East	Low	High	High
ORAAN WEST ELEMENTARY 5	Oraan East	Medium	High	High
DO	Pantal			
ADVENTIST SCHOOL MANAOAG	Poblacion	Low	Medium	Medium
MANAOAG NATIONAL HIGHSCHOOL 10	Poblacion	Low	Low	Low
MANAOAG NATIONAL HIGHSCHOOL 3	Poblacion			
MANAOAG NATIONAL HIGHSCHOOL 4	Poblacion			
MANAOAG NATIONAL HIGHSCHOOL 5	Poblacion			
MANAOAG NATIONAL HIGHSCHOOL 6	Poblacion		Medium	Medium
MANAOAG NATIONAL HIGHSCHOOL 8	Poblacion			
PIO GENEROSA ELEMENTARY	Pugaro			
PIO GENEROSA ELEMENTARY 2	Pugaro			
PIO GENEROSA ELEMENTARY 3	Pugaro			
PIO GENEROSA ELEMENTARY 4	Pugaro			
PIO GENEROSA ELEMENTARY 5	Pugaro			
PIO GENEROSA ELEMENTARY 6	Pugaro			
PIO GENEROSA ELEMENTARY 7	Pugaro			
PIO GENEROSA ELEMENTARY 9	Pugaro			
BARITAO ELEMENTARY	San Ramon		Low	Low
BARITAO ELEMENTARY 11	San Ramon	Low	Low	Low
BARITAO ELEMENTARY 12	San Ramon	Low	Low	Low
BARITAO ELEMENTARY 2	San Ramon	Low	Low	Low
BARITAO ELEMENTARY 3	San Ramon		Low	Low
BARITAO ELEMENTARY 5	San Ramon	Low	Low	Low
BARITAO ELEMENTARY 6	San Ramon	Low	Low	Low
BARITAO ELEMENTARY 7	San Ramon	Low	Low	Low
BARITAO ELEMENTARY 8	San Ramon	Low	Low	Low
BARITAO ELEMENTARY 9	San Ramon	Low	Low	Low
CALMAY ELEMENTARY	Santa Ines	Low	Medium	Medium
CALMAY ELEMENTARY 4	Santa Ines	Low	Medium	High
CALMAY ELEMENTARY 5	Santa Ines	Medium	Medium	High
CALMAY ELEMENTARY 6	Santa Ines	Low	Medium	High
CALMAY ELEMENTARY 7	Santa Ines	Low	Medium	Medium

Pangasinan				
Manaoag				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
NANBAGATAN ELEMENTARY 2	Santa Ines	Low	Medium	Medium
NANBAGATAN ELEMENTARY 3	Santa Ines	Medium	Medium	Medium
NANBAGATAN ELEMENTARY 4	Santa Ines	Low	Medium	Medium
NANBAGATAN ELEMENTARY 7	Santa Ines	Low	Medium	Medium

Table A-12.4. Educational Institutions Affected in Mangaldan

Pangasinan				
Mangaldan				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
BERNABE BIAGTAN ELEMENTARY SCHOOL 3	Embarcadero	High	High	High
BERNABE BIAGTAN ELEMENTARY SCHOOL 4	Embarcadero	High	High	High
BERNABE BIAGTAN ELEMENTARY SCHOOL 5	Embarcadero	High	High	High
BERNABE BIAGTAN ELEMENTARY SCHOOL 6	Embarcadero	High	High	High
BERNABE BIAGTAN ELEMENTARY SCHOOL 7	Embarcadero	High	High	High
BERNABE BIAGTAN ELEMENTARY SCHOOL 8	Embarcadero	High	High	High

Table A-12.5. Educational Institutions Affected in Pozzorubio

Pangasinan				
Mangaldan				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 1	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 10	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 11	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 12	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 13	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 14	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 15	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 16	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 17	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 2	Alipangpang	Medium		Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 20	Alipangpang	Low	Low	Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 22	Alipangpang		Low	Low

Pangasinan				
Mangaldan				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 23	Alipangpang			Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 24	Alipangpang		Low	Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 25	Alipangpang		Low	Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 27	Alipangpang	Low	Low	Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 28	Alipangpang			Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 29	Alipangpang			
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 3	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 30	Alipangpang		Low	Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 34	Alipangpang	Low	Low	Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 35	Alipangpang		Low	Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 36	Alipangpang			
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 37	Alipangpang			
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 4	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 5	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 6	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 7	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 8	Alipangpang	Medium	Medium	Medium
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 9	Alipangpang	Medium	Medium	Medium
MARY HELP OF CHRISTIANS LEARNING CENTER 1	Alipangpang	Low	Low	Low
MARY HELP OF CHRISTIANS LEARNING CENTER 2	Alipangpang	Low	Medium	Medium
MARY HELP OF CHRISTIANS LEARNING CENTER 3	Alipangpang	Medium	Low	Medium
MARY HELP OF CHRISTIANS LEARNING CENTER 4	Alipangpang	Low	Low	Medium
MARY HELP OF CHRISTIANS LEARNING CENTER 5	Alipangpang	Low	Low	Low
MARY HELP OF CHRISTIANS LEARNING CENTER 6	Alipangpang	Low	Low	Medium
MOTHER GOOSE INTERNATIONAL PLAY SCHOOL	Alipangpang	Low	Low	Medium
POZORRUBIO CENTRAL SCHOOL 10	Alipangpang	Low	Low	Low
POZORRUBIO CENTRAL SCHOOL 11	Alipangpang		Low	Low
POZORRUBIO CENTRAL SCHOOL 12	Alipangpang	Low	Low	Low
POZORRUBIO CENTRAL SCHOOL 13	Alipangpang		Low	Low
POZORRUBIO CENTRAL SCHOOL 14	Alipangpang	Low	Low	Low
POZORRUBIO CENTRAL SCHOOL 15	Alipangpang	Low	Low	Medium
POZORRUBIO CENTRAL SCHOOL 17	Alipangpang	Low	Low	Low
POZORRUBIO CENTRAL SCHOOL 18	Alipangpang	Low	Low	Low
POZORRUBIO CENTRAL SCHOOL 2	Alipangpang	Low	Low	Low
POZORRUBIO CENTRAL SCHOOL 3	Alipangpang	Low	Low	Low
POZORRUBIO CENTRAL SCHOOL 4	Alipangpang		Low	Low
POZORRUBIO CENTRAL SCHOOL 5	Alipangpang			
POZORRUBIO CENTRAL SCHOOL 6	Alipangpang			
POZORRUBIO CENTRAL SCHOOL 7	Alipangpang		Low	Low
POZORRUBIO CENTRAL SCHOOL 9	Alipangpang			

Pangasinan				
Mangaldan				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
SAINT PHILOMENA'S ACADEMY 1	Alipangpang		Low	Low
SAINT PHILOMENA'S ACADEMY 10	Alipangpang			
SAINT PHILOMENA'S ACADEMY 11	Alipangpang			
SAINT PHILOMENA'S ACADEMY 2	Alipangpang			Low
SAINT PHILOMENA'S ACADEMY 3	Alipangpang			
SAINT PHILOMENA'S ACADEMY 4	Alipangpang		Low	Low
SAINT PHILOMENA'S ACADEMY 6	Alipangpang	Low	Low	Low
SAINT PHILOMENA'S ACADEMY 8	Alipangpang	Low	Medium	Medium
AMA-TALO ELEMETARY SCHOOL 1	Amagbagan			
AMA-TALO ELEMETARY SCHOOL 2	Amagbagan			
AMA-TALO ELEMETARY SCHOOL 3	Amagbagan			Low
AMA-TALO ELEMETARY SCHOOL 4	Amagbagan			Low
AMA-TALO ELEMETARY SCHOOL 5	Amagbagan	Low		
MALASIN ELEMENTARY SCHOOL 11	Amagbagan	Low	Low	Low
MALASIN ELEMENTARY SCHOOL 7	Amagbagan	Low	Low	Low
BALACAG DAY CARE CENTER	Balacag			
BALACAG ELEMENTARY SCHOOL 1	Balacag			
BALACAG ELEMENTARY SCHOOL 2	Balacag			
BALACAG ELEMENTARY SCHOOL 3	Balacag			
BALACAG ELEMENTARY SCHOOL 4	Balacag			
BALACAG ELEMENTARY SCHOOL 5	Balacag			
BALACAG ELEMENTARY SCHOOL 7	Balacag			
JOSE N. JUGUILON ELEMENTARY SCHOOL 1	Balacag			
JOSE N. JUGUILON ELEMENTARY SCHOOL 2	Balacag			
JOSE N. JUGUILON ELEMENTARY SCHOOL 3	Balacag			
JOSE N. JUGUILON ELEMENTARY SCHOOL 4	Balacag			
STA. CRUZ ELEMENTARY SCHOOL 1	Balacag			
STA. CRUZ ELEMENTARY SCHOOL 2	Balacag			
STA. CRUZ ELEMENTARY SCHOOL 3	Balacag			
STA. CRUZ ELEMENTARY SCHOOL 4	Balacag			
MANAOL ELEMENTARY SCHOOL 3	Bantugan			
MANAOL ELEMENTARY SCHOOL 4	Bantugan			
MANAOL ELEMENTARY SCHOOL 5	Bantugan			
MANAOL ELEMENTARY SCHOOL 6	Bantugan			
MANAOL ELEMENTARY SCHOOL 7	Bantugan			
MANAOL ELEMENTARY SCHOOL 9	Bantugan			
BOBONAN CENTRAL SCHOOL 1	Bobonan	Medium	Medium	Medium
BOBONAN CENTRAL SCHOOL 10	Bobonan	Medium	Medium	Medium
BOBONAN CENTRAL SCHOOL 2	Bobonan	Medium	Medium	Medium
BOBONAN CENTRAL SCHOOL 3	Bobonan	Medium	Medium	Medium

Pangasinan				
Mangaldan				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
BOBONAN CENTRAL SCHOOL 4	Bobonan	High	High	High
BOBONAN CENTRAL SCHOOL 5	Bobonan	Medium	Medium	Medium
BOBONAN CENTRAL SCHOOL 8	Bobonan	Medium	Medium	Medium
BOBONAN LAOAC BATAKIL NATIONAL HIGH SCHOOL 1	Bobonan	Medium	Medium	Medium
BOBONAN LAOAC BATAKIL NATIONAL HIGH SCHOOL 2	Bobonan	Medium	Medium	Medium
BOBONAN LAOAC BATAKIL NATIONAL HIGH SCHOOL 3	Bobonan	Medium	Medium	Medium
BOBONAN LAOAC BATAKIL NATIONAL HIGH SCHOOL 4	Bobonan	Medium	Medium	Medium
BOBONAN LAOAC BATAKIL NATIONAL HIGH SCHOOL 5	Bobonan	Medium	Medium	Medium
BOBONAN LAOAC BATAKIL NATIONAL HIGH SCHOOL 6	Bobonan	Low	Medium	Medium
BOBONAN MULTI-PURPOSE HALL	Bobonan	Medium	Medium	Medium
LAOAC ELEMENTARY SCHOOL 2	Bobonan			
LAOAC ELEMENTARY SCHOOL 3	Bobonan			
BUNEG ELEMENTARY SCHOOL 1	Buneg	Low	Medium	Medium
EUGENIO P. PEREZ NATIONAL HIGH SCHOOL 1	Buneg	Low	Low	Medium
EUGENIO P. PEREZ NATIONAL HIGH SCHOOL 2	Buneg	Low	Medium	Medium
EUGENIO P. PEREZ NATIONAL HIGH SCHOOL 3	Buneg	Low	Low	Medium
EUGENIO P. PEREZ NATIONAL HIGH SCHOOL 4	Buneg	Low	Medium	Medium
VILLEGAS ELEMENTARY SCHOOL 1	Buneg			
VILLEGAS ELEMENTARY SCHOOL 2	Buneg			
VILLEGAS ELEMENTARY SCHOOL 3	Buneg			
VILLEGAS ELEMENTARY SCHOOL 4	Buneg			
VILLEGAS ELEMENTARY SCHOOL 5	Buneg			
VILLEGAS ELEMENTARY SCHOOL 6	Buneg			
VILLEGAS ELEMENTARY SCHOOL 7	Buneg			
VILLEGAS ELEMENTARY SCHOOL 8	Buneg			
VILLEGAS ELEMENTARY SCHOOL 9	Buneg			
PALACPALAC ELEMENTARY SCHOOL 1	Cablong			
PALACPALAC ELEMENTARY SCHOOL 2	Cablong			
PALACPALAC ELEMENTARY SCHOOL 5	Cablong			
PALACPALAC ELEMENTARY SCHOOL 6	Cablong			
PALACPALAC ELEMENTARY SCHOOL 7	Cablong			
MALASIN ELEMENTARY SCHOOL 1	Dilan			
MALASIN ELEMENTARY SCHOOL 10	Dilan			
MALASIN ELEMENTARY SCHOOL 11	Dilan			
MALASIN ELEMENTARY SCHOOL 12	Dilan			

Pangasinan				
Mangaldan				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
MALASIN ELEMENTARY SCHOOL 13	Dilan			
MALASIN ELEMENTARY SCHOOL 14	Dilan		Low	Low
MALASIN ELEMENTARY SCHOOL 2	Dilan			
MALASIN ELEMENTARY SCHOOL 4	Dilan			
MALASIN ELEMENTARY SCHOOL 5	Dilan			
MALASIN ELEMENTARY SCHOOL 7	Dilan			
MALASIN ELEMENTARY SCHOOL 8	Dilan	Low	Low	Low
MALASIN ELEMENTARY SCHOOL 9	Dilan	Low	Low	Low
CASANFERNANDOAN ELEMENTARY SCHOOL 1	Haway			
CASANFERNANDOAN ELEMENTARY SCHOOL 2	Haway			
CASANFERNANDOAN ELEMENTARY SCHOOL 4	Haway			
CASANFERNANDOAN ELEMENTARY SCHOOL 5	Haway			
CASANFERNANDOAN ELEMENTARY SCHOOL 6	Haway			
NAMA ELEMENTARY/ NATIONAL HIGH SCHOOL 1	Imbalbalatong			
NAMA ELEMENTARY/ NATIONAL HIGH SCHOOL 2	Imbalbalatong			
NAMA ELEMENTARY/ NATIONAL HIGH SCHOOL 3	Imbalbalatong			
NAMA ELEMENTARY/ NATIONAL HIGH SCHOOL 4	Imbalbalatong			
NAMA ELEMENTARY/ NATIONAL HIGH SCHOOL 5	Imbalbalatong			
SCHOOL 1	Imbalbalatong	Low	Low	Low
SCHOOL 2	Imbalbalatong			
SCHOOL 3	Imbalbalatong	Low		
SCHOOL 4	Imbalbalatong	Low	Low	Low
SCHOOL 5	Imbalbalatong	Low	Low	Low
SCHOOL 6	Imbalbalatong	Low	Low	Low
INOMAN ELEMENTARY SCHOOL 5	Inoman			
SCHOOL 1	Malasin			
SCHOOL 2	Malasin			
SCHOOL 3	Malasin			
SCHOOL 4	Malasin			
SCHOOL 5	Malasin			
SCHOOL 6	Malasin			
SCHOOL 7	Malasin			
DON BENITO AGRO-INDUSTRIAL HIGH SCHOOL 2	Malokiat			
DON BENITO AGRO-INDUSTRIAL HIGH SCHOOL 3	Malokiat			
DON BENITO AGRO-INDUSTRIAL HIGH SCHOOL 4	Malokiat			
DON BENITO AGRO-INDUSTRIAL HIGH SCHOOL 5	Malokiat			
DON BENITO AGRO-INDUSTRIAL HIGH SCHOOL 6	Malokiat			
DON BENITO ELEMENTARY SCHOOL 1	Malokiat			
DON BENITO ELEMENTARY SCHOOL 2	Malokiat			
DON BENITO ELEMENTARY SCHOOL 3	Malokiat			

Pangasinan				
Mangaldan				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
DON BENITO ELEMENTARY SCHOOL 4	Malokiat			
INOMAN ELEMENTARY SCHOOL 1	Nama			
INOMAN ELEMENTARY SCHOOL 2	Nama			
INOMAN ELEMENTARY SCHOOL 3	Nama			
INOMAN ELEMENTARY SCHOOL 4	Nama			
INOMAN ELEMENTARY SCHOOL 5	Nama			
INOMAN ELEMENTARY SCHOOL 6	Nama			Low
INOMAN ELEMENTARY SCHOOL 8	Nama			
UNIVERSITY OF LUZON 1	Poblacion III			
UNIVERSITY OF LUZON 2	Poblacion III		Low	Low
UNIVERSITY OF LUZON 3	Poblacion III		Low	Low
UNIVERSITY OF LUZON 4	Poblacion III			
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 27	Poblacion IV			Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 30	Poblacion IV		Low	Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 31	Poblacion IV			Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 32	Poblacion IV	Low	Low	Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 33	Poblacion IV			Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 34	Poblacion IV	Low	Low	Low
BENIGNO V. ALDANA NATIONAL HIGH SCHOOL 38	Poblacion IV			
POZORRUBIO CENTRAL SCHOOL 14	Poblacion IV		Low	Low
POZORRUBIO CENTRAL SCHOOL 15	Poblacion IV	Low	Low	Low
POZORRUBIO CENTRAL SCHOOL 16	Poblacion IV	Low	Low	Medium
POZORRUBIO CENTRAL SCHOOL 18	Poblacion IV	Low	Medium	Medium
POZORRUBIO CENTRAL SCHOOL 19	Poblacion IV	Medium	Medium	Medium
POZORRUBIO CENTRAL SCHOOL 20	Poblacion IV	Low	Medium	Medium
POZORRUBIO CENTRAL SCHOOL 4	Poblacion IV			
POZORRUBIO CENTRAL SCHOOL 5	Poblacion IV		Low	Low
SAINT PHILOMENA'S ACADEMY 2	Poblacion IV			
SAINT PHILOMENA'S ACADEMY 5	Poblacion IV	Low	Low	Low
SAINT PHILOMENA'S ACADEMY 6	Poblacion IV	Low	Low	Low
SAINT PHILOMENA'S ACADEMY 8	Poblacion IV	Medium	Medium	Medium
ALIPANGPANG ELEMENTARY SCHOOL 1	Rosario		Medium	Medium
ALIPANGPANG ELEMENTARY SCHOOL 10	Rosario	Medium	Medium	Medium
ALIPANGPANG ELEMENTARY SCHOOL 2	Rosario	Low	Medium	Medium
ALIPANGPANG ELEMENTARY SCHOOL 3	Rosario	Low	Medium	Medium
ALIPANGPANG ELEMENTARY SCHOOL 4	Rosario	Low	Medium	Medium
ALIPANGPANG ELEMENTARY SCHOOL 5	Rosario	Low	Medium	Medium
ALIPANGPANG ELEMENTARY SCHOOL 6	Rosario	Low	Low	Medium
ALIPANGPANG ELEMENTARY SCHOOL 7	Rosario	Medium	Medium	Medium
ALIPANGPANG ELEMENTARY SCHOOL 8	Rosario	Medium	Medium	Medium

Pangasinan				
Mangaldan				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
ALIPANGPANG ELEMENTARY SCHOOL 9	Rosario	Low	Medium	Medium
BUNEG ELEMENTARY SCHOOL 1	Rosario		Low	Low
BUNEG ELEMENTARY SCHOOL 2	Rosario		Low	Low
BUNEG ELEMENTARY SCHOOL 3	Rosario	Medium	Medium	Medium
BUNEG ELEMENTARY SCHOOL 4	Rosario	Medium	Medium	Medium
BUNEG ELEMENTARY SCHOOL 5	Rosario	Medium	Medium	Medium
BUNEG ELEMENTARY SCHOOL 6	Rosario	Low	Low	Medium
DON DOMINGO MAGNO ELEMENTARY SCHOOL 1	Rosario	Medium	Medium	Medium
DON DOMINGO MAGNO ELEMENTARY SCHOOL 2	Rosario	Low	Medium	Medium
DON DOMINGO MAGNO ELEMENTARY SCHOOL 3	Rosario	Low	Medium	Medium
DON DOMINGO MAGNO ELEMENTARY SCHOOL 4	Rosario	Low	Medium	Medium
PALGUYOD ELEMENTARY SCHOOL 1	Tulnac			
PALGUYOD ELEMENTARY SCHOOL 10	Tulnac			Low
PALGUYOD ELEMENTARY SCHOOL 11	Tulnac			
PALGUYOD ELEMENTARY SCHOOL 12	Tulnac			
PALGUYOD ELEMENTARY SCHOOL 2	Tulnac			
PALGUYOD ELEMENTARY SCHOOL 3	Tulnac			
PALGUYOD ELEMENTARY SCHOOL 4	Tulnac			
PALGUYOD ELEMENTARY SCHOOL 6	Tulnac			
PALGUYOD ELEMENTARY SCHOOL 7	Tulnac			
PALGUYOD ELEMENTARY SCHOOL 8	Tulnac			
PALGUYOD ELEMENTARY SCHOOL 9	Tulnac			
PALGUYOD NATIONAL HIGH SCHOOL 1	Tulnac			
PALGUYOD NATIONAL HIGH SCHOOL 2	Tulnac			
PALGUYOD NATIONAL HIGH SCHOOL 3	Tulnac			
PALGUYOD NATIONAL HIGH SCHOOL 4	Tulnac			
PALGUYOD NATIONAL HIGH SCHOOL 5	Tulnac			

Table A-12.6. Educational Institutions Affected in San Fabian

Pangasinan				
San Fabian				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
ANGIO ELEMENTARY SCHOOL 1	Angio			
ANGIO ELEMENTARY SCHOOL 10	Angio			
ANGIO ELEMENTARY SCHOOL 2	Angio		Low	Low
ANGIO ELEMENTARY SCHOOL 3	Angio			

Pangasinan				
San Fabian				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
ANGIO ELEMENTARY SCHOOL 4	Angio			
ANGIO ELEMENTARY SCHOOL 5	Angio			
ANGIO ELEMENTARY SCHOOL 6	Angio			
ANGIO ELEMENTARY SCHOOL 7	Angio			
ANGIO ELEMENTARY SCHOOL 9	Angio			
ANONANG NATIONAL HIGH SCHOOL 1	Angio			
ANONANG NATIONAL HIGH SCHOOL 2	Angio			
ANONANG NATIONAL HIGH SCHOOL 3	Angio			
ANONANG NATIONAL HIGH SCHOOL 4	Angio			
ANONANG NATIONAL HIGH SCHOOL 5	Angio			
ANONANG NATIONAL HIGH SCHOOL 6	Angio			
ANONANG ELEMENTARY SCHOOL 5	Anonang			
ANONANG ELEMENTARY SCHOOL 6	Anonang		Low	Low
ANONANG ELEMENTARY SCHOOL 7	Anonang			
ANONANG ELEMENTARY SCHOOL 8	Anonang			
ANONANG ELEMENTARY SCHOOL 9	Anonang			
ARCHDIOCESAN SCHOOL OF SAN FABIAN 1	Cayanga		Medium	High
ARCHDIOCESAN SCHOOL OF SAN FABIAN 2	Cayanga		Medium	Medium
ARCHDIOCESAN SCHOOL OF SAN FABIAN 3	Cayanga		Medium	Medium
GLOBAL FILIPINO TECHNICAL SCHOOL INC. 1	Cayanga	Medium	Medium	High
GLOBAL FILIPINO TECHNICAL SCHOOL INC. 2	Cayanga	Medium	High	High
ST. BLAISE CHRISTIAN SCHOOL 1	Cayanga	High	High	High
ST. BLAISE CHRISTIAN SCHOOL 10	Cayanga	Medium	Medium	Medium
ST. BLAISE CHRISTIAN SCHOOL 2	Cayanga	High	High	High
ST. BLAISE CHRISTIAN SCHOOL 4	Cayanga	Medium	Medium	High
ST. BLAISE CHRISTIAN SCHOOL 5	Cayanga	Medium	Medium	High
ST. BLAISE CHRISTIAN SCHOOL 6	Cayanga	Medium	Medium	Medium
ST. BLAISE CHRISTIAN SCHOOL 7	Cayanga	Medium	Medium	Medium
ST. BLAISE CHRISTIAN SCHOOL 8	Cayanga	Medium	Medium	Medium
ST. BLAISE CHRISTIAN SCHOOL 9	Cayanga	Medium	Medium	Medium
ANGIO ELEMENTARY SCHOOL 10	Lekep-Butao			
ANGIO ELEMENTARY SCHOOL 12	Lekep-Butao			
ANGIO ELEMENTARY SCHOOL 6	Lekep-Butao			
CABARUAN ELEMENTARY SCHOOL 1	Lekep-Butao			
CABARUAN ELEMENTARY SCHOOL 2	Lekep-Butao			
CABARUAN ELEMENTARY SCHOOL 3	Lekep-Butao			
CABARUAN ELEMENTARY SCHOOL 5	Lekep-Butao			
CABARUAN ELEMENTARY SCHOOL 6	Lekep-Butao			
CABARUAN ELEMENTARY SCHOOL 7	Lekep-Butao			
CABARUAN ELEMENTARY SCHOOL 8	Lekep-Butao			

Pangasinan				
San Fabian				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
LONGOS ELEMENTARY SCHOOL 3	Longos	Medium	High	High
LONGOS ELEMENTARY SCHOOL 4	Longos	Medium	High	High
LONGOS ELEMENTARY SCHOOL 5	Longos	Medium	High	High
LONGOS ELEMENTARY SCHOOL 7	Longos	Medium	High	High
LONGOS ELEMENTARY SCHOOL 1	Longos Proper	Medium	High	High
LONGOS ELEMENTARY SCHOOL 2	Longos Proper	Medium	High	High
LONGOS ELEMENTARY SCHOOL 3	Longos Proper	Medium	Medium	High
LONGOS ELEMENTARY SCHOOL 4	Longos Proper	Medium	High	High
LONGOS ELEMENTARY SCHOOL 6	Longos Proper	Medium	High	High
LONGOS ELEMENTARY SCHOOL 7	Longos Proper	Medium	High	High
NIBALIW EAST DAY CARE CENTER	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 1	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 10	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 11	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 12	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 13	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 14	Nibaliw Central	Medium	Medium	High
SAN FABIAN NATIONAL HIGH SCHOOL 16	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 17	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 18	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 19	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 2	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 20	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 21	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 22	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 23	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 24	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 3	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 4	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 5	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 6	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 7	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 8	Nibaliw Central	Medium	High	High
SAN FABIAN NATIONAL HIGH SCHOOL 9	Nibaliw Central	Medium	High	High
SANITAS ELEMENTARY SCHOOL 1	Nibaliw Magliba	Low		
SANITAS ELEMENTARY SCHOOL 10	Nibaliw Magliba			
SANITAS ELEMENTARY SCHOOL 11	Nibaliw Magliba			

Pangasinan				
San Fabian				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
SANITAS ELEMENTARY SCHOOL 12	Nibaliw Magliba	Low		Low
SANITAS ELEMENTARY SCHOOL 2	Nibaliw Magliba			
SANITAS ELEMENTARY SCHOOL 3	Nibaliw Magliba			
SANITAS ELEMENTARY SCHOOL 4	Nibaliw Magliba			
SANITAS ELEMENTARY SCHOOL 5	Nibaliw Magliba			
SANITAS ELEMENTARY SCHOOL 6	Nibaliw Magliba			
SANITAS ELEMENTARY SCHOOL 8	Nibaliw Magliba			
SANITAS ELEMENTARY SCHOOL 9	Nibaliw Magliba			
SANITAS ELEMENTARY SCHOOL 2	Nibaliw Narvarte			
SANITAS ELEMENTARY SCHOOL 3	Nibaliw Narvarte			
ARCHDIOCESAN SCHOOL OF SAN FABIAN 3	Poblacion	Low	Medium	Medium
EAST CENTRAL ELEMENTARY SCHOOL 1	Poblacion	Low	Medium	Medium
EAST CENTRAL ELEMENTARY SCHOOL 10	Poblacion		Medium	Medium
EAST CENTRAL ELEMENTARY SCHOOL 3	Poblacion		Medium	Medium
EAST CENTRAL ELEMENTARY SCHOOL 4	Poblacion		Medium	Medium
EAST CENTRAL ELEMENTARY SCHOOL 5	Poblacion		Medium	Medium
EAST CENTRAL ELEMENTARY SCHOOL 6	Poblacion		Medium	Medium
EAST CENTRAL ELEMENTARY SCHOOL 7	Poblacion		Medium	Medium
EAST CENTRAL ELEMENTARY SCHOOL 8	Poblacion		Medium	Medium
MARIAN SCHOOL OF SAN FABIAN 1	Poblacion	Medium	Medium	High
MARIAN SCHOOL OF SAN FABIAN 2	Poblacion	Medium	Medium	High
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 1	Poblacion	Low	Medium	High
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 10	Poblacion	Medium	High	High
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 11	Poblacion	Medium	High	High
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 12	Poblacion	Medium	Medium	High
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 13	Poblacion	Low	Medium	High
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 14	Poblacion		Medium	Medium

Pangasinan				
San Fabian				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 15	Poblacion		Medium	High
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 2	Poblacion	Low	Medium	High
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 3	Poblacion	Medium	Medium	High
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 4	Poblacion	Medium	High	High
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 5	Poblacion	Medium	High	High
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 6	Poblacion	Low	Medium	High
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 7	Poblacion	Medium	Medium	High
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 8	Poblacion	Medium	High	High
SAN FABIAN WEST-CENTRAL ELEMENTARY SCHOOL 9	Poblacion	Medium	High	High
TOCOK ELEMENTARY SCHOOL 1	Tocok	Medium	Medium	High
TOCOK ELEMENTARY SCHOOL 10	Tocok	Medium	High	High
TOCOK ELEMENTARY SCHOOL 2	Tocok	Medium	Medium	High
TOCOK ELEMENTARY SCHOOL 3	Tocok	Medium	Medium	High
TOCOK ELEMENTARY SCHOOL 4	Tocok	Medium	Medium	High
TOCOK ELEMENTARY SCHOOL 5	Tocok	Medium	Medium	High
TOCOK ELEMENTARY SCHOOL 6	Tocok	Medium	Medium	High
TOCOK ELEMENTARY SCHOOL 7	Tocok	Medium	High	High
TOCOK ELEMENTARY SCHOOL 8	Tocok	Medium	High	High
TOCOK ELEMENTARY SCHOOL 9	Tocok	Medium	High	High

Table A-12.7. Educational Institutions Affected in San Jacinto

Pangasinan				
San Jacinto				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
AWAI ELEMETARY SCHOOL 1	Awai			
AWAI ELEMETARY SCHOOL 2	Awai			
AWAI ELEMETARY SCHOOL 4	Awai			
AWAI ELEMETARY SCHOOL 5	Awai			
AWAI ELEMETARY SCHOOL 6	Awai			

Pangasinan				
San Jacinto				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
DAY CARE CENTER	Awai			
SAN JACINTO CATHOLIC SCHOOL 1	Capaoay		Medium	Medium
SAN JACINTO CATHOLIC SCHOOL 2	Capaoay		Medium	Medium
SAN JACINTO CATHOLIC SCHOOL 3	Capaoay	Medium	Medium	Medium
SAN JACINTO CATHOLIC SCHOOL 4	Capaoay			Low
SAN JACINTO CATHOLIC SCHOOL 5	Capaoay		Medium	Medium
SAN JACINTO CATHOLIC SCHOOL 7	Capaoay	Medium	Medium	High
EAST CENTRAL SCHOOL 1	Guibel	Medium	High	High
EAST CENTRAL SCHOOL 10	Guibel	Medium	High	High
EAST CENTRAL SCHOOL 12	Guibel	Medium	High	High
EAST CENTRAL SCHOOL 2	Guibel	Medium	High	High
EAST CENTRAL SCHOOL 3	Guibel	Medium	High	High
EAST CENTRAL SCHOOL 4	Guibel	Medium	High	High
EAST CENTRAL SCHOOL 5	Guibel	Medium	High	High
EAST CENTRAL SCHOOL 6	Guibel	Medium	High	High
EAST CENTRAL SCHOOL 7	Guibel	High	High	High
EAST CENTRAL SCHOOL 8	Guibel	Medium	High	High
SAN JACINTO NATIONAL HIGH SCHOOL 1	Guibel	Medium	High	High
SAN JACINTO NATIONAL HIGH SCHOOL 10	Guibel	Medium	High	High
SAN JACINTO NATIONAL HIGH SCHOOL 11	Guibel	Medium	High	High
SAN JACINTO NATIONAL HIGH SCHOOL 12	Guibel	Medium	High	High
SAN JACINTO NATIONAL HIGH SCHOOL 13	Guibel	Medium	High	High
SAN JACINTO NATIONAL HIGH SCHOOL 14	Guibel	Medium	High	High
SAN JACINTO NATIONAL HIGH SCHOOL 3	Guibel	Medium	High	High
SAN JACINTO NATIONAL HIGH SCHOOL 4	Guibel	High	High	High
SAN JACINTO NATIONAL HIGH SCHOOL 5	Guibel	High	High	High
SAN JACINTO NATIONAL HIGH SCHOOL 6	Guibel	High	High	High
SAN JACINTO NATIONAL HIGH SCHOOL 8	Guibel	High	High	High
SAN JACINTO NATIONAL HIGH SCHOOL 9	Guibel	Medium	High	High
SAN JOSE ELEMENTARY SCHOOL 1	Guibel	Medium	Medium	High
SAN JOSE ELEMENTARY SCHOOL 2	Guibel	Medium	Medium	Medium
SAN JOSE ELEMENTARY SCHOOL 4	Guibel	Medium	Medium	High
SAN JOSE ELEMENTARY SCHOOL 6	Guibel	Medium	Medium	High
SAN JOSE ELEMENTARY SCHOOL 7	Guibel	Medium	Medium	Medium
SAN JOSE ELEMENTARY SCHOOL 8	Guibel	Medium	Medium	Medium
LABNEY DAY CARE CENTER	Labney			
LABNEY ELEMENTARY SCHOOL 1	Labney			
LABNEY ELEMENTARY SCHOOL 2	Labney			
LABNEY ELEMENTARY SCHOOL 3	Labney			
LABNEY ELEMENTARY SCHOOL 4	Labney			

Pangasinan				
San Jacinto				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
LABNEY ELEMENTARY SCHOOL 5	Labney			
LABNEY ELEMENTARY SCHOOL 6	Labney			
LABNEY ELEMENTARY SCHOOL 7	Labney			
LABNEY ELEMENTARY SCHOOL 8	Labney			
SAN JACINTO CATHOLIC SCHOOL 1	San Guillermo		Medium	Medium
SAN JACINTO CATHOLIC SCHOOL 2	San Guillermo		Medium	Medium
SAN JACINTO CATHOLIC SCHOOL 3	San Guillermo	Low	Medium	Medium
SAN JACINTO WEST CENTRAL SCHOOL 12	San Guillermo	Medium	High	High
SAN JACINTO WEST CENTRAL SCHOOL 14	San Guillermo	Medium	High	High
SAN JACINTO WEST CENTRAL SCHOOL 15	San Guillermo	Medium	High	High
SAN JACINTO WEST CENTRAL SCHOOL 16	San Guillermo	Medium	High	High
SAN JACINTO WEST CENTRAL SCHOOL 3	San Guillermo	Medium	High	High
SAN JACINTO WEST CENTRAL SCHOOL 5	San Guillermo	High	High	High
SAN JACINTO WEST CENTRAL SCHOOL 6	San Guillermo	High	High	High
SAN JACINTO WEST CENTRAL SCHOOL 7	San Guillermo	High	High	High
SAN JACINTO WEST CENTRAL SCHOOL 8	San Guillermo	Medium	High	High
SAN JACINTO WEST CENTRAL SCHOOL 9	San Guillermo	Medium	High	High
SENIOR CITIZENS' AFFAIRS	San Guillermo	Medium	Medium	Medium
LOBONG ELEMENTARY SCHOOL 1	San Juan			
LOBONG ELEMENTARY SCHOOL 10	San Juan			
LOBONG ELEMENTARY SCHOOL 12	San Juan			
LOBONG ELEMENTARY SCHOOL 13	San Juan			
LOBONG ELEMENTARY SCHOOL 14	San Juan			
LOBONG ELEMENTARY SCHOOL 2	San Juan			
LOBONG ELEMENTARY SCHOOL 3	San Juan			
LOBONG ELEMENTARY SCHOOL 4	San Juan			
LOBONG ELEMENTARY SCHOOL 5	San Juan			
LOBONG ELEMENTARY SCHOOL 6	San Juan			
LOBONG ELEMENTARY SCHOOL 7	San Juan			
LOBONG ELEMENTARY SCHOOL 8	San Juan			
LOBONG ELEMENTARY SCHOOL 9	San Juan			
LOBONG NATIONAL HIGH SCHOOL 1	San Juan			
LOBONG NATIONAL HIGH SCHOOL 10	San Juan			
LOBONG NATIONAL HIGH SCHOOL 2	San Juan			
LOBONG NATIONAL HIGH SCHOOL 3	San Juan			
LOBONG NATIONAL HIGH SCHOOL 4	San Juan			
LOBONG NATIONAL HIGH SCHOOL 5	San Juan			
LOBONG NATIONAL HIGH SCHOOL 7	San Juan			
LOBONG NATIONAL HIGH SCHOOL 8	San Juan			
LOBONG NATIONAL HIGH SCHOOL 9	San Juan			

Pangasinan				
San Jacinto				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
SAN VICENTE ELEMENTARY SCHOOL 1	San Vicente	High	High	High
SAN VICENTE ELEMENTARY SCHOOL 2	San Vicente	High	High	High
SAN VICENTE ELEMENTARY SCHOOL 5	San Vicente	High	High	High
SAN VICENTE ELEMENTARY SCHOOL 6	San Vicente	High	High	High

Table A-12.8. Educational Institutions Affected in Sison

Pangasinan				
Sison				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
SUGCONG ELEMENTARY SCHOOL 1	Calunetan			
SUGCONG ELEMENTARY SCHOOL 2	Calunetan			

ANNEX 13. Health Institutions affected by flooding in Patalan Floodplain

Table A-13.1. Health Institutions Affected in Binalonan

Pangasinan				
Binalonan				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
CLINIC	Poblacion	Low	Low	Low
PRUDENCIO MEDICAL CLINIC	Poblacion		Low	Low

Table A-13.2. Health Institutions Affected in Laoac

Pangasinan				
Laoac				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
INMANDUYAN HEALTH CENTER	Casanestebanan		Low	Medium

Table A-13.2. Health Institutions Affected in Manaoag

Pangasinan				
Manaoag				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
DIVINE SALVATION MEDICAL CLINIC	Licsi	Medium	Medium	Medium
MANAOAG COMMUNITY HOSPITAL 2	Pantal			
MANAOAG COMMUNITY HOSPITAL 3	Pantal			
MANAOAG COMMUNITY HOSPITAL 4	Pantal			
MANAOAG COMMUNITY HOSPITAL 5	Pantal			

Table A-13.2. Health Institutions Affected in Pozzorubio

Pangasinan				
Pozzorubio				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
BAUTISTA MEDICAL CLINIC	Alipangpang			
POZORRUBIO COMMUNITY HOSPITAL 1	Banding			
POZORRUBIO COMMUNITY HOSPITAL 2	Banding			
POZORRUBIO COMMUNITY HOSPITAL 3	Banding			
POZORRUBIO COMMUNITY HOSPITAL 4	Banding			Low

Pangasinan				
Pozzorubio				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
BANTUGAN HEALTH CENTER	Dilan		Medium	High
FAIRVILLE DENTAL CARE	Poblacion IV		Low	Low
POZDIAL	Poblacion IV	Medium	Medium	Medium

Table A-13.2. Health Institutions Affected in San Fabian

Pangasinan				
San Fabian				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
SAN FABIAN LYING-IN CLINIC	Poblacion		Medium	Medium
SAN FABIAN HEALTH CENTER	Awai		Medium	Medium

Table A-13.2. Health Institutions Affected in San Jacinto

Pangasinan				
San Jacinto				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
AWAI BARANGAY HEALTH STATION	Awai			
LABNEY HEALTH CENTER	Labney			
MACAYUG HEALTH CENTER	Macayug	High	High	High
ST. MARY'S MEDICAL & MATERNITY CLINIC	Santa Maria		Medium	Medium