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

LiDAR Surveys and Flood Mapping of Catubig River

University of the Philippines Training Center
for Applied Geodesy and Photogrammetry
Visayas State University

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LIST OF ACRONYMS AND ABBREVIATIONS

AAC	Asian Aerospace Corporation
Ab	abutment
ALTM	Airborne LiDAR Terrain Mapper
ARG	automatic rain gauge
AWLS	Automated Water Level Sensor
BA	Bridge Approach
BM	benchmark
BSWM	Bureau of Soils and Water Management
CAD	Computer-Aided Design
CN	Curve Number
CSRS	Chief Science Research Specialist
DA	Department of Agriculture
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
HONS	H.O. Noveloso Surveying
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
PSA	Philippine Statistics Authority
PTM	Philippine Transverse Mercator
QC	Quality Check
QT	Quick Terrain [Modeler]
RA	Research Associate
RBCO	River Basin Control Office
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
VSU	Visayas State University
WGS	World Geodetic System

CHAPTER 1: OVERVIEW OF THE PROGRAM AND CATUBIG RIVER

Enrico C. Paringit, Dr. Eng., Dr. George Puno, and Eric Bruno

1.1 Background of the Phil-LiDAR 1 Program

The University of the Philippines Training Center for Applied Geodesy and Photogrammetry (UP-TCAGP) launched a research program in 2014 entitled “Nationwide Hazard Mapping using LiDAR” or Phil-LiDAR 1, supported by the Department of Science and Technology (DOST) Grants-in-Aid (GiA) Program. The program was primarily aimed at acquiring a national elevation and resource dataset at a 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 was also aimed at producing an up-to-date and detailed national elevation dataset suitable for a 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 the DOST. The methods applied in this report are thoroughly described in a separate publication entitled “Flood Mapping of Rivers in the Philippines Using Airborne LiDAR: Methods” (Paringit, et. al., 2017), available separately.

The implementing partner university for the Phil-LiDAR 1 Program is the Visayas State University (VSU). VSU 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 twenty-eight (28) river basins in the Eastern Visayas Region. The university is located in Baybay City in the province of Leyte.

1.2 Overview of the Catubig River Basin

The Catubig River Basin covers three (3) municipalities in the province of Northern Samar – Catubig, Laoang, and Las Navas; and the Municipality of Matuguinao in the province of Samar. It also covers some portions of the Municipalities of Pambujan, Silvino Lobos, and Palapag in Northern Samar; and some portions of the Municipalities of San Jose de Buan, Maslog, and Jipapad in Samar. The Department of Environment and Natural Resources (DENR) River Basin Control Office (RCBO) states that the Catubig River Basin has a drainage area of 688km^2, and an estimated 1,037 cubic meters (MCM) in annual run-off (RCBO, 2015). The basin’s main stem, the Catubig River, is among the twenty-eight (28) river systems in the Eastern Visayas Region.

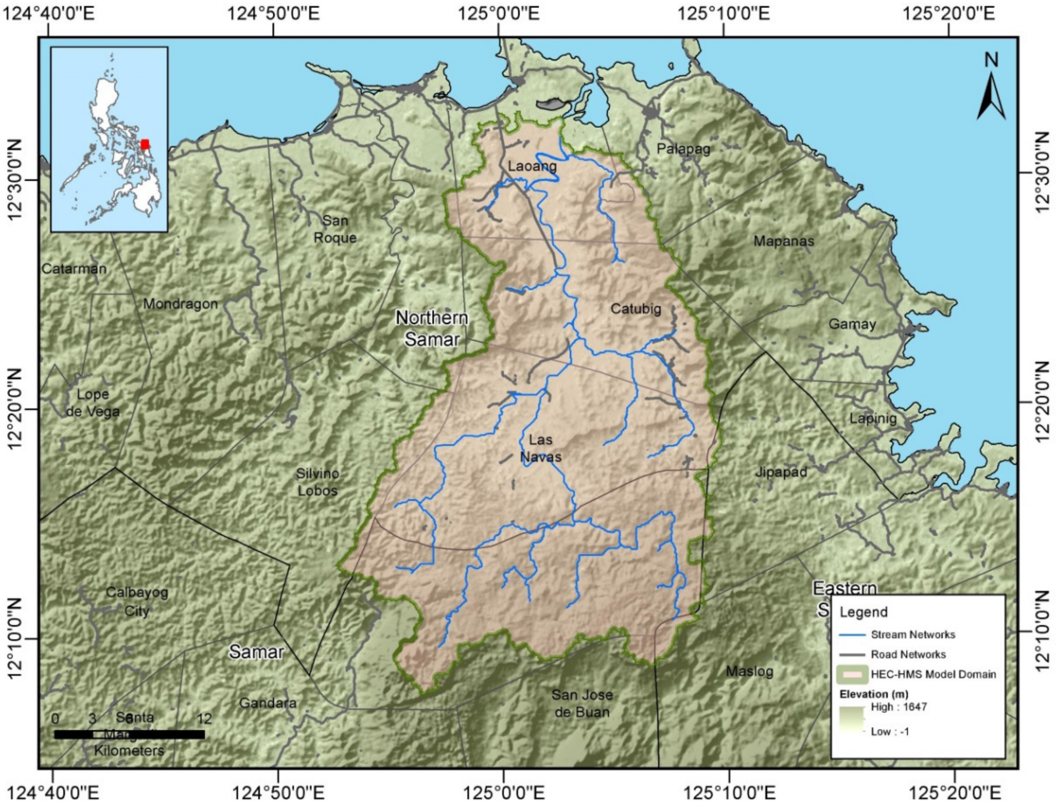

Figure 1. Location map of the Catubig River Basin (in brown)

According to the 2015 national census of the Philippine Statistics Authority (PSA), the total population of residents within the immediate vicinity of the river is 25,219 persons, are distributed among barangays Guibwangan, Canuctan, Calingan, 2 (Poblacion), 7 (Poblacion), 8 (Poblacion), Viena Maria, Hiparayan, D. Mercader, Opong, Tangbo, and Lenoyahan in the Municipality of Catubig; and barangays Cagdara-O, Abaton, Simora, Bawang, La Perla, Bongliw, San Antonio, Vigo, Tarusan, Lawaan, Talisay, Baybay, Sangcol, Cagaasan, and Rawis in the Municipality of Laoang.

The major industries fueling the economy of the province include fishing and agriculture. The main products are traditional crops; such as, rice, corn, vegetables, and fruits (National Economic and Development Authority, 2011).

On December 17, 2016, about 7,333 families – consisting of 32,358 individuals – in Northern Samar were displaced by floods spawned by torrential rains (Gabriela, J. & Dejon, R., 2016).

CHAPTER 2: LIDAR DATA ACQUISITION OF THE CATUBIG FLOODPLAIN

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

2.1 Flight Plans

To initiate the LiDAR acquisition survey of the Catubig floodplain, the Data Acquisition Component (DAC) created flight plans within the delineated priority area for the floodplain in the province of Northern Samar. These missions were planned for fourteen (14) lines that ran for at most four and a half (4.5) hours, including take-off, landing and turning time. The Aquarius and Gemini LiDAR systems were used for the missions (See Annex 1 for the sensor specifications). The flight planning parameters for the LiDAR system are found in Table 1 and Table 2. Figure 2 illustrates the flight plans for the Catubig floodplain survey.

Table 1. Flight planning parameters for the Aquarius LiDAR system

Block Name	Flying Height (m AGL)	Overlap (%)	Field of View (θ)	Pulse Repetition Frequency (PRF) (kHz)	Scan Frequency (Hz)	Average Speed (kts)	Average Turn Time (Minutes)
BLK33A	500	30	36	50	45	120	5
BLK33B	500	30	36	50	50	120	5
BLK33C	500	30	36	50	45	120	5
BLK33D	500	30	36	50	45	120	5
BLK33H	500	30	36	50	45	120	5
BLK33I	500	30	36	50	45	120	5
BLK33J	500	30	36	50	50	120	5
BLK33K	500	30	36	50	45	120	5
BLK33L	500	30	36	50	45	120	5
BLK33M	500	30	36	50	45	120	5
BLK33N	500	30	36	50	45	120	5
BLK33P	500	30	36	50	45	120	5
BLK33R	500,600	30	36	50	45	120	5
BLK33S	500	30	36	50	45	120	5
BLK33T	500	30	36	50	45	120	5
BLK33V	500	30	36	50	45	120	5
BLK331H	600	30	36	50	45	120	5
BLK331L	600	30	40	50	45	120	5
BLK331N	600	30	36,40	50	45	120	5
BLK331O	600	30	36,40	50	45	120	5
BLK331P	600	30	40	50	45	120	5

Table 2. Flight planning parameters for the Gemini LiDAR system

Block Name	Flying Height (m AGL)	Overlap (%)	Field of View (θ)	Pulse Repetition Frequency (PRF) (kHz)	Scan Frequency (Hz)	Average Speed (kts)	Average Turn Time (Minutes)
BLK33K	900	30	50	125	40	120	5
BLK33L	900	30	50	125	40	120	5
BLK33E	900	30	50	125	40	120	5
BLK33G	900	30	50	125	40	120	5

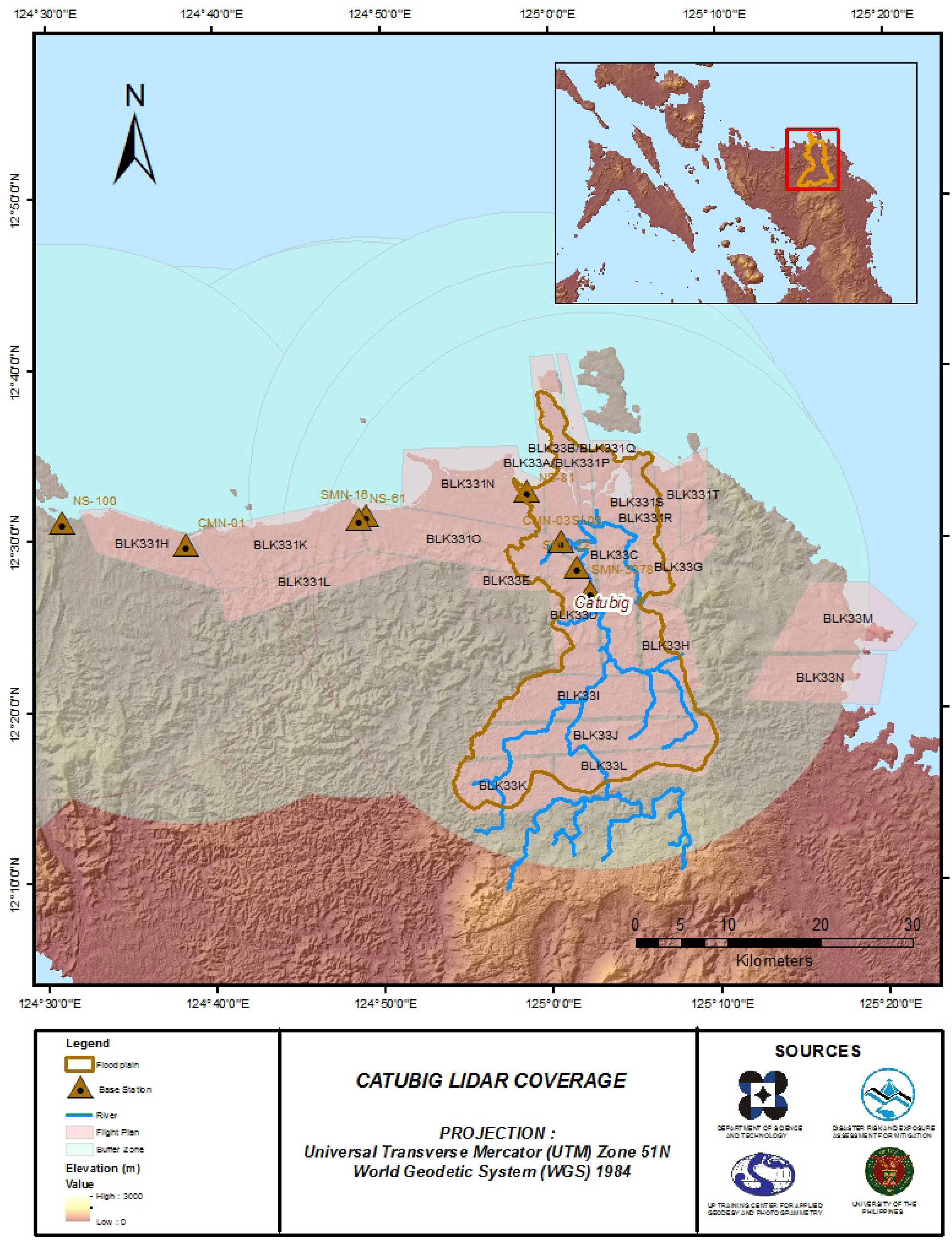


Figure 2. Flight plans and base stations used to cover the Catubig floodplain survey

2.2 Ground Base Stations

The field team for this undertaking was able to recover three (3) NAMRIA horizontal ground control points: SMN-16 (SMN-19), SMN-22, and SMN-12 which are all of second (2nd) order accuracy. The field team also re-established one (1) ground control point, SMN-3378, a NAMRIA reference point of third 3rd order accuracy. The field team established ground control points CMN-01 and CMN-03. Four (4) NAMRIA benchmarks were recovered: NS-61, NS-81, NS-100, and SI-08, which are all of first (1st) order accuracy. These benchmarks were used as vertical reference points and were also established as ground control points. The certifications for the NAMRIA reference points and benchmarks are found in Annex 2; while the baseline processing reports for the established control points are found in Annex 3. These were used as base stations during the flight operations for the entire duration of the survey, held on February 21-March 9, 2015, and on August 1-28, 2015. The base stations were observed using dual frequency GPS receivers, TOPCON GR5, TRIMBLE SPS 852, and SPS 985. The flight plans and locations of the base stations used during the aerial LiDAR acquisition in the Catubig floodplain are shown in Figure 2. The composition of the project team is provided in Annex 4.

Figure 3 to Figure 7 exhibit the recovered NAMRIA reference points within the area. Table 3 to Table 11 provide the details about the NAMRIA control stations and established points. Table 12 lists all of the ground control points occupied during the acquisition, together with the corresponding dates of utilization.

(a)

(b)

Figure 3. (a) GPS set-up over SMN-16, situated inside the basketball court in Barangay Bagasbas, Municipality of Mondragon; and (b) NAMRIA reference point SMN-16, as recovered by the field team

Table 3. Details of the recovered NAMRIA horizontal control point SMN-16, used as a base station for the LiDAR acquisition

Station Name	SMN-16	
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	12°31’32.33268” North 124° 48’56.69485”East 5.45500 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting Northing	479974.965 meters 1385085.603 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	12° 31’ 27.72792” North 124° 49’ 1.74020”East 63.99100 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting Northing	697302.11 meters 1385272.01 meters

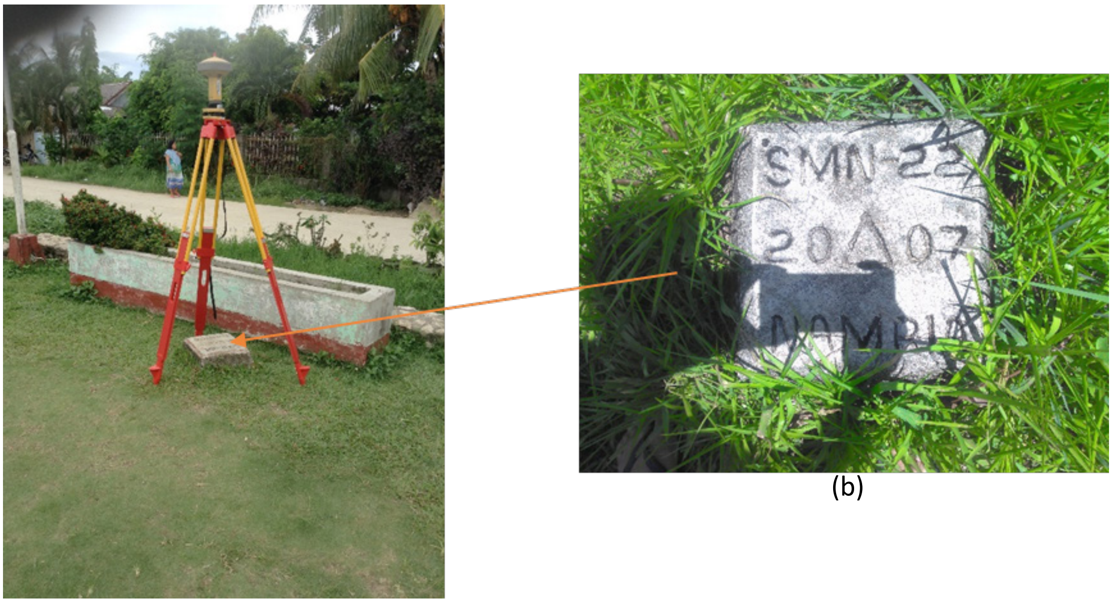
(a)

(b)

Figure 4. (a) GPS set-up over SMN-12, located inside a school in the Municipality of Mondragon; and (b) NAMRIA reference point SMN-12, as recovered by the field team

Table 4. Details of the recovered NAMRIA horizontal control point SMN-12, used as a base station for the LiDAR acquisition

Station Name	SMN-12	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude	12° 26’ 15.70013” North
	Longitude	124° 19’ 13.39605”East
	Ellipsoidal Height	5.45500 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting	426111.163 meters
	Northing	1375444.106 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude	12° 26’ 11.07561” North
	Longitude	124° 19’ 18.45344” East
	Ellipsoidal Height	64.58200 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting	643513.56 meters
	Northing	1375224.53 meters



(a)

(b)

Figure 5. (a) GPS set-up over SMN-22, located in Barangay Simora Elementary School, Northern Samar; and (b) NAMRIA reference point SMN-22, as recovered by the field team

Table 5. Details of the recovered NAMRIA horizontal control point SMN-22, used as a base station for the LiDAR acquisition

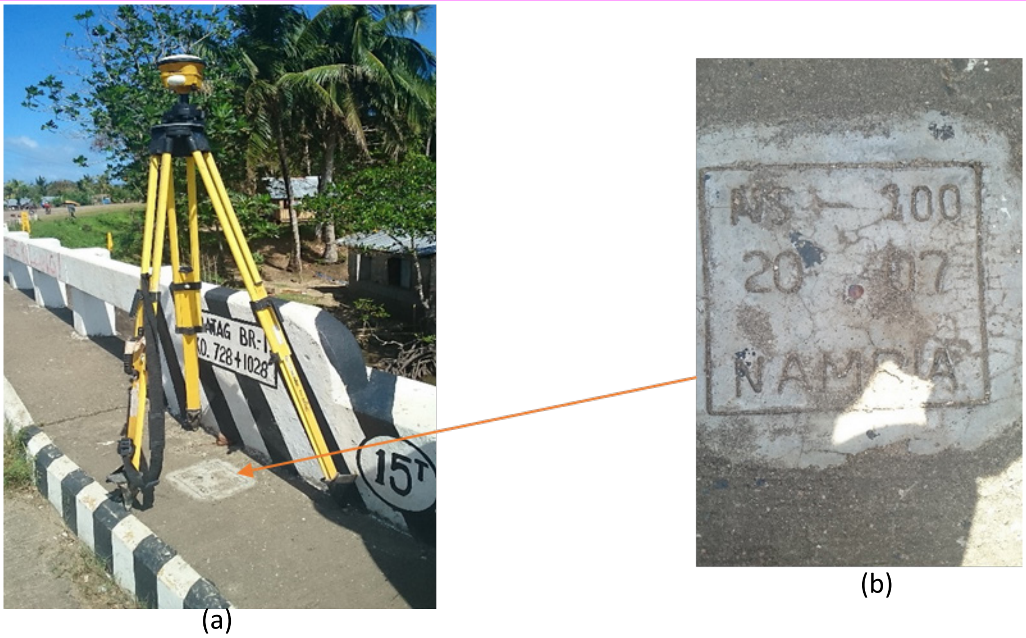
Station Name	SMN-22	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude	12°28’27.20633” North
	Longitude	125°1’25.36067” East
	Ellipsoidal Height	-1.70407 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting	502577.525meters
	Northing	1379390.508meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude	12°28’22.63174” North
	Longitude	125°1’30.408661” East
	Ellipsoidal Height	57.47400 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting Northing	719951.32 meters 1379746.87 meters

Table 6. Details of the recovered NAMRIA horizontal control point SMN-3378, used as a base station for the LiDAR acquisition, with processed coordinates

Station Name	SMN-3378	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude	12° 26’ 01.70620” North
	Longitude	125° 02’ 15.92453” East
	Ellipsoidal Height	1.514 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting	721612.775 meters
	Northing	1375286.867 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude	12° 26’ 57.14186” North
	Longitude	125° 02’ 20.97581” East
	Ellipsoidal Height	60.832 meters

Table 7. Details of the recovered NAMRIA vertical control point NS-81, used as a base station for the LiDAR acquisition, with established coordinates

Station Name	NS-81	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude	12° 32’ 56.09555” North
	Longitude	124° 58’ 29.89302” East
	Ellipsoidal Height	-0.487 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting	714590.119 meters
	Northing	1387970.443 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude	12° 32’ 51.49836” North
	Longitude	124° 58’ 34.93490” East
	Ellipsoidal Height	58.377 meters



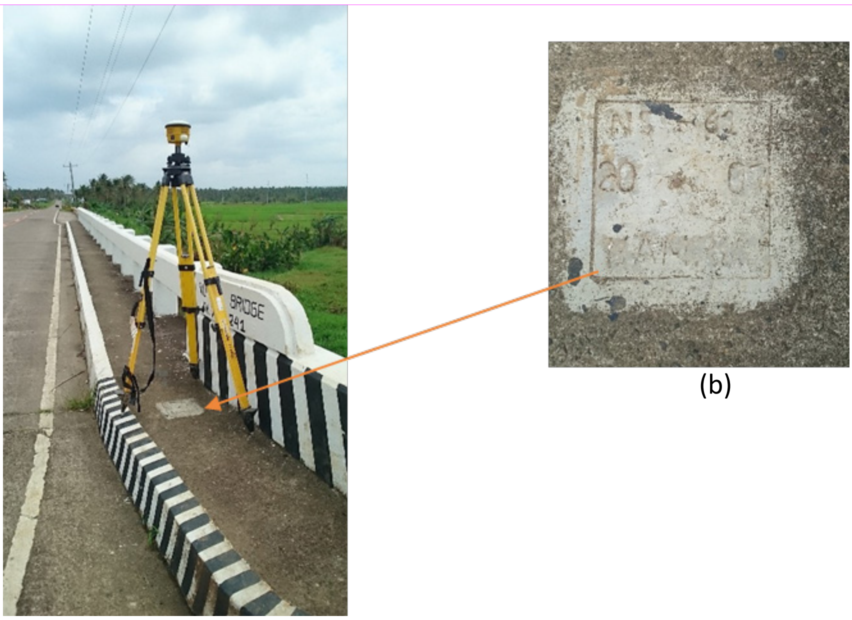
(a)

(b)

Figure 6. (a) GPS set-up over NS-100, situated in the Geratag Bridge 1, Northern Samar; and (b) NAMRIA reference point NS-100, as recovered by the field team

Table 8. Details of the recovered NAMRIA vertical control point NS-100, used as a base station for the LiDAR acquisition, with established coordinates

Station Name	NS-100	
Order of Accuracy	2^{nd}	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude	12° 31’ 15.60049” North
	Longitude	124° 30’ 47.05130” East
	Ellipsoidal Height	5.524 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting	664407.825meters
	Northing	1384550.595meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude	12° 31’ 10.97151” North
	Longitude	124° 30’ 52.09977” East
	Ellipsoidal Height	63.332 meters


(a)

(b)

Figure 7. (a) NS-61, as situated in the Muyaw Bridge, Mondragon, Northern Samar; and (b) NAMRIA reference point NS-61, as recovered by the field team

Table 9. Details of the recovered NAMRIA vertical control point NS-61, used as a base station for the LiDAR acquisition, with established coordinates

Station Name	NS-61	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1:50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude	12°31’17.86801” North
	Longitude	124°48’26.40323” East
	Ellipsoidal Height	5.208 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude	12°31’13.26354” North
	Longitude	124°48’31.44902” East
	Ellipsoidal Height	63.733 meters
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting	696390.555 meters
	Northing	1384821.249 meters

Table 10. Details of the recovered NAMRIA vertical control point CMN-01, used as a base station for the LiDAR acquisition, with established coordinates

Station Name	CMN-01	
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	12° 29’ 53.60604” 124° 38’ 11.46535” 12.573 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	12° 29’ 48.99306” North 124° 38’ 16.51471” East 70.742 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N WGS 1984)	Easting Northing	677840.326 meters 1382111.129 meters

Table 11. Details of the recovered NAMRIA vertical control point CMN-03, used as a base station for the LiDAR acquisition, with established coordinates

Station Name	CMN-03	
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	12° 59’ 56.60839” 125° 00’ 19031” -0.122 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	12° 29’ 52.02635” North 125° 00’ 34.23621” East 58.953 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N WGS 1984)	Easting Northing	718234.013 meters 1382481.531 meters

Table 12. Ground control points used during the LiDAR data acquisition

Date Surveyed	Flight Number	Mission Name	Ground Control Points
01-Mar-15	7830AC	3BLK331HS006A	SMN-16 and NS-61
04-Mar-15	7836AC	3BLK331ON063A	SMN-16 and NS-61
10-Aug-15	8154AC	3BLK331NO222A	SMN-19 and CMN-01
11-Aug-15	8156 AC	3BLK331LNS223A	SMN-19 and CMN-01
11-Aug-15	8157AC	3BLK331NS223B	SMN-19 and CMN-01
12-Aug-15	8158AC	3BLK331P224A	SMN-22 and CMN-03
12-Aug-15	8159AC	3BLK331NSPS224B	SMN-22 and CMN-03
13-Aug-15	8160AC	3BLK331PQRS225A	SMN-22 and SI-08
23-Aug-15	8180AC	3BLK33R235A	SMN-16, SMN-12, NS-61 and NS-100
24-Aug-15	8182AC	3BLK33R236A	SMN-22 and SI-08
24-Aug-15	8183AC	3BLK33STV236B	SMN-22 and SI-08
25-Aug-15	8184AC	3BLK33PS2237A	SMN-22, SMN-16, SI-08 and NS-61
26-Aug-15	8186AC	3BLK33SPST238A	SMN-22 and SI-08
08-Apr-16	3913G	2BLK33LK099A	SMN-22 and NS-81
09-Apr-16	8426AC	3BLK33BC100A	SMN-22 and NS-81
09-Apr-16	3917G	2BLK33EG100A	SMN-22 and NS-81
09-Apr-16	8427AC	3BLK33CS100B	SMN-22 and NS-81
10-Apr-16	8428AC	3BLK33CSH101A	SMN-22 and NS-81
11-Apr-16	8431AC	3BLK33D102A	SMN-22 and NS-81
12-Apr-16	8433AC	3BLK33KSJ103A	SMN-22 and NS-81
13-Apr-16	8435AC	3BLK33IK104A	SMN-22 and NS-81
14-Apr-16	8437AC	3BLK33ISA105A	SMN-22 and NS-81
14-Apr-16	8438AC	3BLK33AS105B	SMN-22 and NS-81
16-Apr-16	8441AC	3BLK33N107A	SMN-22 and SMN-3378
16-Apr-16	8442AC	3BLK33MNS107B	SMN-22 and SMN-3378
17-Apr-16	8443AC	3BLK33MS108A	SMN-22 and SMN-3378
17-Apr-16	8444AC	3BLK33BSDS108B	SMN-22 and SMN-3378
18-Apr-16	8446AC	3BLK33JVKVS109B	SMN-19, SMN-22, SMN-3378 and NS-55
19-Apr-16	8447AC	3BLK33IVJV110A	SMN-22, SMN-3378
19-Apr-16	8448AC	3BLK33CVDV110B	SMN-22, SMN-3378

2.3 Flight Missions

A total of twenty (20) flight missions were conducted to complete LiDAR data acquisition in the Catubig floodplain, for a total of one hundred five hours and thirty-seven minutes (105+37) of flying time for RP-C9022 and RP-C9322. All missions were acquired using Aquarius and Gemini LiDAR systems. The flight logs of the missions are provided in Annex 6. Table 13 indicates the total area of actual coverage and the corresponding flying hours per mission; while Table 14 presents the actual parameters used during the LiDAR data acquisition.

Table 13. Flight missions for the LiDAR data acquisition in the Catubig floodplain

Date Surveyed	Flight Number	Flight Plan Area (km^2)	Surveyed Area (km^2)	Area Surveyed within the Floodplain (km^2)	Area Surveyed Outside the Floodplain (km^2)	No. of Images (Frames)	Flying Hours	
							Hr	**Min**
01-Mar-15	7830AC	166.23	86.45	20.18	66.26	NA	3	59
04-Mar-15	7836AC	101.48	43.38	9.36	34.02	NA	2	43
10-Aug-15	8154AC	211.75	78.70	17.28	61.42	NA	3	23
11-Aug-15	8156 AC	169.46	90.17	11.03	79.14	NA	3	41
11-Aug-15	8157AC	110.27	67.86	15.60	52.25	NA	2	47
12-Aug-15	8158AC	75.85	92.03	66.06	25.97	NA	2	29
12-Aug-15	8159AC	142.31	37.63	11.85	25.79	NA	**2**	**29**
13-Aug-15	8160AC	75.85	41.72	27.34	14.38	NA	**2**	**41**
23-Aug-15	8180AC	99.63	77.20	72.74	4.46	NA	**8**	**47**
24-Aug-15	8182AC	45.80	55.06	46.33	8.73	NA	**3**	**35**
24-Aug-15	8183AC	142.06	39.83	0.61	39.22	NA	**2**	**41**
25-Aug-15	8184AC	63.26	16.83	15.01	1.82	NA	**3**	**53**
26-Aug-15	8186AC	90.74	68.98	23.90	45.08	NA	**4**	**17**
08-Apr-16	3913G	176.37	140.11	70.19	69.93	NA	2	50
09-Apr-16	8426AC	131.67	116.90	90.86	26.05	NA	4	17
09-Apr-16	3917G	98.93	127.79	26.26	101.53	NA	4	23
09-Apr-16	8427AC	99.63	32.76	30.04	2.72	NA	**1**	**59**
10-Apr-16	8428AC	52.81	61.31	51.89	9.42	NA	**4**	**17**
11-Apr-16	8431AC	63.26	87.00	74.19	12.82	NA	4	13
12-Apr-16	8433AC	150.3	108.17	98.83	9.34	NA	4	11
13-Apr-16	8435AC	147.23	92.18	78.41	13.77	NA	4	11
14-Apr-16	8437AC	158.25	112.56	86.99	25.57	NA	4	29
14-Apr-16	8438AC	75.85	21.58	8.51	13.07	NA	1	41
16-Apr-16	8441AC	71.26	91.36	0.13	91.23	NA	4	29

16-Apr-16	8442AC	158.19	35.23	25.70	15.69	NA	2	17
17-Apr-16	8443AC	86.93	72.50	29.20	5.67	NA	4	11
17-Apr-16	8444AC	75.85	41.39	49.15	10.57	NA	2	17
18-Apr-16	8446AC	150.3	34.88	22.18	5.54	NA	1	59
19-Apr-16	8447AC	167.87	59.71	20.18	66.26	NA	3	59
19-Apr-16	8448AC	232.14	27.72	9.36	34.02	NA	2	29
TOTAL		3591.53	2058.99	1109.36	971.74	NA	105	37

Table 14. Actual parameters used during the LiDAR data acquisition

Flight Number	Flying Height (m AGL)	Overlap (%)	FOV (θ)	PRF (khz)	Scan Frequency (Hz)	Average Speed (kts)	Average Turn Time (Minutes)
7830AC	600	30	36	50	50	120	5
7836AC	600	30	36	50	50	120	5
8154AC	600	30	40	50	45	120	5
8156 AC	600	30	40	50	45	120	5
8157AC	600	30	40	50	45	120	5
8158AC	600	30	40	50	45	120	5
8159AC	600	30	40	50	45	120	5
8160AC	500	30	36	50	45	120	5
8180AC	600	30	36	50	45	120	5
8182AC	500	30	36	50	45	120	5
8183AC	500	30	36	50	45	120	5
8184AC	500	30	36	50	45	120	5
8186AC	500	30	36	50	45	120	5
3913G	900	30	50	125	40	120	5
8426AC	500	30	36	50	45	120	5
3917G	900	30	50	125	40	120	5
8427AC	500	30	36	50	45	120	5
8428AC	500	30	36	50	45	120	5
8431AC	500	30	36	50	45	120	5
8433AC	500	30	36	50	45	120	5
8435AC	500	30	36	50	45	120	5
8437AC	500	30	36	50	45	120	5
8438AC	500	30	36	50	45	120	5
8441AC	500	30	36	50	45	120	5
8442AC	500	30	36	50	45	120	5
8443AC	500	30	36	50	45	120	5
8444AC	500	30	36	50	45	120	5
8446AC	500	30	36	50	45	120	5
8447AC	500	30	36	50	45	120	5
8448AC	500	30	36	50	45	120	5

2.4 Survey Coverage

This certain LiDAR acquisition survey covered the Catubig floodplain, located in the province of Northern Samar. The list of municipalities and cities surveyed, with at least one (1) square kilometer coverage, is outlined in Table 15. The actual coverage of the LiDAR acquisition for the Catubig floodplain is presented in Figure 8. See Annex 7 for the flight status report.

Table 15. List of municipalities and cities surveyed during the Catubig floodplain LiDAR survey

Province	Municipality/ City	Area of Municipality/City (km2)	Total Area Surveyed (km2)	Percentage of Area Surveyed
Northern Samar	Las Navas	267.47	263.03	98.34%
	Gamay	95.17	87.35	91.78%
	Laoang	207.6	175.61	84.59%
	Catubig	217.59	169.37	77.84%
	Palapag	153.46	113.12	73.71%
	Pambujan	150.63	85.37	56.68%
	San Roque	166.51	74.46	44.72%
	Lapinig	57.03	15.53	27.22%
	Mapanas	143.56	22.8	15.88%
	Mondragon	322.75	49.32	15.28%
	Silvino Lobos	255.34	36.53	14.31%
	Catarman	255.77	28.9	11.30%
	Bobon	198.53	2.88	1.45%
Eastern Samar	Jipapad	173.29	31.16	17.98%
Samar	Matuguinao	368.83	38.38	10.41%
Total		3033.53	1193.81	39.35%

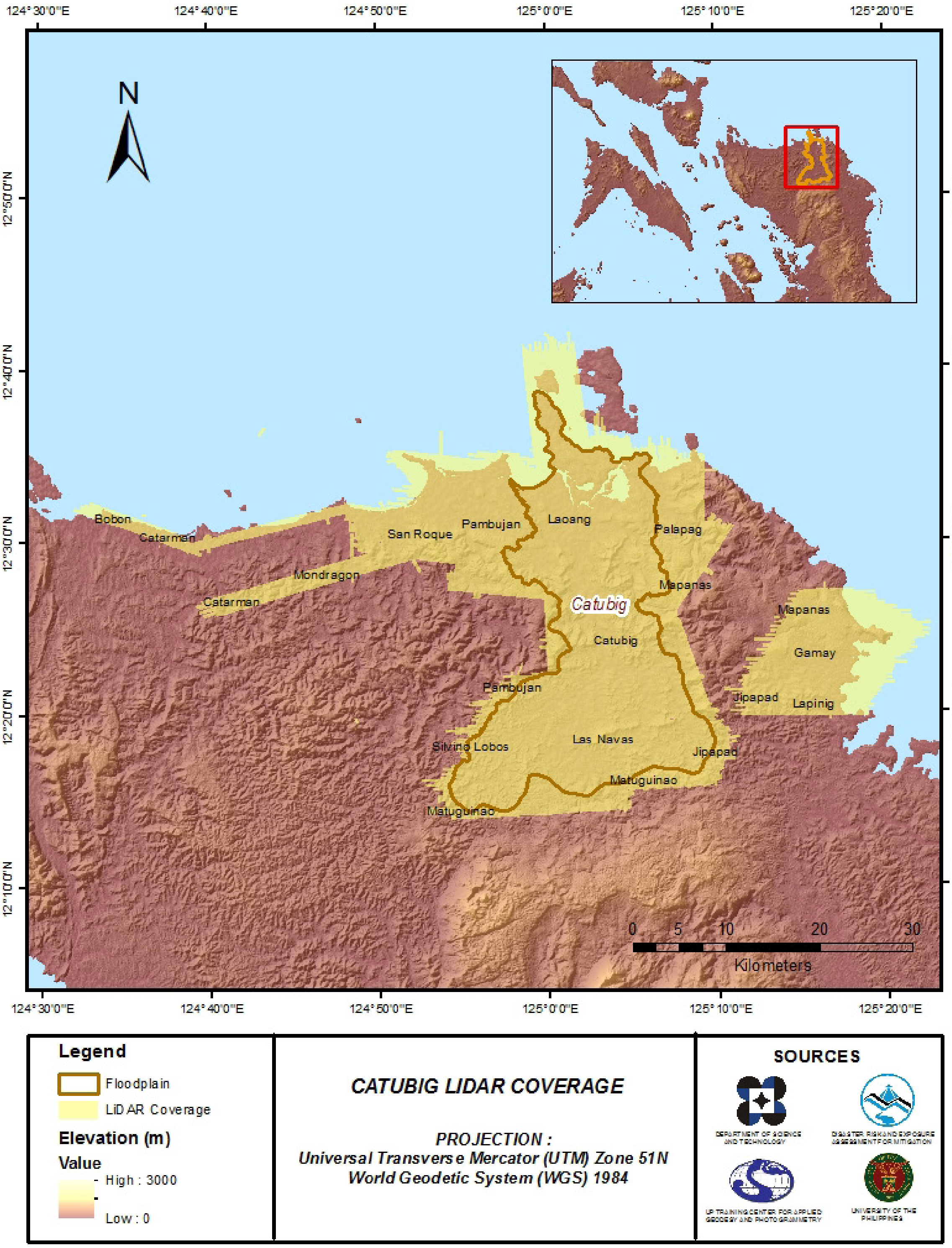


Figure 8. Actual LiDAR survey coverage of the Catubig floodplain

CHAPTER 3: LIDAR DATA PROCESSING OF THE CATUBIG 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 DAC 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 the correct position and orientation for each point acquired. The georectified LiDAR point clouds were subjected to quality checking to ensure that the required accuracies of the program, which are the minimum point density, and the vertical and horizontal accuracies, were met. The point clouds were then categorized into various classes before generating Digital Elevation Models (DEMs), such as the Digital Terrain Model (DTM) and the Digital Surface Model (DSM).

Using the elevation of points gathered from 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 (DVBC). 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 accomplished through the help of the georectified point clouds, and the metadata containing the time that the image was captured.

These processes are summarized in the diagram in Figure 9.

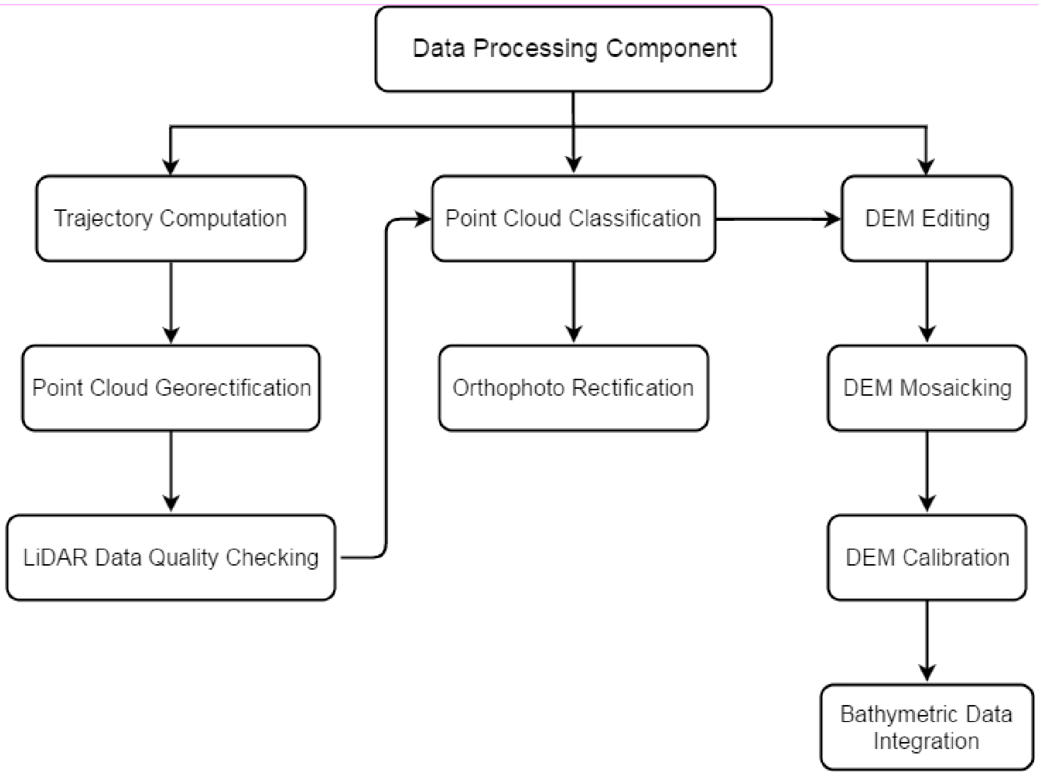

Figure 9. Schematic diagram for the Data Pre-Processing Component

3.2 Transmittal of Acquired LiDAR Data

The data transfer sheets for all the LiDAR missions for the Catubig floodplain can be found in Annex 5. The missions flown during the first survey conducted in June 2014 used the Airborne LiDAR Terrain Mapper (ALTM™ Optech Inc.) Aquarius system. The missions acquired during the second survey in September 2015 and third survey in May 2016 were flown using the same system over Northern Samar. The DAC transferred a total of 247.20 Gigabytes of Range data, 4.88 Gigabytes of POS data, 2.20 Gigabytes of GPS base station data, and 647.1 Gigabytes of raw image data to the data server on June 25, 2014 for the first survey, on September 8, 2015 for the second survey, and on May 24, 2016 for the third survey. The Data Pre-processing Component (DPPC) verified the completeness of the transferred data. The whole dataset for the Catubig survey was fully transferred on June 4, 2016, as indicated on the data transfer sheets for the Catubig floodplain.

3.3 Trajectory Computation

The Smoothed Performance Metric parameters of the computed trajectory for Flight 8182AC, one of the Catubig flights, which are the North, East, and Down position RMSE values, are illustrated 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 fell on August 24, 2015 at 00:00 hrs. on that week. The y-axis represents the RMSE value for that particular position.

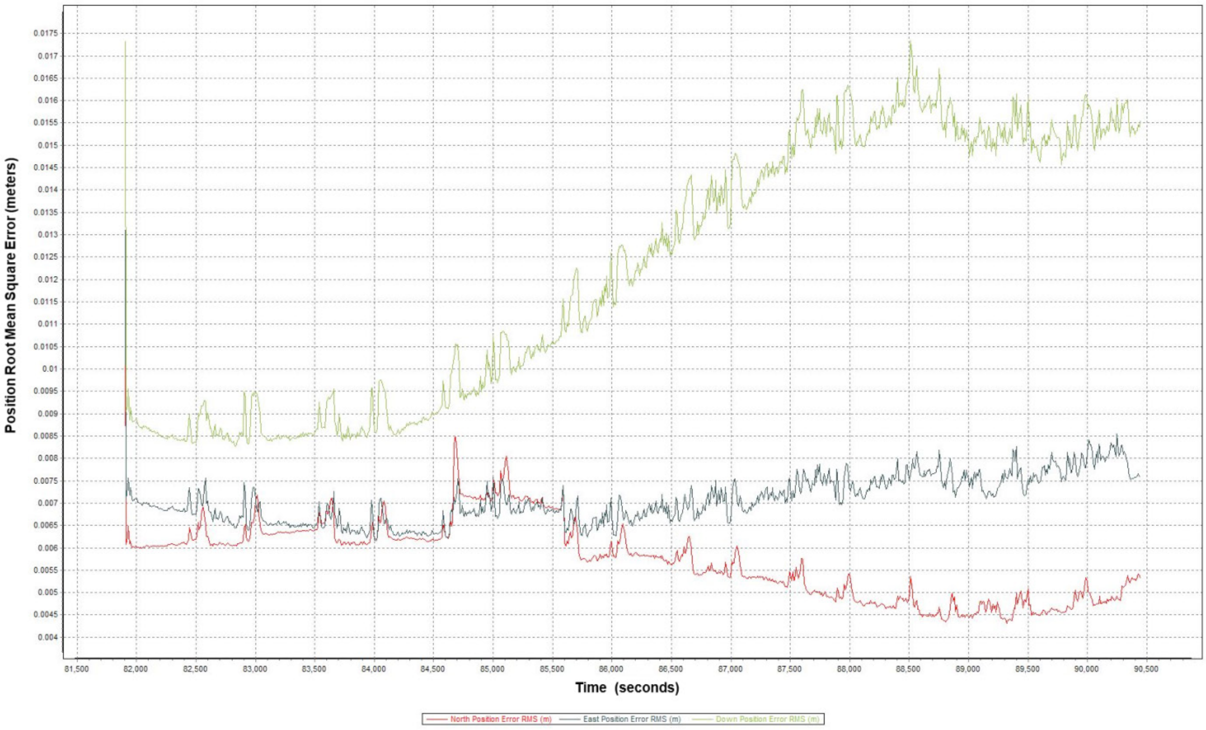

Figure 10. Smoothed Performance Metric Parameters of Catubig Flight 8182AC

The time of flight was from 82000 seconds to 90500 seconds, which corresponds to the morning of August 24, 2015. The initial spike reflected on the data corresponds to the time that the aircraft was getting into position to start the acquisition, and the POS system was starting to compute for the position and orientation of the aircraft. Redundant measurements from the POS system quickly minimized the RMSE values of the positions. The periodic increase in RMSE values from an otherwise smoothly curving set of RMSE values corresponds to the turn-around period of the aircraft, when the aircraft makes a turn to start a new flight line. Figure 10 demonstrates that the North position RMSE peaked at 0.80 centimeters, the East position RMSE peaked at 1. 60 centimeters, and the Down position RMSE peaked at 0.80 centimeters, which are within the prescribed accuracies described in the methodology.

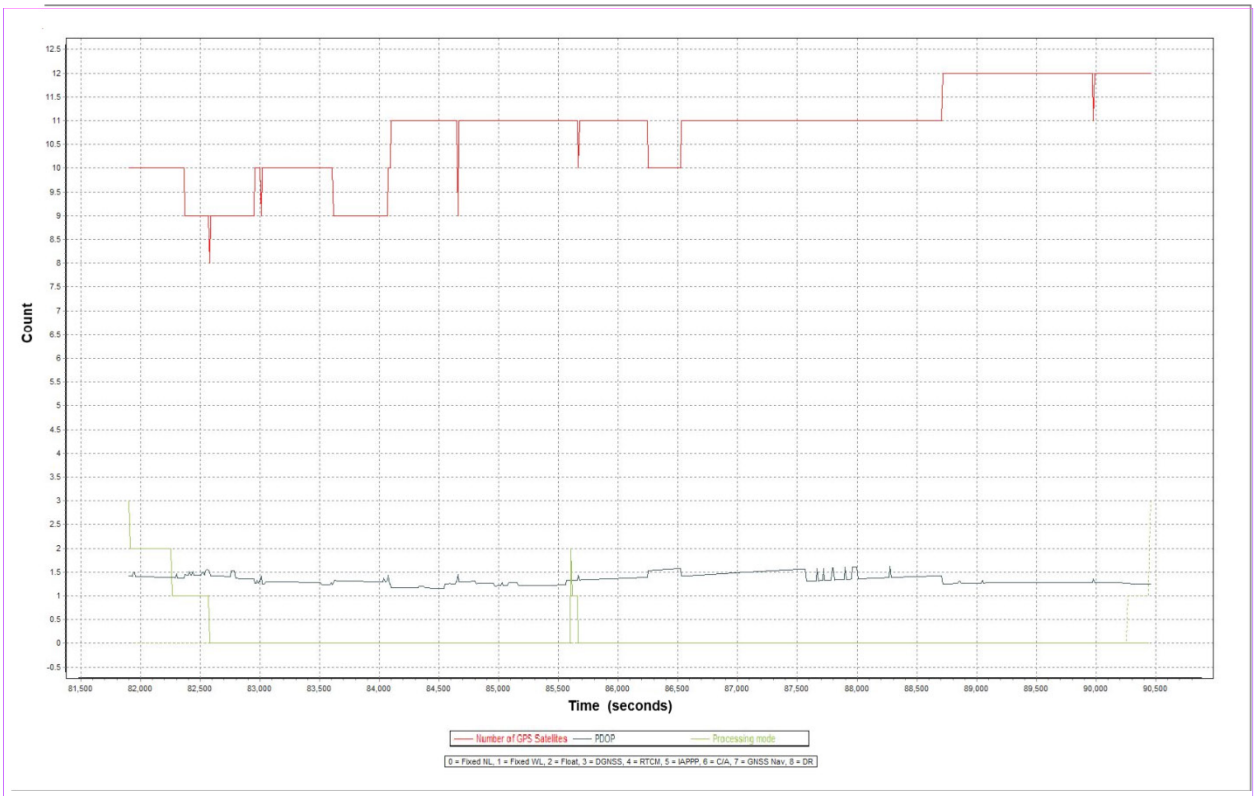

Figure 11. Solution Status Parameters of Catubig Flight 8182AC

The Solution Status parameters of Flight 8182AC, one of the Catubig flights, which are the number of GPS satellites, Positional Dilution of Precision (PDOP), and the GPS processing mode used, are depicted in Figure 11. The graphs indicate that the number of satellites during the acquisition did not go down to 8. Majority of the time, the number of satellites tracked was between 8 and 12. The PDOP value did not go above the value of 2, which indicates optimal GPS geometry. The processing mode remained at the value of 0 for majority of the survey, with some peaks to up to 1, attributed to the turns performed by the aircraft. The value of 0 corresponds to a Fixed, Narrow-Lane mode, which is the optimum carrier-cycle integer ambiguity resolution technique available for POSPAC MMS. All of the parameters satisfied the accuracy requirements for optimal trajectory solutions, as indicated in the methodology. The computed best estimated trajectory for all Catubig flights is exhibited in Figure 12.

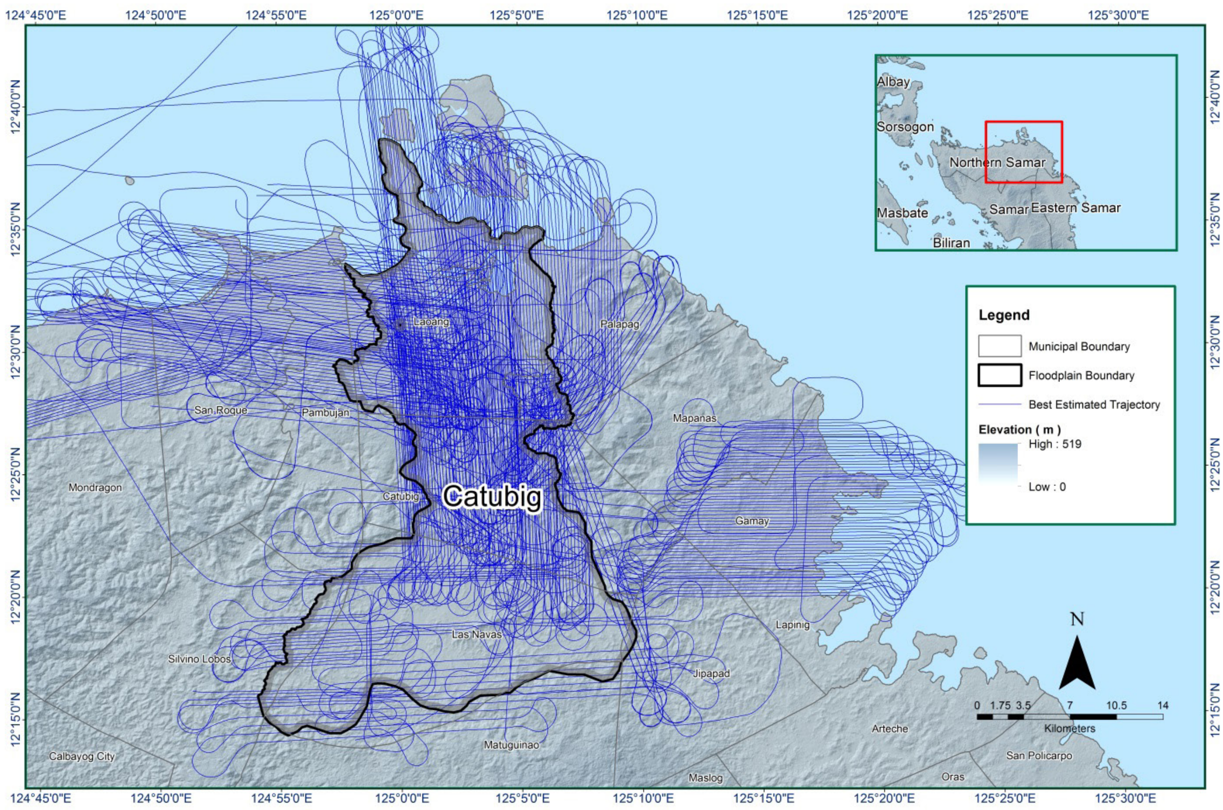

Figure 12. The best estimated trajectory conducted over the Catubig floodplain

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3.4 LiDAR Point Cloud Computation

The produced LAS data contains 510 flight lines, with each flight line containing one (1) channel, since the Gemini and Aquarius systems both contain only one (1) channel. The summary of the self-calibration results for all flights over the Catubig floodplain, obtained through LiDAR processing in the LiDAR Mapping Suite (LMS) software, is given in Table 16.

Table 16. Self-calibration results for the Catubig flights

Parameter	Absolute Value	Computed Value
Boresight Correction stdev	(<0.001degrees)	0.000477
IMU Attitude Correction Roll and Pitch Corrections stdev	(<0.001degrees)	0.000986
GPS Position Z-correction stdev	(<0.01meters)	0.0032

Optimum accuracy was obtained for all Catubig flights, based on the computed standard deviations of the corrections of the orientation parameters. The standard deviation values for the individual blocks are available in Annex 8: Mission Summary Reports.

3.5 LiDAR Data Quality Checking

The boundaries of the processed LiDAR data on top of an SAR Elevation Data over the Catubig floodplain are represented in Figure 13. The map shows gaps in the LiDAR coverage that are attributed to cloud coverage.

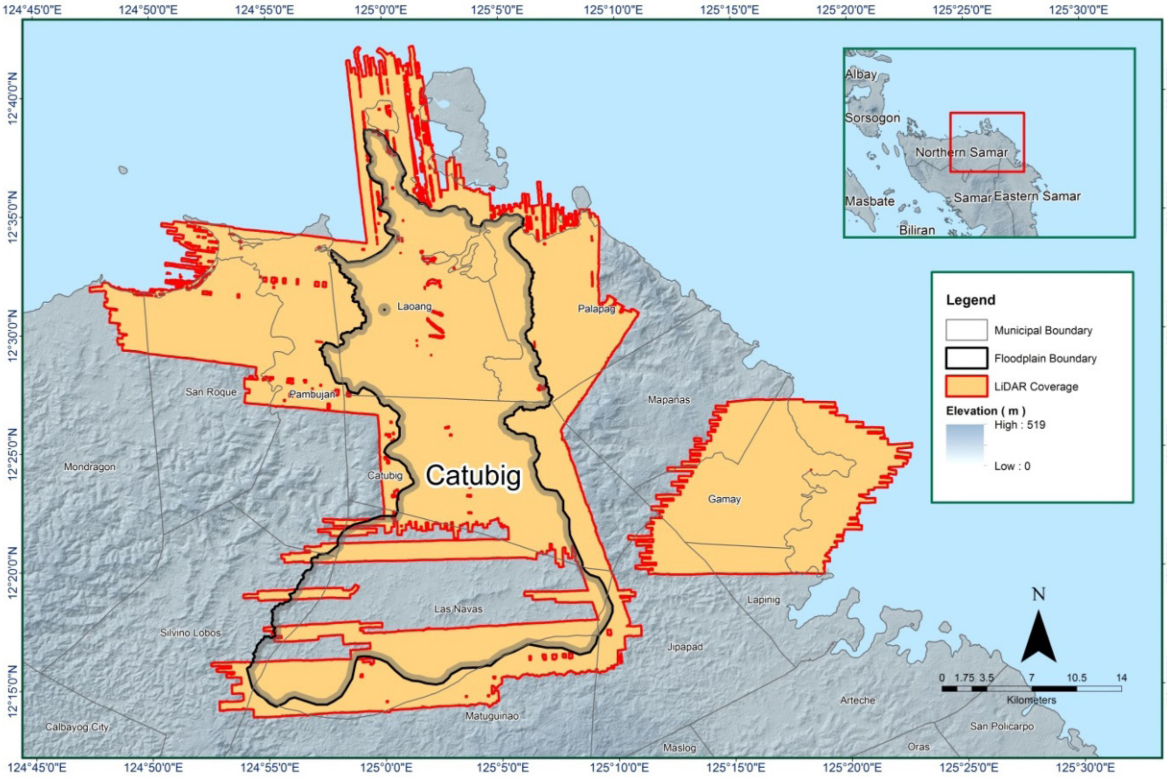


Figure 13. Boundaries of the processed LiDAR data over the Catubig floodplain

The total area covered by the Catubig missions is 1,318.30 square kilometers, comprised of twenty eight (28) flight acquisitions and twenty seven (27) blocks, as indicated in Table 17.

Table 17. List of LiDAR blocks for the Catubig floodplain

LiDAR Blocks	Flight Numbers	Area (sq.km)
Catarman_Blk33R	8182AC	51.64
Catarman_Blk33R_supplement	8183AC	20.81
Catarman_Blk33T	8186AC	27.82
Catarman_Blk33T_supplement	8186AC	5.91
Catarman_Blk33Q	8180AC	19.28
Catarman_Blk33P_supplement	8184AC	33.64
	8186AC	
Catarman_Blk331N	8154AC	93.71
	8156AC	
	8157AC	
	8159AC	
Catarman_Blk331O	7836AC	102.39
	7830AC	
Catarman_Blk331O_supplement	8154AC	60.20
Catarman_reflights_Blk331O	3917G	34.91
Catarman_reflights_Blk331P_supplement	8437AC	17.98
Catarman_reflights_Blk331P	8438AC	44.94
Catarman_reflights_Blk331P_additional	8444AC	29.85
Catarman_reflights_Blk331QR	8426AC	132.08
	8427AC	
Catarman_reflights_Blk33V	8428AC	56.81
Catarman_reflights_Blk33W	3913G	122.00
Catarman_reflights_Blk33X	8443AC	70.45
Catarman_reflights_Blk33Y	8441AC	89.40
Catarman_reflights_Blk33Y_supplement	8442AC	34.50
Catarman_reflights_Blk33T	3917G	51.24
Catarman_reflights_Blk33U	3917G	38.42
Catarman_reflights_Blk33P	8431AC	84.07
Catarman__reflights_Blk331R_additional	8448AC	14.17
Catarman__reflights_Blk331S_ additional	8447AC	30.80
Catarman_reflights_Blk331T_ additional	8447AC	20.27
Catarman_reflights_Blk331U_ additional	8446AC	13.58
Catarman_reflights_Blk33W_ additional	3913G	17.43
TOTAL		**1,318.30 sq.km**

The overlap data for the merged LiDAR blocks, showing the number of channels that pass through a particular location, is presented in Figure 14. Since the Gemini and Aquarius systems both employ one (1) channel, it is expected to have 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.

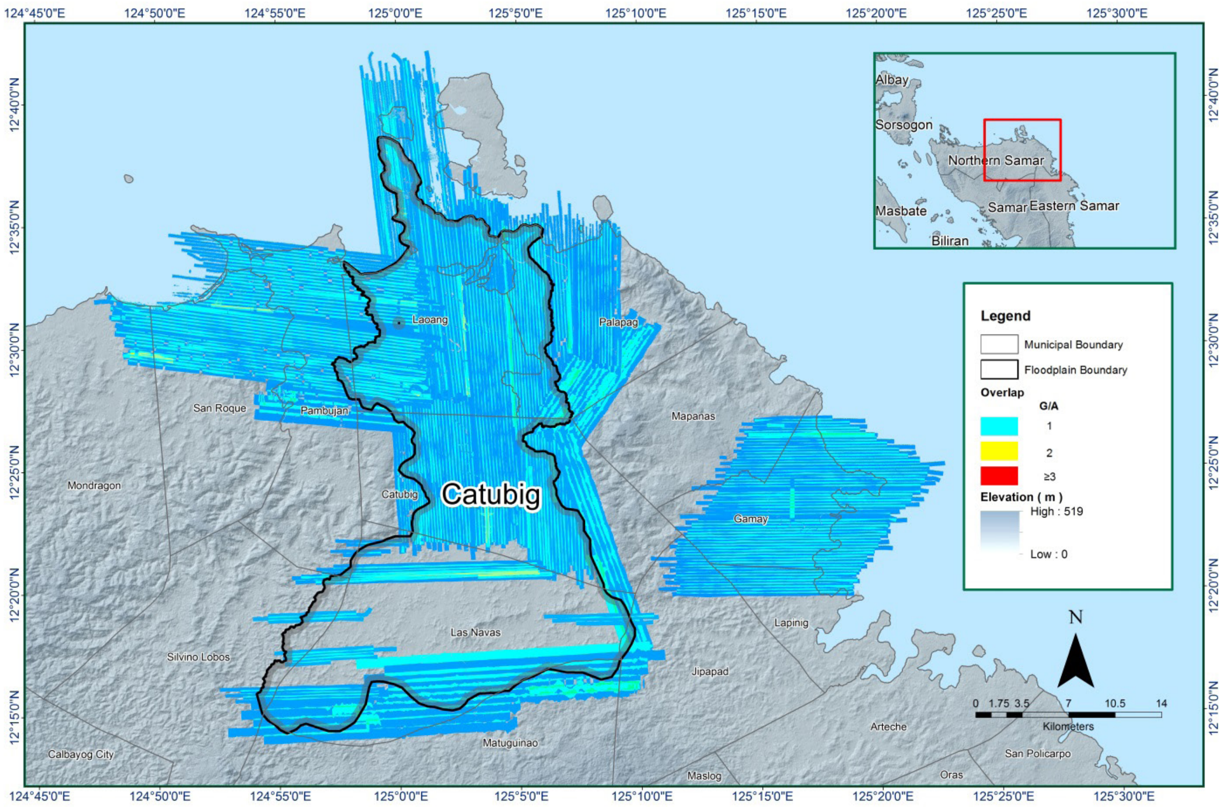


Figure 14. Image of data overlap for the Catubig floodplain

The overlap statistics per block for the Catubig floodplain can be found in Annex 8. One (1) pixel corresponds to 25.0 square meters on the ground. For this area, the minimum and maximum percent overlaps were 25.19% and 47.26%, 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 two (2) points per square meter criterion, is illustrated in Figure 15. It was determined that all LiDAR data for the Catubig floodplain satisfy the point density requirement, and that the average density for the entire survey area is 3.35 points per square meter.

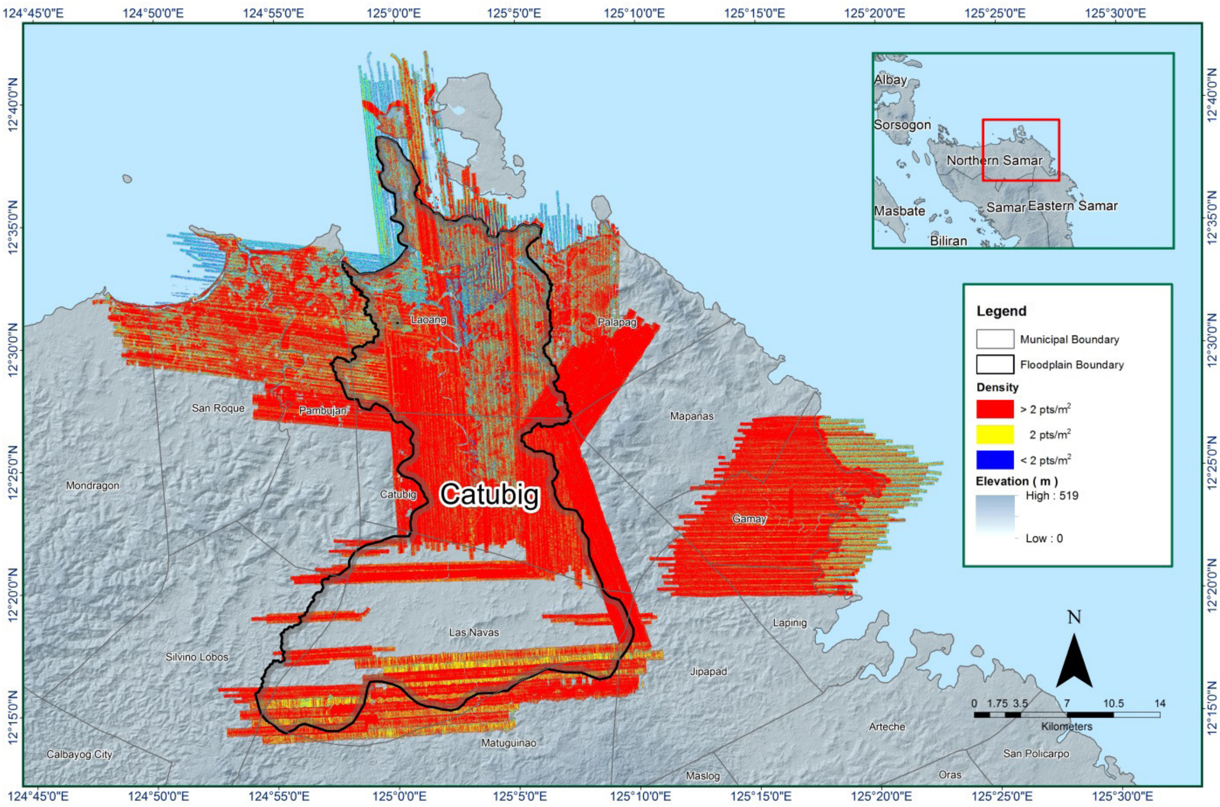


Figure 15. Pulse density map of merged LiDAR data for the Catubig floodplain

The elevation difference between overlaps of adjacent flight lines is shown in Figure 16. The default color range is from blue to red. Bright blue areas correspond to portions where elevations of a previous flight line, identified by its acquisition time, are higher by more than 0.20 meters relative to the elevations of its adjacent flight line. Bright red areas indicate portions where elevations of a previous flight line are lower by more than 0.20 meters relative to the elevations of its adjacent flight line. Areas with bright red or bright blue colors were investigated further using the Quick Terrain (QT) Modeler software.

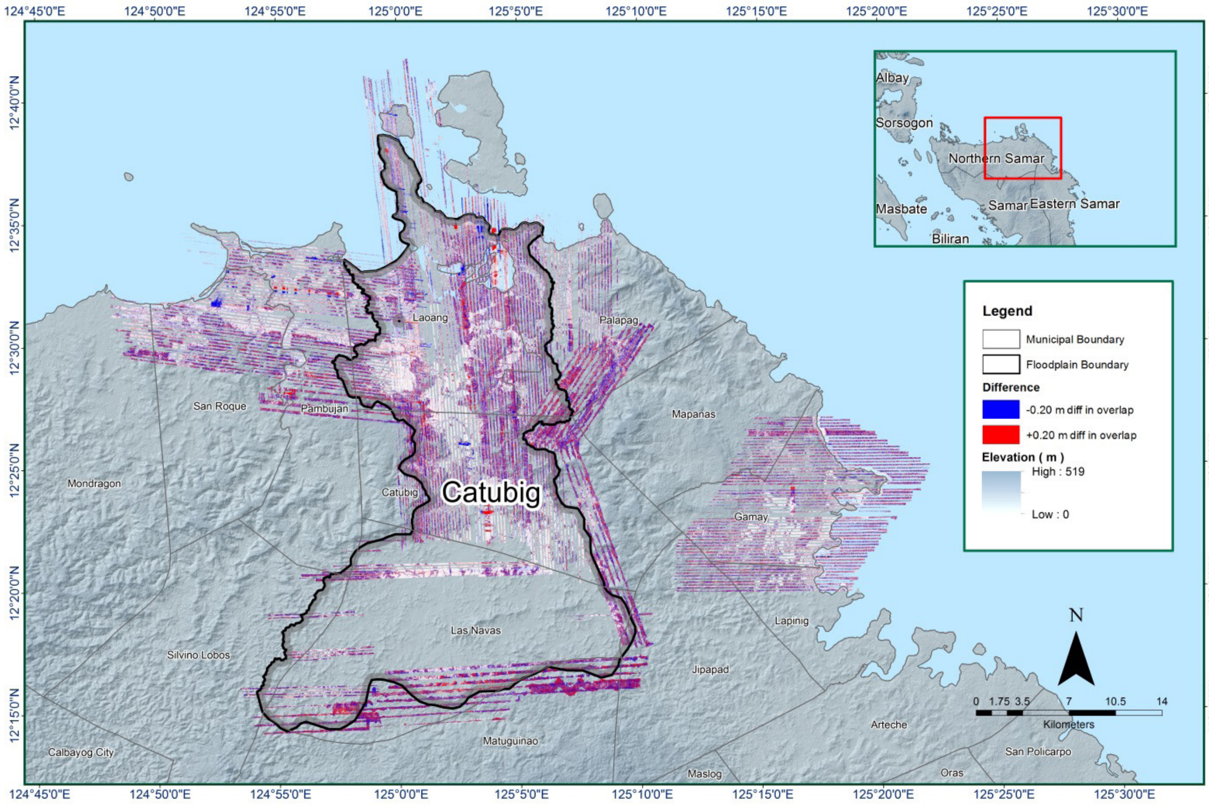


Figure 16. Elevation difference map between flight lines for the Catubig floodplain

A screen capture of the processed LAS data from a Catubig flight 8182AC loaded in the QT Modeler is provided in Figure 17. The upper left image shows the elevations of the points from two (2) overlapping flight strips traversed by the profile, illustrated by a dashed red line. The x-axis corresponds to the length of the profile. It is evident that there were differences in elevation, but the differences did not exceed the 20-centimeter mark. This profiling was repeated until the quality of the LiDAR data became satisfactory. No reprocessing was done for this LiDAR dataset.

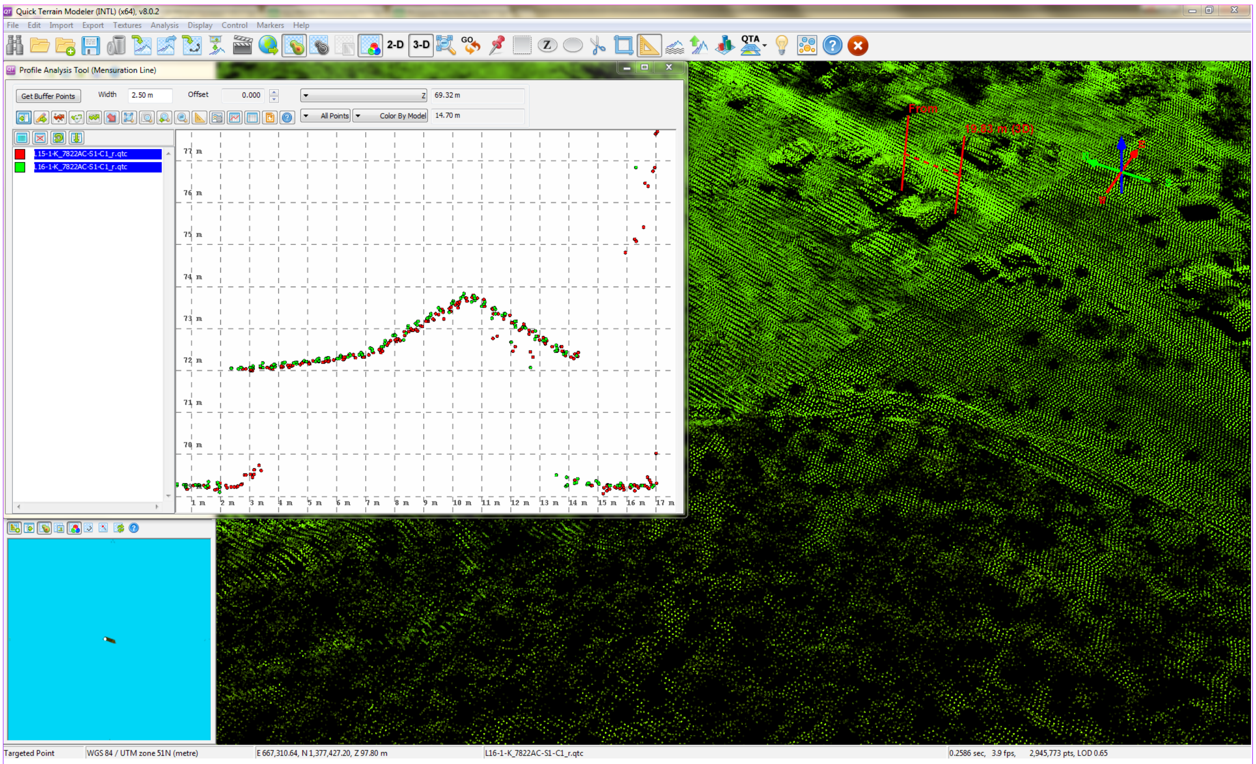


Figure 17. Quality checking for Catubig flight 8182AC, using the Profile Tool of QT Modeler

3.6 LiDAR Point Cloud Classification and Rasterization

Table 18. Catubig classification results in TerraScan

Pertinent Class	Total Number of Points
Ground	830,819,592
Low Vegetation	515,029,963
Medium Vegetation	1,062,344,741
High Vegetation	1,561,880,657
Building	19,572,108

The tile system that TerraScan employed for the LiDAR data, as well as the final classification image for a block in the Catubig floodplain, are presented in Figure 18. A total of 2,418 1km by 1km tiles were produced. The number of points classified according to the pertinent categories is illustrated in Table 18. The point cloud had a maximum and minimum height of 734.77 meters and 2.06 meters, respectively.

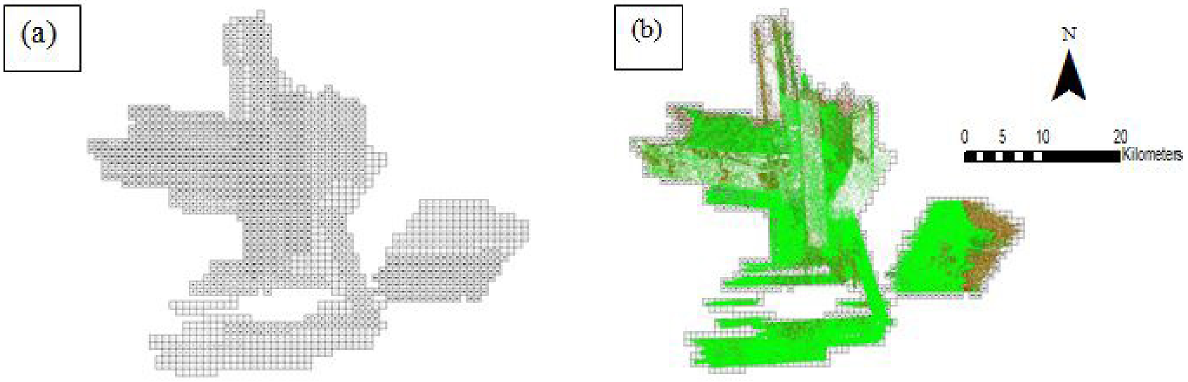


Figure 18. (a) Tiles for Catubig floodplain, and (b) classification results in TerraScan

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 is visible that the residential structures adjacent or even below canopy were classified correctly, due to the density of the LiDAR data.

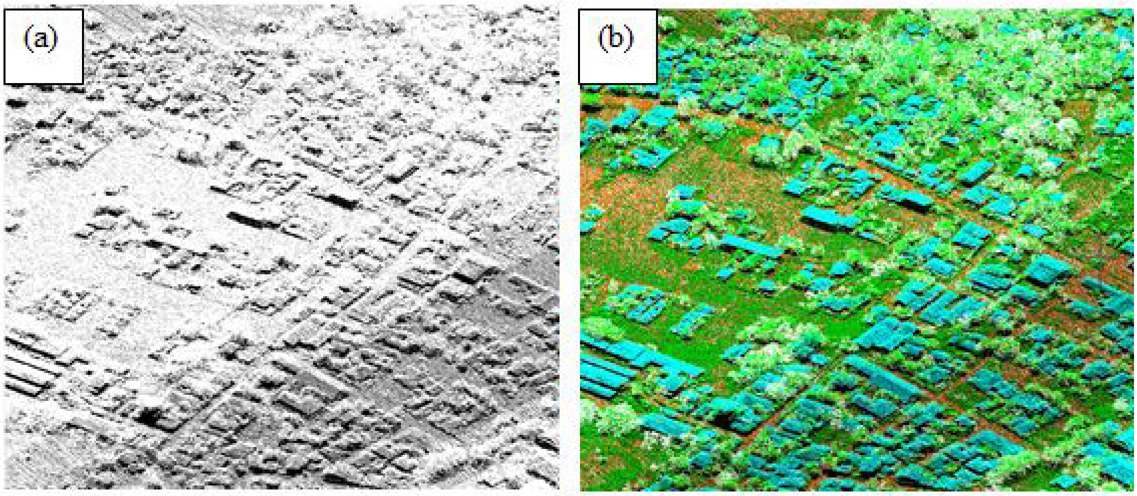


Figure 19. Point cloud (a) before and (b) after classification

The production of last return (V_ASCII) and the secondary (T_ ASCII) DTM, and the first (S_ ASCII) and last (D_ ASCII) return DSM of the area are illustrated in Figure 20, in top view display. The images show that the DTMs are a representation of the bare earth; while the DSMs reflect all features that are present, such as buildings and vegetation.

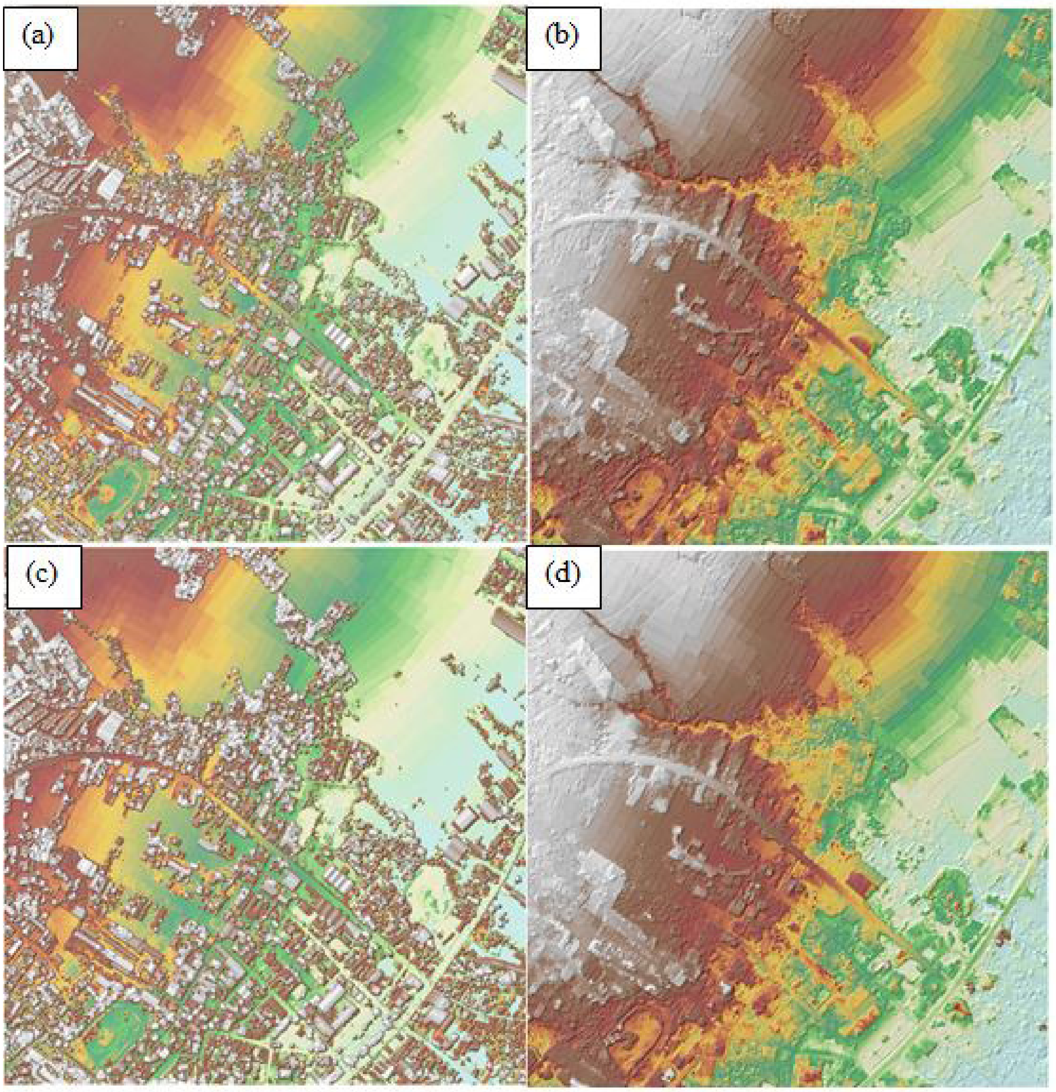


Figure 20. The production of (a) last return DSM and (b) DTM, (c) first return DSM and (d) secondary DTM in some portion of the Catubig floodplain

3.7 LiDAR Image Processing and Orthophotograph Rectification

There are no available orthophotographs for the Catubig floodplain.

3.8 DEM Editing and Hydro-Correction

Twenty seven (27) mission blocks were processed for the Catubig floodplain. These blocks are composed of Catarman and Catarman_Reflights blocks, with a total area of 1,318.30 square kilometers. Table 19 lists the names and corresponding areas of the blocks, in square kilometers.

Table 19. LiDAR blocks with their corresponding areas

LiDAR Blocks	Area (sq.km)
Catarman_Blk33R	51.64
Catarman_Blk33R_supplement	20.81
Catarman_Blk33T	27.82
Catarman_Blk33T_supplement	5.91
Catarman_Blk33Q	19.28
Catarman_Blk33P_supplement	33.64
Catarman_Blk331N	93.71
Catarman_Blk331O	102.39
Catarman_Blk331O_supplement	60.20
Catarman_reflights_Blk331O	34.91
Catarman_reflights_Blk331P_supplement	17.98
Catarman_reflights_Blk331P	44.94
Catarman_reflights_Blk331P_additional	29.85
Catarman_reflights_Blk331QR	132.08
Catarman_reflights_Blk33V	56.81
Catarman_reflights_Blk33W	122.00
Catarman_reflights_Blk33X	70.45
Catarman_reflights_Blk33Y	89.40
Catarman_reflights_Blk33Y_supplement	34.50
Catarman_reflights_Blk33T	51.24
Catarman_reflights_Blk33U	38.42
Catarman_reflights_Blk33P	84.07
Catarman_reflights_Blk331R_additional	14.17
Catarman_reflights_Blk331S_ additional	30.80
Catarman_reflights_Blk331T_ additional	20.27
Catarman_reflights_Blk331U_ additional	13.58
Catarman_reflights_Blk33W_ additional	17.43
TOTAL	1,318.30 sq.km

Portions of the DTM before and after manual editing are exhibited in Figure 21. Areas without data along the water bodies had to be interpolated for hydrologic correction. The bridge (Figure 21a) was considered to be an obstruction to the flow of water along the river, and had to be removed (Figure 21b) in order to hydrologically correct the river. The road (Figure 21c) was misclassified and removed during the classification process, and had to be retrieved to complete the surface (Figure 21d) in order to allow for the correct flow of water.

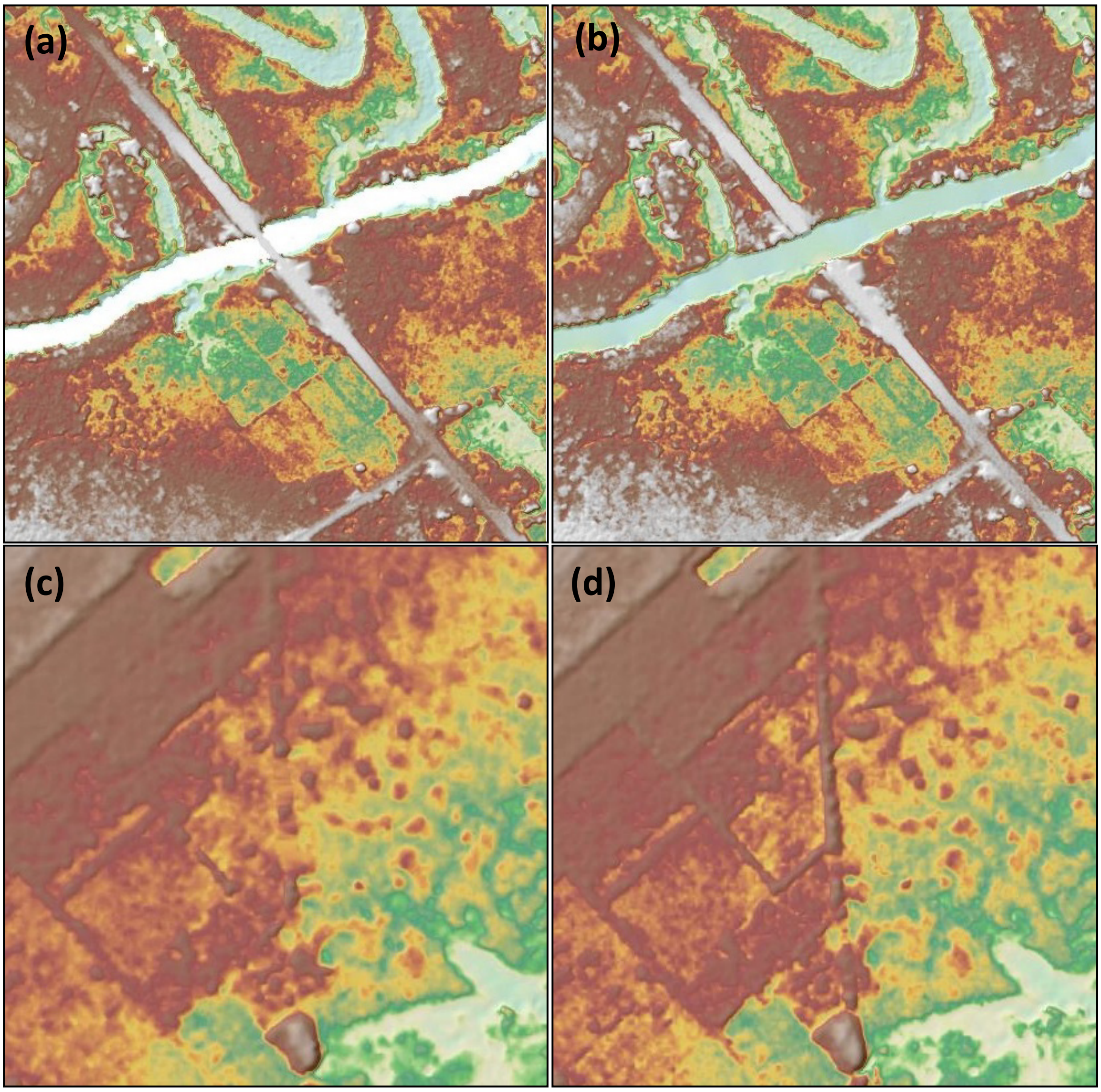


Figure 21. Portions in the DTM of the Catubig floodplain – a bridge (a) before and (b) after manual editing; and a road (c) before and (d) after data retrieval

3.9 Mosaicking of Blocks

The Catarman_Blk331H block was used as the reference block at the start of mosaicking, as this was the first available block for processing in the Catubig floodplain. The shift values applied to the blocks during mosaicking are summarized in Table 20.

The mosaicked LiDAR DTM for the Catubig floodplain is represented in Figure 22. The Catubig flood plain is 76.03% covered by LiDAR data. Portions without LiDAR data were patched with the available IFSAR data.

Table 20. Shift values of each LiDAR block of the Catubig floodplain

Mission Blocks	Shift Values (meters)		
	x	y	z
Catarman_Blk33R	-15.00	-16.00	4.04
Catarman_Blk33R_supplement	-15.00	-16.00	4.04
Catarman_Blk33T	-15.00	-17.00	3.98
Catarman_Blk33T_supplement	-14.00	-16.00	4.05
Catarman_Blk33Q	-15.00	-16.00	3.86
Catarman_Blk33P_supplement	-15.00	-17.00	3.84
Catarman_Blk331N	0.00	0.00	0.05
Catarman_Blk331O	0.00	0.00	0.00
Catarman_Blk331O_supplement	0.00	0.00	0.15
Catarman_reflights_Blk331O	-14.00	-17.00	3.57
Catarman_reflights_Blk331P_supplement	16.00	-17.00	4.41
Catarman_reflights_Blk331P	-14.00	-17.00	4.44
Catarman_reflights_Blk331P_additional	-14.00	-17.00	4.24
Catarman_reflights_Blk331QR	-15.00	-16.00	4.49
Catarman_reflights_Blk33V	-14.00	-17.00	4.63
Catarman_reflights_Blk33W	-14.00	-18.00	4.20
Catarman_reflights_Blk33X	-1.00	1.00	0.28
Catarman_reflights_Blk33Y	1.00	-1.00	0.04
Catarman_reflights_Blk33Y_supplement	0.00	0.00	0.00
Catarman_reflights_Blk33T	-15.00	-17.00	3.74
Catarman_reflights_Blk33U	-14.00	-17.00	4.2
Catarman_reflights_Blk33P	-14.00	-17.00	4.33
Catarman_reflights_Blk331R_additional	-15.00	-16.00	4.42
Catarman_reflights_Blk331S_additional	-14.00	-17.00	4.45
Catarman_reflights_Blk331T_additional	-14.00	-16.00	4.70
Catarman_reflights_Blk331U_additional	-14.00	-18.00	5.18
Catarman_reflights_Blk33W_additional	-14.00	-18.00	4.20

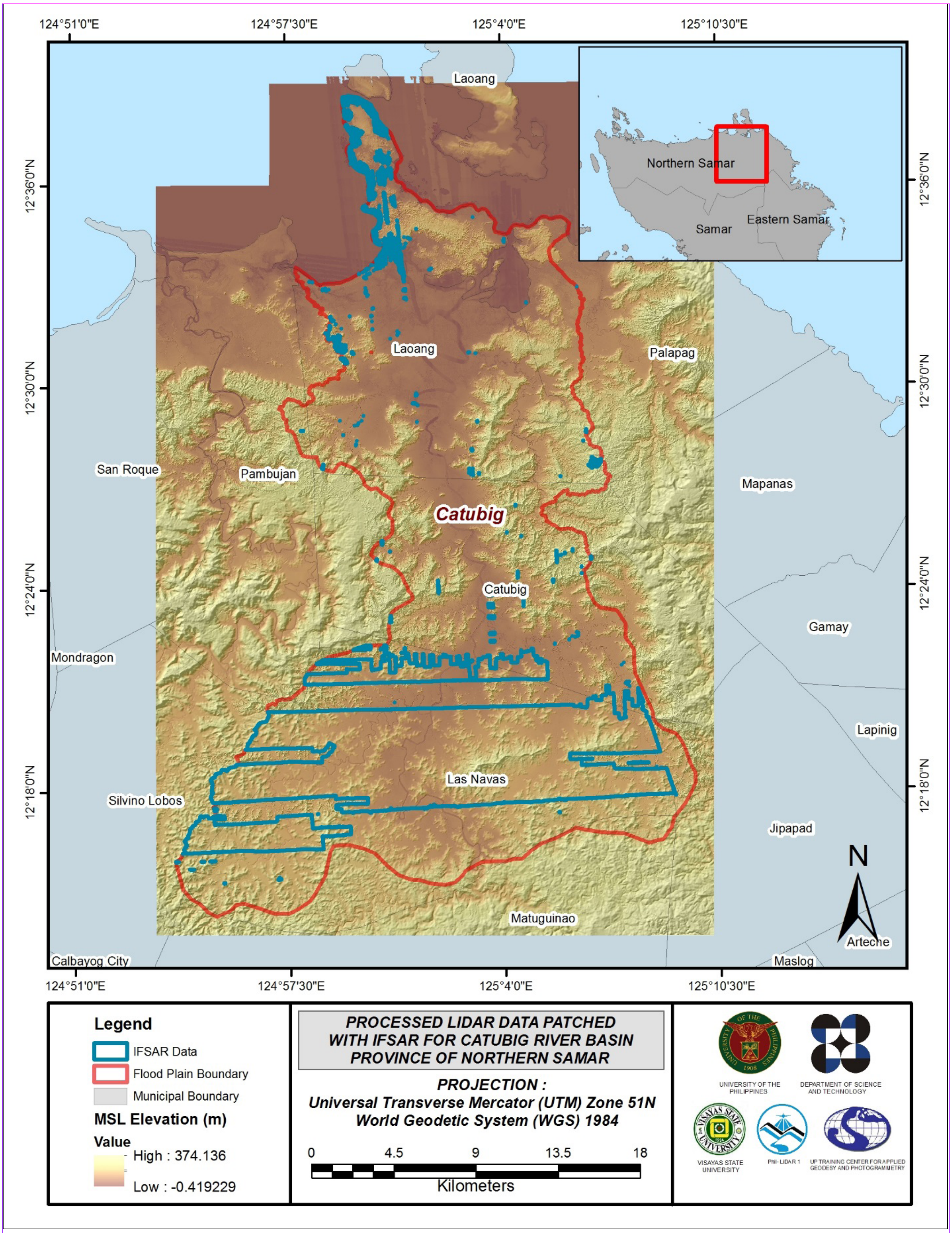


Figure 22. Map of processed LiDAR data for the Catubig floodplain

3.10 Calibration and Validation of Mosaicked LiDAR DEM

To undertake the data validation of the Mosaicked LiDAR DEMs, the DVBC conducted a validation survey along the Catubig floodplain. The extent of the validation survey done in Northern Samar to collect points with which the LiDAR dataset was validated is presented in Figure 23, with the validation survey points highlighted in green. A total of 14,268 survey points were gathered for all of the floodplains within the province of Northern Samar, where the Catubig floodplain is located. Random selection of 80% of the survey points resulted in 11,415 points, which were used for calibration.

A good correlation between the uncalibrated mosaicked LiDAR elevation values and the ground survey elevation values is reflected in Figure 24. Statistical values were computed from the extracted LiDAR values using the selected points, to assess the quality of data and to obtain the values for vertical adjustment. The computed height difference between the LiDAR DTM and the calibration elevation values is 2.79 meters, with a standard deviation of 0.18 meters. Calibration of the Catarman LiDAR data was done by subtracting the height difference value, 2.79 meters, from the Catubig mosaicked LiDAR data. Table 21 summarizes the statistical measurements of the compared elevation values between the LiDAR data and the calibration data.

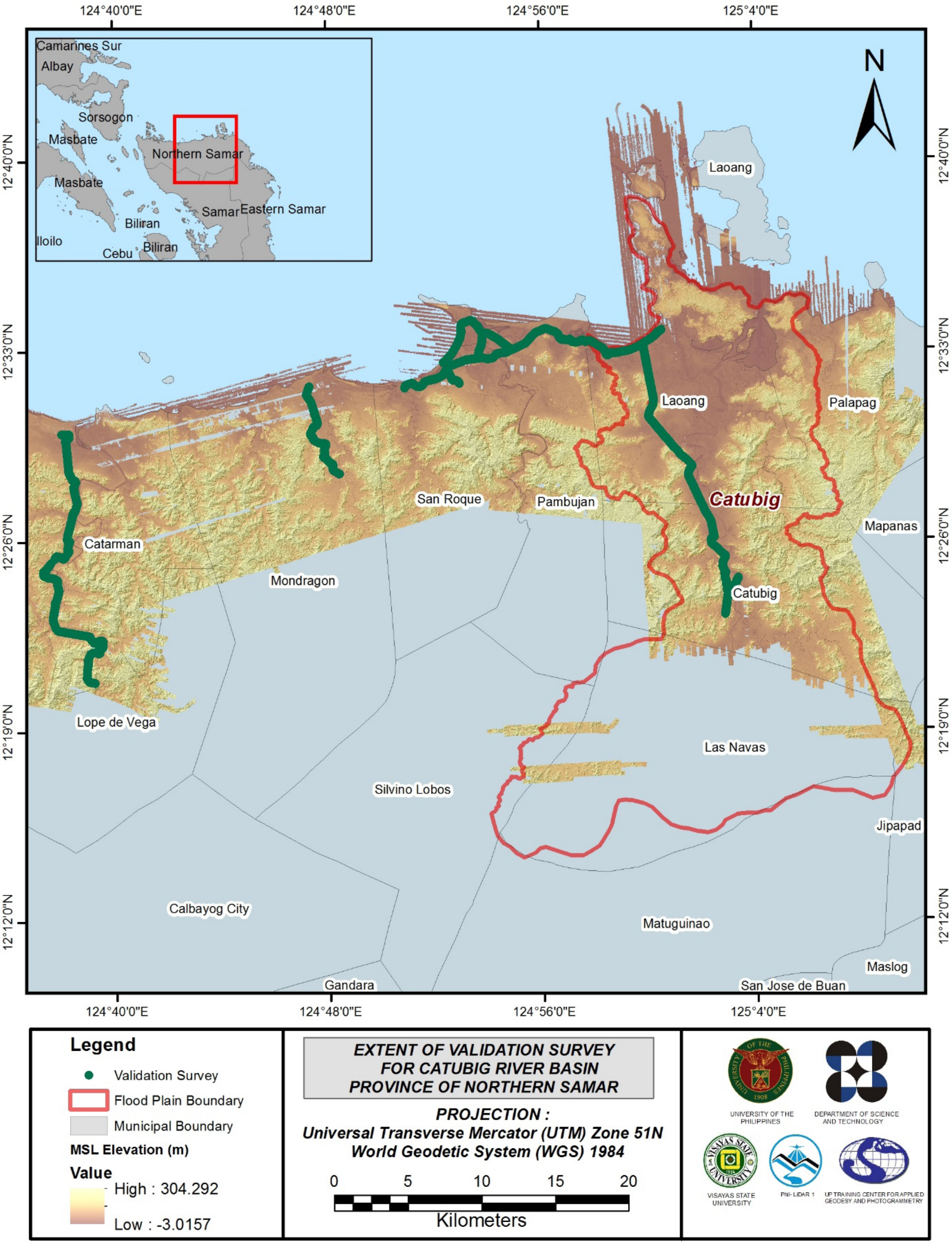


Figure 23. Map of the Catubig floodplain, with the validation survey points in green

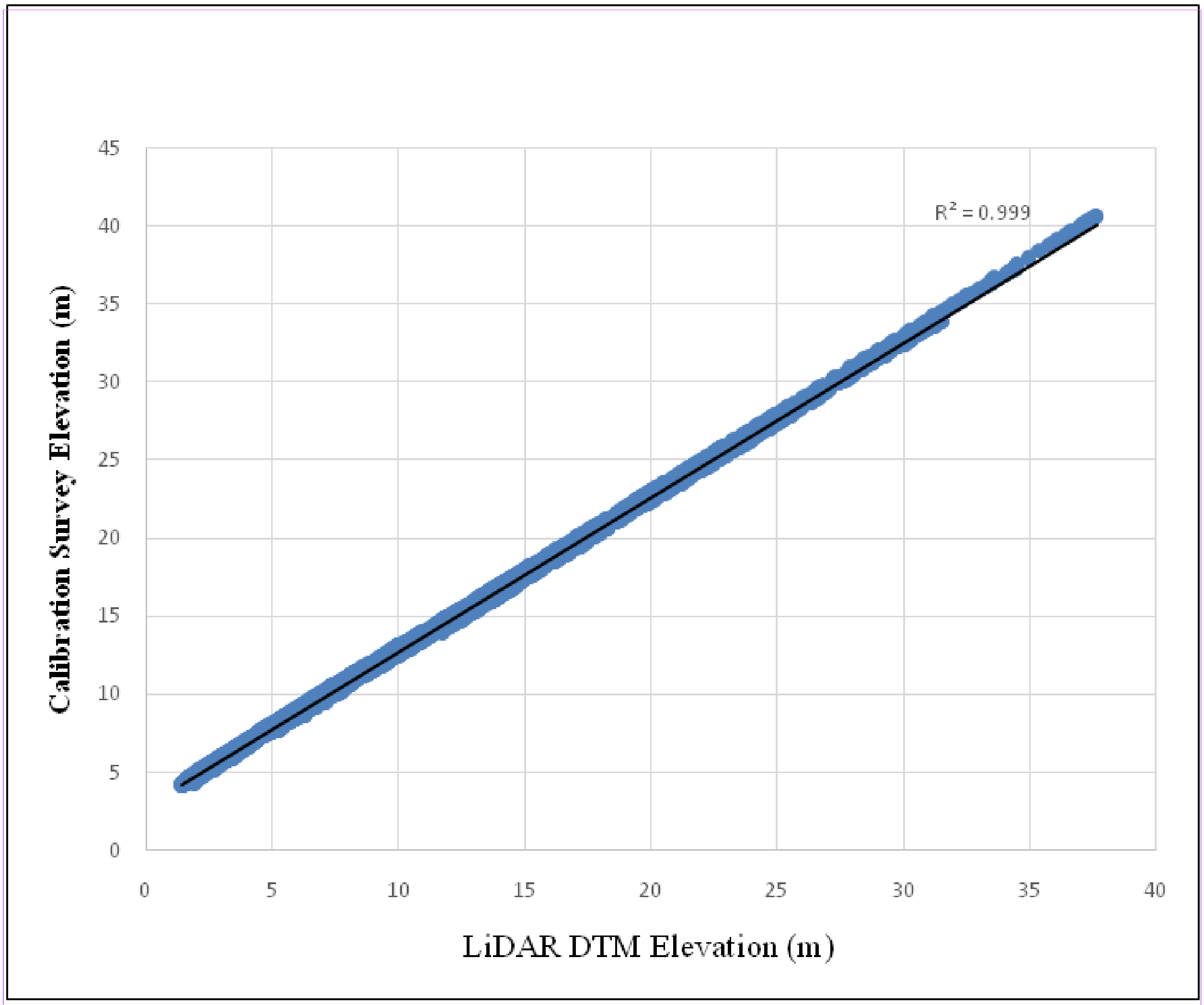


Figure 24. Correlation plot between the calibration survey points and the LiDAR data

Table 21. Calibration statistical measures

Calibration Statistical Measures	Value (meters)
Height Difference	2.79
Standard Deviation	0.18
Average	-2.79
Minimum	-3.15
Maximum	-2.43

A total of 951 survey points lie within the Catubig floodplain, and were used for the validation of the calibrated Catubig 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 depicted in Figure 25. The computed RMSE between the calibrated LiDAR DTM and the validation elevation values is 0.16 meters, with a standard deviation of 0.15 meters, as indicated in Table 22.

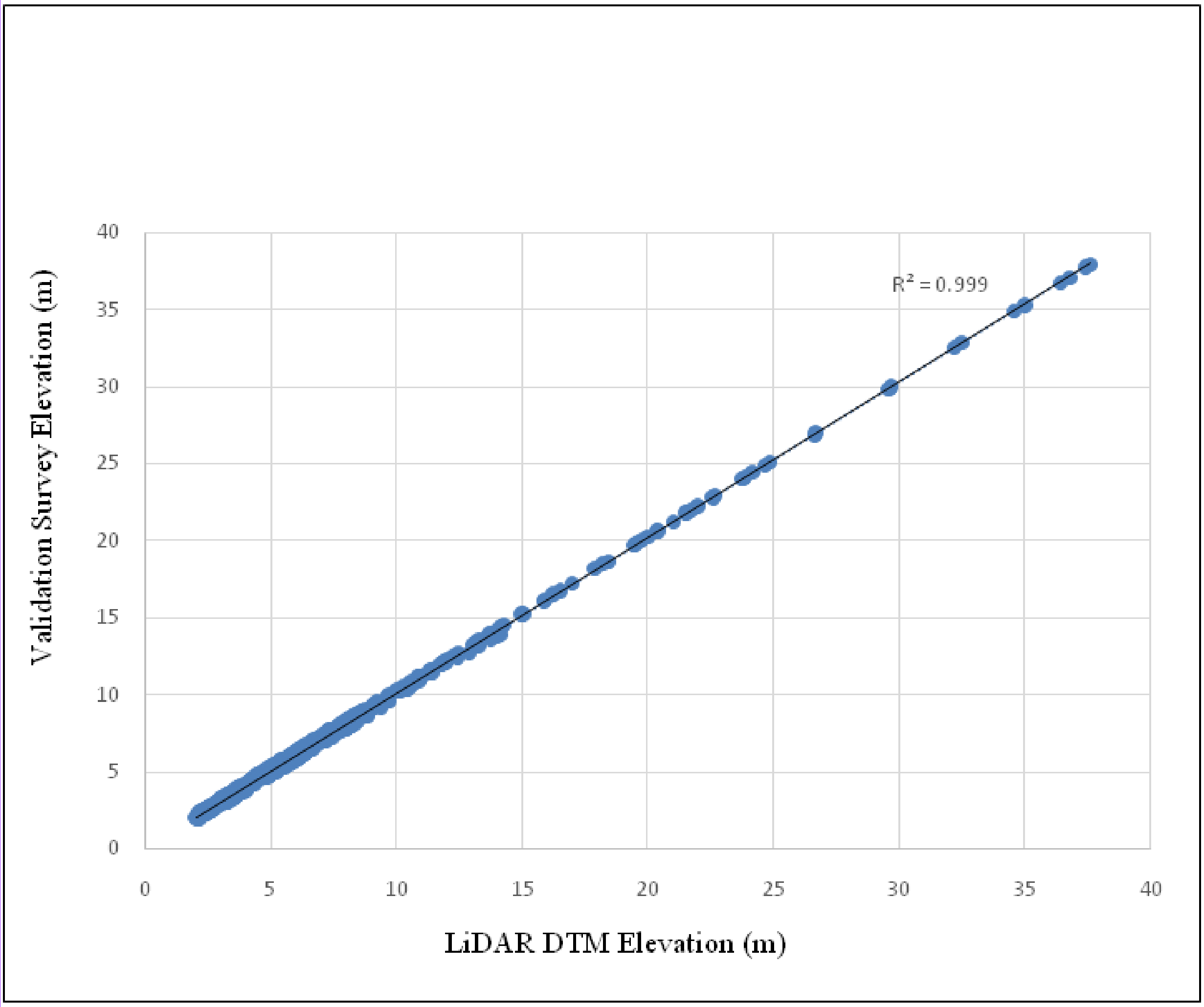


Figure 25. Correlation plot between the validation survey points and the LiDAR data

Table 22. Validation statistical measures

Validation Statistical Measures	Value (meters)
RMSE	0.16
Standard Deviation	0.15
Average	-0.06
Minimum	-0.37
Maximum	0.25

3.11 Integration of Bathymetric Data into the LiDAR Digital Terrain Model

For bathy integration, centerline and zigzag data were available for Catubig, with 29,329 bathymetric survey points. The resulting raster surface produced was obtained through the 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 0.07 meters. The extent of the bathymetric survey done by the DVBC) in the Catubig floodplain, integrated with the processed LiDAR DEM, is shown in Figure 26.

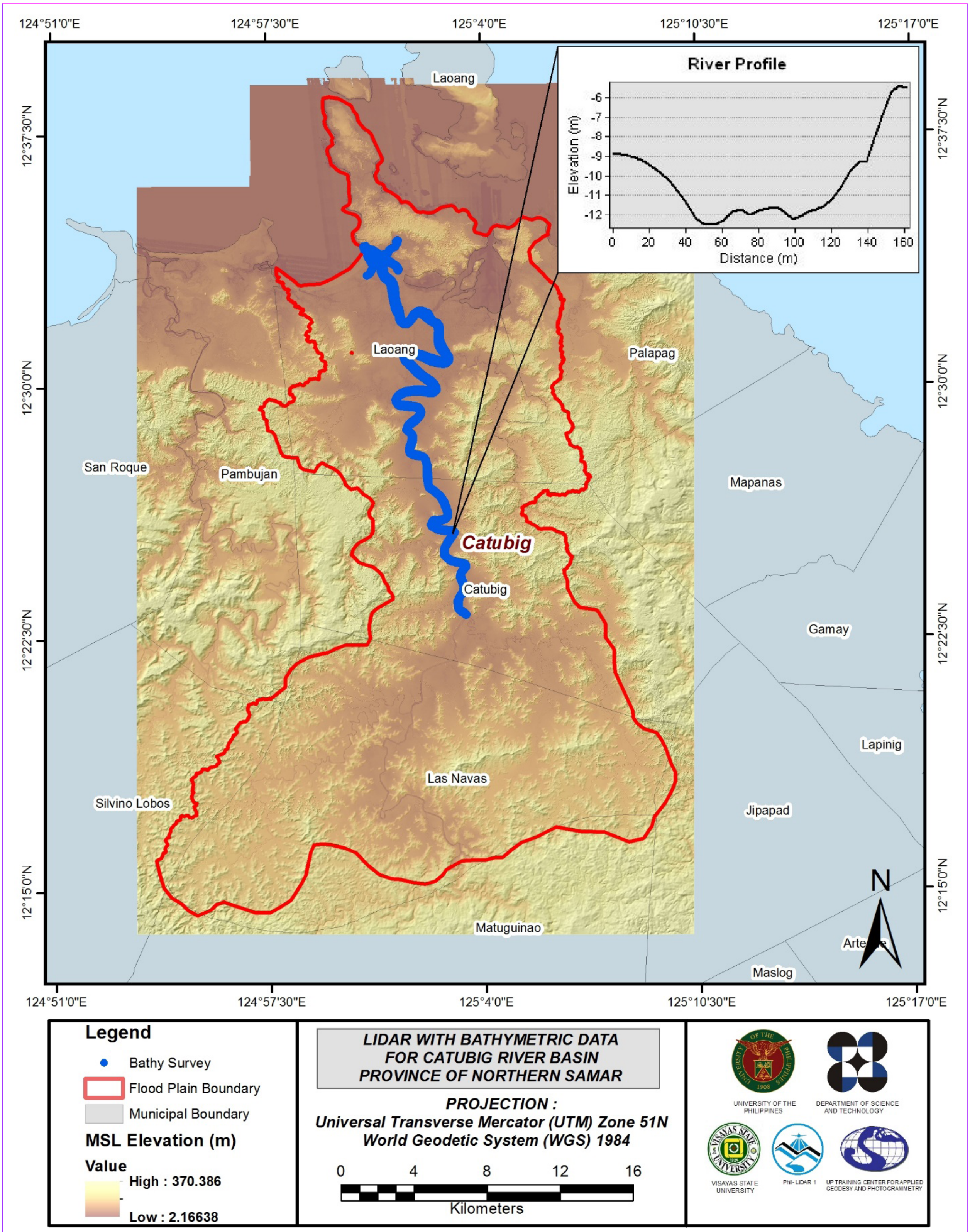


Figure 26. Map of the Catubig floodplain, with bathymetric survey points in blue

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 a 200-meter buffer zone. Mosaicked LiDAR DEM with a 1-meter 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 – comprised of main thoroughfares, such as highways, and municipal and barangay roads – are essential for routing disaster response efforts. These features are represented by a network of road centerlines.

3.12.1 Quality Checking of Digitized Features' Boundary

The Catubig floodplain, including its 200-meter buffer zone, has a total area of 652.20 square kilometers. Of this area, a total of 19.00 square kilometers, corresponding to a total of 3,634 building features, were considered for quality checking (QC). Figure 27 presented the QC blocks for the Catubig floodplain.

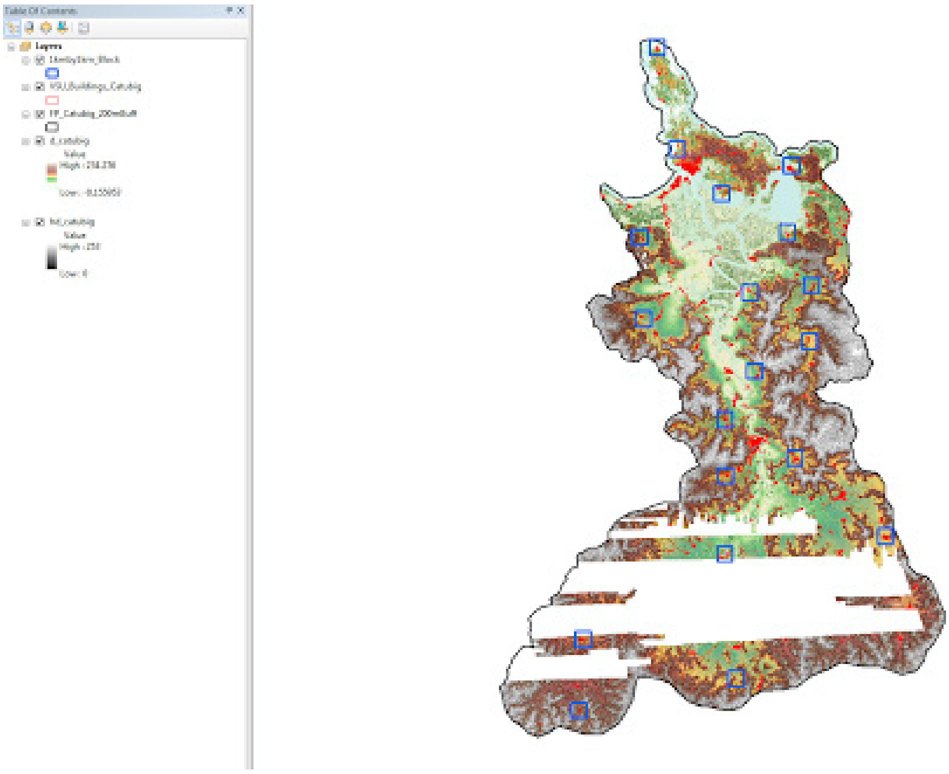


Figure 27. Blocks (in blue) of Catubig building features that were subjected to QC

Quality checking of the Catubig building features resulted in the ratings shown in Table 23.

Table 23. Quality checking ratings for the Catubig building features

FLOODPLAIN	COMPLETENESS	CORRECTNESS	QUALITY	REMARKS
Catubig	96.52	99.23	86.02	PASSED

3.12.2 Height Extraction

Height extraction was done for 24,660 building features in the Catubig floodplain. Of these building features, 427 were filtered out after height extraction, resulting in 24,233 buildings with height attributes. The lowest building height is at 2.00 meters, while the highest building is at 7.61 meters.

3.12.3 Feature Attribution

The digitized features were marked and coded in the field using handheld GPS receivers. The attributes of non-residential buildings were first identified; and then all other buildings were coded as residential. An nDSM was generated using the LiDAR DEMs to extract the heights of the buildings. A minimum height of 2 meters was applied to filter out the terrain features that were digitized as buildings. Buildings that were not yet constructed during the time of LiDAR acquisition were noted as new buildings in the attribute table.

Table 24 summarizes the number of building features per type. Table 25 indicates the total length of each road type, and Table 26 specifies the number of water features extracted per type.

Table 24. Building features extracted for the Catubig floodplain

Facility Type	No. of Features
Residential	22,975
School	603
Market	3
Agricultural/Agro-Industrial Facilities	6
Medical Institutions	45
Barangay Hall	105
Military Institution	16
Sports Center/Gymnasium/Covered Court	53
Telecommunication Facilities	2
Transport Terminal	7
Warehouse	53
Power Plant/Substation	1
NGO/CSO Offices	4
Police Station	3
Water Supply/Sewerage	10
Religious Institutions	122
Bank	3
Factory	0
Gas Station	2
Fire Station	1
Other Government Offices	56
Other Commercial Establishments	163
Total	**24,233**

Table 25. Total length of extracted roads for the Catubig floodplain

Floodplain	Road Network Length (km)					Total
	Barangay Road	City/ Municipal Road	Provincial Road	National Road	Others	
Catubig	183.82	18.92	6.02	45.36	0.00	**254.12**

Table 26. Number of extracted water bodies for the Catubig floodplain

Floodplain	**Water Body Type**					**Total**
	Rivers/ Streams	Lakes/ Ponds	Sea	Dam	Fish Pen	
Catubig	304	4	0	0	0	**308**

A total of one hundred and fifty (150) 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 comprised the flood hazard exposure database for the floodplain. This completes the feature extraction phase of the project.

Figure 28 exhibits the Digital Surface Model (DSM) of the Catubig floodplain, overlaid with its ground features.

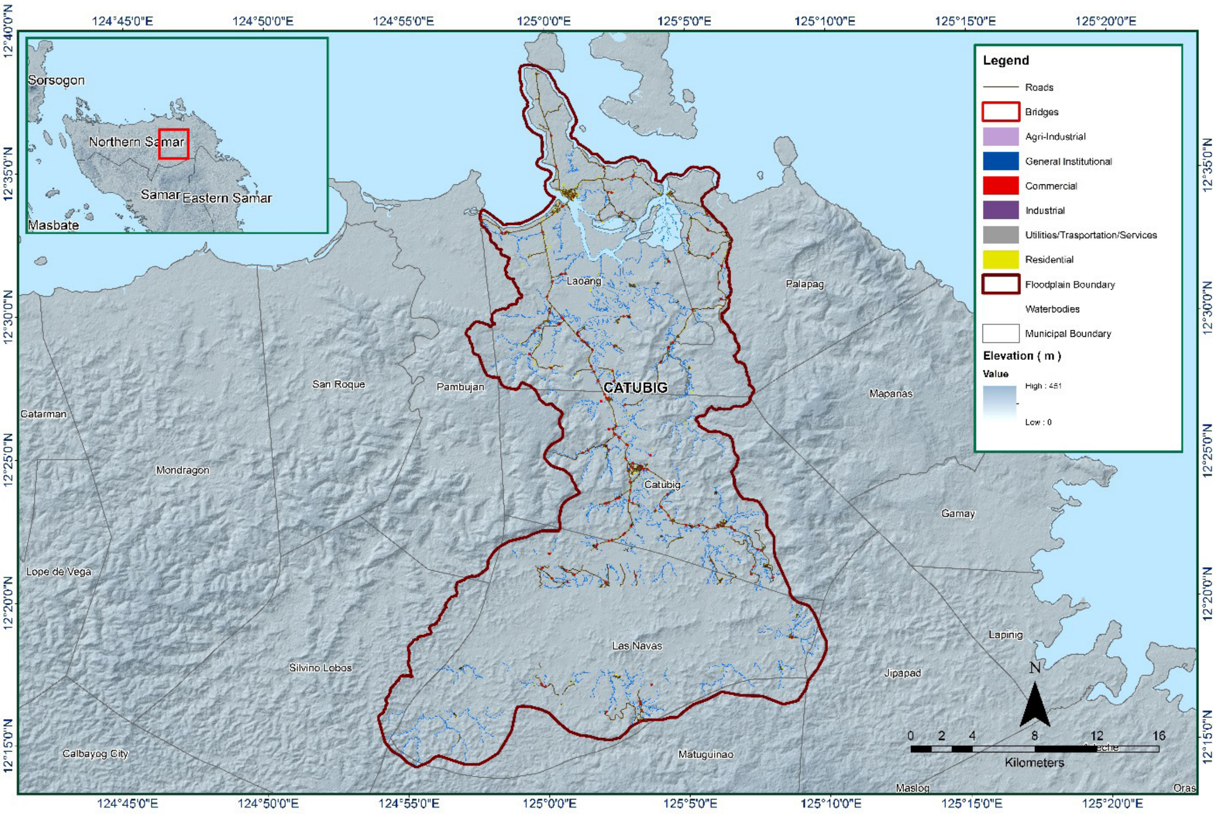


Figure 28. Extracted features for the Catubig floodplain

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

Engr. Louie P. Balicanta, Engr. Joemarie S. Caballero, Patrizcia Mae. P. dela Cruz, Engr. Kristine Ailene B. Borromeo, 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 H.O. Noveloso Surveying (HONS) team conducted field surveys on November 22-23, 2016, November 30, 2016, December 7-15, 2016, and January 6, 2017 in the Catubig River. On the other hand, the DVBC conducted field surveys in the river on August 28-September 5, and October 17-26, 2016. The scope of work of the surveys conducted are as follows: (i.) initial reconnaissance; (ii.) control survey for the establishment of a control point; (iii.) cross-section and bridge as-built survey at the Las Navas Bridge in Barangay Rebong, Municipality of Las Navas, Northern Samar; and at the Rauis Bridge in Barangay Rawis, Municipality of Laoang, Northern Samar; and (iv.) bathymetric survey from the river’s three (3) upstream sides located in Barangay Guibwangan, Municipality of Catubig; and in Barangay Cagaasan, and Barangay Talisay in the Municipality of Laoang, Northern Samar. The bathymetric survey extended until the mouth of the river located in Barangay Baybay, Laoang, Northern Samar, spanning an approximate length of 36.51 kilometers using a HI-Target^{TM} Single Beam Echo Sounder and Hi-Target^{TM} GNSS in RTK survey technique. The extent of the entire survey is illustrated in the map in Figure 29.

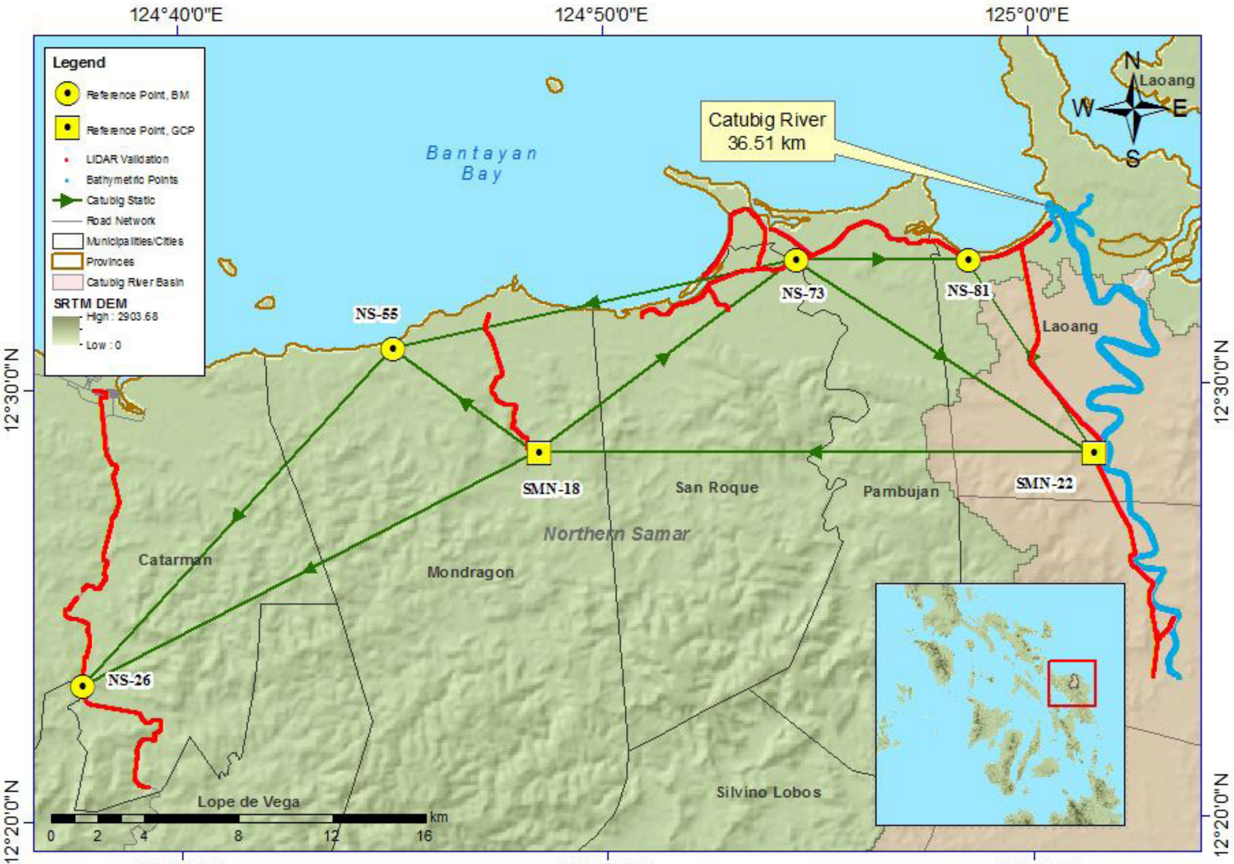


Figure 29. Extent of the bathymetric survey (in blue line) in the Catubig River Basin and the LiDAR data validation survey (in red)

4.2 Control Survey

The GNSS network used for Catubig River Basin is composed of four (4) loops established on September 2, 2016, occupying the following control points: (i.) SMN-18, a 2nd order GCP in Barangay Nenita, Municipality of Mondragon, Northern Samar; (ii.) NS-26, a 1st order BM in Barangay Polangi, Municipality of Catarman; (iii.) NS-55, a 1st order BM in Barangay Eco Poblacion, Municipality of Mondragon; (iv.) NS-73, a 1st order BM in Barangay Dale, Municipality of San Roque; and (v.) NS-81, a 1st order BM located in Barangay Burabud, Municipality of Laoang. All of these are located in the province of Northern Samar.

A NAMRIA-established control point, SMN-22, located in Barangay Simora, Municipality of Laoang, was also utilized as a marker.

The summary of reference and control points and their corresponding locations is provided in Table 27; while the established GNSS network is illustrated in Figure 30.

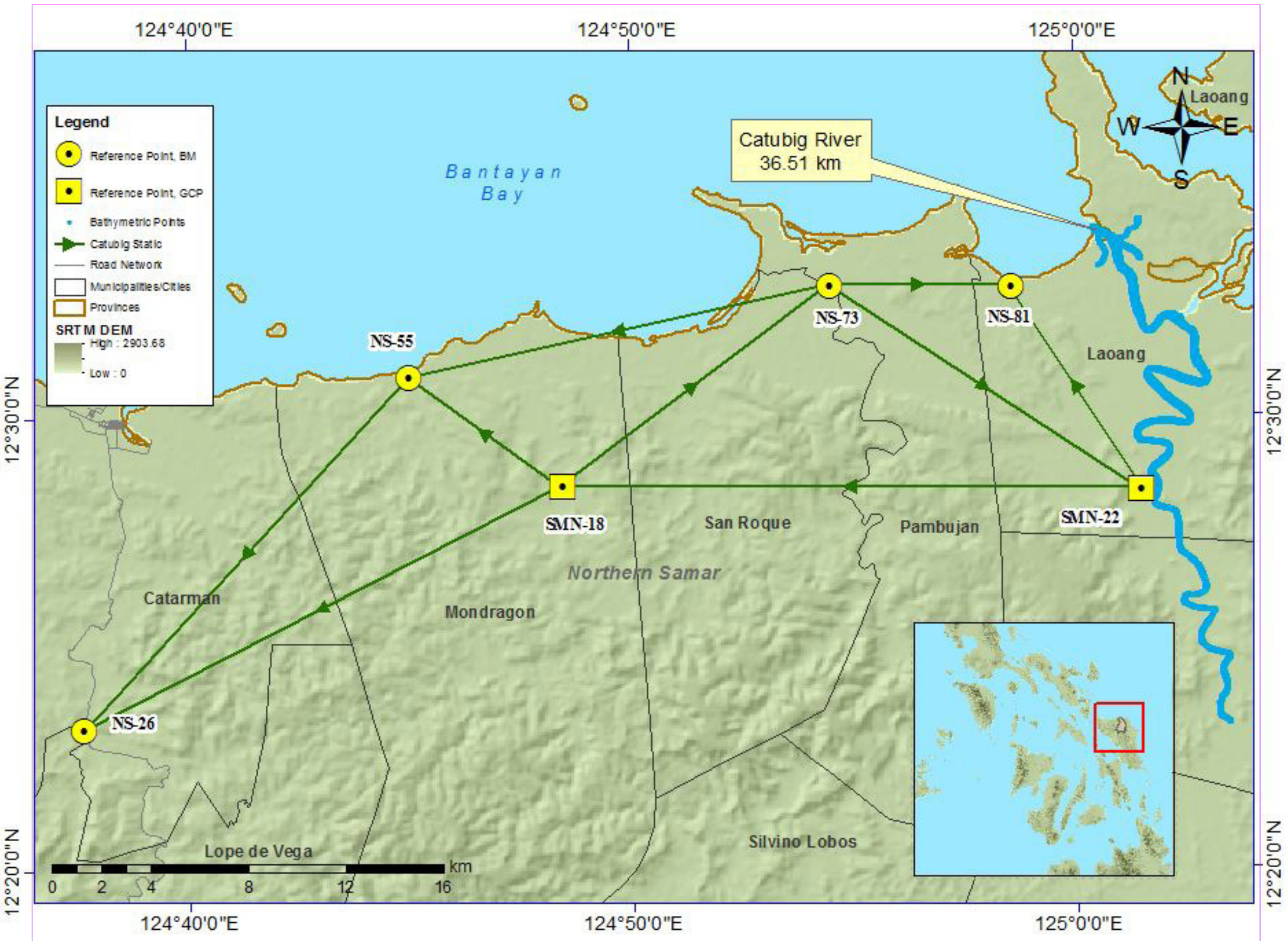


Figure 30. Catubig River static survey extent

Table 27. List of reference and control points occupied for the Catubig River Survey

Control Point	Order of Accuracy	Geographic Coordinates (WGS 84)				
		Latitude	Longitude	Ellipsoidal Height (m)	MSL Elevation (m)	Date Established
SMN-18	2nd Order, GCP	12°28’28.14643”	124°48’26.98399”	64.624	8.910	09-07-16
NS-26	Acc. Class at 95%CL: 4cm	12°23’08.14503”	124°37’40.19430”	70.990	13.480	09-01-16
NS-55	Acc. Class at 95%CL: 4cm	12°30’53.61856”	124°45’01.76667”	61.077	5.710	05-02-16
NS-73	Acc. Class at 95%CL: 6cm	12°32’52.45862”	124°54’30.80700”	60.314	5.945	09-01-16
NS-81	Acc. Class at 95%CL: 6cm	12°32’50.94301”	124°58’34.46636”	59.293	5.105	04-14-16
SMN-22	Used as Marker	-	-	-	-	09-04-15

The GNSS set-ups on the recovered reference points and established control points in the Catubig River are exhibited in Figure 31 to Figure 36.

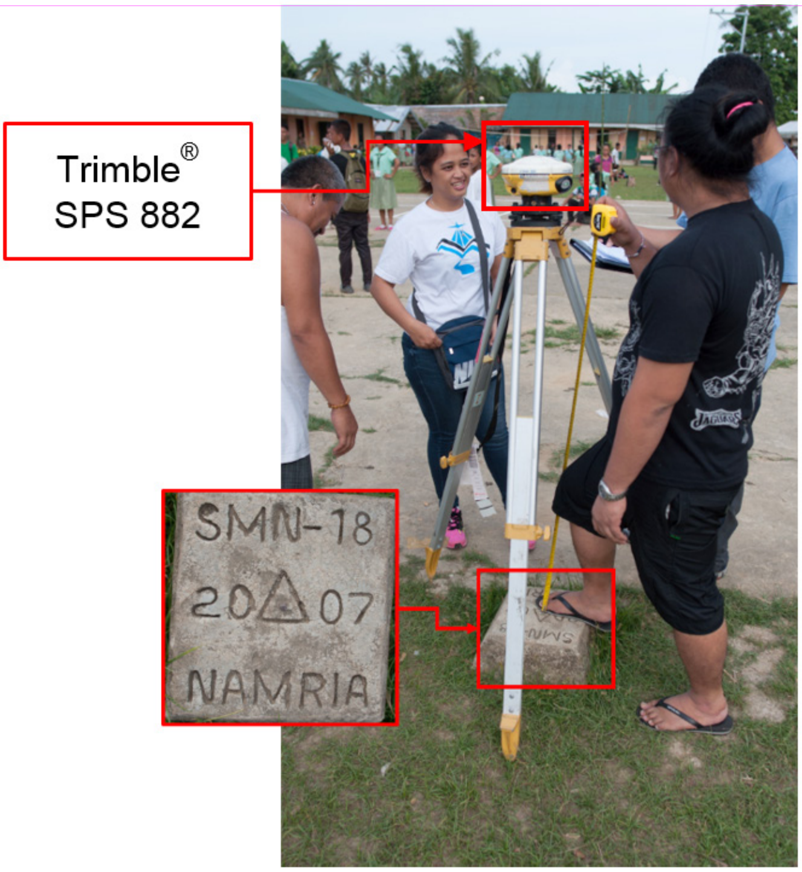


Figure 31. GNSS receiver set-up, Trimble® SPS 882 at SMN-18, located inside Nenita Elementary School in Barangay Nenita, Municipality of Mondragon, Northern Samar

Figure 32. GNSS base set-up, Trimble® SPS 852 at NS-26, located near the approach of the Paticua Bridge in Barangay Polangi, Municipality of Catarman, Northern Samar

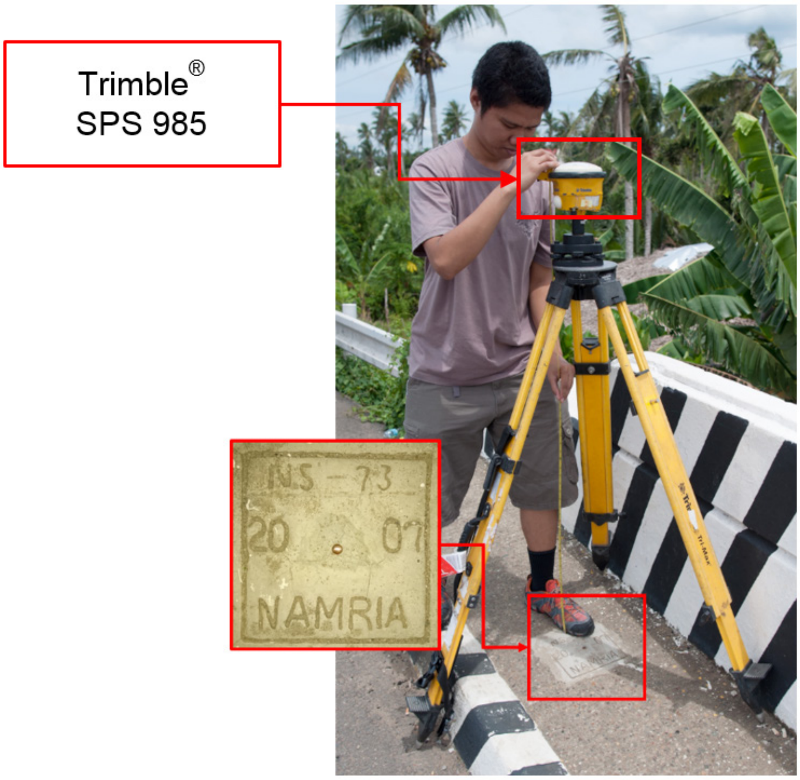


Figure 33. GNSS receiver set-up, Trimble® SPS 985 at NS-55, located at the approach of the Mondragon Bridge in Barangay Eco Poblacion, Municipality of Mondragon, Northern Samar

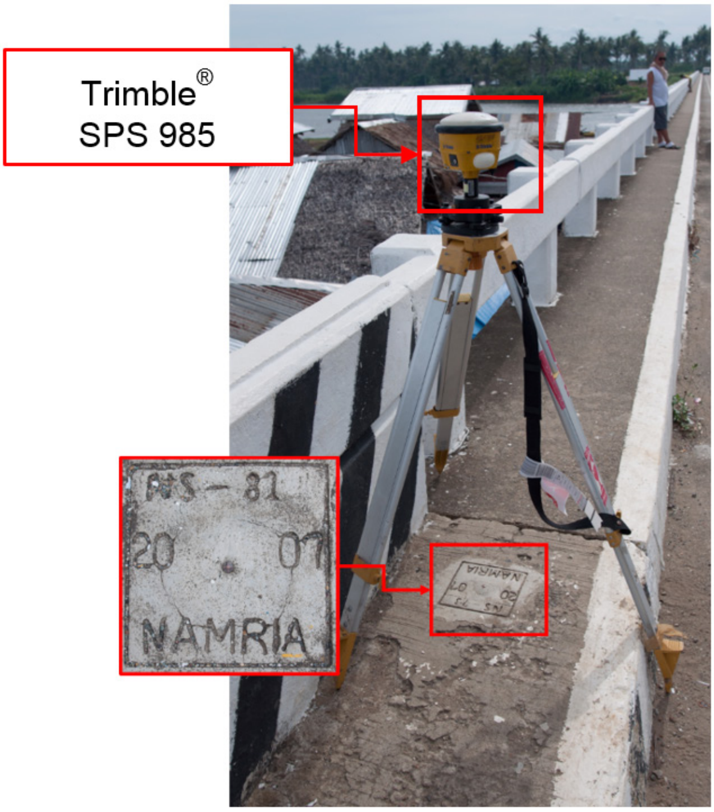


Figure 34. GNSS receiver set-up, Trimble® SPS 985 at NS-73, located at the approach of the Pambujan Bridge, in Barangay Dale, Municipality of San Roque, Northern Samar

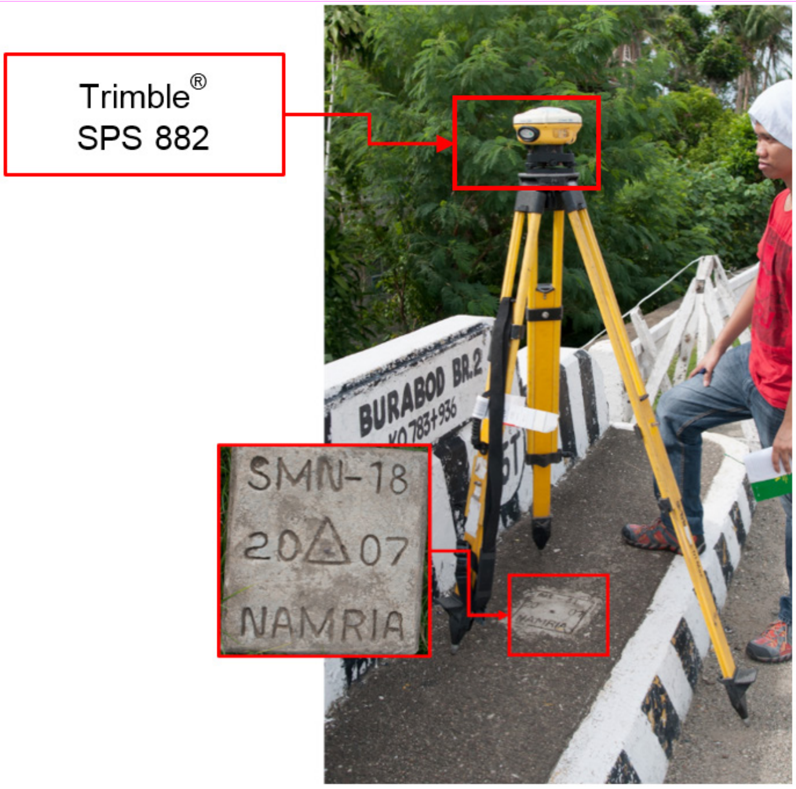


Figure 35. GNSS receiver set-up, Trimble® SPS 882 at NS-81, located at the approach of the Burabod Bridge in Barangay Burabud, Municipality of Laoang, Northern Samar

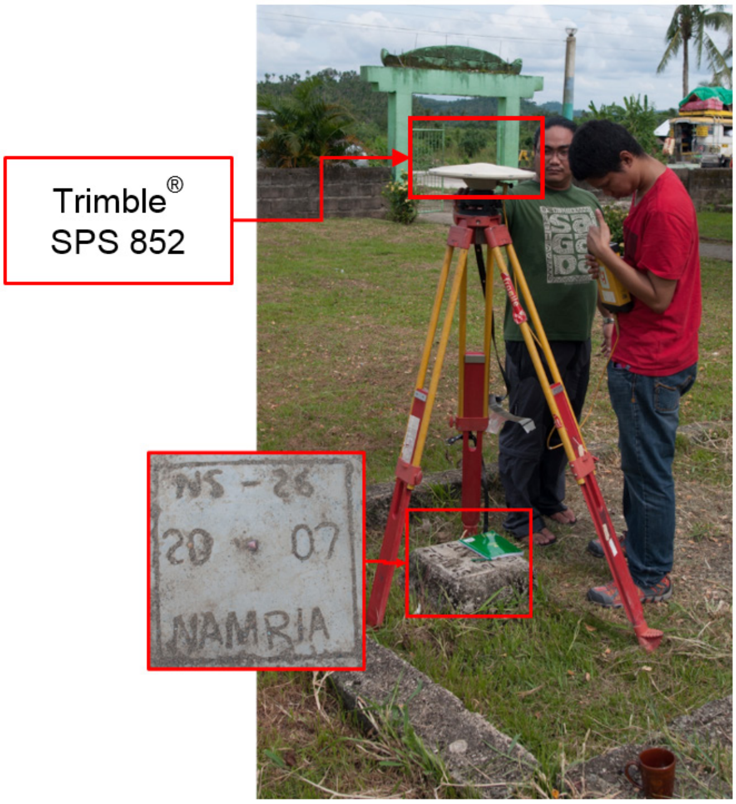


Figure 36. GNSS receiver set-up, Trimble® SPS 852 at SMN-22, located at Simora Elementary School in Barangay Simora, Municipality of Laoang, Northern Samar

4.3 Baseline Processing

The GNSS baselines were processed simultaneously in TBC by observing that all baselines have fixed solutions, with horizontal and vertical precisions within the +/- 20-centimeter and +/- 10-centimeter requirement, respectively. In cases where one or more baselines did not meet all of these criteria, masking was performed. Masking is the removal of portions of the 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, a re-survey is initiated. The baseline processing results of the control points in the Catubig River Basin, generated by the TBC software, are summarized in Table 28.

Table 28. Baseline processing summary report for the Catubig River survey

Observation	Date of Obser-vation	Solution Type	H.Prec. (Meter)	V.Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	Height (Meter)
NS-73 --- SMN-18 (B2)	09-02-16	Fixed	0.007	0.019	53°30’34”	13661.419	-4.222
NS-26 --- SMN-18 (B5)	09-02-16	Fixed	0.003	0.015	243°17’56”	21869.739	6.334
NS-55 --- NS-26 (B7)	09-02-16	Fixed	0.003	0.014	223°00’23”	19555.744	9.752
NS-73 --- NS-55 (B8)	09-02-16	Fixed	0.005	0.013	258°00’58”	17563.299	0.841
NS-55 --- SMN-18 (B9)	09-02-16	Fixed	0.004	0.015	305°48’50”	7640.620	-3.409
NS-73 --- NS-81 (B11)	09-02-16	Fixed	0.003	0.013	90°21’20”	7355.805	-1.057
NS-73 --- SMN-22 (B18)	09-02-16	Fixed	0.009	0.017	123°16’30”	15138.600	-2.047
SMN-22 --- SMN-18 (B19)	09-02-16	Fixed	0.004	0.015	270°28’32”	23643.589	6.262
SMN-22 --- NS-81 (B20)	09-02-16	Fixed	0.004	0.016	327°20’08”	9814.890	0.918
NS-73 --- SMN-22 (B21)	09-02-16	Fixed	0.004	0.014	123°16’30”	15138.605	-1.963

As reflected in Table 28, a total of ten (10) baselines were processed. The values of all the reference points, except SMN-22, were held fixed for the coordinate and elevation values. All of the baselines passed the required accuracy.

4.4 Network Adjustment

After the baseline processing procedure, network adjustment was performed using the TBC software. 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 20 centimeters, and z less than 10 centimeters, or in equation form:

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

Where:

x_e is the Easting Error,

y_e is the Northing Error, and

z_e is the Elevation Error

for each control point. See the Network Adjustment Report presented in Table 29 to Table 32 for complete details.

The six (6) control points – NS-26, NS-55, NS-73, NS-81, SMN-18, and SMN-22 – were occupied and observed simultaneously to form a GNSS loop. The coordinates of SMN-18 and the elevation values of all benchmarks were held fixed during the processing of the control points, as demonstrated in Table 29. Through these reference points, the coordinates and elevation values of the unknown control points were computed.

Table 29. Constraints applied to the adjustments of the control points

Point ID	Type	East σ (Meter)	North σ (Meter)	Height σ (Meter)	Elevation σ (Meter)
SMN-18	Global	Fixed	Fixed		
NS-26	Grid				
NS-55	Grid				
NS-73	Grid				
NS-81	Grid				Fixed
Fixed = 0.000001 (Meter)					

The list of adjusted grid coordinates; i.e., Northing, Easting, Elevation, and computed standard errors of the control points in the network, is indicated in Table 30. All of the fixed control points did not yield values for grid and elevation errors.

Table 30. Adjusted grid coordinates for the control points used in the Catubig floodplain survey

Point ID	Easting (Meter)	Easting Error (Meter)	Northing (Meter)	Northing Error (Meter)	Elevation (Meter)	Elevation Error (Meter)	Constraint
SMN-18	696441.22698	?	1379691.63306	?	8.9098	0.031	LL
NS-26	676970.19397	0.007	1369731.98493	0.006	13.4801	?	e
NS-55	690214.51511	0.008	1384120.46061	0.006	5.7095	?	e
NS-73	707369.75759	0.009	1387891.68118	0.006	5.9447	?	e
NS-81	714726.67255	0.011	1387899.30448	0.008	5.1053	?	e
SMN-22	720088.05329	0.009	1379675.96886	0.006	3.45269	0.067	

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

a. **SMN-18**
Horizontal Accuracy = Fixed
Vertical Accuracy = 3.1 cm < 10 cm

b. **NS-26**
Horizontal Accuracy = $\surd((0.7)^2 + (0.6)^2$
= $\surd (0.49 + 0.36)$
= 0.92 < 20 cm
Vertical Accuracy = Fixed

c. **NS-55**
Horizontal Accuracy = $\surd((0.8)^2 + (0.6)^2$
= $\surd (0.64 + 0.36)$
= 1.00 < 20 cm
Vertical Accuracy = Fixed

d. **NS-73**
Horizontal Accuracy = $\surd((0.9)^2 + (0.6)^2$
= $\surd (0.81 + 0.36)$
= 1.08 < 20 cm
Vertical Accuracy = Fixed

e. **NS-81**
Horizontal Accuracy = $\surd((1.1)^2 + (0.8)^2$
= $\surd (1.21 + 0.64)$
= 1.36 cm < 20 cm
Vertical Accuracy = Fixed

f. **SMN-22**
Horizontal Accuracy = $\surd((0.9)^2 + (0.6)^2$
= $\surd (0.81 + 0.36)$
= 1.08 cm < 20 cm
Vertical Accuracy = 6.7 cm < 10 cm

Following the given formula, the horizontal and vertical accuracy results of the two (2) occupied control points are within the required precision.

Table 31. Adjusted geodetic coordinates for control points used in the Catubig River floodplain validation

Point ID	Latitude	Longitude	Ellipsoid Height (Meter)	Height Error (Meter)	Constraint
SMN-18	N12°28'28.14643"	E124°48'26.98399"	64.6235	0.031	LL
NS-26	N12°23'08.14503"	E124°37'40.1943"	70.99005	?	e
NS-55	N12°30'53.61856"	E124°45'01.76667"	61.0772	?	e
NS-73	N12°32'52.45862"	E124°54'30.807"	60.31401	?	e
NS-81	N12°32'50.94301"	E124°58'34.46636"	59.29264	?	e
SMN-22	N12°28'22.07678"	E125°01'29.94039"	58.56371	0.067	

The corresponding geodetic coordinates of the observed points are within the required accuracy, as shown in Table 31. Based on the results of the computations, the accuracy conditions are satisfied; hence, the required accuracy for the program was met.

The computed coordinates of the reference and control points utilized in the Catubig River GNSS Static Survey are indicated in Table 32.

Table 32. Reference and control points used in the Catubig River Static Survey, with their corresponding locations (Source: NAMRIA, UP-TCAGP)

Control Point	Order of Accuracy	Geographic Coordinates (WGS 84)			UTM ZONE 51 N		
		Latitude	Longitude	Ellipsoidal Height (m)	Northing (m)	Easting (m)	BM Ortho (m)
SMN-18	2nd Order, GCP	12°28'28.14643"	124°48'26.98399"	64.624	1379691.633	696441.227	8.910
NS-26	Acc. Class at 95%CL: 4cm	12°23'08.14503"	124°37'40.19430"	70.990	1369731.985	676970.194	13.480
NS-55	Acc. Class at 95%CL: 4cm	12°30'53.61856"	124°45'01.76667"	61.077	1384120.461	690214.515	5.710
NS-73	Acc. Class at 95%CL: 6cm	12°32'52.45862"	124°54'30.80700"	60.314	1387891.681	707369.758	5.945
NS-81	Acc. Class at 95%CL: 6cm	12°32'50.94301"	124°58'34.46636"	59.293	1387899.304	714726.673	5.105
SMN-22	Used as Marker	12°28'22.07678"	125°01'29.94039"	58.564	1379675.969	720088.053	3.453

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

The cross-section and bridge as-built surveys at the downstream side of the Rauis Bridge, located along the tributary of the Catubig River, were conducted on December 15, 2016 in Barangay Rawis, Laoang, Northern Samar (Figure 37). A GNSS Receiver, Hi-Target™ V30 GNSS, in RTK survey technique was utilized for this survey, as illustrated in Figure 38 and Figure 39.

Figure 37. Downstream side of the Rauis Bridge

Figure 38. As-built survey of the Rauis Bridge

Figure 39. Cross-section survey of the Rauis Bridge

The length of the cross-sectional line surveyed in the Rauis Bridge is about 93 meters with two hundred seventy-one (271) cross-sectional points, using the control point UP-CATU-11 as the GNSS base station. The location map, cross-section diagram, and bridge data form are presented in Figure 40 to Figure 42.

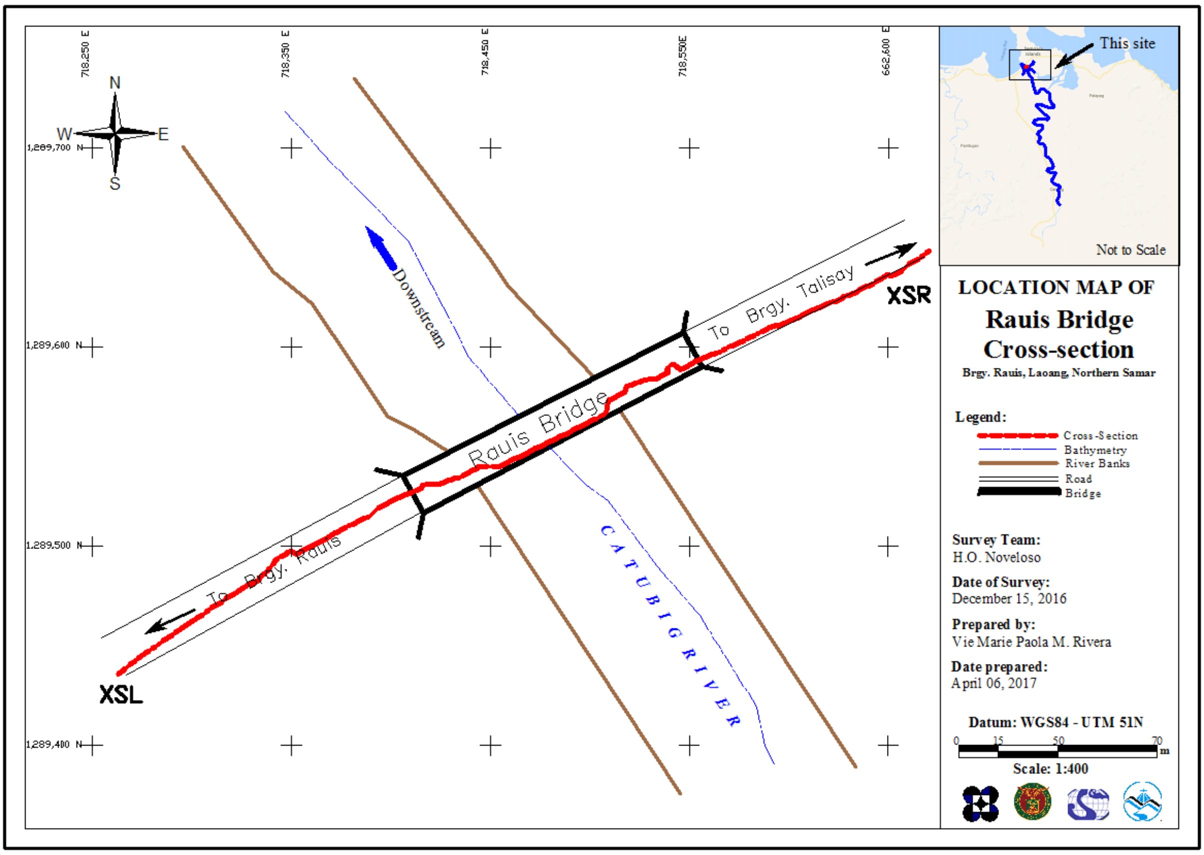


Figure 40. Location map of the Rauis Bridge cross-section

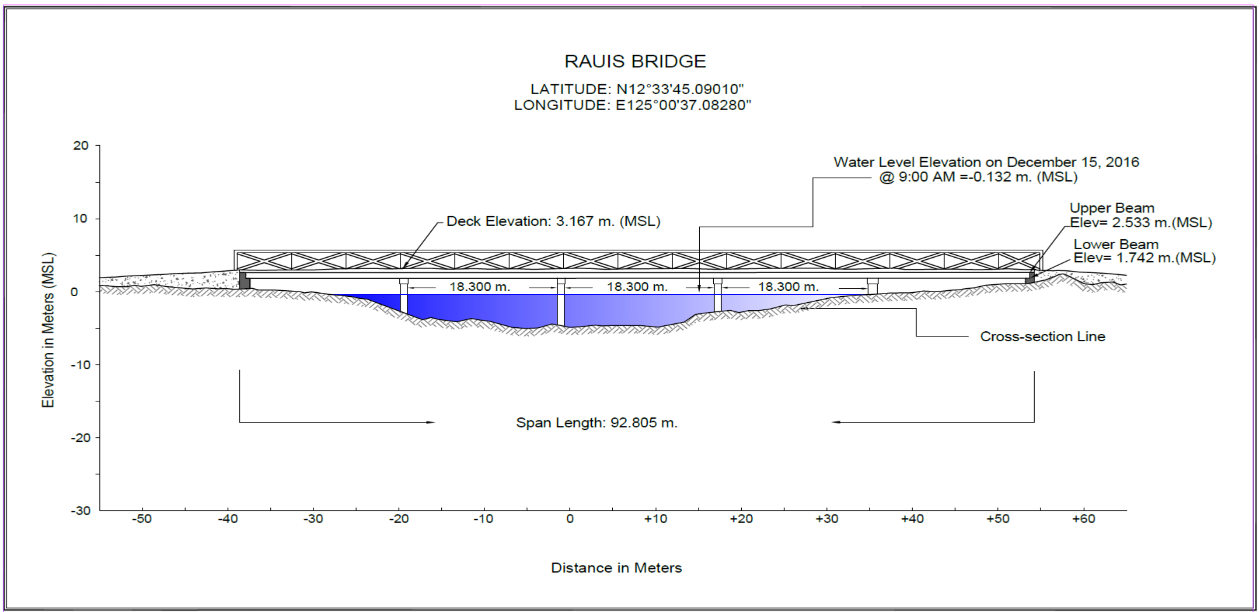
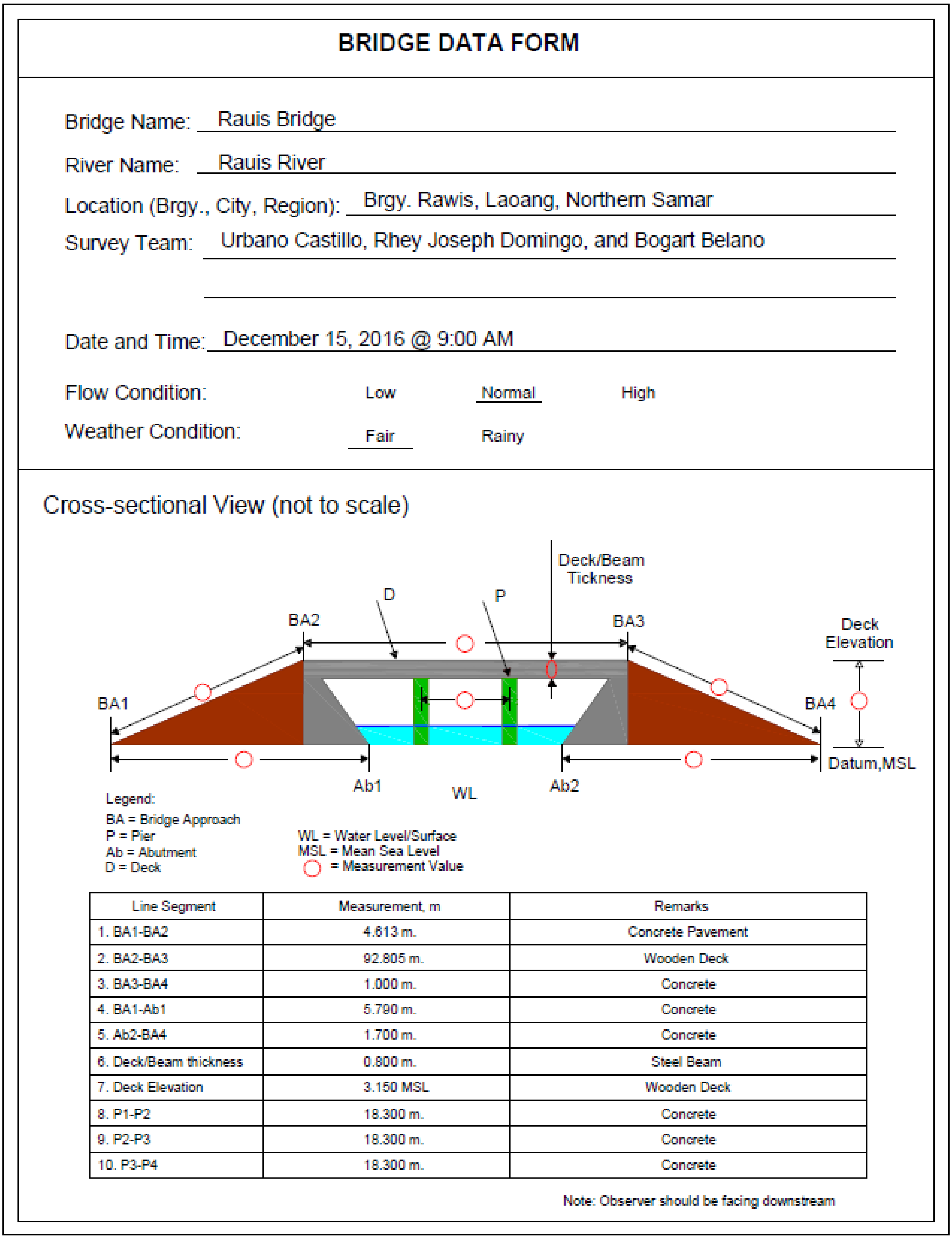


Figure 41. Rauis Bridge cross-section diagram



BRIDGE DATA FORM

Bridge Name: Rauis Bridge

River Name: Rauis River

Location (Brgy., City, Region): Brgy. Rawis, Laoang, Northern Samar

Survey Team: Urbano Castillo, Rhey Joseph Domingo, and Bogart Belano

Date and Time: December 15, 2016 @ 9:00 AM

Flow Condition: Low [✓ Normal] High

Weather Condition: [✓ Fair] Rainy

Cross-sectional View (not to scale)

Legend:

BA = Bridge Approach
P = Pier
Ab = Abutment
D = Deck
WL = Water Level/Surface
MSL = Mean Sea Level
○ = Measurement Value

Line Segment	Measurement, m	Remarks
1. BA1-BA2	4.613 m.	Concrete Pavement
2. BA2-BA3	92.805 m.	Wooden Deck
3. BA3-BA4	1.000 m.	Concrete
4. BA1-Ab1	5.790 m.	Concrete
5. Ab2-BA4	1.700 m.	Concrete
6. Deck/Beam thickness	0.800 m.	Steel Beam
7. Deck Elevation	3.150 MSL	Wooden Deck
8. P1-P2	18.300 m.	Concrete
9. P2-P3	18.300 m.	Concrete
10. P3-P4	18.300 m.	Concrete

Note: Observer should be facing downstream

Figure 42. Rauis Bridge data form

The cross-section and bridge as-built surveys of the Las Navas Bridge, which is at the upstream part of the Catubig River, were conducted on January 6, 2017 at the downstream side of the bridge in Barangay Rebong, Las Navas, Northern Samar (Figure 43). A Sokkia™ Set CX-105 Total Station and a GNSS receiver, Hi-Target™ V30 GNSS, in RTK survey technique were utilized for this survey, as depicted in Figure 44 and Figure 45. The Automated Water Level System (AWLS) is located on the upstream side of the bridge; and its elevation was measured at 13.803 meters above MSL.

Figure 43. Las Navas Bridge, facing upstream

Figure 44. Cross-section survey for the Las Navas Bridge

Figure 45. As-Built survey of the Las Navas Bridge

The length of the cross-sectional line surveyed in the Las Navas Bridge is about 122 meters with two hundred thirteen (213) cross-sectional points, using the control point UP-CATU-1 as the GNSS base station. The location map, cross-section diagram, and bridge data form are provided in Figure 46 to Figure 48.

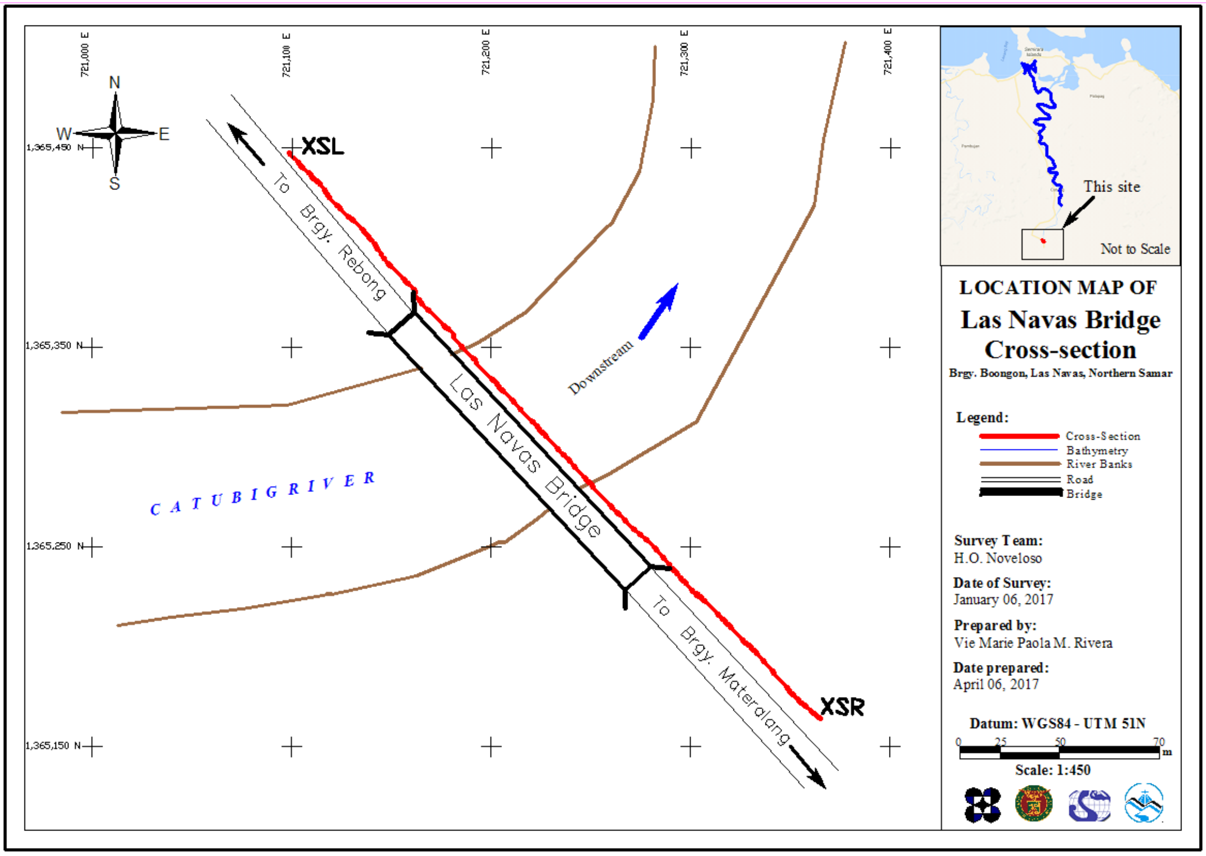


Figure 46. Location map of the Las Navas Bridge cross-section

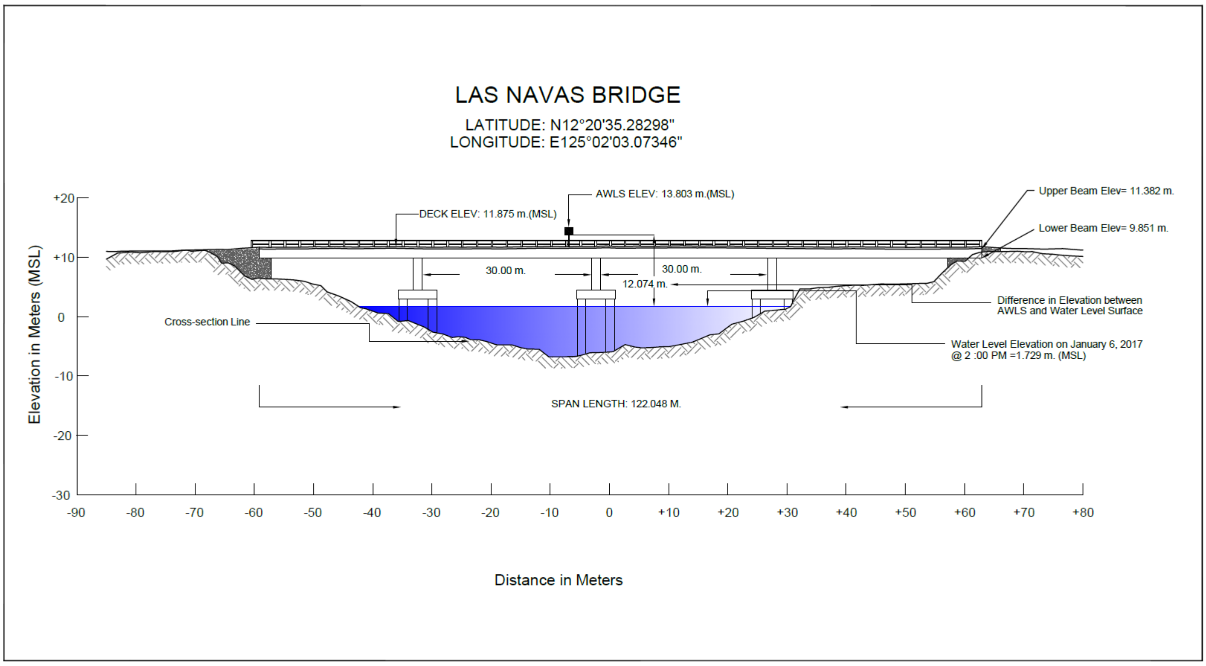
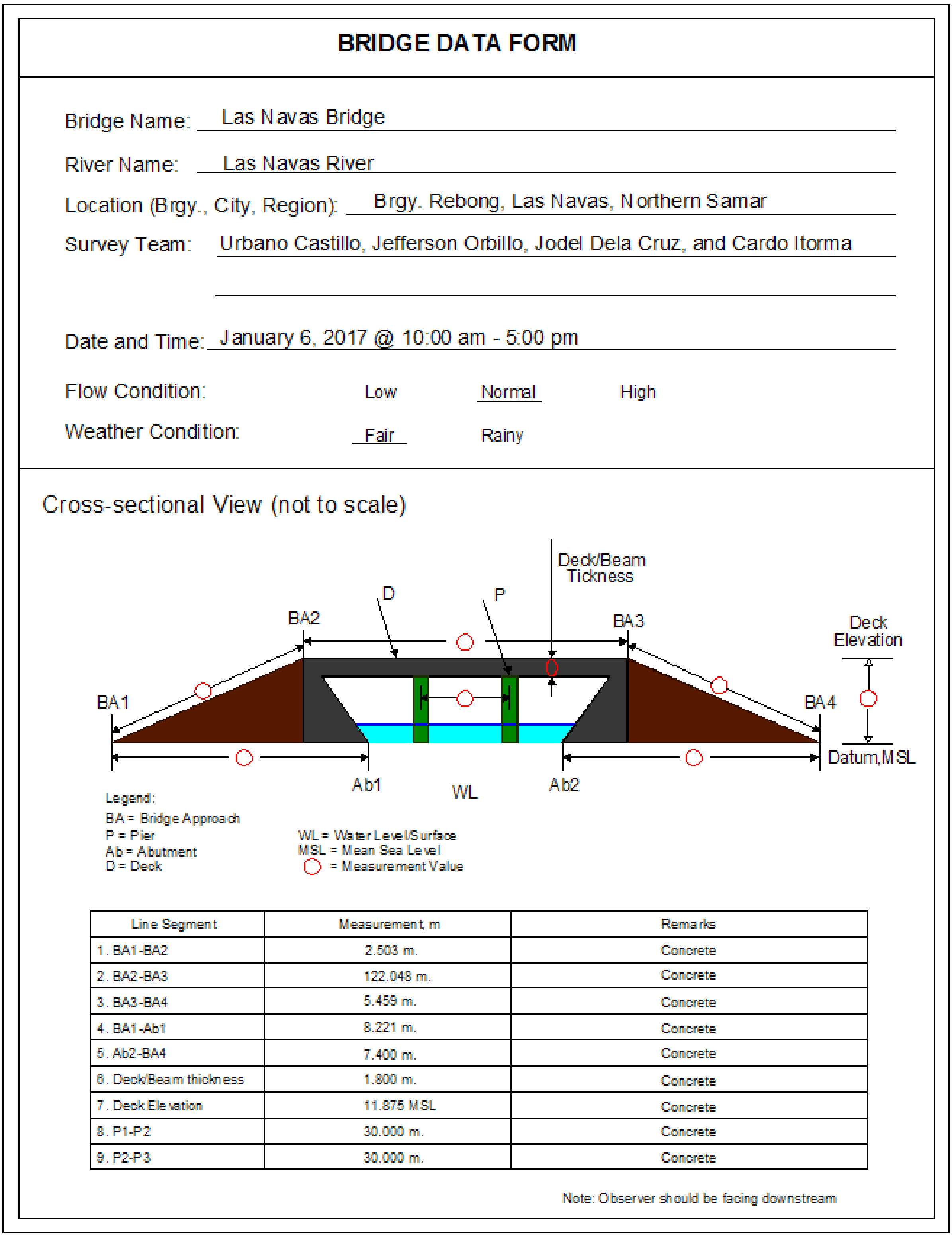


Figure 47. Las Navas Bridge cross-section diagram



BRIDGE DATA FORM

Bridge Name: Las Navas Bridge

River Name: Las Navas River

Location (Brgy., City, Region): Brgy. Rebong, Las Navas, Northern Samar

Survey Team: Urbano Castillo, Jefferson Orbillo, Jodel Dela Cruz, and Cardo Itorma

Date and Time: January 6, 2017 @ 10:00 am - 5:00 pm

Flow Condition: Low [✓ Normal] High

Weather Condition: [✓ Fair] Rainy

Cross-sectional View (not to scale)

Legend:
BA = Bridge Approach
P = Pier
Ab = Abutment
D = Deck

WL = Water Level/Surface
MSL = Mean Sea Level
○ = Measurement Value

Line Segment	Measurement, m	Remarks
1. BA1-BA2	2.503 m.	Concrete
2. BA2-BA3	122.048 m.	Concrete
3. BA3-BA4	5.459 m.	Concrete
4. BA1-Ab1	8.221 m.	Concrete
5. Ab2-BA4	7.400 m.	Concrete
6. Deck/Beam thickness	1.800 m.	Concrete
7. Deck Elevation	11.875 MSL	Concrete
8. P1-P2	30.000 m.	Concrete
9. P2-P3	30.000 m.	Concrete

Note: Observer should be facing downstream

Figure 48. Las Navas Bridge data form

The cross-section of the Laoang River, a tributary of the Catubig River, was also acquired on December 15, 2016 in Barangay Baybay, Laoang, Northern Samar (Figure C-21). A Hi-Target ™ V30 GNSS was utilized for this survey, as demonstrated in Figure 50.

Figure 49. Laoang cross-section area

Figure 50. Laoang cross-section survey

The length of the cross-sectional line surveyed in the Laoang River is about 517.899 meters with four hundred twenty-six (426) cross-sectional points, using the control point UP-CATU-11 as the GNSS base station. The cross-section diagram is shown in Figure 51.

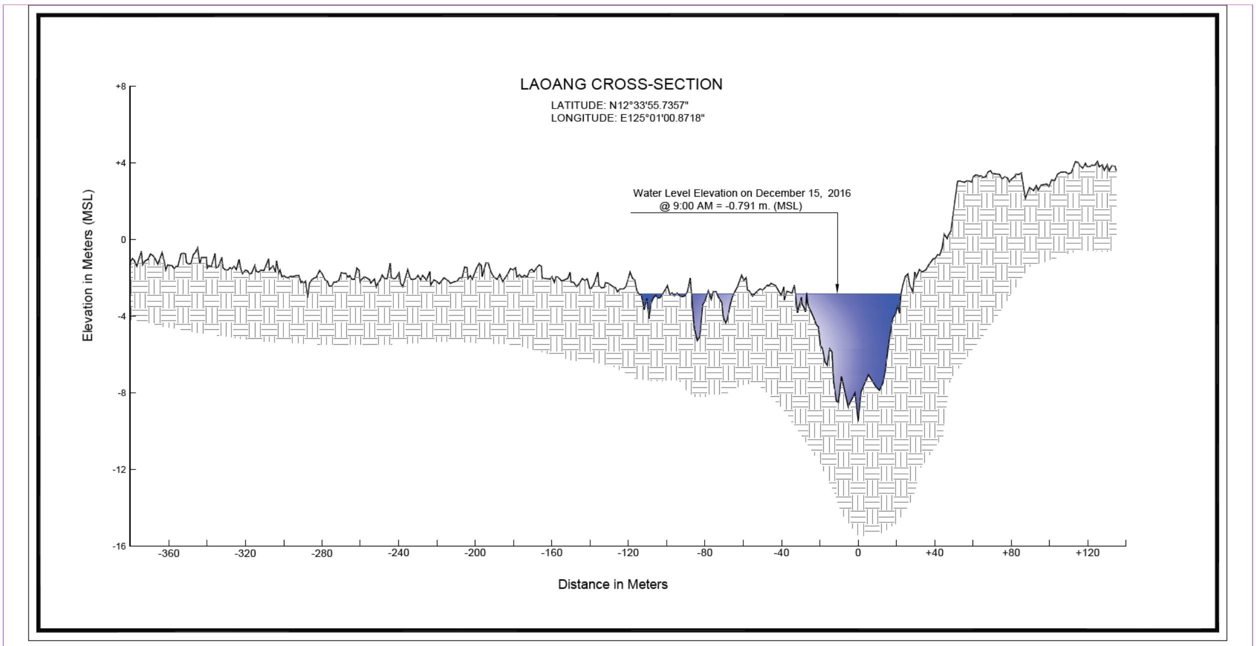


Figure 51. Laoang tributary cross-section

The water surface elevation of the Catubig River was determined using a Hi-Target™ V30 GNSS on November 28, 2015 at 13:35 hrs. at the riprap of the Catubig River, near the Catubig Public Market in Barangay Poblacion, Catubig, Northern Samar. The elevation value obtained was 3.002 meters in MSL. This was translated into markings on the river's riprap 2 meters away from the hanging bridge, as shown in Figure 52. The marking served as a reference for flow data gathering and depth gauge deployment of the VSU Phil-LiDAR Team.

Figure 52. Water surface elevation markings on the riprap of the Catubig River

The water surface elevation of the Catubig River at the Las Navas Bridge was also determined, using a Sokkia™ Set-CX Total Station on January 6, 2017 at 14:00 hrs. The value obtained was 1.729 meters in MSL. This was translated into markings on the foundation of a house along the Catubig River, as exhibited in Figure 53..

Figure 53. Water level markings on a house beside the Catubig River

4.6 Validation Points Acquisition Survey

The validation points acquisition survey was conducted on August 31, 2016, and on September 2-3, 2016 using a survey-grade GNSS Rover receiver, Trimble® SPS 882. The receiver was mounted in front of a vehicle, as depicted in Figure 54. It was secured with a nylon rope to ensure that it was horizontally and vertically balanced. The antenna height was 1.907 meters, measured from the ground up to the bottom of the notch of the GNSS Rover receiver. The PPK technique utilized for the conduct of the survey was set to continuous topo mode with NS-26, SMN-18, and SMN-22 occupied as the GNSS base stations during the conduct of the survey.

Figure 54. Validation points acquisition survey set-up along the Catubig River Basin

The survey took three (3) routes. The first route started in Barangay Molave and went south, covering thirteen (13) barangays in the Municipality of Catarman, ending in Barangay Cervantes. The second route started in Barangay Bugko, headed south and ended in Barangay Nenita in the Municipality of Mondragon. The third route started in Barangay Bantayan, Municipality of San Roque, and traveled east, covering twelve (12) barangays in the Municipalities of Laoang, Pambujan, and San Roque, ending in Barangay Rawis, Municipality of Laoang. The third route then went south, covering eighteen (18) more barangays, and finally ended in Barangay Sagudsuron in the Municipality of Catubig. The survey gathered a total of 13,816 points with an approximate length of 79 kilometers, using NS-26, SMN-18, and SMN-22 as the GNSS base stations for the entire extent validation points acquisition survey. This is illustrated in the map in Figure 55.

Figure 55. Extent of the LiDAR ground validation survey of the Catubig River Basin

4.7 Bathymetric Survey

A bathymetric survey of the Catubig River was executed on December 7-14, 2016 using a Hi-Target™ Single Beam Echo Sounder, as seen in Figure 56. The survey started in three (3) different locations: in (i.) Barangay Guibwangan, Catubig, Northern Samar, with coordinates 12°23’22.2617”N, 125°03’14.6123”E; in (ii.) Barangay Cagaasan, Laoang, Northern Samar, with coordinates 12°34’17.7372”N, 125°01’25.0851”E; and in (iii.) Barangay Talisay, Laoang, Northern Samar, with coordinates 12°33’19.0979”N, 125°00’34.1537”E. The survey ended at the mouth of the river in Barangay Baybay, Laoang, Northern Samar, with coordinates 12°34’07.4587”N, 125°00’26.0784”E. The control points UP-CATU-3, UP-CATU-5, UP-CATU-8, UP-CATU-9, and UP-CATU-11 were used as the GNSS base stations all throughout the survey.

Figure 56. Bathymetric survey at the Catubig River using Hi-Target™ Echo Sounder

The bathymetric survey for the Catubig River gathered a total of 29,955 points covering 36.51 kilometers of the river. The survey traversed Barangays Guibwangan, Canuctan, Calingnan, 2 (Poblacion), 7 (Poblacion), 8 (Poblacion), Viena Maria, Hiparayan, D. Mercader, Opong, Tangbo, and Lenoyahan in the Municipality of Catubig; and Barangays Cagdara-O, Abaton, Simora, Bawang, La Perla, Bongliw, San Antonio, Vigo, Tarusan, Lawaan, Talisay, Baybay, Sangcol, Cagaasan, and Rawis in the Municipality of Laoang. The scope is illustrated in the map in Figure 57. CAD drawings were also produced to illustrate the riverbed profile of the Catubig River, presented in Figure 58 to Figure 62. The profiles demonstrate that the highest and lowest elevation had a 20.529-meter difference. The highest elevation observed was -2.519 meters below MSL, located in in Barangay Tangbo, Catubig, Northern Samar. The lowest elevation observed was -23.048 meters below MSL, located in Barangay Simora, Laoang, Northern Samar.

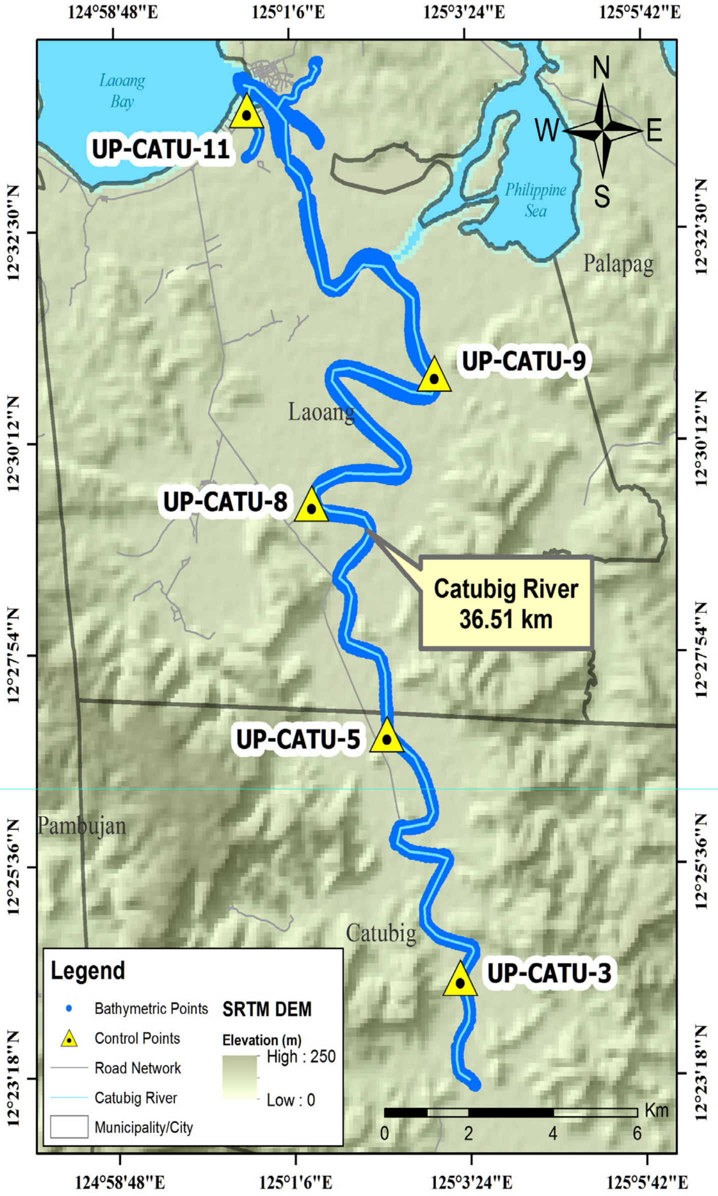


Figure 57. Extent of the bathymetric survey of the Catubig River

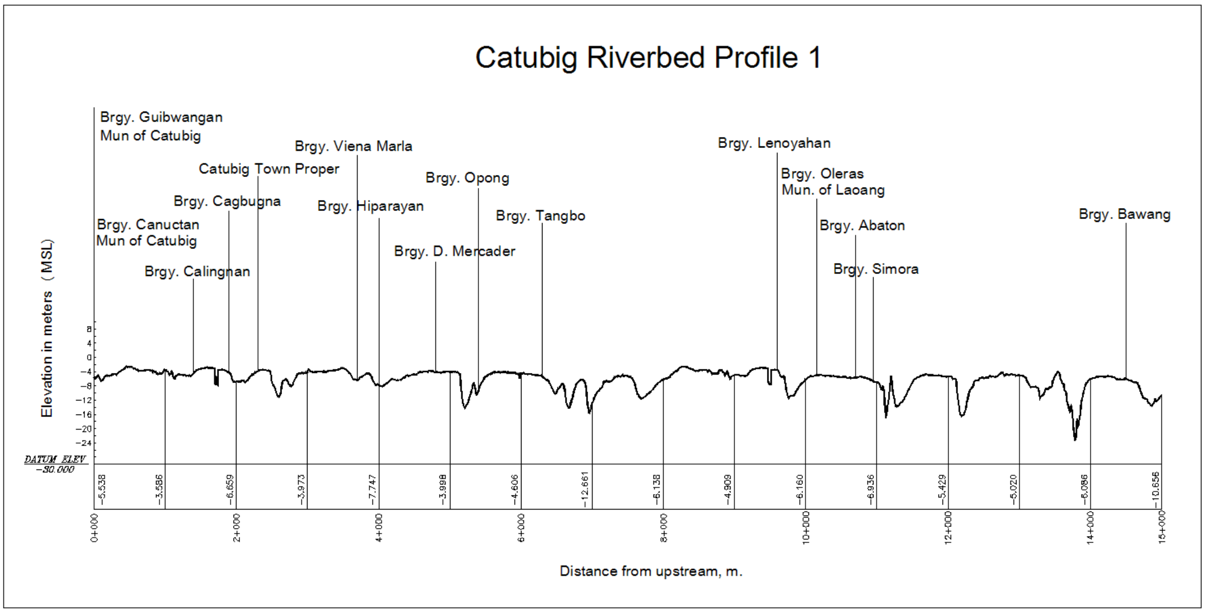


Figure 58. Catubig riverbed profile, in the upstream portion

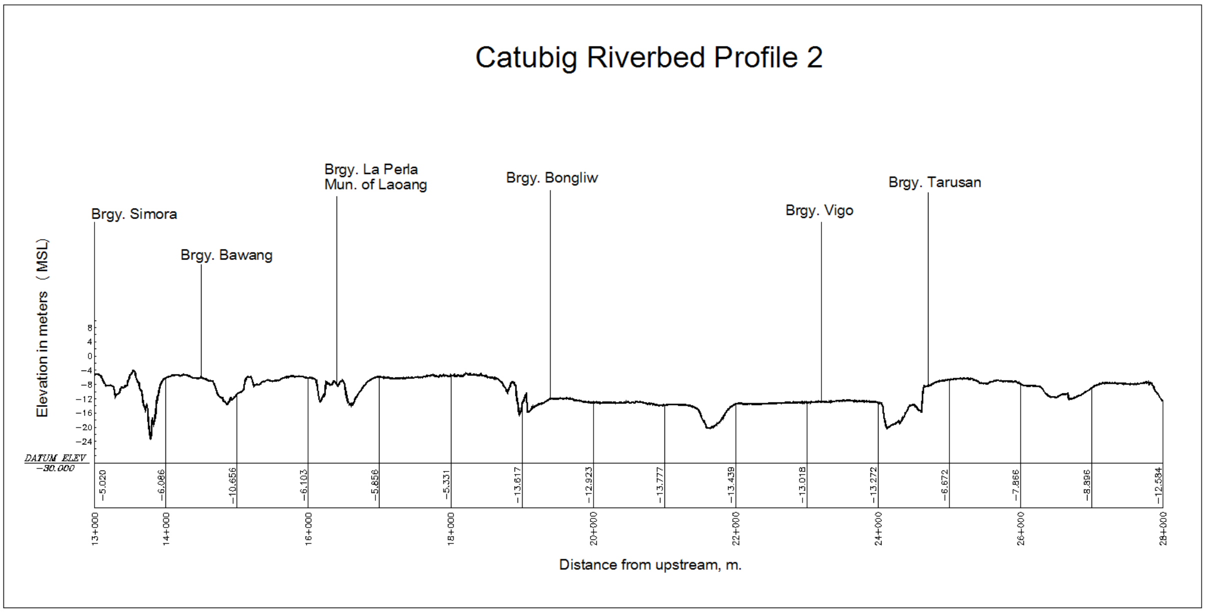


Figure 59. Catubig riverbed profile, in the midstream portion

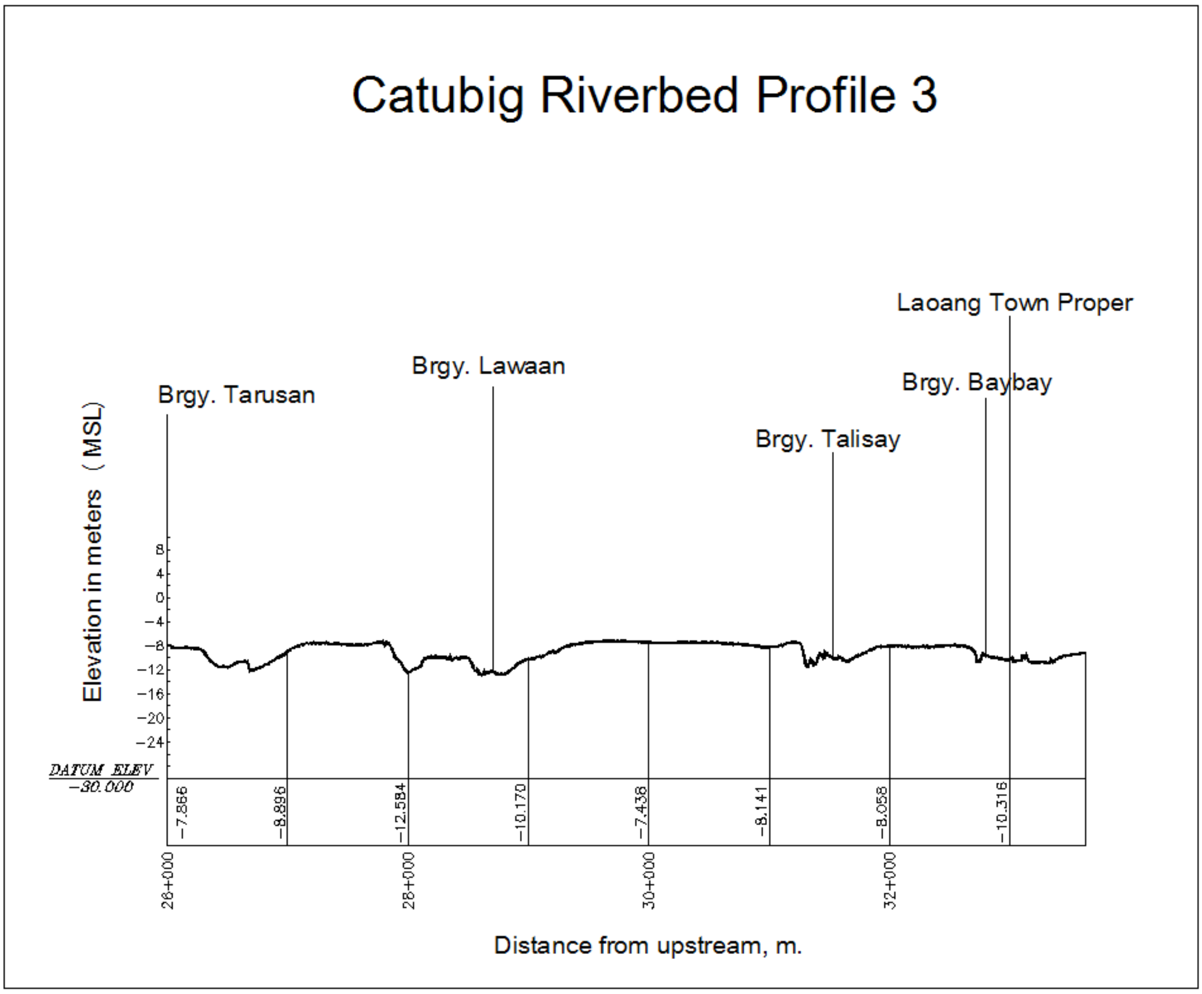


Figure 60. Catubig riverbed profile, downstream portion

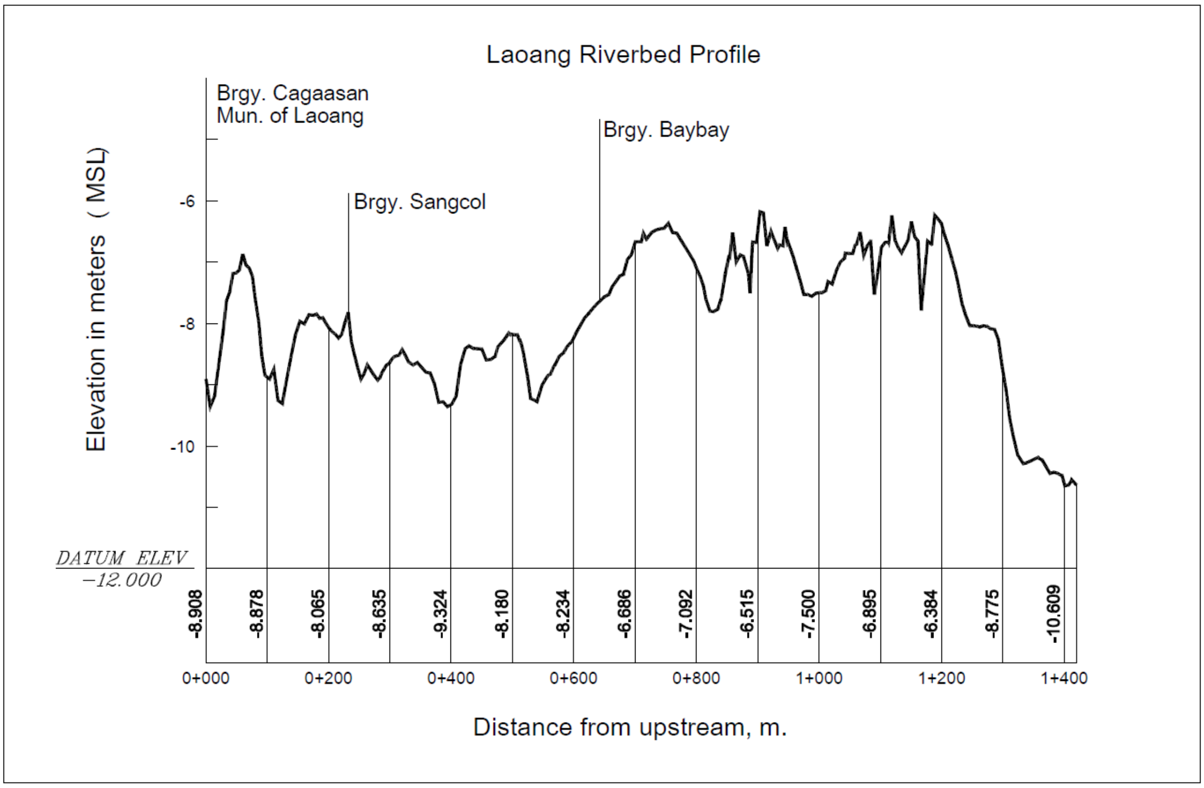


Figure 61. Catubig riverbed profile, in the Laoang tributary

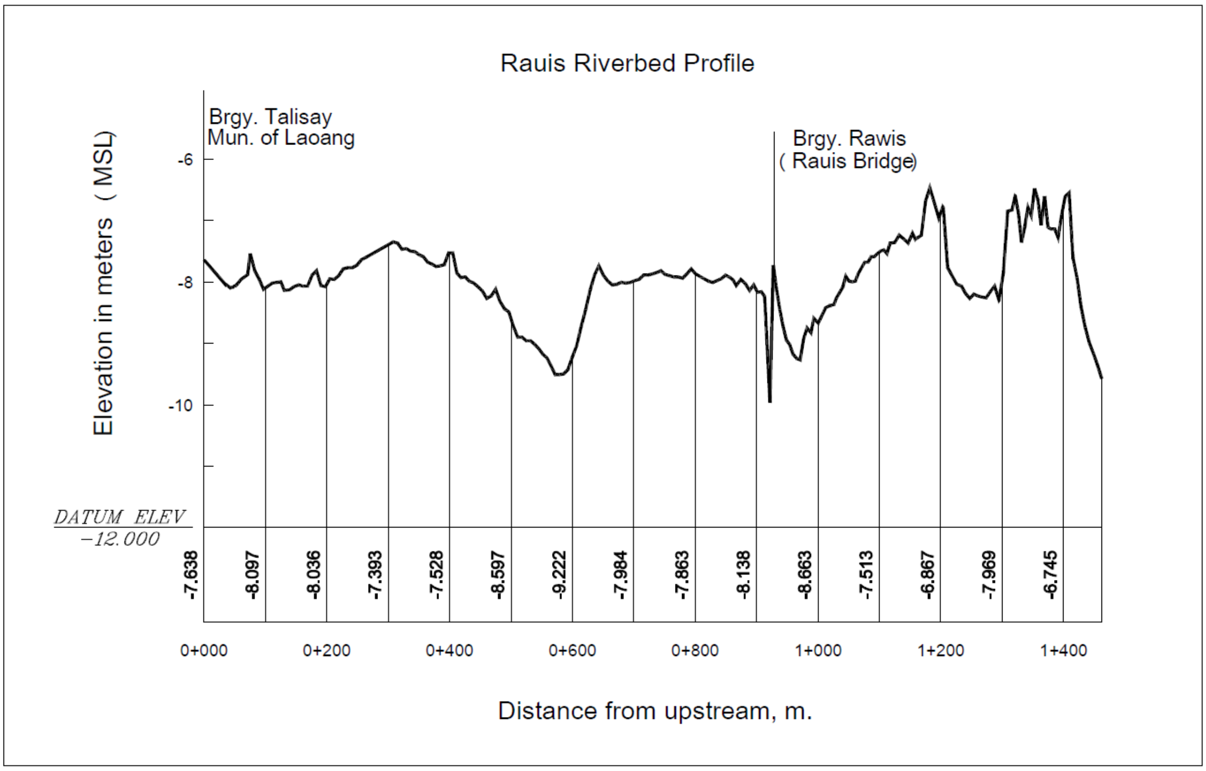


Figure 62. Catubig riverbed profile, in the Rauis tributary

CHAPTER 5: FLOOD MODELING AND MAPPING

Dr. Alfredo Mahar Lagmay, Christopher Uichanco, Sylvia Sueno, Marc Moises, Hale Ines, Miguel del Rosario, Kenneth Punay, and Neil Tingin

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

Rainfall, water level, and flow in a certain period of time, which are all components and data that may affect the hydrologic cycle of the Catubig River Basin, were monitored, collected, and analyzed.

5.1.2 Precipitation

Precipitation data was taken from one automatic rain gauge (ARG) temporarily installed by the VSU Phil-LiDAR 1 Flood Modeling Component (FMC). This was the Las Navas ARG, with the location map provided in Figure 63.

Total rain from Las Navas rain gauge was 130 millimeters. It peaked at 18.5 millimeters on January 20, 2017 at 13:45 hrs. The lag time between the peak rainfall and discharge was nineteen (19) hours and fifty-five (55) minutes.

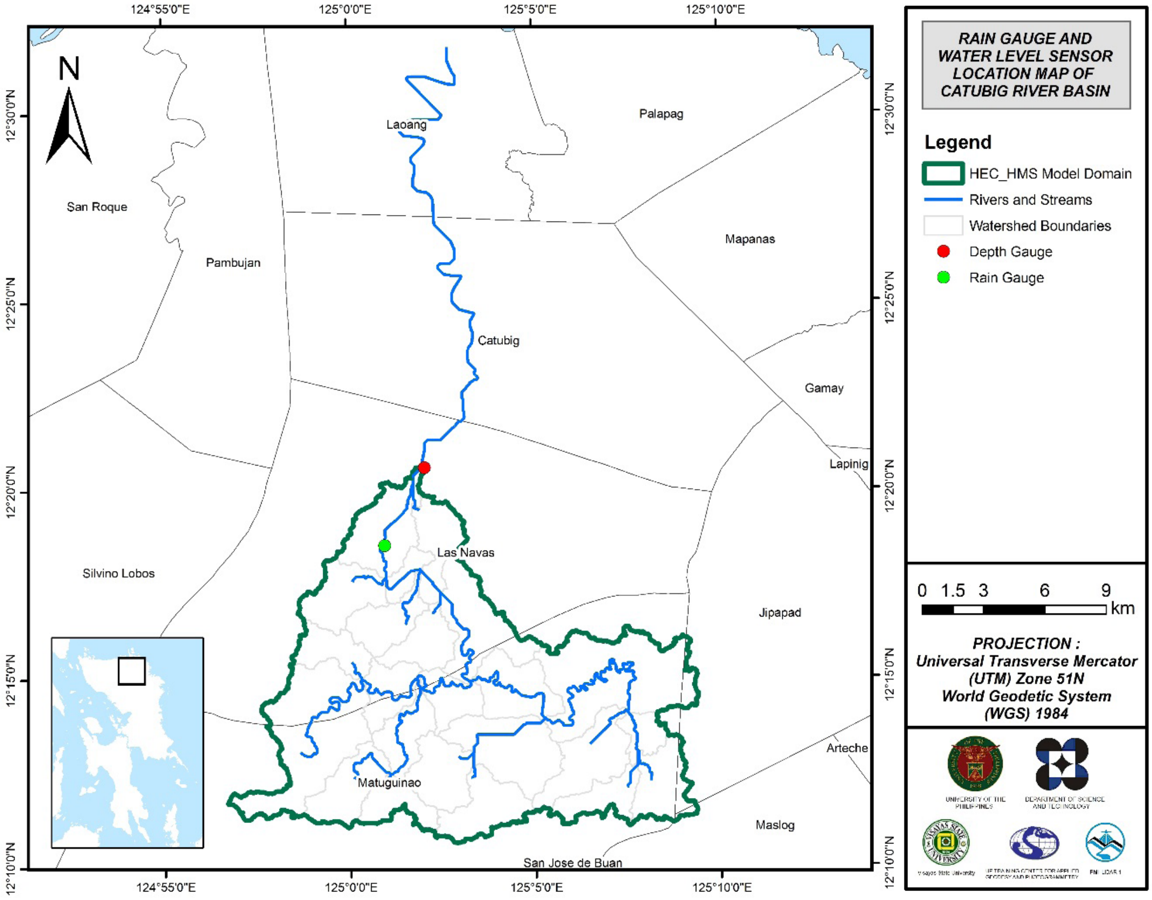


Figure 63. Location map of the Catubig HEC-HMS model, which was used for calibration

5.1.3 Rating Curves and River Outflow

A rating curve was computed using the prevailing cross-section (Figure 64) at the Las Navas Bridge in Barangay Rebong, Las Navas, Northern Samar (12.343127° N, 125.034024° E) to establish the relationship between the observed water levels (H) from the Las Navas Bridge Automated Water Level Sensor (AWLS) HOBO Depth Gauge and the combined discharge (Q) from the baseflow and bankful.

For the Las Navas Bridge, the rating curve is expressed as $Q = 122.59e^{0.199385h}$, as shown in Figure 65.

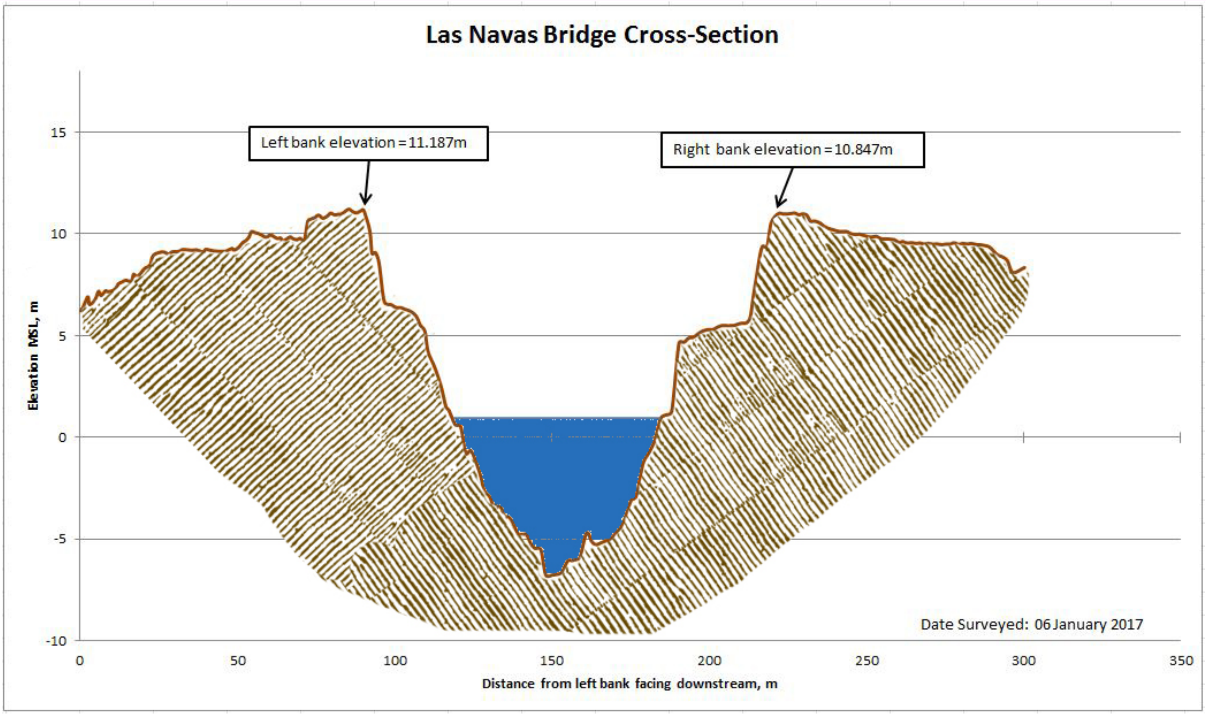


Figure 64. Cross-section plot of the Las Navas Bridge

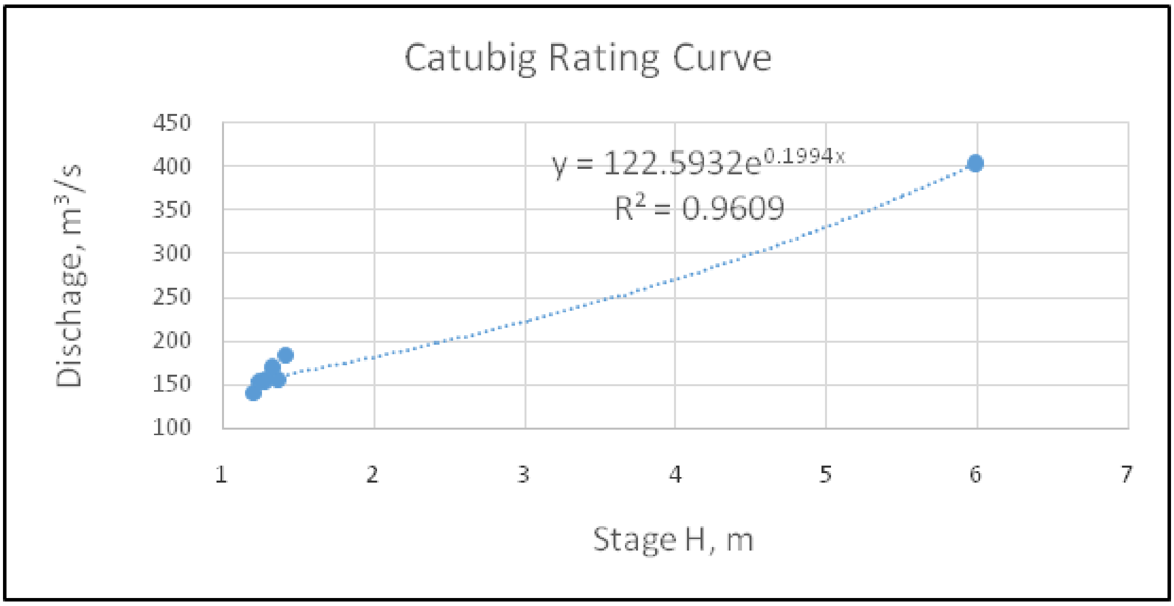


Figure 65. Rating curve at the Las Navas Bridge

This rating curve equation was used to compute for the river outflow at the Las Navas Bridge, for the calibration of the HEC-HMS model presented in Figure 66.

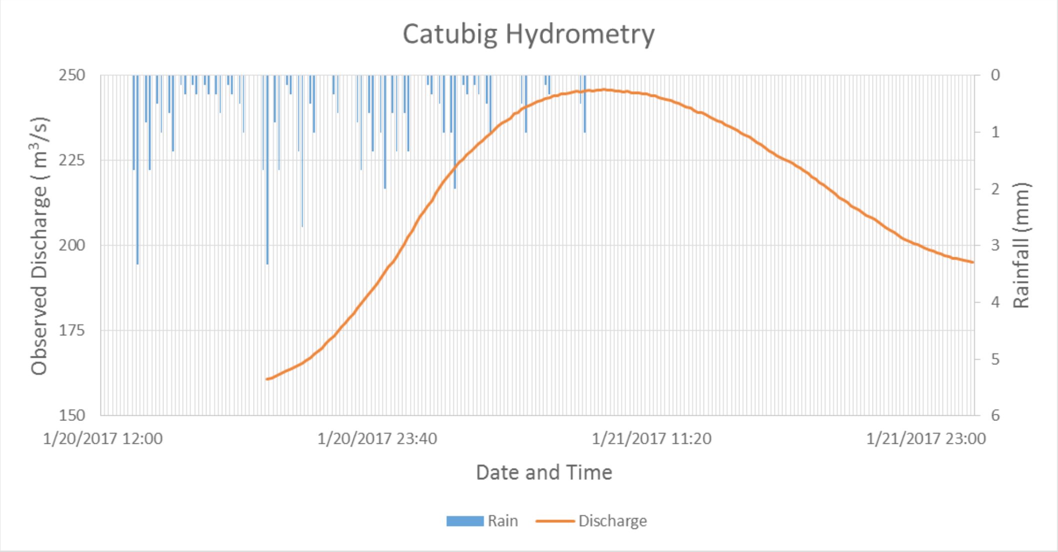


Figure 66. Rainfall and outflow data at the Las Navas Bridge, which were used for modeling

5.2 RIDF Station

The Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) computed for the Rainfall Intensity Duration Frequency (RIDF) values for the Catarman Rain Gauge (Table 33). This station was selected based on its proximity to the Catubig watershed (Figure 67). The RIDF rainfall amount for twenty-four (24) hours was converted into a synthetic storm by interpolating and re-arranging the values such that certain peak values were attained at a certain time. The extreme values for this watershed were computed based on a 52-year record.

Table 33. RIDF values for the Catarman 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	22.5	34.2	42.4	57.5	80.9	96.4	125.2	156.6	180
5	29.9	45.4	56.2	77	110.3	135.9	183.5	229.5	255.4
10	34.7	52.8	65.4	90	129.7	162	222.1	277.8	305.4
15	37.5	57	70.5	97.3	140.7	176.7	243.9	305.1	333.6
20	39.4	60	74.2	102.4	148.4	187.1	259.1	324.1	353.3
25	40.9	62.2	76.9	106.3	154.3	195	270.9	338.8	368.5
50	45.5	69.2	85.5	118.4	172.6	219.5	307.1	384.1	415.3
100	50	76.1	94	130.5	190.7	243.8	343	429	461.8

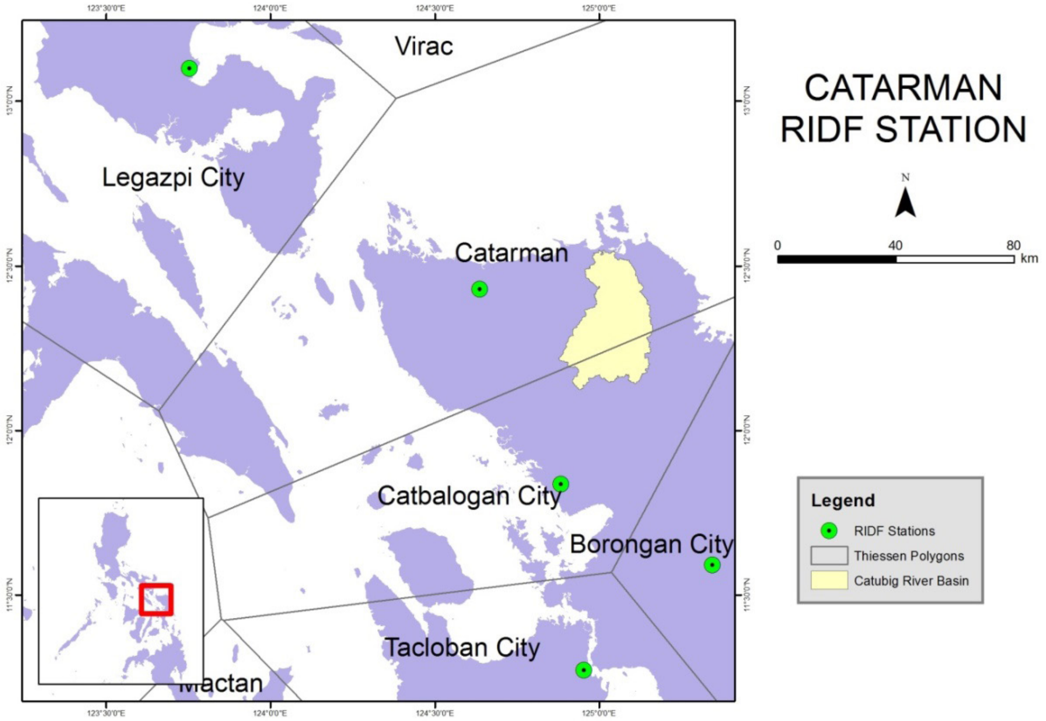


Figure 67. Location of the Catarman RIDF station, relative to the Catubig River Basin

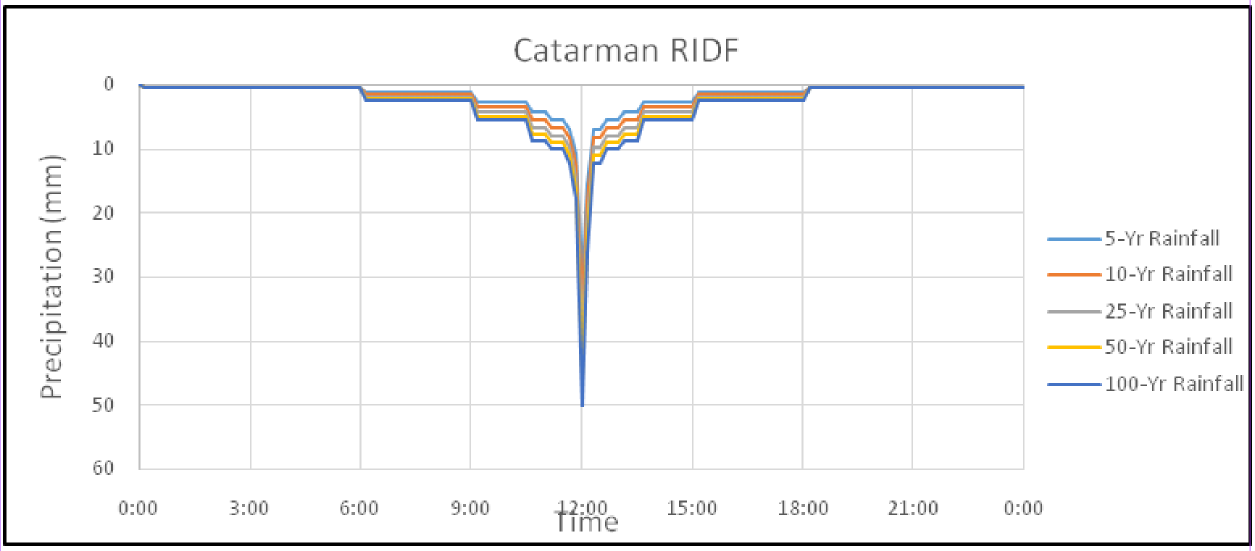


Figure 68. Synthetic storm generated from a 24-hour period rainfall, for various return periods

5.3 HMS Model

The soil shapefile was taken from the Bureau of Soils and Water Management (BSWM) under the Department of Agriculture (DA). The land cover dataset is from the National Mapping and Resource information Authority (NAMRIA). These soil datasets were taken before 2004. The soil and land cover maps of the Catubig River Basin are presented in Figures 69 and 70, respectively.

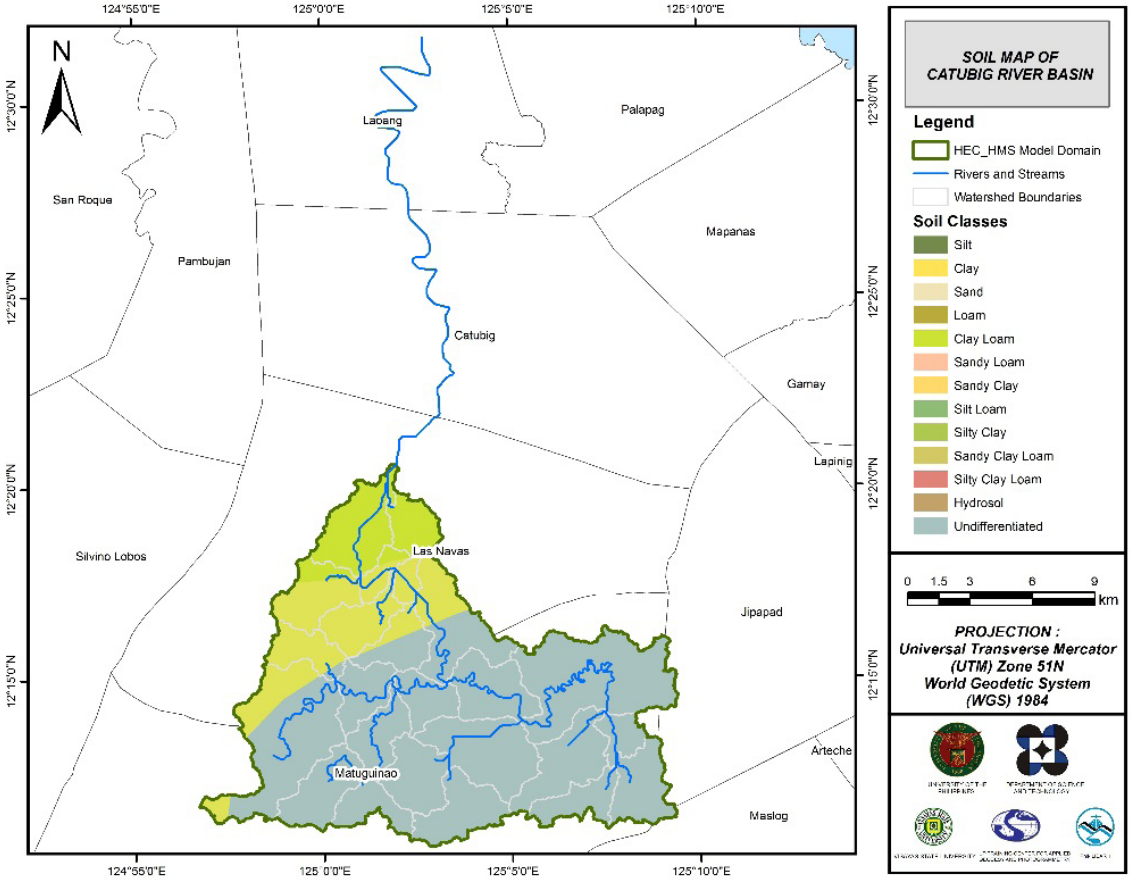


Figure 69. Soil map of the Catubig River Basin (Source: DA)

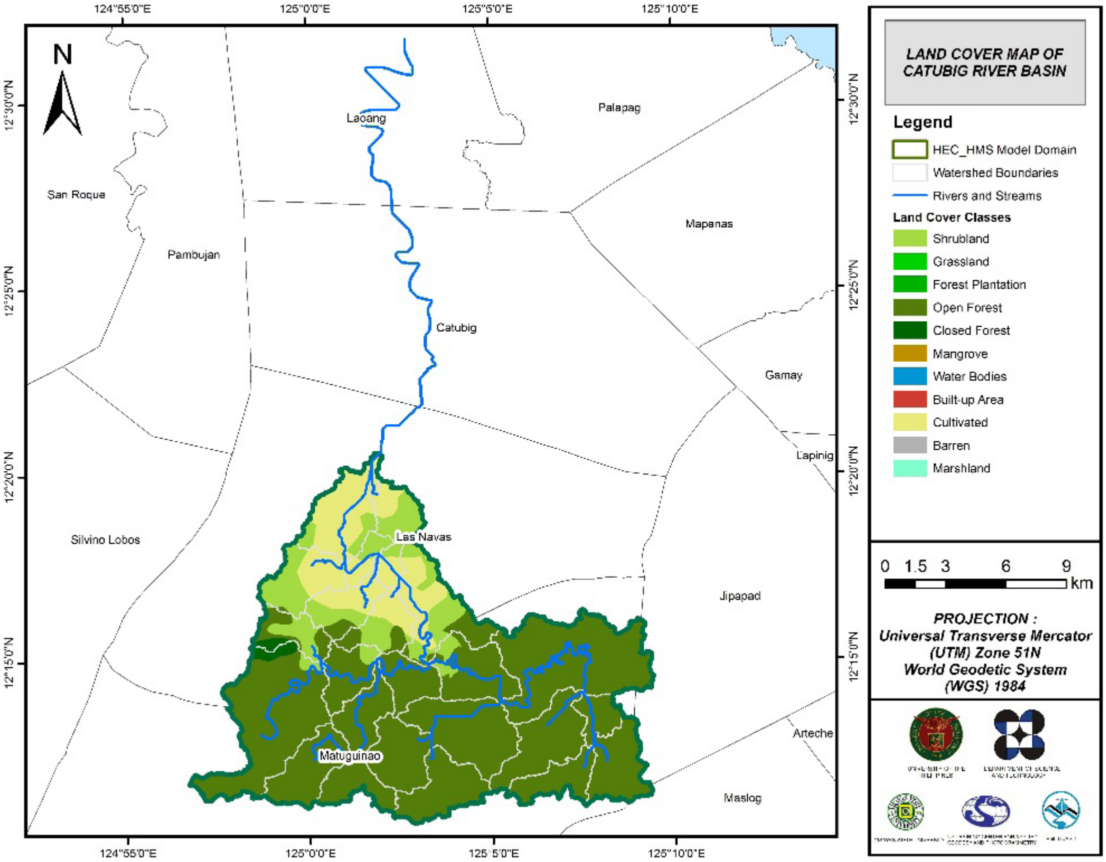


Figure 70. Land cover map of the Catubig River Basin (Source: NAMRIA)

The soil classes identified in the Catubig River Basin were clay, clay loam, and undifferentiated soil. The land cover types identified were shrub lands, open forests, closed forests, and cultivated land.

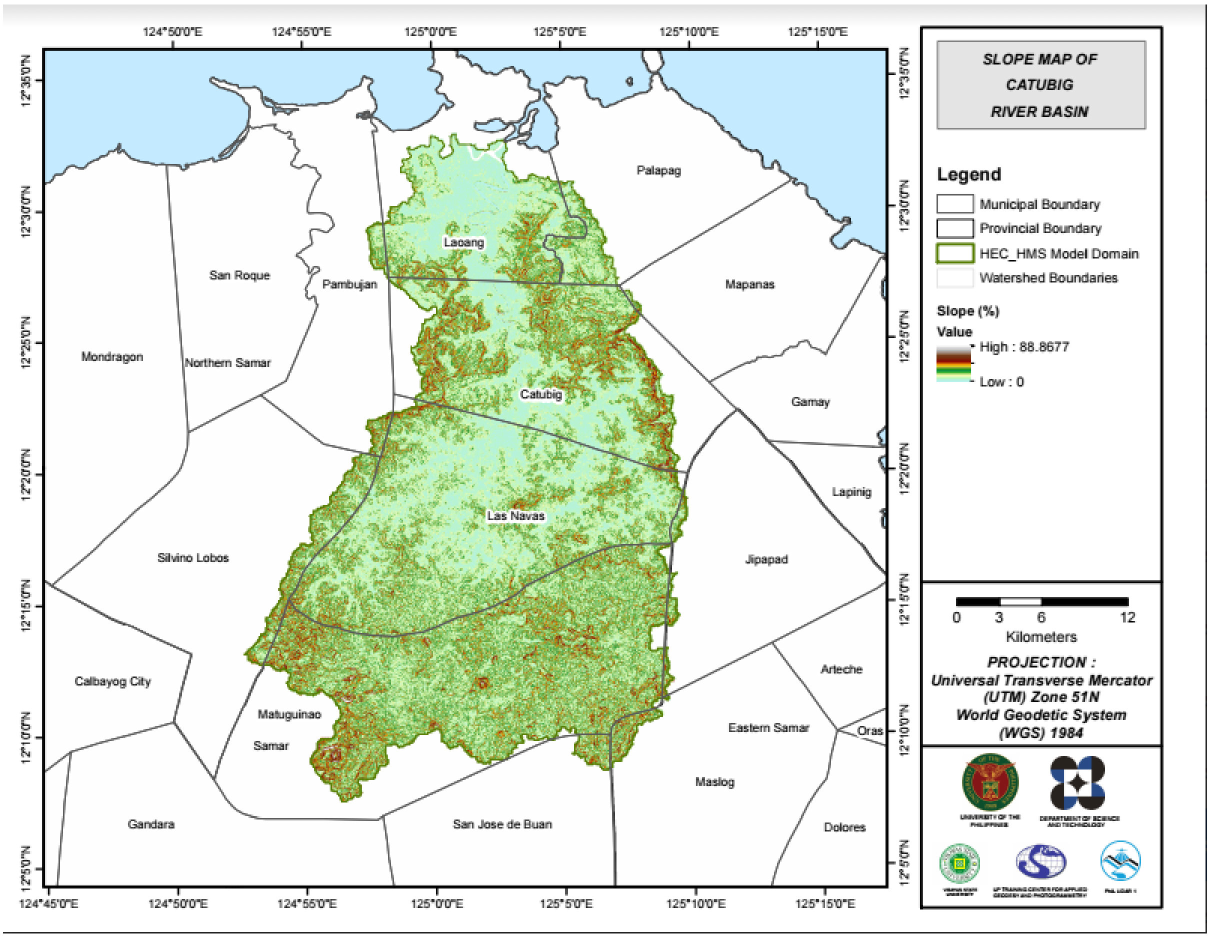


Figure 71. Slope map of the Catubig River Basin

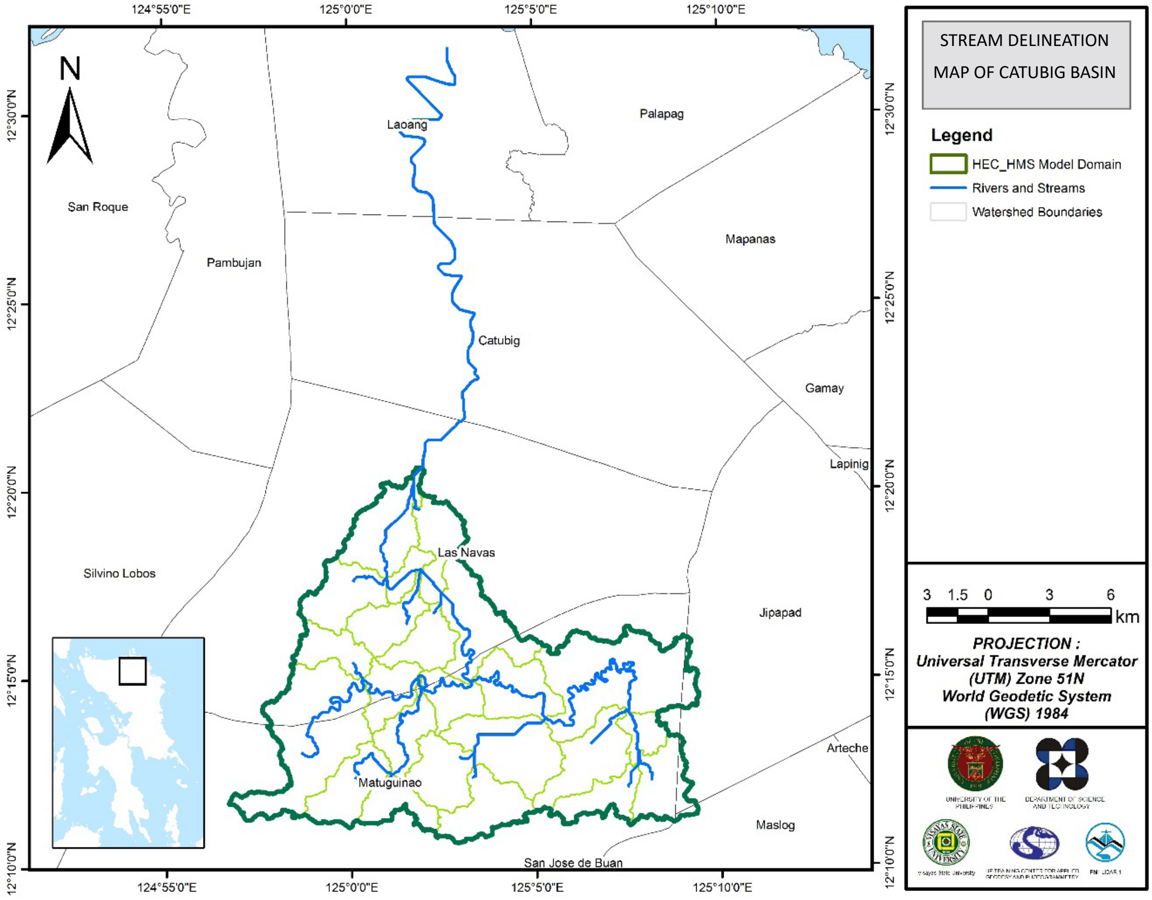


Figure 72. Stream delineation Map of Catubig River Basin

Catubig Bridge

Using the SAR-based DEM, the Catubig basin was delineated and further subdivided into sub-basins. The model consists of twenty-five (25) sub-basins, twelve (12) reaches, and twelve (12) junctions, as illustrated in Figure 73. The main outlet is at the Catubig Bridge. See Annex 10 for the Catubig Model Reach Parameters.

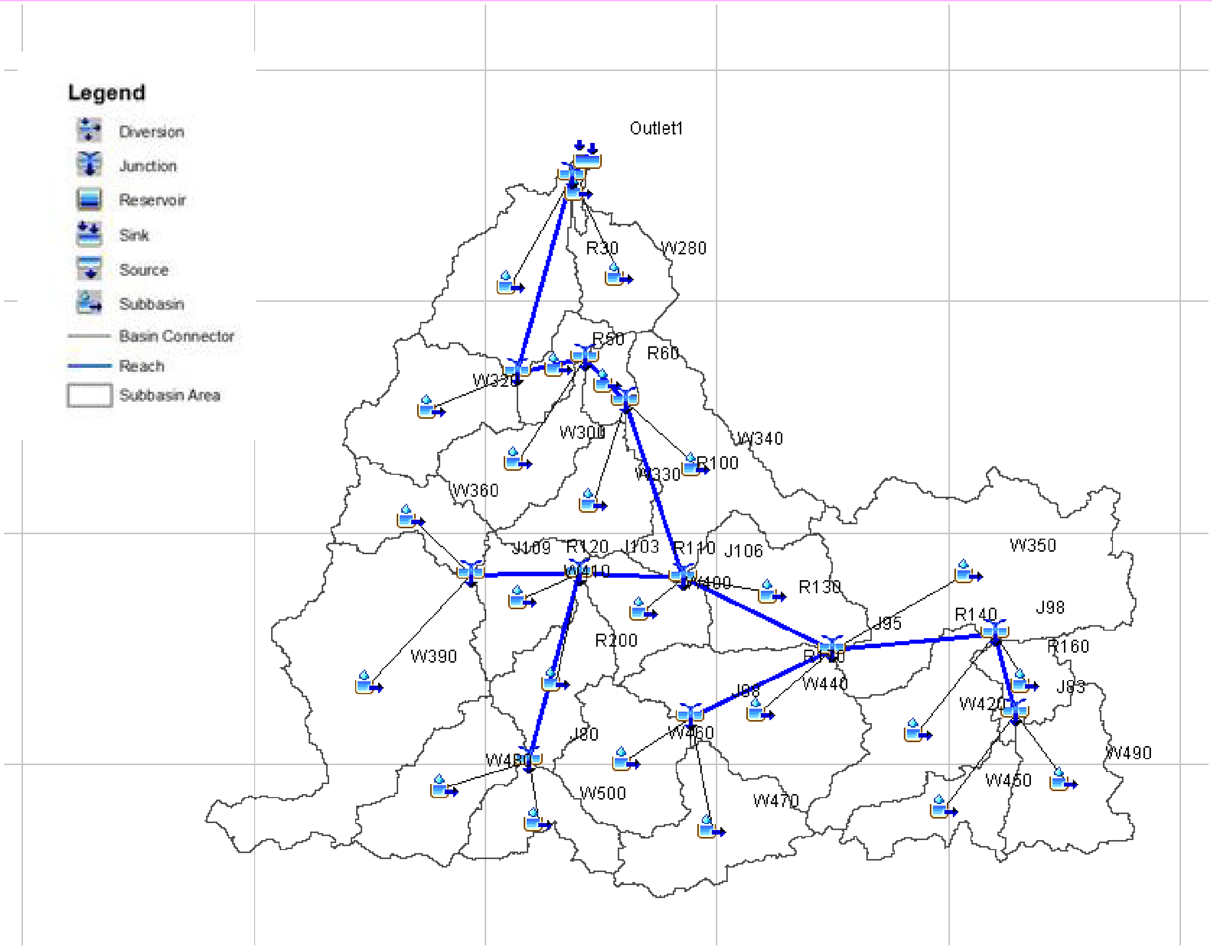


Figure 73. The Catubig River Basin model, generated using HEC-HMS

5.4 Cross-section Data

Riverbed cross-sections of the watershed were necessary in the HEC-RAS model set-up. The cross-section data for the HEC-RAS model were derived from the LiDAR DEM data. These were defined using the Arc GeoRAS tool and post-processed in ArcGIS (Figure 74).

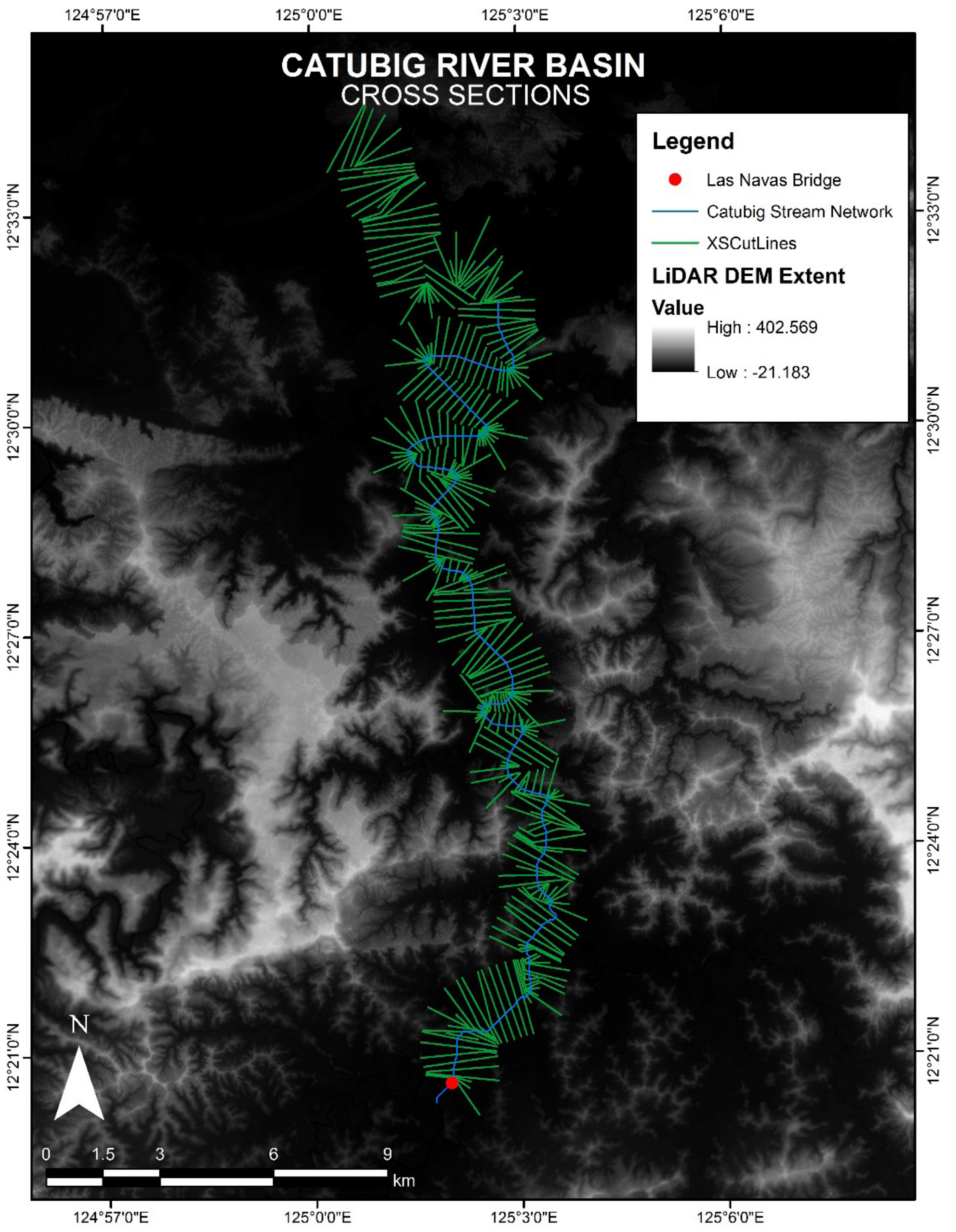


Figure 74. River cross-section of the Catubig River, generated through the ArcMap HEC GeoRAS tool

5.5 Flo 2D Model

The automated modeling 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 meters by 10 meters in size. Each element was assigned a unique grid element number, which served as its identifier. The elements were then attributed with the parameters required for modeling, such as x- and y- coordinates of centroid, names of adjacent grid elements, Manning's coefficient of roughness, infiltration, and elevation values. The elements were arranged spatially to form the model, allowing the software to simulate the flow of water across the grid elements in eight (8) directions (i.e., north, south, east, west, northeast, northwest, southeast, and southwest).

Based on the elevation and flow direction, it was observed that the water will generally flow from the south 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.

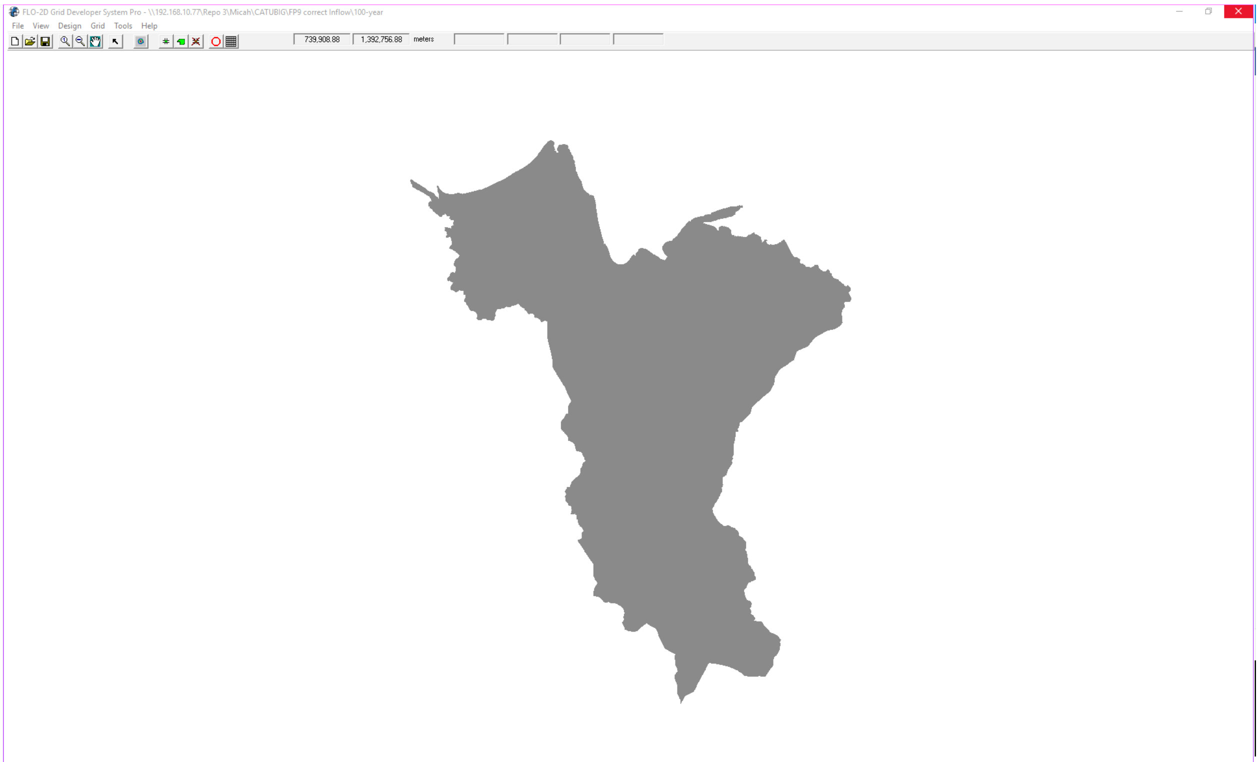


Figure 75. A screenshot of a sub-catchment, with the computational area to be modeled in the FLO-2D GDS Pro

The simulation was then run through the FLO-2D GDS Pro. This particular model had a computer run time of 79.87109 hours. After the simulation, the FLO-2D Mapper Pro was utilized to transform the simulation results into spatial data that shows the 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 generated the flood hazard map. Most of the default values given by the FLO-2D Mapper Pro were used, except for those in the Low hazard level. For this particular level, the minimum h (Maximum depth) was set at 0.2 meters, while the minimum vh (product of maximum velocity (v) and maximum depth (h)) was set at 0 m^2/s.

The creation of a flood hazard map from the model also automatically generated a flow depth map, depicting the maximum amount of inundation for every grid element. The legend used by default in the Flo-2D Mapper was not considered to be a good representation of the range of flood inundation values, so a different legend was used for the layout. In this particular model, the inundated parts covered a maximum land area of 99085920.00 m^2.

There was a total of 74222659.77 m^3 of water that entered the model. Of this amount, 27389593.99 m^3 was due to rainfall, while 46833065.78 m^3 was inflow from other areas outside the model. 14963672.00 m^3 of this water was lost to infiltration and interception, while 47964971.16 m^3 was stored by the floodplain. The rest, amounting to up to 11294038.50 m^3, was outflow.

5.6 Results of HMS Calibration

After calibrating the Catubig HEC-HMS river basin model, its accuracy was measured against the observed values. Figure 76 depicts the comparison between the two (2) discharge data. The Catubig Model Basin Parameters are available in Annex 9.

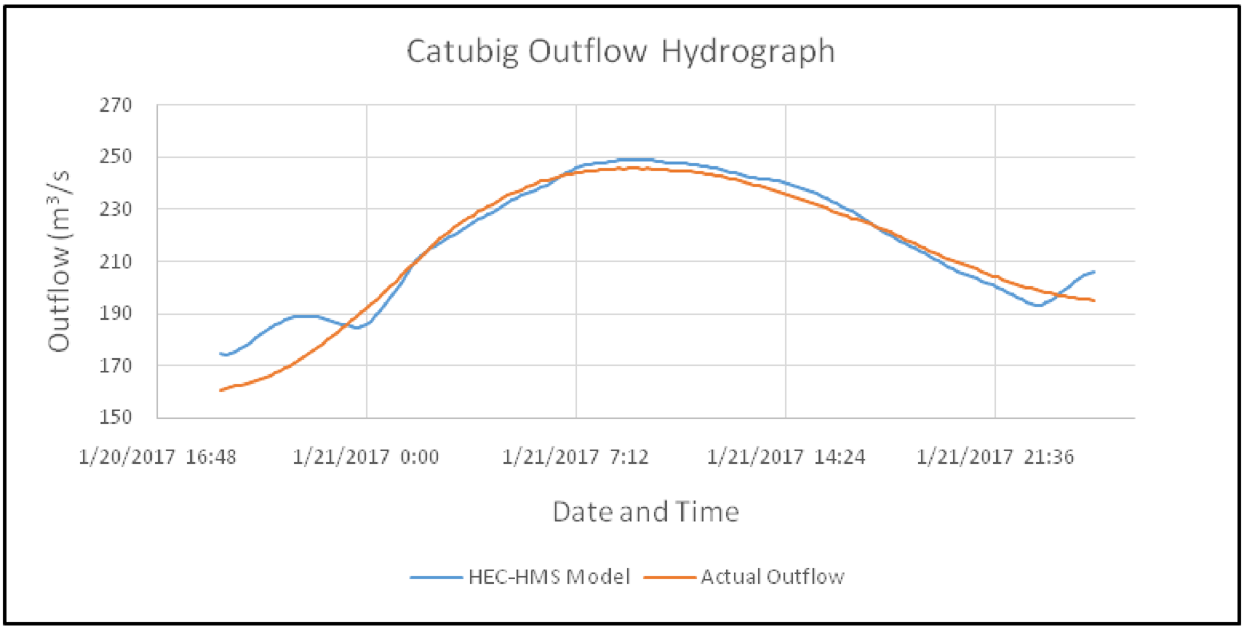


Figure 76. Outflow hydrograph of the Catubig Bridge generated in the HEC-HMS model, compared with observed outflow

Enumerated in Table 34 are the adjusted ranges of values of the parameters used in calibrating the model.

Table 34. Range of calibrated values for the Catubig River Basin model

Hydrologic Element	Calculation Type	Method	Parameter	Range of Calibrated Values
Basin	Loss	SCS Curve number	Initial Abstraction (mm)	6 - 37
			Curve Number	68 - 88
	Transform	Clark Unit Hydrograph	Time of Concentration (hr)	0.2 - 12
			Storage Coefficient (hr)	0.3 - 19
	Baseflow	Recession	Recession Constant	0.4
			Ratio to Peak	0.48
Reach	Routing	Muskingum-Cunge	Manning’s Coefficient	0.04

The initial abstraction defines the amount of precipitation that must fall before surface runoff. The magnitude of the outflow hydrograph increases as the initial abstraction decreases. The range of values from 6 – 37 millimeters for the initial abstraction means that there is a minimal to average amount of infiltration or rainfall interception by vegetation.

The curve number is the estimate of the precipitation excess of soil cover, land use, and antecedent moisture. The magnitude of the outflow hydrograph increases as the curve number increases. A range of 68 - 88 for the curve number is advisable for Philippine watersheds, depending on the soil and land cover of the area (M. Horritt, personal communication, 2012).

The time of concentration and the storage coefficient are the travel time and the index of temporary storage of runoff in a watershed. The range of calibrated values from 0.2 hours to 19 hours determines the reaction time of the model, with respect to the rainfall. The peak magnitude of the hydrograph decreases when these parameters are increased.

The recession constant is the rate at which the baseflow recedes between storm events; and ratio to peak is the ratio of the baseflow discharge to the peak discharge. A recession constant of 0.4 indicates that the basin is unlikely to quickly return to its original discharge, and will be higher instead. A ratio to peak of 0.48 indicates a steeper to average slope of receding limb of the outflow hydrograph.

A Manning's roughness coefficient of 0.04 corresponds to the common roughness of the Catubig watershed, which is determined to be cultivated with mature field crops (Brunner, 2010).

Table 35. Summary of the efficiency test of the Catubig HMS Model

RMSE	6.9
r^2	0.96
NSE	0.94
PBIAS	-0.93
RSR	0.25

The Root Mean Square Error (RMSE) method aggregates the individual differences of these two measurements. It was computed as 6.9 (m3/s).

The Pearson correlation coefficient (r2) assesses the strength of the linear relationship between the observations and the model. A coefficient value close to 1 signifies an almost perfect match of the observed discharge and the resulting discharge from the HEC HMS model. Here, it was measured at 0.96.

The Nash-Sutcliffe (E) method was also used to assess the predictive power of the model. Here, the optimal value is 1. The model attained an efficiency coefficient of 0.94.

A positive Percent Bias (PBIAS) indicates a model's propensity towards under-prediction. Negative values indicate a bias towards over-prediction. The optimal value is 0. In the model, the PBIAS is -0.93.

The Observation Standard Deviation Ratio (RSR) is an error index. A perfect model attains a value of 0 when the error units of the values are quantified. The model has an RSR value of 0.25.

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

5.7.1 Hydrograph using the Rainfall Runoff Model

The summary graph in Figure 77 shows the Catubig outflow using the Catarman RIDF curves in five (5) different return periods (i.e., 5-year, 10-year, 25-year, 50-year, and 100-year rainfall time series), based on the data from PAGASA. The simulation results reveal a significant increase in outflow magnitude as the rainfall intensity increases, for a range of durations and return periods.

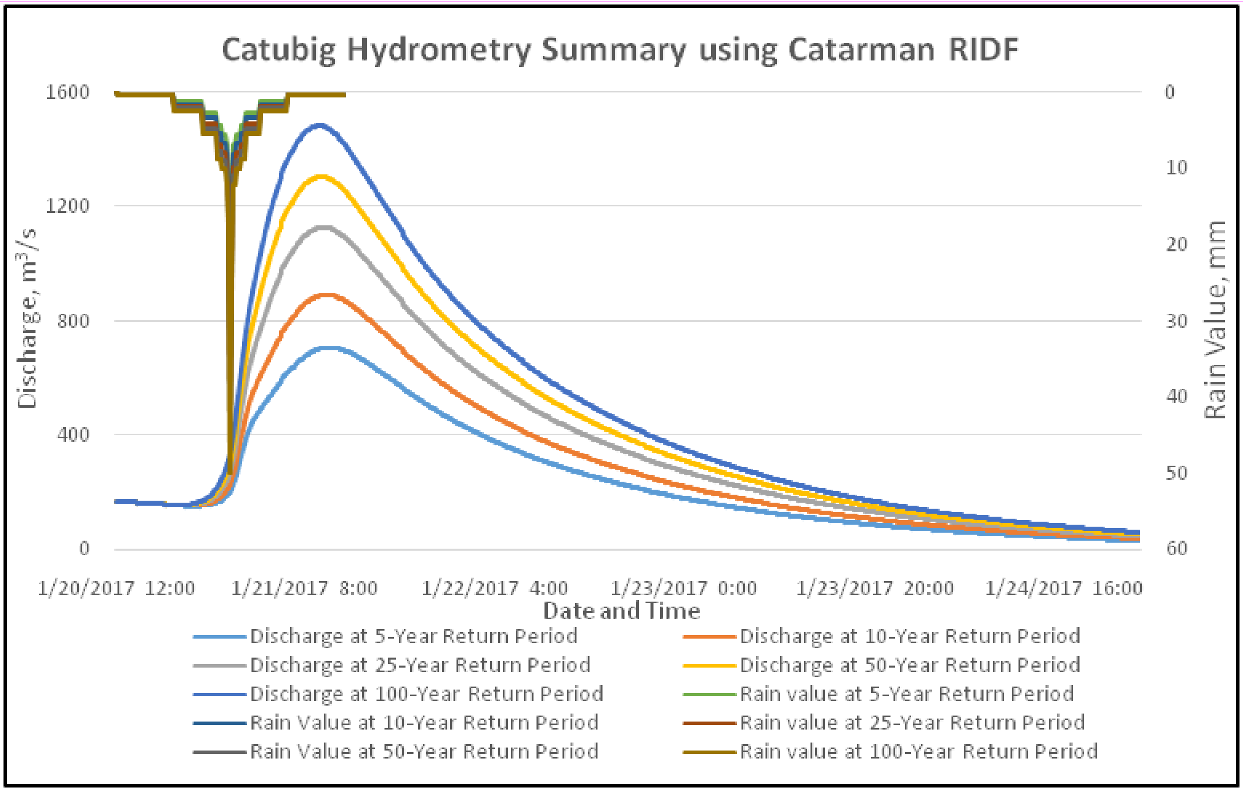


Figure 77. Outflow hydrograph at the Catubig Station generated using the Tacloban RIDF, simulated in HEC-HMS

A summary of the total precipitation, peak rainfall, peak outflow, and time to peak of the Catubig discharge using the Catarman RIDF curves in five (5) different return periods is shown in Table 36.

Table 36. Peak values of the Catubig HEC-HMS Model outflow, using the Tacloban RIDF

RIDF Period	Total Precipitation (mm)	Peak rainfall (mm)	Peak outflow (m3/s)	Time to Peak
5-Year	255.4	29.9	707.8	10 hours, 30 minutes
10-Year	305.4	34.7	891.4	10 hours, 10 minutes
25-Year	368.5	40.9	1127.8	9 hours, 50 minutes
50-Year	415.3	45.5	1304.9	9 hours, 40 minutes
100-Year	461.8	50	1482.7	9 hours, 20 minutes

5.8 River Analysis (RAS) Model Simulation

The HEC-RAS flood model produced a simulated water level at every cross-section, for every time step, for every flood simulation created. The resulting model will be used in determining the flooded areas within the model. The simulated model will be an integral part in determining the extent of the real-time flood inundation of the river, after it has been automated and uploaded on the DREAM website. For this publication, only a sample output map river is presented, since only the VSU-FMC base flow was calibrated. The sample generated map of the Catubig River using the calibrated HMS base flow is provided in Figure 78.

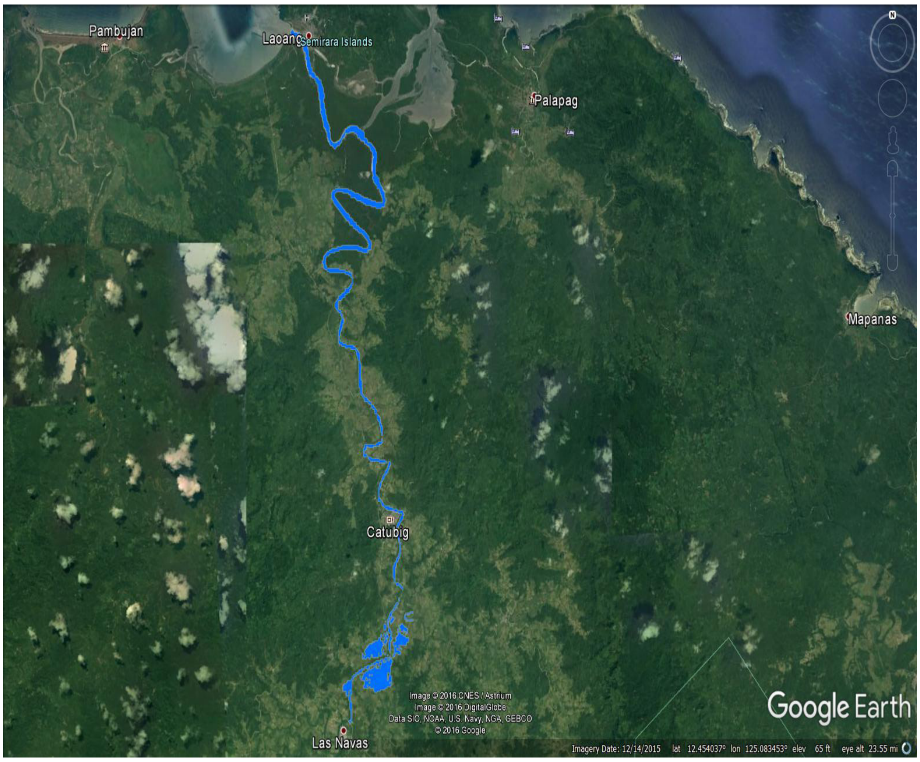


Figure 78. Sample output map of the Catubig RAS Model

5.9 Flow Depth and Flood Hazard

The resulting flood hazard and flow depth maps for the 5-year, 25-year, and 100-year rain return scenarios of the Catubig floodplain are exhibited in Figures 79 to 84. The floodplain, with an area of 371.89 square kilometers, covers nine (9) municipalities; namely, Jipapad, Catubig, Laoang, Las Navas, Mapanas, Palapag, Pambujan, Silvino Lobos and Sablayan. Table 37 specifies the percentage of area affected by flooding per municipality.

Table 37. Municipalities affected in the Catubig floodplain

Municipality	Total Area	Area Flooded	% Flooded
Jipapad	173.29	1.57	0.90%
Catubig	217.59	174.68	80.28%
Laoang	207.60	118.88	57.26%
Las Navas	267.47	235.92	88.20%
Mapanas	143.56	42.04	29.29%
Palapag	153.46	137.13	89.36%
Pambujan	150.63	7.82	5.19%
Silvino Lobos	255.34	18.45	7.22%
Matuguinao	368.83	4.78	1.30%

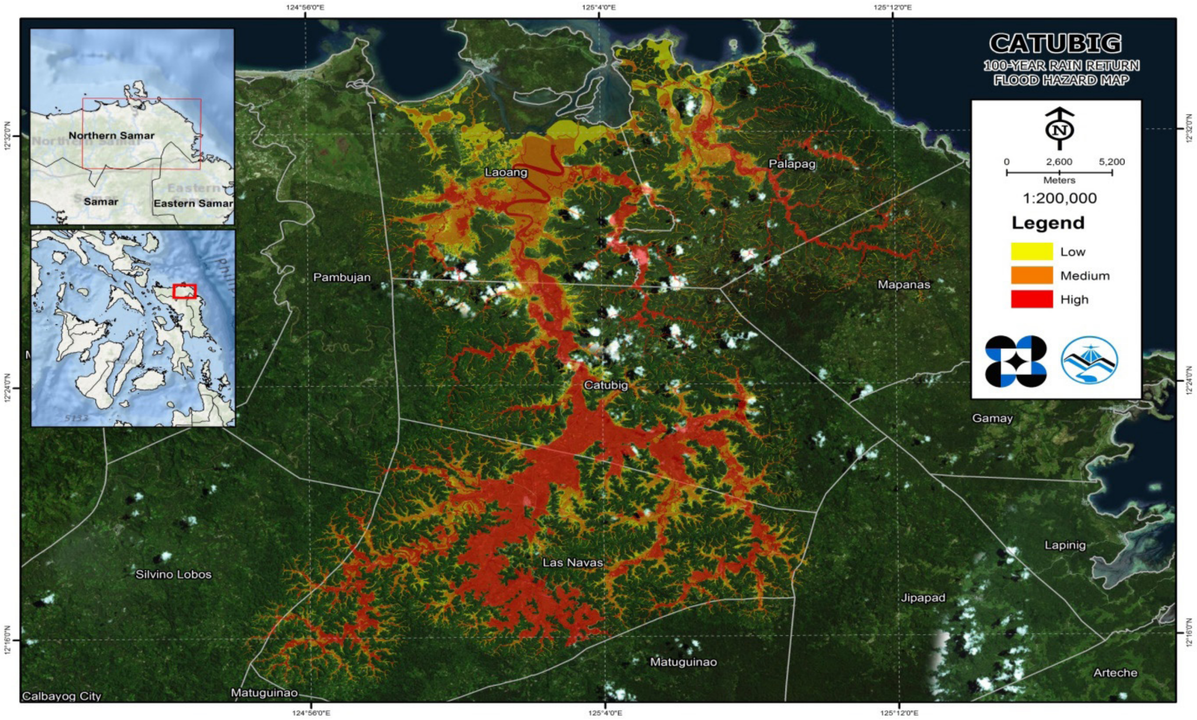


Figure 79. 100-year flood hazard map for the Catubig floodplain

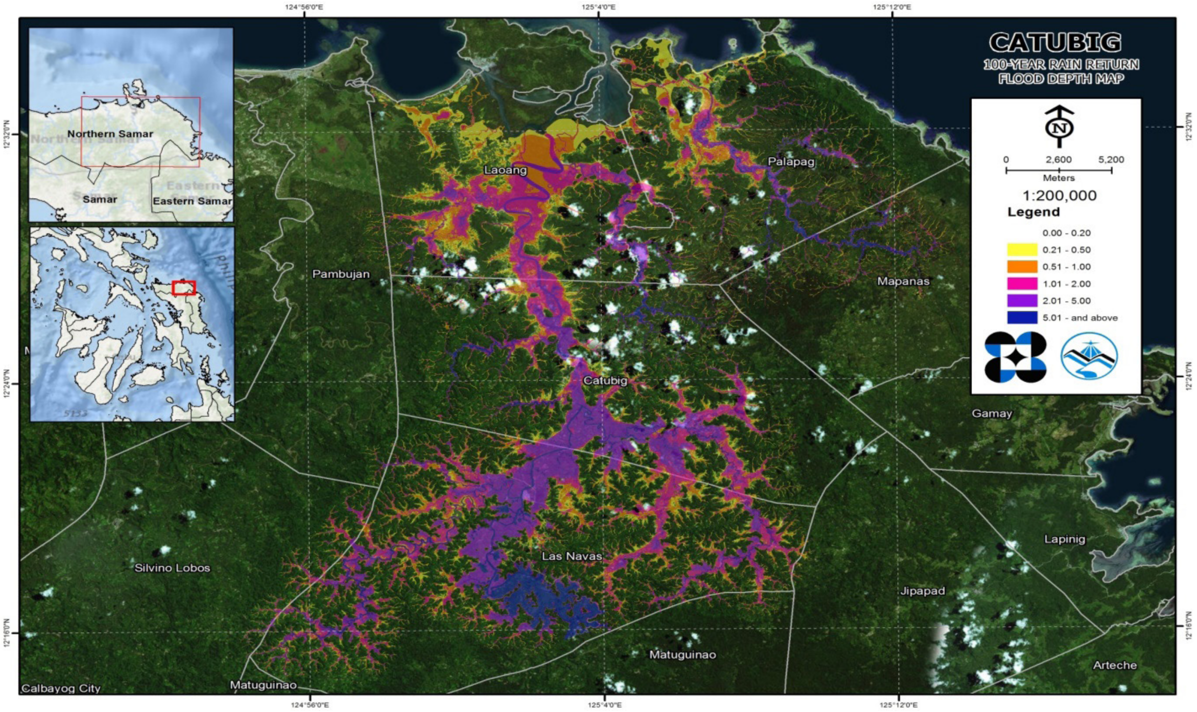


Figure 80. 100-year flow depth map for the Catubig floodplain

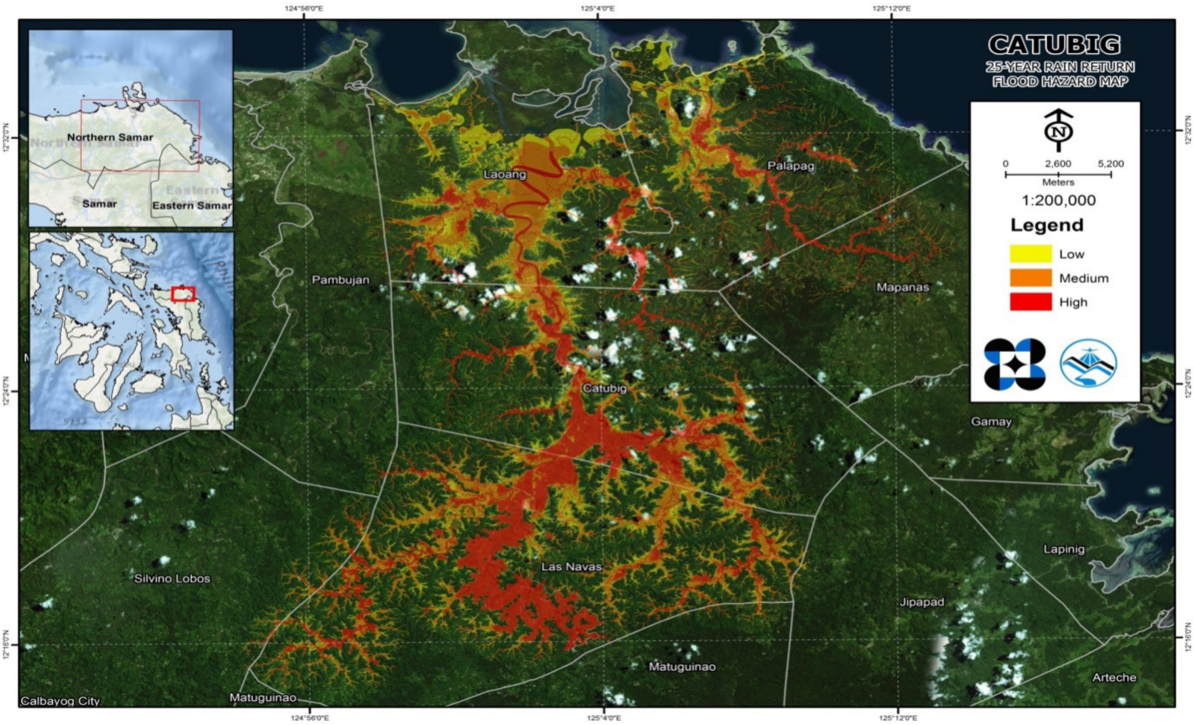


Figure 81.25-year flood hazard map for the Catubig floodplain

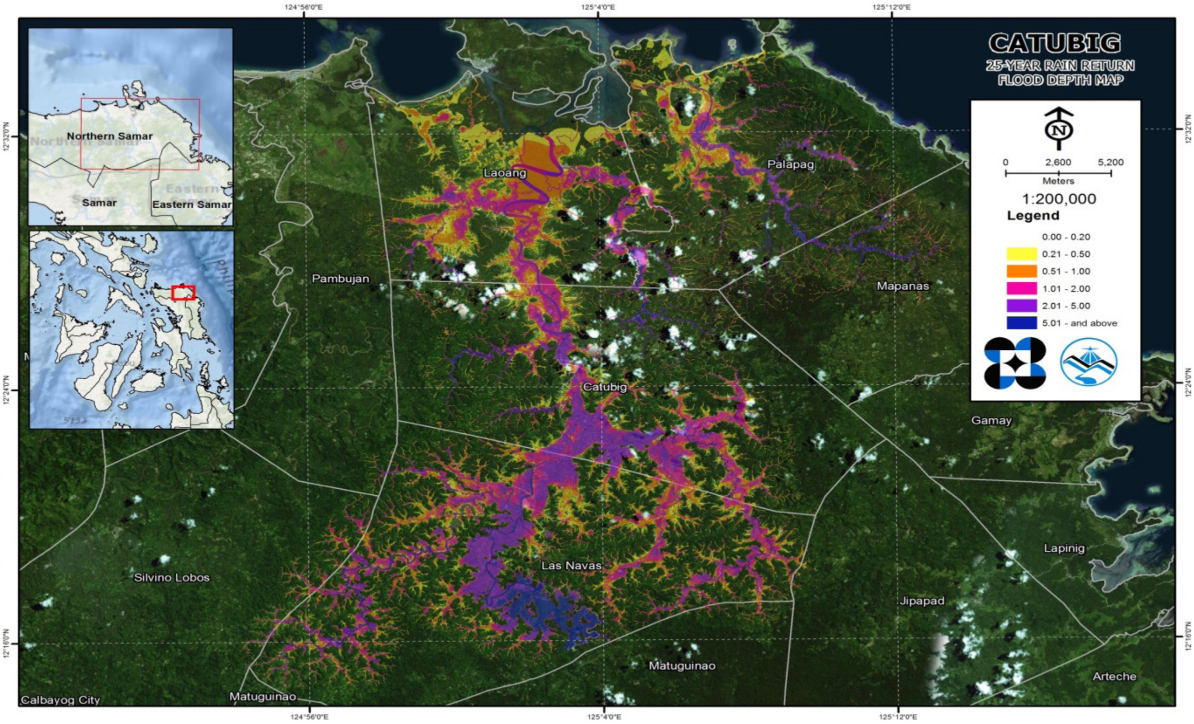


Figure 82. 25-year flow depth map for the Catubig floodplain

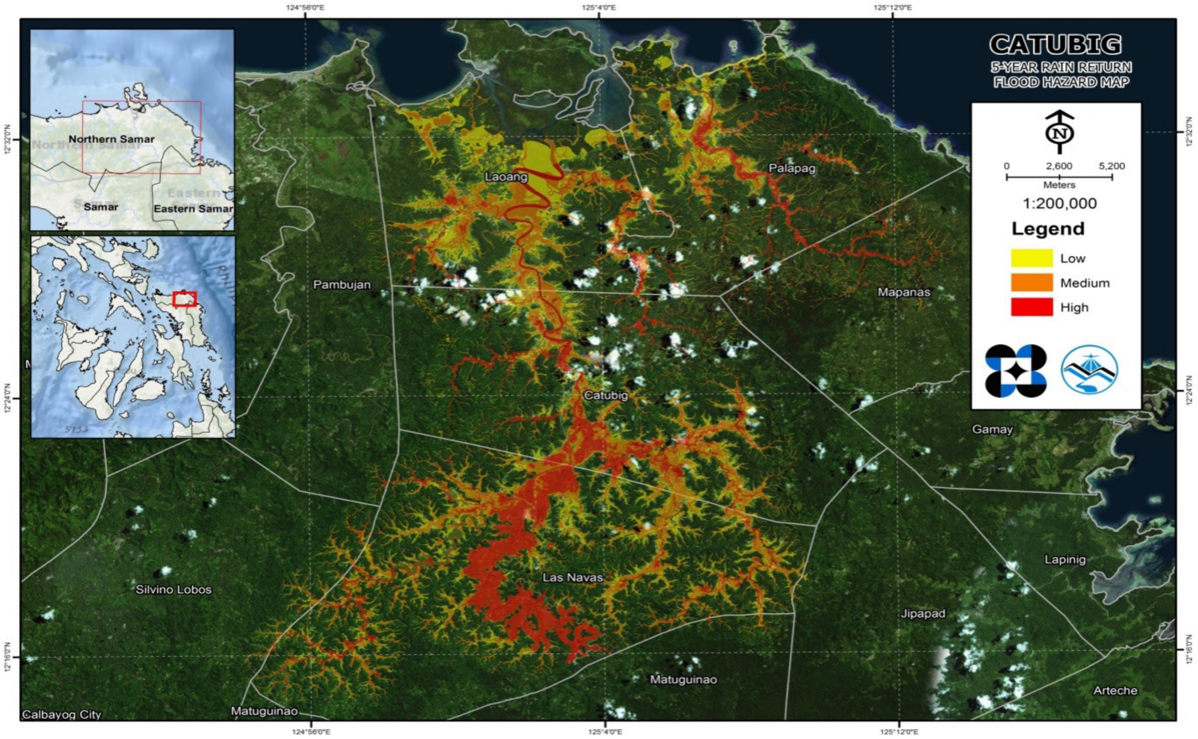


Figure 83. 5-year flood hazard map for the Catubig floodplain

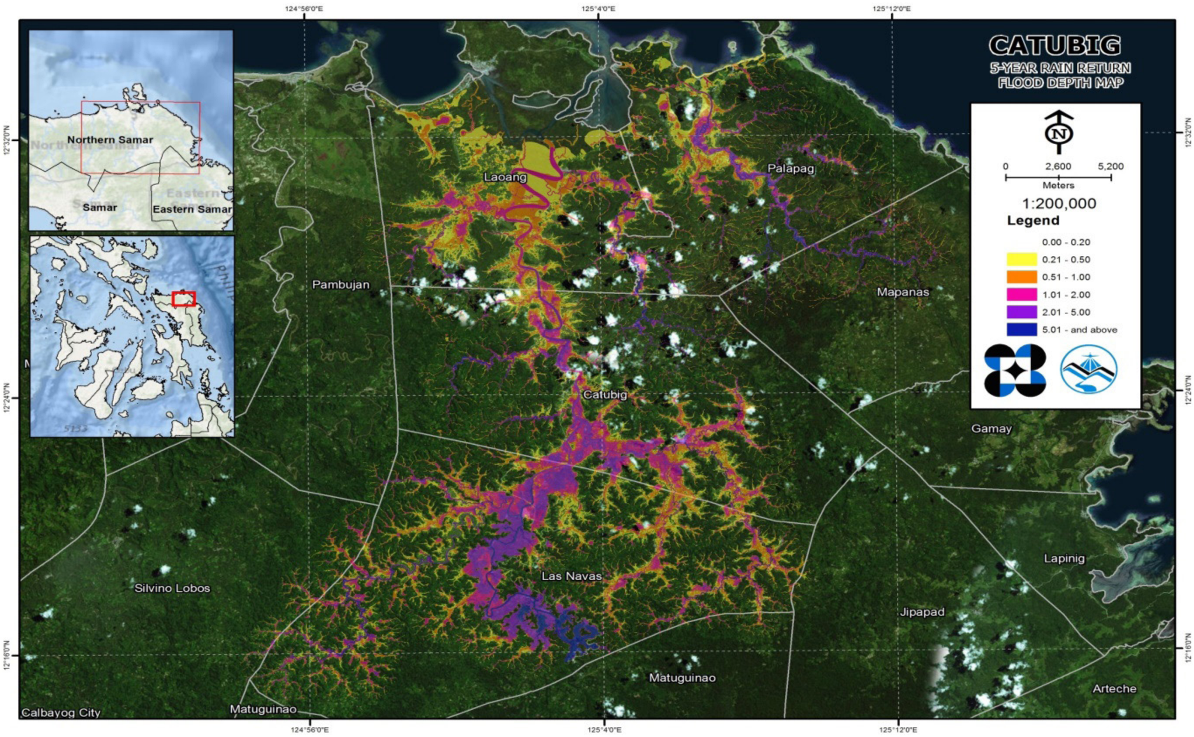


Figure 84. 5-year flow depth map for the Catubig floodplain

5.10 Inventory of Areas Exposed to Flooding of Affected Areas

Listed below are the barangays affected in the Catubig River Basin, grouped accordingly by municipality. For the said basin, nine (9) municipalities consisting of one hundred and seventy-two (172) barangays are expected to experience flooding when subjected to a 5-year rainfall return period.

For the 5-year return period, 0.81% of the Municipality of Jipapad, with an area of 173.29 square kilometers, will experience flood levels of less than 0.20 meters; while 0.05% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 0.04%, 0.01%, 0.0001%, 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. Table 38 depicts the areas affected in Jipapad, in square kilometers, by flood depth per barangay.

Table 38. Affected areas in Jipapad, Eastern Samar during a 5-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Jipapad (in sq. km.)**	
	Cagmanaba	San Roque
0.03-0.20	0.81	0.59
0.21-0.50	0.041	0.05
0.51-1.00	0.035	0.03
1.01-2.00	0.014	0.0038
2.01-5.00	0.0002	0
> 5.00	0.095	0

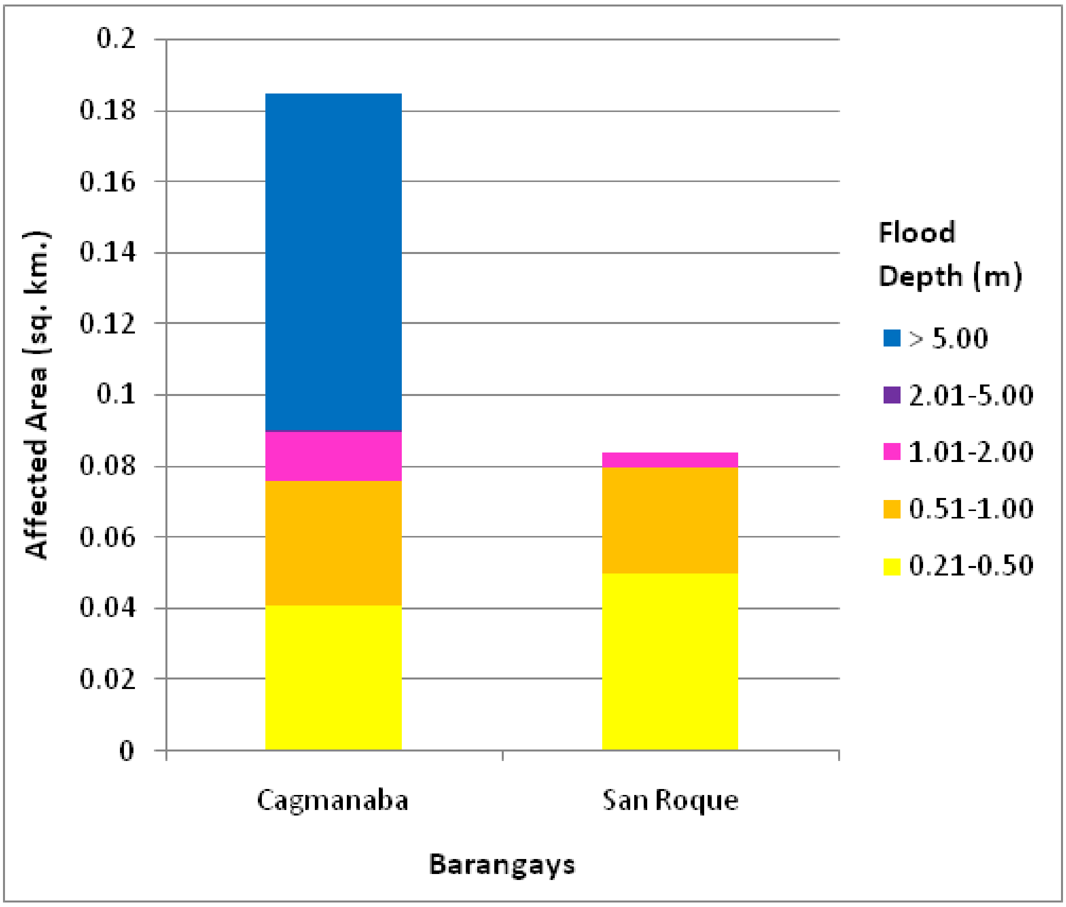


Figure 85. Affected areas in Jipapad, Eastern Samar during a 5-year rainfall return period

For the Municipality of Catubig, with an area of 217.59 square kilometers, 53.63% will experience flood levels of less than 0.20 meters. 4.93% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 5.79%, 6.32%, 3.39%, and 0.44% 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. Tables 39-43 depict the affected areas, in square kilometers, by flood depth per barangay.

Table 39. Affected areas in Catubig, Northern Samar during a 5-year rainfall return period

Affected area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Catubig (in sq. km.)**								
	Anongo	Barangay 1	Barangay 2	Barangay 3	Barangay 4	Barangay 5	Barangay 6	Barangay 7	Barangay 8
0.03-0.20	2.82	0.49	0.055	0.018	0.019	0.025	0.024	0.018	0.012
0.21-0.50	0.73	0.081	0.019	0.012	0.012	0.0087	0.0059	0.0084	0.0033
0.51-1.00	1.3	0.039	0.02	0.0011	0	0	0	0.012	0.0054
1.01-2.00	1.06	0.0082	0.034	0.0014	0.0032	0.0027	0.00011	0.024	0.031
2.01-5.00	0.28	0.00031	0.029	0	0.00057	0.0019	0.0056	0.0098	0.031
> 5.00	0.054	0	0	0	0	0	0	0	0

Table 40. Affected areas in Catubig, Northern Samar during a 5-year rainfall return period

Affected area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Catubig (in sq. km.)**								
	Bonifacio	Boring	Cagbugna	Cagmanaba	Cagogobngan	Calingnan	Canuctan	Claro M. Recto	D. Mercader
0.03-0.20	1.04	0.56	0.35	0.81	1.12	1.29	1.21	7.37	1.38
0.21-0.50	0.3	0.0081	0.13	0.041	0.17	0.25	0.32	0.31	0.092
0.51-1.00	0.68	0.0049	0.14	0.035	0.29	0.2	0.18	0.3	0.081
1.01-2.00	0.83	0.0056	0.12	0.014	0.28	0.26	0.32	0.14	0.1
2.01-5.00	0.13	0.001	0.001	0.0002	0.14	0.11	0.21	0.038	0.095
> 5.00	0	0	0	0.095	0	0	0	0.0019	0

Table 41. Affected areas in Catubig, Northern Samar during a 5-year rainfall return period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Catubig (in sq. km.)								
	Guibwangan	Hinagonoyan	Hiparayan	Hitapi-An	Inoburan	Irawahan	Lenoyahan	Libon	Magongon
0.03-0.20	0.29	1.41	5.78	5.93	0.27	5.46	0.46	0.13	7.64
0.21-0.50	0.099	0.079	0.35	0.35	0.086	0.35	0.42	0.012	0.4
0.51-1.00	0.054	0.074	0.33	0.42	0.21	0.35	0.82	0.047	0.32
1.01-2.00	0.073	0.04	0.24	0.37	0.66	0.4	0.6	0.49	0.48
2.01-5.00	0.062	0.0056	0.19	0.11	0.5	0.52	0.11	0.67	0.35
> 5.00	0	0	0.03	0	0	0.19	0	0	0

Table 42. Affected areas in Catubig, Northern Samar during a 5-year rainfall return period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Catubig (in sq. km.)								
	Magtuad	Manering	Nabulo	Nagoocan	Nahulid	Opong	Osang	Osmeña	P. Rebadulla
0.03-0.20	0.88	11.7	2.12	1.5	0.17	13.99	2.33	0.71	9.51
0.21-0.50	0.12	0.35	0.076	0.2	0.062	1.23	0.15	0.21	0.33
0.51-1.00	0.15	0.19	0.078	0.38	0.11	0.87	0.12	0.42	0.24
1.01-2.00	0.66	0.23	0.086	0.2	0.6	0.6	0.1	0.95	0.17
2.01-5.00	0.43	0.44	0.026	0.038	0.17	0.29	0.025	0.22	0.18
> 5.00	0	0.27	0	0.0012	0.00052	0	0	0.029	0.15

Table 43. Affected areas in Catubig, Northern Samar during a 5-year rainfall return period

Affected area (sq. km.) by flood depth (in m.)	Area of affected barangays in Catubig (in sq. km.)										
	Roxas	Sagudsuron	San Antonio	San Francisco	San Jose	San Vicente	Santa Fe	Sulitan	Tangbo	Tungodnon	Vienna Maria
0.03-0.20	6.19	2.13	2.65	6.5	2.19	0.85	1.37	0.54	3.42	1.2	0.77
0.21-0.50	0.39	0.16	0.59	0.37	0.27	0.15	0.33	0.047	0.86	0.082	0.096
0.51-1.00	0.55	0.12	0.91	0.37	0.4	0.37	0.25	0.096	0.85	0.053	0.15
1.01-2.00	0.32	0.2	0.7	0.27	0.39	0.3	0.087	0.28	0.62	0.084	0.31
2.01-5.00	0.18	0.11	0.25	0.045	0.12	0.084	0.04	0.48	0.36	0.016	0.28
> 5.00	0.0032	0	0.073	0.001	0.0062	0.046	0.015	0	0	0	0

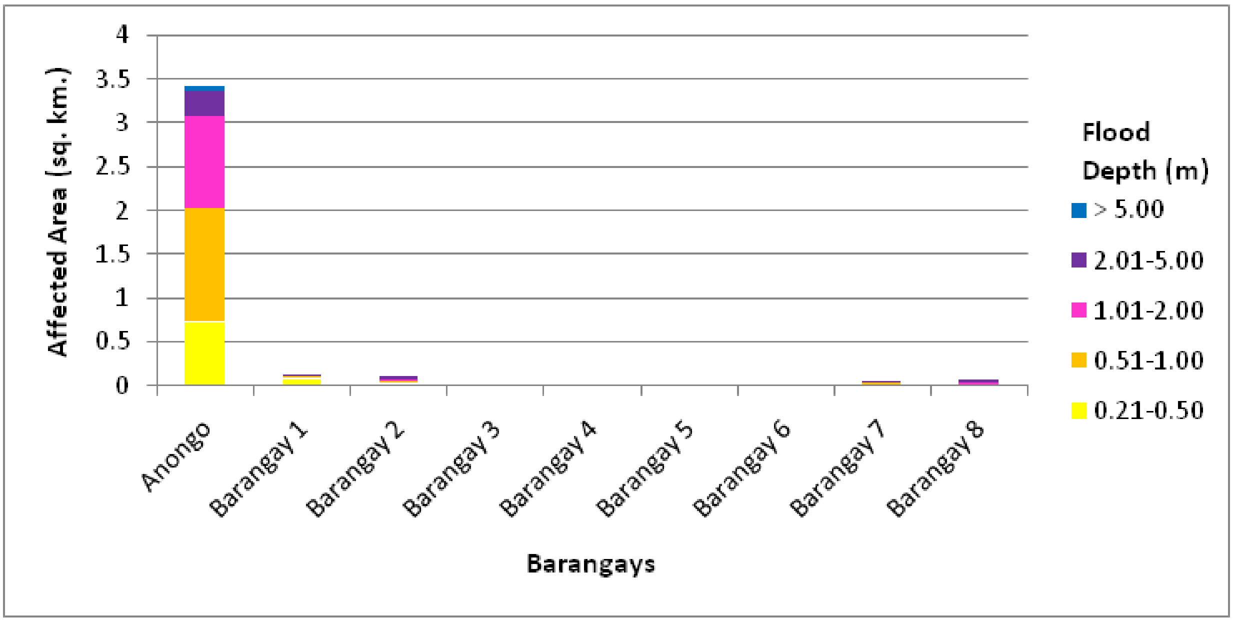


Figure 86. Affected areas in Catubig, Northern Samar during a 5-year rainfall return period

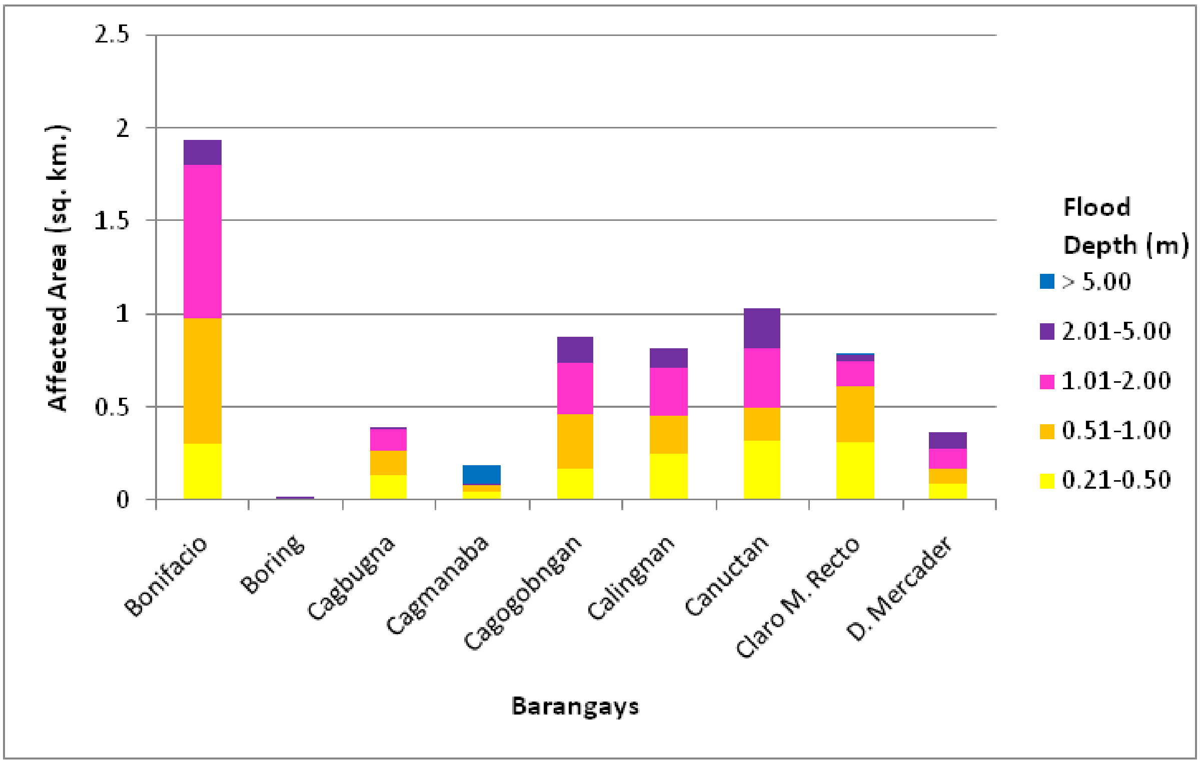


Figure 87. Affected areas in Catubig, Northern Samar during a 5-year rainfall return period

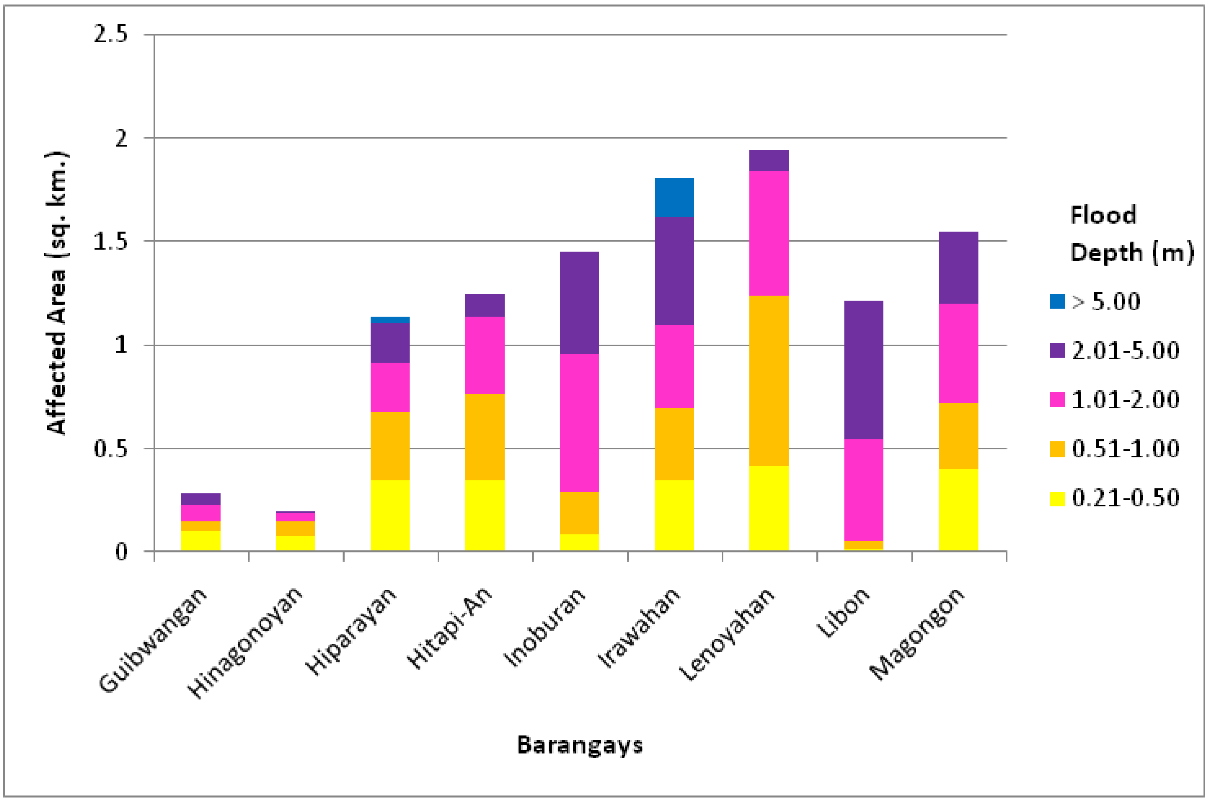


Figure 88. Affected areas in Catubig, Northern Samar during a 5-year rainfall return period

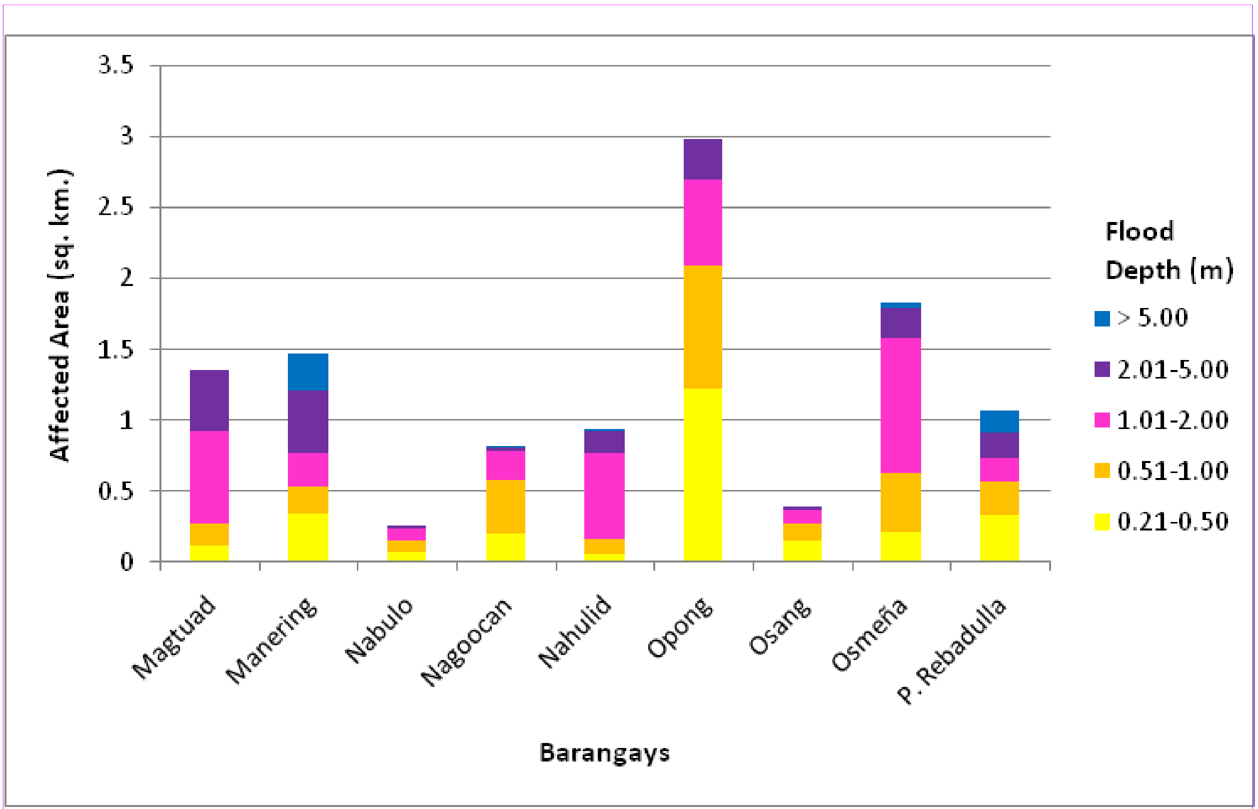


Figure 89. Affected areas in Catubig, Northern Samar during a 5-year rainfall return period

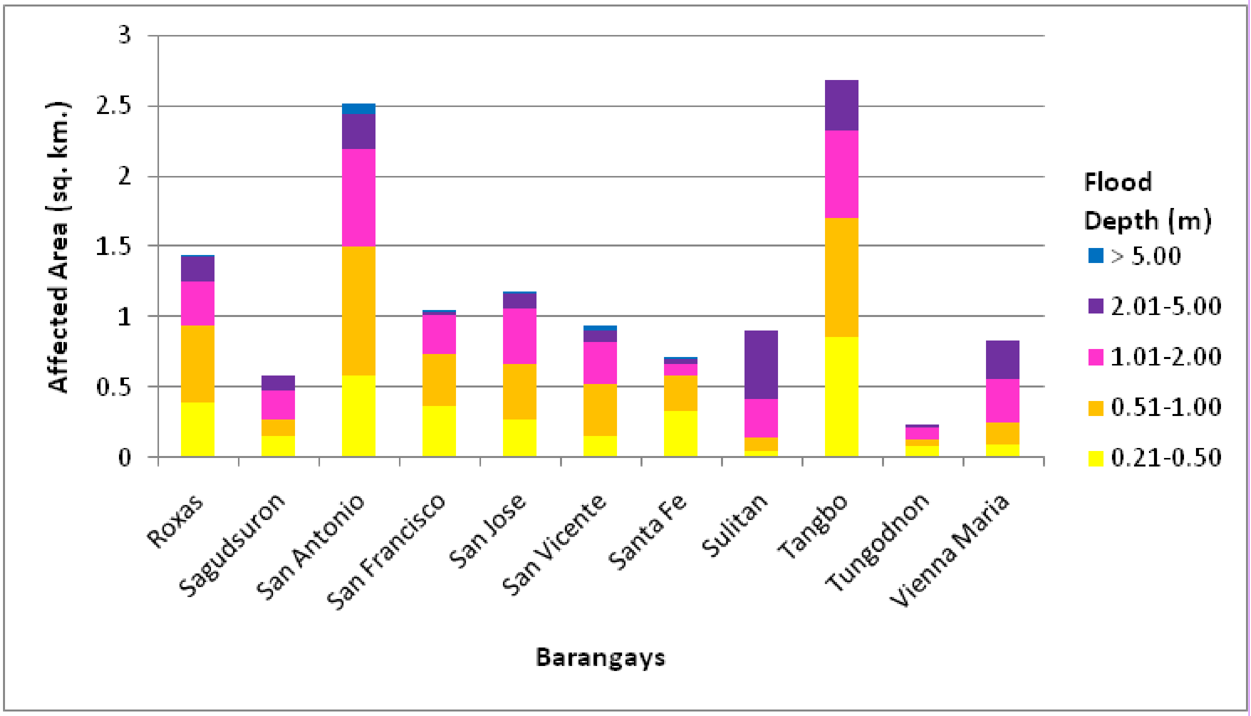


Figure 90. Affected areas in Catubig, Northern Samar during a 5-year rainfall return period

For the Municipality of Laoang, with an area of 207.60 square kilometers, 35.70% will experience flood levels of less than 0.20 meters. 10.11% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 7.49%, 4.39%, 0.85%, 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. Tables 44-47 depict the affected areas, in square kilometers, by flood depth per barangay.

Table 44. Affected areas in Laoang, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Laoang (in sq. km.)**						
	Abaton	Atipolo	Bawang	Bobolosan	Bongliw	Burabud	Cabagngan
0.03-0.20	7.19	3.02	3.28	2.27	2.22	1.34	3.19
0.21-0.50	1.07	0.94	1.09	0.69	2.12	0.37	1.09
0.51-1.00	1.35	0.27	1.57	0.38	1.47	0.25	0.8
1.01-2.00	0.62	0.2	0.81	0.28	0.85	0.029	0.16
2.01-5.00	0.095	0.0011	0.0019	0	0	0.0002	0.058
> 5.00	0.0036	0	0	0	0	0	0.012

Table 45. Affected areas in Laoang, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Laoang (in sq. km.)**						
	Cabago-An	Cabulaloan	Cagdara-O	Cangcahipos	Catigbian	E. J. Dulay	Gibatangan
0.03-0.20	2.06	0.74	2.39	2.81	2.06	3.48	1.58
0.21-0.50	0.99	0.88	0.15	0.63	0.52	0.19	0.11
0.51-1.00	0.57	0.82	0.15	0.57	0.33	0.29	0.12
1.01-2.00	0.064	0.55	0.21	0.25	0.5	0.16	0.12
2.01-5.00	0.0051	0.095	0.065	0.0096	0.063	0.11	0.14
> 5.00	0	0.0052	0.0032	0	0	0.033	0.029

Table 46. Affected areas in Laoang, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Laoang (in sq. km.)**						
	La Perla	Lawaan	Oleras	Palmera	Rawis	Rombang	San Antonio
0.03-0.20	1.27	4.84	5.33	1.14	2.11	4.31	2.65
0.21-0.50	0.43	1.93	0.59	0.066	0.49	0.38	0.59
0.51-1.00	0.89	0.38	0.38	0.04	0.12	0.45	0.91
1.01-2.00	0.81	0.058	0.21	0.019	0.0034	0.42	0.7
2.01-5.00	0.032	0	0.13	0.0016	0	0.13	0.25
> 5.00	0	0	0.019	0	0	0.055	0.073

Table 47. Affected areas in Laoang, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Laoang (in sq. km.)**						
	Sibunot	Simora	Talisay	Tarusan	Tinoblan	Vigo	Yapas
0.03-0.20	3.03	2.36	0.92	1.63	1.72	2.26	2.91
0.21-0.50	0.55	0.57	0.045	2.85	0.32	1.08	0.25
0.51-1.00	0.57	0.75	0.12	0.28	0.67	0.83	0.21
1.01-2.00	0.3	0.27	0	0.19	0.43	0.78	0.13
2.01-5.00	0.089	0.088	0	0	0.25	0.1	0.055
> 5.00	0.0076	0.27	0	0	0.0095	0	0

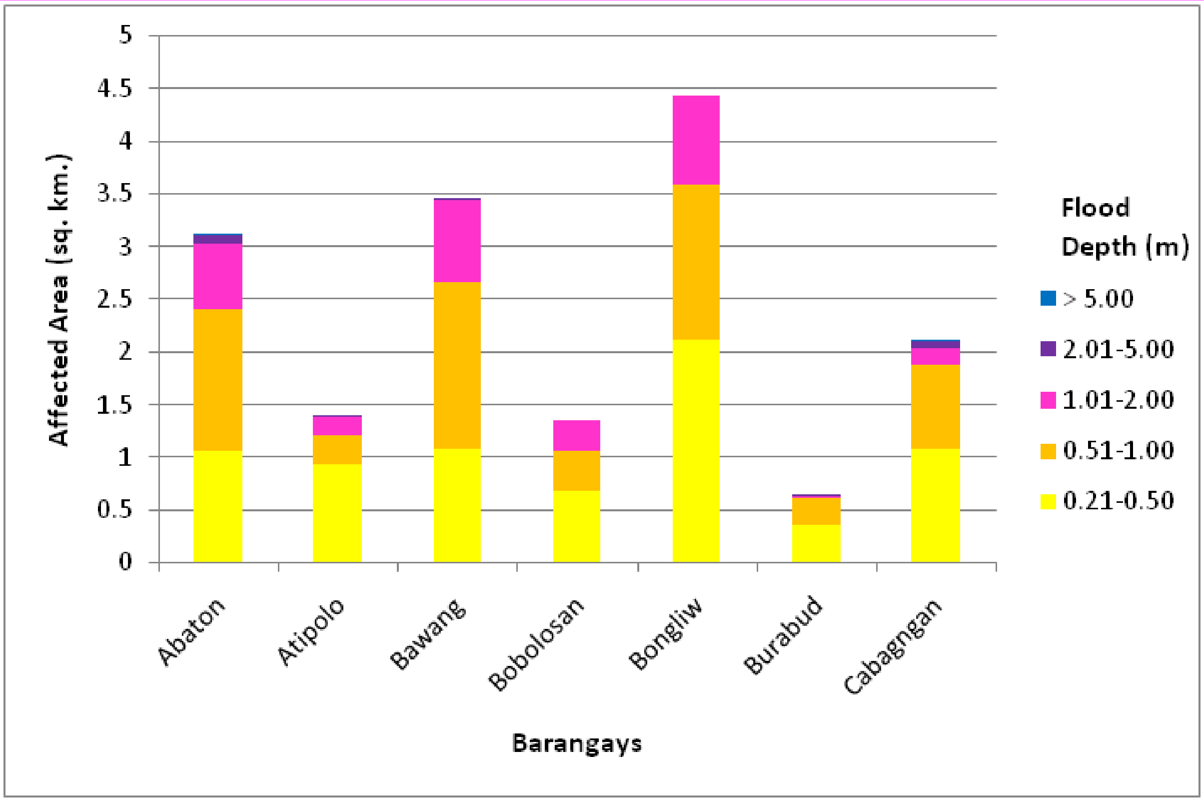


Figure 91. Affected areas in Laoang, Northern Samar during a 5-year rainfall return period

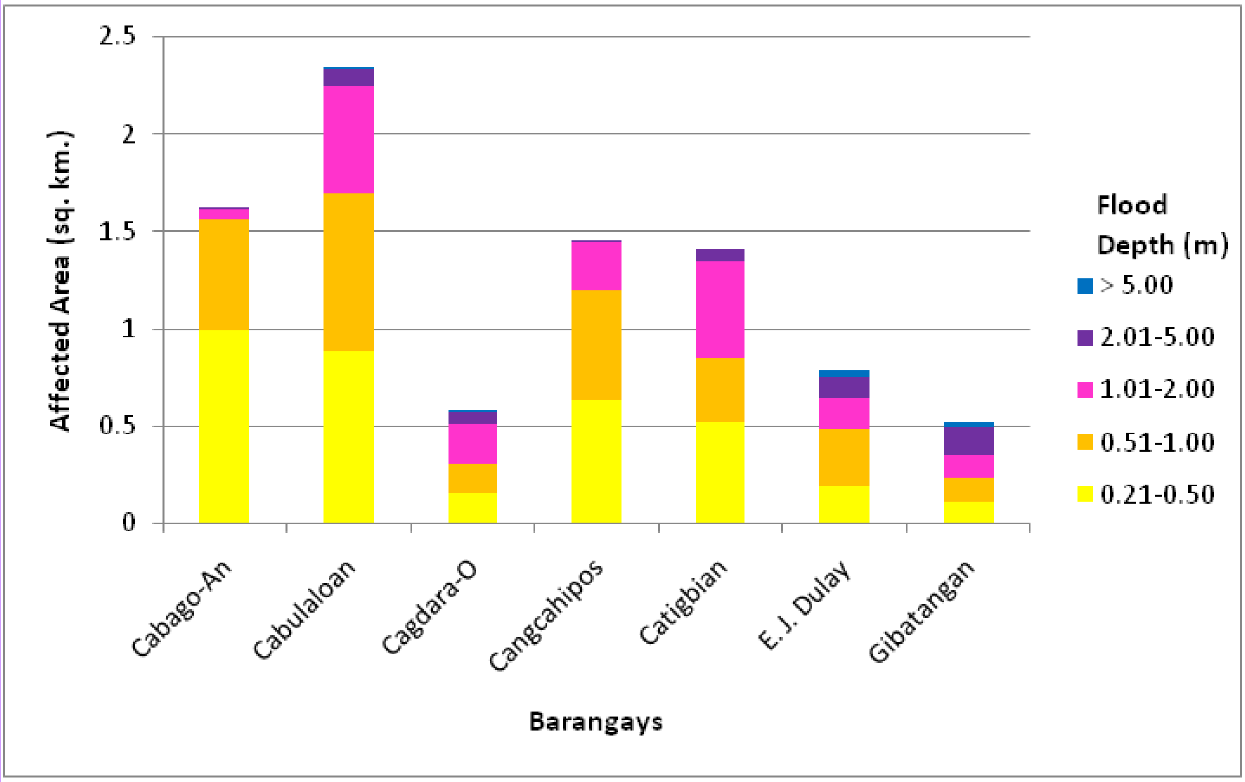


Figure 92. Affected areas in Laoang, Northern Samar during a 5-year rainfall return period

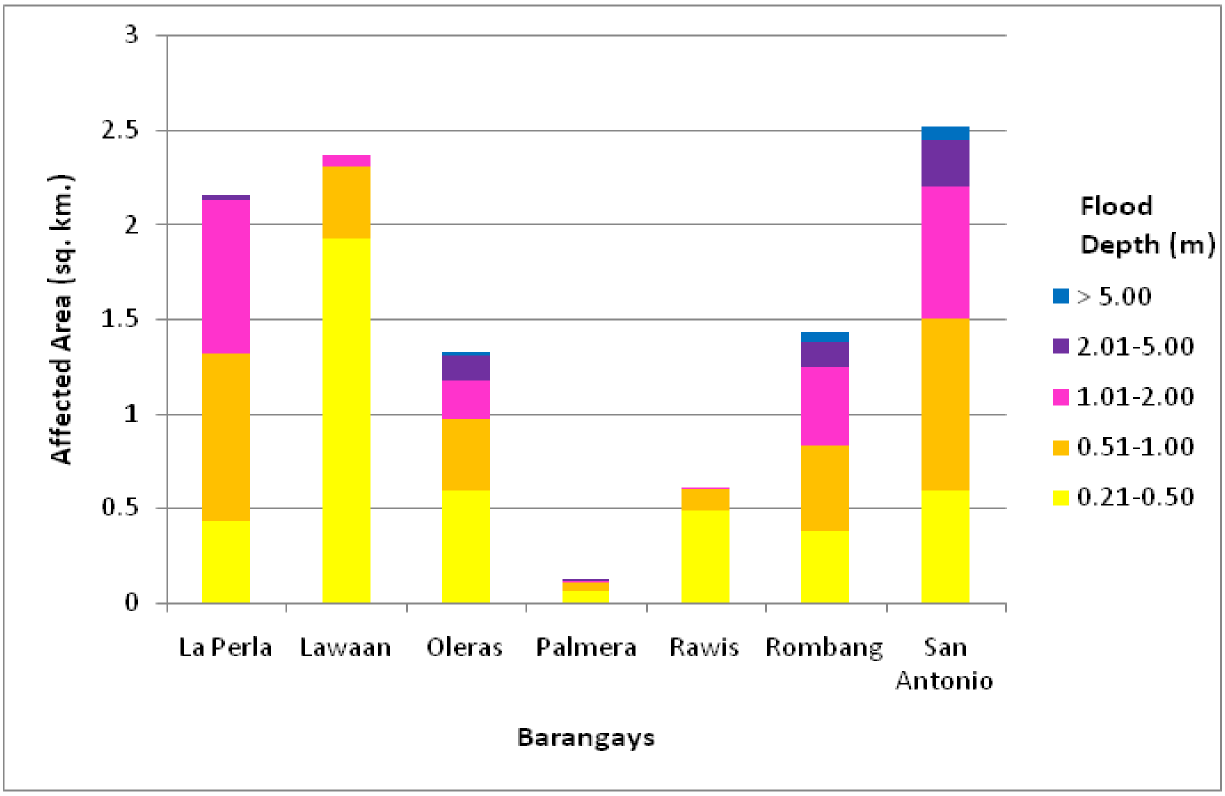


Figure 93. Affected areas in Laoang, Northern Samar during a 5-year rainfall return period

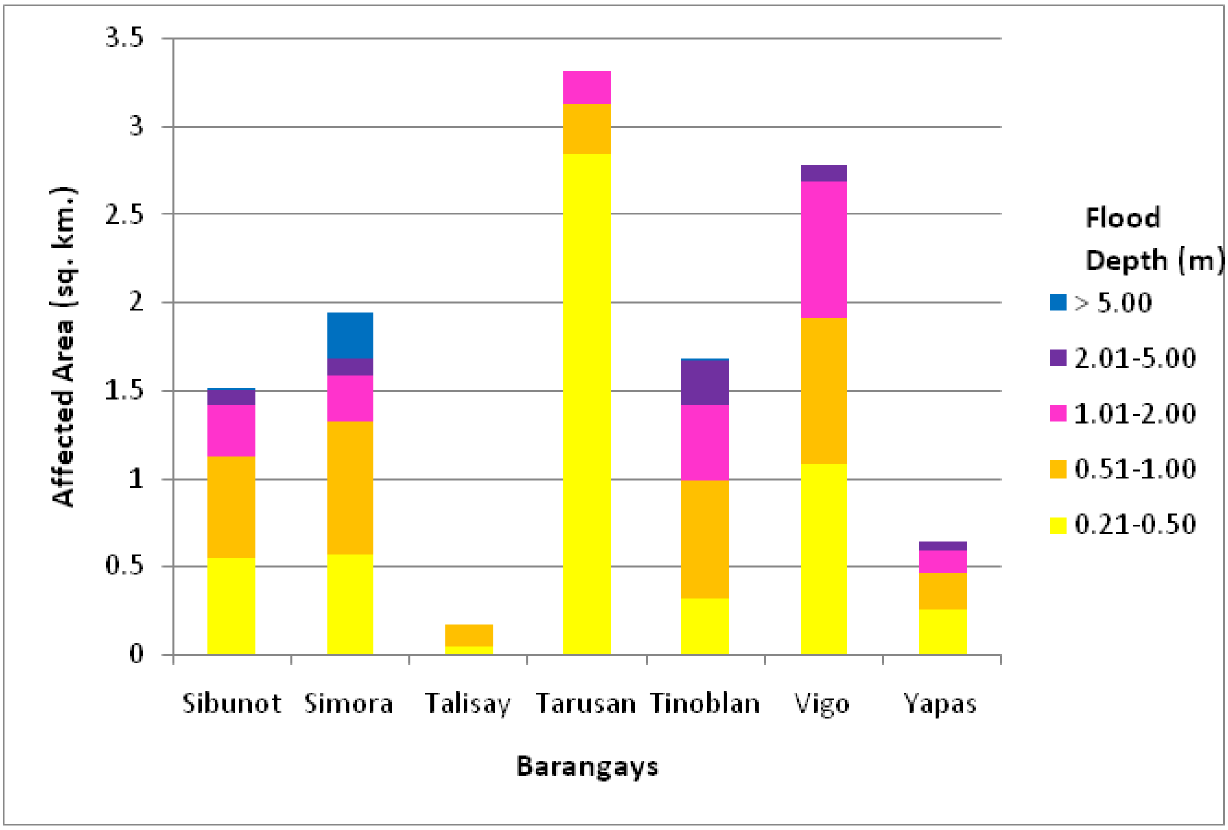


Figure 94. Affected areas in Laoang, Northern Samar during a 5-year rainfall return period

For the Municipality of Las Navas, with an area of 267.47 square kilometers, 60.88% will experience flood levels of less than 0.20 meters. 7.09% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 8.13%, 7.43%, 6.47%, and 2.04% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Tables 48-54 depict the affected areas, in square kilometers, by flood depth per barangay.

Table 48. Affected areas in Las Navas, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.)	Affected Barangays in Las Navas							
by flood depth (in m.)	Balugo	Bugay	Bugtosan	Bukid	Bulao	Caputoan	Catoto-Ogan	Cuenco
0.03-0.20	0.32	2.04	2.18	3.04	2.02	4.25	15.62	5
0.21-0.50	0.026	0.31	0.55	0.45	0.84	0.23	1.81	0.27
0.51-1.00	0.13	0.62	0.6	0.57	1.07	0.26	1.75	0.26
1.01-2.00	0.58	1.08	0.35	0.66	0.28	0.18	1.24	0.3
2.01-5.00	1.43	0.37	0.12	0.18	0.062	0.012	0.23	0.17
> 5.00	0.00023	0.065	0.13	0	0	0	0.0005	0.011

Table 49. Affected areas in Las Navas, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.)	Affected Barangays in Las Navas							
by flood depth (in m.)	Dapdap	Del Pilar	Dolores	Epaw	Geguinta	Geracdo	Guyo	H. Jolejole
0.03-0.20	1.57	0.55	3.3	2.29	0.91	0.17	0.97	1.73
0.21-0.50	0.073	0.023	0.26	0.11	0.25	0.04	0.075	0.22
0.51-1.00	0.095	0.031	0.16	0.14	0.31	0.19	0.042	0.19
1.01-2.00	0.19	0.068	0.072	0.13	0.37	0.45	0.18	0.14
2.01-5.00	0.98	1.22	0.0039	0.29	0.13	0.4	0.52	0.022
> 5.00	0.68	0.58	0	0.28	0.036	0.011	0.016	0

Table 50. Affected areas in Las Navas, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Las Navas (in sq. km.)							
by flood depth (in m.)	H. Jolejole District	Hangi	Imelda	L. Empon	Lakandula	Lourdes	Lumala-Og	Mabini
0.03-0.20	0.037	2.12	1.76	1.93	2.21	4.83	0.81	2.98
0.21-0.50	0.012	0.37	0.16	0.26	0.15	0.52	0.05	0.54
0.51-1.00	0.045	0.39	0.19	0.28	0.15	0.71	0.15	0.45
1.01-2.00	0.16	1.03	0.15	0.21	0.13	0.22	0.45	0.23
2.01-5.00	0.082	2.84	0.066	0.13	0.12	0.005	1.09	0.16
> 5.00	0.043	0.26	0	0.13	0.0014	0	0.13	0.14

Table 51. Affected areas in Las Navas, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Las Navas (in sq. km.)**							
by flood depth (in m.)	Macarthur	Magsaysay	Matelarag	Osmeña	Paco	Palanas	Perez	Poponton
0.03-0.20	4.42	2.05	1.29	0.71	2.68	7.12	4.32	3.16
0.21-0.50	0.59	0.41	0.15	0.21	0.45	0.88	0.67	0.25
0.51-1.00	0.57	0.5	0.14	0.42	0.48	0.78	0.81	0.42
1.01-2.00	0.25	0.23	0.52	0.95	0.33	0.53	0.46	0.49
2.01-5.00	0.077	0.077	0.91	0.22	0.22	0.036	0.16	0.11
> 5.00	0.051	0.0019	0.13	0.029	0.11	0.00031	0.046	0.07

Table 52. Affected areas in Las Navas, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Las Navas (in sq. km.)**							
by flood depth (in m.)	Quezon	Quirino	Rebong	Rizal	Roxas	Rufino	Sag-Od	San Andres
0.03-0.20	2.16	8.26	0.36	3.85	6.19	3.25	2.28	3.34
0.21-0.50	0.45	0.88	0.037	0.4	0.39	0.14	0.089	0.27
0.51-1.00	0.44	1.17	0.069	0.56	0.55	0.11	0.068	0.21
1.01-2.00	0.19	0.82	0.44	0.44	0.32	0.082	0.046	0.19
2.01-5.00	0.0034	0.32	0.95	0.1	0.18	0.008	0.014	0.2
> 5.00	0	0.086	0.087	0.061	0.0032	0.0018	0	0.002

Table 53. Affected areas in Las Navas, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Las Navas (in sq. km.)**							
by flood depth (in m.)	San Antonio	San Fernando	San Francisco	San Isidro	San Jorge	San Jose	San Miguel	Santo Tomas
0.03-0.20	2.65	1.25	6.5	14.95	1.89	2.19	3.68	1.73
0.21-0.50	0.59	0.72	0.37	1.01	0.21	0.27	0.57	0.35
0.51-1.00	0.91	0.33	0.37	1.23	0.13	0.4	0.95	0.21
1.01-2.00	0.7	0.071	0.27	0.94	0.03	0.39	0.39	0.11
2.01-5.00	0.25	0.0048	0.045	0.62	0.0004	0.12	0.15	0.0068
> 5.00	0.073	0	0.001	1.73	0	0.0062	0.04	0

Table 54. Affected areas in Las Navas, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Las Navas (in sq. km.)**			
	Tagab-Iran	Tagan-Ayan	Taylor	Victory
0.03-0.20	0.84	5.37	1.22	2.48
0.21-0.50	0.044	0.56	0.22	0.19
0.51-1.00	0.068	0.53	0.26	0.28
1.01-2.00	0.81	0.33	0.36	0.33
2.01-5.00	1.22	0.46	0.14	0.074
> 5.00	0.24	0.021	0.11	0.03

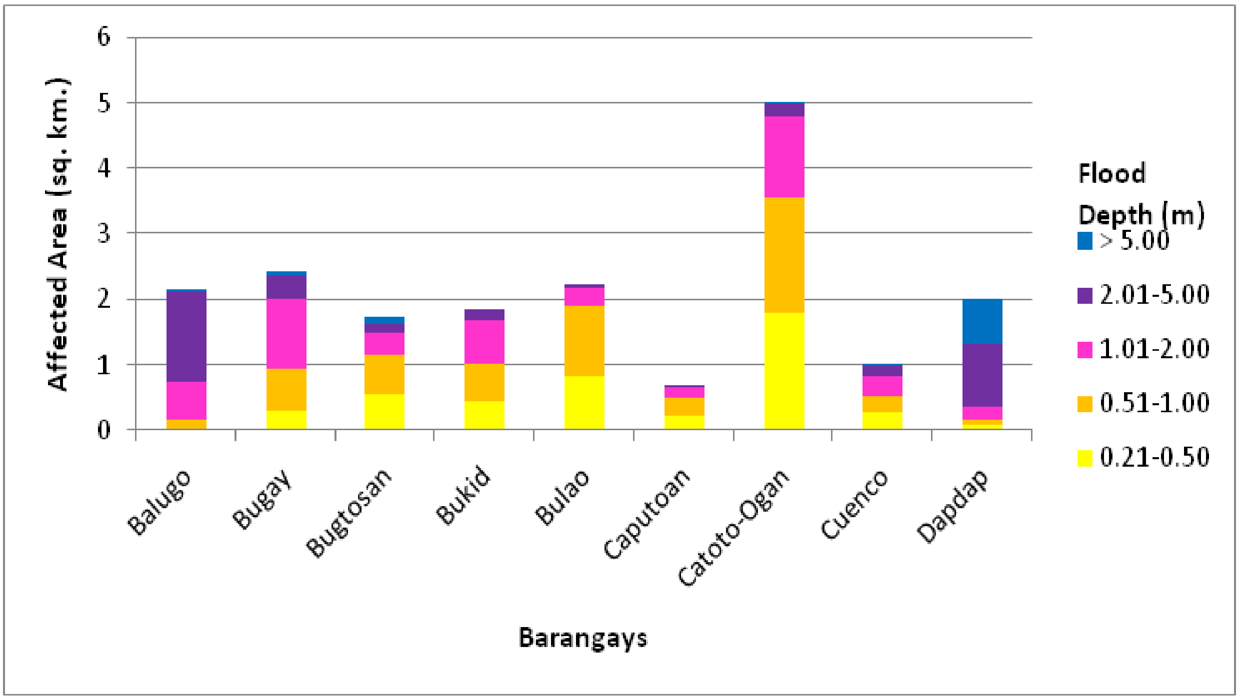


Figure 95. Affected areas in Las Navas, Northern Samar during a 5-year rainfall return period

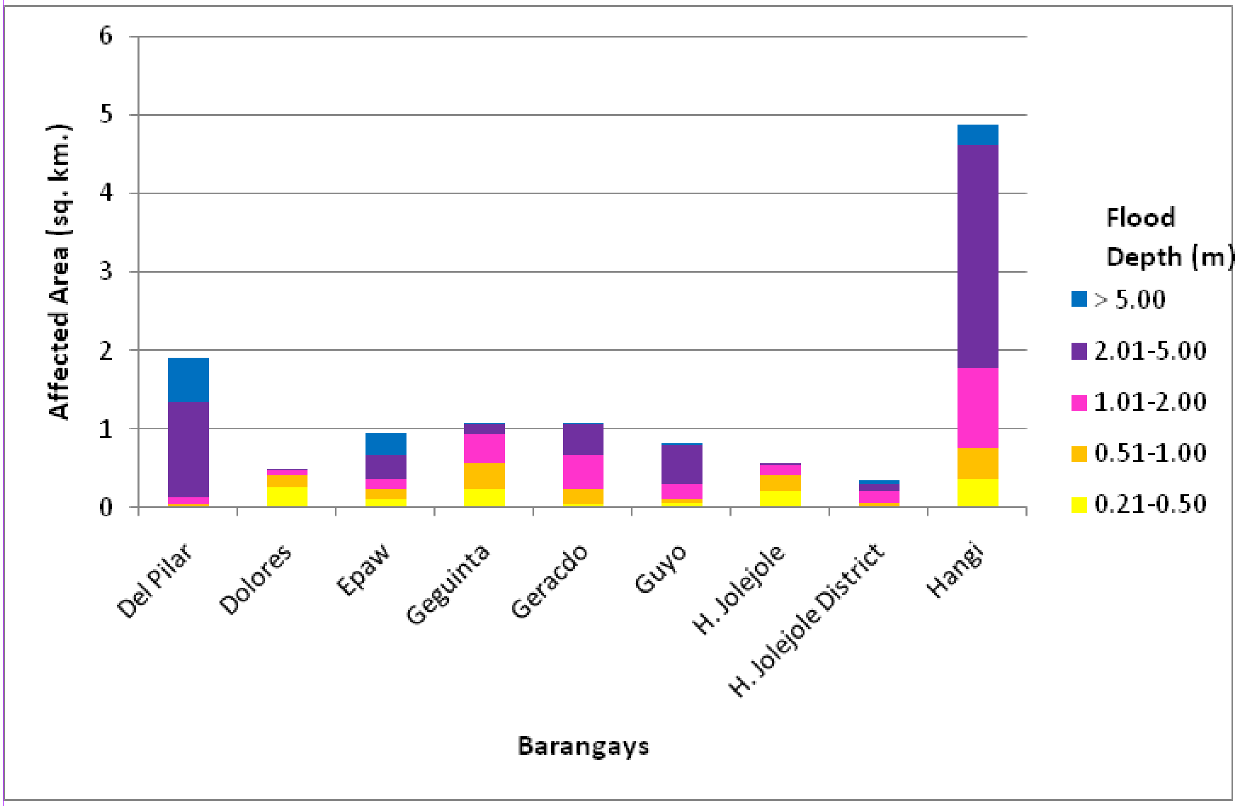


Figure 96. Affected areas in Las Navas, Northern Samar during a 5-year rainfall return period

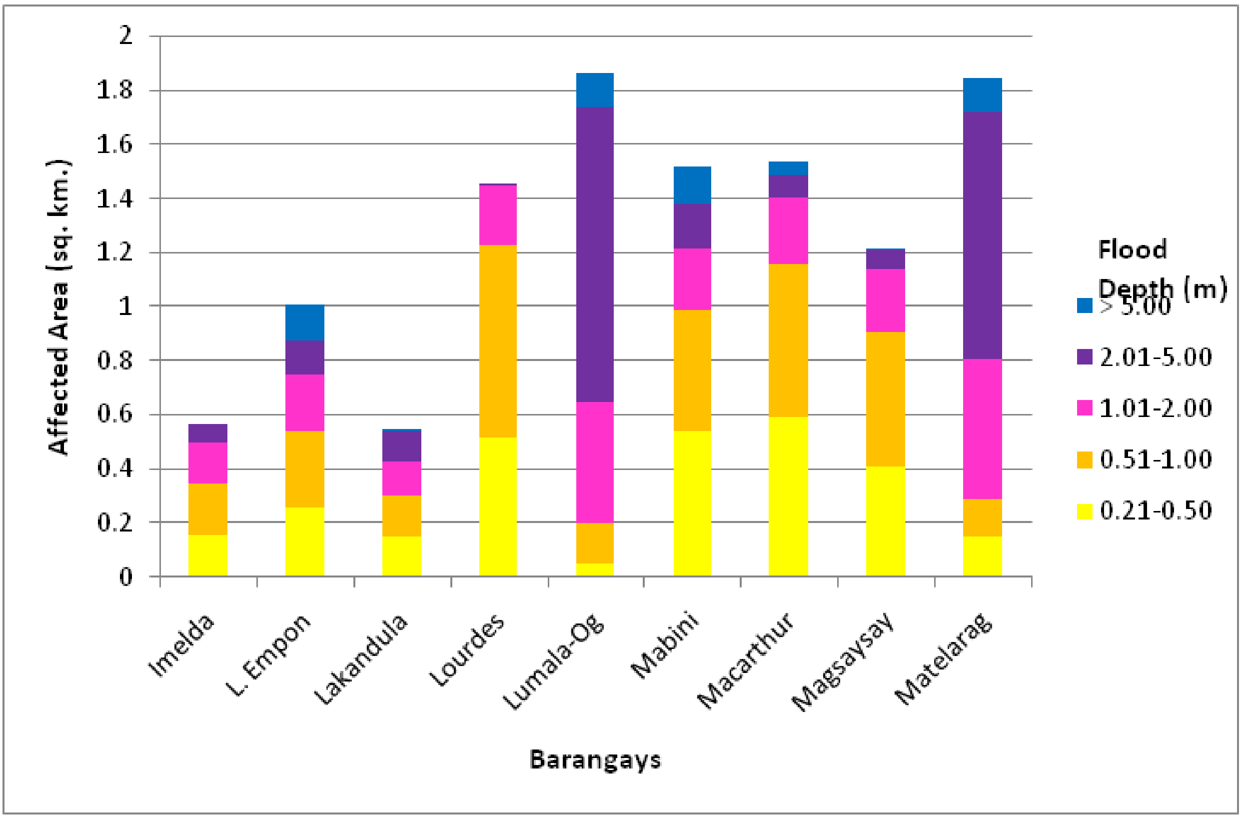


Figure 97. Affected areas in Las Navas, Northern Samar during a 5-year rainfall return period

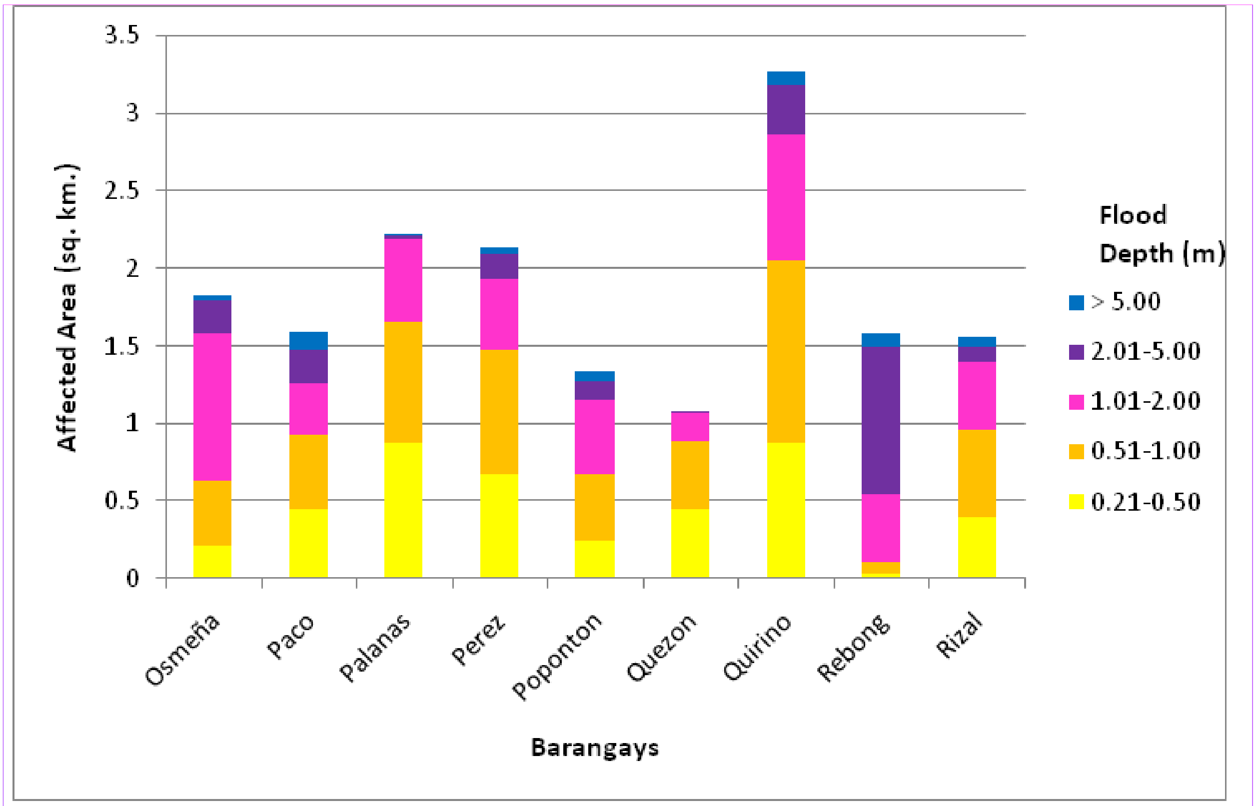


Figure 98. Affected areas in Las Navas, Northern Samar during a 5-year rainfall return period

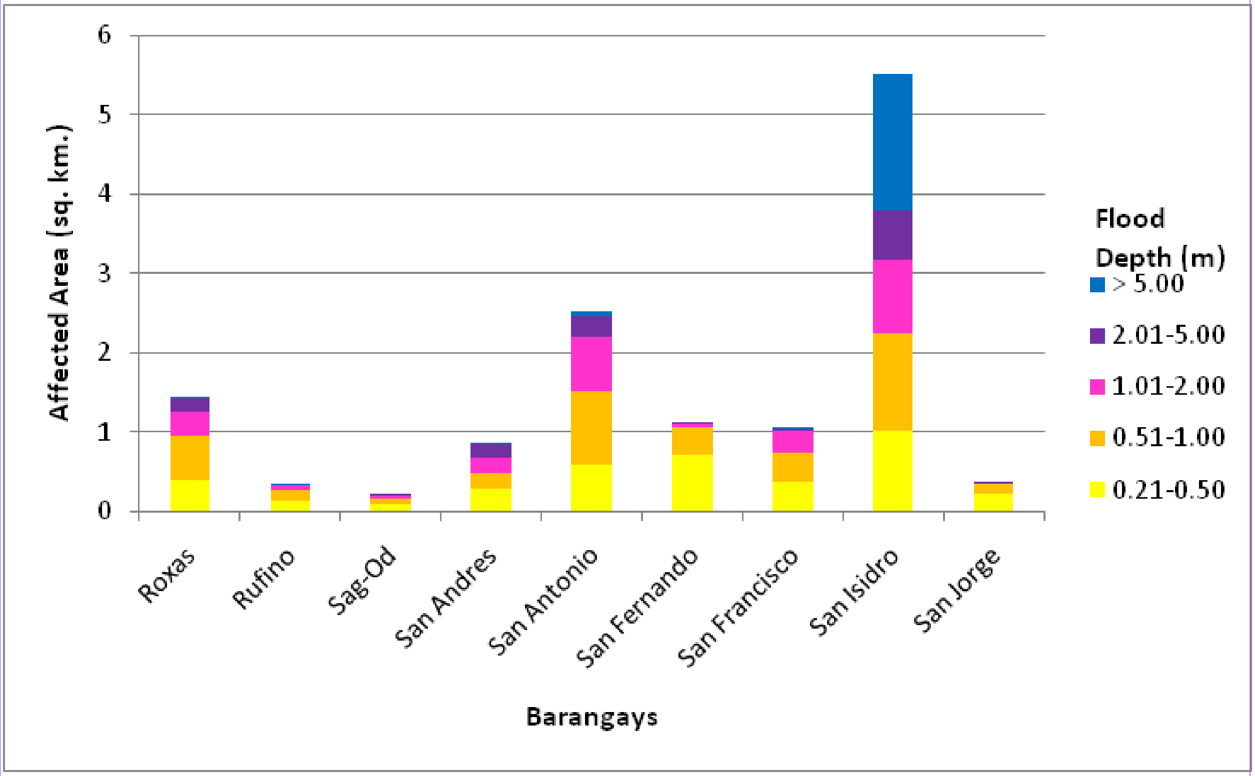


Figure 99. Affected areas in Las Navas, Northern Samar during a 5-year rainfall return period

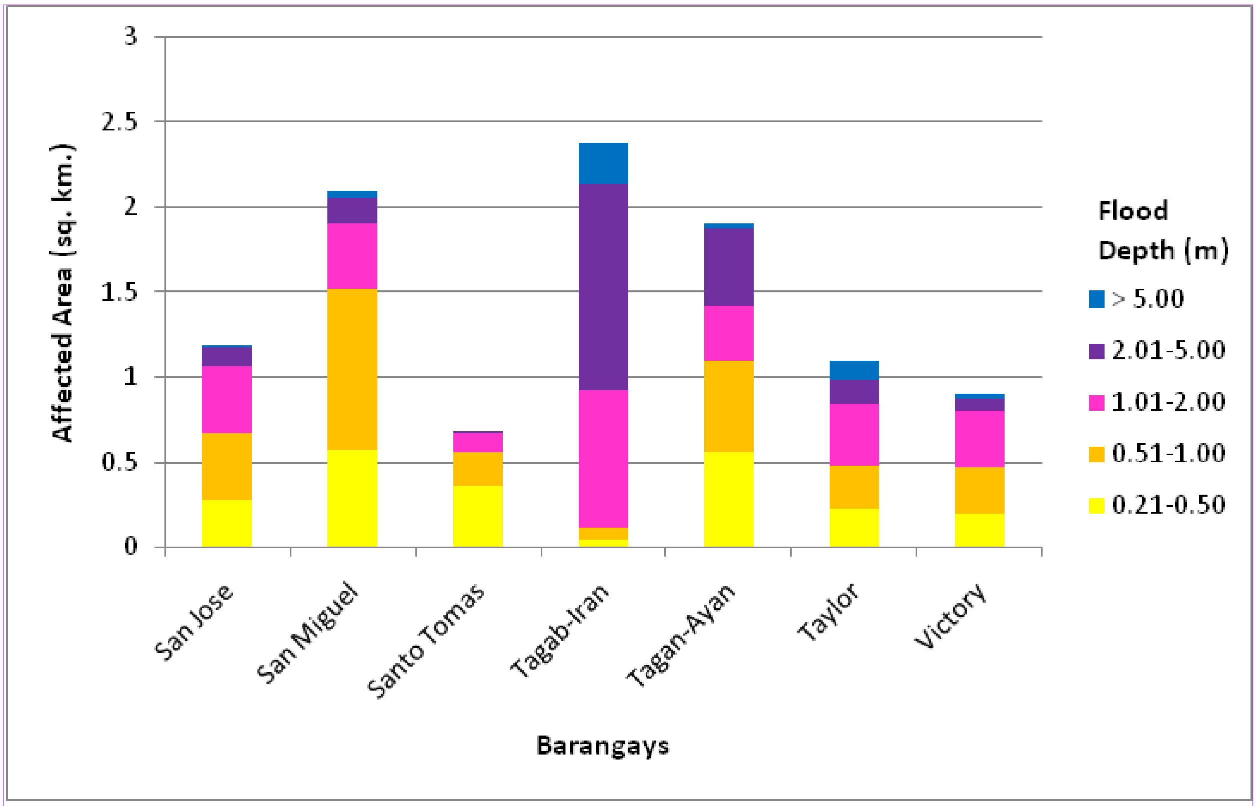


Figure 100. Affected areas in Las Navas, Northern Samar during a 5-year rainfall return period

For the Municipality of Mapanas, with an area of 143.56 square kilometers, 17.62% will experience flood levels of less than 0.20 meters. 0.76% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 0.64%, 0.65%, 0.63%, and 0.38% 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. Table 55 depicts the affected areas, in square kilometers, by flood depth per barangay.

Table 55. Affected areas in Mapanas, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Mapanas (in sq. km.)**		
	Magtaon	San Jose	Siljagon
0.03-0.20	0.04	2.19	23.07
0.21-0.50	0	0.27	0.82
0.51-1.00	0	0.4	0.52
1.01-2.00	0	0.39	0.55
2.01-5.00	0	0.12	0.78
> 5.00	0	0.0062	0.54

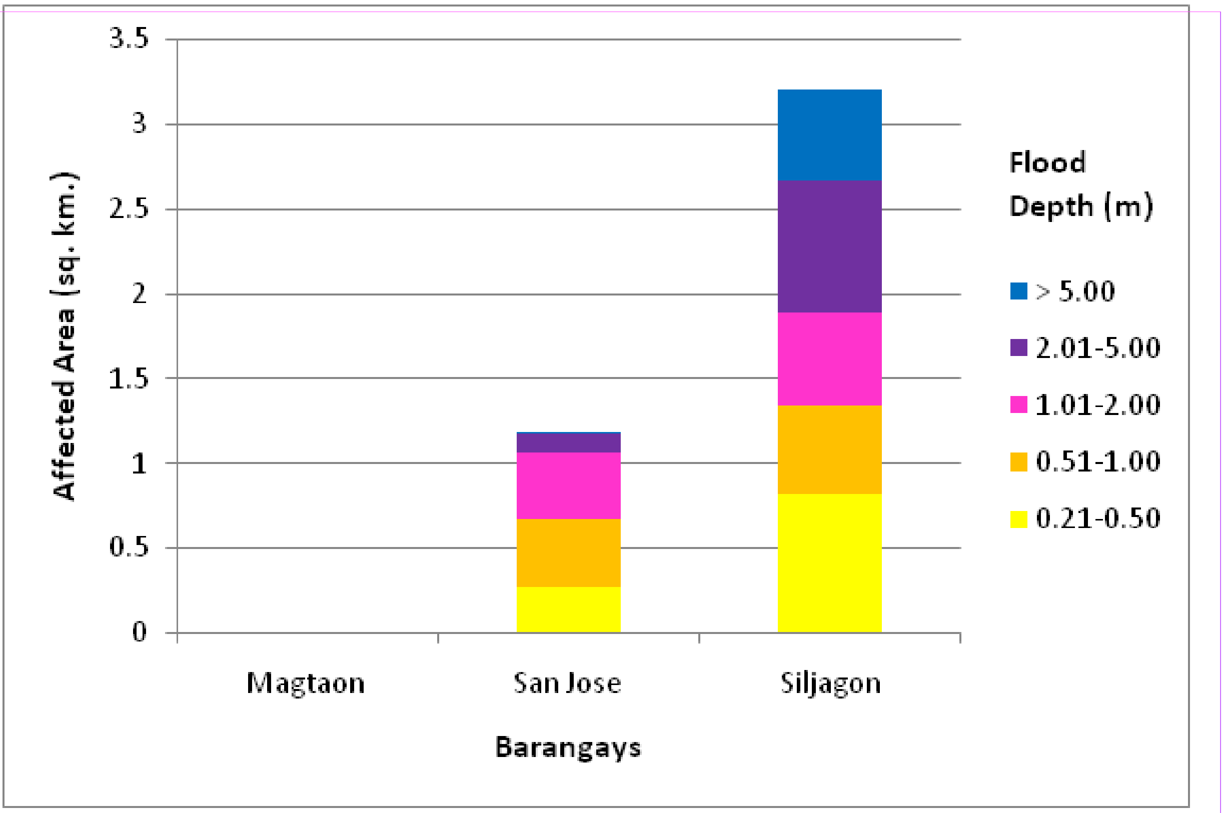


Figure 101. Affected areas in Mapanas, Northern Samar during a 5-year rainfall return period

For the Municipality of Palapag, with an area of 153.46 square kilometers, 62.11% will experience flood levels of less than 0.20 meters. 6.04% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 4.49%, 3.36%, 2.14%, and 0.72% 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. Tables 56-59 depict the affected areas, in square kilometers, by flood depth per barangay.

Table 56. Affected areas in Palapag, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.)	Affected Barangays in Palapag						
by flood depth (in m.)	Asum	Bagacay	Bangon	Benigno S. Aquino, Jr.	Cabariwan	Cabatuan	Campedico
0.03-0.20	0.59	25.63	8.81	0.31	1.75	0.42	1.15
0.21-0.50	0.24	0.95	0.48	0.22	0.13	0.0061	0.054
0.51-1.00	0.1	0.59	0.51	0.2	0.12	0.0016	0.023
1.01-2.00	0.012	0.48	0.48	0.11	0.035	0	0.044
2.01-5.00	0	0.74	0.72	0.0009	0.075	0	0
> 5.00	0	0.45	0.21	0	0	0	0

Table 57. Affected areas in Palapag, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.)	Affected Barangays in Palapag						
by flood depth (in m.)	Capacujan	Jangtud	Laniwan	Mabaras	Magsaysay	Manajao	Mapno
0.03-0.20	8.84	2.19	0.14	2.94	2.05	0.87	4.24
0.21-0.50	0.38	0.24	0.049	0.31	0.41	0.24	0.45
0.51-1.00	0.24	0.19	0.14	0.21	0.5	0.11	0.2
1.01-2.00	0.29	0.086	0.18	0.093	0.23	0.095	0.059
2.01-5.00	0.31	0.002	0.05	0.0068	0.077	0	0.014
> 5.00	0.006	0	0.0078	0	0.0019	0	0

Table 58. Affected areas in Palapag, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.)	**Affected Barangays in Palapag**						
by flood depth (in m.)	Maragano	Matambag	Monbon	Nagbobtac	Napo	Natawo	Nipa
0.03-0.20	1.32	0.86	2.65	6.5	3.48	1.6	2.47
0.21-0.50	0.041	0.27	0.6	0.36	0.72	0.37	0.075
0.51-1.00	0.0086	0.39	0.048	0.41	0.58	0.19	0.0078
1.01-2.00	0.0044	0.3	0.0061	0.35	0.54	0.071	0
2.01-5.00	0.0005	0.045	0	0.15	0.68	0.0001	0
> 5.00	0	0	0	0.0095	0.12	0	0

Table 59. Affected areas in Palapag, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.)	**Affected Barangays in Palapag**									
by flood depth (in m.)	Osmeña	Pangpang	Paysud	Sangay	Simora	Sinalaran	Sumoroy	Talolora	Tambangan	Tinampo
0.03-0.20	0.71	2.83	1.73	4.43	2.36	1.25	0.81	0.8	0.59	0.99
0.21-0.50	0.21	0.29	0.39	0.26	0.57	0.069	0.22	0.37	0.28	0.0085
0.51-1.00	0.42	0.15	0.1	0.26	0.75	0.073	0.092	0.12	0.16	0.00098
1.01-2.00	0.95	0.04	0.061	0.15	0.27	0.039	0.082	0.09	0.0079	0
2.01-5.00	0.22	0	0.012	0.067	0.088	0	0.00016	0.014	0.011	0
> 5.00	0.029	0	0	0.0001	0.27	0	0	0	0	0

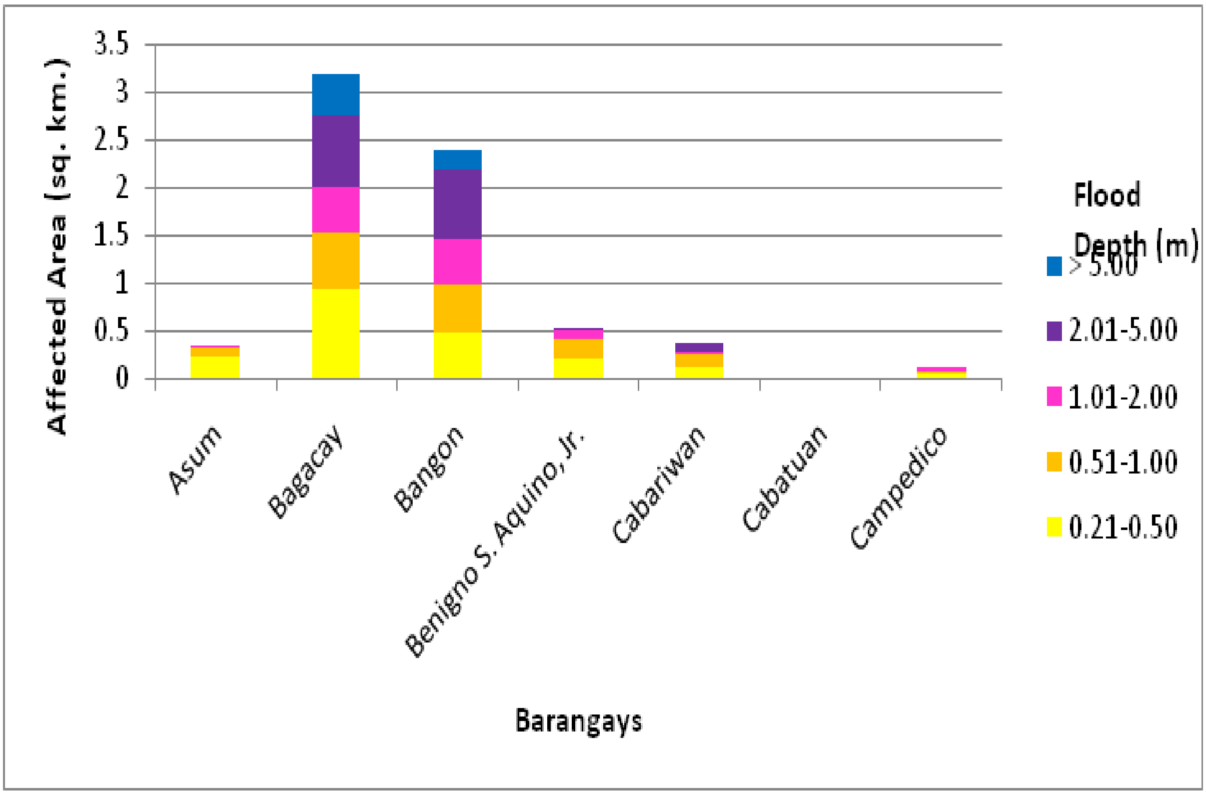


Figure 102. Affected areas in Palapag, Northern Samar during a 5-year rainfall return period

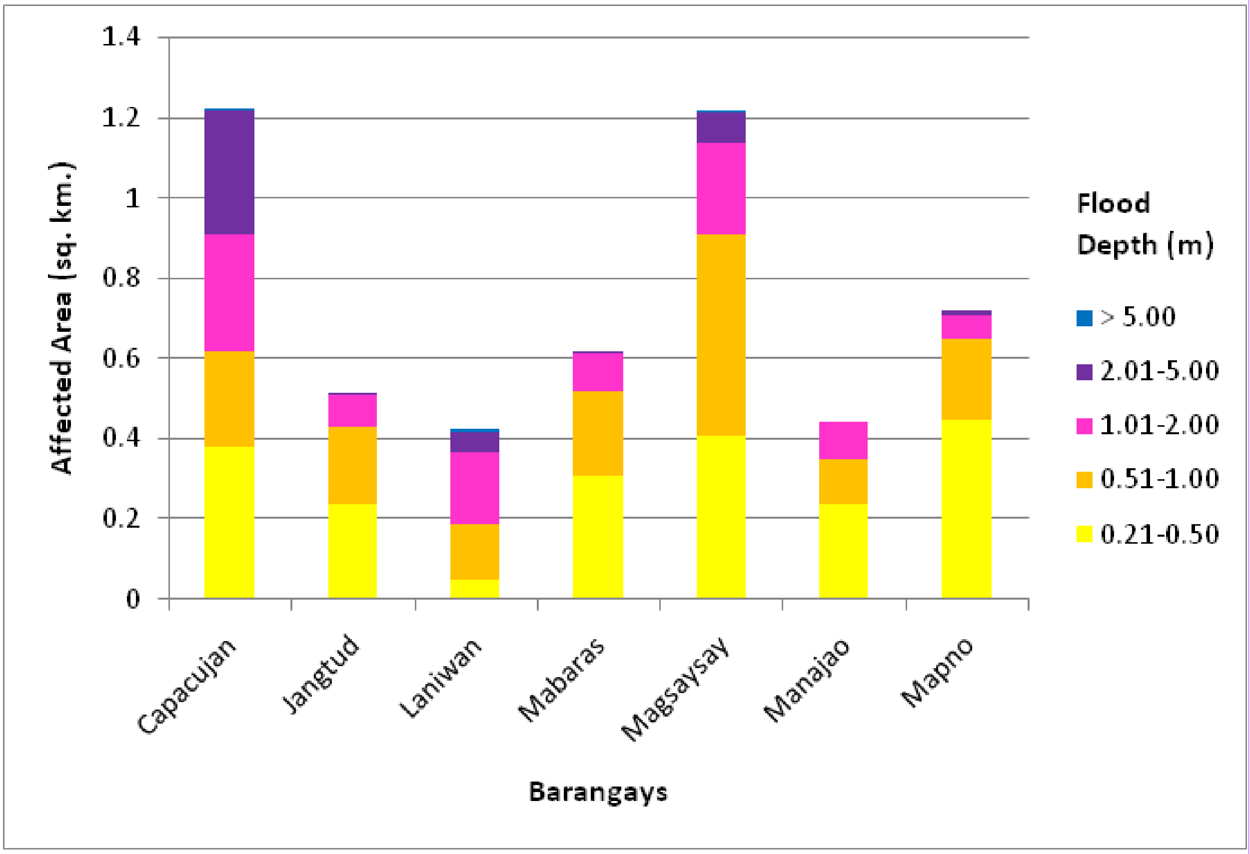


Figure 103. Affected areas in Palapag, Northern Samar during a 5-year rainfall return period

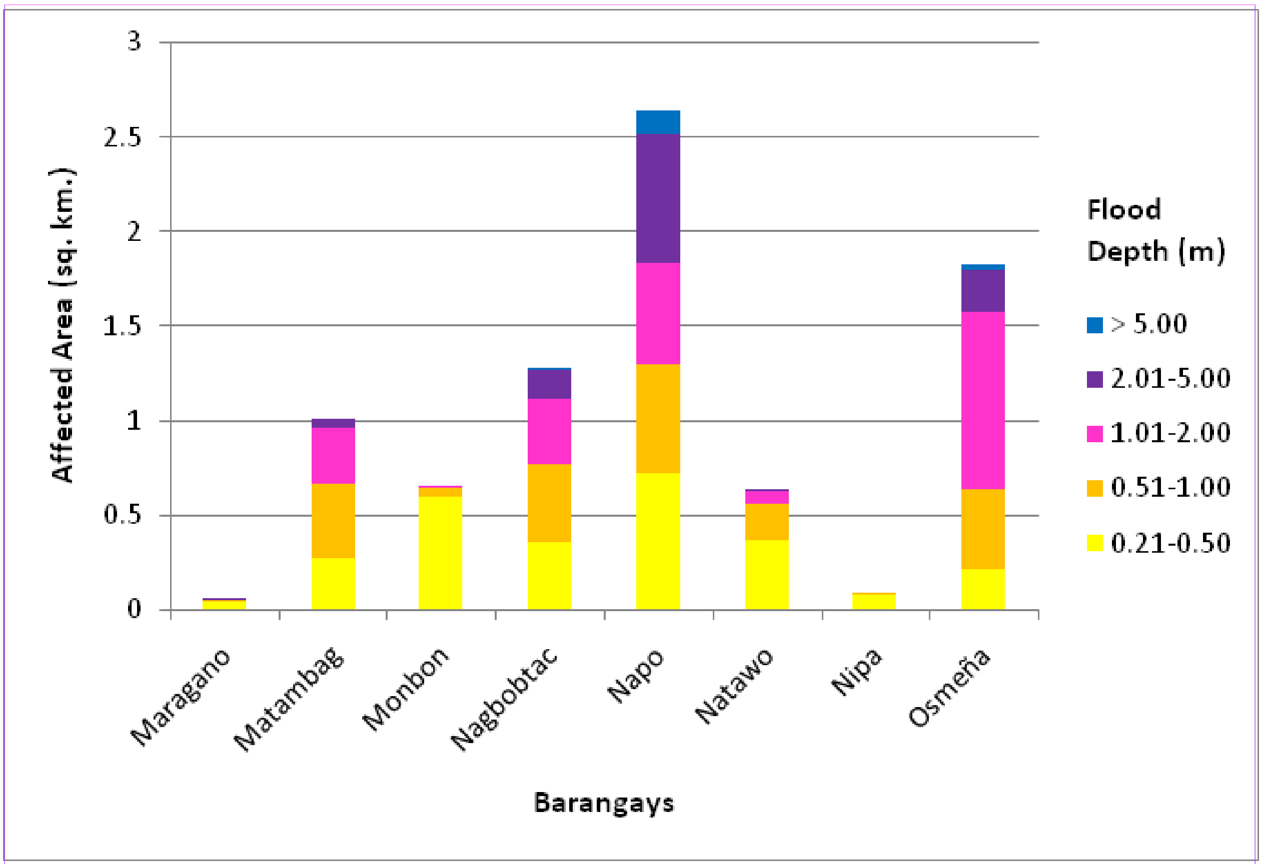


Figure 104. Affected areas in Palapag, Northern Samar during a 5-year rainfall return period

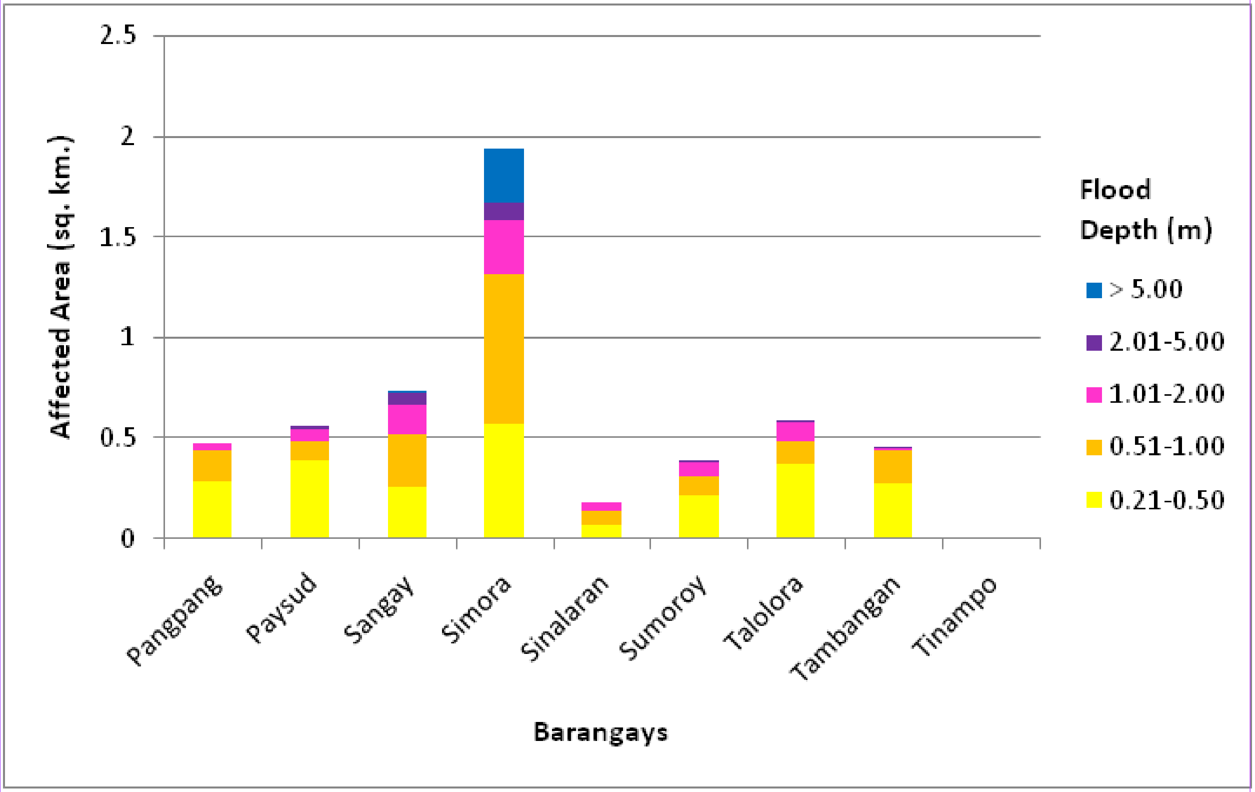


Figure 105. Affected areas in Palapag, Northern Samar during a 5-year rainfall return period

For the Municipality of Pambujan, with an area of 150.63 square kilometers, 4.81% will experience flood levels of less than 0.20 meters. 0.19% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 0.10%, 0.07%, and 0.03% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and more than 2 meters, respectively. Table 60 depicts the affected areas, in square kilometers, by flood depth per barangay.

Table 60. Affected areas in Pambujan, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	Affected Barangays in Pambujan			
	Geparayan	Ginulgan	Inanahawan	Sixto T. Balanguit, Sr.
0.03-0.20	1.95	1.43	0.74	3.12
0.21-0.50	0.1	0.049	0.023	0.11
0.51-1.00	0.056	0.028	0.017	0.053
1.01-2.00	0.034	0.021	0.0036	0.043
2.01-5.00	0.0029	0.0058	0.00049	0.039
> 5.00	0	0	0	0

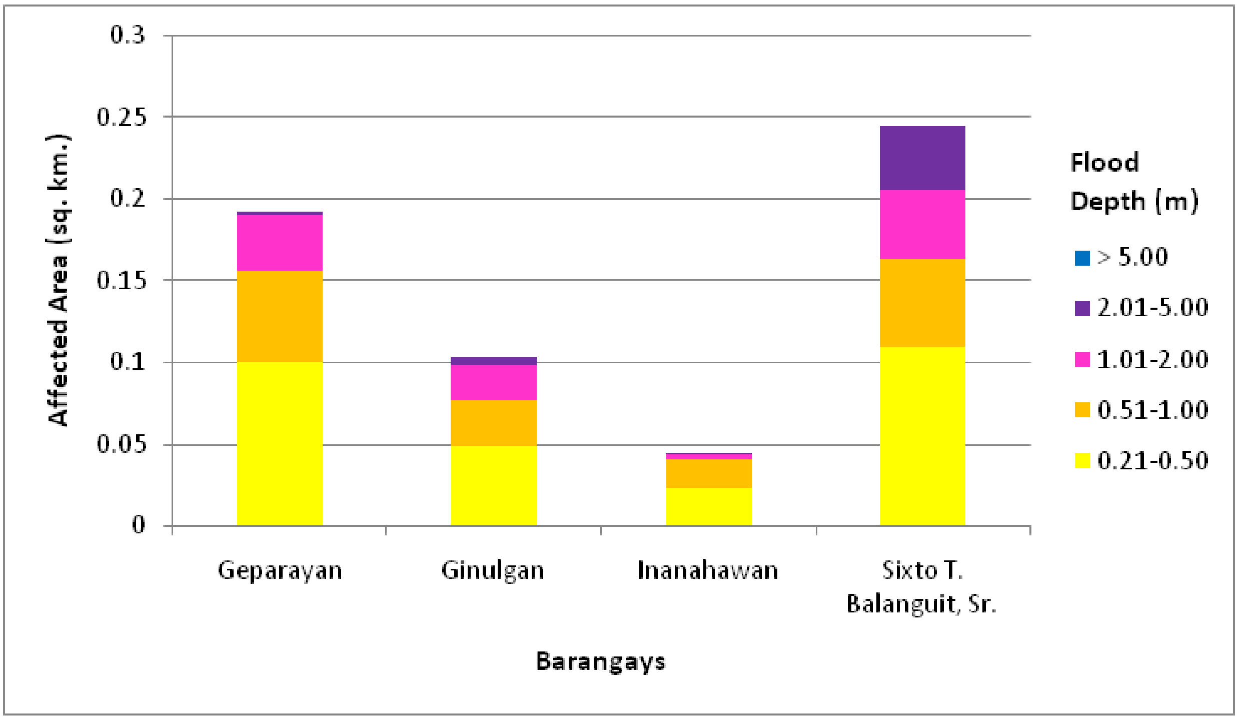


Figure 106. Affected areas in Pambujan, Northern Samar during a 5-year rainfall return period

For the Municipality of Silvino Lobos, with an area of 255.34 square kilometers, 6.13% will experience flood levels of less than 0.20 meters. 0.30% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 0.39%, 0.34%, and 0.06% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and more than 2 meters, respectively. Table 61 depicts the affected areas, in square kilometers, by flood depth per barangay.

Table 61. Affected areas in Silvino Lobos, Northern Samar during a 5-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Affected Barangays in Silvino Lobos**		
	Balud	Geparayan de Turag	Senonogan de Tubang
0.03-0.20	0.045	9.27	6.34
0.21-0.50	0.0013	0.46	0.31
0.51-1.00	0.0011	0.6	0.39
1.01-2.00	0.0042	0.53	0.34
2.01-5.00	0.0005	0.055	0.11
> 5.00	0	0	0

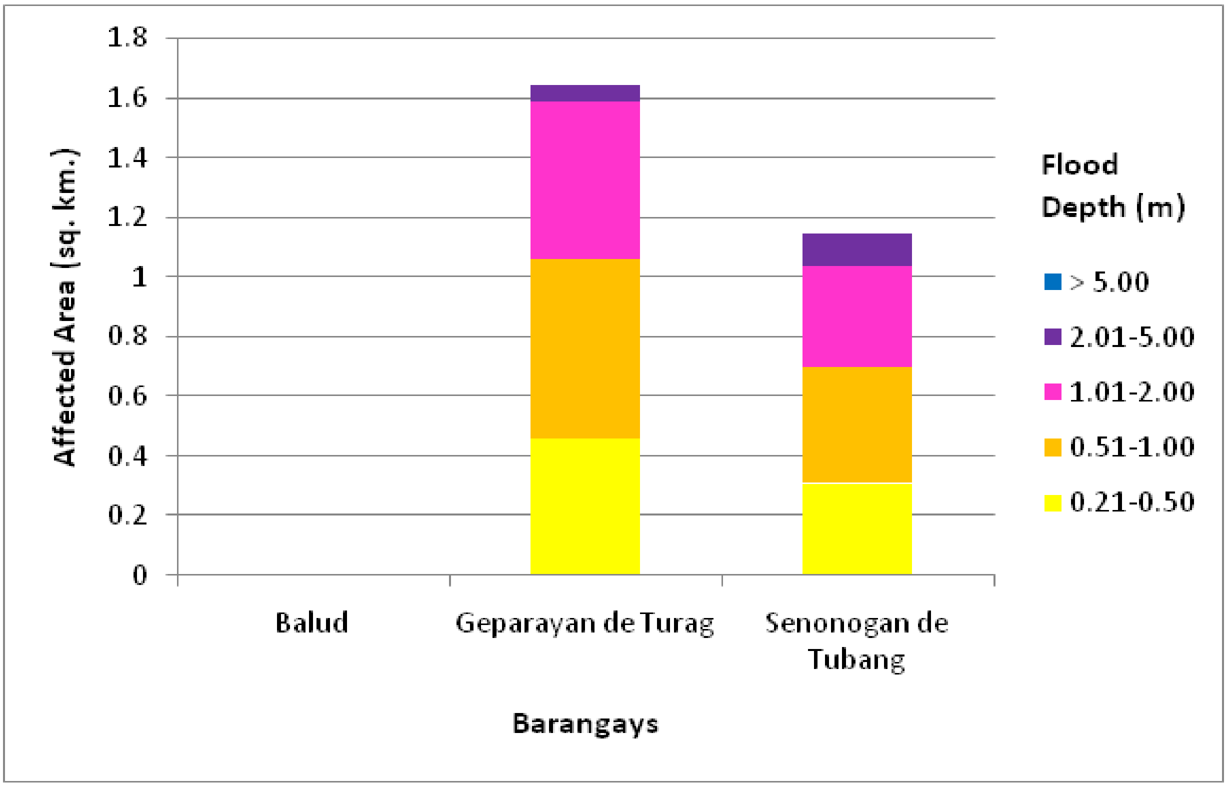


Figure 107. Affected areas in Silvino Lobos, Northern Samar during a 5-year rainfall return period

For the Municipality of Matuguinao, with an area of 368.83 square kilometers, 1.14% will experience flood levels of less than 0.20 meters. 0.05% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 0.05%, 0.03%, and 0.009% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and more than 2 meters, respectively. Table 62 depicts the affected areas, in square kilometers, by flood depth per barangay.

Table 62. Affected areas in Matuguinao, Samar during a 5-year rainfall return period

Affected Area (sq. km.)	Affected Barangays in Matuguinao	
by flood depth (in m.)	Camonoan	Ligaya
0.03-0.20	4.1	0.12
0.21-0.50	0.2	0.0015
0.51-1.00	0.2	0.00047
1.01-2.00	0.12	0.0002
2.01-5.00	0.033	0
> 5.00	0	0

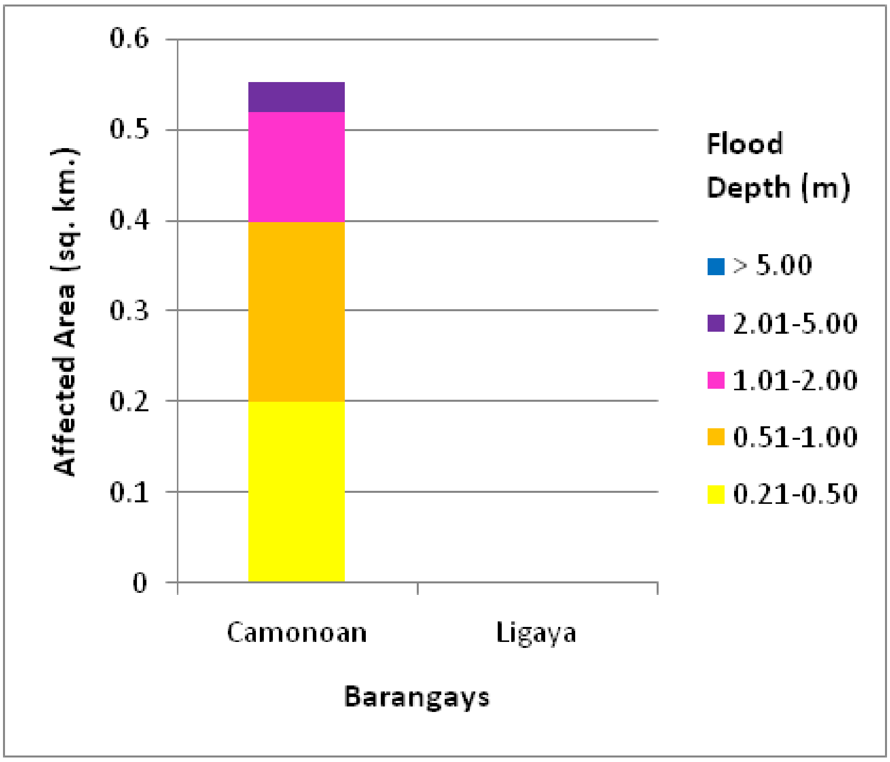


Figure 108. Affected areas in Matuguinao, Samar during a 5-year rainfall return period

For the 25-year return period, 0.79% of the Municipality of Jipapad, with an area of 173.29 square kilometers, will experience flood levels of less than 0.20 meters, while 0.05% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 0.05%, 0.02%, 0.0002%, and 0.10% 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. Table 63 depicts the areas affected in Jipapad, in square kilometers, by flood depth per barangay.

Table 63. Affected areas in Jipapad, Eastern Samar during a 25-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Affected Barangays in Jipapad**	
	Cagmanaba	San Roque
0.03-0.20	0.79	0.58
0.21-0.50	0.043	0.045
0.51-1.00	0.037	0.043
1.01-2.00	0.022	0.0062
2.01-5.00	0.0003	0
> 5.00	0.18	0

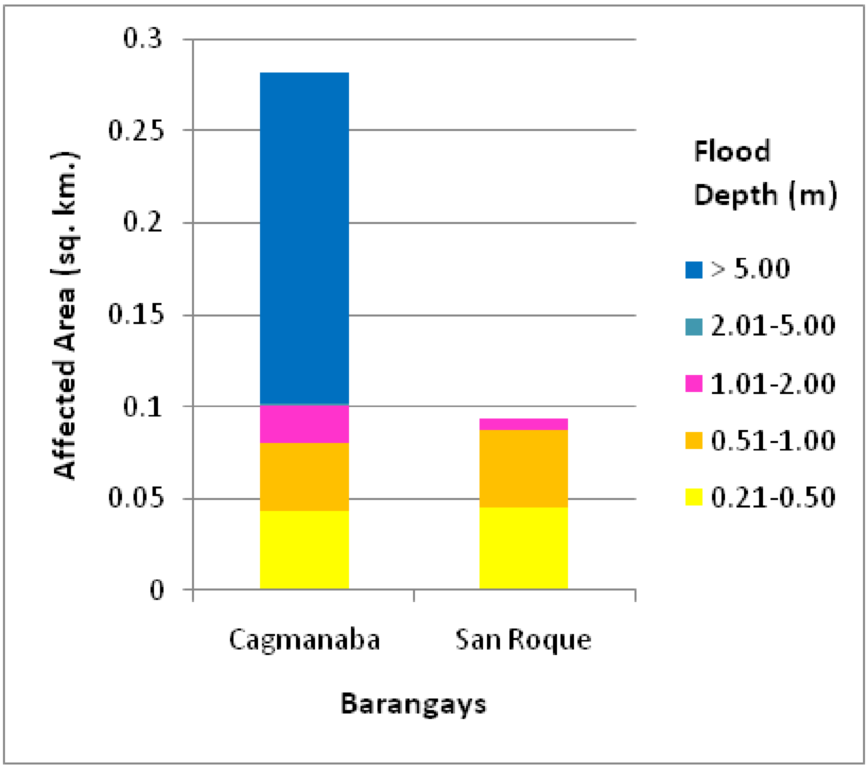


Figure 109. Affected areas in Jipapad, Eastern Samar during a 25-year rainfall return period

For the Municipality of Catubig, with an area of 217.59 square kilometers, 51.43% will experience flood levels of less than 0.20 meters. 4.07% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 4.22%, 7.41%, 6.68%, and 0.75% 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. Tables 64-68 depict the affected areas, in square kilometers, by flood depth per barangay.

Table 64. Affected areas in Catubig, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Catubig (in sq. km.)								
by flood depth (in m.)	Anongo	Barangay 1	Barangay 2	Barangay 3	Barangay 4	Barangay 5	Barangay 6	Barangay 7	Barangay 8
0.03-0.20	2.55	0.47	0.042	0.012	0.0099	0.007	0.0064	0.000049	0.0056
0.21-0.50	0.41	0.087	0.0073	0.0038	0.0065	0.01	0.011	0.0064	0.0031
0.51-1.00	0.65	0.038	0.022	0.013	0.014	0.016	0.013	0.018	0.006
1.01-2.00	1.98	0.018	0.023	0.0009	0	0	0.00042	0.029	0.016
2.01-5.00	0.62	0.0036	0.062	0.0019	0.0037	0.0046	0.0057	0.015	0.046
> 5.00	0.075	0	0.0039	0	0	0	0.000017	0.0024	0.0047

Table 65. Affected areas in Catubig, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Catubig (in sq. km.)								
by flood depth (in m.)	Bonifacio	Boring	Cagbugna	Cagmanaba	Cagogobngan	Calingnan	Canuctan	Claro M. Recto	D. Mercader
0.03-0.20	0.9	0.56	0.28	0.79	1.03	1.15	1.04	7.25	1.37
0.21-0.50	0.12	0.01	0.08	0.043	0.12	0.21	0.27	0.33	0.08
0.51-1.00	0.29	0.0056	0.081	0.037	0.22	0.13	0.18	0.29	0.043
1.01-2.00	1.13	0.0059	0.25	0.022	0.29	0.33	0.31	0.22	0.12
2.01-5.00	0.52	0.0024	0.058	0.0003	0.34	0.29	0.45	0.057	0.14
> 5.00	0.0054	0	0	0.18	0	0	0	0.0053	0

Table 66. Affected areas in Catubig, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Catubig (in sq. km.)**								
	Guibwangan	Hinagonoyan	Hiparayan	Hitapi-An	Inoburan	Irawahan	Lenoyahan	Libon	Magongon
0.03-0.20	0.19	1.39	5.59	5.8	0.19	5.22	0.31	0.11	7.5
0.21-0.50	0.092	0.077	0.34	0.35	0.037	0.27	0.16	0.0049	0.42
0.51-1.00	0.11	0.072	0.35	0.32	0.06	0.36	0.61	0.0096	0.27
1.01-2.00	0.092	0.065	0.36	0.54	0.41	0.5	1.06	0.075	0.39
2.01-5.00	0.098	0.0095	0.2	0.17	1.02	0.6	0.27	1.14	0.62
> 5.00	0	0	0.084	0	0.0016	0.3	0	0	0

Table 67. Affected areas in Catubig, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Catubig (in sq. km.)**								
	Magtuad	Manering	Nabulo	Nagoocan	Nahulid	Opong	Osang	Osmeña	P. Rebadulla
0.03-0.20	0.79	11.4	2.06	1.44	0.12	13.64	2.28	0.6	9.32
0.21-0.50	0.083	0.43	0.077	0.13	0.035	1.16	0.17	0.12	0.35
0.51-1.00	0.093	0.2	0.051	0.32	0.083	0.97	0.11	0.098	0.25
1.01-2.00	0.17	0.21	0.087	0.37	0.26	0.75	0.14	0.48	0.21
2.01-5.00	1.05	0.49	0.091	0.064	0.58	0.45	0.035	1.21	0.24
> 5.00	0.069	0.45	0.012	0.0015	0.033	0.0028	0	0.0025	0.2

Table 68. Affected areas in Catubig, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Catubig (in sq. km.)**										
by flood depth (in m.)	Roxas	Sagudsuron	San Antonio	San Francisco	San Jose	San Vicente	Santa Fe	Sulitan	Tangbo	Tungodnon	Vienna Maria
0.03-0.20	6.02	2.01	2.4	6.37	2.03	0.78	1.23	0.48	3.24	1.21	0.72
0.21-0.50	0.38	0.16	0.37	0.37	0.26	0.06	0.25	0.03	0.7	0.08	0.073
0.51-1.00	0.4	0.11	0.4	0.37	0.32	0.17	0.3	0.027	0.51	0.052	0.12
1.01-2.00	0.6	0.16	1.31	0.37	0.43	0.59	0.24	0.13	1.12	0.083	0.18
2.01-5.00	0.23	0.29	0.6	0.08	0.33	0.13	0.06	0.78	0.54	0.015	0.52
> 5.00	0.0067	0	0.097	0.0039	0.017	0.059	0.019	0.0012	0	0	0.0001

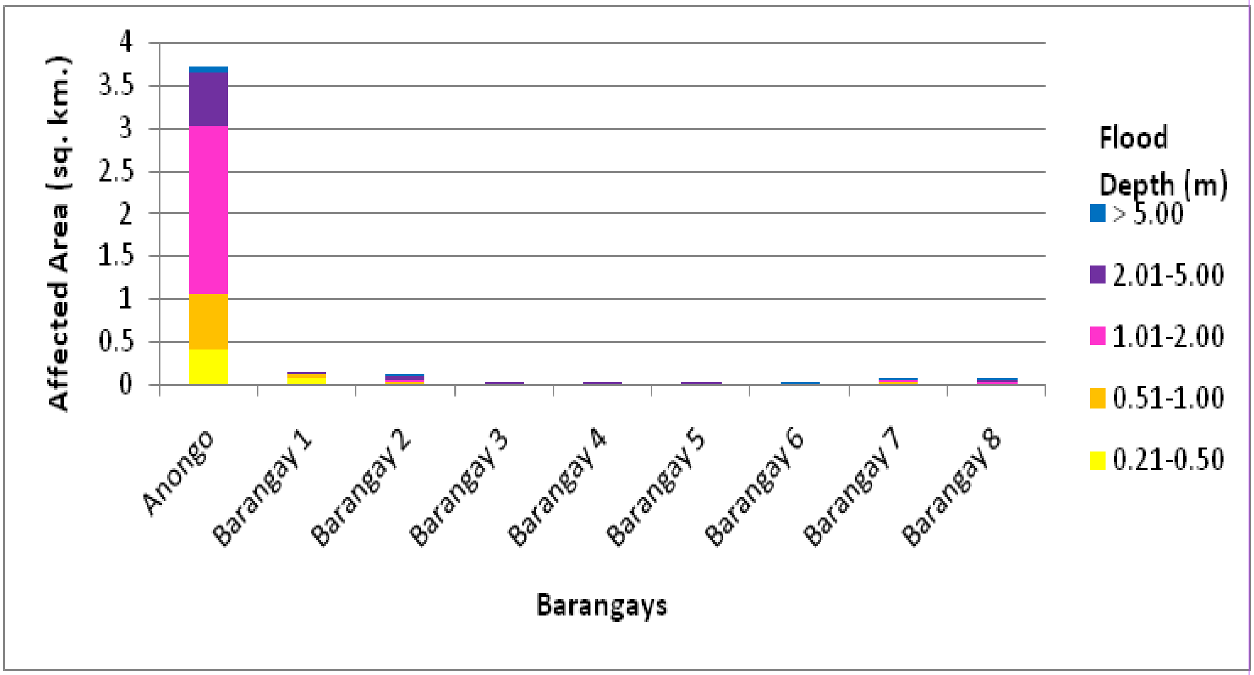


Figure 110. Affected areas in Catubig, Northern Samar during a 25-year rainfall return period

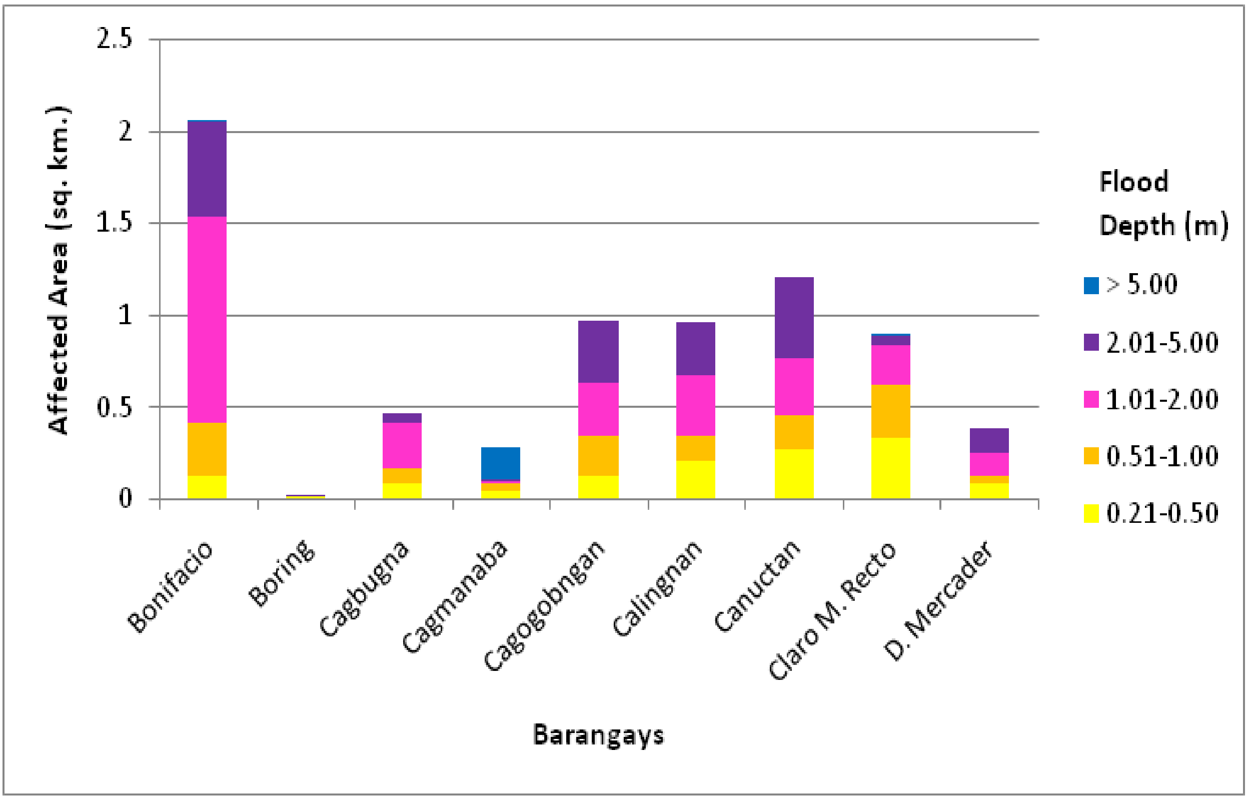


Figure 111. Affected areas in Catubig, Northern Samar during a 25-year rainfall return period

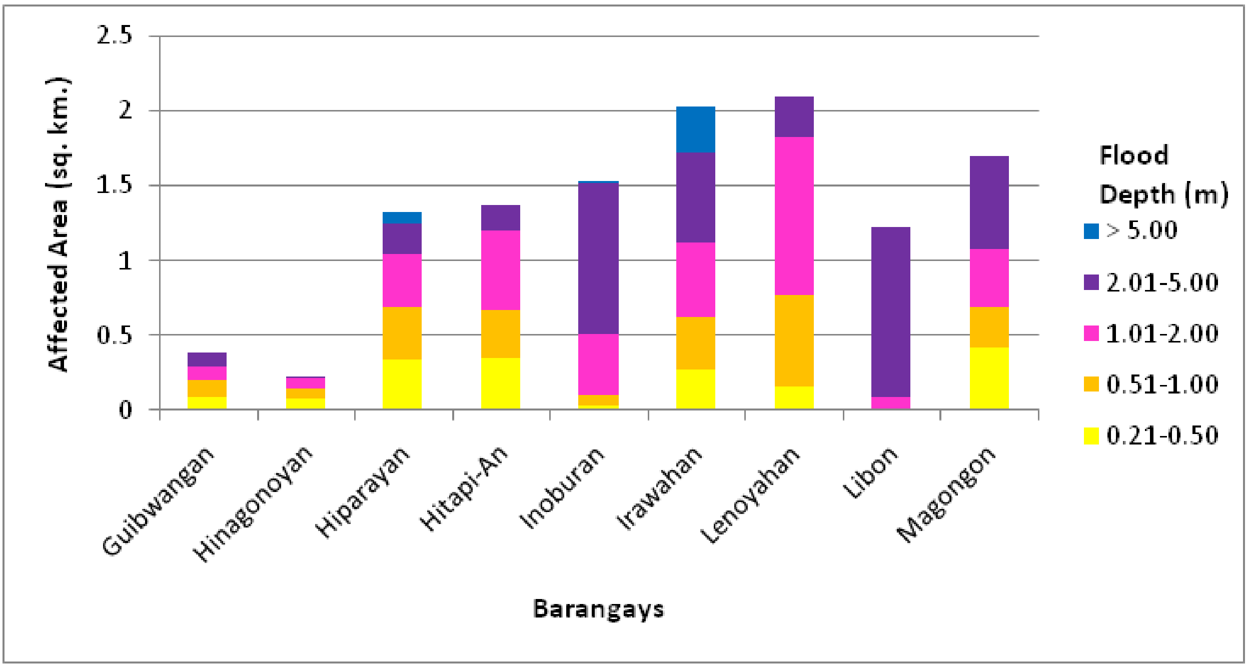


Figure 112. Affected areas in Catubig, Northern Samar during a 25-year rainfall return period

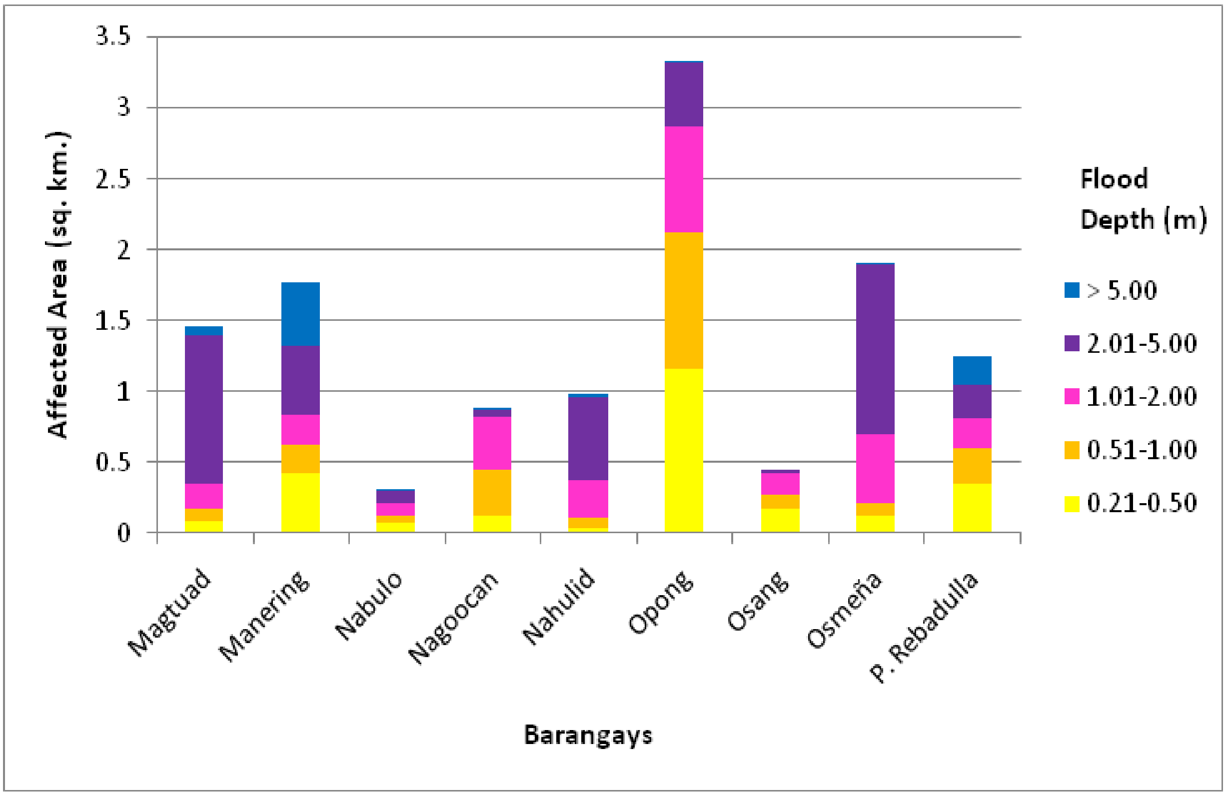


Figure 113. Affected areas in Catubig, Northern Samar during a 25-year rainfall return period

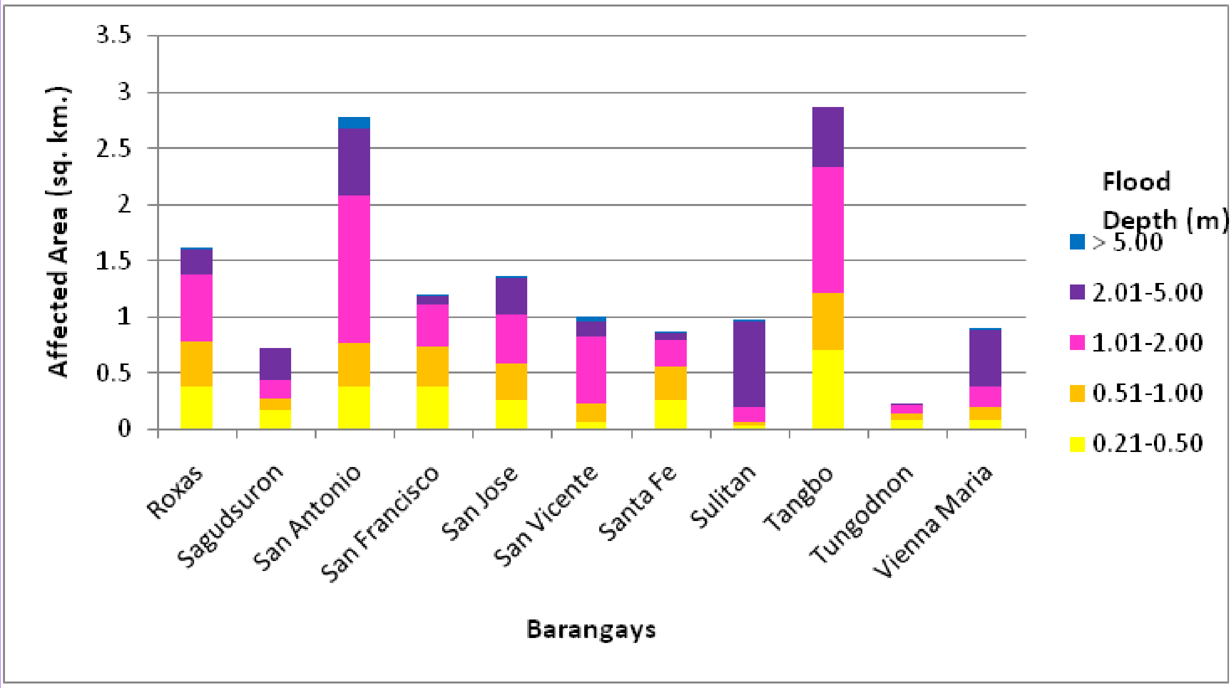


Figure 114. Affected areas in Catubig, Northern Samar during a 25-year rainfall return period

For the Municipality of Laoang, with an area of 207.60 square kilometers, 32.91% will experience flood levels of less than 0.20 meters. 7.97% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 8.45%, 7.0008%, 2.16%, and 0.36% 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. Tables 69-72 depict the affected areas, in square kilometers, by flood depth per barangay.

Table 69. Affected areas in Laoang, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Laoang (in sq. km.)**						
	Abaton	Atipolo	Bawang	Bobolosan	Bongliw	Burabud	Cabagngan
0.03-0.20	7.01	2.56	3.15	2.26	1.58	1.29	2.91
0.21-0.50	0.82	1.39	0.61	0.7	1.16	0.4	0.96
0.51-1.00	1.17	0.27	1.2	0.38	2.45	0.26	0.97
1.01-2.00	1.01	0.21	1.35	0.29	1.19	0.038	0.37
2.01-5.00	0.31	0.0012	0.44	0	0.29	0.0004	0.07
> 5.00	0.0073	0	0	0	0	0	0.015

Table 70. Affected areas in Laoang, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Laoang (in sq. km.)**						
	Cabago-An	Cabulaloan	Cagdara-O	Cangcahipos	Catigbian	E. J. Dulay	Gibatangan
0.03-0.20	2.06	0.48	2.35	2.52	1.86	3.35	1.49
0.21-0.50	0.98	0.56	0.11	0.63	0.51	0.14	0.11
0.51-1.00	0.58	0.97	0.092	0.57	0.38	0.15	0.14
1.01-2.00	0.067	0.88	0.31	0.55	0.46	0.4	0.17
2.01-5.00	0.0051	0.19	0.084	0.047	0.27	0.18	0.15
> 5.00	0	0.007	0.0062	0	0	0.038	0.055

Table 71. Affected areas in Laoang, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Laoang (in sq. km.)**						
	La Perla	Lawaan	Oleras	Palmera	Rawis	Rombang	San Antonio
0.03-0.20	1.11	4.79	5.04	1.12	2.11	4.11	2.4
0.21-0.50	0.25	1.93	0.41	0.072	0.49	0.26	0.37
0.51-1.00	0.63	0.42	0.56	0.05	0.12	0.28	0.4
1.01-2.00	1.27	0.069	0.45	0.026	0.0034	0.67	1.31
2.01-5.00	0.18	0	0.15	0.0031	0	0.34	0.6
> 5.00	0	0	0.058	0	0	0.069	0.097

Table 72. Affected areas in Laoang, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Laoang (in sq. km.)**						
	Sibunot	Simora	Talisay	Tarusan	Tinoblan	Vigo	Yapas
0.03-0.20	2.77	2.23	0.92	1.07	1.58	1.33	2.88
0.21-0.50	0.43	0.44	0.045	1.23	0.15	1.18	0.21
0.51-1.00	0.7	0.54	0.12	2.39	0.43	1.18	0.15
1.01-2.00	0.5	0.67	0	0.27	0.84	0.94	0.22
2.01-5.00	0.14	0.15	0	0.0034	0.36	0.42	0.1
> 5.00	0.016	0.36	0	0	0.018	0	0

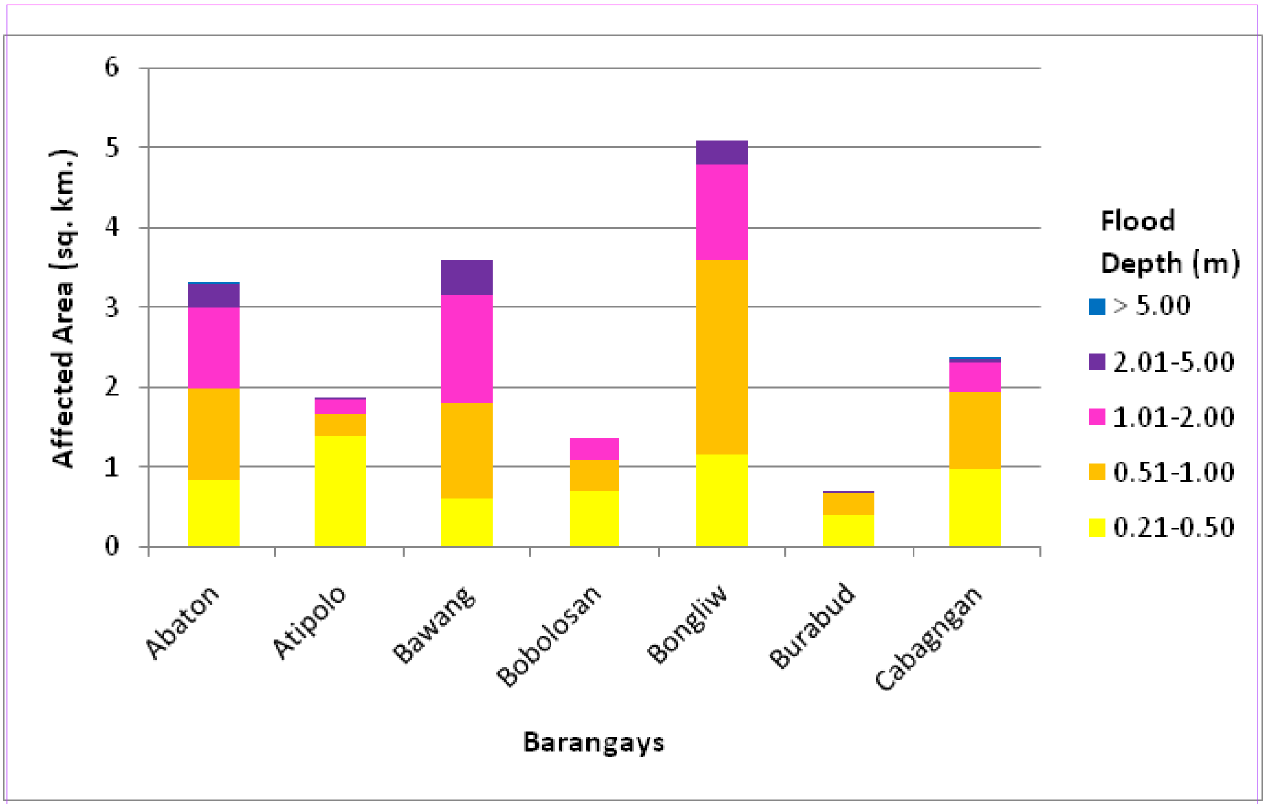


Figure 115. Affected areas in Laoang, Northern Samar during a 25-year rainfall return period

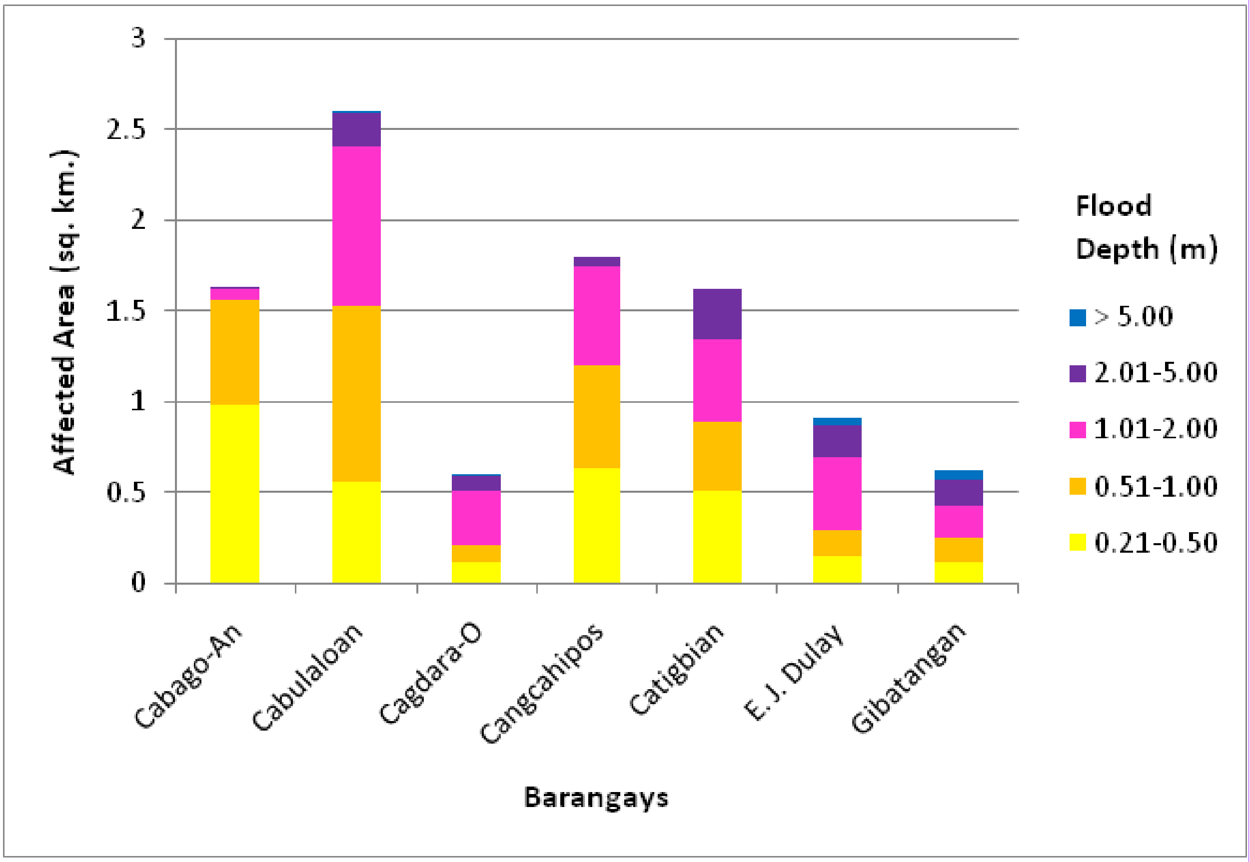


Figure 116. Affected areas in Laoang, Northern Samar during a 25-year rainfall return period

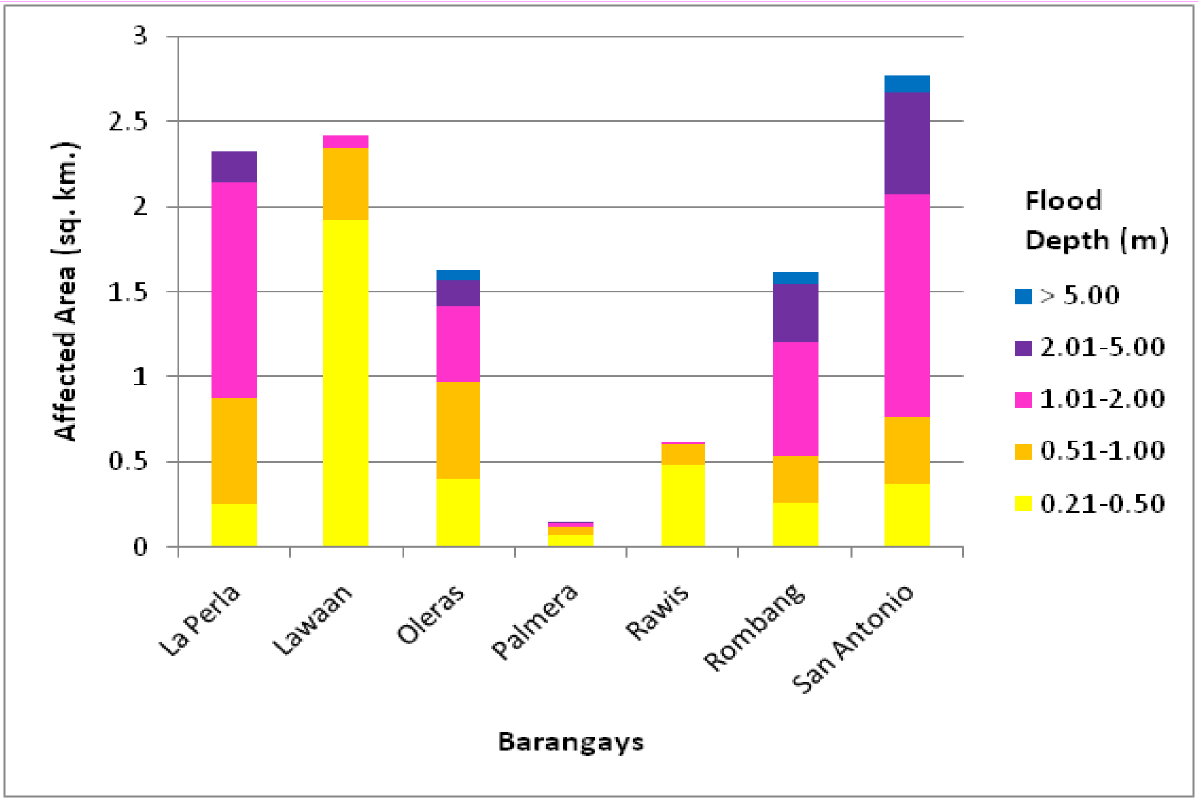


Figure 117. Affected areas in Laoang, Northern Samar during a 25-year rainfall return period

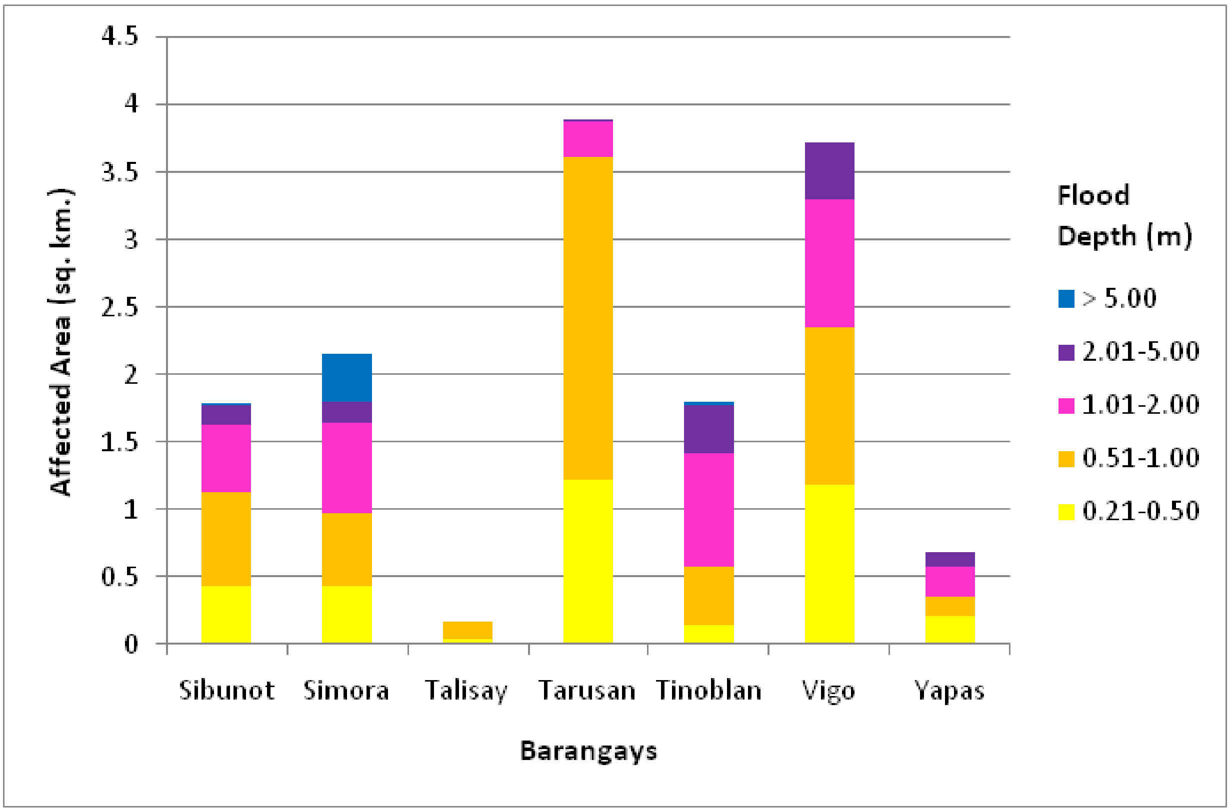


Figure 118. Affected areas in Laoang, Northern Samar during a 25-year rainfall return period

For the Municipality of Las Navas, with an area of 267.47 square kilometers, 57.03% will experience flood levels of less than 0.20 meters. 5.67% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 7.49%, 9.94%, 8.58%, and 3.23% 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. Tables 73-79 depict the affected areas, in square kilometers, by flood depth per barangay.

Table 73. Affected areas in Las Navas, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Las Navas (in sq. km.)**							
by flood depth (in m.)	Balugo	Bugay	Bugtosan	Bukid	Bulao	Caputoan	Catoto-Ogan	Cuenco
0.03-0.20	0.3	1.96	1.76	2.9	1.75	4.16	15	4.8
0.21-0.50	0.021	0.27	0.49	0.36	0.63	0.22	1.61	0.25
0.51-1.00	0.041	0.54	0.71	0.54	1.11	0.27	1.87	0.28
1.01-2.00	0.39	1.28	0.66	0.79	0.71	0.26	1.72	0.38
2.01-5.00	1.72	0.36	0.17	0.32	0.081	0.033	0.43	0.28
> 5.00	0.016	0.064	0.15	0	0	0	0.0091	0.031

Table 74. Affected areas in Las Navas, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Las Navas (in sq. km.)**							
by flood depth (in m.)	Dapdap	Del Pilar	Dolores	Epaw	Geguinta	Geracdo	Guyo	H. Jolejole
0.03-0.20	1.38	0.47	3.21	2.12	0.8	0.15	0.88	1.64
0.21-0.50	0.05	0.019	0.3	0.092	0.15	0.027	0.084	0.2
0.51-1.00	0.073	0.025	0.18	0.1	0.25	0.09	0.077	0.2
1.01-2.00	0.14	0.049	0.094	0.14	0.48	0.47	0.069	0.18
2.01-5.00	0.5	0.55	0.02	0.31	0.28	0.5	0.61	0.068
> 5.00	1.45	1.36	0.0001	0.47	0.041	0.027	0.034	0

Table 75. Affected areas in Las Navas, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Las Navas (in sq. km.)							
by flood depth (in m.)	H. Jolejole District	Hangi	Imelda	L. Empon	Lakandula	Lourdes	Lumala-Og	Mabini
0.03-0.20	0.042	1.65	1.71	1.66	2.14	4.68	0.81	2.03
0.21-0.50	0.018	0.21	0.12	0.15	0.13	0.39	0.058	0.33
0.51-1.00	0.047	0.26	0.17	0.22	0.15	0.79	0.15	0.54
1.01-2.00	0.16	0.73	0.24	0.47	0.18	0.41	0.5	0.93
2.01-5.00	0.068	3.65	0.09	0.28	0.14	0.014	1.05	0.49
> 5.00	0.042	0.35	0	0.16	0.016	0	0.1	0.2

Table 76. Affected areas in Las Navas, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Las Navas (in sq. km.)							
by flood depth (in m.)	Macarthur	Magsaysay	Matelarag	Osmeña	Paco	Palanas	Perez	Poponton
0.03-0.20	4.06	1.94	1.28	0.6	2.33	6.69	4.01	2.99
0.21-0.50	0.37	0.27	0.21	0.12	0.24	0.81	0.47	0.21
0.51-1.00	0.61	0.48	0.2	0.098	0.42	0.73	0.61	0.33
1.01-2.00	0.7	0.47	0.57	0.48	0.72	0.71	0.97	0.59
2.01-5.00	0.14	0.12	0.77	1.21	0.42	0.41	0.31	0.3
> 5.00	0.065	0.0068	0.11	0.0025	0.13	0.002	0.074	0.084

Table 77. Affected areas in Las Navas, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Las Navas (in sq. km.)							
by flood depth (in m.)	Quezon	Quirino	Rebong	Rizal	Roxas	Rufino	Sag-Od	San Andres
0.03-0.20	2.04	7.87	0.35	3.58	6.02	3.2	2.25	3.18
0.21-0.50	0.35	0.66	0.043	0.33	0.38	0.15	0.091	0.23
0.51-1.00	0.53	0.88	0.065	0.52	0.4	0.13	0.076	0.29
1.01-2.00	0.31	1.41	0.44	0.62	0.6	0.1	0.059	0.24
2.01-5.00	0.015	0.6	0.95	0.27	0.23	0.012	0.018	0.26
> 5.00	0	0.11	0.088	0.073	0.0067	0.0028	0	0.011

Table 78. Affected areas in Las Navas, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Las Navas (in sq. km.)							
by flood depth (in m.)	San Antonio	San Fernando	San Francisco	San Isidro	San Jorge	San Jose	San Miguel	Santo Tomas
0.03-0.20	2.4	1.03	6.37	14.19	1.84	2.03	3.48	1.59
0.21-0.50	0.37	0.57	0.37	0.85	0.2	0.26	0.4	0.33
0.51-1.00	0.4	0.59	0.37	1.21	0.18	0.32	0.71	0.23
1.01-2.00	1.31	0.16	0.37	1.33	0.043	0.43	0.92	0.15
2.01-5.00	0.6	0.013	0.08	0.71	0.0006	0.33	0.23	0.11
> 5.00	0.097	0	0.0039	2.19	0	0.017	0.049	0

Table 79. Affected areas in Las Navas, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Las Navas (in sq. km.)			
by flood depth (in m.)	Tagab-Iran	Tagan-Ayan	Taylor	Victory
0.03-0.20	0.74	5.14	0.99	2.36
0.21-0.50	0.033	0.44	0.1	0.13
0.51-1.00	0.035	0.48	0.24	0.23
1.01-2.00	0.081	0.46	0.46	0.45
2.01-5.00	1.75	0.53	0.39	0.17
> 5.00	0.59	0.23	0.14	0.043

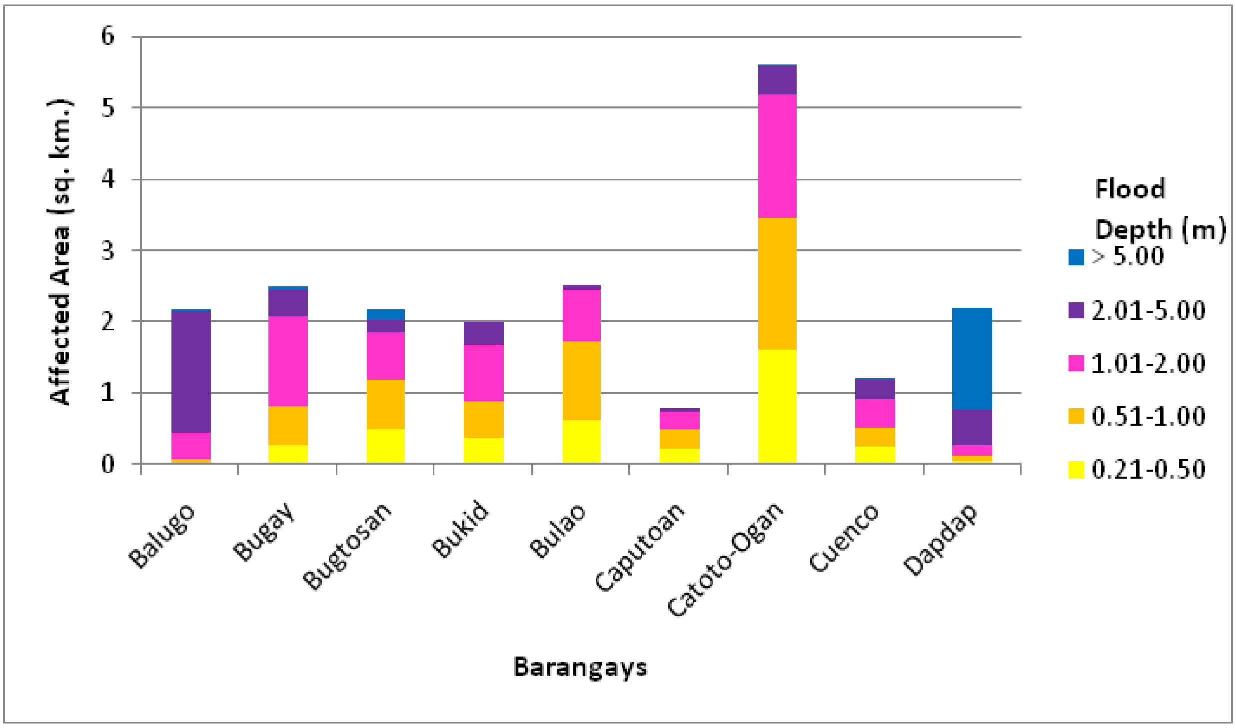


Figure 119. Affected areas in Las Navas, Northern Samar during a 25-year rainfall return period

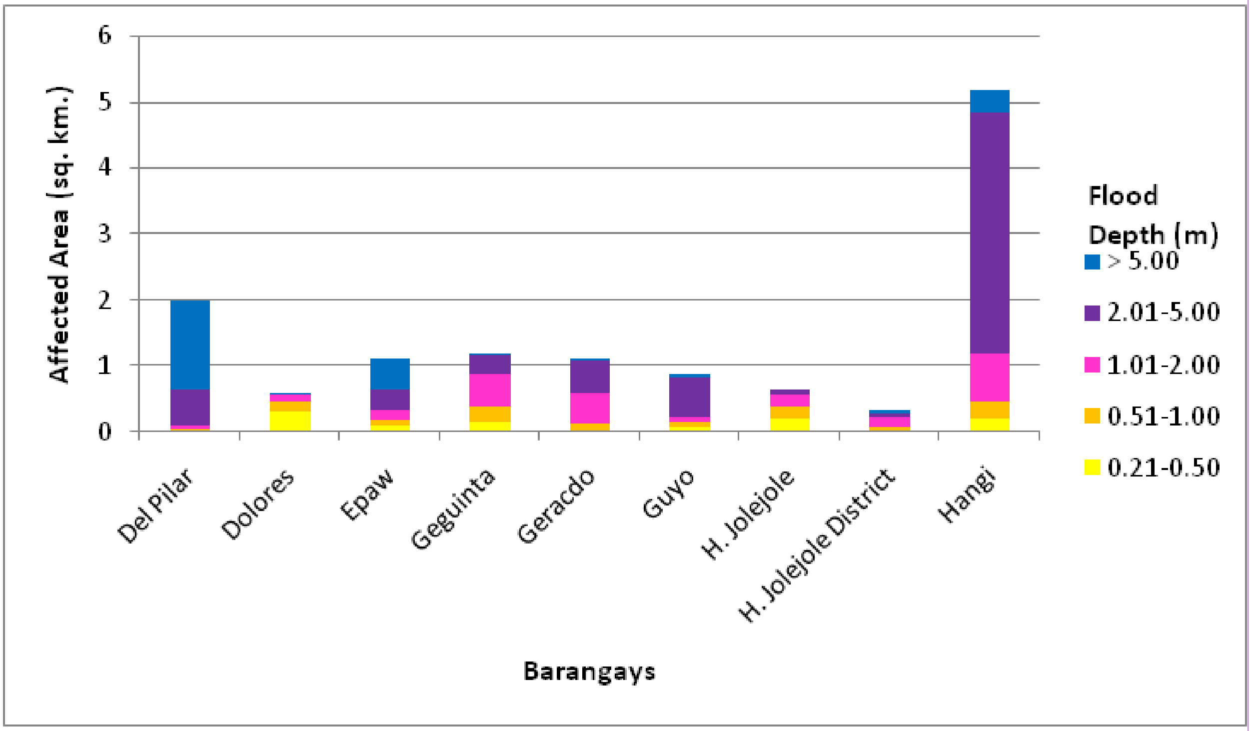


Figure 120. Affected areas in Las Navas, Northern Samar during a 25-year rainfall return period

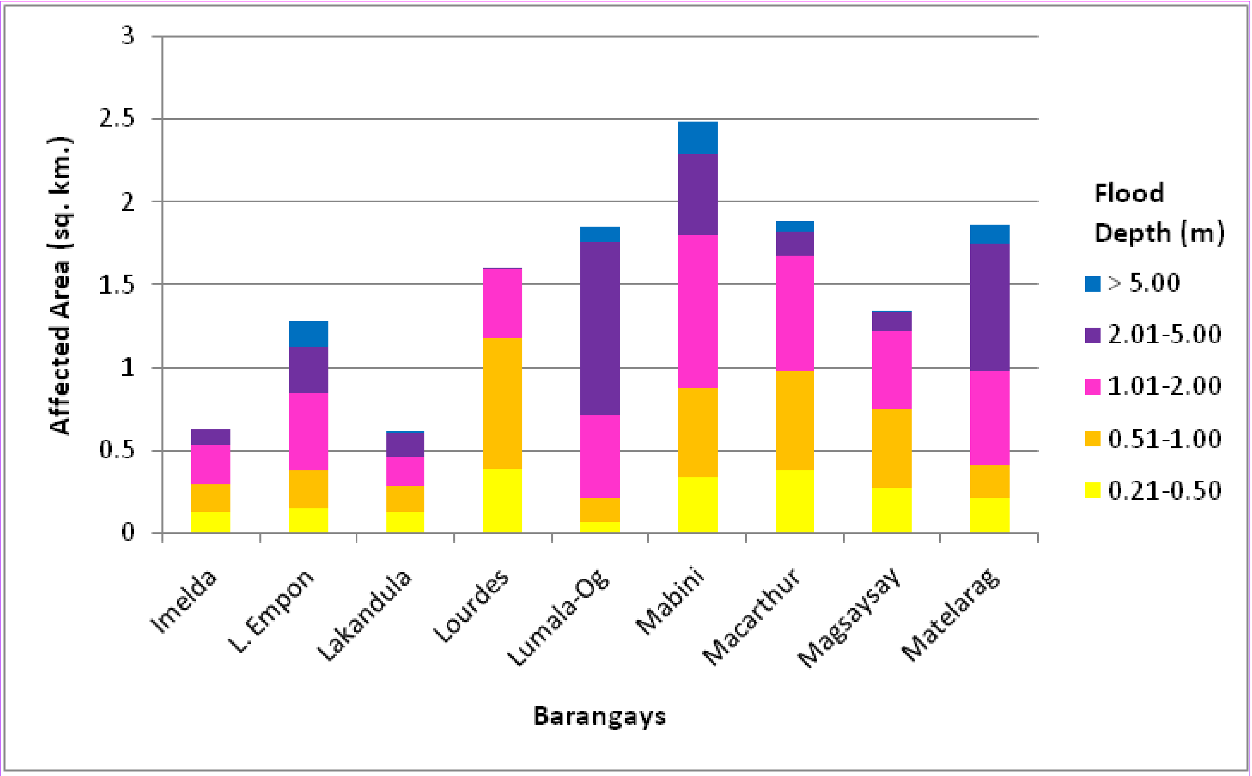


Figure 121. Affected areas in Las Navas, Northern Samar during a 25-year rainfall return period

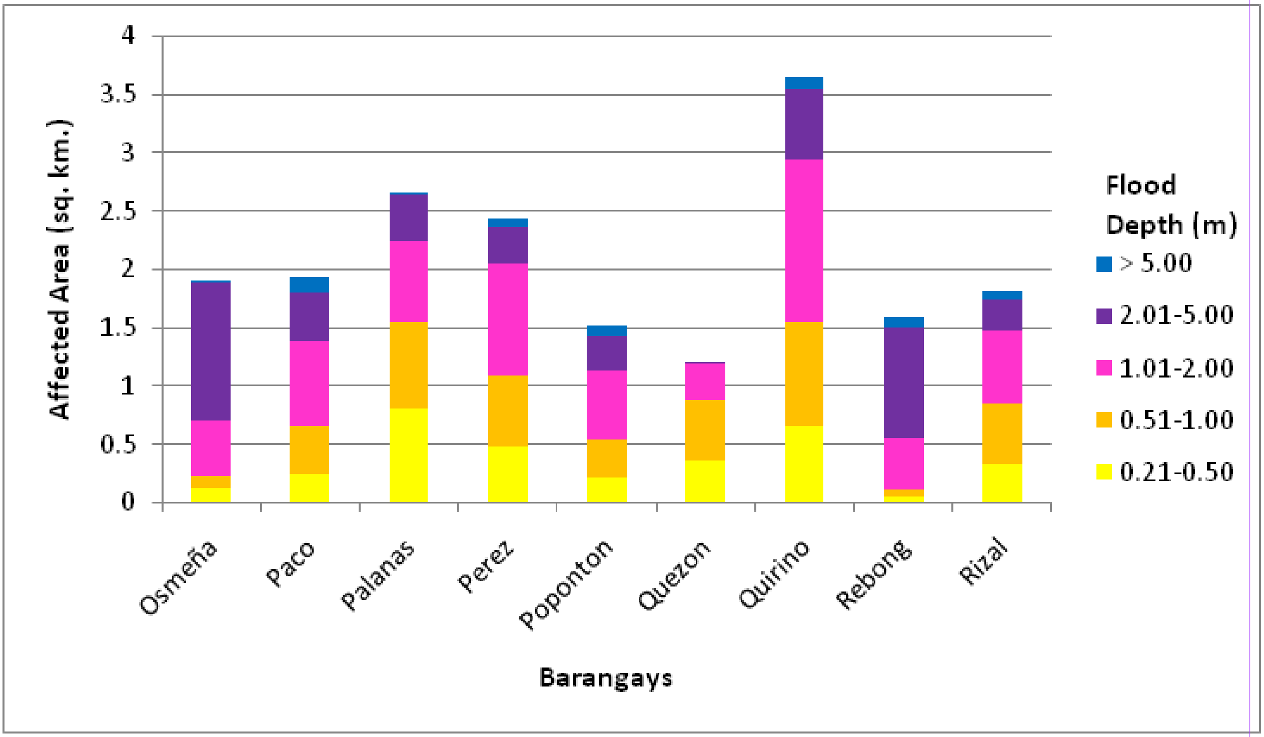


Figure 122. Affected areas in Las Navas, Northern Samar during a 25-year rainfall return period

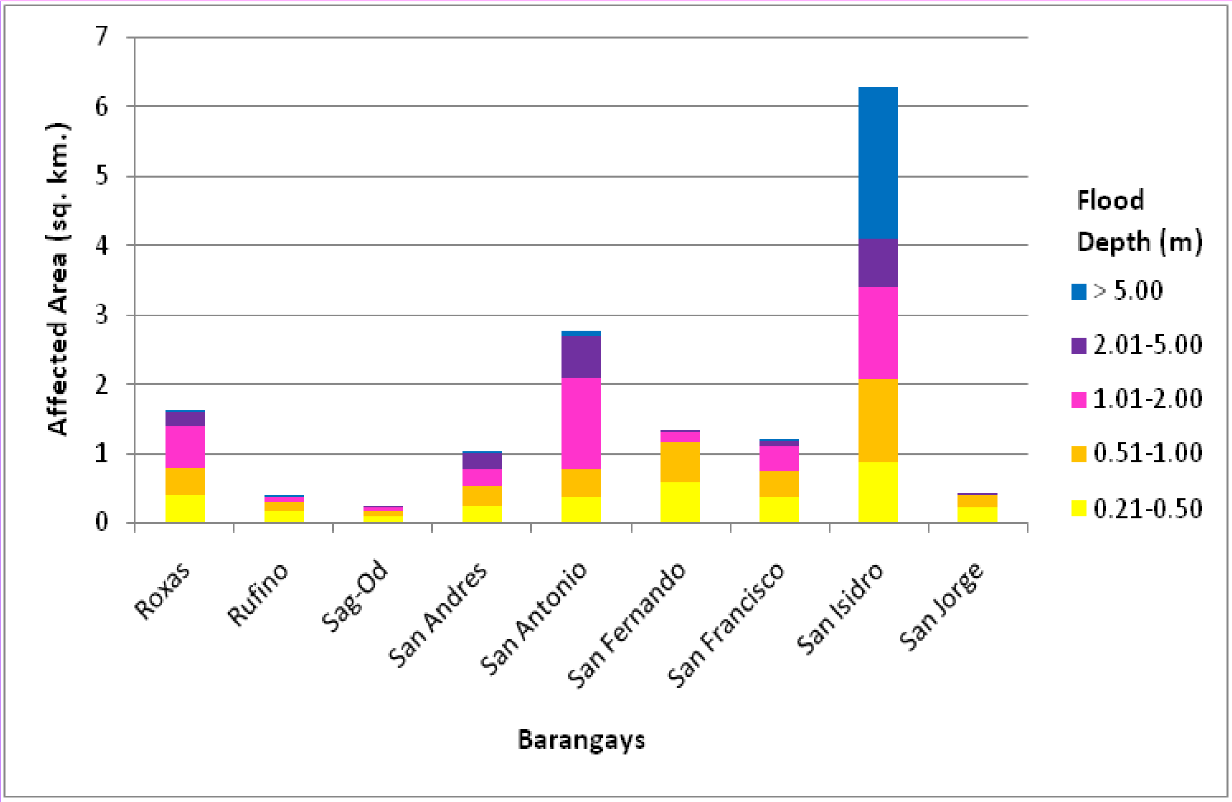


Figure 123. Affected areas in Las Navas, Northern Samar during a 25-year rainfall return period

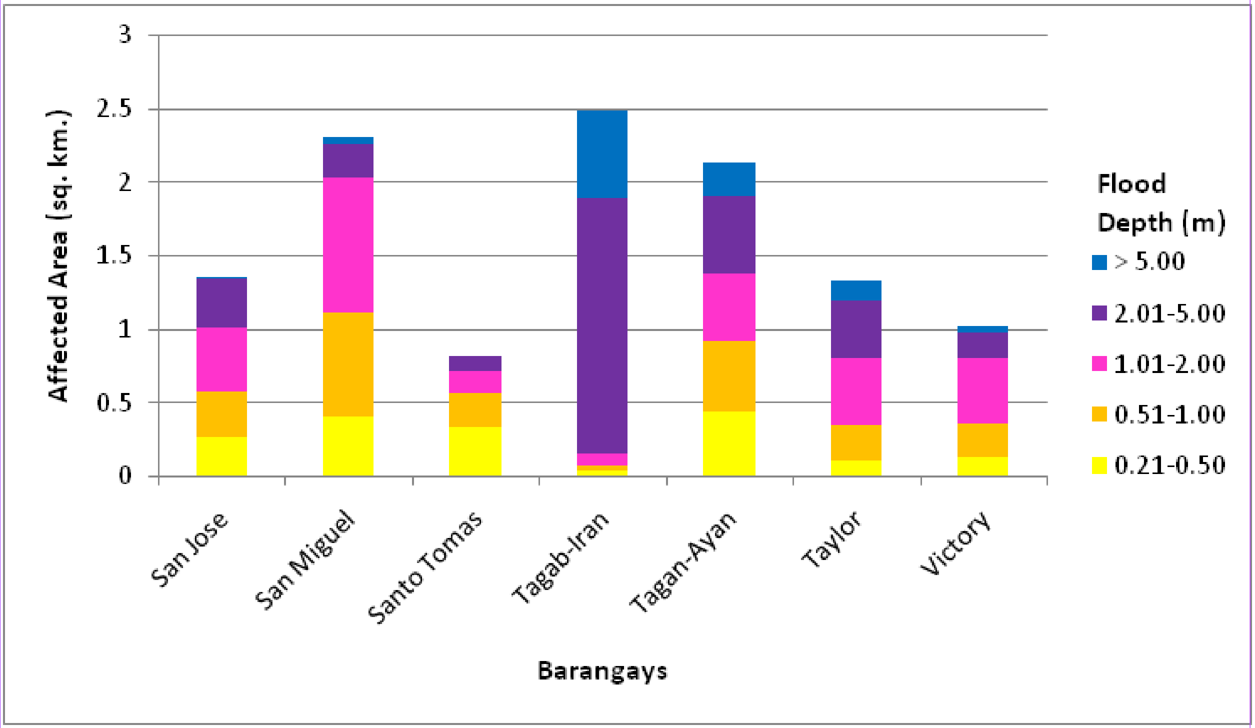


Figure 124. Affected areas in Las Navas, Northern Samar during a 25-year rainfall return period

For the Municipality of Mapanas, with an area of 143.56 square kilometers, 17.15% will experience flood levels of less than 0.20 meters. 0.82% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 0.60%, 0.69%, 0.85%, and 0.59% 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. Table 80 depicts the affected areas, in square kilometers, by flood depth per barangay.

Table 80. Affected areas in Mapanas, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	Affected Barangays in Mapanas		
	Magtaon	San Jose	Siljagon
0.03-0.20	0.04	2.03	22.55
0.21-0.50	0	0.26	0.91
0.51-1.00	0	0.32	0.54
1.01-2.00	0	0.43	0.56
2.01-5.00	0	0.33	0.89
> 5.00	0	0.017	0.83

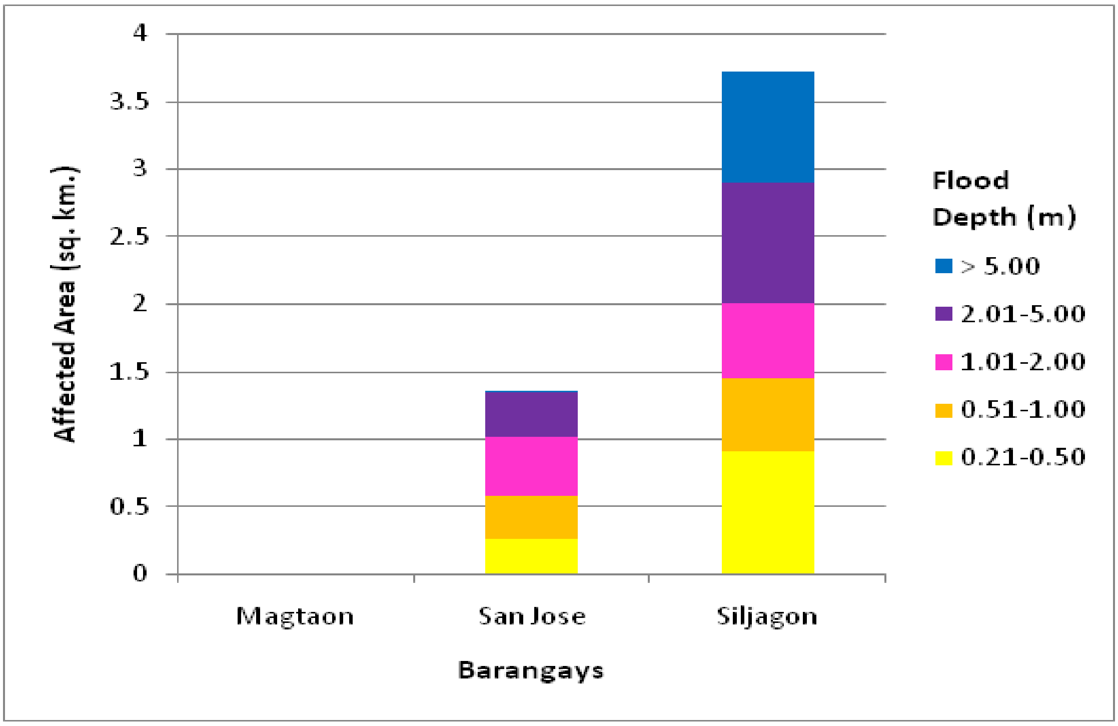


Figure 125. Affected areas in Mapanas, Northern Samar during a 25-year rainfall return period

For the Municipality of Palapag, with an area of 153.46 square kilometers, 60.21% will experience flood levels of less than 0.20 meters. 6.31% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 4.57%, 3.93%, 2.99%, and 0.98% 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. Tables 81-84 depict the affected areas, in square kilometers, by flood depth per barangay.

Table 81. Affected areas in Palapag, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Palapag (in sq. km.)**						
	Asum	Bagacay	Bangon	Benigno S. Aquino, Jr.	Cabariwan	Cabatuan	Campedico
0.03-0.20	0.53	25.4	8.62	0.22	1.74	0.42	1.13
0.21-0.50	0.2	1.03	0.42	0.19	0.11	0.0084	0.063
0.51-1.00	0.21	0.59	0.44	0.26	0.15	0.002	0.029
1.01-2.00	0.026	0.5	0.56	0.18	0.039	0.0001	0.052
2.01-5.00	0	0.74	0.83	0.004	0.076	0	0
> 5.00	0	0.6	0.34	0	0	0	0

Table 82. Affected areas in Palapag, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Palapag (in sq. km.)**						
	Capacujan	Jangtud	Laniwan	Mabaras	Magsaysay	Manajao	Mapno
0.03-0.20	8.78	2.14	0.13	2.87	1.94	0.69	4.24
0.21-0.50	0.4	0.23	0.046	0.32	0.27	0.35	0.45
0.51-1.00	0.22	0.19	0.12	0.22	0.48	0.15	0.2
1.01-2.00	0.3	0.16	0.21	0.13	0.47	0.13	0.059
2.01-5.00	0.33	0.0038	0.052	0.0071	0.12	0.0001	0.014
> 5.00	0.03	0	0.0093	0	0.0068	0	0

Table 83. Affected areas in Palapag, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Palapag (in sq. km.)						
by flood depth (in m.)	Maragano	Matambag	Monbon	Nagbobtac	Napo	Natawo	Nipa
0.03-0.20	1.31	0.79	2.07	6.44	3.34	1.49	2.45
0.21-0.50	0.051	0.27	1.13	0.36	0.61	0.33	0.094
0.51-1.00	0.013	0.44	0.088	0.41	0.67	0.31	0.0092
1.01-2.00	0.0051	0.31	0.0095	0.4	0.64	0.11	0
2.01-5.00	0.001	0.045	0	0.17	0.72	0.0001	0
> 5.00	0	0	0	0.0096	0.15	0	0

Table 84. Affected areas in Palapag, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Palapag (in sq. km.)									
by flood depth (in m.)	Osmeña	Pangpang	Paysud	Sangay	Simora	Sinalaran	Sumoroy	Talolora	Tambangan	Tinampo
0.03-0.20	0.6	2.68	1.71	4.42	2.23	1.17	0.55	0.74	0.57	0.98
0.21-0.50	0.12	0.35	0.4	0.24	0.44	0.12	0.44	0.41	0.22	0.018
0.51-1.00	0.098	0.2	0.11	0.27	0.54	0.061	0.13	0.14	0.26	0.0018
1.01-2.00	0.48	0.085	0.064	0.16	0.67	0.073	0.1	0.093	0.0089	0
2.01-5.00	1.21	0	0.012	0.068	0.15	0	0.0012	0.016	0.012	0
> 5.00	0.0025	0	0	0.0001	0.36	0	0	0	0	0

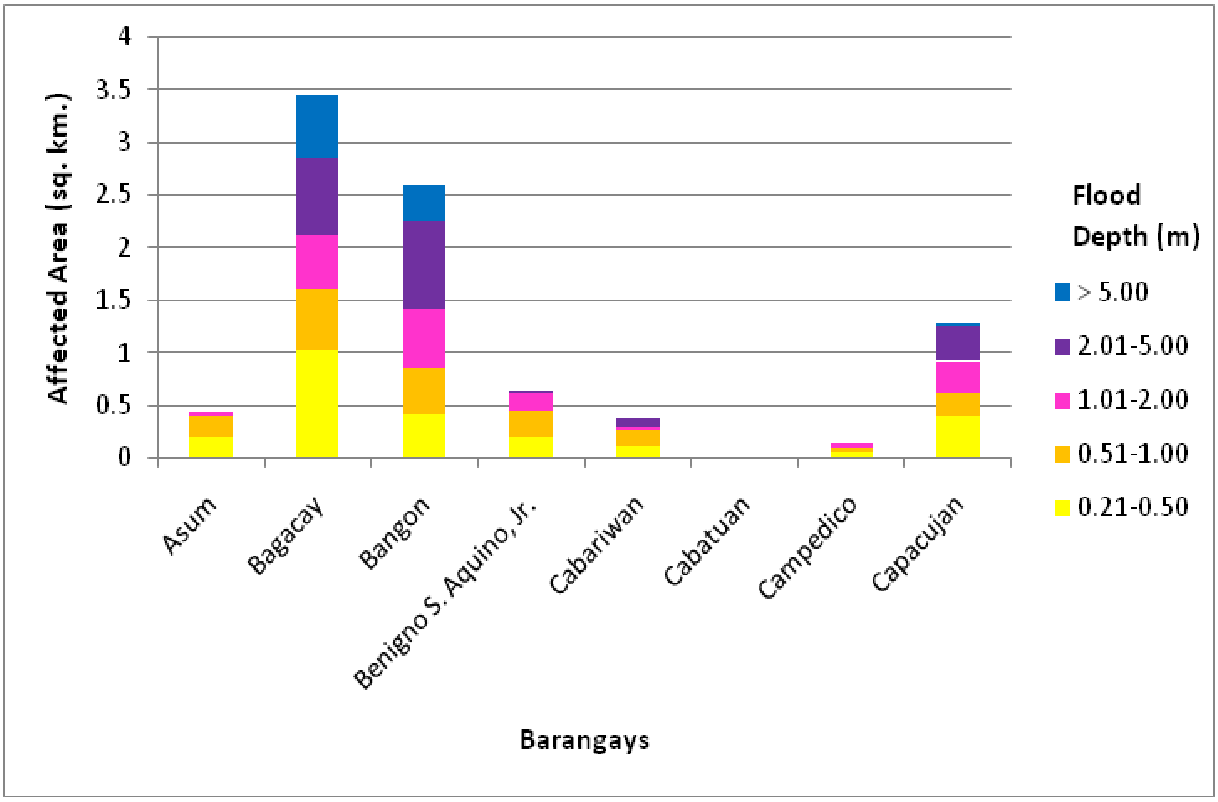


Figure 126. Affected areas in Palapag, Northern Samar during a 25-year rainfall return period

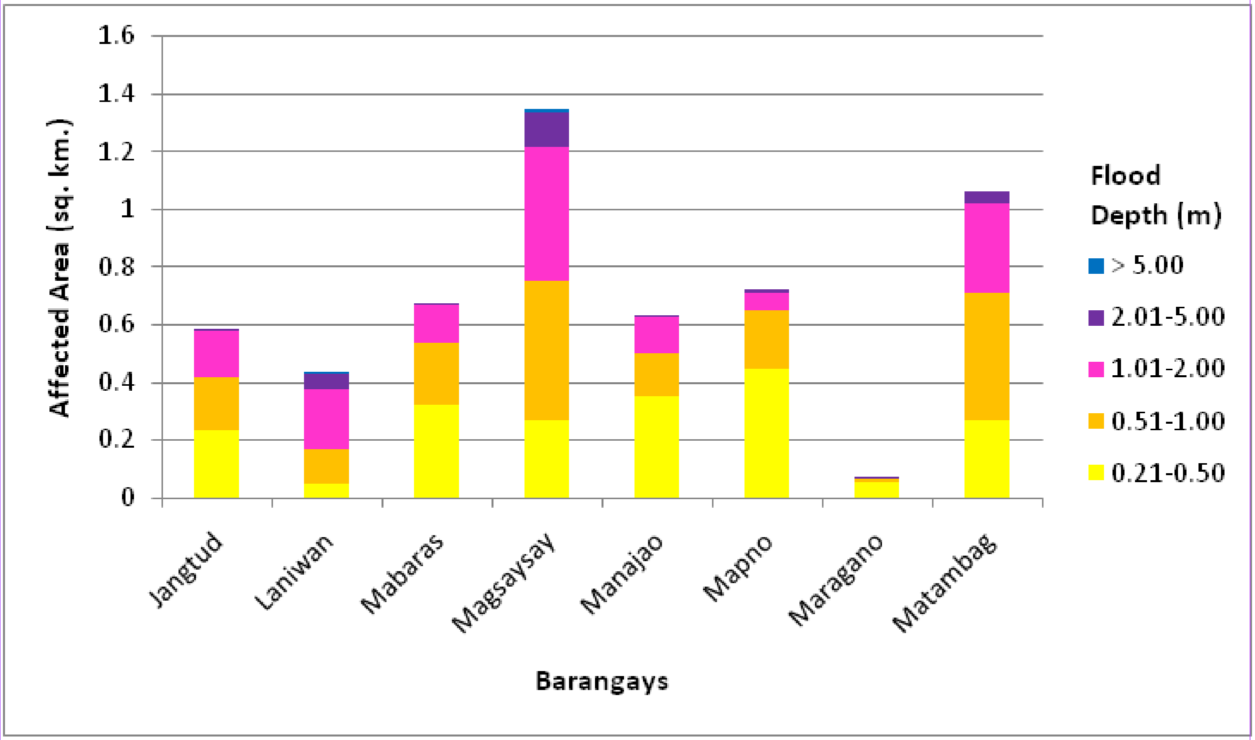


Figure 127. Affected areas in Palapag, Northern Samar during a 25-year rainfall return period

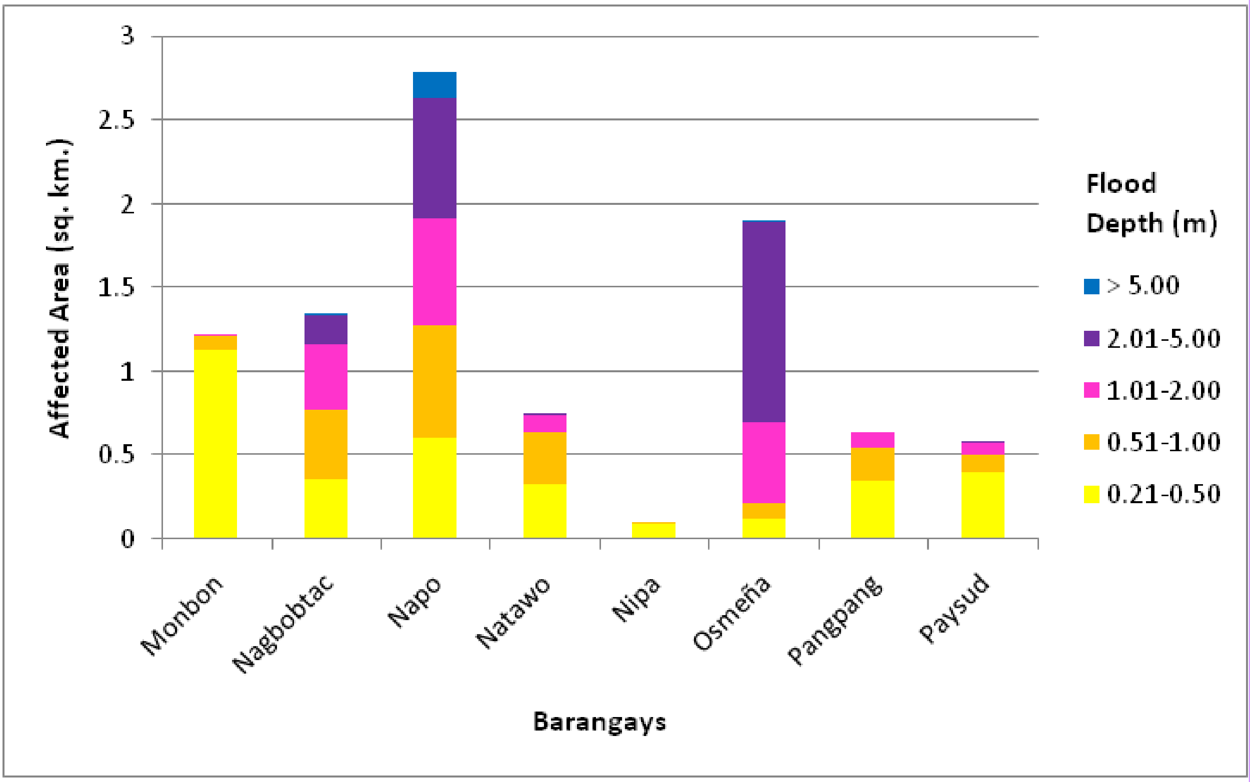


Figure 128. Affected areas in Palapag, Northern Samar during a 25-year rainfall return period

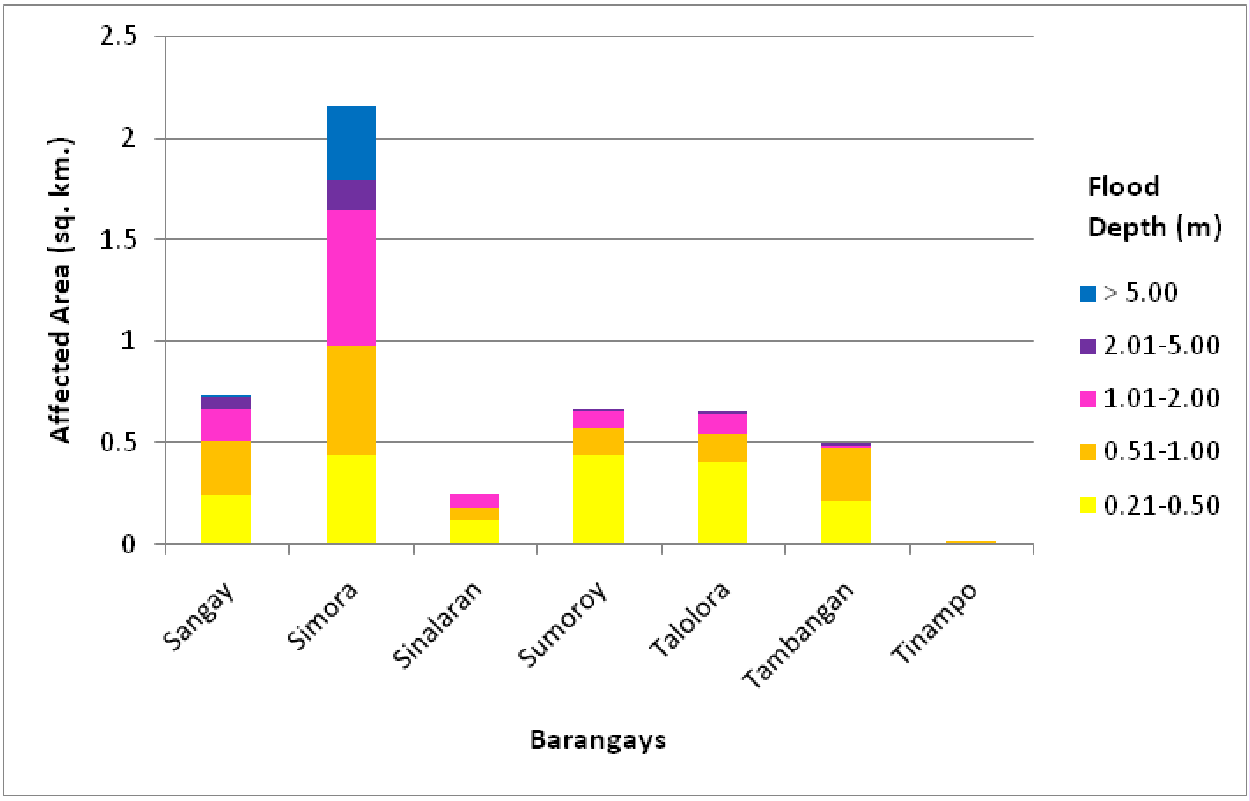


Figure 129. Affected areas in Palapag, Northern Samar during a 25-year rainfall return period

For the Municipality of Pambujan, with an area of 150.63 square kilometers, 4.73% will experience flood levels of less than 0.20 meters. 0.21% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 0.12%, 0.08%, 0.04%, and 0.002% 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. Table 85 depicts the affected areas, in square kilometers, by flood depth per barangay.

Table 85. Affected areas in Pambujan, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.)	**Affected Barangays in Pambujan**			
by flood depth (in m.)	Geparayan	Ginulgan	Inanahawan	Sixto T. Balanguit, Sr.
0.03-0.20	1.91	1.41	0.73	3.08
0.21-0.50	0.11	0.055	0.028	0.12
0.51-1.00	0.066	0.031	0.019	0.06
1.01-2.00	0.042	0.025	0.0053	0.05
2.01-5.00	0.0075	0.0099	0.00071	0.049
> 5.00	0	0	0	0.0031

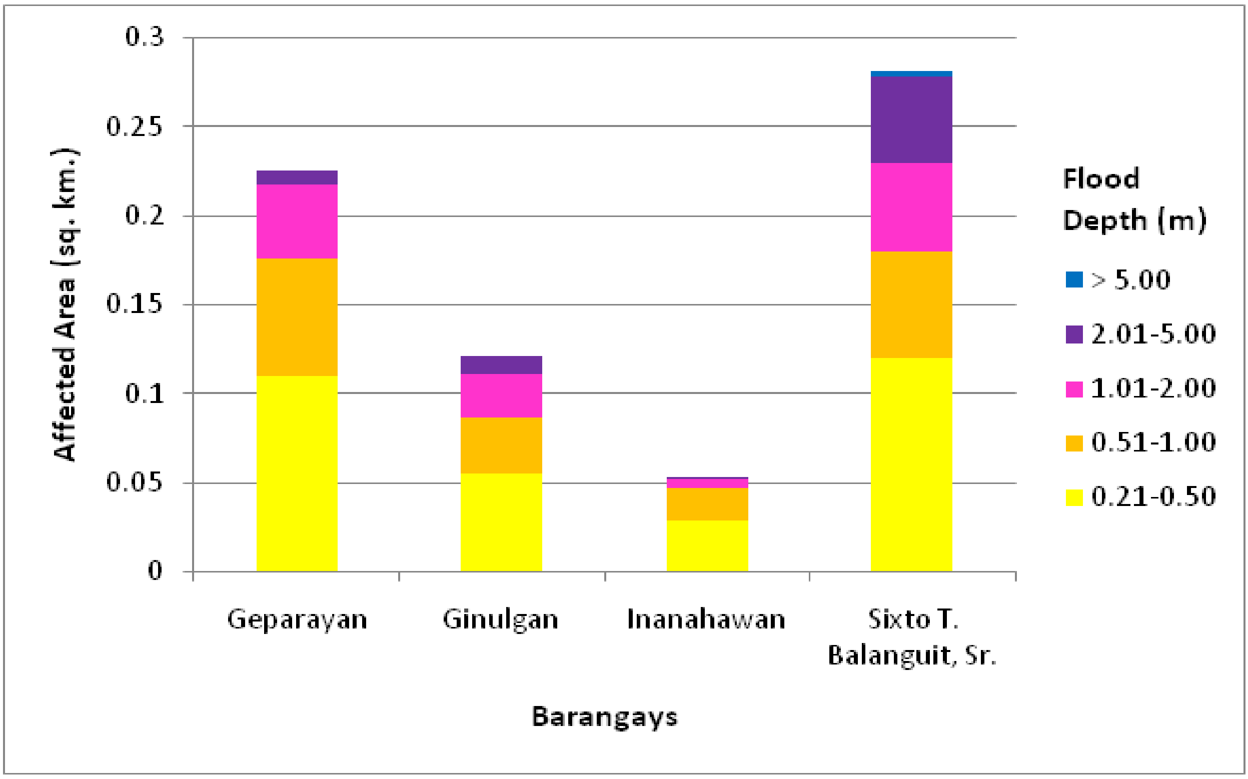


Figure 130. Affected areas in Pambujan, Northern Samar during a 25-year rainfall return period

For the Municipality of Silvino Lobos, with an area of 255.34 square kilometers, 6.001% will experience flood levels of less than 0.20 meters. 0.29% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile 0.35%, 0.46%, and 0.13% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and more than 2 meters, respectively. Table 86 depicts the affected areas, in square kilometers, by flood depth per barangay.

Table 86. Affected areas in Silvino Lobos, Northern Samar during a 25-year rainfall return period

Affected Area (sq. km.)	**Affected Barangays in Silvino Lobos**		
by flood depth (in m.)	Balud	Geparayan de Turag	Senonogan de Tubang
0.03-0.20	0.044	9.08	6.2
0.21-0.50	0.0012	0.44	0.29
0.51-1.00	0.0014	0.54	0.36
1.01-2.00	0.0037	0.71	0.46
2.01-5.00	0.0018	0.14	0.18
> 5.00	0	0	0

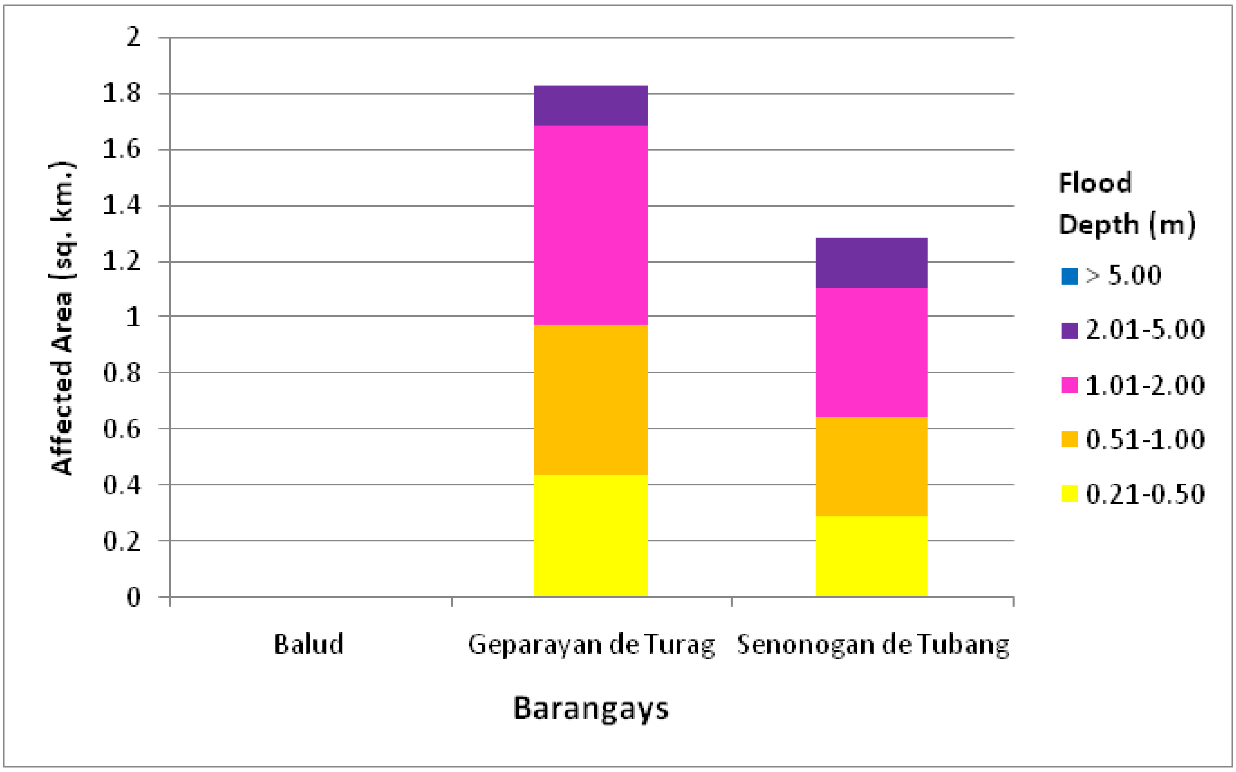


Figure 131. Affected areas in Silvino Lobos, Northern Samar during a 25-year rainfall return period

For the Municipality of Matuguinao, with an area of 368.83 square kilometers, 1.13% will experience flood levels of less than 0.20 meters. 0.05% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 0.05%, 0.05%, and 0.01% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and more than 2 meters, respectively. Table 87 depicts the affected areas, in square kilometers, by flood depth per barangay.

Table 87. Affected areas in Matuguinao, Samar during a 25-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Matuguinao (in sq. km.)**	
	Camonoan	Ligaya
0.03-0.20	4.04	0.12
0.21-0.50	0.2	0.0011
0.51-1.00	0.2	0.00087
1.01-2.00	0.17	0.0001
2.01-5.00	0.052	0.0002
> 5.00	0	0

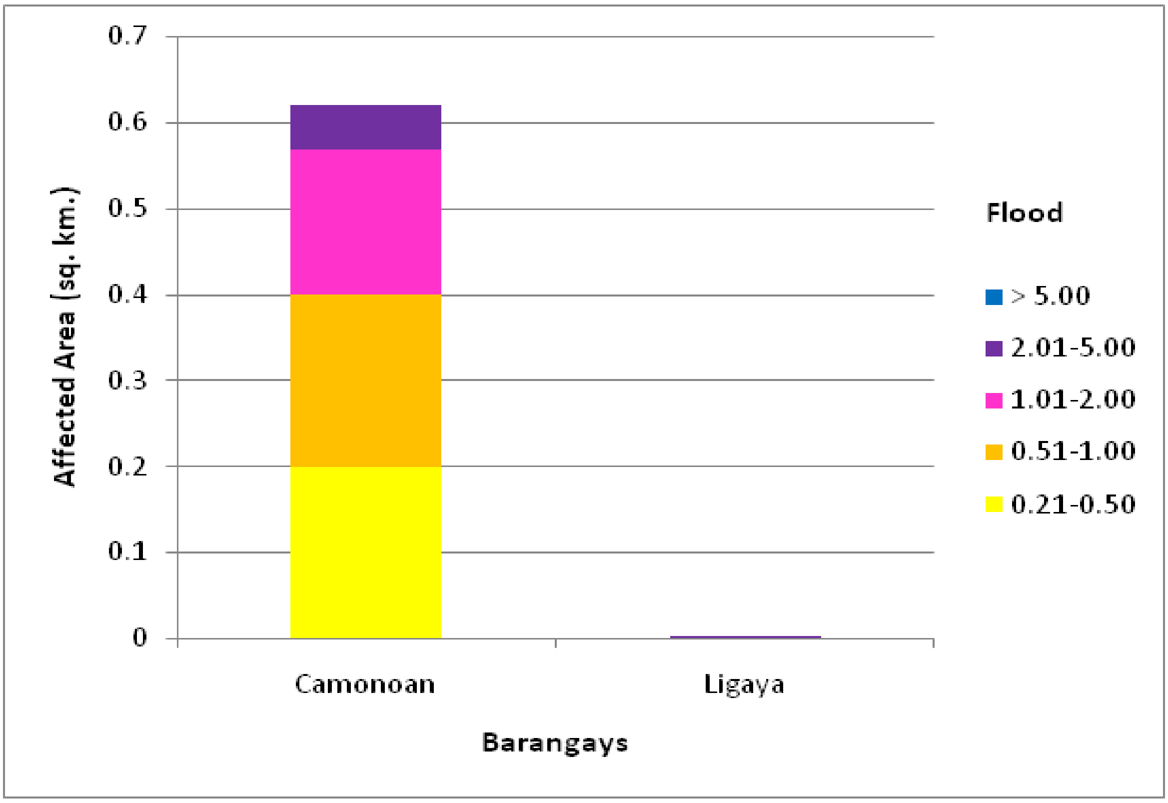


Figure 132. Affected areas in Matuguinao, Samar during a 25-year rainfall return period

For the 100-year return period, 0.78% of the municipality of Jipapad, with an area of 173.29 square kilometers, will experience flood levels of less than 0.20 meters. 0.05% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 0.05%, 0.02%, 0.0002%, and 0.15% 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. Table 88 depicts the areas affected in Jipapad, in square kilometers, by flood depth per barangay.

Table 88. Affected areas in Jipapad, Eastern Samar during a 100-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Areas affected barangays in Jipapad (in sq. km.)**	
	Cagmanaba	San Roque
0.03-0.20	0.79	0.57
0.21-0.50	0.044	0.045
0.51-1.00	0.037	0.048
1.01-2.00	0.029	0.011
2.01-5.00	0.0004	0
> 5.00	0.26	0

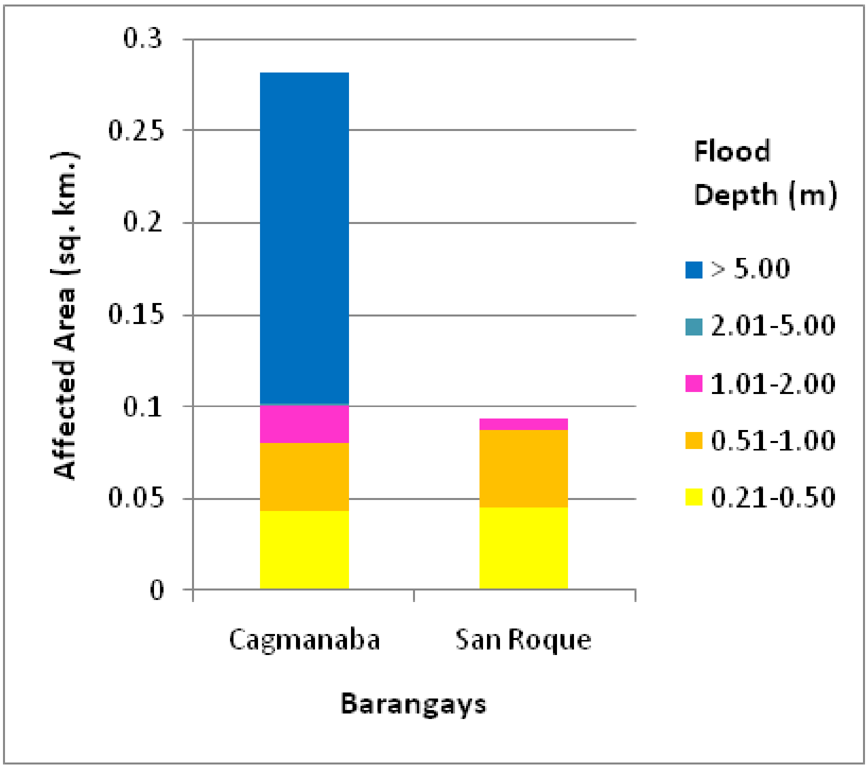


Figure 133. Affected areas in Jipapad, Eastern Samar during a 100-year rainfall return period

For the Municipality of Catubig, with an area of 217.59 square kilometers, 50.13% will experience flood levels of less than 0.20 meters. 3.74% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 3.39%, 6.58%, 9.39%, and 1.36% 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. Tables 89-93 depict the affected areas, in square kilometers, by flood depth per barangay.

Table 89. Affected areas in Catubig, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Catubig (in sq. km.)**								
by flood depth (in m.)	Anongo	Barangay 1	Barangay 2	Barangay 3	Barangay 4	Barangay 5	Barangay 6	Barangay 7	Barangay 8
0.03-0.20	2.43	0.45	0.034	0.0097	0.0064	0.0031	0.002	0	0.0042
0.21-0.50	0.34	0.092	0.0044	0.0034	0.0059	0.007	0.004	0.000047	0.0014
0.51-1.00	0.45	0.041	0.0071	0.0057	0.01	0.015	0.019	0.011	0.0049
1.01-2.00	1.42	0.027	0.03	0.011	0.0082	0.0081	0.0054	0.03	0.011
2.01-5.00	1.54	0.0055	0.069	0.0028	0.0037	0.0046	0.0051	0.02	0.034
> 5.00	0.1	0	0.014	0	0	0	0.00059	0.0098	0.026

Table 90. Affected areas in Catubig, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Catubig (in sq. km.)**								
by flood depth (in m.)	Bonifacio	Boring	Cagbugna	Cagmanaba	Cagogobngan	Calingnan	Canuctan	Claro M. Recto	D. Mercader
0.03-0.20	0.85	0.55	0.24	0.79	0.98	1.08	0.95	7.17	1.36
0.21-0.50	0.078	0.012	0.078	0.044	0.092	0.22	0.24	0.34	0.077
0.51-1.00	0.13	0.0056	0.041	0.037	0.15	0.093	0.15	0.27	0.035
1.01-2.00	0.74	0.0065	0.21	0.029	0.29	0.25	0.27	0.28	0.06
2.01-5.00	1.16	0.003	0.18	0.0004	0.49	0.46	0.64	0.073	0.22
> 5.00	0.016	0	0	0.26	0.0075	0.0076	0	0.012	0.0014

Table 91. Affected areas in Catubig, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Catubig (in sq. km.)								
by flood depth (in m.)	Guibwangan	Hinagonoyan	Hiparayan	Hitapi-An	Inoburan	Irawahan	Lenoyahan	Libon	Magongon
0.03-0.20	0.14	1.37	5.49	5.7	0.15	5.1	0.26	0.1	7.39
0.21-0.50	0.044	0.077	0.32	0.37	0.027	0.23	0.061	0.004	0.42
0.51-1.00	0.13	0.065	0.33	0.28	0.022	0.33	0.25	0.0082	0.26
1.01-2.00	0.13	0.086	0.44	0.57	0.11	0.51	1.17	0.019	0.25
2.01-5.00	0.12	0.014	0.23	0.26	1.25	0.71	0.67	1.04	0.87
> 5.00	0.004	0	0.12	0.0008	0.16	0.38	0	0.17	0.014

Table 92. Affected areas in Catubig, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Catubig (in sq. km.)								
by flood depth (in m.)	Magtuad	Manering	Nabulo	Nagoocan	Nahulid	Opong	Osang	Osmeña	P. Rebadulla
0.03-0.20	0.72	11.18	2.02	1.41	0.11	13.35	2.25	0.54	9.2
0.21-0.50	0.057	0.48	0.078	0.11	0.021	1.1	0.17	0.093	0.38
0.51-1.00	0.075	0.21	0.043	0.22	0.062	1.03	0.11	0.091	0.25
1.01-2.00	0.11	0.21	0.064	0.47	0.16	0.78	0.16	0.11	0.22
2.01-5.00	1.14	0.45	0.16	0.11	0.7	0.71	0.041	1.59	0.29
> 5.00	0.15	0.64	0.018	0.0016	0.067	0.013	0	0.079	0.24

Table 93. Affected areas in Catubig, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Catubig (in sq. km.)**										
by flood depth (in m.)	Roxas	Sagudsuron	San Antonio	San Francisco	San Jose	San Vicente	Santa Fe	Sulitan	Tangbo	Tungodnon	Vienna Maria
0.03-0.20	5.91	1.95	2.27	6.29	1.91	0.75	1.17	0.44	3.1	1.21	0.68
0.21-0.50	0.4	0.15	0.32	0.37	0.23	0.06	0.2	0.028	0.57	0.079	0.056
0.51-1.00	0.32	0.094	0.27	0.36	0.28	0.058	0.21	0.019	0.38	0.052	0.099
1.01-2.00	0.7	0.13	1.02	0.44	0.45	0.57	0.38	0.048	1.1	0.083	0.15
2.01-5.00	0.3	0.39	1.17	0.11	0.48	0.29	0.098	0.78	0.95	0.016	0.59
> 5.00	0.014	0.005	0.12	0.0066	0.041	0.068	0.022	0.13	0	0	0.041

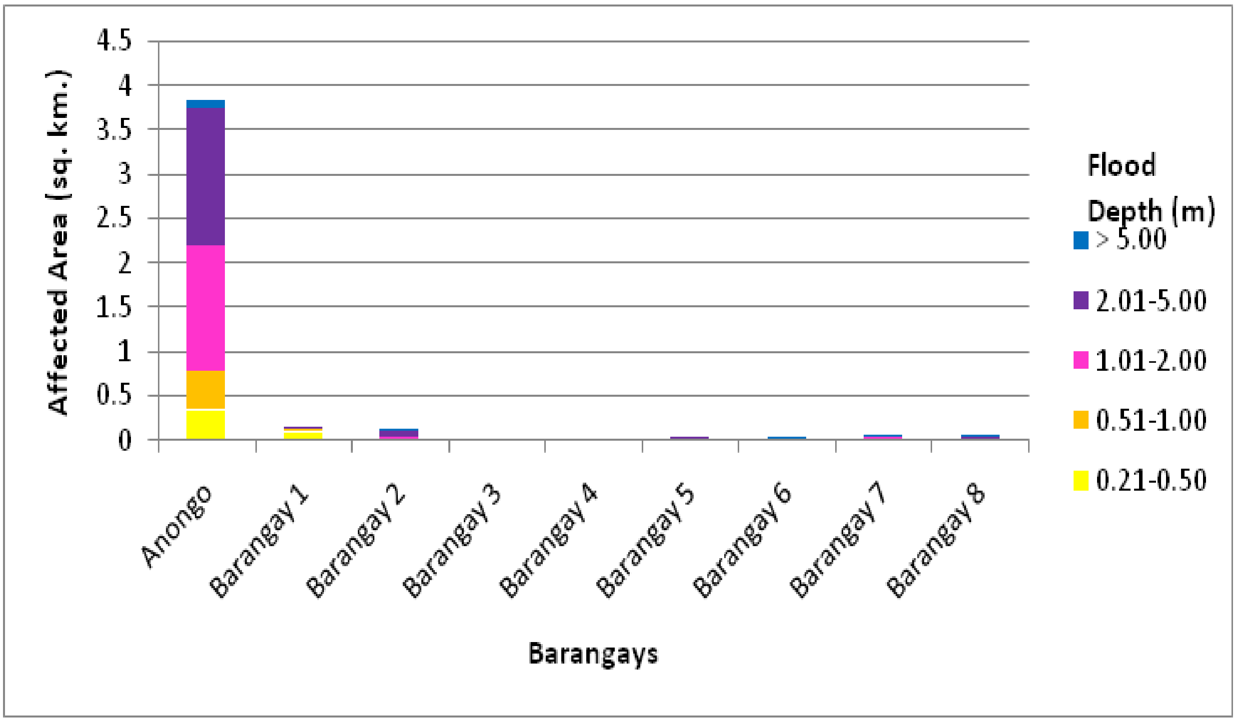


Figure 134. Affected areas in Catubig, Northern Samar during a 100-year rainfall return period

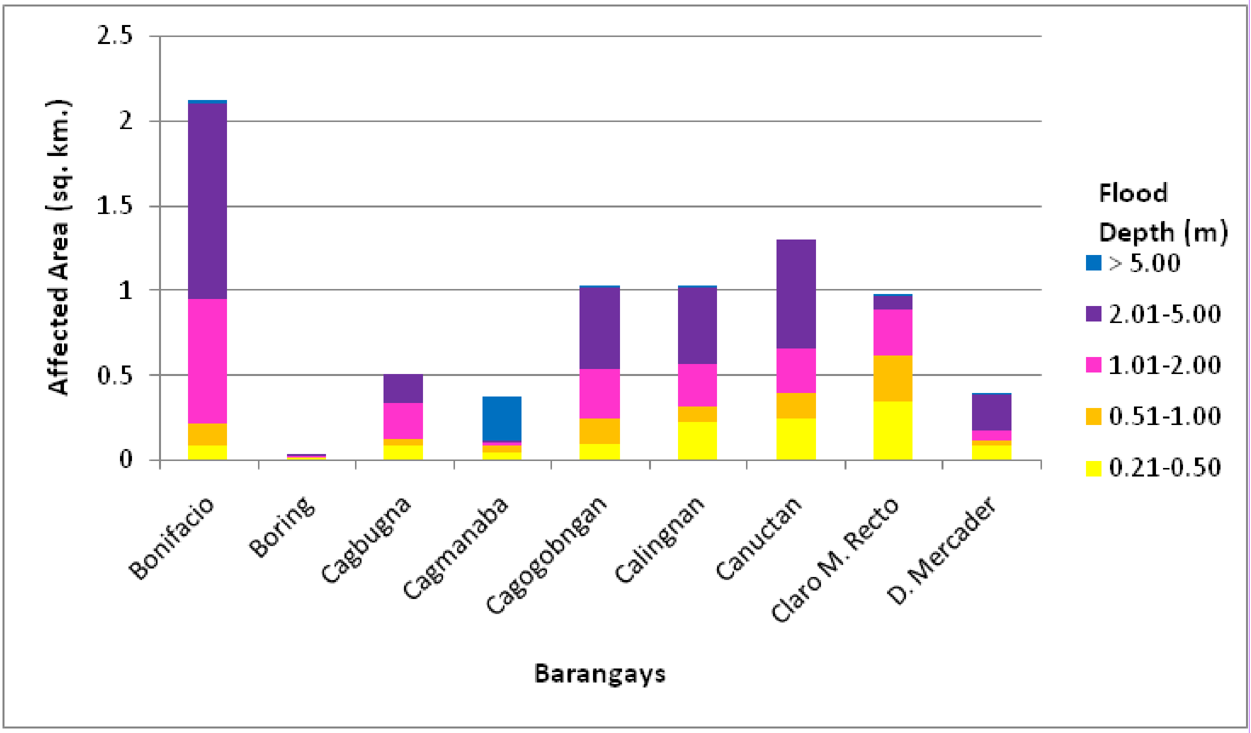


Figure 135. Affected areas in Catubig, Northern Samar during a 100-year rainfall return period

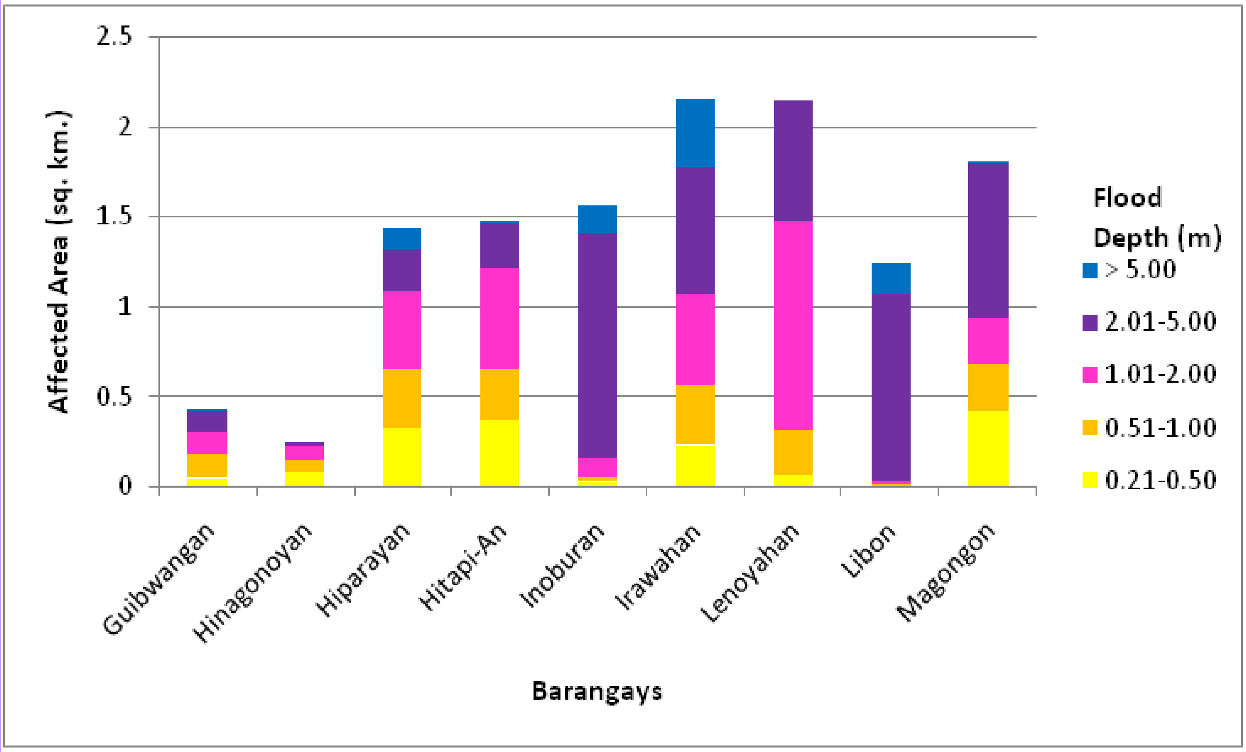


Figure 136. Affected areas in Catubig, Northern Samar during a 100-year rainfall return period

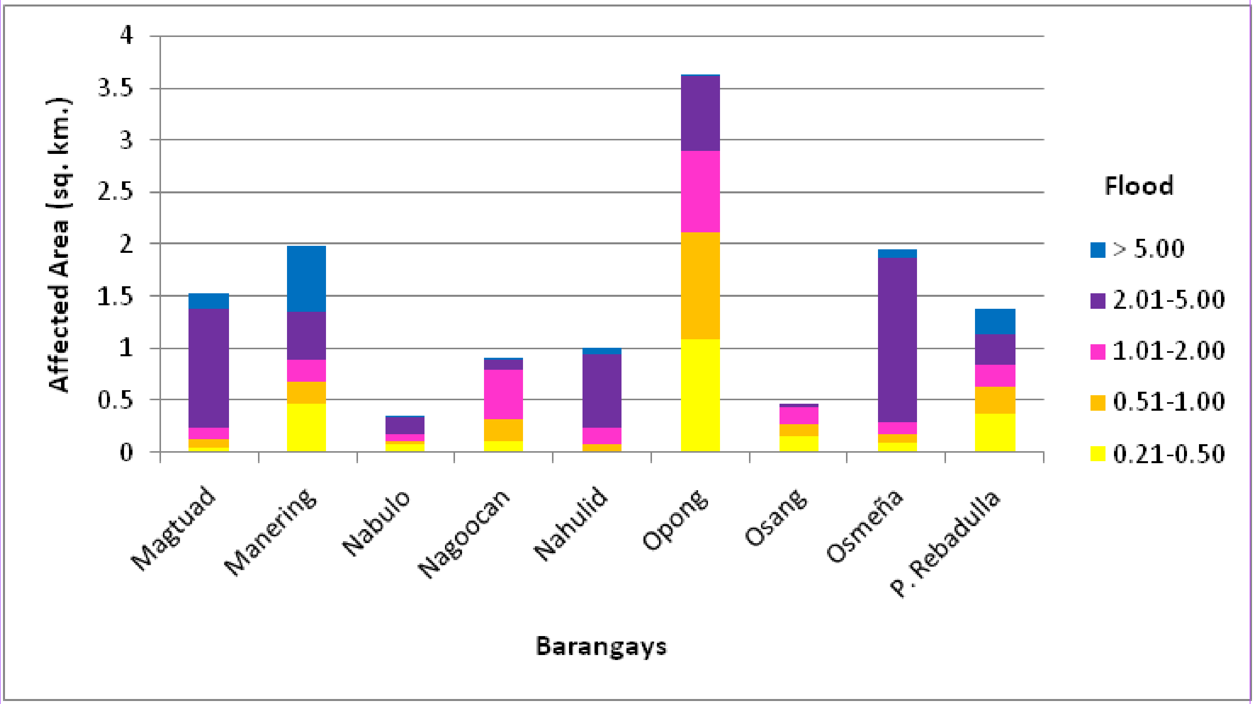


Figure 137. Affected areas in Catubig, Northern Samar during a 100-year rainfall return period

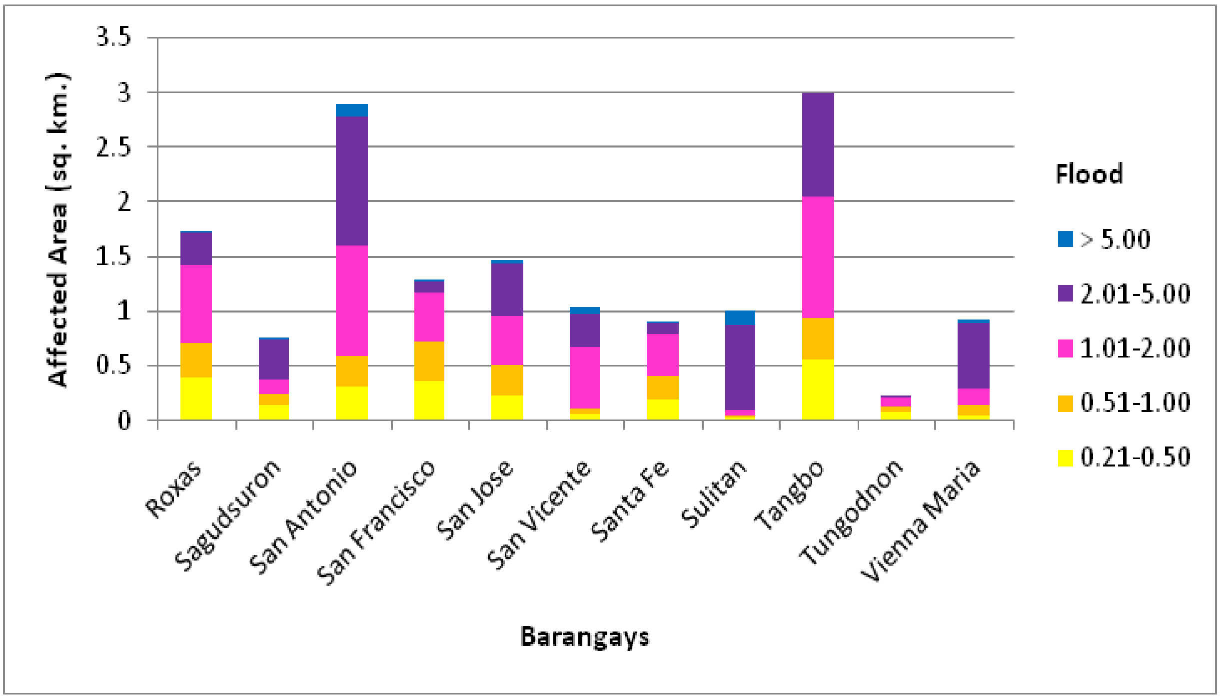


Figure 138. Affected areas in Catubig, Northern Samar during a 100-year rainfall return period

For the Municipality of Laoang, with an area of 207.60 square kilometers, 31.35% will experience flood levels of less than 0.20 meters. 7.53% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 7.55%, 8.44%, 3.59%, and 0.44% 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. Tables 94-97 depict the affected areas, in square kilometers, by flood depth per barangay.

Table 94. Affected areas in Laoang, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Laoang (in sq. km.)**						
by flood depth (in m.)	Abaton	Atipolo	Bawang	Bobolosan	Bongliw	Burabud	Cabagngan
0.03-0.20	6.88	1.81	3.08	2.26	1.19	1.24	2.75
0.21-0.50	0.7	2.11	0.52	0.7	1	0.43	0.83
0.51-1.00	0.91	0.28	0.85	0.38	2.04	0.27	0.98
1.01-2.00	1.42	0.22	1.77	0.29	1.88	0.045	0.62
2.01-5.00	0.41	0.0012	0.53	0	0.55	0.00085	0.1
> 5.00	0.0094	0	0	0	0	0	0.018

Table 95. Affected areas in Laoang, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Laoang (in sq. km.)**						
by flood depth (in m.)	Cabago-An	Cabulaloan	Cagdara-O	Cangcahipos	Catigbian	E. J. Dulay	Gibatangan
0.03-0.20	2.05	0.44	2.32	2.35	1.74	3.28	1.43
0.21-0.50	0.97	0.29	0.11	0.62	0.49	0.13	0.11
0.51-1.00	0.6	0.9	0.061	0.51	0.41	0.11	0.13
1.01-2.00	0.069	1.11	0.23	0.74	0.42	0.31	0.18
2.01-5.00	0.0053	0.35	0.24	0.11	0.42	0.37	0.18
> 5.00	0	0.007	0.007	0	0	0.049	0.072

Table 96. Affected areas in Laoang, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Laoang (in sq. km.)**						
by flood depth (in m.)	La Perla	Lawaan	Oleras	Palmera	Rawis	Rombang	San Antonio
0.03-0.20	1.04	4.74	4.95	1.1	2.11	4.03	2.27
0.21-0.50	0.18	1.95	0.34	0.078	0.49	0.24	0.32
0.51-1.00	0.37	0.43	0.31	0.058	0.12	0.22	0.27
1.01-2.00	1.37	0.089	0.74	0.031	0.0034	0.61	1.02
2.01-5.00	0.48	0	0.24	0.0055	0	0.56	1.17
> 5.00	0	0	0.084	0	0	0.077	0.12

Table 97. Affected areas in Laoang, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Laoang (in sq. km.)**						
	Sibunot	Simora	Talisay	Tarusan	Tinoblan	Vigo	Yapas
0.03-0.20	2.63	2.16	0.92	0.86	1.53	1.07	2.86
0.21-0.50	0.34	0.36	0.045	1.06	0.11	0.91	0.2
0.51-1.00	0.67	0.45	0.12	2.68	0.24	1.17	0.13
1.01-2.00	0.67	0.86	0	0.3	0.94	1.33	0.25
2.01-5.00	0.22	0.21	0	0.053	0.53	0.57	0.14
> 5.00	0.023	0.42	0	0	0.027	0	0

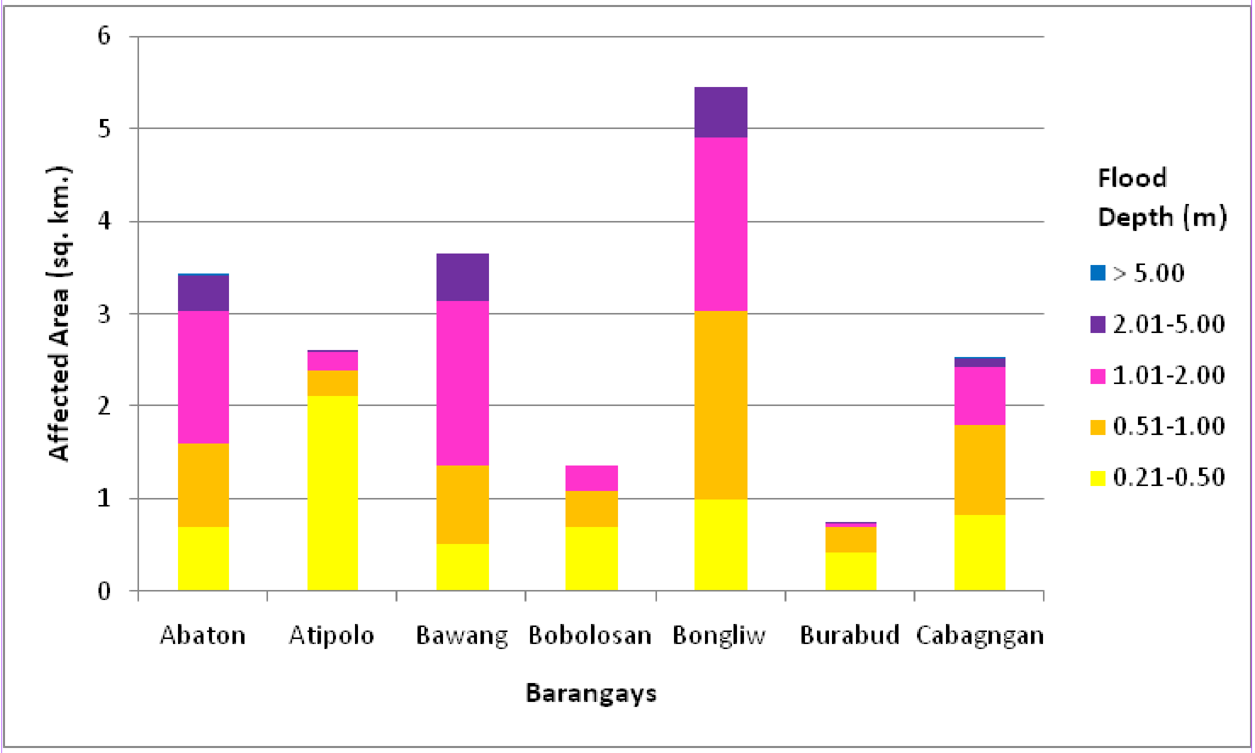


Figure 139. Affected areas in Laoang, Northern Samar during a 100-year rainfall return period

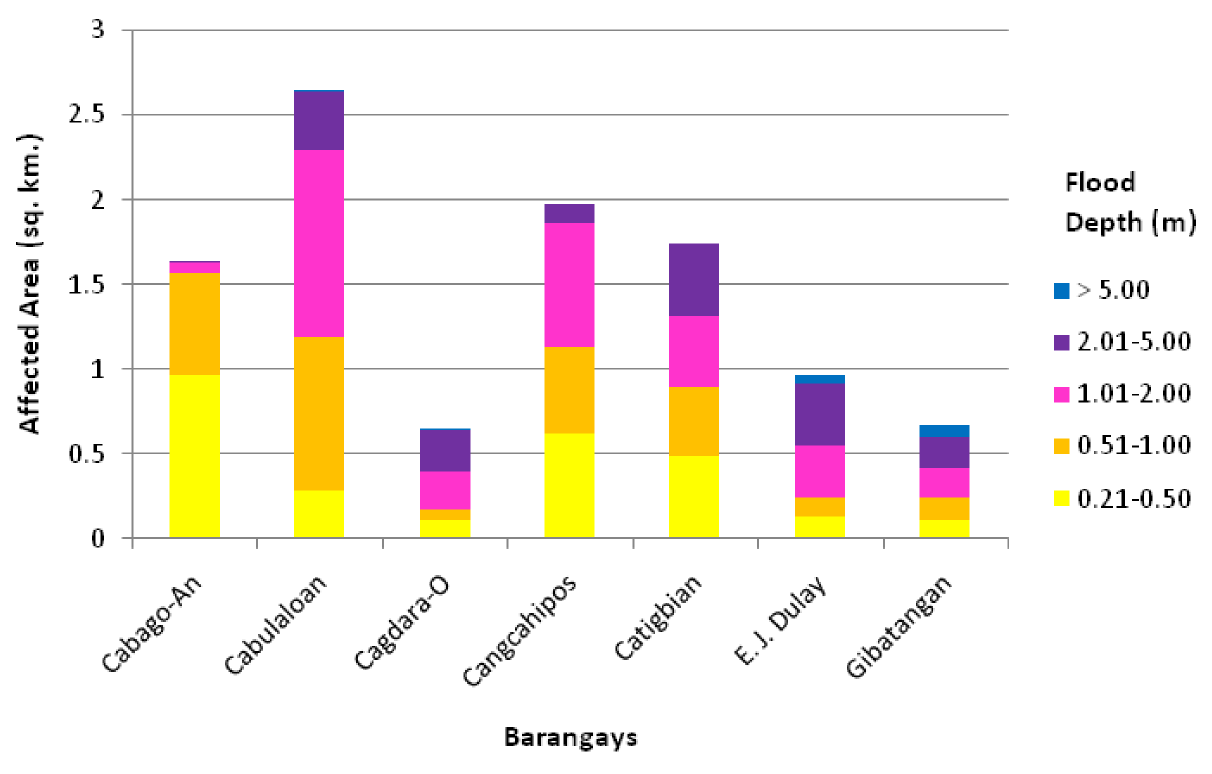


Figure 140. Affected areas in Laoang, Northern Samar during a 100-year rainfall return period

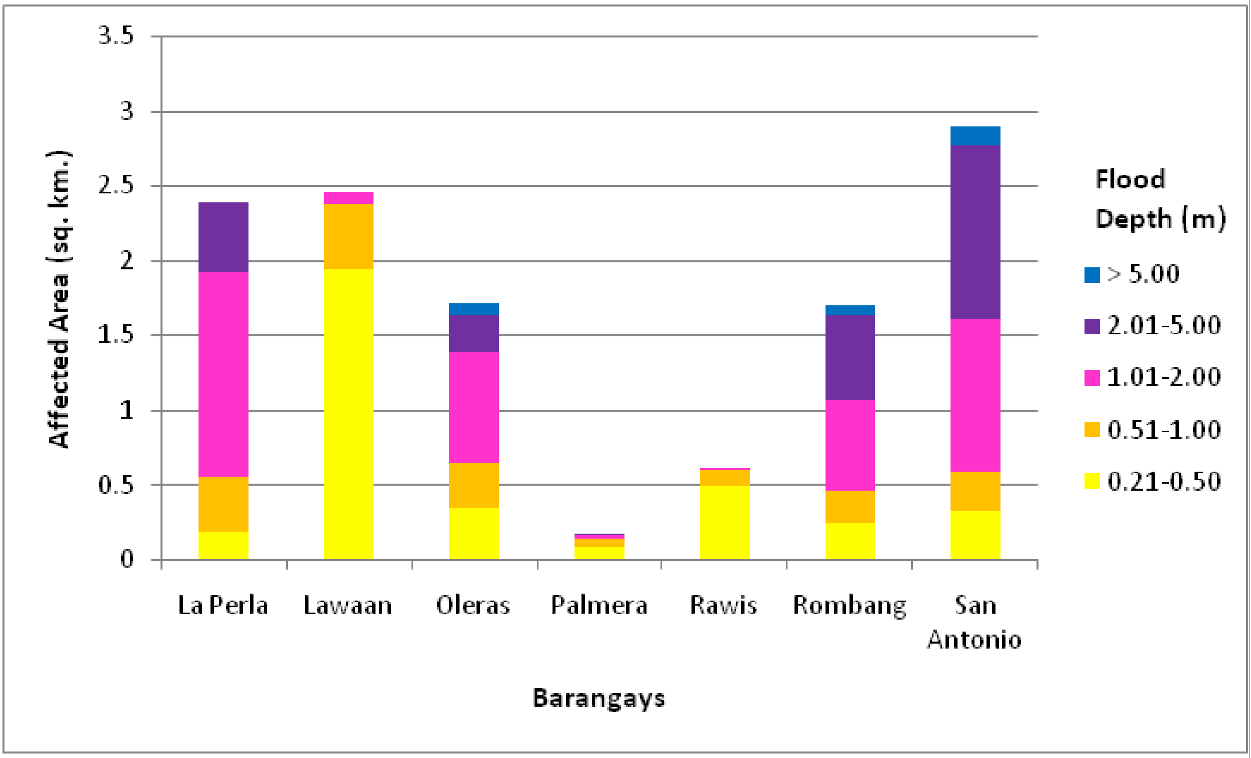


Figure 141. Affected areas in Laoang, Northern Samar during a 100-year rainfall return period

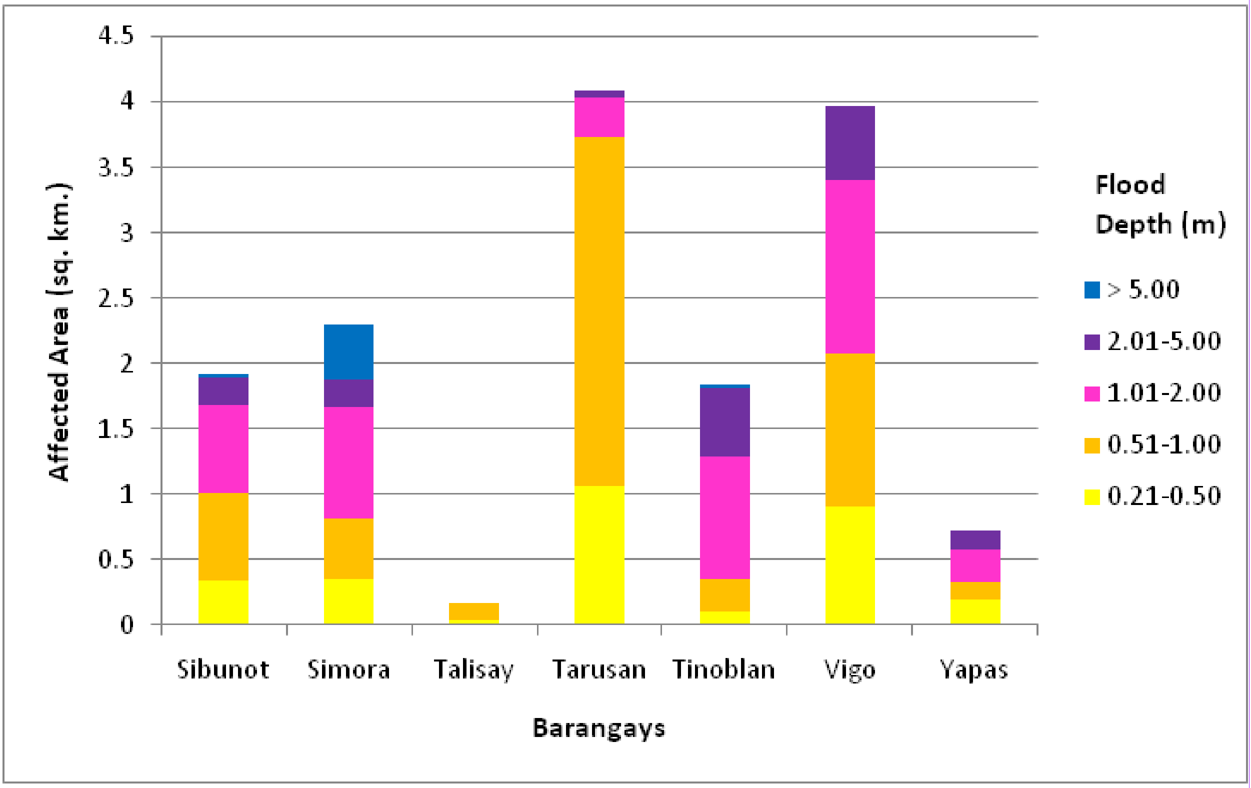


Figure 142. Affected areas in Laoang, Northern Samar during a 100-year rainfall return period

For the Municipality of Las Navas, with an area of 267.47 square kilometers, 54.85% will experience flood levels of less than 0.20 meters. 4.86% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 6.19%, 9.58%, 11.85%, and 4.23% 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. Tables 98-104 depict the affected areas, in square kilometers, by flood depth per barangay.

Table 98. Affected areas in Las Navas, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Las Navas (in sq. km.)**							
by flood depth (in m.)	Balugo	Bugay	Bugtosan	Bukid	Bulao	Caputoan	Catoto-Ogan	Cuenco
0.03-0.20	0.27	1.86	1.42	2.77	1.61	4.09	14.6	4.69
0.21-0.50	0.015	0.2	0.3	0.27	0.47	0.22	1.43	0.24
0.51-1.00	0.016	0.25	0.58	0.41	0.92	0.25	1.74	0.27
1.01-2.00	0.063	0.65	1.11	0.47	1.16	0.31	1.97	0.4
2.01-5.00	1.97	1.44	0.36	0.98	0.12	0.067	0.89	0.38
> 5.00	0.16	0.083	0.16	0	0	0	0.025	0.047

Table 99. Affected areas in Las Navas, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Las Navas (in sq. km.)**							
by flood depth (in m.)	Dapdap	Del Pilar	Dolores	Epaw	Geguinta	Geracdo	Guyo	H. Jolejole
0.03-0.20	1.24	0.41	3.14	1.99	0.77	0.12	0.82	1.57
0.21-0.50	0.043	0.017	0.32	0.084	0.071	0.008	0.075	0.18
0.51-1.00	0.062	0.018	0.2	0.07	0.17	0.014	0.091	0.16
1.01-2.00	0.11	0.041	0.12	0.12	0.42	0.12	0.082	0.17
2.01-5.00	0.36	0.16	0.029	0.31	0.52	0.94	0.63	0.21
> 5.00	1.77	1.82	0.0002	0.67	0.058	0.063	0.042	0

Table 100. Affected areas in Las Navas, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Las Navas (in sq. km.)**							
by flood depth (in m.)	H. Jolejole District	Hangi	Imelda	L. Empon	Lakandula	Lourdes	Lumala-Og	Mabini
0.03-0.20	0.027	1.52	1.68	1.57	2.09	4.6	0.72	1.87
0.21-0.50	0.0017	0.18	0.098	0.12	0.12	0.32	0.031	0.17
0.51-1.00	0.0041	0.18	0.16	0.16	0.14	0.74	0.038	0.39
1.01-2.00	0.039	0.6	0.26	0.42	0.21	0.6	0.16	1.03
2.01-5.00	0.26	3.53	0.13	0.49	0.17	0.027	1.36	0.83
> 5.00	0.053	0.61	0	0.19	0.023	0.0001	0.35	0.22

Table 101. Affected areas in Las Navas, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Las Navas (in sq. km.)							
by flood depth (in m.)	Macarthur	Magsaysay	Matelarag	Osmeña	Paco	Palanas	Perez	Poponton
0.03-0.20	3.92	1.87	1.1	0.54	2.22	6.44	3.86	2.9
0.21-0.50	0.33	0.24	0.13	0.093	0.18	0.79	0.43	0.18
0.51-1.00	0.55	0.34	0.091	0.091	0.26	0.69	0.48	0.28
1.01-2.00	0.77	0.65	0.21	0.11	0.75	0.76	0.87	0.57
2.01-5.00	0.3	0.17	1.35	1.59	0.69	0.67	0.72	0.47
> 5.00	0.073	0.011	0.26	0.079	0.17	0.011	0.088	0.095

Table 102. Affected areas in Las Navas, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Las Navas (in sq. km.)							
by flood depth (in m.)	Quezon	Quirino	Rebong	Rizal	Roxas	Rufino	Sag-Od	San Andres
0.03-0.20	1.98	7.67	0.29	3.45	5.91	3.17	2.23	3.09
0.21-0.50	0.32	0.6	0.027	0.3	0.4	0.16	0.096	0.21
0.51-1.00	0.5	0.7	0.03	0.49	0.32	0.14	0.079	0.31
1.01-2.00	0.42	1.41	0.076	0.66	0.7	0.12	0.069	0.27
2.01-5.00	0.033	1.01	1.38	0.43	0.3	0.019	0.021	0.31
> 5.00	0	0.13	0.12	0.08	0.014	0.0038	0	0.022

Table 103. Affected areas in Las Navas, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Las Navas (in sq. km.)							
by flood depth (in m.)	San Antonio	San Fernando	San Francisco	San Isidro	San Jorge	San Jose	San Miguel	Santo Tomas
0.03-0.20	2.27	0.91	6.29	13.68	1.81	1.91	3.37	1.51
0.21-0.50	0.32	0.38	0.37	0.8	0.19	0.23	0.35	0.3
0.51-1.00	0.27	0.54	0.36	1.07	0.21	0.28	0.47	0.21
1.01-2.00	1.02	0.45	0.44	1.41	0.056	0.45	1.17	0.15
2.01-5.00	1.17	0.091	0.11	0.95	0.0013	0.48	0.36	0.24
> 5.00	0.12	0	0.0066	2.56	0	0.041	0.056	0.000048

Table 104. Affected areas in Las Navas, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Area of affected barangays in Las Navas (in sq. km.)**			
	Tagab-Iran	Tagan-Ayan	Taylor	Victory
0.03-0.20	0.67	4.97	0.93	2.29
0.21-0.50	0.023	0.38	0.063	0.13
0.51-1.00	0.029	0.4	0.15	0.19
1.01-2.00	0.068	0.47	0.46	0.42
2.01-5.00	1.22	0.58	0.57	0.31
> 5.00	1.21	0.48	0.15	0.049

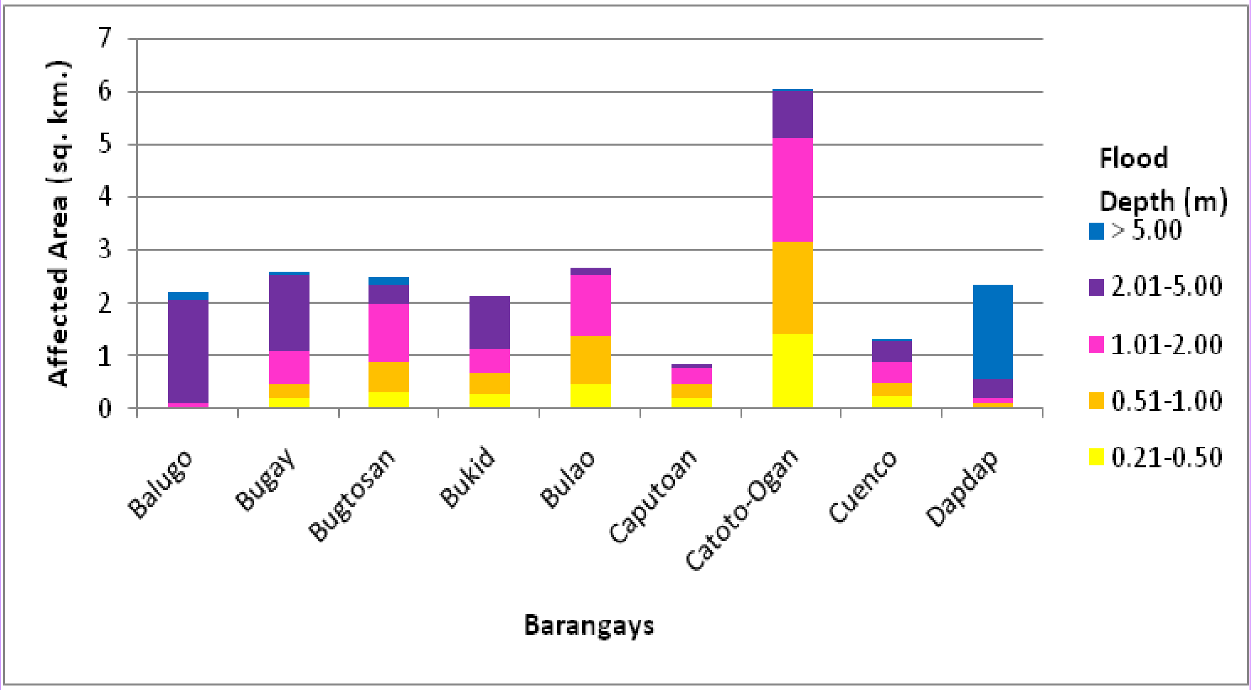


Figure 143. Affected areas in Las Navas, Northern Samar during a 100-year rainfall return period

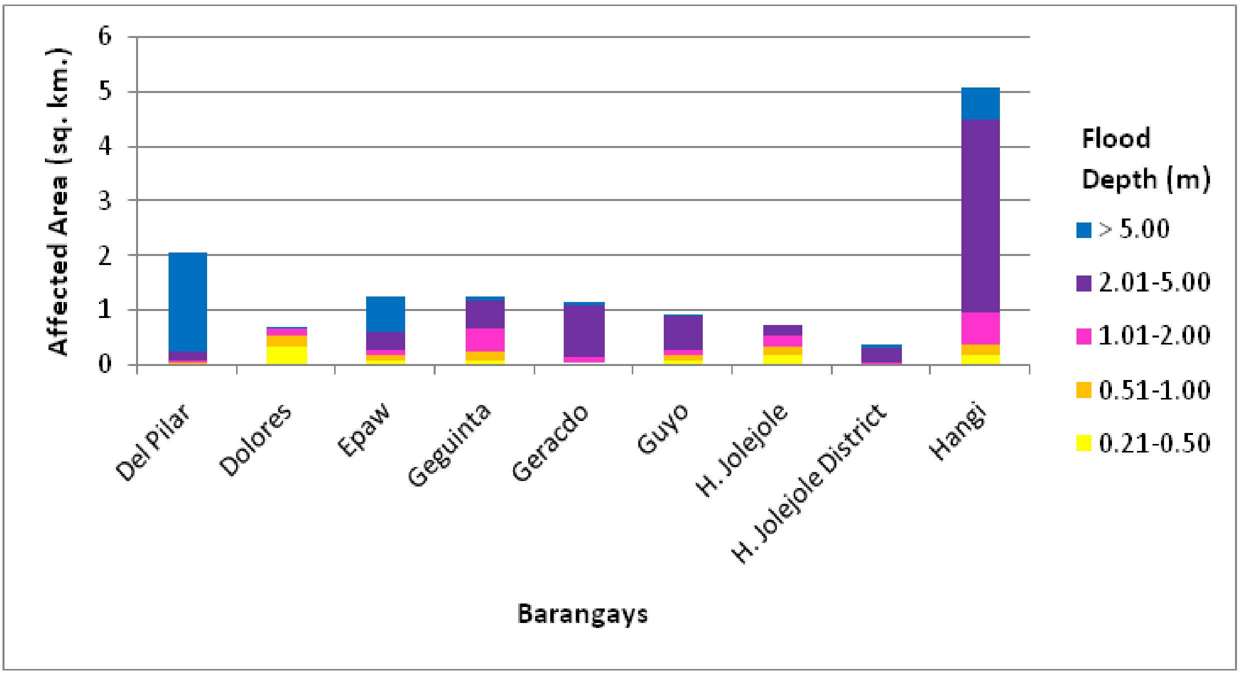


Figure 144. Affected areas in Las Navas, Northern Samar during a 100-year rainfall return period

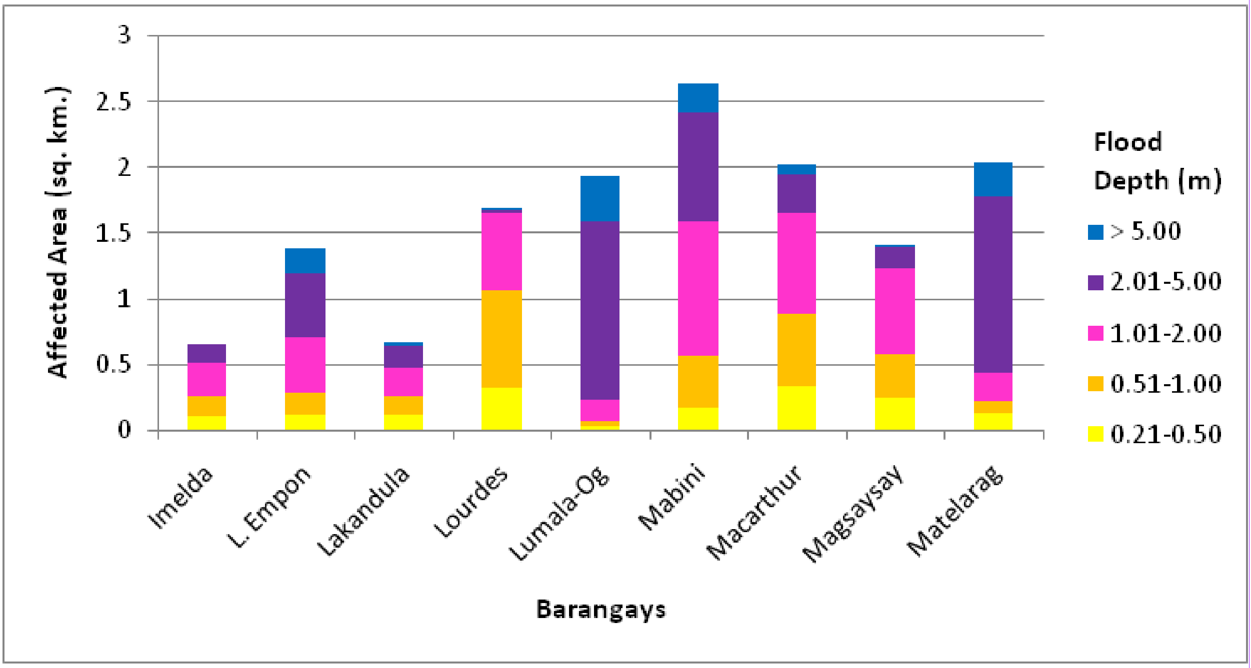


Figure 145. Affected areas in Las Navas, Northern Samar during a 100-year rainfall return period

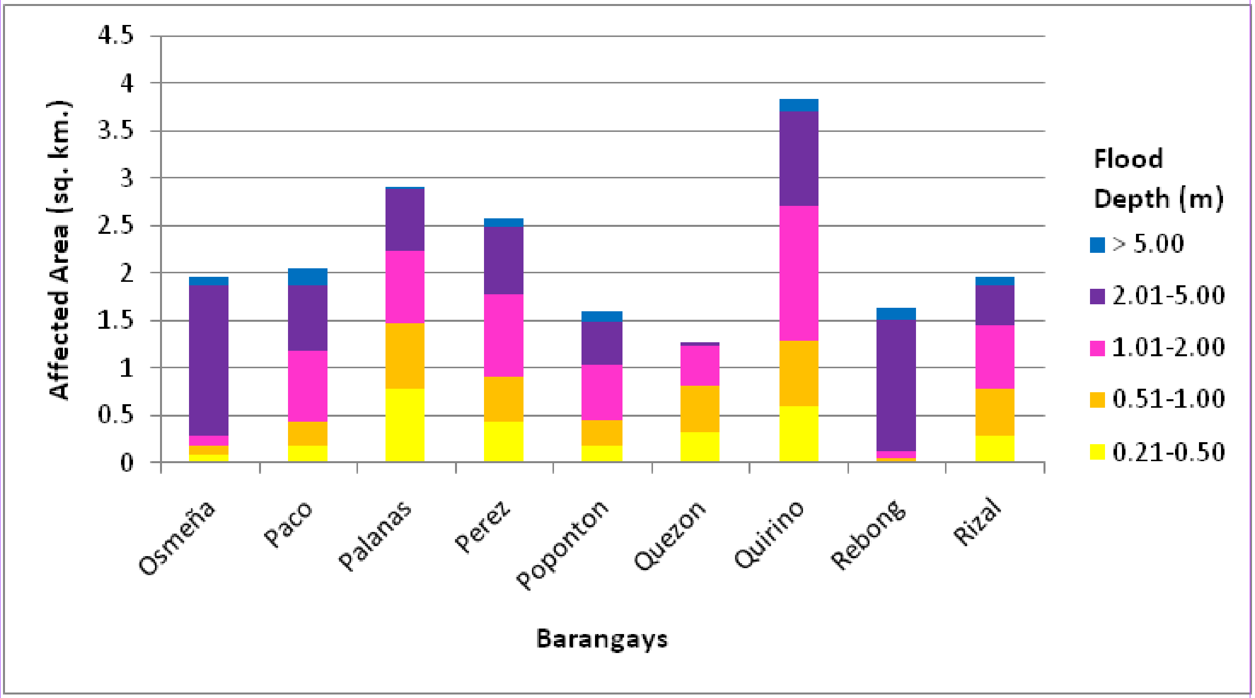


Figure 146. Affected areas in Las Navas, Northern Samar during a 100-year rainfall return period

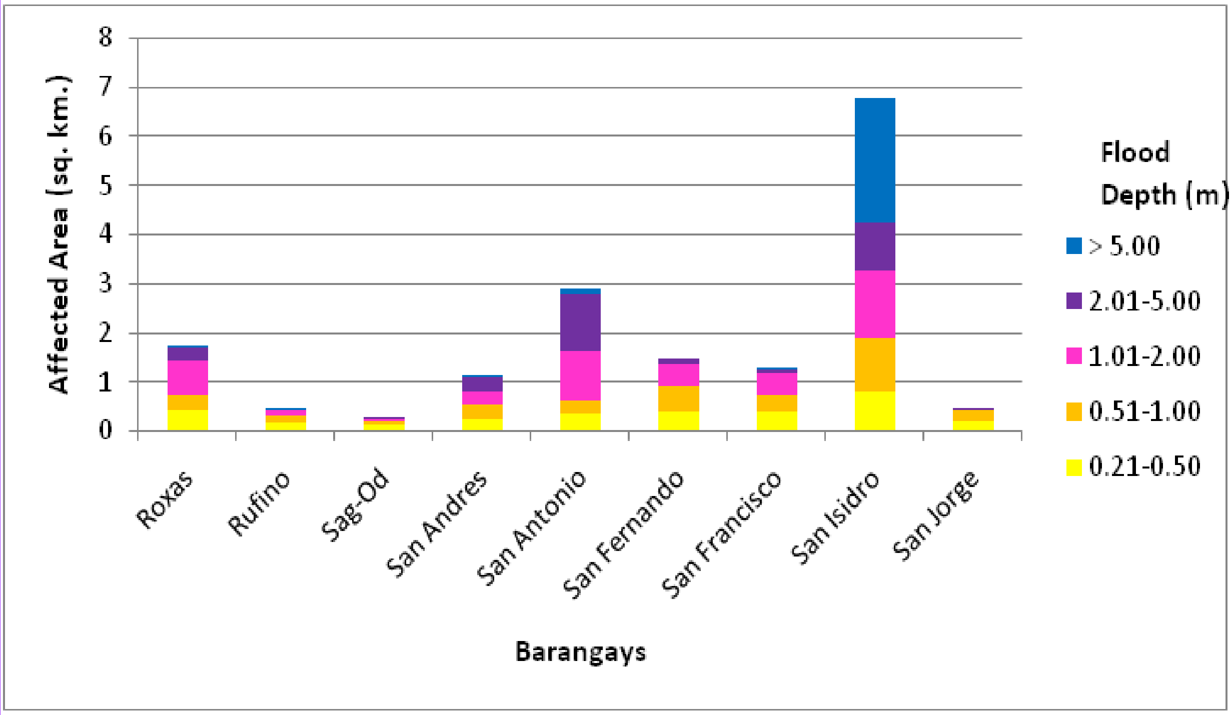


Figure 147. Affected areas in Las Navas, Northern Samar during a 100-year rainfall return period

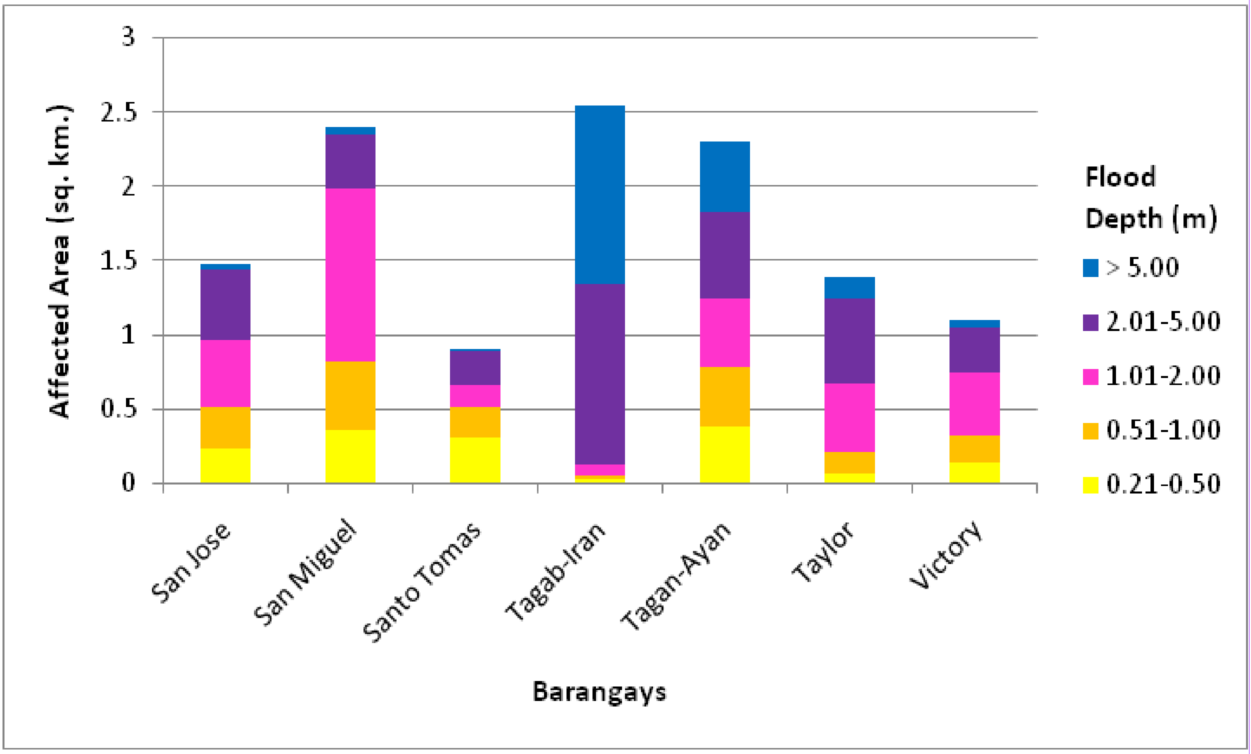


Figure 148. Affected areas in Las Navas, Northern Samar during a 100-year rainfall return period

For the Municipality of Mapanas, with an area of 143.56 square kilometers, 16.81% will experience flood levels of less than 0.20 meters. 0.85% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 0.59%, 0.70%, 0.95%, and 0.79% 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. Table 105 depicts the affected areas, in square kilometers, by flood depth per barangay.

Table 105. Affected areas in Mapanas, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	Affected Barangays in Mapanas		
by flood depth (in m.)	Magtaon	San Jose	Siljagon
0.03-0.20	0.04	1.91	22.18
0.21-0.50	0	0.23	0.99
0.51-1.00	0	0.28	0.56
1.01-2.00	0	0.45	0.56
2.01-5.00	0	0.48	0.88
> 5.00	0	0.041	1.1

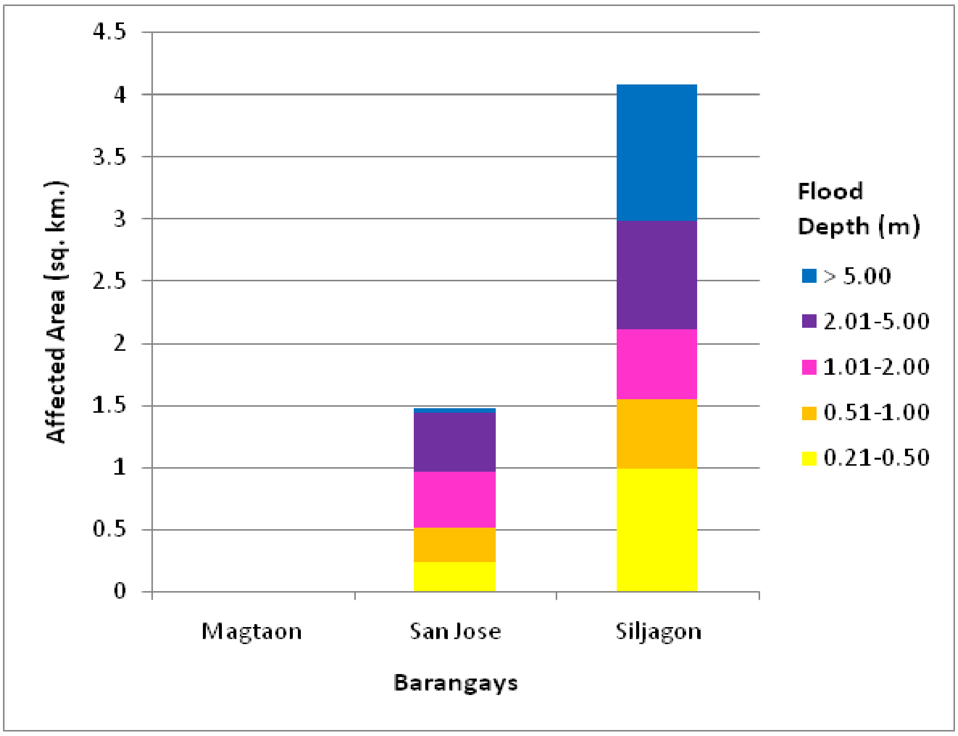


Figure 149. Affected areas in Mapanas, Northern Samar during a 100-year rainfall return period

For the Municipality of Palapag, with an area of 153.46 square kilometers, 59.01% will experience flood levels of less than 0.20 meters. 6.45% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 4.66%, 4.24%, 3.46%, and 1.24% 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. Tables 106-109 depict the affected areas, in square kilometers, by flood depth per barangay.

Table 106. Affected areas in Palapag, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Palapag (in sq. km.)						
by flood depth (in m.)	Asum	Bagacay	Bangon	Benigno S. Aquino, Jr.	Cabariwan	Cabatuan	Campedico
0.03-0.20	0.5	25.21	8.49	0.17	1.73	0.42	1.11
0.21-0.50	0.19	1.1	0.41	0.17	0.096	0.0094	0.07
0.51-1.00	0.25	0.59	0.38	0.28	0.16	0.0028	0.033
1.01-2.00	0.041	0.49	0.56	0.22	0.048	0.0002	0.056
2.01-5.00	0	0.75	0.94	0.0078	0.077	0	0
> 5.00	0	0.71	0.44	0	0	0	0

Table 107. Affected areas in Palapag, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Palapag (in sq. km.)						
by flood depth (in m.)	Capacujan	Jangtud	Laniwan	Mabaras	Magsaysay	Manajao	Mapno
0.03-0.20	8.73	2.11	0.13	2.84	1.87	0.59	4.24
0.21-0.50	0.41	0.2	0.045	0.31	0.24	0.39	0.45
0.51-1.00	0.22	0.19	0.096	0.24	0.34	0.19	0.2
1.01-2.00	0.28	0.21	0.24	0.16	0.65	0.15	0.059
2.01-5.00	0.37	0.0056	0.056	0.0093	0.17	0.0053	0.014
> 5.00	0.044	0	0.011	0	0.011	0	0

Table 108. Affected areas in Palapag, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	Area of affected barangays in Palapag (in sq. km.)						
by flood depth (in m.)	Maragano	Matambag	Monbon	Nagbobtac	Napo	Natawo	Nipa
0.03-0.20	1.3	0.74	1.7	6.4	3.28	1.42	2.43
0.21-0.50	0.059	0.27	1.47	0.35	0.47	0.29	0.11
0.51-1.00	0.017	0.48	0.14	0.41	0.69	0.37	0.012
1.01-2.00	0.0056	0.32	0.017	0.41	0.77	0.16	0.0002
2.01-5.00	0.0014	0.046	0	0.21	0.74	0.0012	0
> 5.00	0	0	0	0.0097	0.18	0	0

Table 109. Affected areas in Palapag, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	**Area of affected barangays in Palapag (in sq. km.)**									
by flood depth (in m.)	Osmeña	Pangpang	Paysud	Sangay	Simora	Sinalaran	Sumoroy	Talolora	Tambangan	Tinampo
0.03-0.20	0.54	2.57	1.7	4.41	2.16	1.1	0.45	0.7	0.55	0.96
0.21-0.50	0.093	0.42	0.4	0.23	0.36	0.18	0.47	0.41	0.19	0.032
0.51-1.00	0.091	0.21	0.11	0.26	0.45	0.069	0.19	0.17	0.31	0.0021
1.01-2.00	0.11	0.12	0.065	0.19	0.86	0.086	0.12	0.094	0.01	0
2.01-5.00	1.59	0	0.012	0	0	0	0	0	0.012	0
> 5.00	0.079	0	0	0	0	0	0	0	0	0

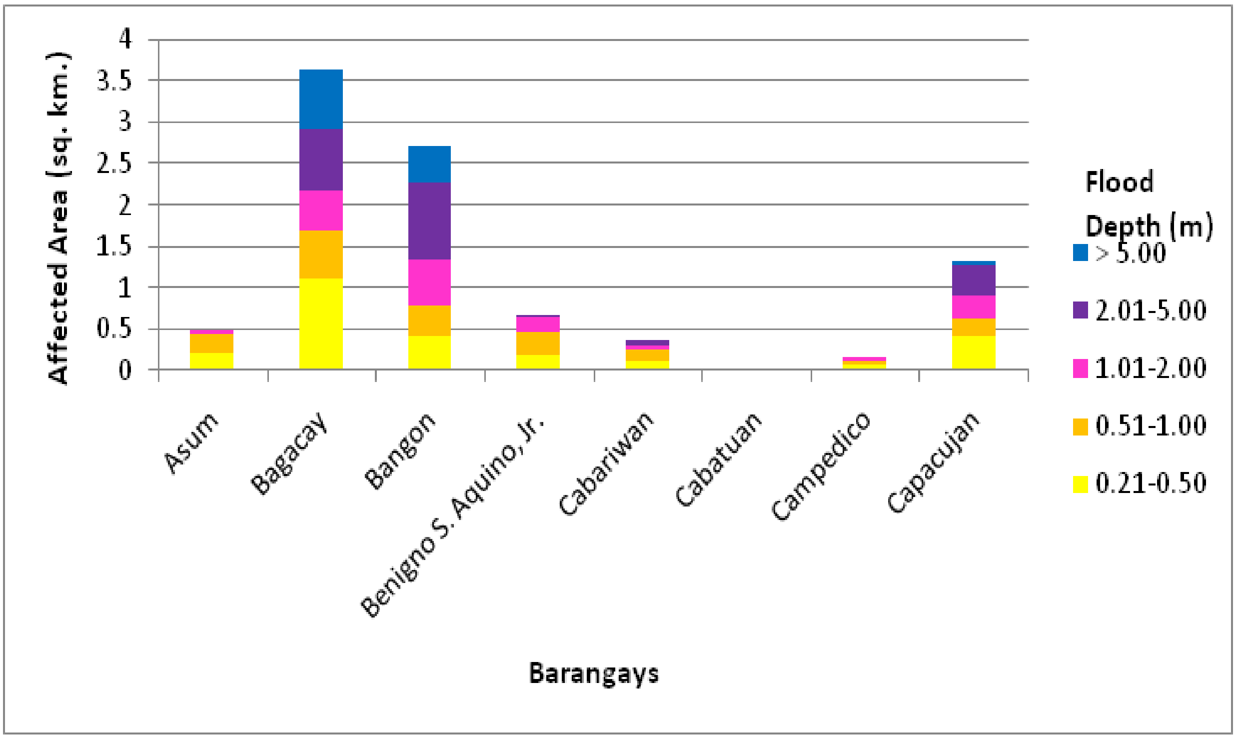


Figure 150. Affected areas in Palapag, Northern Samar during a 100-year rainfall return period

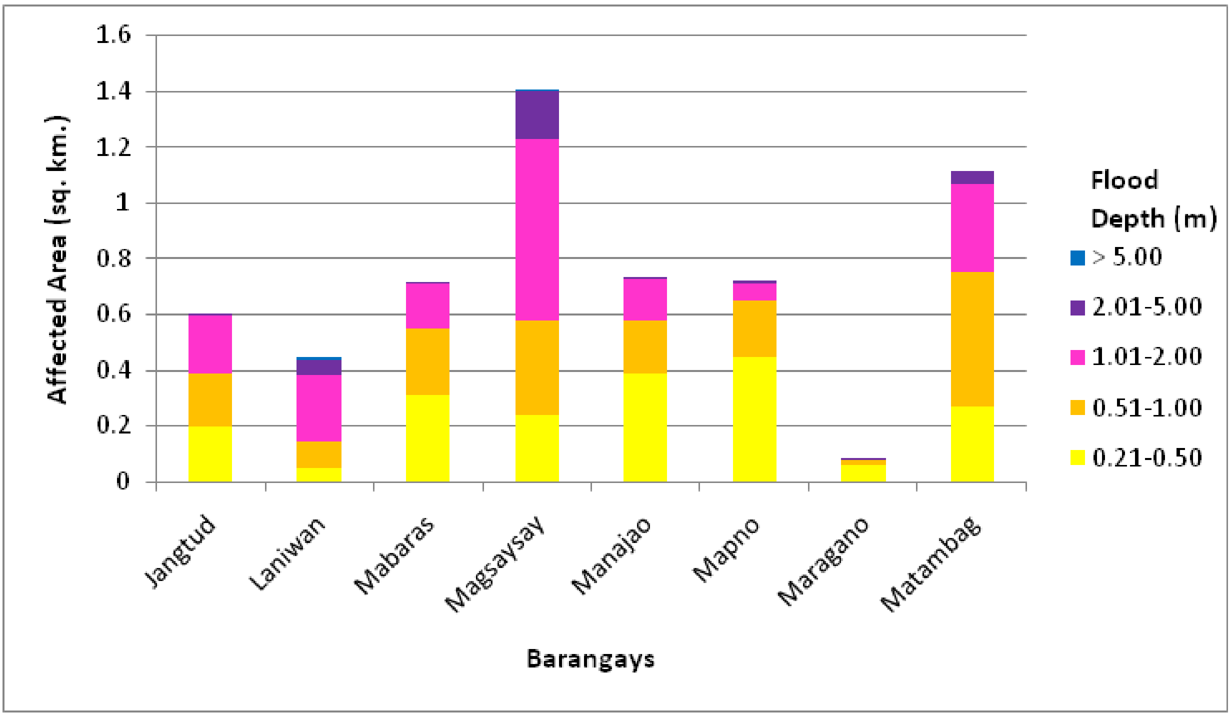


Figure 151. Affected areas in Palapag, Northern Samar during a 100-year rainfall return period

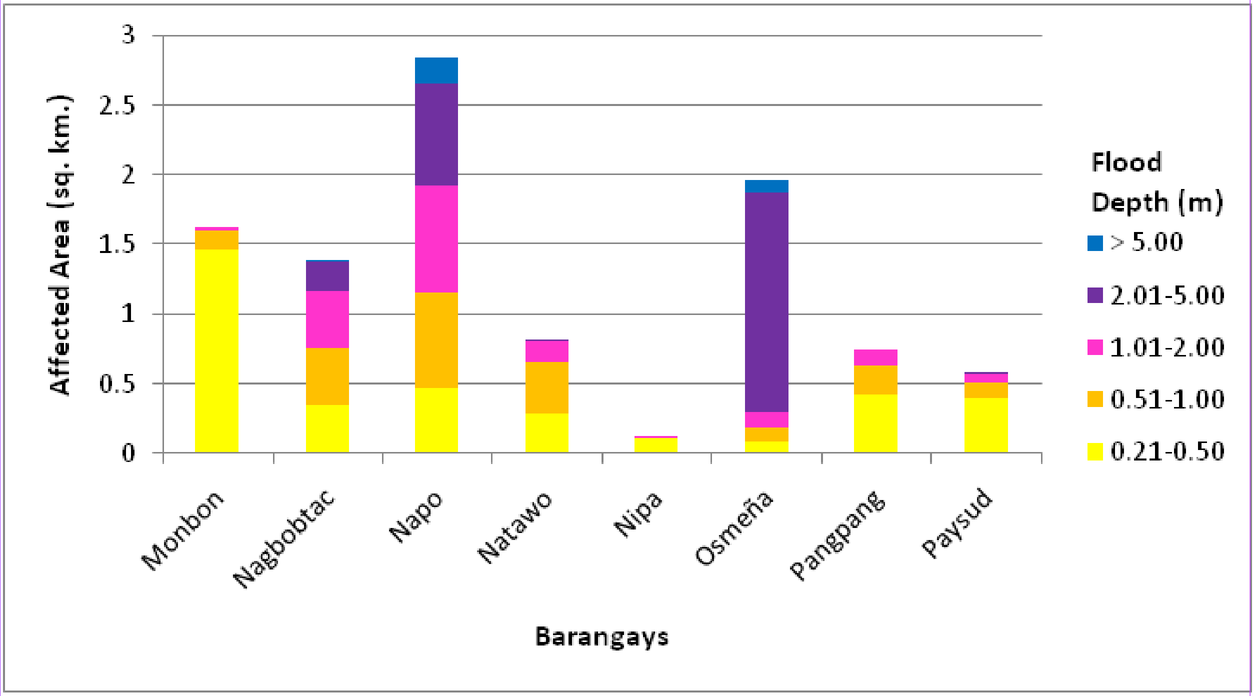


Figure 152. Affected areas in Palapag, Northern Samar during a 100-year rainfall return period

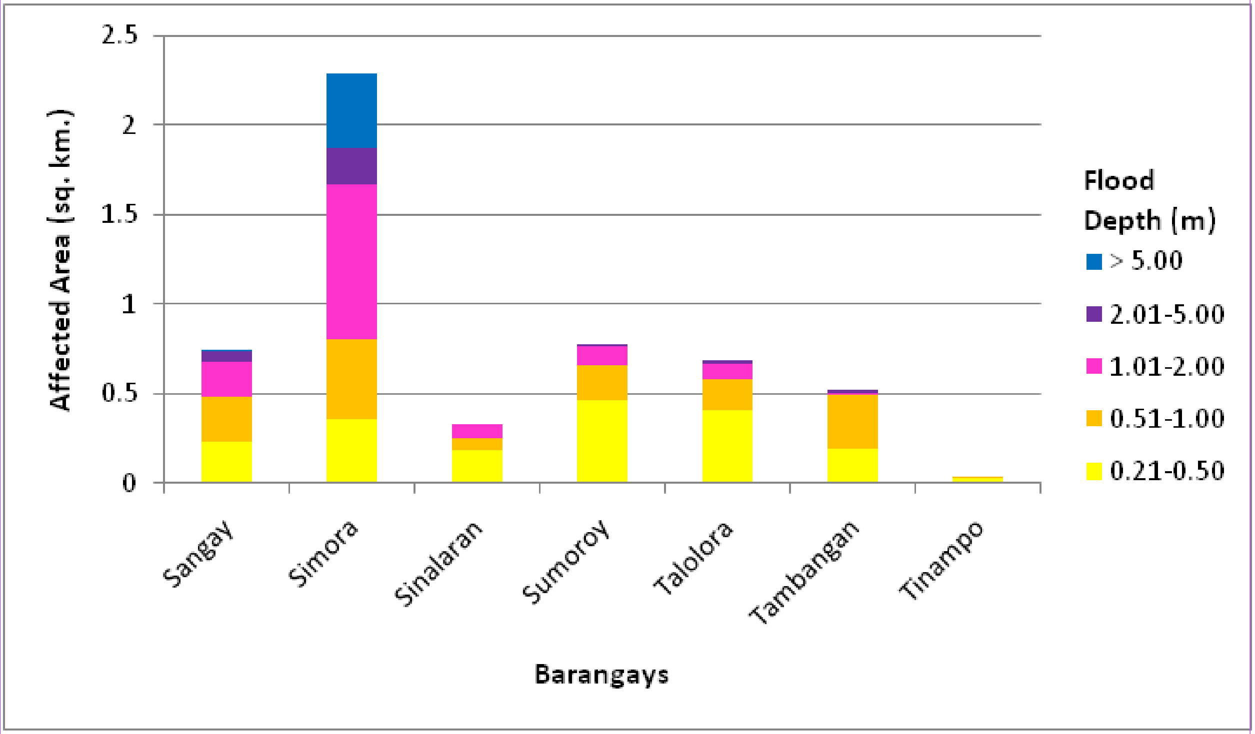


Figure 153. Affected areas in Palapag, Northern Samar during a 100-year rainfall return period

For the Municipality of Pambujan, with an area of 150.63 square kilometers, 4.68% 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. Meanwhile, 0.13%, 0.09%, 0.05%, and 0.008% 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. Table 110 depicts the affected areas, in square kilometers, by flood depth per barangay.

Table 110. Affected areas in Pambujan, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	**Affected Barangays in Pambujan**			
by flood depth (in m.)	**Geparayan**	**Ginulgan**	**Inanahawan**	**Sixto T. Balanguit, Sr.**
0.03-0.20	1.89	1.39	0.72	3.05
0.21-0.50	0.12	0.062	0.033	0.13
0.51-1.00	0.076	0.035	0.02	0.063
1.01-2.00	0.047	0.026	0.0077	0.054
2.01-5.00	0.012	0.016	0.00089	0.052
> 5.00	0	0	0	0.012

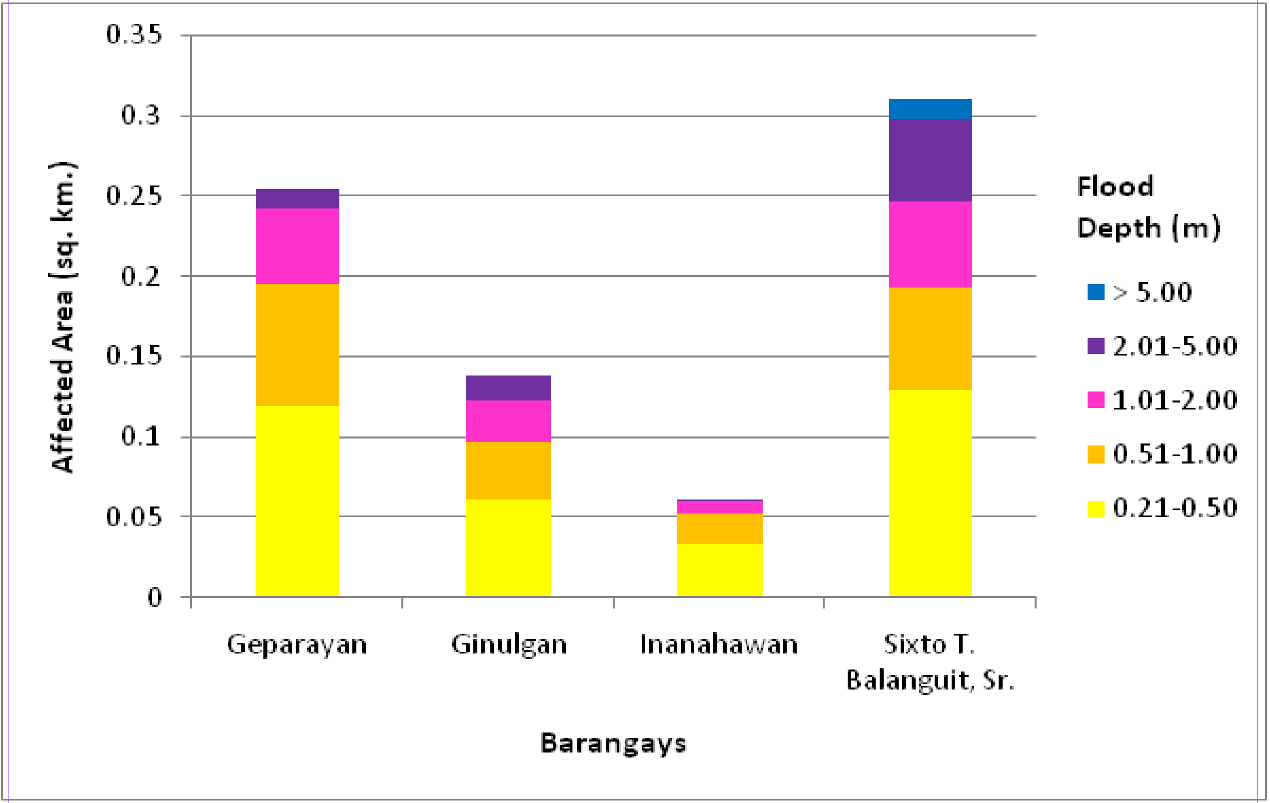


Figure 154. Affected areas in Pambujan, Northern Samar during a 100-year rainfall return period

For the Municipality of Silvino Lobos, with an area of 255.34 square kilometers, 5.91% will experience flood levels of less than 0.20 meters. 0.28% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 0.33%, 0.52%, and 0.19% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and more than 2 meters, respectively. Table 111 depicts the affected areas, in square kilometers, by flood depth per barangay.

Table 111. Affected areas in Silvino Lobos, Northern Samar during a 100-year rainfall return period

Affected Area (sq. km.)	Affected Barangays in Silvino Lobos		
by flood depth (in m.)	Balud	Geparayan de Turag	Senonogan de Tubang
0.03-0.20	0.044	8.94	6.11
0.21-0.50	0.0011	0.44	0.28
0.51-1.00	0.0014	0.5	0.33
1.01-2.00	0.0033	0.8	0.52
2.01-5.00	0.0028	0.23	0.25
> 5.00	0	0	0

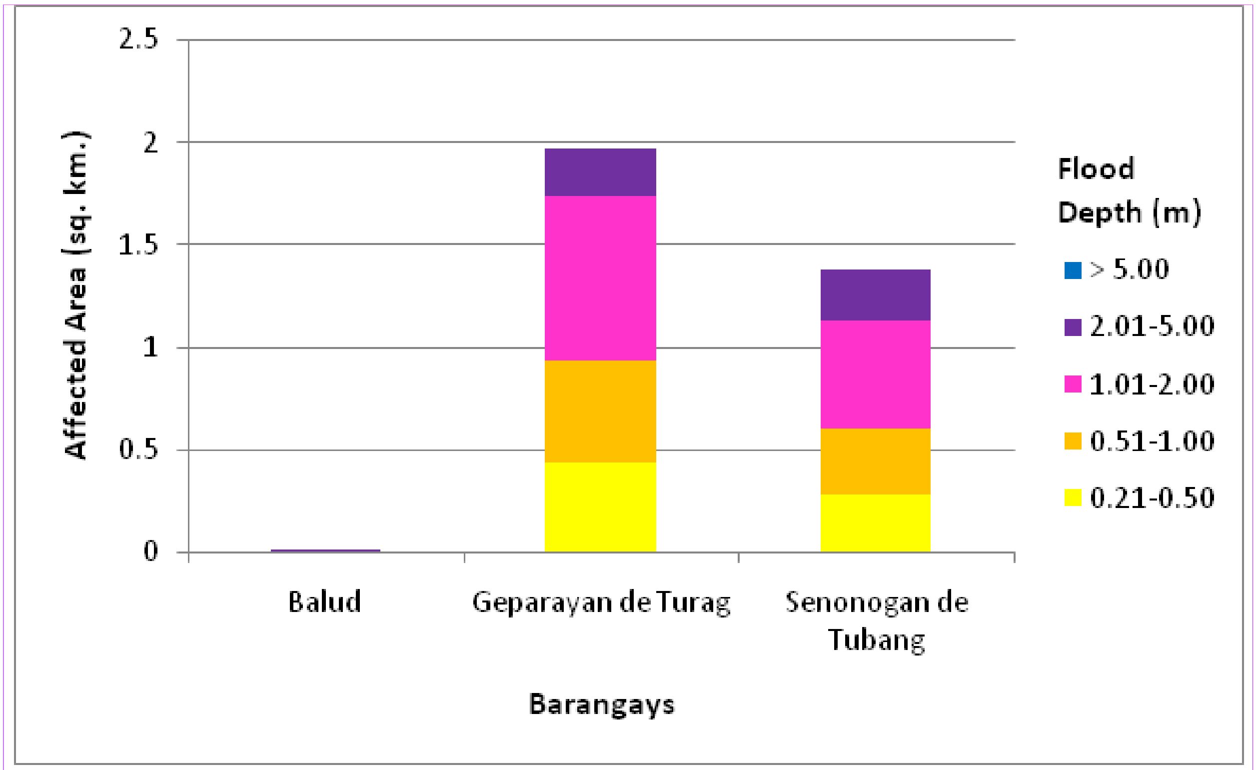


Figure 155. Affected areas in Silvino Lobos, Northern Samar during a 100-year rainfall return period

For the Municipality of Matuguinao, with an area of 368.83 square kilometers, 1.12% will experience flood levels of less than 0.20 meters. 0.06% of the area will experience flood levels of 0.21 to 0.50 meters. Meanwhile, 0.05%, 0.06%, and 0.02% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and more than 2 meters, respectively. Table 112 depicts the affected areas, in square kilometers, by flood depth per barangay.

Table 112. Affected areas in Matuguinao, Samar during a 100-year rainfall return period

Affected Area (sq. km.) by flood depth (in m.)	**Affected Barangays in Matuguinao**	
	Camonoan	Ligaya
0.03-0.20	3.99	0.12
0.21-0.50	0.21	0.001
0.51-1.00	0.18	0.0011
1.01-2.00	0.21	0.0001
2.01-5.00	0.073	0.0002
> 5.00	0	0

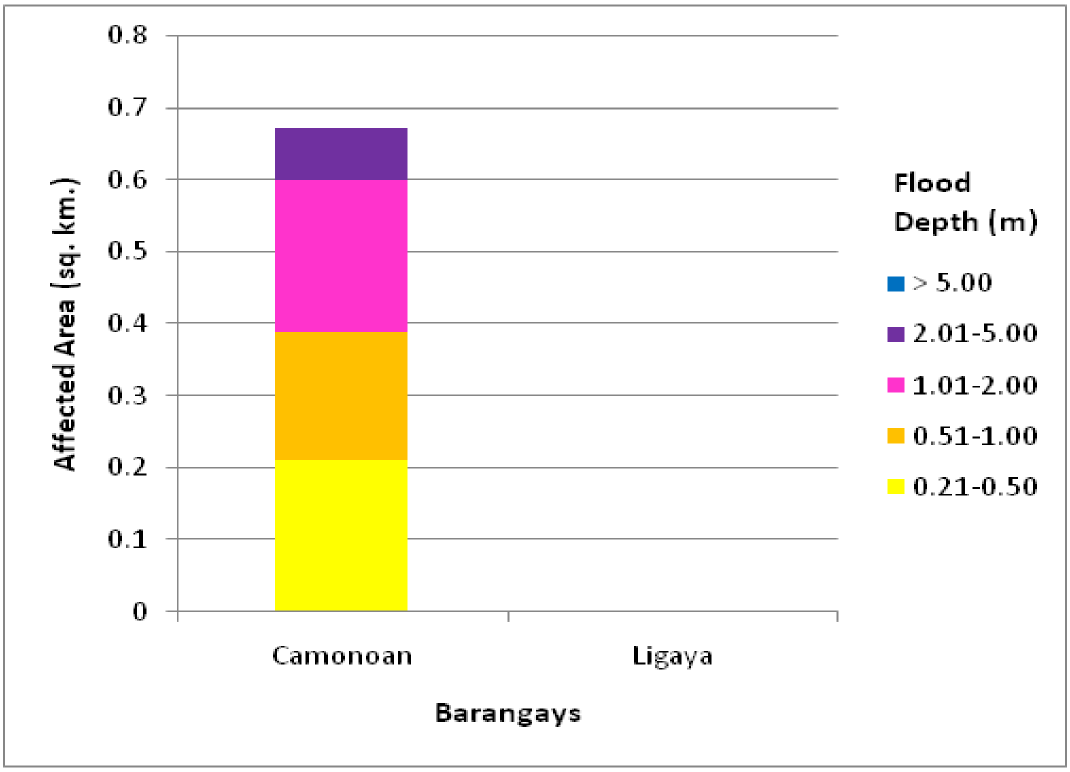


Figure 156. Affected areas in Matuguinao, Samar during a 100-year rainfall return period

Among the barangays in the Municipality of Jipapad, Cagmanaba is projected to have the highest percentage of area that will experience flood levels, at 0.57%. On the other hand, San Roque posted the percentage of area that may be affected by flood depths, at 0.39%.

Among the barangays in the Municipality of Catubig, Opong is projected to have the highest percentage of area that will experience flood levels, at 7.80%. On the other hand, Manering posted the percentage of area that may be affected by flood depths, at 6.06%.

Among the barangays in the Municipality of Laoang, Abaton is projected to have the highest percentage of area that will experience flood levels, at 4.98%. On the other hand, Lawaan posted the percentage of area that may be affected by flood depths, at 3.47%.

Among the barangays in the Municipality of Las Navas, Catoto-Ogan is projected to have the highest percentage of area that will experience flood levels, at 7.72%. On the other hand, San Isidro posted the percentage of area that may be affected by flood depths, at 7.66%.

Among the barangays in the Municipality of Mapanas, Siljagon is projected to have the highest percentage of area that will experience flood levels, at 18.31%. On the other hand, San Jose posted the percentage of area that may be affected by flood depths, at 2.35%.

Among the barangays in the Municipality of Palapag, Bagacay is projected to have the highest percentage of area that will experience flood levels, at 18.79%. On the other hand, Bangon posted the percentage of area that may be affected by flood depths, at 7.30%.

Among the barangays in the Municipality of Pambujan, Sixto T. Balanguit, Sr. is projected to have the highest percentage of area that will experience flood levels, at 2.23%. On the other hand, Geparayan posted the percentage of area that may be affected by flood depths, at 1.42%.

Among the barangays in the Municipality of Silvino Lobos, Geparayan de Turag is projected to have the highest percentage of area that will experience flood levels, at 4.27%. On the other hand, Senonogan de Tubang posted the percentage of area that may be affected by flood depths, at 2.93%.

Among the barangays in the Municipality of Matuguinao, Camonoan is projected to have the highest percentage of area that will experience flood levels, at 1.26%. On the other hand, Ligaya posted the percentage of area that may be affected by flood depths, at 0.03%.

The generated flood hazard maps for the Catubig floodplain were also used to assess the vulnerability of the educational and medical institutions in the floodplain. Using the flood depth units of PAGASA for the flood hazard maps – "Low", "Medium", and "High" – the affected institutions were given an individual assessment for each flood hazard scenario (i.e., 5-year, 25-year, and 100-year).

Table 113. Area covered by each warning level, with respect to the rainfall scenario

Warning Level	Area Covered in sq. km.		
	5 year	25 year	100 year
Low	64.34	54.73	51.01
Medium	87.77	96.45	88.52
High	59.50	85.36	111.70
Total	**211.61**	**236.54**	**251.23**

Of the one hundred and sixty-seven (167) identified educational institutions in the Catubig floodplain, thirty (30) were assessed to be exposed to Low-level flooding during a 5-year scenario. On the other hand, forty-two (42) schools were assessed to be exposed to Medium-level flooding, and fifteen (15) to High-level flooding in the same scenario. In the 25-year scenario, twenty-one (21) schools were assessed to be exposed to Low-level flooding, fifty-four (54) to Medium-level flooding, and twenty-three (23) to High-level flooding. For the 100-year scenario, twenty-two (22) schools were assessed to be subjected to Low-level flooding, and forty (40) schools were expected to experience Medium-level flooding. In the same scenario, forty-five (45) schools were found to be exposed to High-level flooding. See Annex 12 for a detailed enumeration of the schools exposed to flooding within the Catubig floodplain.

Of the seven (7) identified medical institutions in the Catubig floodplain, one (1) was assessed to be exposed to Medium-level flooding in the 5-year scenario. In the 25-year and 100-year scenarios, one (1) institution was found to be exposed to Low-level flooding; and one (1) was expected to experience High-level flooding. See Annex 13 for a detailed enumeration of medical institutions exposed to flooding within the Catubig floodplain.

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. For this purpose, field personnel gathered secondary data regarding flood occurrences in the respective areas within the major river systems in the Philippines.

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

The validation personnel then went to the specified points identified in the river basin to gather data regarding the actual flood levels in each location. Data gathering was conducted through assistance from a local DRRM office to obtain maps or situation reports about the past flooding events, or through interviews with some residents with knowledge or experience of flooding in a particular area.

After which, the actual data from the field were compared with the simulated data to assess the accuracy of the flood depth maps produced, and to improve on the results of the flood map. The points in the flood map versus the corresponding validation depths are illustrated in Figure 158.

The flood validation consists of one hundred and eighty-three (183) points, randomly selected all over the Catubig floodplain (Figure 157). It attained an RMSE value of 1.75. Table 114 outlines a contingency matrix of the comparison. The validation points are found in Annex 11.

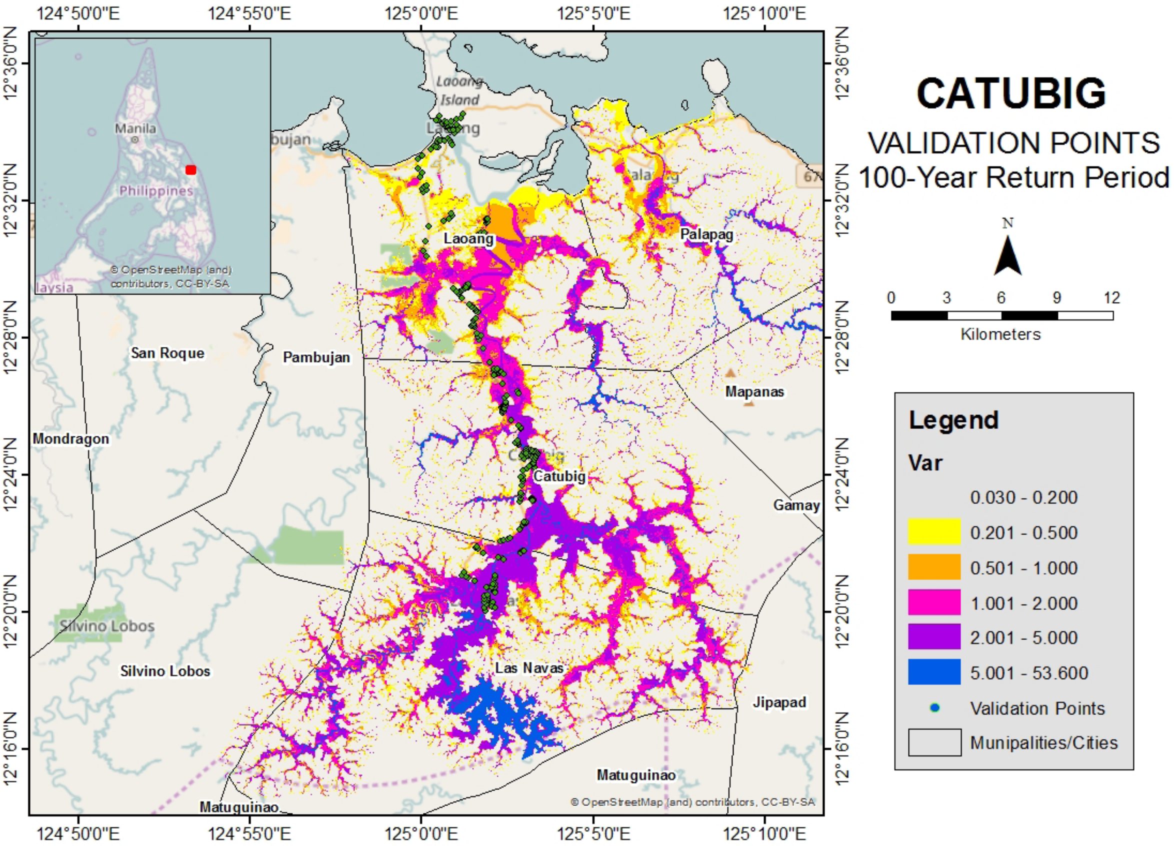


Figure 157. Validation points for the 100-year flood depth map of the Catubig floodplain

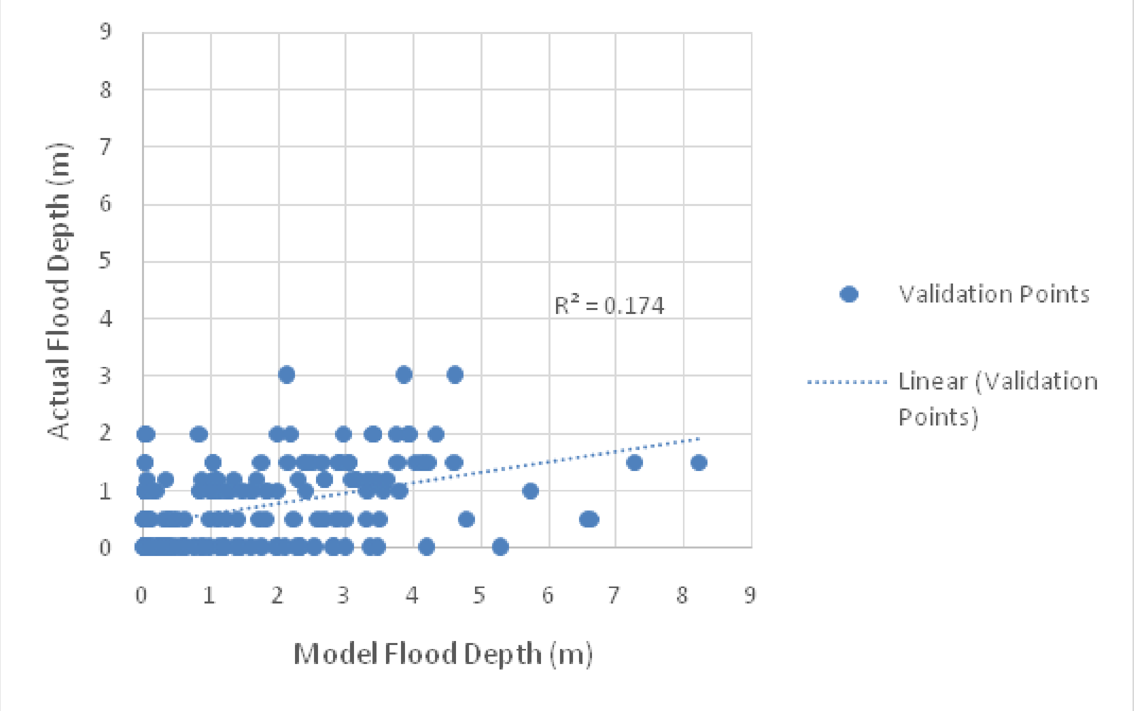


Figure 158. Flood map depth vs. actual flood depth

Table 114. Actual flood depth vs. simulated flood depth in the Catubig floodplain

CATUBIG BASIN		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
Actual Flood Depth (m)	0-0.20	28	11	8	8	12	1	68
	0.21-0.50	11	4	3	5	8	2	33
	0.51-1.00	7	1	2	11	4	1	26
	1.01-2.00	6	1	2	9	33	2	53
	2.01-5.00	0	0	0	0	3	0	3
	> 5.00	0	0	0	0	0	0	0
	Total	52	17	15	33	60	6	183

The overall accuracy generated by the flood model is estimated at 25.14%, with forty-six (46) points correctly matching the actual flood depths. In addition, there were seventy-one (71) points estimated one (1) level above and below the correct flood depths. Meanwhile, there were twenty-seven (27) points and thirty-eight (38) points estimated two (2) levels above and below, and three (3) or more levels above and below the correct flood levels, respectively. A total of four (4) points were overestimated, while a total of twenty-eight (28) points were underestimated in the modeled flood depths of the Catubig River Basin. Table 155 depicts the summary of the accuracy assessment of the Catubig survey.

Table 115. Summary of Accuracy Assessment in the Catubig River Basin

	No. of Points	%
Correct	46	25.14
Overestimated	109	59.56
Underestimated	28	15.30
Total	183	100.00

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ANNEXES

Annex 1. Technical Specifications of the LiDAR Sensors used in the Catubig Floodplain Survey

Table A-1.1. Specifications of the Aquarius sensor

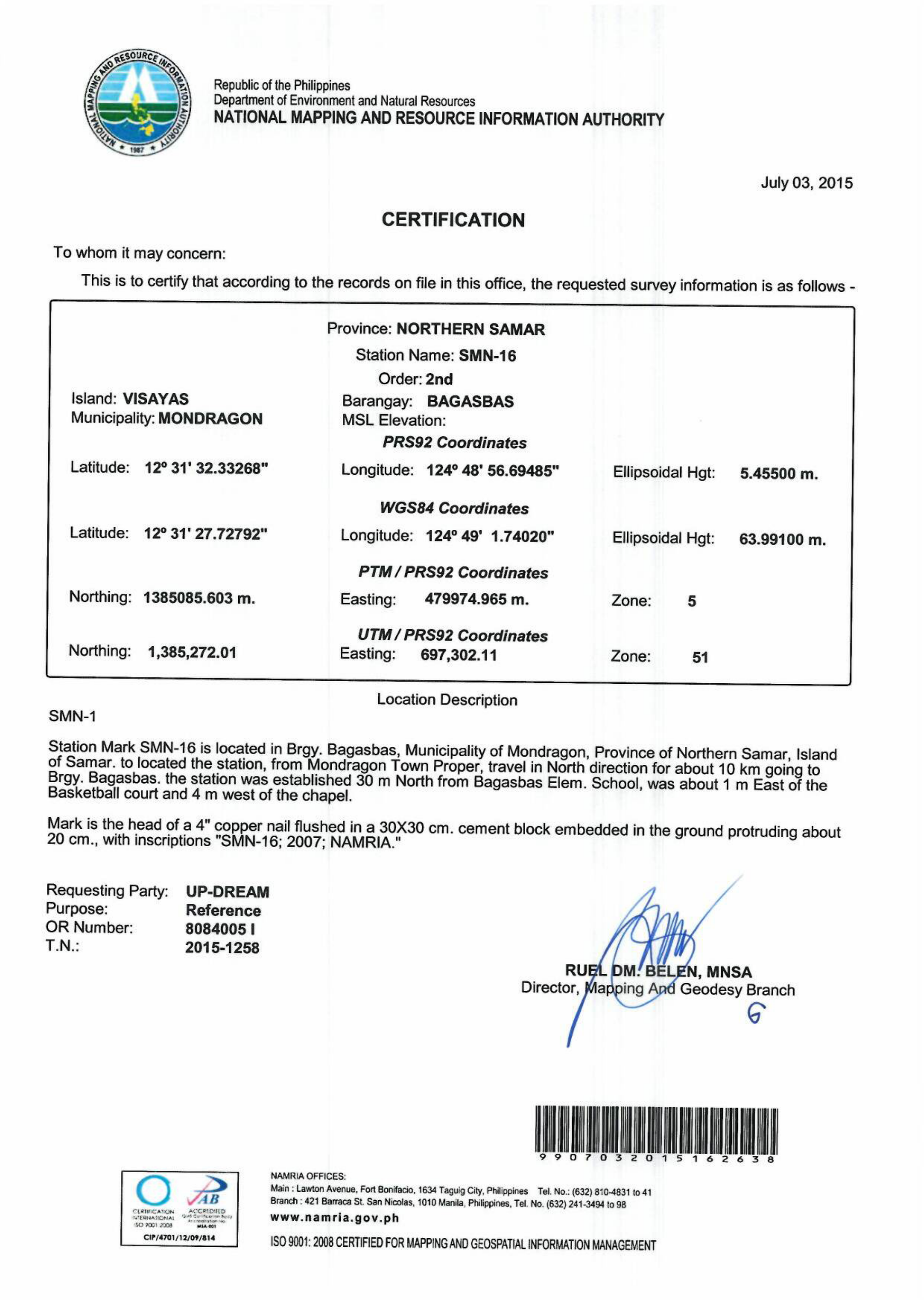
Parameter	Specification
Operational altitude	300-600 m AGL
Laser pulse repetition rate	33, 50. 70 kHz
Scan rate	0-70 Hz
Scan half-angle	0 to ± 25 ˚
Laser footprint on water surface	30-60 cm
Depth range	0 to > 10 m (for k < 0.1/m)
Topographic mode	
Operational altitude	300-2500
Range Capture	Up to 4 range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

Table A-1.2. Specifications of the 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. SMN-16



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

July 03, 2015

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: **NORTHERN SAMAR**
Station Name: **SMN-16**
Order: **2nd**
Island: **VISAYAS**
Municipality: **MONDRAGON**
Barangay: **BAGASBAS**
MSL Elevation:

PRS92 Coordinates

Latitude:	**12° 31' 32.33268"**	Longitude:	**124° 48' 56.69485"**	Ellipsoidal Hgt:	**5.45500 m.**

WGS84 Coordinates

Latitude:	**12° 31' 27.72792"**	Longitude:	**124° 49' 1.74020"**	Ellipsoidal Hgt:	**63.99100 m.**

PTM / PRS92 Coordinates

Northing:	**1385085.603 m.**	Easting:	**479974.965 m.**	Zone:	**5**

UTM / PRS92 Coordinates

Northing:	**1,385,272.01**	Easting:	**697,302.11**	Zone:	**51**

Location Description

SMN-1

Station Mark SMN-16 is located in Brgy. Bagasbas, Municipality of Mondragon, Province of Northern Samar, Island of Samar. to located the station, from Mondragon Town Proper, travel in North direction for about 10 km going to Brgy. Bagasbas. the station was established 30 m North from Bagasbas Elem. School, was about 1 m East of the Basketball court and 4 m west of the chapel.

Mark is the head of a 4" copper nail flushed in a 30X30 cm. cement block embedded in the ground protruding about 20 cm., with inscriptions "SMN-16; 2007; NAMRIA."

Requesting Party:	**UP-DREAM**
Purpose:	**Reference**
OR Number:	**8084005 I**
T.N.:	**2015-1258**

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

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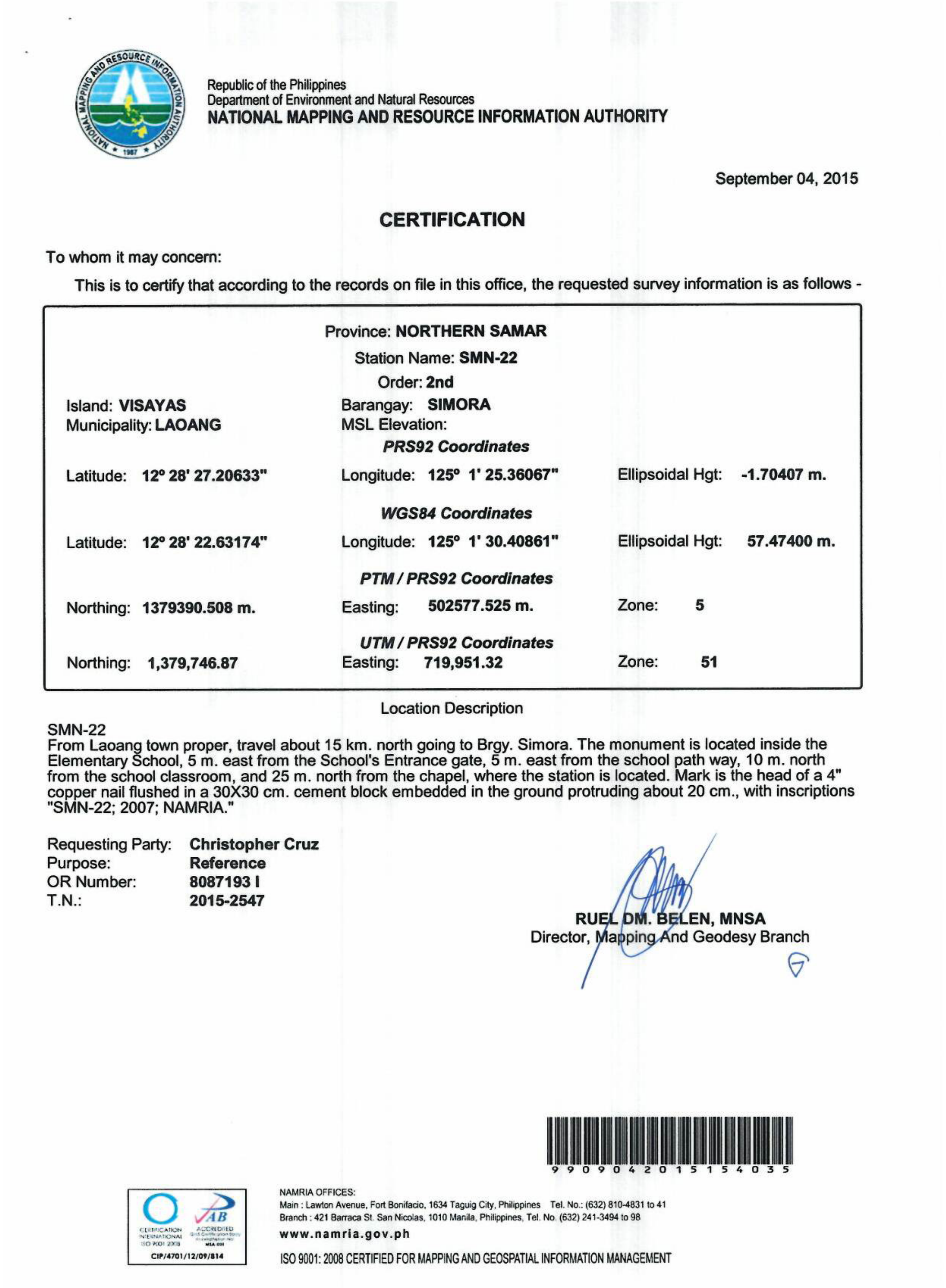
CIP/4701/12/09/814

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

ISO 9001: 2008 CERTIFIED FOR MAPPING AND GEOSPATIAL INFORMATION MANAGEMENT

Figure A-2.1. SMN-16

2. SMN-22



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

September 04, 2015

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: **NORTHERN SAMAR**	
	Station Name: **SMN-22**	
	Order: **2nd**	
Island: **VISAYAS**	Barangay: **SIMORA**	
Municipality: **LAOANG**	MSL Elevation:	
	PRS92 Coordinates	
Latitude: **12° 28' 27.20633"**	Longitude: **125° 1' 25.36067"**	Ellipsoidal Hgt: **-1.70407 m.**
	WGS84 Coordinates	
Latitude: **12° 28' 22.63174"**	Longitude: **125° 1' 30.40861"**	Ellipsoidal Hgt: **57.47400 m.**
	PTM / PRS92 Coordinates	
Northing: **1379390.508 m.**	Easting: **502577.525 m.**	Zone: **5**
	UTM / PRS92 Coordinates	
Northing: **1,379,746.87**	Easting: **719,951.32**	Zone: **51**

Location Description

SMN-22
From Laoang town proper, travel about 15 km. north going to Brgy. Simora. The monument is located inside the Elementary School, 5 m. east from the School's Entrance gate, 5 m. east from the school path way, 10 m. north from the school classroom, and 25 m. north from the chapel, where the station is located. Mark is the head of a 4" copper nail flushed in a 30X30 cm. cement block embedded in the ground protruding about 20 cm., with inscriptions "SMN-22; 2007; NAMRIA."

Requesting Party:	**Christopher Cruz**
Purpose:	**Reference**
OR Number:	**8087193 I**
T.N.:	**2015-2547**

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

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Branch : 421 Barraca St. San Nicolas, 1010 Manila, Philippines, Tel. No. (632) 241-3494 to 98
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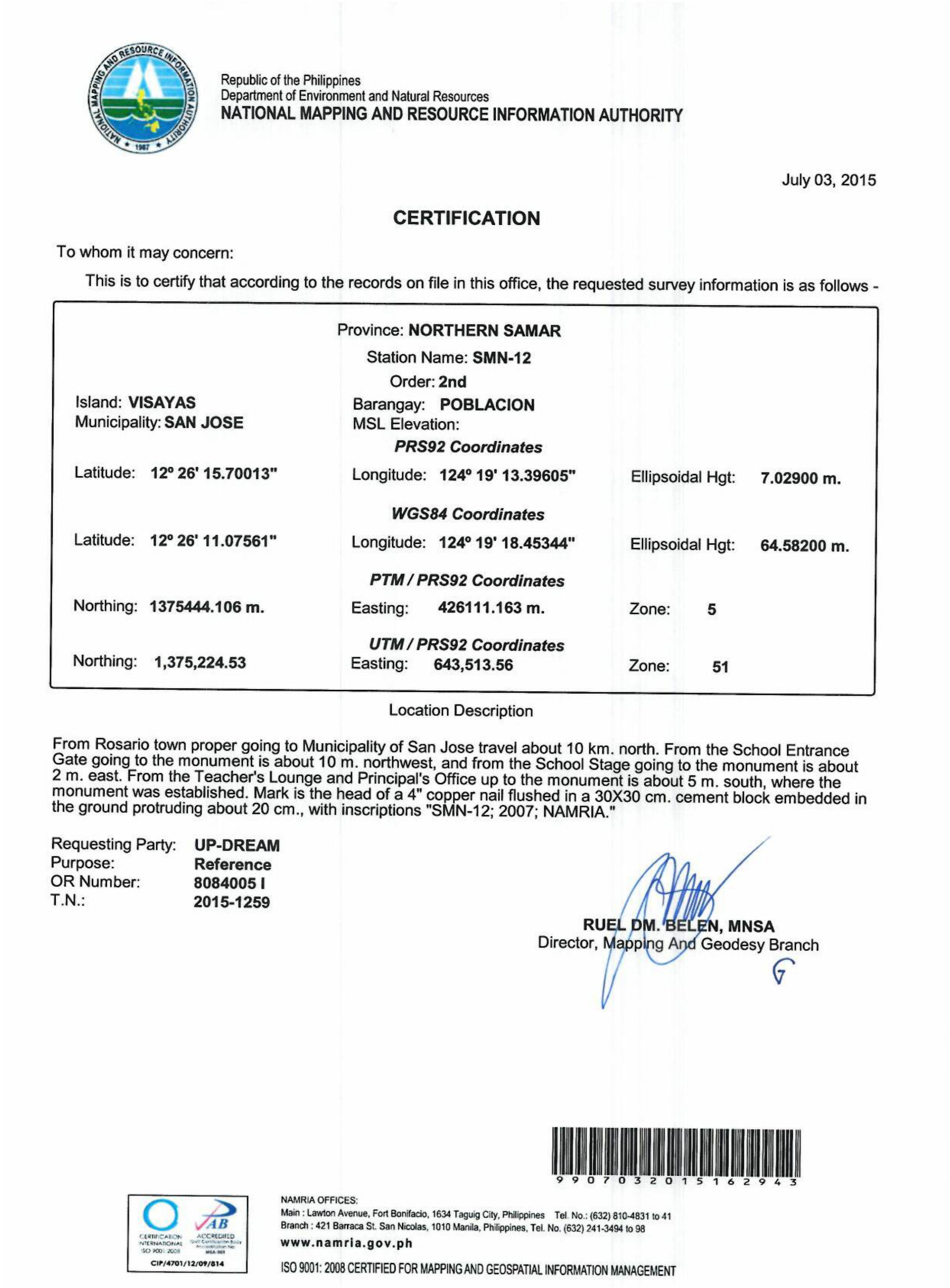
Figure A-2.2. SMN-22

3. SMN-12



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

July 03, 2015

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: **NORTHERN SAMAR**
Station Name: **SMN-12**
Order: **2nd**

Island: **VISAYAS**
Municipality: **SAN JOSE**
Barangay: **POBLACION**
MSL Elevation:

PRS92 Coordinates

Latitude:	**12° 26' 15.70013"**	Longitude:	**124° 19' 13.39605"**	Ellipsoidal Hgt:	**7.02900 m.**

WGS84 Coordinates

Latitude:	**12° 26' 11.07561"**	Longitude:	**124° 19' 18.45344"**	Ellipsoidal Hgt:	**64.58200 m.**

PTM / PRS92 Coordinates

Northing:	**1375444.106 m.**	Easting:	**426111.163 m.**	Zone:	**5**

UTM / PRS92 Coordinates

Northing:	**1,375,224.53**	Easting:	**643,513.56**	Zone:	**51**

Location Description

From Rosario town proper going to Municipality of San Jose travel about 10 km. north. From the School Entrance Gate going to the monument is about 10 m. northwest, and from the School Stage going to the monument is about 2 m. east. From the Teacher's Lounge and Principal's Office up to the monument is about 5 m. south, where the monument was established. Mark is the head of a 4" copper nail flushed in a 30X30 cm. cement block embedded in the ground protruding about 20 cm., with inscriptions "SMN-12; 2007; NAMRIA."

Requesting Party: **UP-DREAM**
Purpose: **Reference**
OR Number: **8084005 I**
T.N.: **2015-1259**

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

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CERTIFICATION INTERNATIONAL ISO 9001: 2008 ACCREDITED MSA-001
CIP/4701/12/09/814

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Figure A-2.3. SMN-12

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

1. CMN-01

Table A-3.1. CMN-01

Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
CMN-01 --- SMN-19 (B1)	SMN-19	CMN-01	Fixed	0.004	0.018	261°10'06"	19716.093	7.117
CMN-01 --- SMN-19 (B2)	SMN-19	CMN-01	Fixed	0.004	0.016	261°10'06"	19716.092	7.056

Acceptance Summary

Processed	Passed	Flag	⚑	Fail	⚑
2	2	0		0	

Vector Components (Mark to Mark)

From:	SMN-19				
Grid		Local		Global	
Easting	697302.106 m	Latitude	N12°31'32.33268"	Latitude	N12°31'27.72792"
Northing	1385272.014 m	Longitude	E124°48'56.69484"	Longitude	E124°49'01.74020"
Elevation	8.997 m	Height	5.456 m	Height	63.991 m

To:	CMN-01				
Grid		Local		Global	
Easting	677840.326 m	Latitude	N12°29'53.60604"	Latitude	N12°29'48.99306"
Northing	1382111.129 m	Longitude	E124°38'11.46535"	Longitude	E124°38'16.51471"
Elevation	14.613 m	Height	12.573 m	Height	70.742 m

Vector					
ΔEasting	-19461.780 m	NS Fwd Azimuth	261°10'06"	ΔX	15632.874 m
ΔNorthing	-3160.884 m	Ellipsoid Dist.	19716.093 m	ΔY	11643.556 m
ΔElevation	5.615 m	ΔHeight	7.117 m	ΔZ	-2960.605 m

Standard Errors

Vector errors:					
σ ΔEasting	0.002 m	σ NS fwd Azimuth	0°00'00"	σ ΔX	0.005 m
σ ΔNorthing	0.002 m	σ Ellipsoid Dist.	0.002 m	σ ΔY	0.007 m
σ ΔElevation	0.009 m	σ ΔHeight	0.009 m	σ ΔZ	0.003 m

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000248767		
Y	-0.0000327811	0.0000524301	
Z	-0.0000118537	0.0000172626	0.0000085902

2. CMN-03

Table A-3.2. CMN-03

Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
SMN-22 --- CMN-03 (B1)	SMN-22	CMN-03	Fixed	0.003	0.013	328°18'36"	3228.537	1.582
SMN-22 --- CMN-03 (B2)	SMN-22	CMN-03	Fixed	0.003	0.011	328°18'36"	3228.533	1.564

Acceptance Summary

Processed	Passed	Flag ⚑	Fail ⚑
2	2	0	0

Vector Components (Mark to Mark)

From:	SMN-22				
Grid		Local		Global	
Easting	719951.311 m	Latitude	N12°28'27.20631"	Latitude	N12°28'22.63174"
Northing	1379746.868 m	Longitude	E125°01'25.36070"	Longitude	E125°01'30.40861"
Elevation	2.366 m	Height	-1.704 m	Height	57.474 m

To:	CMN-03				
Grid		Local		Global	
Easting	718234.013 m	Latitude	N12°29'56.60839"	Latitude	N12°29'52.02635"
Northing	1382481.531 m	Longitude	E125°00'29.19031"	Longitude	E125°00'34.23621"
Elevation	4.145 m	Height	-0.122 m	Height	58.953 m

Vector					
ΔEasting	-1717.298 m	NS Fwd Azimuth	328°18'36"	ΔX	1729.089 m
ΔNorthing	2734.663 m	Ellipsoid Dist.	3228.537 m	ΔY	488.102 m
ΔElevation	1.779 m	ΔHeight	1.582 m	ΔZ	2682.431 m

Standard Errors

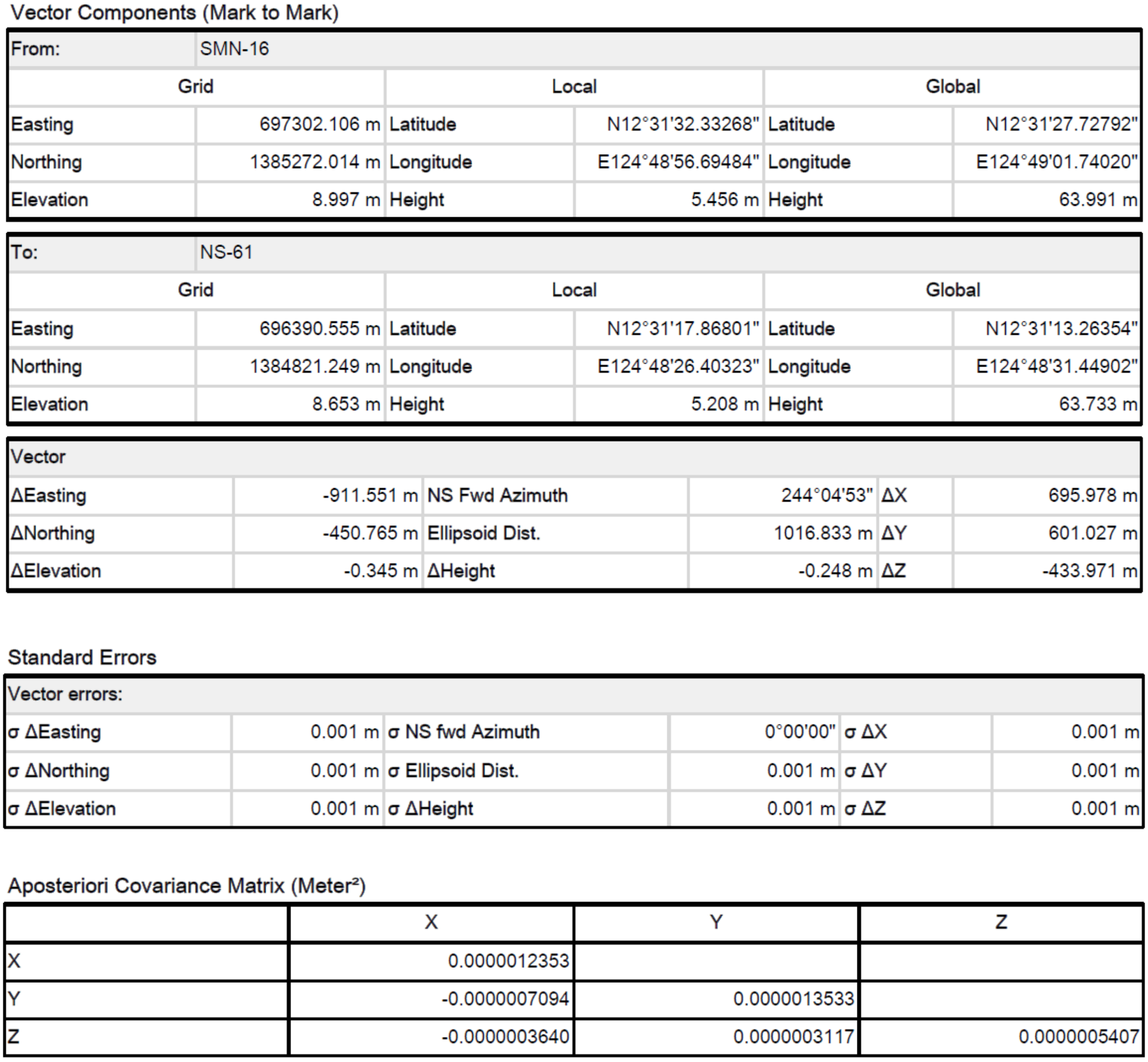
Vector errors:					
σ ΔEasting	0.001 m	σ NS fwd Azimuth	0°00'00"	σ ΔX	0.004 m
σ ΔNorthing	0.001 m	σ Ellipsoid Dist.	0.001 m	σ ΔY	0.005 m
σ ΔElevation	0.006 m	σ ΔHeight	0.006 m	σ ΔZ	0.002 m

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000131932		
Y	-0.0000175996	0.0000266165	
Z	-0.0000049526	0.0000073425	0.0000030832

3. NS-61

Table A-3.3. NS-61



Vector Components (Mark to Mark)

From:	SMN-16				
Grid		Local		Global	
Easting	697302.106 m	Latitude	N12°31'32.33268"	Latitude	N12°31'27.72792"
Northing	1385272.014 m	Longitude	E124°48'56.69484"	Longitude	E124°49'01.74020"
Elevation	8.997 m	Height	5.456 m	Height	63.991 m

To:	NS-61				
Grid		Local		Global	
Easting	696390.555 m	Latitude	N12°31'17.86801"	Latitude	N12°31'13.26354"
Northing	1384821.249 m	Longitude	E124°48'26.40323"	Longitude	E124°48'31.44902"
Elevation	8.653 m	Height	5.208 m	Height	63.733 m

Vector					
ΔEasting	-911.551 m	NS Fwd Azimuth	244°04'53"	ΔX	695.978 m
ΔNorthing	-450.765 m	Ellipsoid Dist.	1016.833 m	ΔY	601.027 m
ΔElevation	-0.345 m	ΔHeight	-0.248 m	ΔZ	-433.971 m

Standard Errors

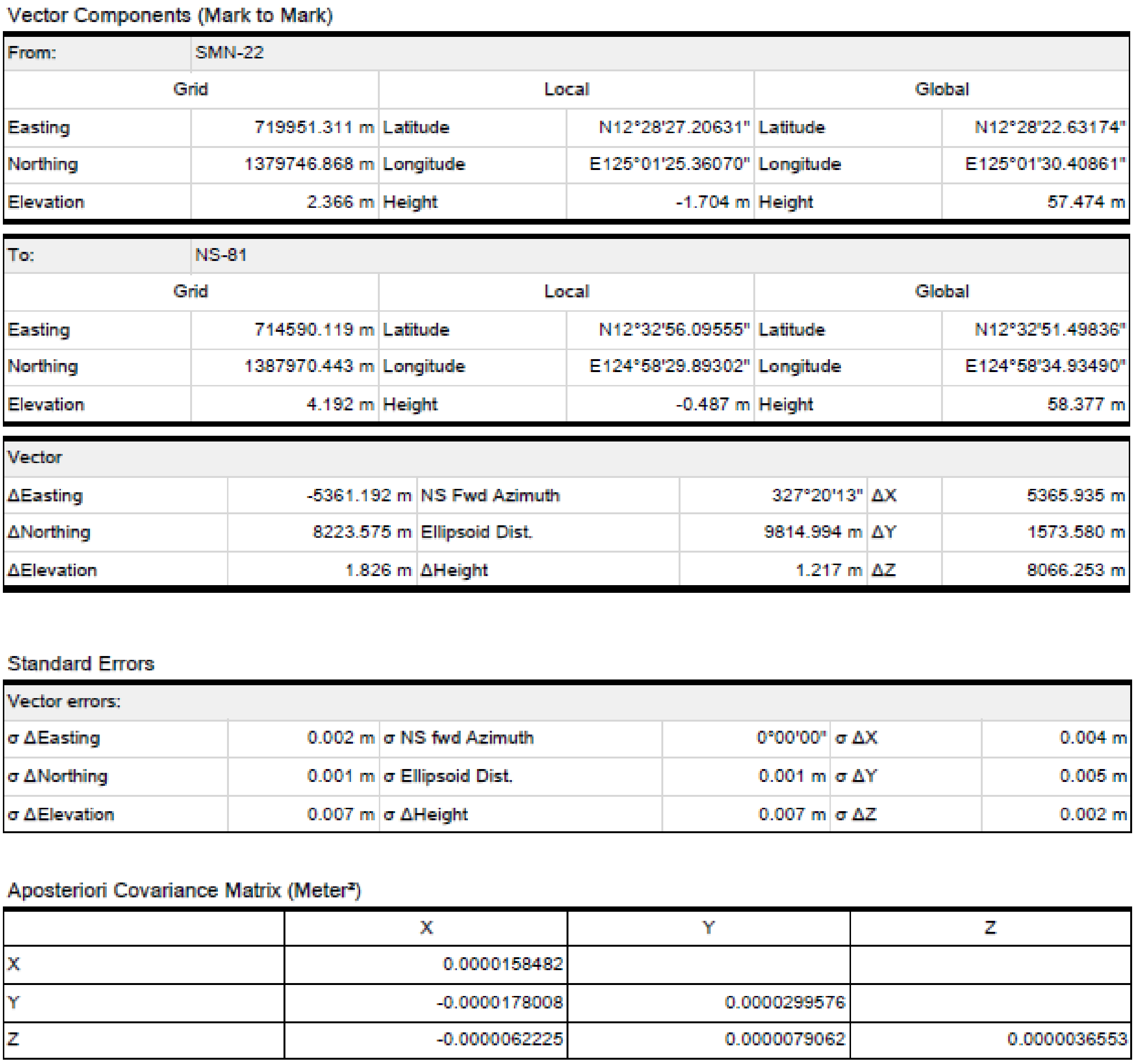
Vector errors:					
σ ΔEasting	0.001 m	σ NS fwd Azimuth	0°00'00"	σ ΔX	0.001 m
σ ΔNorthing	0.001 m	σ Ellipsoid Dist.	0.001 m	σ ΔY	0.001 m
σ ΔElevation	0.001 m	σ ΔHeight	0.001 m	σ ΔZ	0.001 m

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000012353		
Y	-0.0000007094	0.0000013533	
Z	-0.0000003640	0.0000003117	0.0000005407

4. NS-81

Table A-3.4. NS-81



Vector Components (Mark to Mark)

From:	SMN-22				
Grid		Local		Global	
Easting	719951.311 m	Latitude	N12°28'27.20631"	Latitude	N12°28'22.63174"
Northing	1379746.868 m	Longitude	E125°01'25.36070"	Longitude	E125°01'30.40861"
Elevation	2.366 m	Height	-1.704 m	Height	57.474 m

To:	NS-81				
Grid		Local		Global	
Easting	714590.119 m	Latitude	N12°32'56.09555"	Latitude	N12°32'51.49836"
Northing	1387970.443 m	Longitude	E124°58'29.89302"	Longitude	E124°58'34.93490"
Elevation	4.192 m	Height	-0.487 m	Height	58.377 m

Vector					
ΔEasting	-5361.192 m	NS Fwd Azimuth	327°20'13"	ΔX	5365.935 m
ΔNorthing	8223.575 m	Ellipsoid Dist.	9814.994 m	ΔY	1573.580 m
ΔElevation	1.826 m	ΔHeight	1.217 m	ΔZ	8066.253 m

Standard Errors

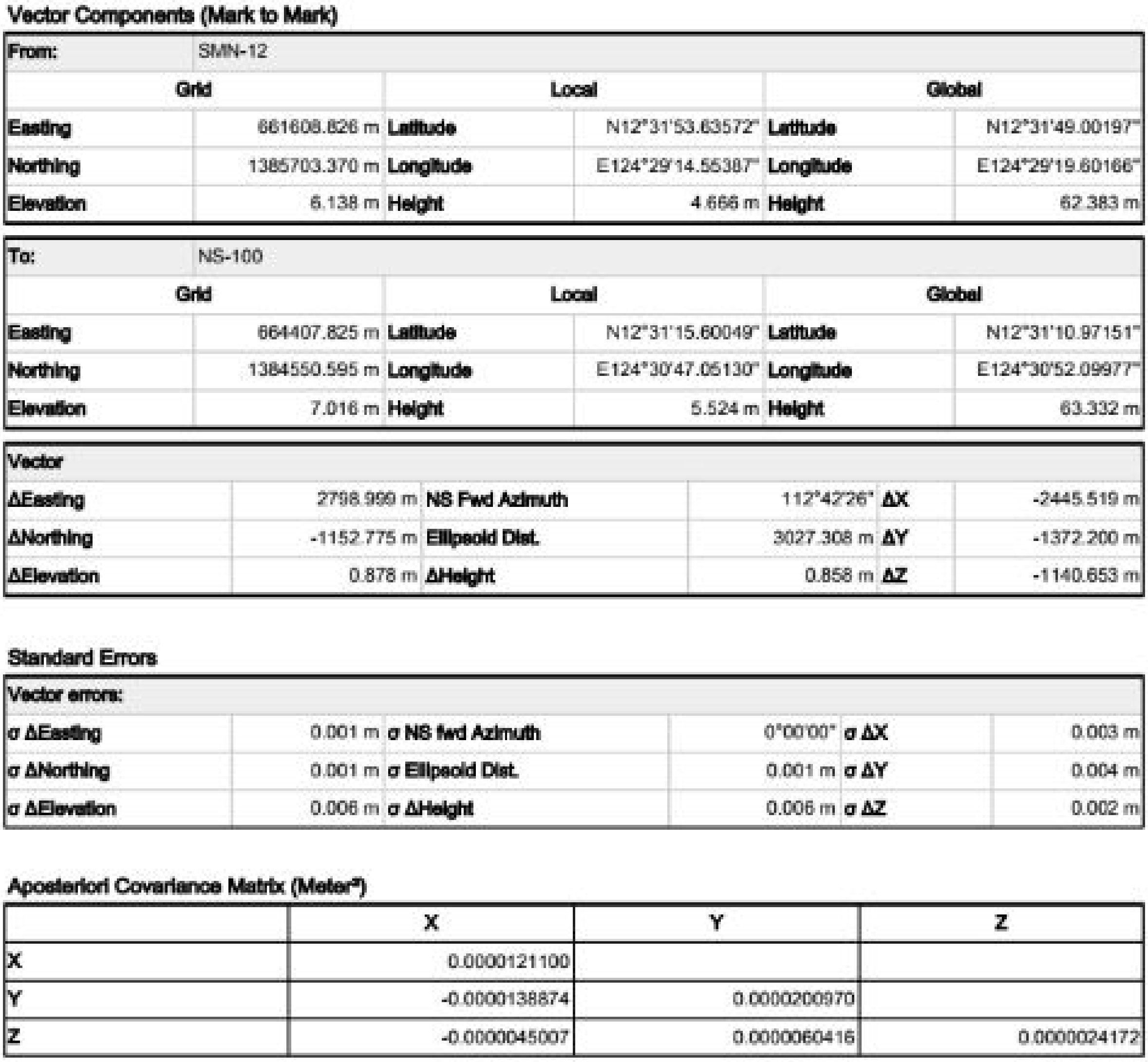
Vector errors:					
σ ΔEasting	0.002 m	σ NS fwd Azimuth	0°00'00"	σ ΔX	0.004 m
σ ΔNorthing	0.001 m	σ Ellipsoid Dist.	0.001 m	σ ΔY	0.005 m
σ ΔElevation	0.007 m	σ ΔHeight	0.007 m	σ ΔZ	0.002 m

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000158482		
Y	-0.0000178008	0.0000299576	
Z	-0.0000062225	0.0000079062	0.0000036553

5. NS-100

Table A-3.5. NS-100



Vector Components (Mark to Mark)

From:	SMN-12				
Grid		**Local**		**Global**	
Easting	661608.826 m	**Latitude**	N12°31'53.63572"	**Latitude**	N12°31'49.00197"
Northing	1385703.370 m	**Longitude**	E124°29'14.55387"	**Longitude**	E124°29'19.60166"
Elevation	6.138 m	**Height**	4.666 m	**Height**	62.383 m

To:	NS-100				
Grid		**Local**		**Global**	
Easting	664407.825 m	**Latitude**	N12°31'15.60049"	**Latitude**	N12°31'10.97151"
Northing	1384550.595 m	**Longitude**	E124°30'47.05130"	**Longitude**	E124°30'52.09977"
Elevation	7.016 m	**Height**	5.524 m	**Height**	63.332 m

Vector					
ΔEasting	2798.999 m	**NS Fwd Azimuth**	112°42'26"	**ΔX**	-2445.519 m
ΔNorthing	-1152.775 m	**Ellipsoid Dist.**	3027.308 m	**ΔY**	-1372.200 m
ΔElevation	0.878 m	**ΔHeight**	0.858 m	**ΔZ**	-1140.653 m

Standard Errors

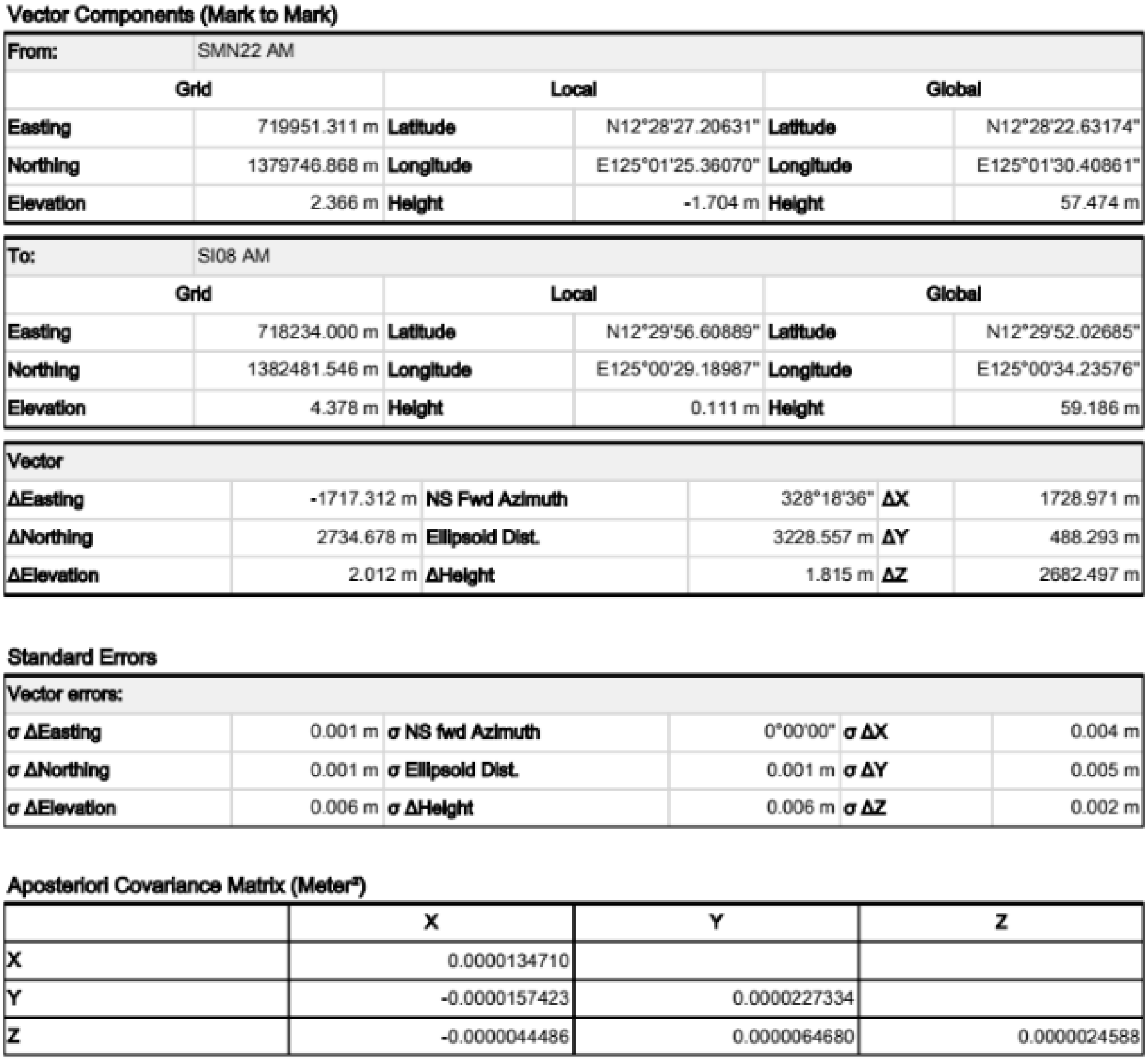
Vector errors:					
σ ΔEasting	0.001 m	**σ NS fwd Azimuth**	0°00'00"	**σ ΔX**	0.003 m
σ ΔNorthing	0.001 m	**σ Ellipsoid Dist.**	0.001 m	**σ ΔY**	0.004 m
σ ΔElevation	0.006 m	**σ ΔHeight**	0.006 m	**σ ΔZ**	0.002 m

Aposteriori Covariance Matrix (Meter²)

	X	**Y**	**Z**
X	0.0000121100		
Y	-0.0000138874	0.0000200970	
Z	-0.0000045007	0.0000060416	0.0000024172

6. SI-08

Table A-3.6. SI-08



Vector Components (Mark to Mark)

From:	SMN22 AM				
Grid		Local		Global	
Easting	719951.311 m	Latitude	N12°28'27.20631"	Latitude	N12°28'22.63174"
Northing	1379746.868 m	Longitude	E125°01'25.36070"	Longitude	E125°01'30.40861"
Elevation	2.366 m	Height	-1.704 m	Height	57.474 m

To:	SI08 AM				
Grid		Local		Global	
Easting	718234.000 m	Latitude	N12°29'56.60889"	Latitude	N12°29'52.02685"
Northing	1382481.546 m	Longitude	E125°00'29.18987"	Longitude	E125°00'34.23576"
Elevation	4.378 m	Height	0.111 m	Height	59.186 m

Vector					
ΔEasting	-1717.312 m	NS Fwd Azimuth	328°18'36"	ΔX	1728.971 m
ΔNorthing	2734.678 m	Ellipsoid Dist.	3228.557 m	ΔY	488.293 m
ΔElevation	2.012 m	ΔHeight	1.815 m	ΔZ	2682.497 m

Standard Errors

Vector errors:					
σ ΔEasting	0.001 m	σ NS fwd Azimuth	0°00'00"	σ ΔX	0.004 m
σ ΔNorthing	0.001 m	σ Ellipsoid Dist.	0.001 m	σ ΔY	0.005 m
σ ΔElevation	0.006 m	σ ΔHeight	0.006 m	σ ΔZ	0.002 m

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000134710		
Y	-0.0000157423	0.0000227334	
Z	-0.0000044486	0.0000064680	0.0000024588

7. SMN-3378

Table A-3.7. SMN-3378

Vector Components (Mark to Mark)

From:	SMN-22				
Grid		**Local**		**Global**	
Easting	719951.311 m	**Latitude**	N12°28'27.20631"	**Latitude**	N12°28'22.63174"
Northing	1379746.868 m	**Longitude**	E125°01'25.36070"	**Longitude**	E125°01'30.40861"
Elevation	2.366 m	**Height**	-1.704 m	**Height**	57.474 m

To:	SMN-3378				
Grid		**Local**		**Global**	
Easting	721512.775 m	**Latitude**	N12°26'01.70520"	**Latitude**	N12°25'57.14186"
Northing	1375286.867 m	**Longitude**	E125°02'15.92453"	**Longitude**	E125°02'20.97581"
Elevation	5.208 m	**Height**	1.514 m	**Height**	60.832 m

Vector					
Δ Easting	1561.463 m	**NS Fwd Azimuth**	161°08'29"	**Δ X**	-1805.737 m
Δ Northing	-4460.001 m	**Ellipsoid Dist.**	4724.481 m	**Δ Y**	-84.519 m
Δ Elevation	2.842 m	**Δ Height**	3.219 m	**Δ Z**	-4364.957 m

Standard Errors

Vector errors:					
σ Δ Easting	0.002 m	**σ NS fwd Azimuth**	0°00'00"	**σ Δ X**	0.004 m
σ Δ Northing	0.001 m	**σ Ellipsoid Dist.**	0.001 m	**σ Δ Y**	0.005 m
σ Δ Elevation	0.006 m	**σ Δ Height**	0.006 m	**σ Δ Z**	0.002 m

Aposteriori Covariance Matrix (Meter^2)

	X	**Y**	**Z**
X	0.0000134646		
Y	-0.0000139256	0.0000212735	
Z	-0.0000056176	0.0000065331	0.0000039306

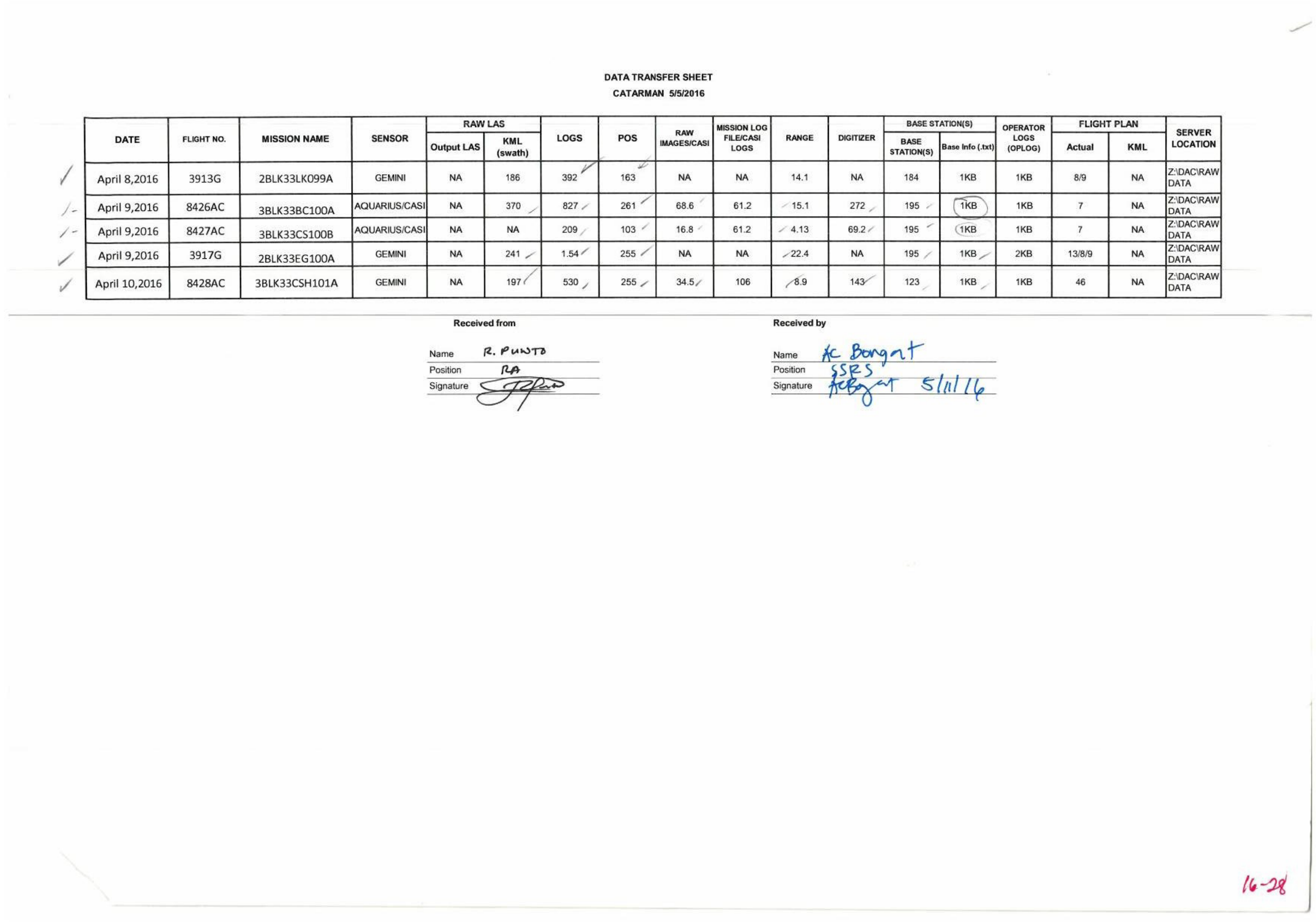
Annex 4. The LiDAR Survey Team Composition

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	UP-TCAGP
	Data Component Project Leader – I	ENGR. LOUIE P. BALICANTA	UP-TCAGP
Survey Supervisor	Chief Science Research Specialist (CSRS)	ENGR. CHRISTOPHER CRUZ	UP-TCAGP
	Supervising Science Research Specialist (Supervising SRS)	LOVELY GRACIA ACUñA	UP-TCAGP
		LOVELYN ASUNCION	UP-TCAGP
FIELD TEAM			
LiDAR Operation	Senior Science Research Specialist (SSRS)	PAULINE JOANNE ARCEO	UP-TCAGP
	Senior Science Research Specialist	AUBREY PAGADOR/ ENGR. IRO NIEL ROXAS	UP-TCAGP
	Senior Science Research Specialist	JASMINE ALVIAR	UP-TCAGP
	Research Associate (RA)	MARY CATHERINE ELIZABETH BALIGUAS	UP-TCAGP
	RA	SANDRA POBLETE	UP-TCAGP
	RA	JONALYN GONZALES	UP-TCAGP
	RA	MA. VERLINA TONGA	UP-TCAGP
	RA	ENGR. MILLIE SHANE REYES	UP-TCAGP
Ground Survey, Data Download and Transfer	RA	JONATHAN ALAMALVEZ	UP-TCAGP
	RA	FRANK NICOLAS ILEJAY	UP-TCAGP
	RA	REGINA AEDRIANNE FELISMINO	UP-TCAGP

LiDAR Operation	Airborne Security	SSG JULIUS RENDON	PHILIPPINE AIR FORCE (PAF)
		SSG JOHN ERIC CACANINDIN	PAF
		SSG SANDY UY	PAF
	Pilot	CAPT. RAUL CZ SAMAR III	ASIAN AEROSPACE CORPORATION (AAC)
		CAPT. RANDY LAGCO	AAC
		CAPT. JERICO JECIEL	AAC
		CAPT. MARK LAWRENCE TANGONAN	AAC
		CAPT. NIEL ACHILLES AGAWIN	AAC
		CAPT. CESAR SHERWIN ALFONSO	AAC

Annex 5. Data Transfer Sheets for the Catubig Floodplain Flights



DATA TRANSFER SHEET
CATARMAN 5/5/2016

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	
April 8,2016	3913G	2BLK33LK099A	GEMINI	NA	186	392	163	NA	NA	14.1	NA	184	1KB	1KB	8/9	NA	Z:\DAC\RAW DATA
April 9,2016	8426AC	3BLK33BC100A	AQUARIUS/CASI	NA	370	827	261	68.6	61.2	15.1	272	195	1KB	1KB	7	NA	Z:\DAC\RAW DATA
April 9,2016	8427AC	3BLK33CS100B	AQUARIUS/CASI	NA	NA	209	103	16.8	61.2	4.13	69.2	195	1KB	1KB	7	NA	Z:\DAC\RAW DATA
April 9,2016	3917G	2BLK33EG100A	GEMINI	NA	241	1.54	255	NA	NA	22.4	NA	195	1KB	2KB	13/8/9	NA	Z:\DAC\RAW DATA
April 10,2016	8428AC	3BLK33CSH101A	GEMINI	NA	197	530	255	34.5	106	8.9	143	123	1KB	1KB	46	NA	Z:\DAC\RAW DATA

Received from

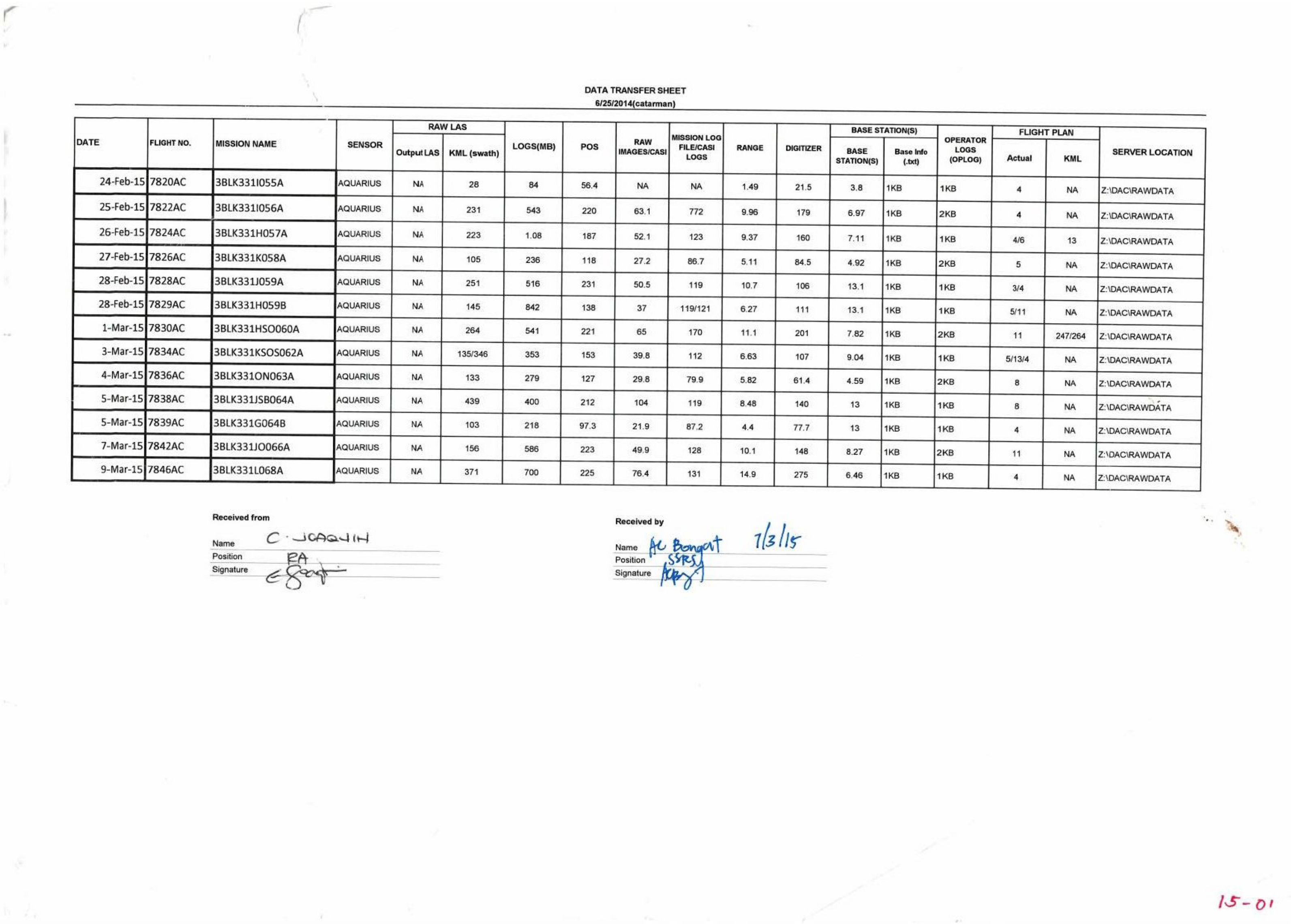
Name R. PUNTO
Position RA
Signature

Received by

Name AC Bongat
Position SSRS
Signature AcBongat 5/11/16

16-28

Figure A-5.1. Data Transfer Sheet for Catubig Floodplain – A



DATA TRANSFER SHEET
6/25/2014(catarman)

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	
24-Feb-15	7820AC	3BLK331I055A	AQUARIUS	NA	28	84	56.4	NA	NA	1.49	21.5	3.8	1KB	1KB	4	NA	Z:\DAC\RAWDATA
25-Feb-15	7822AC	3BLK331I056A	AQUARIUS	NA	231	543	220	63.1	772	9.96	179	6.97	1KB	2KB	4	NA	Z:\DAC\RAWDATA
26-Feb-15	7824AC	3BLK331H057A	AQUARIUS	NA	223	1.08	187	52.1	123	9.37	160	7.11	1KB	1KB	4/6	13	Z:\DAC\RAWDATA
27-Feb-15	7826AC	3BLK331K058A	AQUARIUS	NA	105	236	118	27.2	86.7	5.11	84.5	4.92	1KB	2KB	5	NA	Z:\DAC\RAWDATA
28-Feb-15	7828AC	3BLK331J059A	AQUARIUS	NA	251	516	231	50.5	119	10.7	106	13.1	1KB	1KB	3/4	NA	Z:\DAC\RAWDATA
28-Feb-15	7829AC	3BLK331H059B	AQUARIUS	NA	145	842	138	37	119/121	6.27	111	13.1	1KB	1KB	5/11	NA	Z:\DAC\RAWDATA
1-Mar-15	7830AC	3BLK331HSO060A	AQUARIUS	NA	264	541	221	65	170	11.1	201	7.82	1KB	2KB	11	247/264	Z:\DAC\RAWDATA
3-Mar-15	7834AC	3BLK331KSOS062A	AQUARIUS	NA	135/346	353	153	39.8	112	6.63	107	9.04	1KB	1KB	5/13/4	NA	Z:\DAC\RAWDATA
4-Mar-15	7836AC	3BLK331ON063A	AQUARIUS	NA	133	279	127	29.8	79.9	5.82	61.4	4.59	1KB	2KB	8	NA	Z:\DAC\RAWDATA
5-Mar-15	7838AC	3BLK331JSB064A	AQUARIUS	NA	439	400	212	104	119	8.48	140	13	1KB	1KB	8	NA	Z:\DAC\RAWDATA
5-Mar-15	7839AC	3BLK331G064B	AQUARIUS	NA	103	218	97.3	21.9	87.2	4.4	77.7	13	1KB	1KB	4	NA	Z:\DAC\RAWDATA
7-Mar-15	7842AC	3BLK331JO066A	AQUARIUS	NA	156	586	223	49.9	128	10.1	148	8.27	1KB	2KB	11	NA	Z:\DAC\RAWDATA
9-Mar-15	7846AC	3BLK331L068A	AQUARIUS	NA	371	700	225	76.4	131	14.9	275	6.46	1KB	1KB	4	NA	Z:\DAC\RAWDATA

Received from

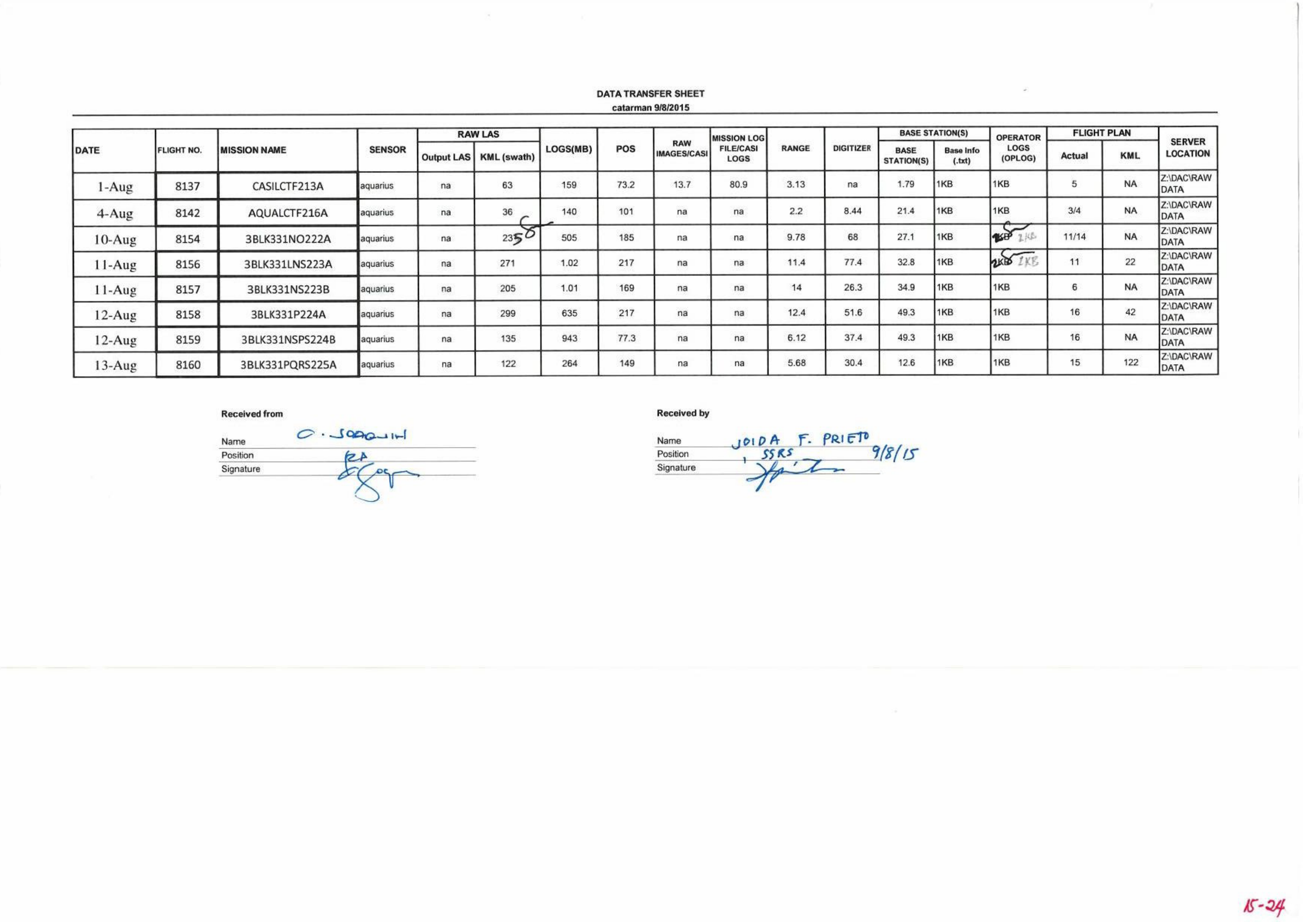
Name C. JOAQUIN
Position RA
Signature

Received by

Name AC Bongat 7/3/15
Position SSRS
Signature

15-01

Figure A-5.2. Data Transfer Sheet for Catubig Floodplain – B



DATA TRANSFER SHEET
catarman 9/8/2015

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	
1-Aug	8137	CASILCTF213A	aquarius	na	63	159	73.2	13.7	80.9	3.13	na	1.79	1KB	1KB	5	NA	Z:\DAC\RAW DATA
4-Aug	8142	AQUALCTF216A	aquarius	na	36	140	101	na	na	2.2	8.44	21.4	1KB	1KB	3/4	NA	Z:\DAC\RAW DATA
10-Aug	8154	3BLK331NO222A	aquarius	na	235	505	185	na	na	9.78	68	27.1	1KB	2KB 1KB	11/14	NA	Z:\DAC\RAW DATA
11-Aug	8156	3BLK331LNS223A	aquarius	na	271	1.02	217	na	na	11.4	77.4	32.8	1KB	2KB 1KB	11	22	Z:\DAC\RAW DATA
11-Aug	8157	3BLK331NS223B	aquarius	na	205	1.01	169	na	na	14	26.3	34.9	1KB	1KB	6	NA	Z:\DAC\RAW DATA
12-Aug	8158	3BLK331P224A	aquarius	na	299	635	217	na	na	12.4	51.6	49.3	1KB	1KB	16	42	Z:\DAC\RAW DATA
12-Aug	8159	3BLK331NSPS224B	aquarius	na	135	943	77.3	na	na	6.12	37.4	49.3	1KB	1KB	16	NA	Z:\DAC\RAW DATA
13-Aug	8160	3BLK331PQRS225A	aquarius	na	122	264	149	na	na	5.68	30.4	12.6	1KB	1KB	15	122	Z:\DAC\RAW DATA

Received from

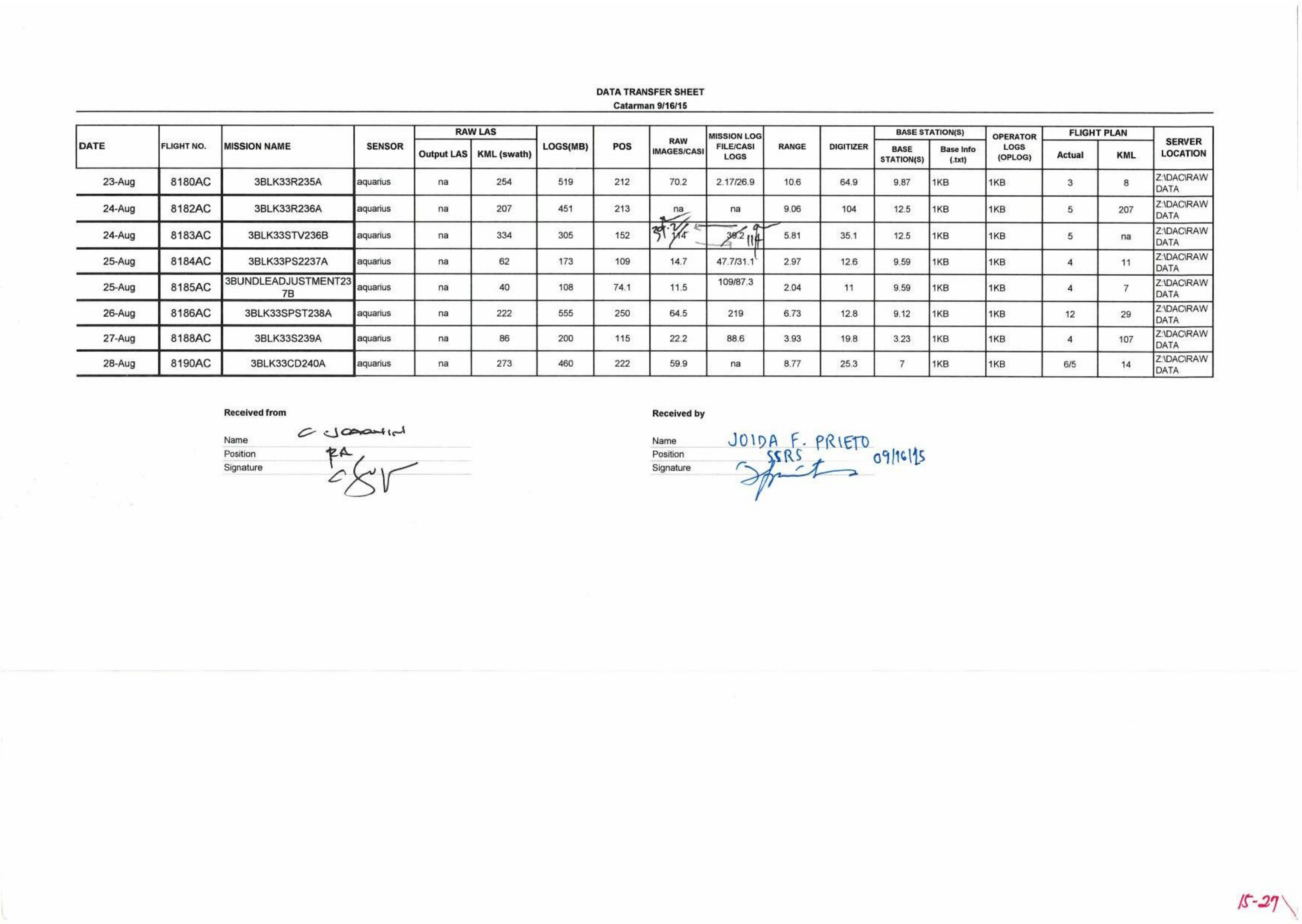
Name O. JOAQUIN
Position RA
Signature

Received by

Name JOIDA F. PRIETO
Position SSRS 9/8/15
Signature

15-24

Figure A-5.3. Data Transfer Sheet for Catubig Floodplain – C



DATA TRANSFER SHEET
Catarman 9/16/15

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	
23-Aug	8180AC	3BLK33R235A	aquarius	na	254	519	212	70.2	2.17/26.9	10.6	64.9	9.87	1KB	1KB	3	8	Z:\DAC\RAW DATA
24-Aug	8182AC	3BLK33R236A	aquarius	na	207	451	213	na	na	9.06	104	12.5	1KB	1KB	5	207	Z:\DAC\RAW DATA
24-Aug	8183AC	3BLK33STV236B	aquarius	na	334	305	152	~~114~~ 39.2	~~39.2~~ 114	5.81	35.1	12.5	1KB	1KB	5	na	Z:\DAC\RAW DATA
25-Aug	8184AC	3BLK33PS2237A	aquarius	na	62	173	109	14.7	47.7/31.1	2.97	12.6	9.59	1KB	1KB	4	11	Z:\DAC\RAW DATA
25-Aug	8185AC	3BUNDLEADJUSTMENT237B	aquarius	na	40	108	74.1	11.5	109/87.3	2.04	11	9.59	1KB	1KB	4	7	Z:\DAC\RAW DATA
26-Aug	8186AC	3BLK33SPST238A	aquarius	na	222	555	250	64.5	219	6.73	12.8	9.12	1KB	1KB	12	29	Z:\DAC\RAW DATA
27-Aug	8188AC	3BLK33S239A	aquarius	na	86	200	115	22.2	88.6	3.93	19.8	3.23	1KB	1KB	4	107	Z:\DAC\RAW DATA
28-Aug	8190AC	3BLK33CD240A	aquarius	na	273	460	222	59.9	na	8.77	25.3	7	1KB	1KB	6/5	14	Z:\DAC\RAW DATA

Received from

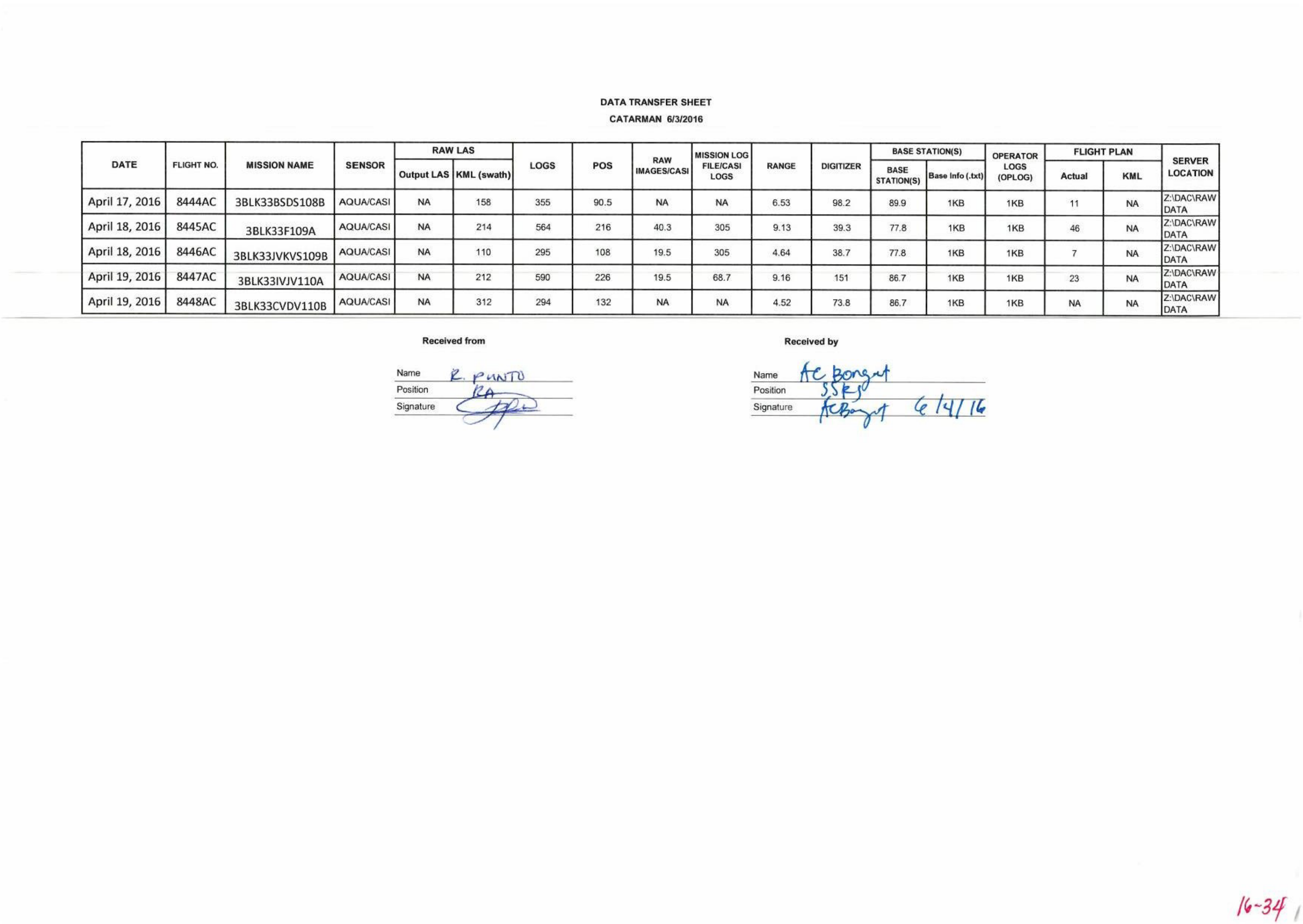
Name C. JOAQUIN
Position RA
Signature

Received by

Name JOIDA F. PRIETO
Position SSRS
Signature 09/16/15

15-27

Figure A-5.4. Data Transfer Sheet for Catubig Floodplain – D



DATA TRANSFER SHEET

CATARMAN 6/3/2016

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	
April 17, 2016	8444AC	3BLK33BSDS108B	AQUA/CASI	NA	158	355	90.5	NA	NA	6.53	98.2	89.9	1KB	1KB	11	NA	Z:\DAC\RAW DATA
April 18, 2016	8445AC	3BLK33F109A	AQUA/CASI	NA	214	564	216	40.3	305	9.13	39.3	77.8	1KB	1KB	46	NA	Z:\DAC\RAW DATA
April 18, 2016	8446AC	3BLK33JVKVS109B	AQUA/CASI	NA	110	295	108	19.5	305	4.64	38.7	77.8	1KB	1KB	7	NA	Z:\DAC\RAW DATA
April 19, 2016	8447AC	3BLK33IVJV110A	AQUA/CASI	NA	212	590	226	19.5	68.7	9.16	151	86.7	1KB	1KB	23	NA	Z:\DAC\RAW DATA
April 19, 2016	8448AC	3BLK33CVDV110B	AQUA/CASI	NA	312	294	132	NA	NA	4.52	73.8	86.7	1KB	1KB	NA	NA	Z:\DAC\RAW DATA

Received from

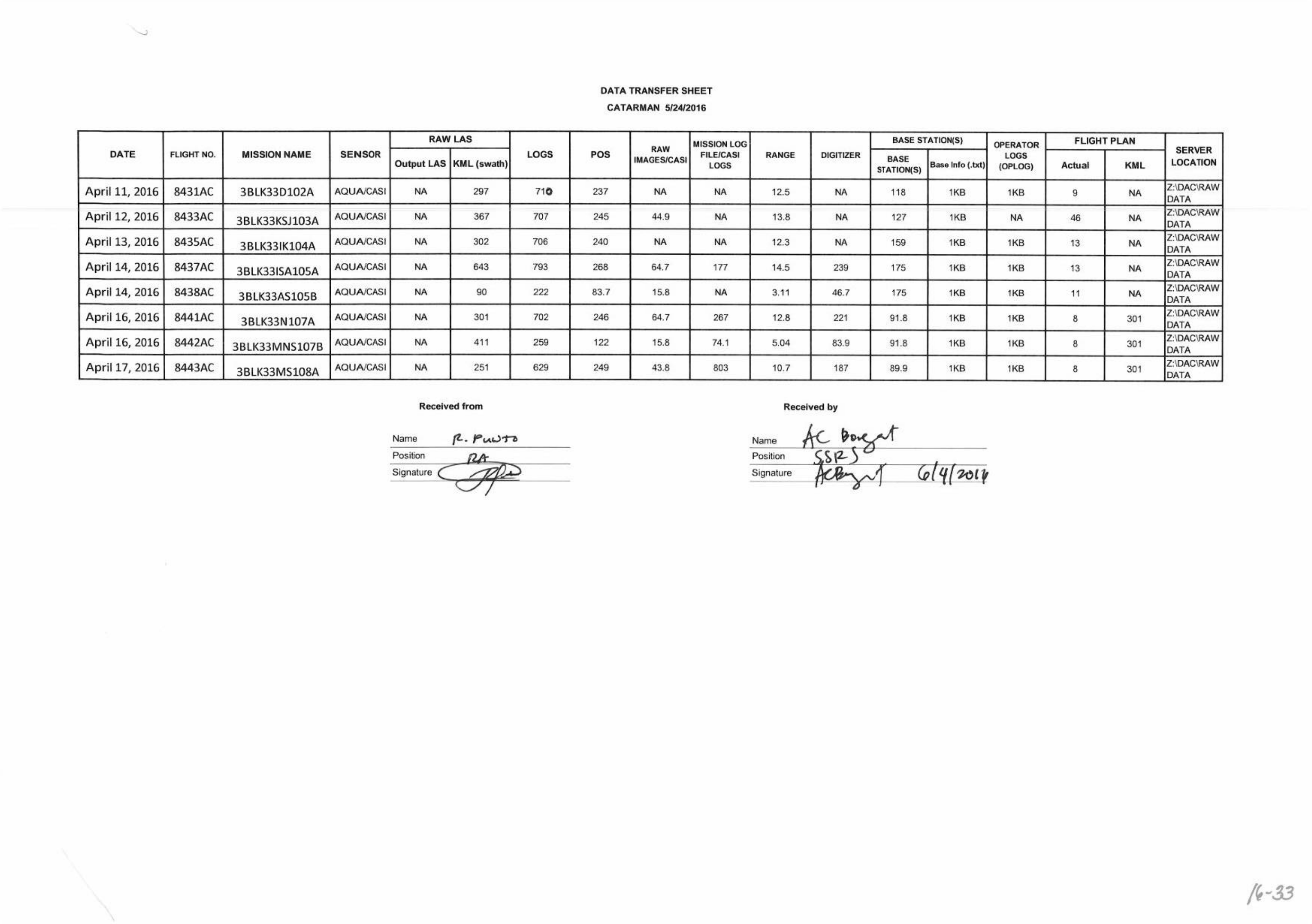
Name R. PUNTO
Position RA
Signature

Received by

Name AC Bongat
Position SSRS
Signature ACBongat 6/4/16

16-34

Figure A-5.5. Data Transfer Sheet for Catubig Floodplain – E



DATA TRANSFER SHEET
CATARMAN 5/24/2016

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	
April 11, 2016	8431AC	3BLK33D102A	AQUA/CASI	NA	297	710	237	NA	NA	12.5	NA	118	1KB	1KB	9	NA	Z:\DAC\RAW DATA
April 12, 2016	8433AC	3BLK33KSJ103A	AQUA/CASI	NA	367	707	245	44.9	NA	13.8	NA	127	1KB	NA	46	NA	Z:\DAC\RAW DATA
April 13, 2016	8435AC	3BLK33IK104A	AQUA/CASI	NA	302	706	240	NA	NA	12.3	NA	159	1KB	1KB	13	NA	Z:\DAC\RAW DATA
April 14, 2016	8437AC	3BLK33ISA105A	AQUA/CASI	NA	643	793	268	64.7	177	14.5	239	175	1KB	1KB	13	NA	Z:\DAC\RAW DATA
April 14, 2016	8438AC	3BLK33AS105B	AQUA/CASI	NA	90	222	83.7	15.8	NA	3.11	46.7	175	1KB	1KB	11	NA	Z:\DAC\RAW DATA
April 16, 2016	8441AC	3BLK33N107A	AQUA/CASI	NA	301	702	246	64.7	267	12.8	221	91.8	1KB	1KB	8	301	Z:\DAC\RAW DATA
April 16, 2016	8442AC	3BLK33MNS107B	AQUA/CASI	NA	411	259	122	15.8	74.1	5.04	83.9	91.8	1KB	1KB	8	301	Z:\DAC\RAW DATA
April 17, 2016	8443AC	3BLK33MS108A	AQUA/CASI	NA	251	629	249	43.8	803	10.7	187	89.9	1KB	1KB	8	301	Z:\DAC\RAW DATA

Received from

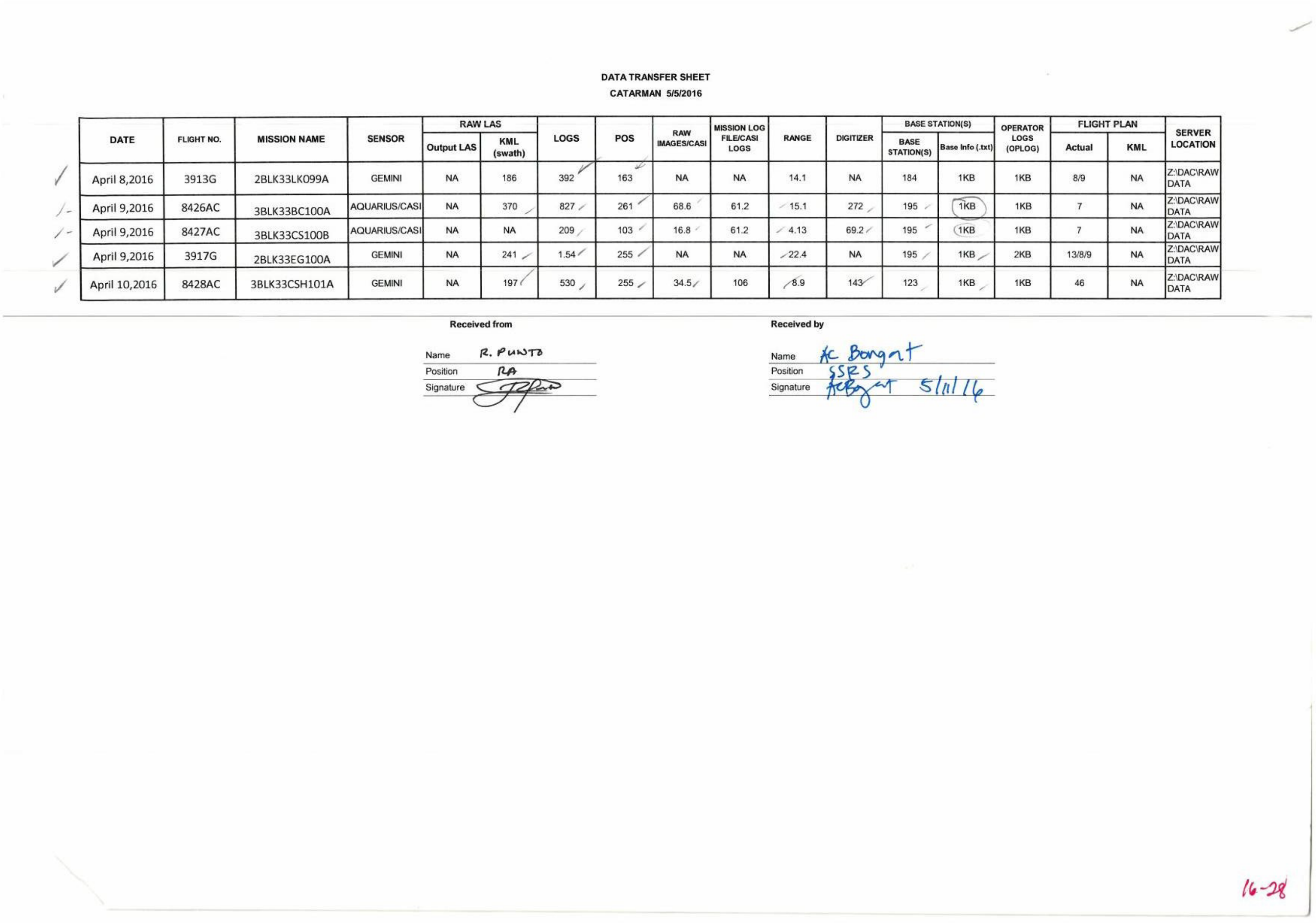
Name R. Punto
Position RA
Signature

Received by

Name AC Bongat
Position SSRS
Signature ACBongat 6/4/2016

16-33

Figure A-5.6. Data Transfer Sheet for Catubig Floodplain – F



DATA TRANSFER SHEET
CATARMAN 5/5/2016

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	
April 8,2016	3913G	2BLK33LK099A	GEMINI	NA	186	392	163	NA	NA	14.1	NA	184	1KB	1KB	8/9	NA	Z:\DAC\RAW DATA
April 9,2016	8426AC	3BLK33BC100A	AQUARIUS/CASI	NA	370	827	261	68.6	61.2	15.1	272	195	1KB	1KB	7	NA	Z:\DAC\RAW DATA
April 9,2016	8427AC	3BLK33CS100B	AQUARIUS/CASI	NA	NA	209	103	16.8	61.2	4.13	69.2	195	1KB	1KB	7	NA	Z:\DAC\RAW DATA
April 9,2016	3917G	2BLK33EG100A	GEMINI	NA	241	1.54	255	NA	NA	22.4	NA	195	1KB	2KB	13/8/9	NA	Z:\DAC\RAW DATA
April 10,2016	8428AC	3BLK33CSH101A	GEMINI	NA	197	530	255	34.5	106	8.9	143	123	1KB	1KB	46	NA	Z:\DAC\RAW DATA

Received from

Name R. PUNTO
Position RA
Signature

Received by

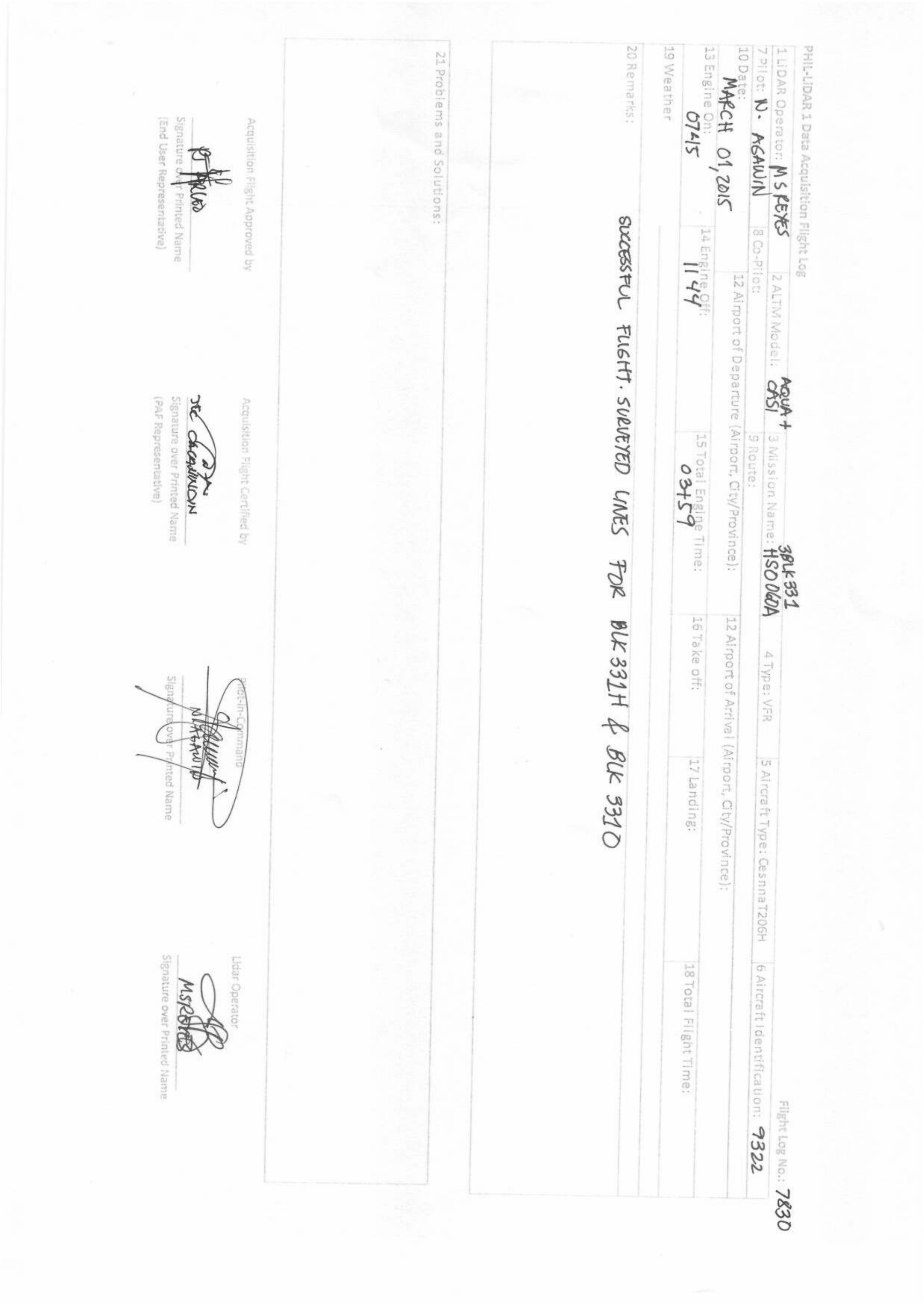
Name AC Bongat
Position SSRS
Signature 5/11/16

16-28

Figure A-5.7. Data Transfer Sheet for Catubig Floodplain – G

Annex 6. Flight Logs for the Flight Missions

1. Flight Log for 7830AC M



PHIL-LIDAR 1 Data Acquisition Flight Log

Flight Log No.: 7830

1 LiDAR Operator: M S REYES
2 ALTM Model: AQUA + CASI
3 Mission Name: 3BLK331 HSO060A
4 Type: VFR
5 Aircraft Type: CesnnaT206H
6 Aircraft Identification: 9322
7 Pilot: N. AGAWIN
8 Co-Pilot:
9 Route:
10 Date: MARCH 01, 2015
12 Airport of Departure (Airport, City/Province):
12 Airport of Arrival (Airport, City/Province):
13 Engine On: 0745
14 Engine Off: 1144
15 Total Engine Time: 03+59
16 Take off:
17 Landing:
18 Total Flight Time:
19 Weather
20 Remarks: SUCCESSFUL FLIGHT. SURVEYED LINES FOR BLK 331H & BLK 331O
21 Problems and Solutions:

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

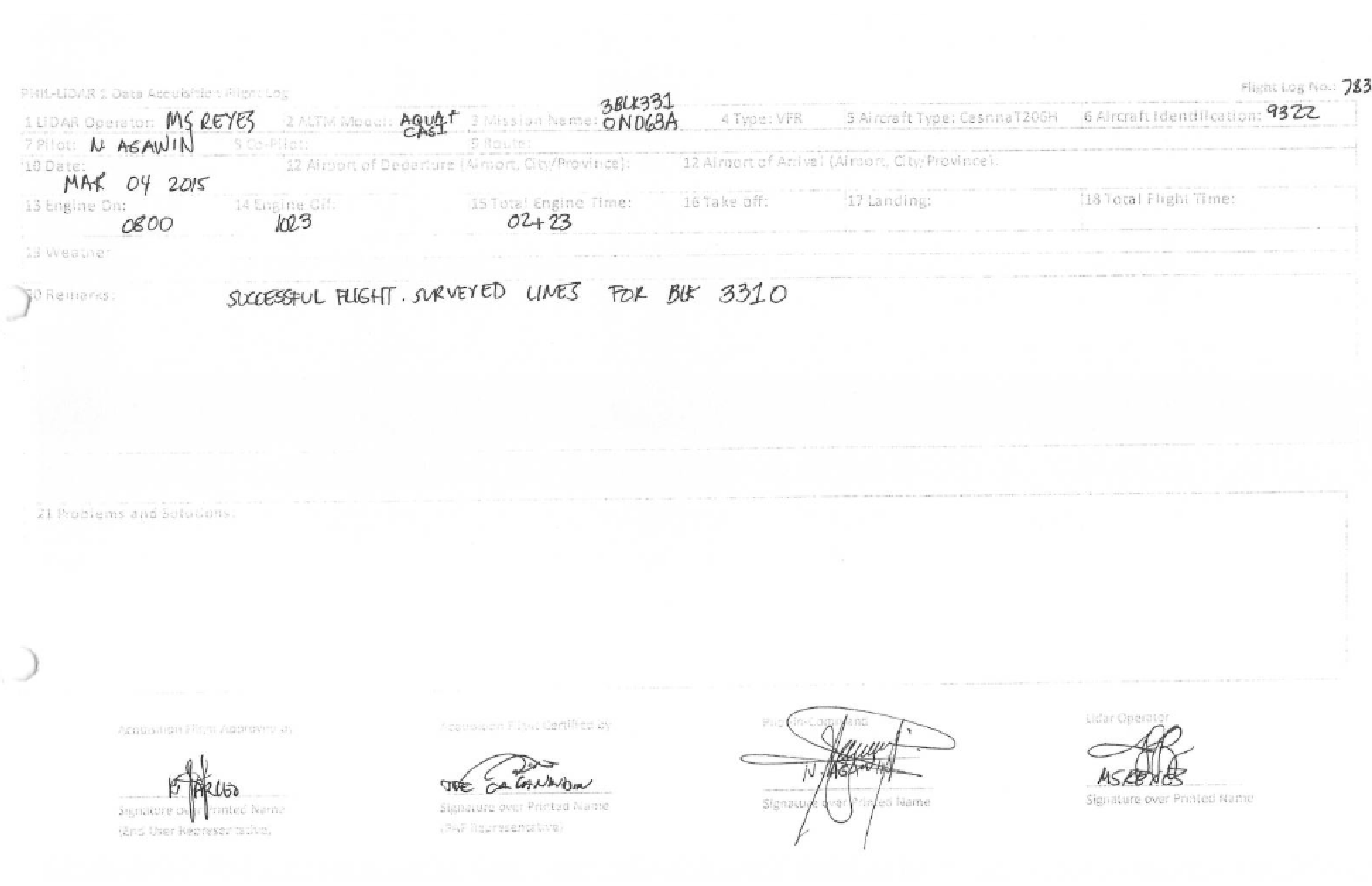
Acquisition Flight Certified by
JEC CACANINDIN
Signature over Printed Name
(PAF Representative)

Pilot-in-Command
N AGAWIN
Signature over Printed Name

Lidar Operator
MSREYES
Signature over Printed Name

Figure A-6.1. Flight Log for Mission 7830AC

2. Flight Log for 7836AC Mission



PHIL-LIDAR 1 Data Acquisition Flight Log

Flight Log No.: 7836

1 LIDAR Operator: MS REYES
2 ALTM Model: AQUA+ CAS1
3 Mission Name: 3BLK331 OND63A
4 Type: VFR
5 Aircraft Type: CesnnaT206H
6 Aircraft Identification: 9322
7 Pilot: N AGAWIN
8 Co-Pilot:
9 Route:
10 Date: MAR 04 2015
12 Airport of Departure (Airport, City/Province):
12 Airport of Arrival (Airport, City/Province):
13 Engine On: 0800
14 Engine Off: 1023
15 Total Engine Time: 02+23
16 Take off:
17 Landing:
18 Total Flight Time:
19 Weather:
20 Remarks: SUCCESSFUL FLIGHT. SURVEYED LINES FOR BLK 3310
21 Problems and Solutions:

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

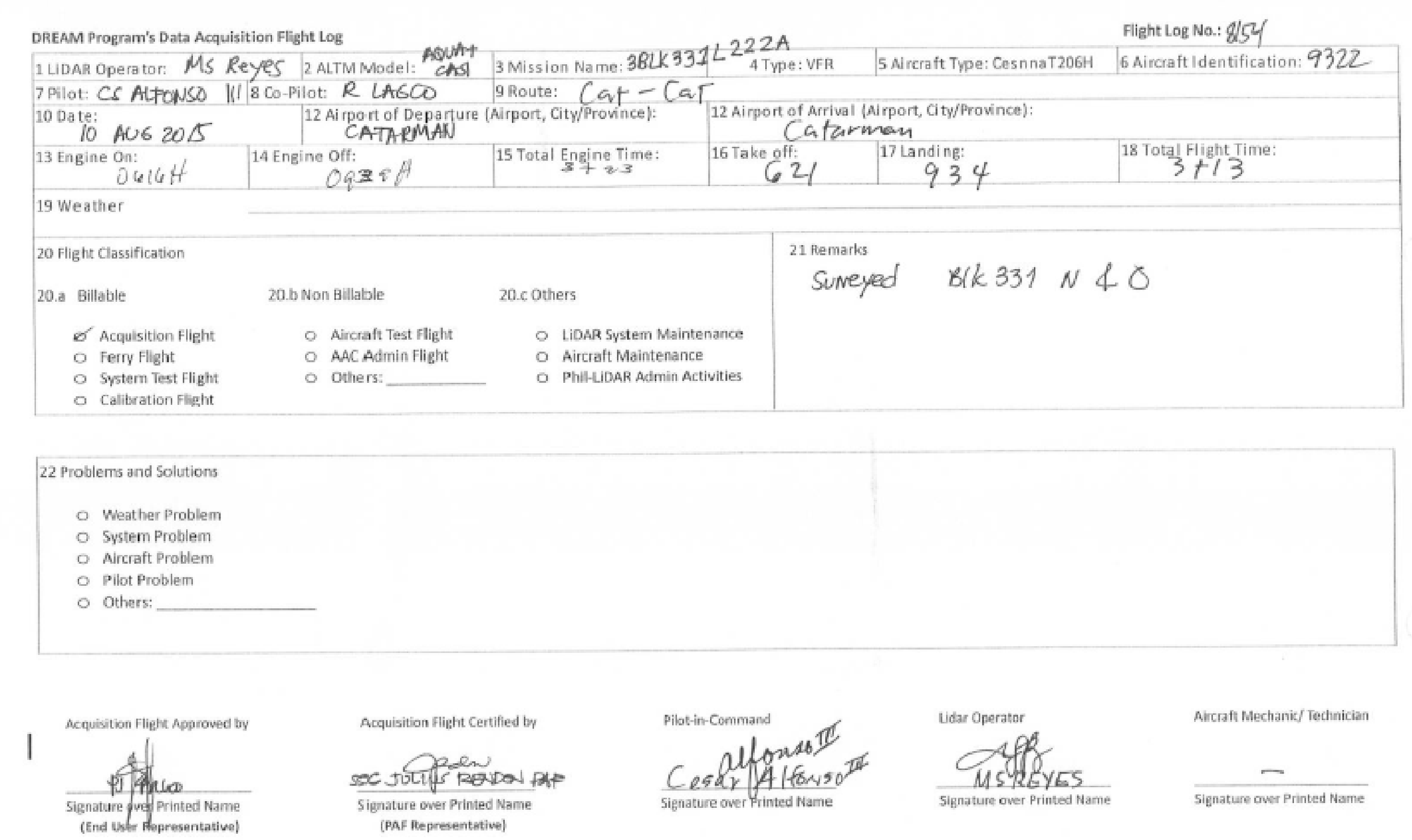
Acquisition Flight Certified by
Signature over Printed Name
(PAF Representative)

Pilot-in-Command
N. AGAWIN
Signature over Printed Name

Lidar Operator
MS REYES
Signature over Printed Name

Figure A-6.2. Flight Log for Mission 7836AC

3. Flight Log for 8154AC Mission



DREAM Program's Data Acquisition Flight Log

Flight Log No.: 8154

1 LiDAR Operator: Ms Reyes	2 ALTM Model: AQUA + CASI	3 Mission Name: 3BLK331L222A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9322
7 Pilot: CS ALFONSO III	8 Co-Pilot: R LAGCO	9 Route: Cat – Cat			
10 Date: 10 AUG 2015	12 Airport of Departure (Airport, City/Province): CATARMAN		12 Airport of Arrival (Airport, City/Province): Catarman		
13 Engine On: 0614H	14 Engine Off: 0938H	15 Total Engine Time: 3+23	16 Take off: 621	17 Landing: 934	18 Total Flight Time: 3+13
19 Weather					

20 Flight Classification

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

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

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

21 Remarks

Surveyed Blk 331 N & O

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

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

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

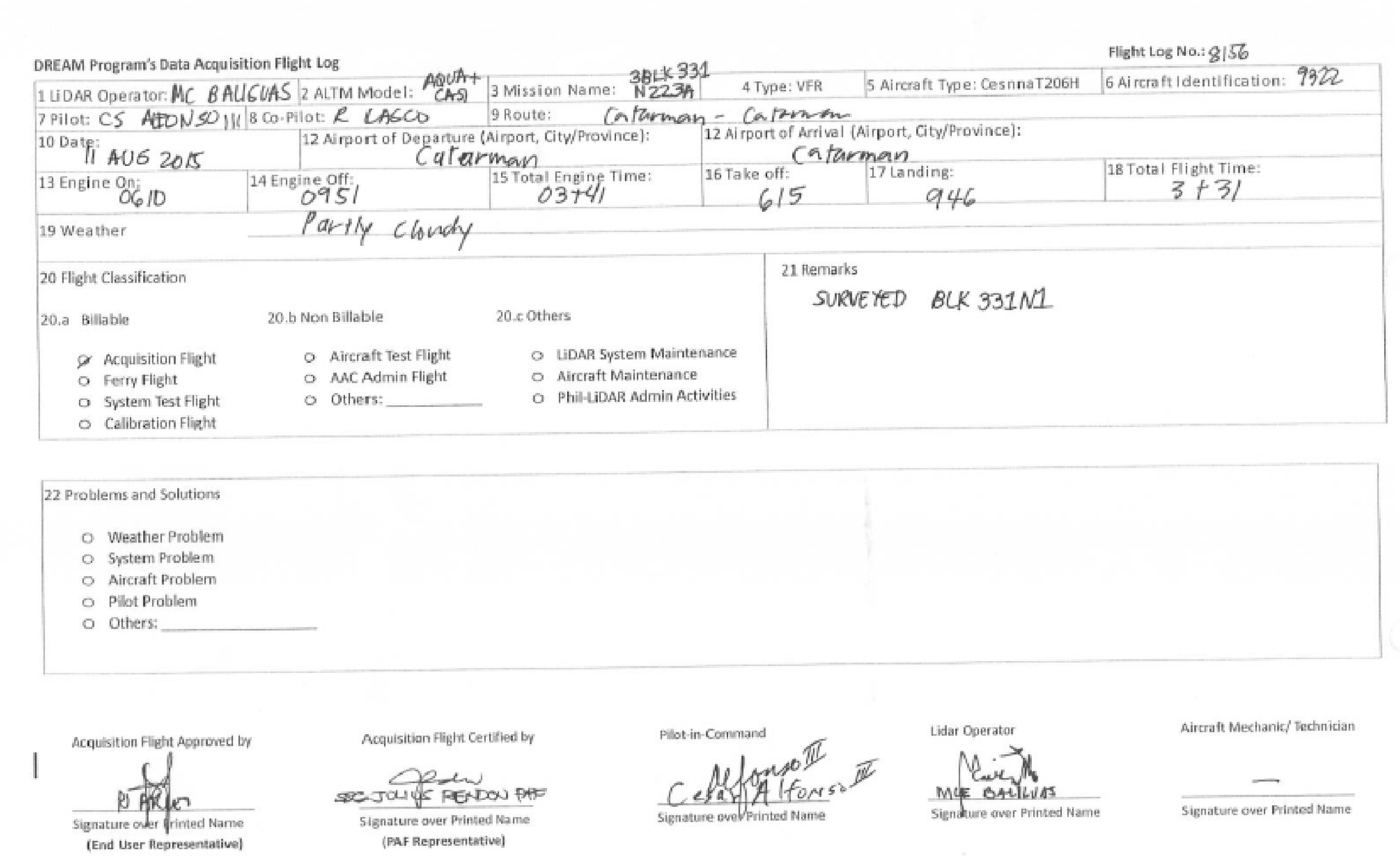
Pilot-in-Command
Cesar A Alfonso III
Signature over Printed Name

Lidar Operator
MS REYES
Signature over Printed Name

Aircraft Mechanic/ Technician
Signature over Printed Name

Figure A-6.3. Flight Log for Mission 8154AC

4. Flight Log for 8156AC Mission



DREAM Program's Data Acquisition Flight Log

Flight Log No.: 8156

1 LiDAR Operator: MC BALIGUAS
2 ALTM Model: AQUA+ CAS)
3 Mission Name: 3BLK331 N223A
4 Type: VFR
5 Aircraft Type: CesnnaT206H
6 Aircraft Identification: 9322
7 Pilot: CS ALFONSO III
8 Co-Pilot: R LASCO
9 Route: Catarman - Catarman
10 Date: 11 AUG 2015
12 Airport of Departure (Airport, City/Province): Catarman
12 Airport of Arrival (Airport, City/Province): Catarman
13 Engine On: 0610
14 Engine Off: 0951
15 Total Engine Time: 03+41
16 Take off: 615
17 Landing: 946
18 Total Flight Time: 3+31
19 Weather: Partly Cloudy

20 Flight Classification

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

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

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

21 Remarks
SURVEYED BLK 331N1

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

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

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

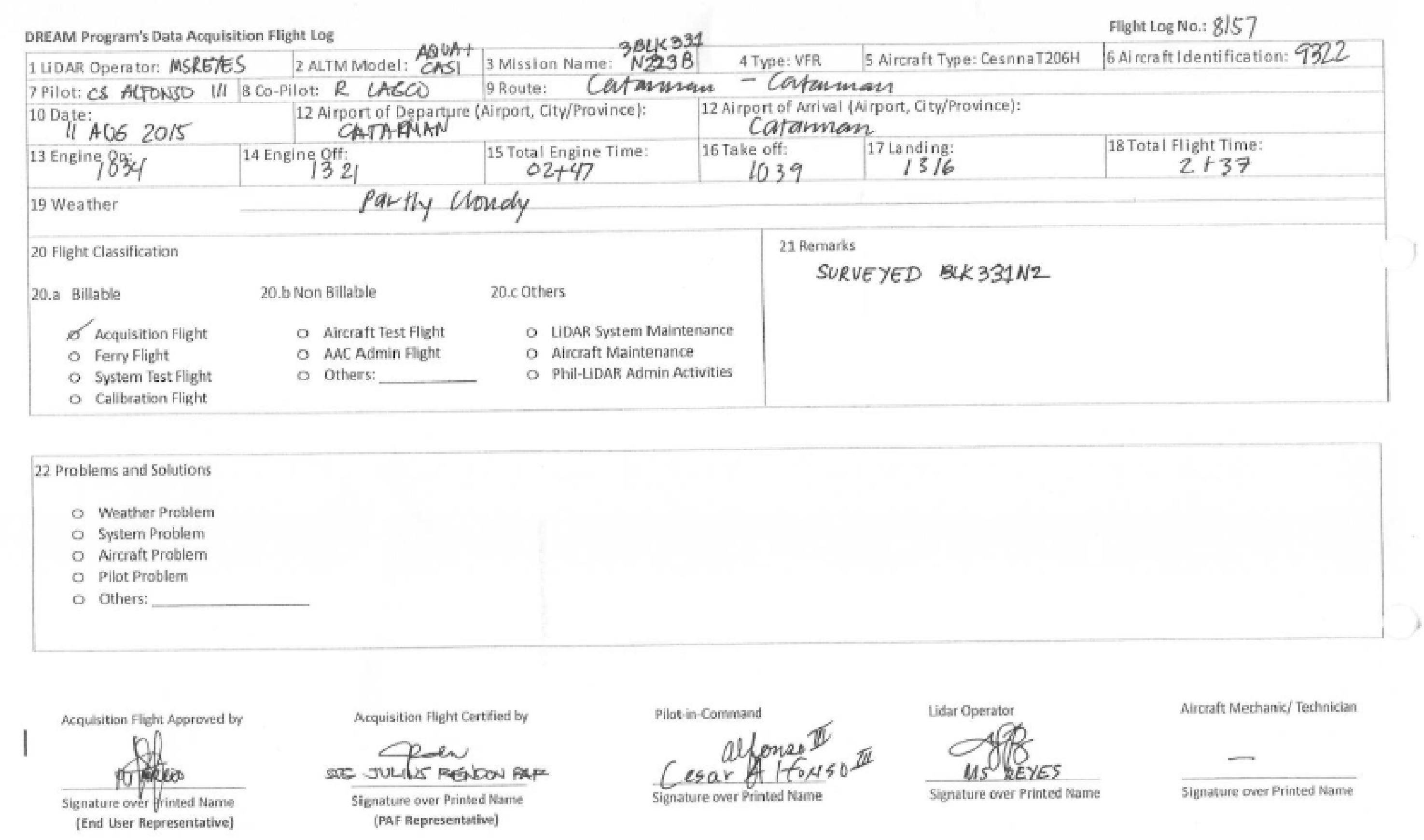
Pilot-in-Command
Cesar Alfonso III
Signature over Printed Name

Lidar Operator
MCE BALIGUAS
Signature over Printed Name

Aircraft Mechanic/ Technician
Signature over Printed Name

Figure A-6.4. Flight Log for Mission 8156AC

5. Flight Log for 8157AC Mission



DREAM Program's Data Acquisition Flight Log

Flight Log No.: 8157

1 LiDAR Operator: MSREYES	2 ALTM Model: AQUA+ CASI	3 Mission Name: 3BLK331 N223B	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9322
7 Pilot: CS ALFONSO III	8 Co-Pilot: R LAGCO	9 Route: Catarman - Catarman			
10 Date: 11 AUG 2015	12 Airport of Departure (Airport, City/Province): CATARMAN		12 Airport of Arrival (Airport, City/Province): Catarman		
13 Engine On: 1034	14 Engine Off: 1321	15 Total Engine Time: 02+47	16 Take off: 1039	17 Landing: 1316	18 Total Flight Time: 2+37
19 Weather: Partly Cloudy					

20 Flight Classification

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

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

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

21 Remarks

SURVEYED BLK331N2

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

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

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

Pilot-in-Command
Cesar Alfonso III
Signature over Printed Name

Lidar Operator
MS REYES
Signature over Printed Name

Aircraft Mechanic/ Technician
Signature over Printed Name

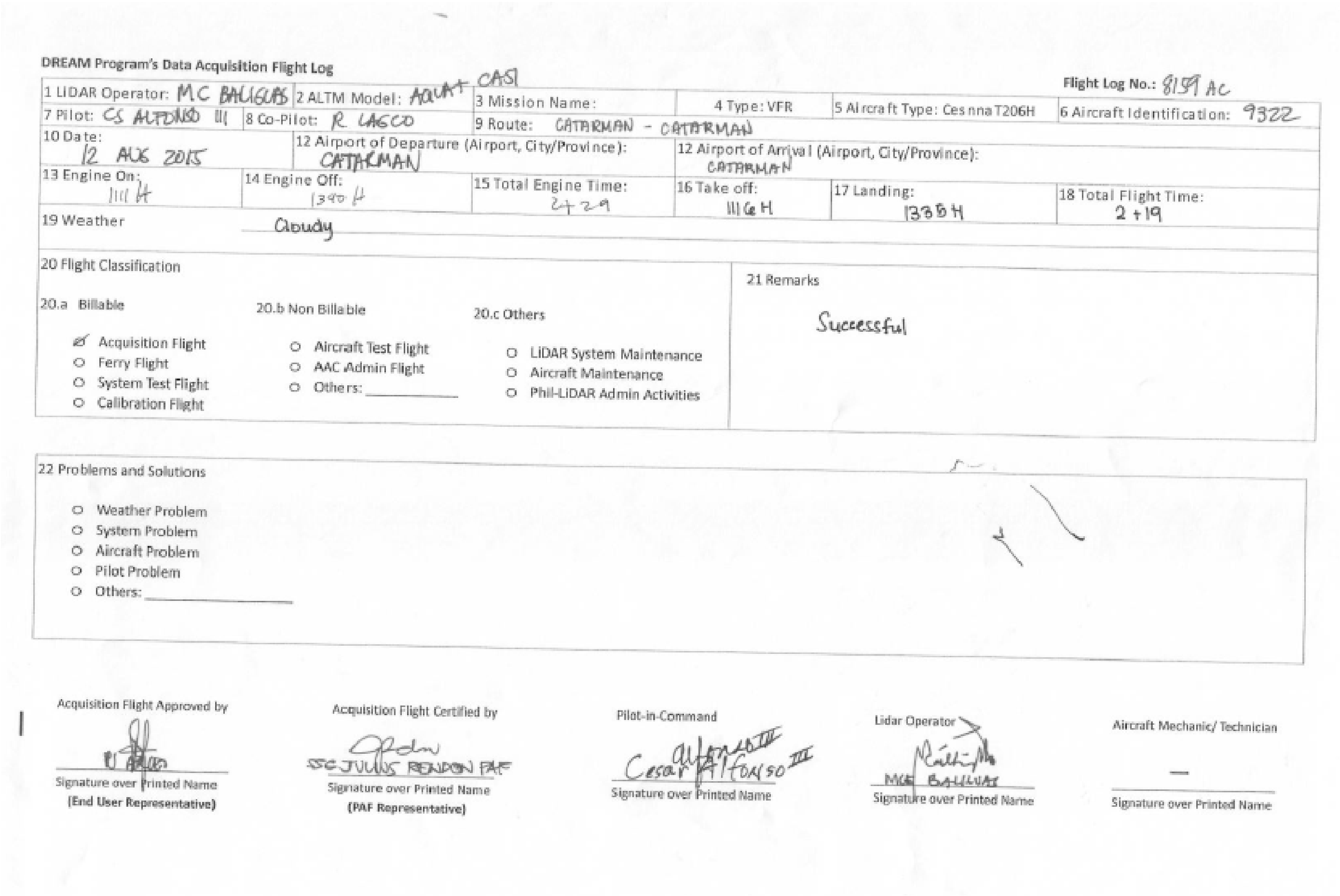
Figure A-6.5. Flight Log for Mission 8157AC

6. Flight Log for 8158AC Mission

PLACEHOLDER

Figure A-6.6. Flight Log for Mission 8158AC

7. Flight Log for 8159AC Mission



DREAM Program's Data Acquisition Flight Log

Flight Log No.: 8159 AC

1 LIDAR Operator: MC BALIGUAS	2 ALTM Model: AQUA+ CASI	3 Mission Name:	4 Type: VFR	5 Aircraft Type: Cessna T206H	6 Aircraft Identification: 9322
7 Pilot: CS ALFONSO III	8 Co-Pilot: R LAGCO	9 Route: CATARMAN - CATARMAN			
10 Date: 12 AUG 2015	12 Airport of Departure (Airport, City/Province): CATARMAN		12 Airport of Arrival (Airport, City/Province): CATARMAN		
13 Engine On: 1111 H	14 Engine Off: 1340 H	15 Total Engine Time: 2+29	16 Take off: 1116 H	17 Landing: 1335 H	18 Total Flight Time: 2+19
19 Weather	Cloudy				

20 Flight Classification

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

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

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

21 Remarks

Successful

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

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

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

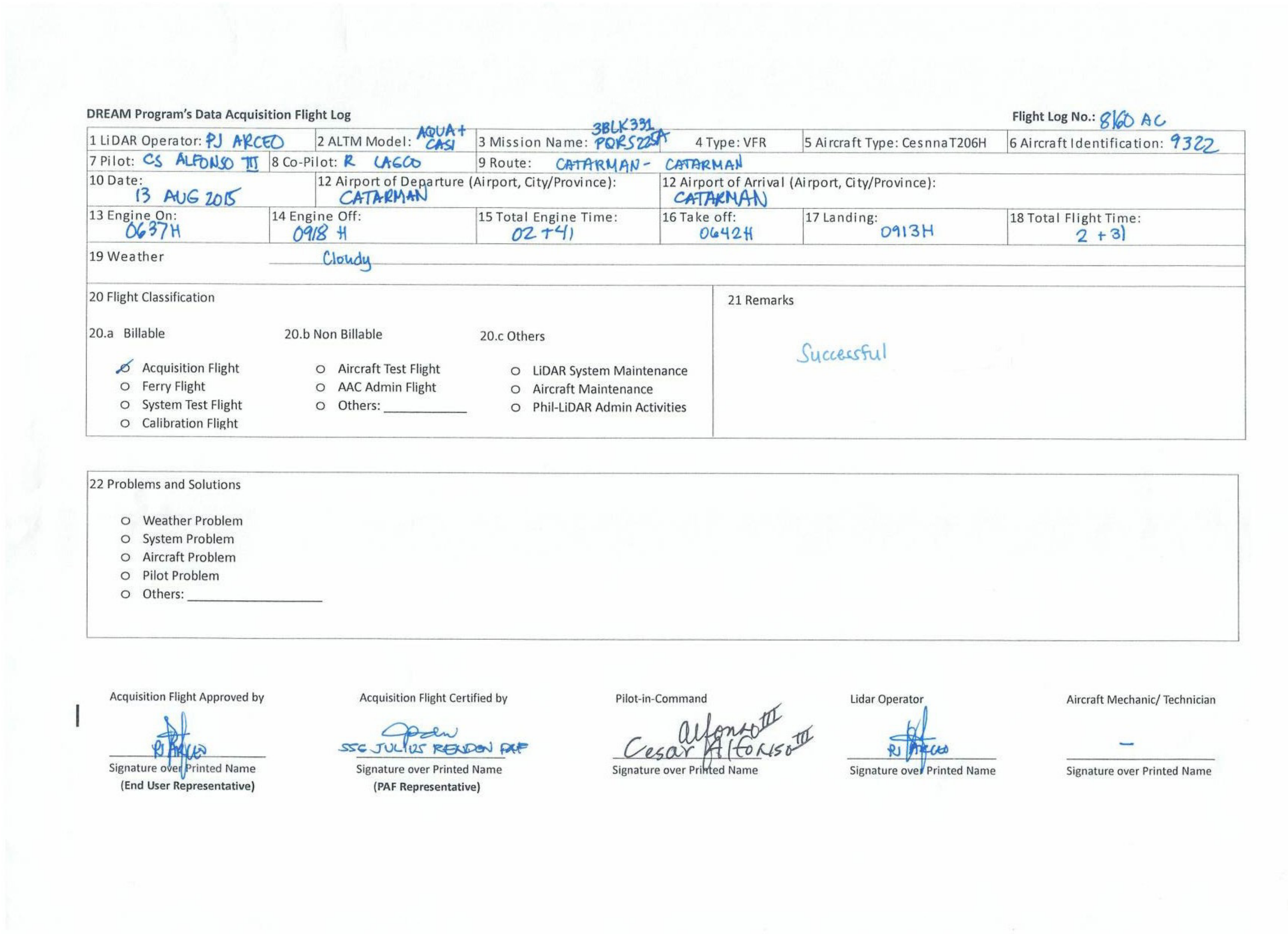
Pilot-in-Command
Cesar Alfonso III
Signature over Printed Name

Lidar Operator
MCE BALIGUAS
Signature over Printed Name

Aircraft Mechanic/ Technician
—
Signature over Printed Name

Figure A-6.7. Flight Log for Mission 8159AC

8. Flight Log for 8160AC Mission



DREAM Program's Data Acquisition Flight Log

Flight Log No.: 8160 AC

1 LiDAR Operator: PJ ARCEO
2 ALTM Model: AQUA+ CASI
3 Mission Name: 3BLK331 PQRS225A
4 Type: VFR
5 Aircraft Type: CesnnaT206H
6 Aircraft Identification: 9322
7 Pilot: CS ALFONSO III
8 Co-Pilot: R LAGCO
9 Route: CATARMAN - CATARMAN
10 Date: 13 AUG 2015
12 Airport of Departure (Airport, City/Province): CATARMAN
12 Airport of Arrival (Airport, City/Province): CATARMAN
13 Engine On: 0637H
14 Engine Off: 0918 H
15 Total Engine Time: 02 +41
16 Take off: 0642H
17 Landing: 0913H
18 Total Flight Time: 2 + 31
19 Weather Cloudy

20 Flight Classification

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

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

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

21 Remarks

Successful

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

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

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

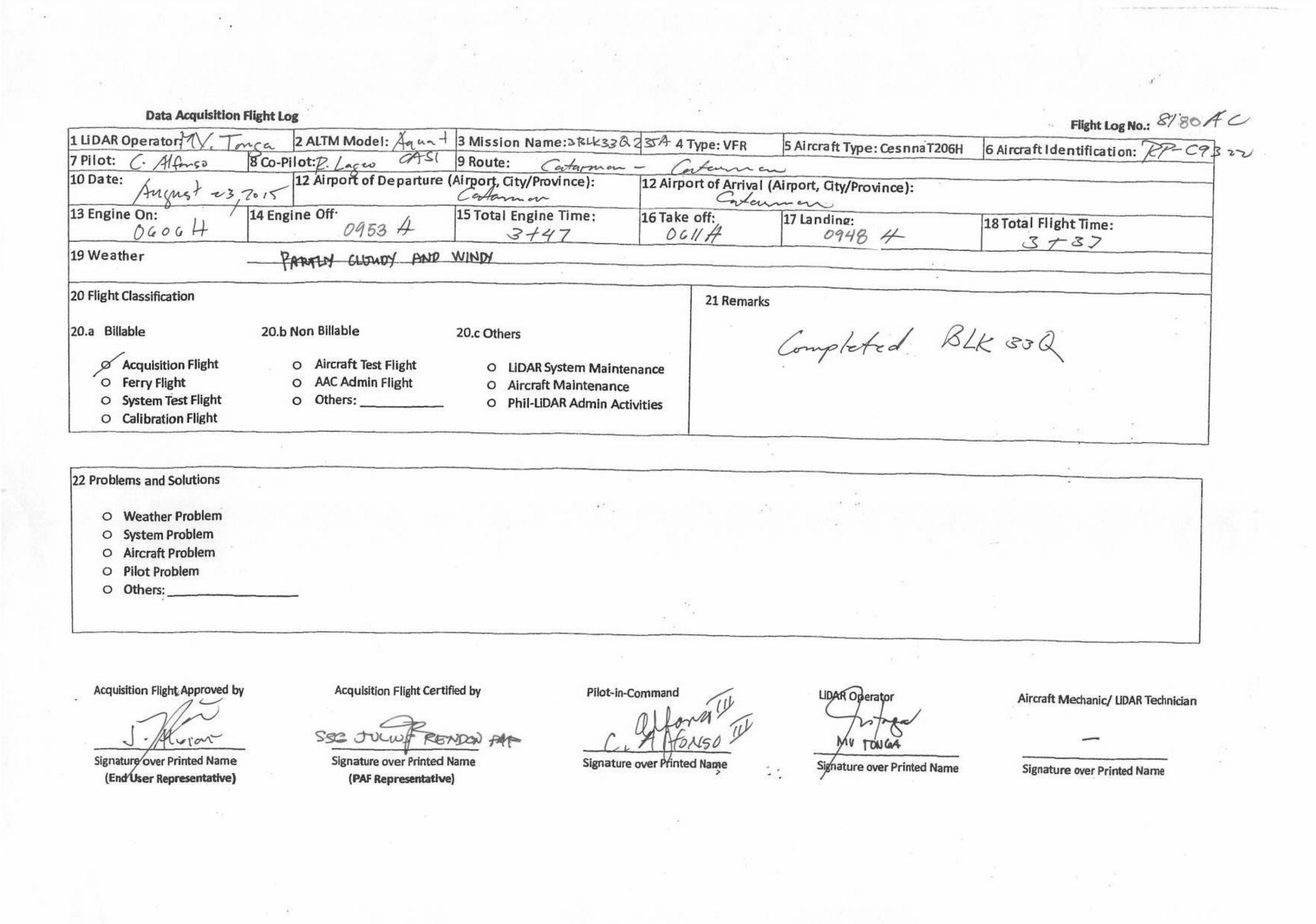
Pilot-in-Command
Cesar Alfonso III
Signature over Printed Name

Lidar Operator
RJ ARCEO
Signature over Printed Name

Aircraft Mechanic/ Technician
–
Signature over Printed Name

Figure A-6.8. Flight Log for Mission 8160AC

9. Flight Log for 8180AC Mission



Data Acquisition Flight Log

Flight Log No.: 8180AC

1 LiDAR Operator: MV. Tonga	2 ALTM Model: Aquarius	3 Mission Name: 2BLK33Q235A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-C9322
7 Pilot: C. Alfonso	8 Co-Pilot: R. Lago CASI	9 Route: Catarman - Catarman			
10 Date: August 23, 2015	12 Airport of Departure (Airport, City/Province): Catarman		12 Airport of Arrival (Airport, City/Province): Catarman		
13 Engine On: 0606H	14 Engine Off: 0953 H	15 Total Engine Time: 3+47	16 Take off: 0611H	17 Landing: 0948 H	18 Total Flight Time: 3+37
19 Weather: PARTLY CLOUDY AND WINDY					

20 Flight Classification

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

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

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

21 Remarks

Completed BLK 33Q

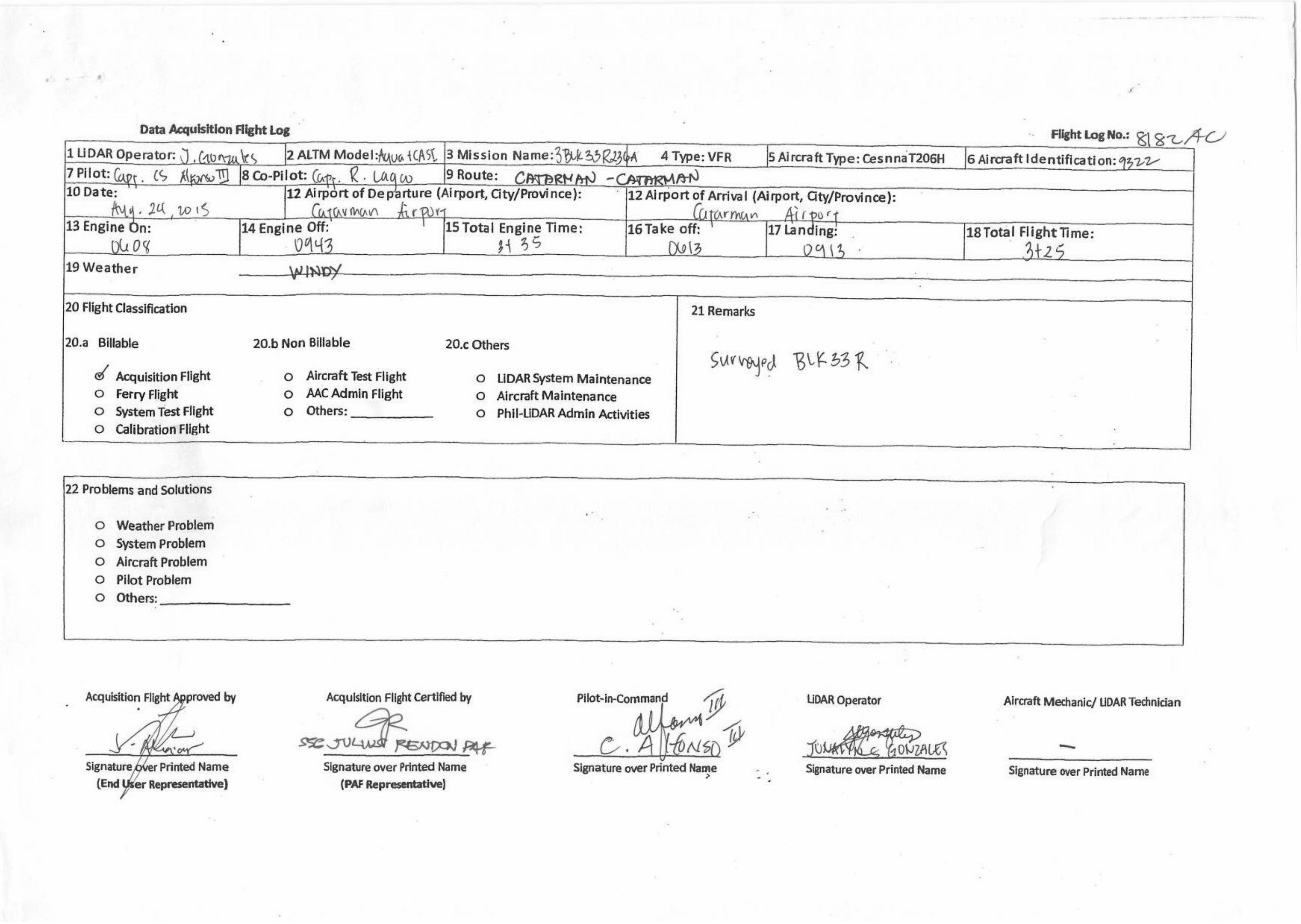
22 Problems and Solutions

- ○ Weather Problem
- ○ System Problem
- ○ Aircraft Problem
- ○ Pilot Problem
- ○ Others: ____________

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	LiDAR Operator	Aircraft Mechanic/ LiDAR Technician
J. Alviar	SSG JULWIN RENDON PAF	C. ALFONSO III	MV TONGA	–
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name	Signature over Printed Name

Figure A-6.9. Flight Log for Mission 8180AC

10. Flight Log for 8182AC Mission



Data Acquisition Flight Log

Flight Log No.: 8182AC

1 LiDAR Operator: J. Gonzales
2 ALTM Model: Aqua 1CASI
3 Mission Name: 3BLK33R236A
4 Type: VFR
5 Aircraft Type: CesnnaT206H
6 Aircraft Identification: 9322
7 Pilot: Capt. CS Alfonso III
8 Co-Pilot: Capt. R. Lagco
9 Route: CATARMAN - CATARMAN
10 Date: Aug. 24, 2015
12 Airport of Departure (Airport, City/Province): Catarman Airport
12 Airport of Arrival (Airport, City/Province): Catarman Airport
13 Engine On: 0608
14 Engine Off: 0943
15 Total Engine Time: 3+35
16 Take off: 0613
17 Landing: 0913
18 Total Flight Time: 3+25
19 Weather: WINDY

20 Flight Classification

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

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

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

21 Remarks

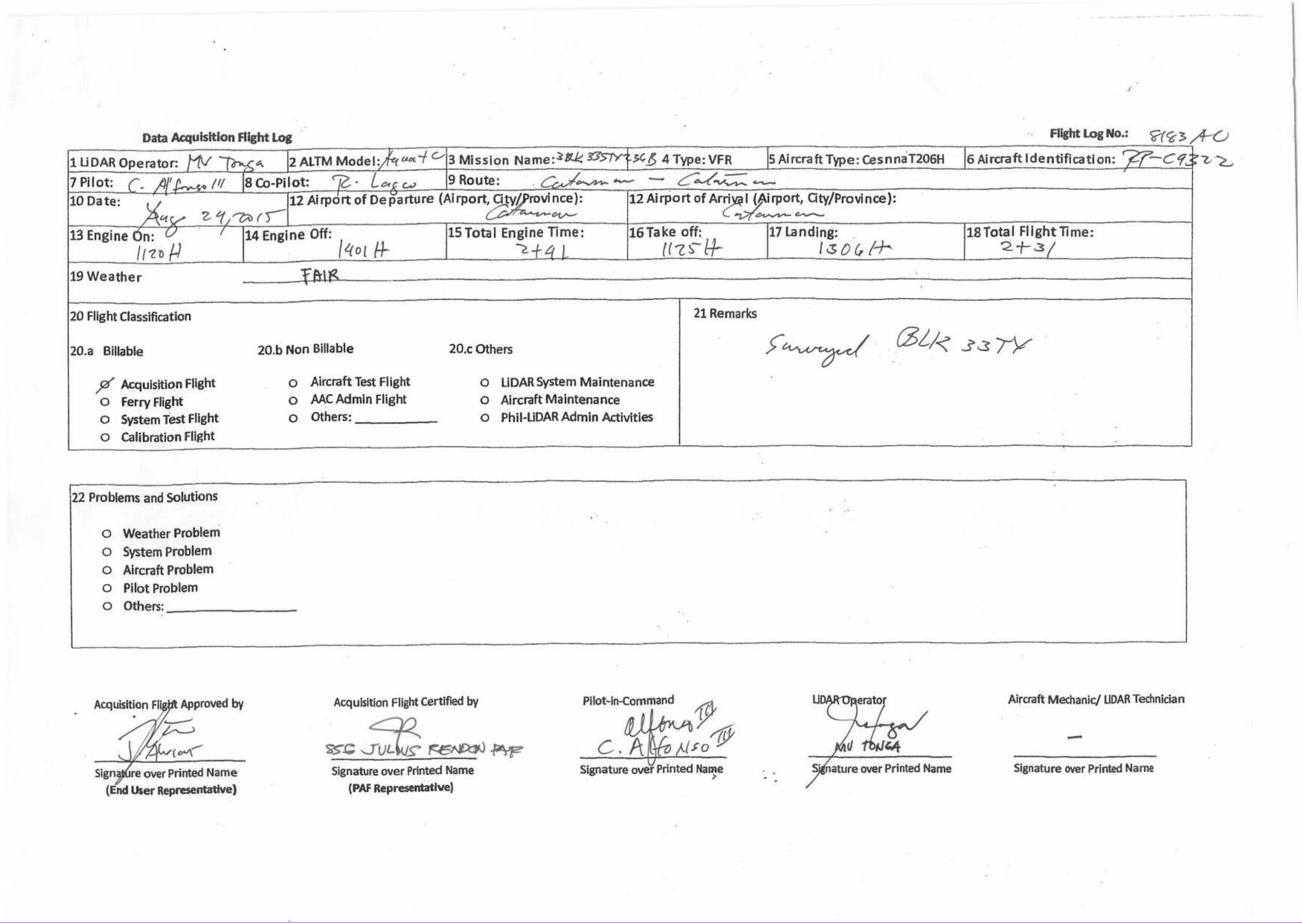
Surveyed BLK33R

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

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	LiDAR Operator	Aircraft Mechanic/ LiDAR Technician
J. Alaniar	SSG JULIUS RENDON PAF	C. ALFONSO III	JUNALYN G. GONZALES	–
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name	Signature over Printed Name

Figure A-6.10. Flight Log for Mission 8182AC

11. Flight Log for 8183AC Mission



Data Acquisition Flight Log

Flight Log No.: 8183AC

1 LiDAR Operator: MV Tonga	2 ALTM Model: Aquarius	3 Mission Name: 3BLK33STY236B	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-C9322
7 Pilot: C. Alfonso III	8 Co-Pilot: R. Lago	9 Route: Catarman – Catarman			
10 Date: Aug 24, 2015	12 Airport of Departure (Airport, City/Province): Catarman		12 Airport of Arrival (Airport, City/Province): Catarman		
13 Engine On: 1120H	14 Engine Off: 1401H	15 Total Engine Time: 2+41	16 Take off: 1125H	17 Landing: 1306H	18 Total Flight Time: 2+31
19 Weather FAIR					

20 Flight Classification

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

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

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

21 Remarks

Surveyed BLK 33TY

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

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

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

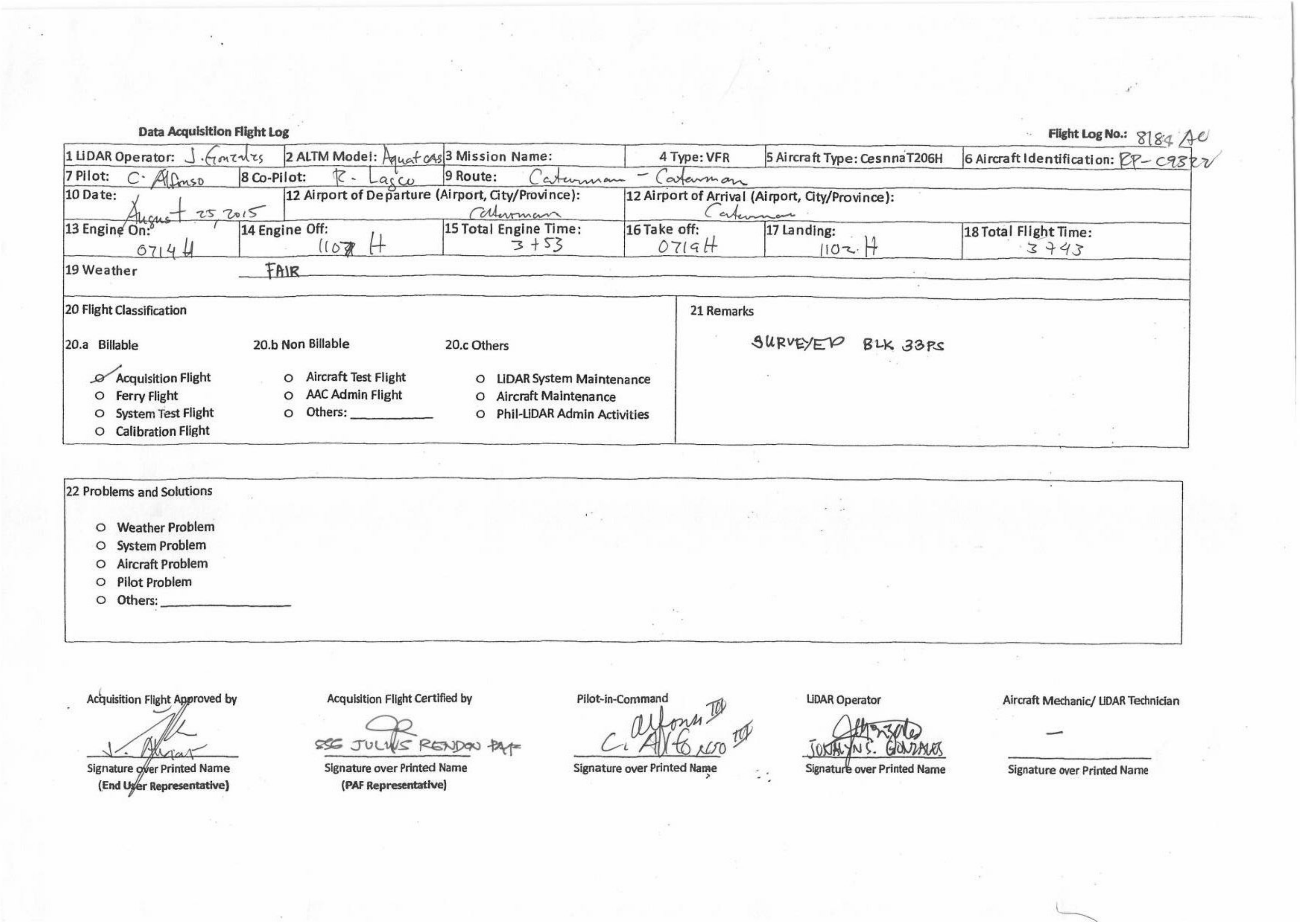
Pilot-in-Command
C. Alfonso III
Signature over Printed Name

LiDAR Operator
MV TONGA
Signature over Printed Name

Aircraft Mechanic/ LIDAR Technician
–
Signature over Printed Name

Figure A-6.11. Flight Log for Mission 8183AC

12. Flight Log for 8184AC Mission



Data Acquisition Flight Log

Flight Log No.: 8184 AC

1 LiDAR Operator: J. Gonzales	2 ALTM Model: Aquarius	3 Mission Name:	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-C9322
7 Pilot: C. Alfonso	8 Co-Pilot: R. Lagco	9 Route: Catarman - Catarman			
10 Date: August 25, 2015	12 Airport of Departure (Airport, City/Province): Catarman		12 Airport of Arrival (Airport, City/Province): Catarman		
13 Engine On: 0714 H	14 Engine Off: 1107 H	15 Total Engine Time: 3+53	16 Take off: 0719H	17 Landing: 1102 H	18 Total Flight Time: 3+43

19 Weather FAIR

20 Flight Classification

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

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

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

21 Remarks

SURVEYED BLK 33PS

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

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

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

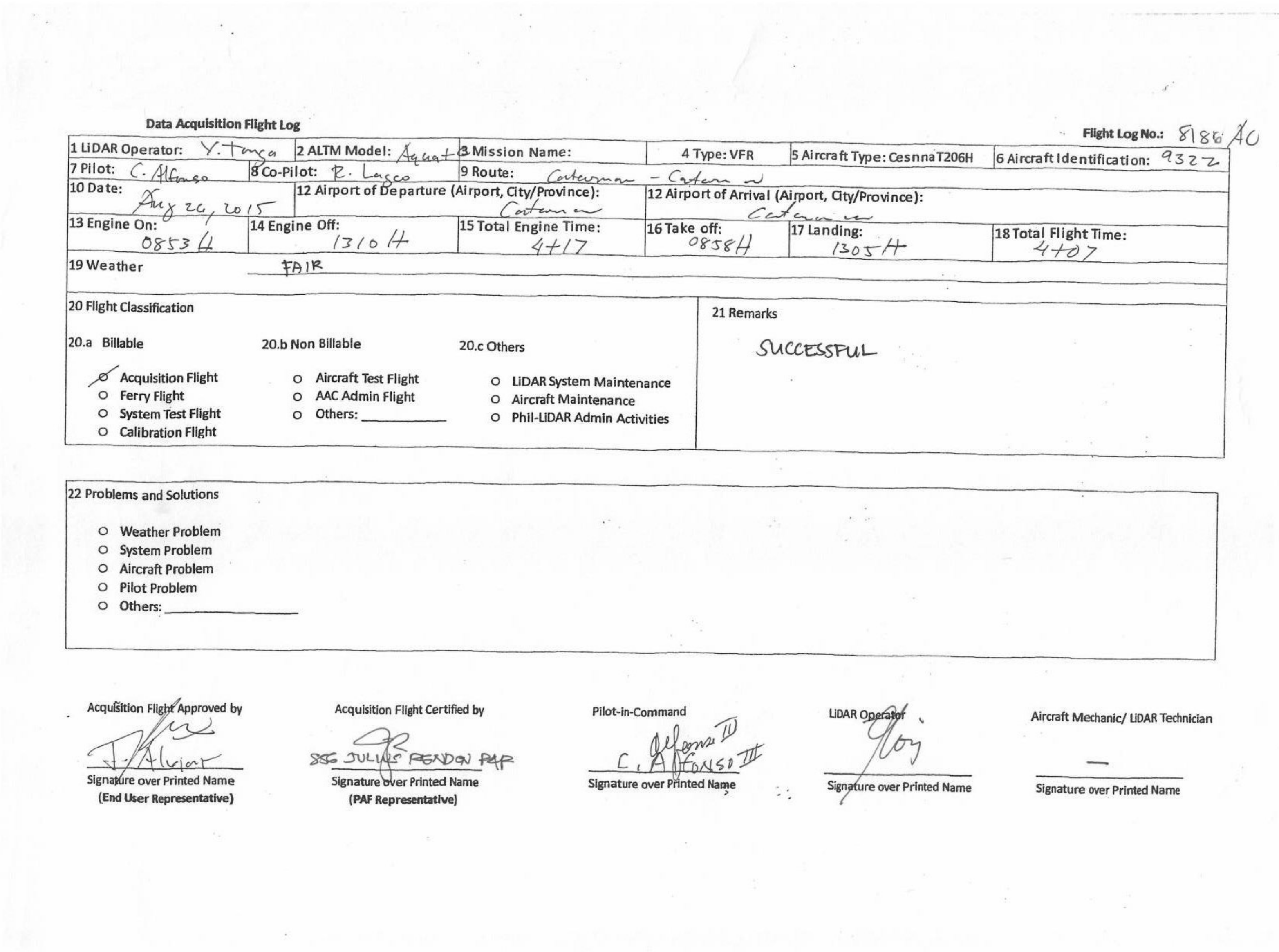
Pilot-in-Command
C. Alfonso III
Signature over Printed Name

LiDAR Operator
JONALYN S. GONZALES
Signature over Printed Name

Aircraft Mechanic/ LiDAR Technician
-
Signature over Printed Name

Figure A-6.12. Flight Log for Mission 8184AC

13. Flight Log for 8186AC Mission



Data Acquisition Flight Log

Flight Log No.: 8186AC

1 LiDAR Operator: Y. Tanga	2 ALTM Model: Aquat	3 Mission Name:	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9322
7 Pilot: C. Alfonso	8 Co-Pilot: R. Lasco	9 Route: Catarman - Catarman			
10 Date: Aug 26, 2015	12 Airport of Departure (Airport, City/Province): Catarman		12 Airport of Arrival (Airport, City/Province): Catarman		
13 Engine On: 0853H	14 Engine Off: 1310H	15 Total Engine Time: 4+17	16 Take off: 0858H	17 Landing: 1305H	18 Total Flight Time: 4+07
19 Weather: FAIR					

20 Flight Classification

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

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

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

21 Remarks

SUCCESSFUL

22 Problems and Solutions

- ○ Weather Problem
- ○ System Problem
- ○ Aircraft Problem
- ○ Pilot Problem
- ○ Others: ____________

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

Figure A-6.13. Flight Log for Mission 8186AC

14. Flight Log for 3913G Mission

PLACEHOLDER

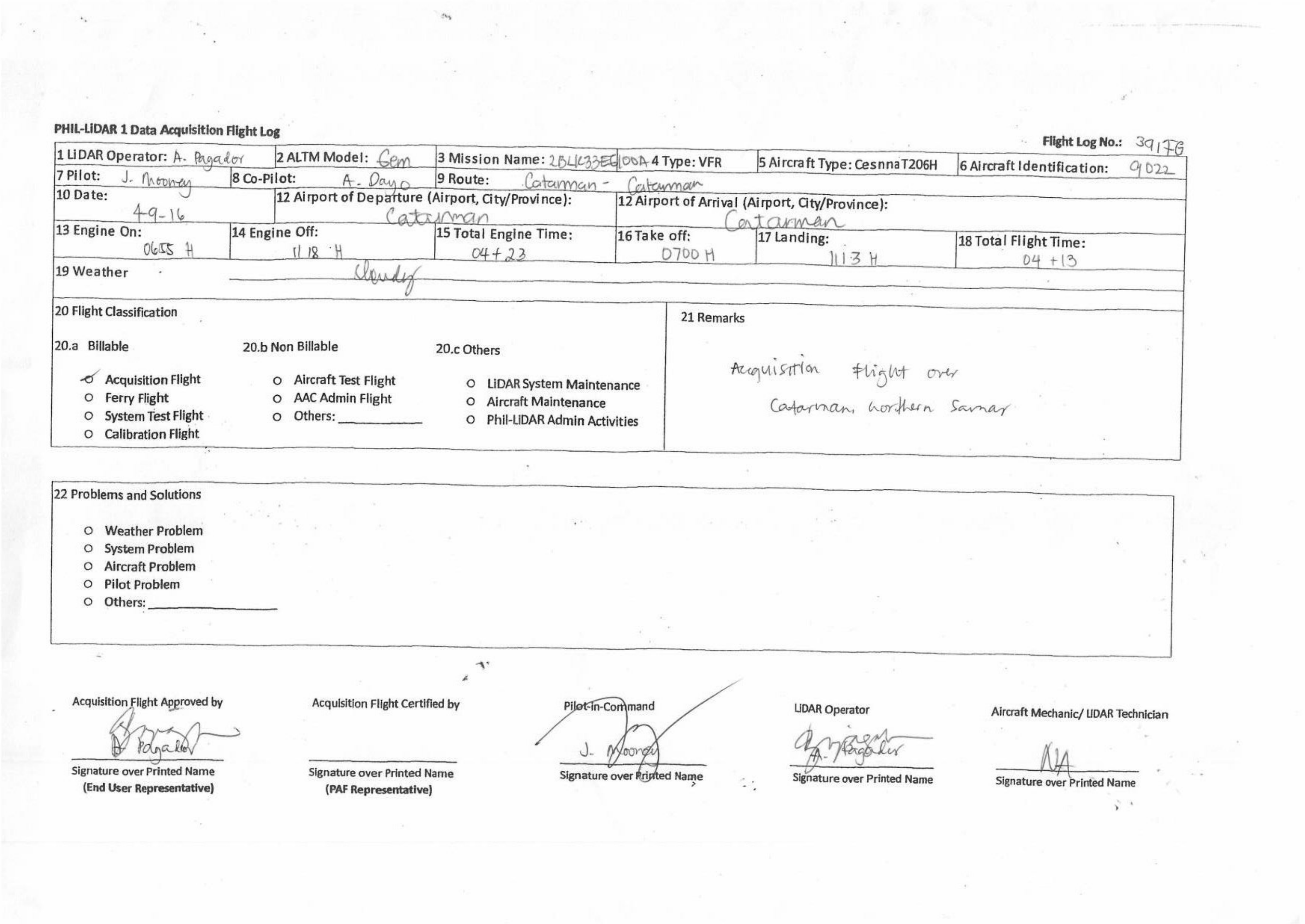
Figure A-6.14. Flight Log for Mission 3913G

15. Flight Log for 8426AC Mission

PLACEHOLDER

Figure A-6.15. Flight Log for Mission 8426AC

16. Flight Log for 3917G Mission



PHIL-LiDAR 1 Data Acquisition Flight Log

Flight Log No.: 3917G

1 LiDAR Operator: A. Pagador	2 ALTM Model: Gem	3 Mission Name: 2BLK33EG100A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9022
7 Pilot: J. Mooney	8 Co-Pilot: A. Dayo	9 Route: Catarman - Catarman			
10 Date: 4-9-16	12 Airport of Departure (Airport, City/Province): Catarman		12 Airport of Arrival (Airport, City/Province): Catarman		
13 Engine On: 0655 H	14 Engine Off: 1118 H	15 Total Engine Time: 04+23	16 Take off: 0700 H	17 Landing: 1113 H	18 Total Flight Time: 04 +13
19 Weather Cloudy					

20 Flight Classification

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

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

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

21 Remarks

Acquisition flight over Catarman, northern Samar

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

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

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

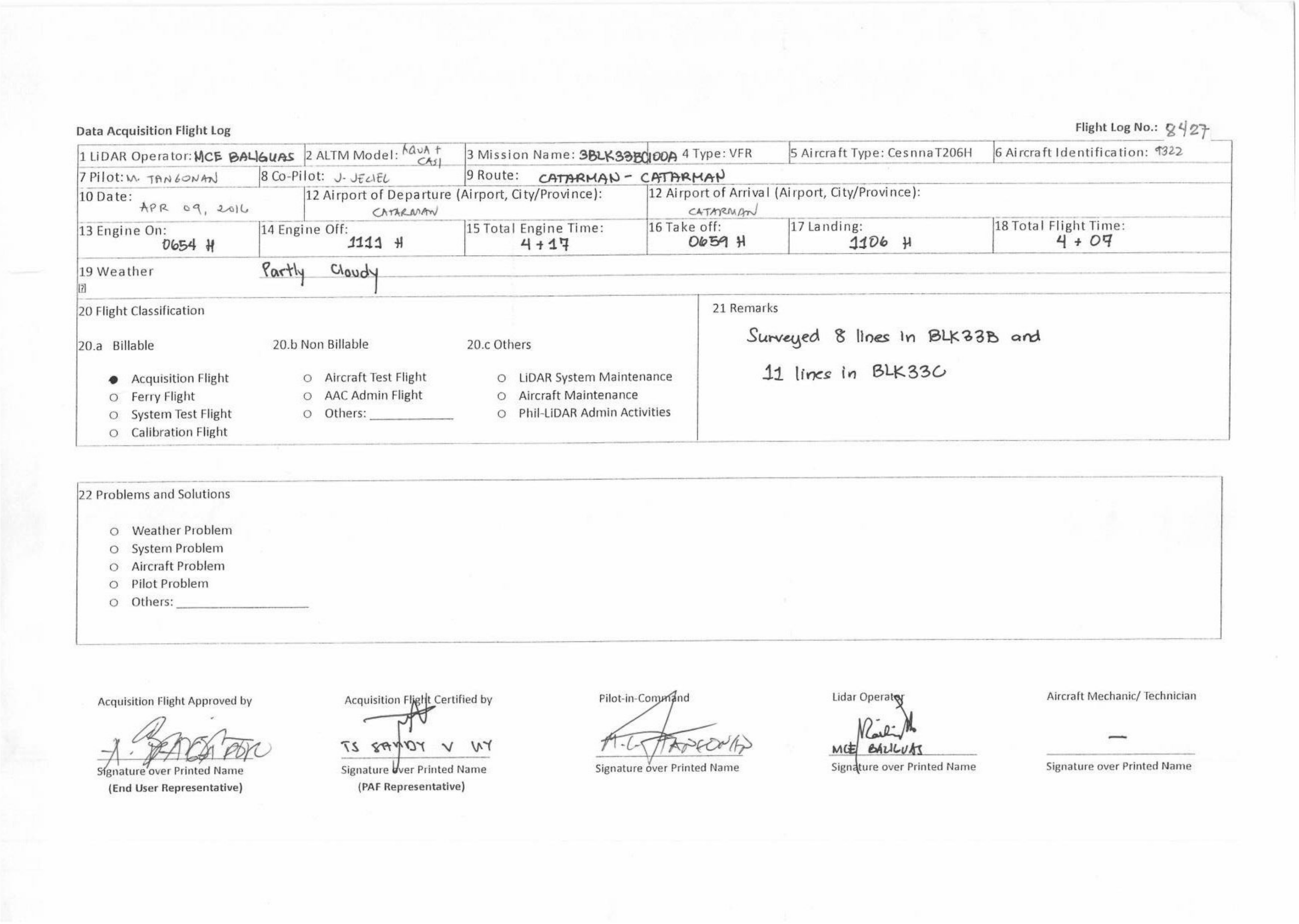
Pilot-in-Command
J. Mooney
Signature over Printed Name

LiDAR Operator
A. Pagador
Signature over Printed Name

Aircraft Mechanic/ LiDAR Technician
NA
Signature over Printed Name

Figure A-6.16. Flight Log for Mission 3917G

17. Flight Log for 8427AC Mission



Data Acquisition Flight Log

Flight Log No.: 8427

1 LiDAR Operator: MCE BALIGUAS
2 ALTM Model: AQUA + CASI
3 Mission Name: 3BLK33BC100A
4 Type: VFR
5 Aircraft Type: CesnnaT206H
6 Aircraft Identification: 9322
7 Pilot: W. TANGONAN
8 Co-Pilot: J. JECIEL
9 Route: CATARMAN - CATARMAN
10 Date: APR 09, 2016
12 Airport of Departure (Airport, City/Province): CATARMAN
12 Airport of Arrival (Airport, City/Province): CATARMAN
13 Engine On: 0654 H
14 Engine Off: 1111 H
15 Total Engine Time: 4 + 17
16 Take off: 0659 H
17 Landing: 1106 H
18 Total Flight Time: 4 + 07
19 Weather: Partly Cloudy

20 Flight Classification

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

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

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

21 Remarks

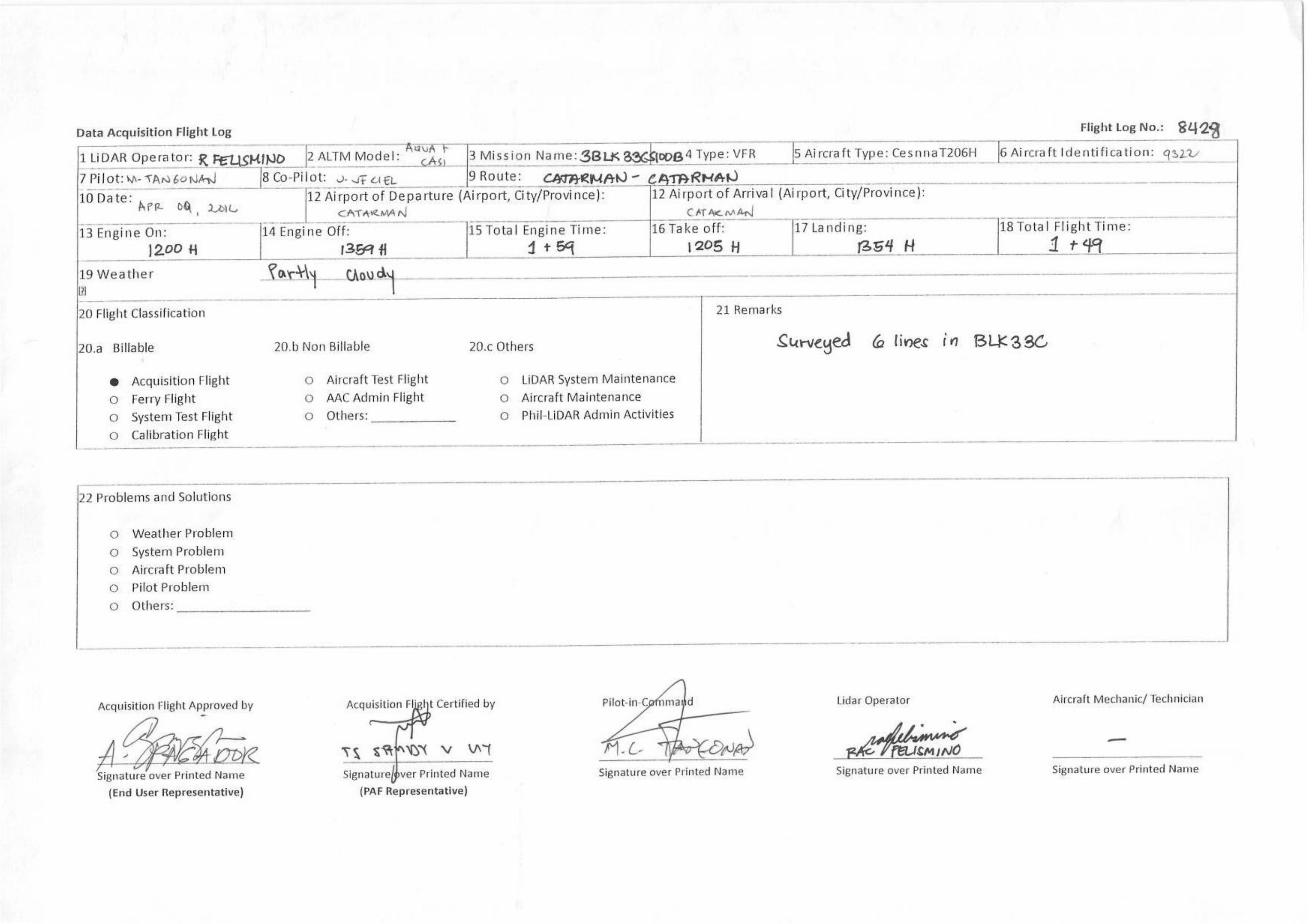
Surveyed 8 lines in BLK33B and 11 lines in BLK33C

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

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator	Aircraft Mechanic/ Technician
	TS SANDY V UY		MCE BALIGUAS	—
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name	Signature over Printed Name

Figure A-6.17. Flight Log for Mission 8427AC

18. Flight Log for 8428AC Mission



Data Acquisition Flight Log

Flight Log No.: 8429

1 LiDAR Operator: R FELISMINO
2 ALTM Model: AQUA + CASI
3 Mission Name: 3BLK33CS100B
4 Type: VFR
5 Aircraft Type: CesnnaT206H
6 Aircraft Identification: 9322
7 Pilot: M-TANGONAN
8 Co-Pilot: J. JECIEL
9 Route: CATARMAN - CATARMAN
10 Date: APR 09, 2016
12 Airport of Departure (Airport, City/Province): CATARMAN
12 Airport of Arrival (Airport, City/Province): CATARMAN
13 Engine On: 1200 H
14 Engine Off: 1359 H
15 Total Engine Time: 1 + 59
16 Take off: 1205 H
17 Landing: 1354 H
18 Total Flight Time: 1 + 49
19 Weather: Partly Cloudy

20 Flight Classification

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

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

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

21 Remarks

Surveyed 6 lines in BLK33C

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

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

Acquisition Flight Certified by
TS SANDY V UY
Signature over Printed Name
(PAF Representative)

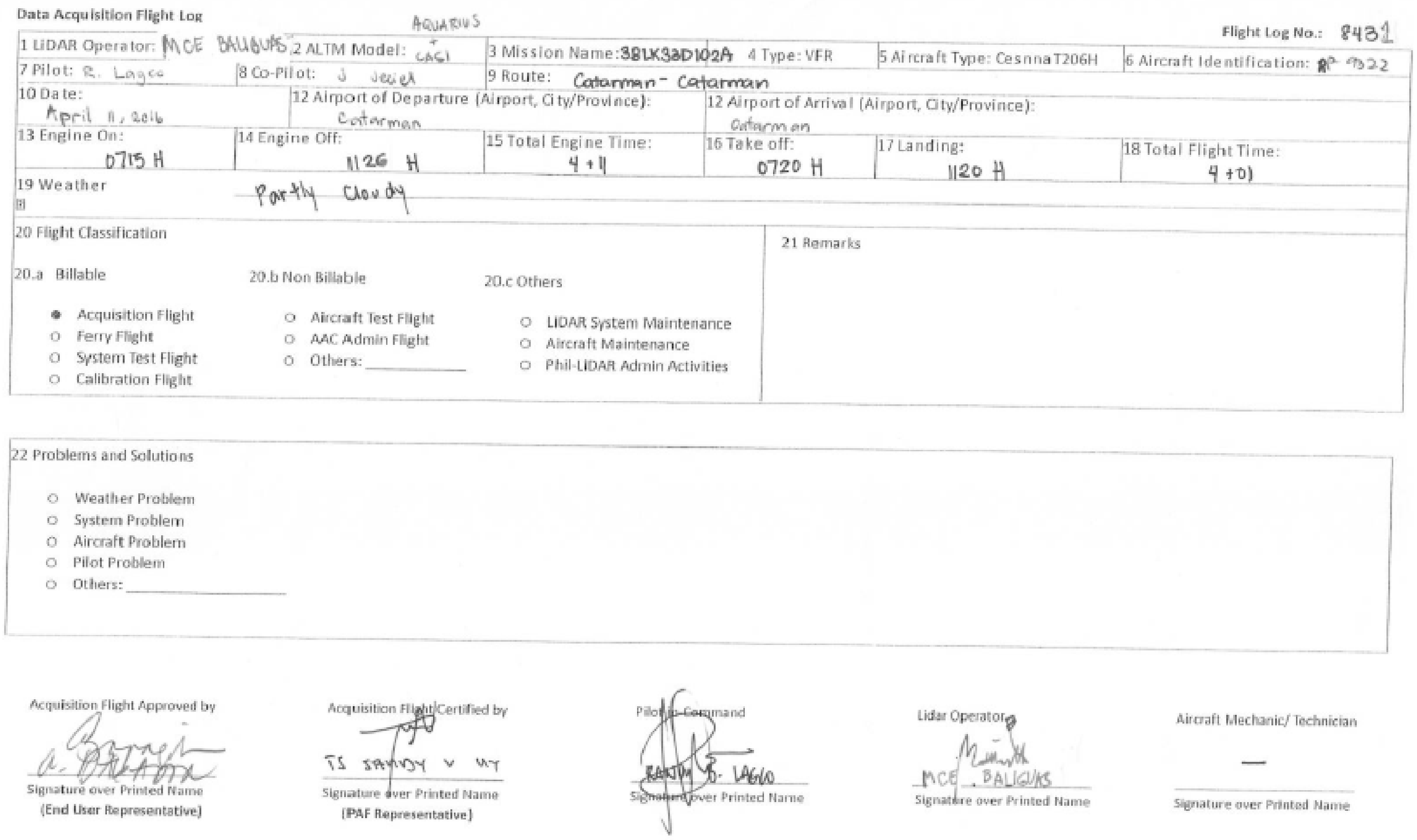
Pilot-in-Command
M.C. TAYCONA
Signature over Printed Name

Lidar Operator
RAC FELISMINO
Signature over Printed Name

Aircraft Mechanic/ Technician
–
Signature over Printed Name

Figure A-6.18. Flight Log for Mission 8428AC

19. Flight Log for 8431AC Mission



Data Acquisition Flight Log

Flight Log No.: 8431

1 LiDAR Operator: MCE BALIGUAS
2 ALTM Model: AQUARIUS + CASI
3 Mission Name: 3BLK38D102A
4 Type: VFR
5 Aircraft Type: Cesnna T206H
6 Aircraft Identification: RP 9322
7 Pilot: R. Lagco
8 Co-Pilot: J. Jecieh
9 Route: Catarman - Catarman
10 Date: April 11, 2016
12 Airport of Departure (Airport, City/Province): Catarman
12 Airport of Arrival (Airport, City/Province): Catarman
13 Engine On: 0715 H
14 Engine Off: 1126 H
15 Total Engine Time: 4 + 11
16 Take off: 0720 H
17 Landing: 1120 H
18 Total Flight Time: 4 + 0)
19 Weather: Partly Cloudy

20 Flight Classification

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

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

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

21 Remarks

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

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

Acquisition Flight Certified by
TS SANDY V MY
Signature over Printed Name
(PAF Representative)

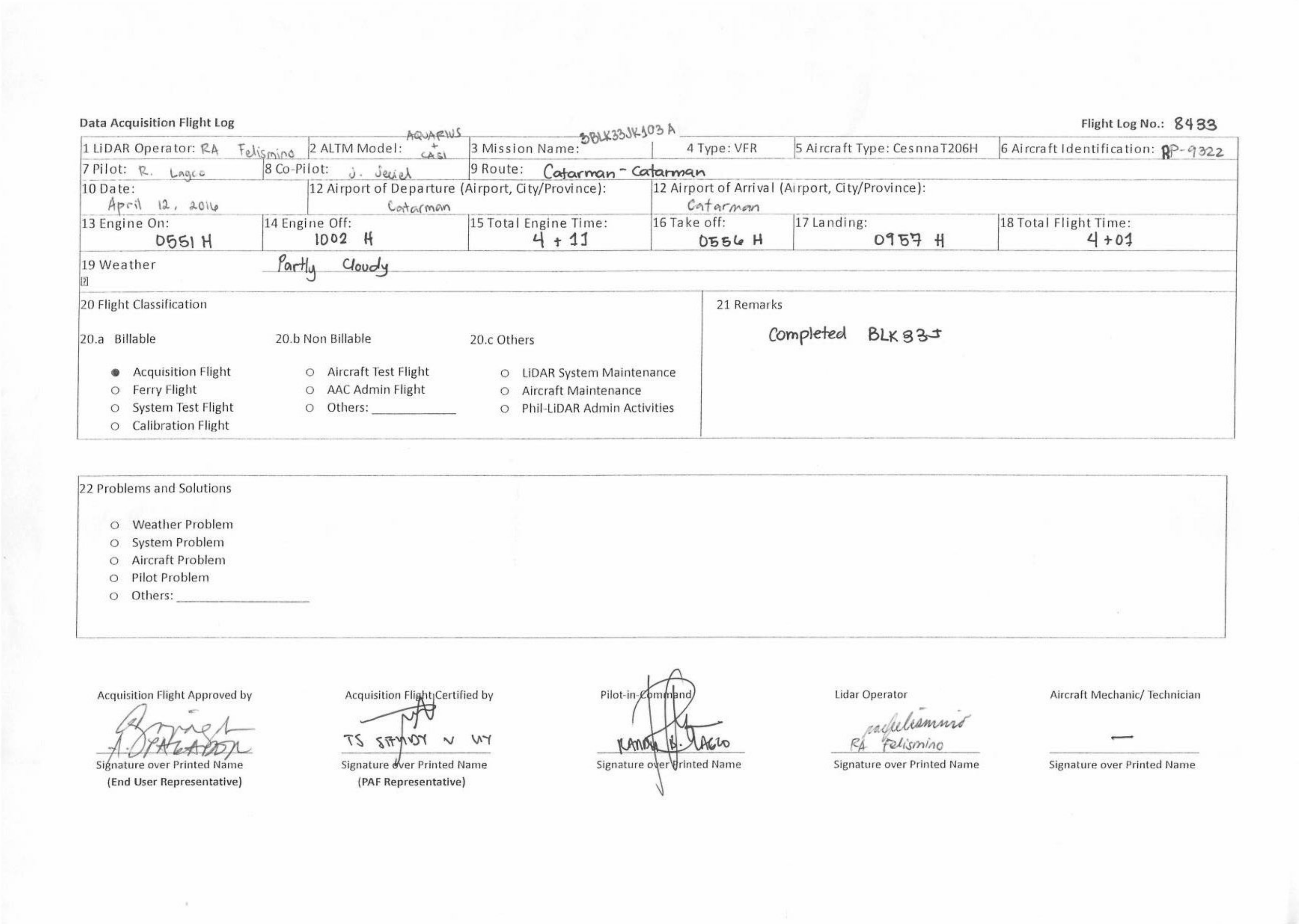
Pilot-in-Command
RENATO B. LAGCO
Signature over Printed Name

Lidar Operator
MCE BALIGUAS
Signature over Printed Name

Aircraft Mechanic/ Technician
—
Signature over Printed Name

Figure A-6.19. Flight Log for Mission 8431AC

20. Flight Log for 8433AC Mission



Data Acquisition Flight Log

Flight Log No.: 8433

1 LiDAR Operator: RA Felismino	2 ALTM Model: AQUARIUS + CASI	3 Mission Name: 3BLK33JK103A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-9322
7 Pilot: R. Lagco	8 Co-Pilot: J. Jeciel	9 Route: Catarman - Catarman			
10 Date: April 12, 2016	12 Airport of Departure (Airport, City/Province): Catarman		12 Airport of Arrival (Airport, City/Province): Catarman		
13 Engine On: 0551 H	14 Engine Off: 1002 H	15 Total Engine Time: 4 + 11	16 Take off: 0556 H	17 Landing: 0957 H	18 Total Flight Time: 4 + 01
19 Weather: Partly Cloudy					

20 Flight Classification

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

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

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

21 Remarks

Completed BLK 33J

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

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

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

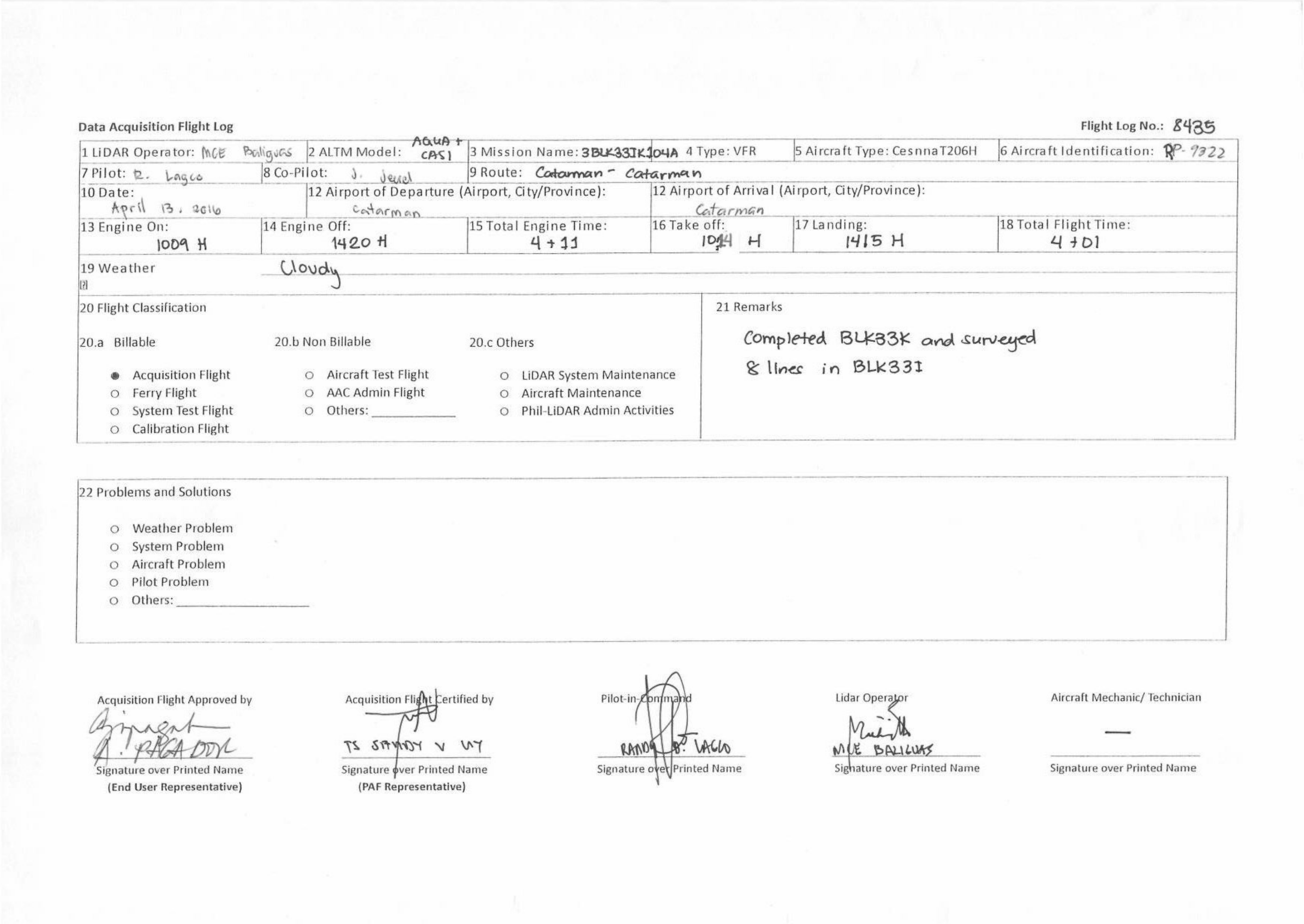
Pilot-in-Command
Signature over Printed Name

Lidar Operator
RA Felismino
Signature over Printed Name

Aircraft Mechanic/ Technician
—
Signature over Printed Name

Figure A-6.20. Flight Log for Mission 8433AC

21. Flight Log for 8435AC Mission



Data Acquisition Flight Log **Flight Log No.:** 8435

1 LiDAR Operator: MCE Baliguas	2 ALTM Model: AQUA + CASI	3 Mission Name: 3BLK33JK104A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-9322
7 Pilot: R. Lagco	8 Co-Pilot: J. Jeciel	9 Route: Catarman - Catarman			
10 Date: April 13, 2016	12 Airport of Departure (Airport, City/Province): Catarman		12 Airport of Arrival (Airport, City/Province): Catarman		
13 Engine On: 1009 H	14 Engine Off: 1420 H	15 Total Engine Time: 4 + 11	16 Take off: 1014 H	17 Landing: 1415 H	18 Total Flight Time: 4 + 01

19 Weather Cloudy

20 Flight Classification

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

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

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

21 Remarks

Completed BLK33K and surveyed 8 lines in BLK33I

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

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

Acquisition Flight Certified by
TS SANDY V UY
Signature over Printed Name
(PAF Representative)

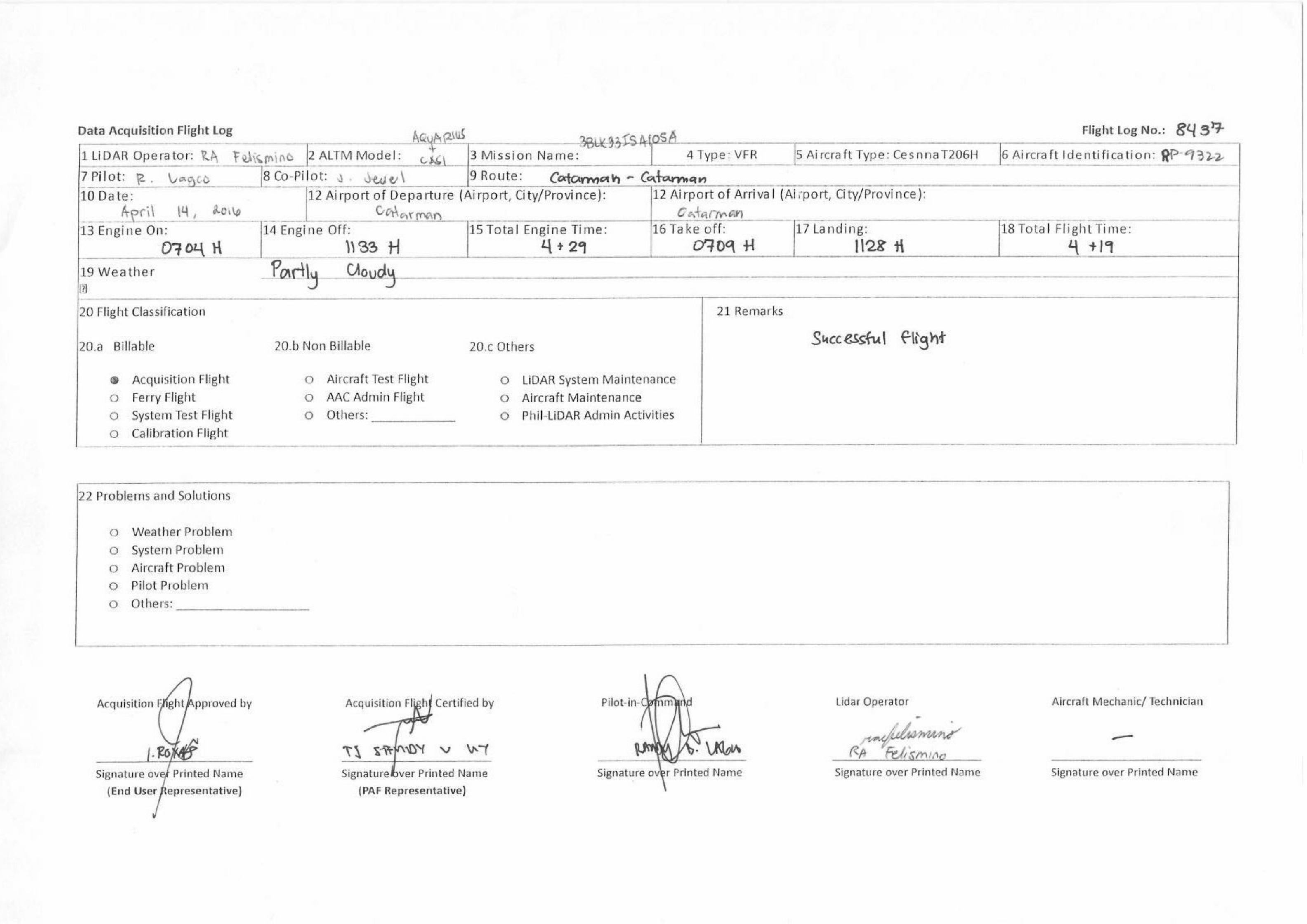
Pilot-in-Command
RANDY B. LAGO
Signature over Printed Name

Lidar Operator
MCE BALIGUAS
Signature over Printed Name

Aircraft Mechanic/ Technician
—
Signature over Printed Name

Figure A-6.21. Flight Log for Mission 8435AC

22. Flight Log for 8437AC Mission



Data Acquisition Flight Log

Flight Log No.: 8437

1 LiDAR Operator: RA Felismino	2 ALTM Model: AQUARIUS + CASI	3 Mission Name: 3BLK33ISA105A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-9322
7 Pilot: R. Lagco	8 Co-Pilot: J. Jewel	9 Route: Catarman - Catarman			
10 Date: April 14, 2016	12 Airport of Departure (Airport, City/Province): Catarman		12 Airport of Arrival (Airport, City/Province): Catarman		
13 Engine On: 0704 H	14 Engine Off: 1133 H	15 Total Engine Time: 4 + 29	16 Take off: 0709 H	17 Landing: 1128 H	18 Total Flight Time: 4 +19
19 Weather	Partly Cloudy				

20 Flight Classification

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

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

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

21 Remarks

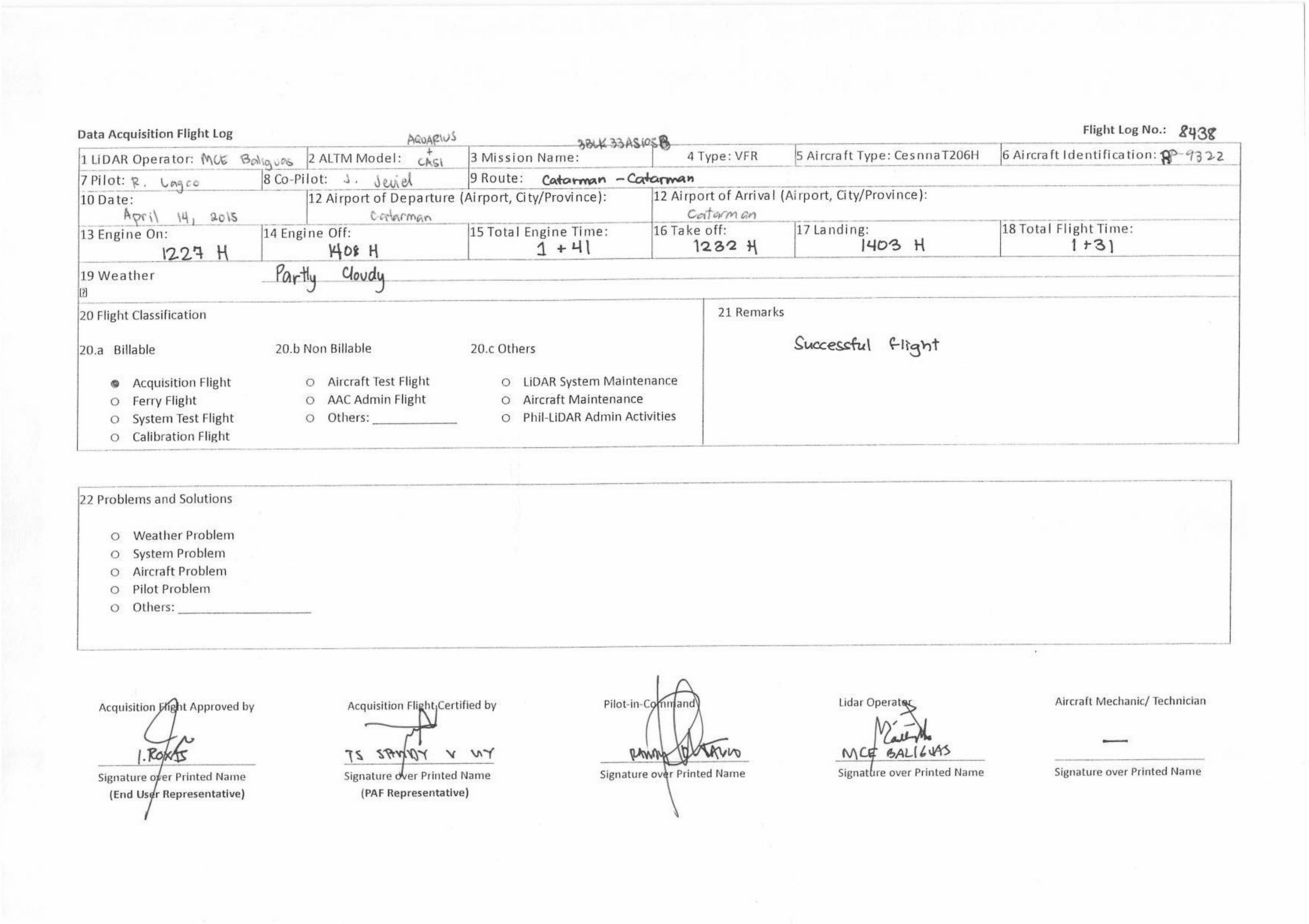
Successful Flight

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

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator	Aircraft Mechanic/ Technician
I. ROXAS	TJ SAMDY V UY	RANDY B. LAGO	RA Felismino	—
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name	Signature over Printed Name

Figure A-6.22. Flight Log for Mission 8437AC

23. Flight Log for 8438AC Mission



Data Acquisition Flight Log

Flight Log No.: 8438

1 LiDAR Operator: MCE Baliguas
2 ALTM Model: AQUARIUS + CASI
3 Mission Name: 3BLK33AS105B
4 Type: VFR
5 Aircraft Type: CesnnaT206H
6 Aircraft Identification: RP-9322
7 Pilot: R. Lagco
8 Co-Pilot: J. Jeviel
9 Route: Catarman - Catarman
10 Date: April 14, 2015
12 Airport of Departure (Airport, City/Province): Catarman
12 Airport of Arrival (Airport, City/Province): Catarman
13 Engine On: 1227 H
14 Engine Off: 1408 H
15 Total Engine Time: 1 + 41
16 Take off: 1232 H
17 Landing: 1403 H
18 Total Flight Time: 1 + 31
19 Weather Partly Cloudy

20 Flight Classification

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

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

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

21 Remarks

Successful Flight

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

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

Acquisition Flight Certified by
TS SANDY V UY
Signature over Printed Name
(PAF Representative)

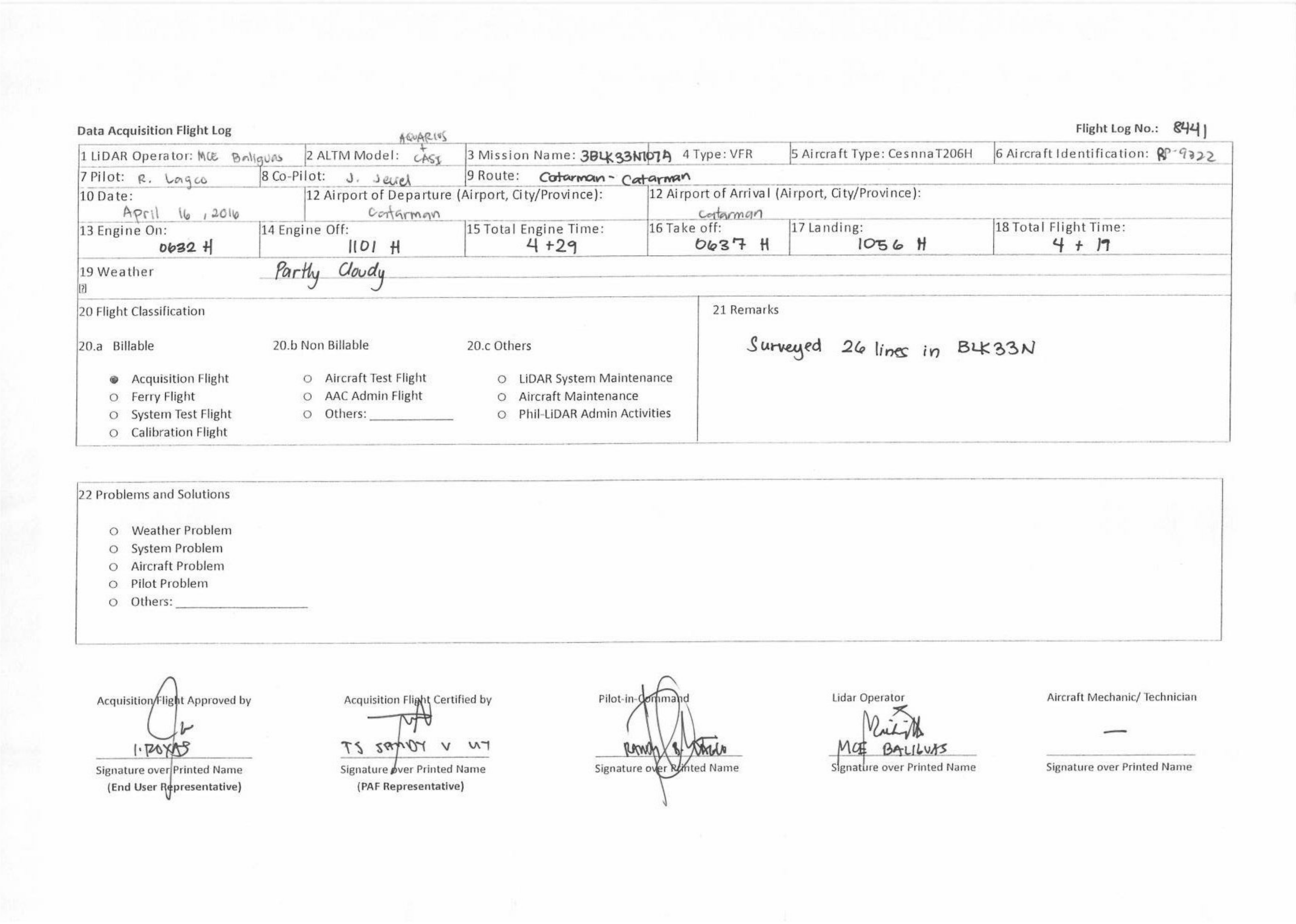
Pilot-in-Command
Signature over Printed Name

Lidar Operator
MCE BALIGUAS
Signature over Printed Name

Aircraft Mechanic/ Technician
—
Signature over Printed Name

Figure A-6.23. Flight Log for Mission 8438AC

24. Flight Log for 8441AC Mission



Data Acquisition Flight Log

Flight Log No.: 8441

1 LiDAR Operator: MCE Balliguas
2 ALTM Model: AQUARIUS + CASI
3 Mission Name: 3BLK33N107A
4 Type: VFR
5 Aircraft Type: Cesnna T206H
6 Aircraft Identification: RP-9322
7 Pilot: R. Lagco
8 Co-Pilot: J. Jeciel
9 Route: Catarman - Catarman
10 Date: April 16, 2016
12 Airport of Departure (Airport, City/Province): Catarman
12 Airport of Arrival (Airport, City/Province): Catarman
13 Engine On: 0632 H
14 Engine Off: 1101 H
15 Total Engine Time: 4+29
16 Take off: 0637 H
17 Landing: 1056 H
18 Total Flight Time: 4 + 19
19 Weather: Partly Cloudy

20 Flight Classification

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

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

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

21 Remarks

Surveyed 26 lines in BLK33N

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

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

Acquisition Flight Certified by
TS SANDY V UY
Signature over Printed Name
(PAF Representative)

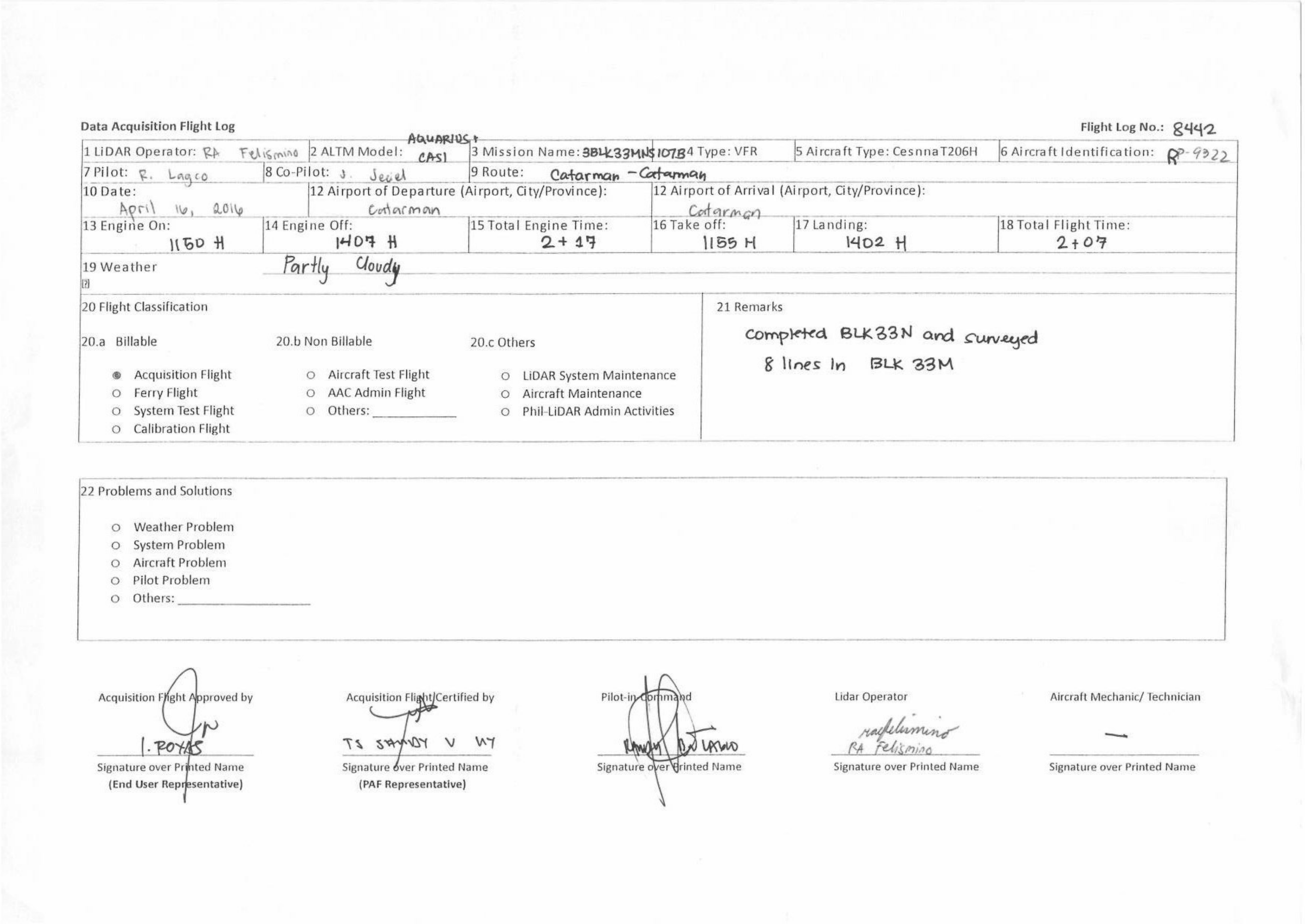
Pilot-in-Command
Signature over Printed Name

Lidar Operator
MCE BALILUAS
Signature over Printed Name

Aircraft Mechanic/ Technician
—
Signature over Printed Name

Figure A-6.24. Flight Log for Mission 8441AC

25. Flight Log for 8442AC Mission



Data Acquisition Flight Log

Flight Log No.: 8442

1 LiDAR Operator: RA Felismino	2 ALTM Model: AQUARIUS + CASI	3 Mission Name: 3BLK33MNS107B	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-9322
7 Pilot: R. Lagco	8 Co-Pilot: J. Jeciel	9 Route: Catarman - Catarman			
10 Date: April 16, 2016	12 Airport of Departure (Airport, City/Province): Catarman		12 Airport of Arrival (Airport, City/Province): Catarman		
13 Engine On: 1150 H	14 Engine Off: 1407 H	15 Total Engine Time: 2+17	16 Take off: 1155 H	17 Landing: 1402 H	18 Total Flight Time: 2+07
19 Weather	Partly Cloudy				

20 Flight Classification

20.a Billable	20.b Non Billable	20.c Others
● Acquisition Flight	○ Aircraft Test Flight	○ LiDAR System Maintenance
○ Ferry Flight	○ AAC Admin Flight	○ Aircraft Maintenance
○ System Test Flight	○ Others: ____________	○ Phil-LiDAR Admin Activities
○ Calibration Flight		

21 Remarks

Completed BLK33N and surveyed 8 lines in BLK 33M

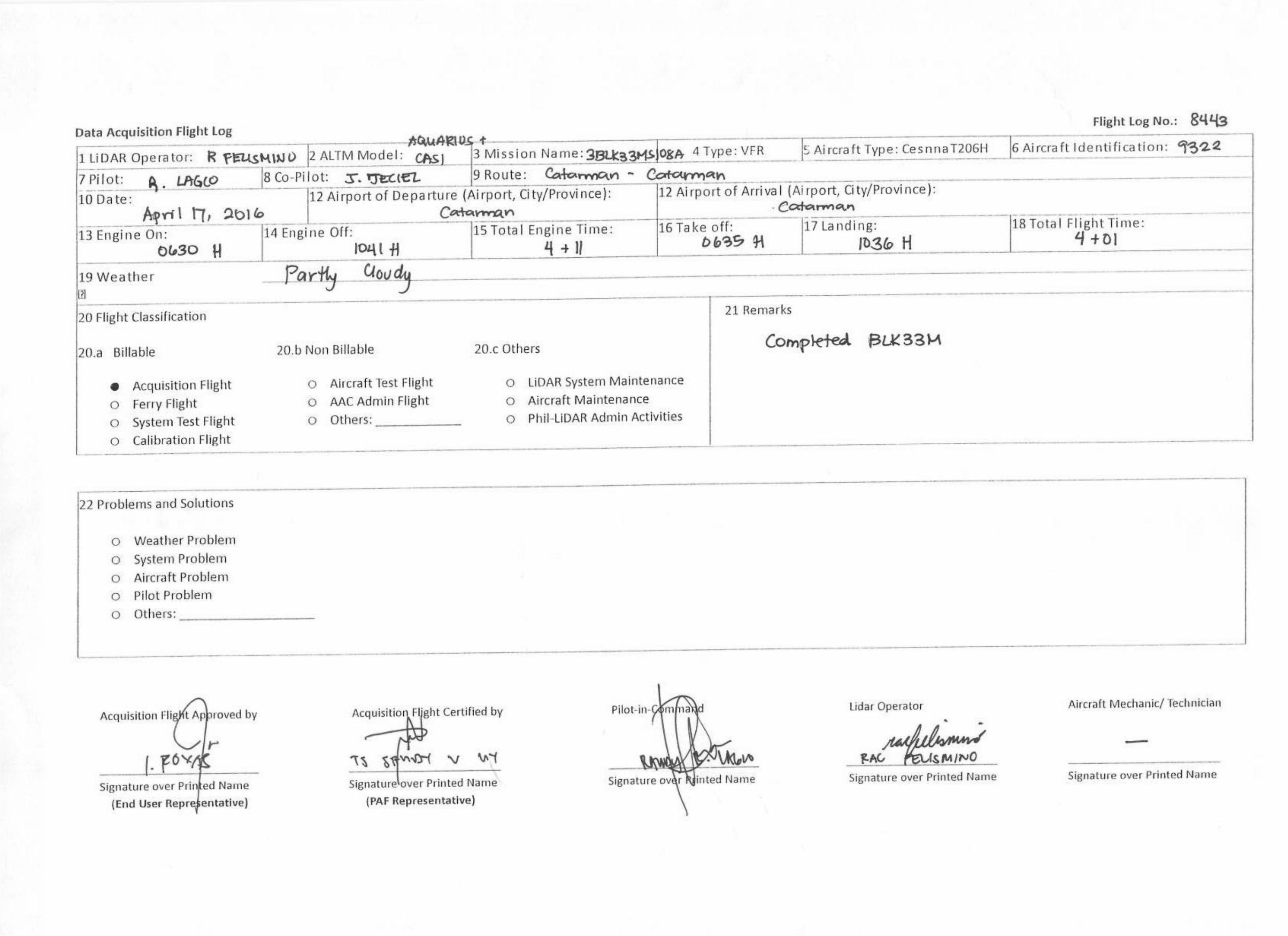
22 Problems and Solutions

- ○ Weather Problem
- ○ System Problem
- ○ Aircraft Problem
- ○ Pilot Problem
- ○ Others: ____________________

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator	Aircraft Mechanic/ Technician
I. ROXAS	TS SANDY V NY	LAVAO	RA Felismino	—
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name	Signature over Printed Name

Figure A-6.25. Flight Log for Mission 8442AC

26. Flight Log for 8443AC Mission



Data Acquisition Flight Log

Flight Log No.: 8443

1 LiDAR Operator: R FELISMINO
2 ALTM Model: AQUARIUS + CASI
3 Mission Name: 3BLK33MS108A
4 Type: VFR
5 Aircraft Type: CesnnaT206H
6 Aircraft Identification: 9322
7 Pilot: A. LAGCO
8 Co-Pilot: J. JECIEL
9 Route: Catarman - Catarman
10 Date: April 17, 2016
12 Airport of Departure (Airport, City/Province): Catarman
12 Airport of Arrival (Airport, City/Province): Catarman
13 Engine On: 0630 H
14 Engine Off: 1041 H
15 Total Engine Time: 4 + 11
16 Take off: 0635 H
17 Landing: 1036 H
18 Total Flight Time: 4 +01
19 Weather: Partly Cloudy

20 Flight Classification

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

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

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

21 Remarks

Completed BLK33M

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

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

Acquisition Flight Certified by
TS SANDY V UY
Signature over Printed Name
(PAF Representative)

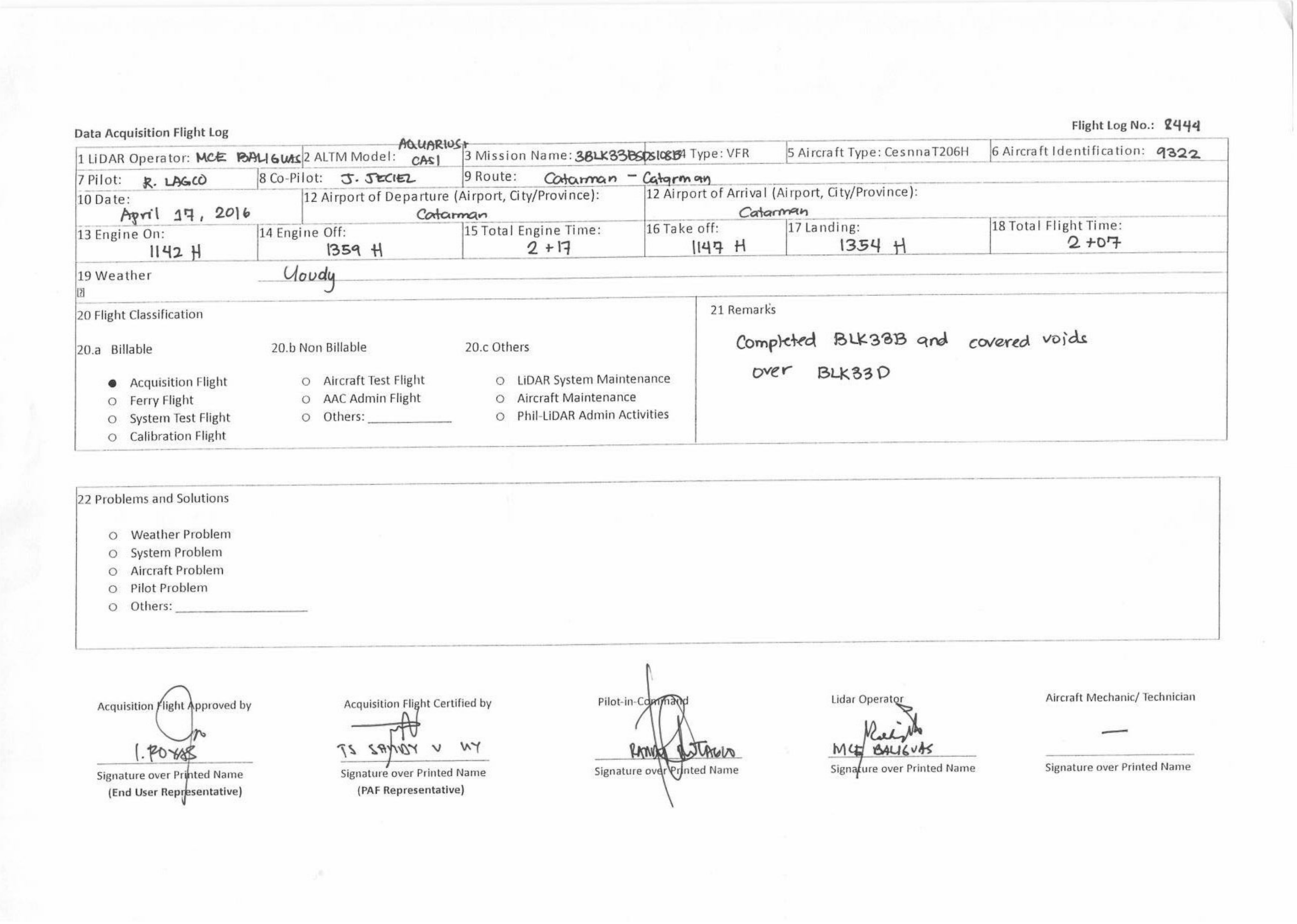
Pilot-in-Command
Signature over Printed Name

Lidar Operator
RAC FELISMINO
Signature over Printed Name

Aircraft Mechanic/ Technician
—
Signature over Printed Name

Figure A-6.26. Flight Log for Mission 8443AC

27. Flight Log for 8444AC Mission



Data Acquisition Flight Log

Flight Log No.: 8444

1 LiDAR Operator: MCE BALIGUAS
2 ALTM Model: AQUARIUS+ CASI
3 Mission Name: 3BLK33BSDS108B
4 Type: VFR
5 Aircraft Type: Cesnna T206H
6 Aircraft Identification: 9322
7 Pilot: R. LAGCO
8 Co-Pilot: J. JECIEL
9 Route: Catarman - Catarman
10 Date: April 17, 2016
12 Airport of Departure (Airport, City/Province): Catarman
12 Airport of Arrival (Airport, City/Province): Catarman
13 Engine On: 1142 H
14 Engine Off: 1359 H
15 Total Engine Time: 2+17
16 Take off: 1147 H
17 Landing: 1354 H
18 Total Flight Time: 2+07
19 Weather: Cloudy

20 Flight Classification

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

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

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

21 Remarks

Completed BLK33B and covered voids over BLK33D

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

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

Acquisition Flight Certified by
TS SANDY V WY
Signature over Printed Name
(PAF Representative)

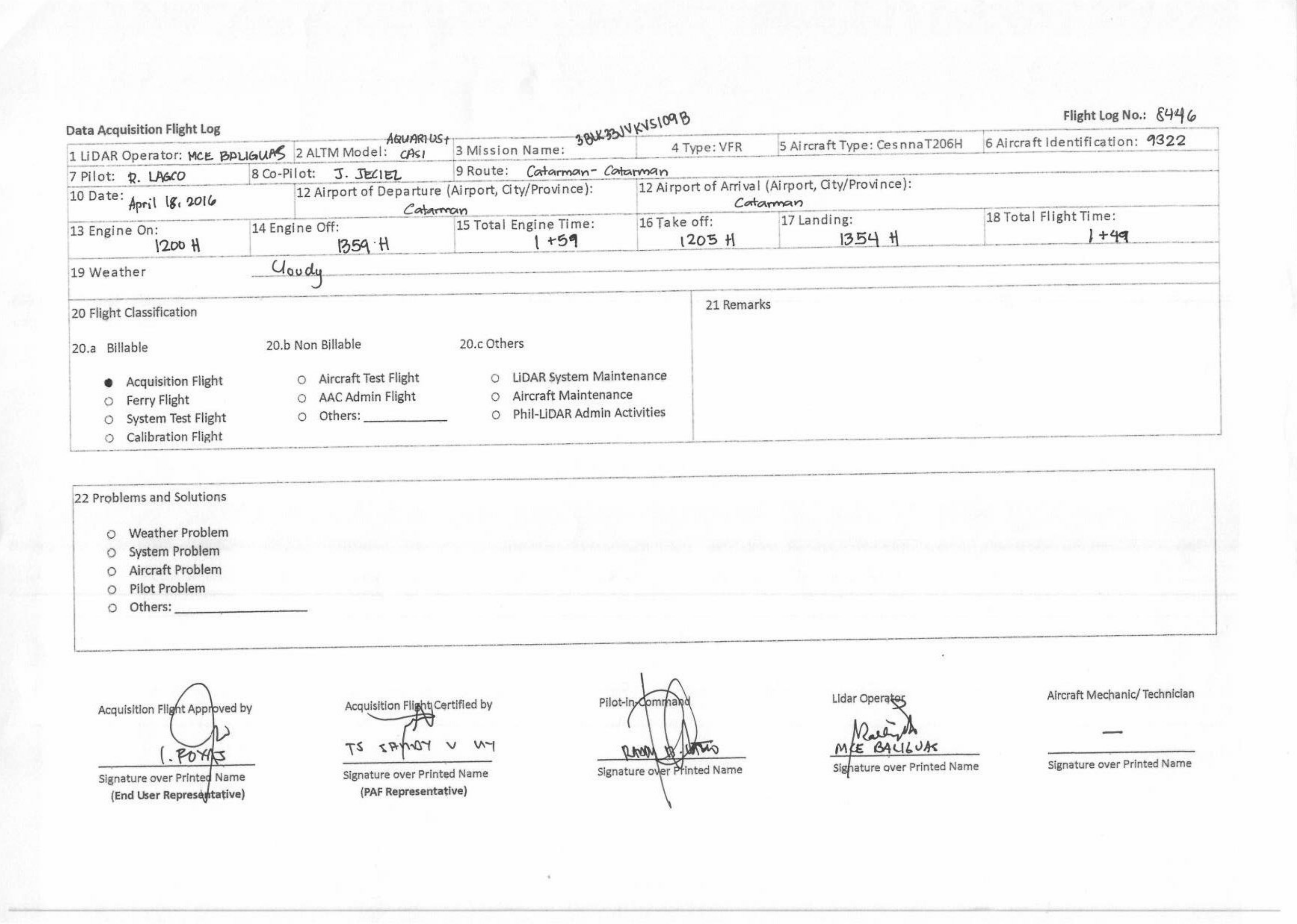
Pilot-in-Command
RANDY LAGCO
Signature over Printed Name

Lidar Operator
MCE BALIGUAS
Signature over Printed Name

Aircraft Mechanic/ Technician
—
Signature over Printed Name

Figure A-6.27. Flight Log for Mission 8444AC

28. Flight Log for 8446AC Mission



Data Acquisition Flight Log

Flight Log No.: 8446

1 LiDAR Operator: MCE BALIGUAS
2 ALTM Model: AQUARIUS+ CASI
3 Mission Name: 3BLK33JVKVS109B
4 Type: VFR
5 Aircraft Type: CesnnaT206H
6 Aircraft Identification: 9322
7 Pilot: R. LAGCO
8 Co-Pilot: J. JECIEL
9 Route: Catarman- Catarman
10 Date: April 18, 2016
12 Airport of Departure (Airport, City/Province): Catarman
12 Airport of Arrival (Airport, City/Province): Catarman
13 Engine On: 1200 H
14 Engine Off: 1359 H
15 Total Engine Time: 1 +59
16 Take off: 1205 H
17 Landing: 1354 H
18 Total Flight Time: 1 +49
19 Weather: Cloudy

20 Flight Classification

20.a Billable

- ● Acquisition Flight
- ○ Ferry Flight
- ○ System Test Flight
- ○ Calibration Flight

20.b Non Billable

- ○ Aircraft Test Flight
- ○ AAC Admin Flight
- ○ Others: ____________

20.c Others

- ○ LiDAR System Maintenance
- ○ Aircraft Maintenance
- ○ Phil-LiDAR Admin Activities

21 Remarks

22 Problems and Solutions

- ○ Weather Problem
- ○ System Problem
- ○ Aircraft Problem
- ○ Pilot Problem
- ○ Others: ____________

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

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

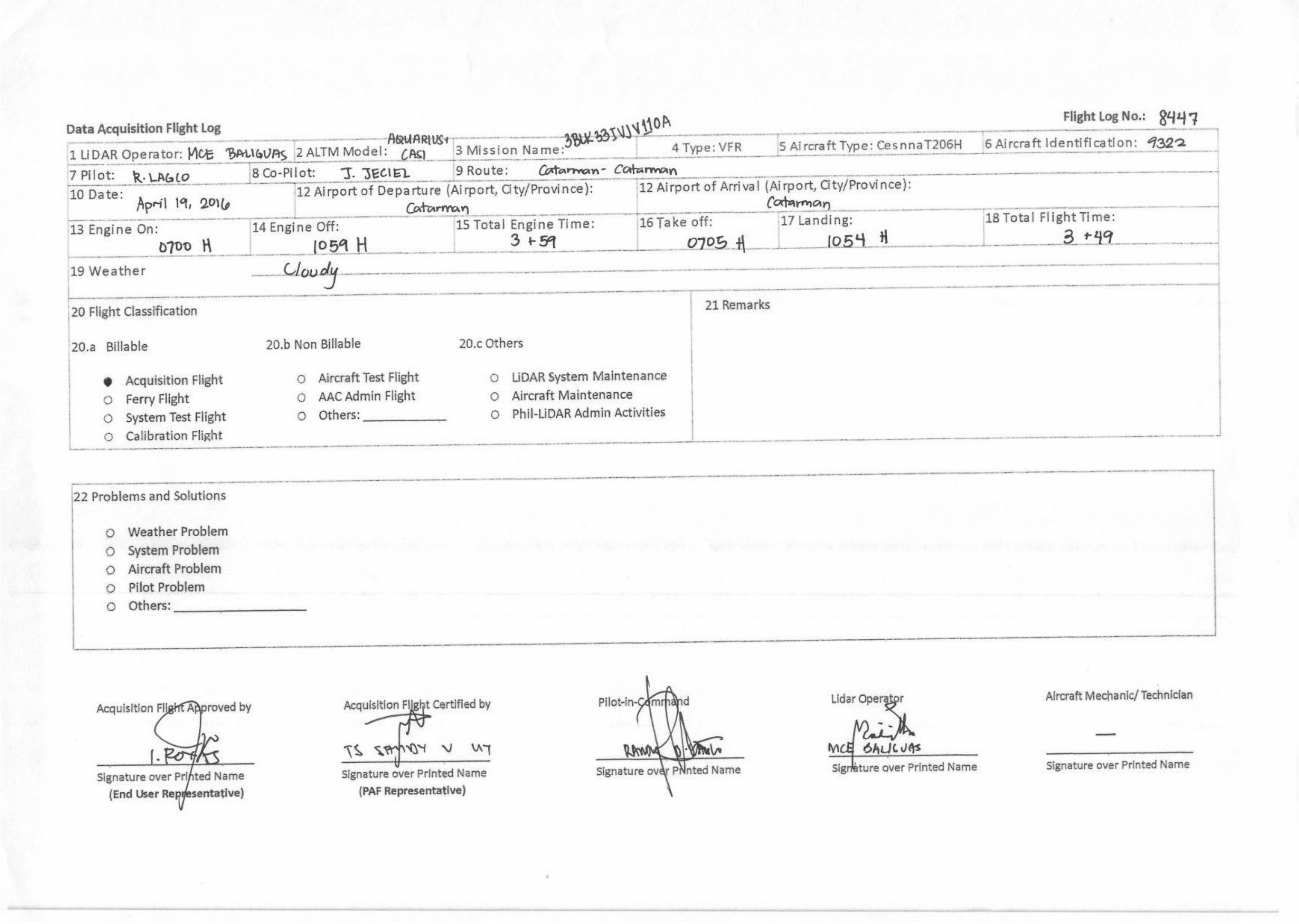
Pilot-in-Command
Signature over Printed Name

Lidar Operator
MCE BALIGUAS
Signature over Printed Name

Aircraft Mechanic/ Technician
—
Signature over Printed Name

Figure A-6.28. Flight Log for Mission 8446AC

29. Flight Log for 8447AC Mission



Data Acquisition Flight Log

Flight Log No.: 8447

1 LiDAR Operator: MCE BALIGUAS	2 ALTM Model: AQUARIUS+ CASI	3 Mission Name: 3BLK33IVJV110A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9322
7 Pilot: R. LAGLO	8 Co-Pilot: J. JECIEL	9 Route: Catarman- Catarman			
10 Date: April 19, 2016	12 Airport of Departure (Airport, City/Province): Catarman		12 Airport of Arrival (Airport, City/Province): Catarman		
13 Engine On: 0700 H	14 Engine Off: 1059 H	15 Total Engine Time: 3 +59	16 Take off: 0705 H	17 Landing: 1054 H	18 Total Flight Time: 3 +49
19 Weather	Cloudy				

20 Flight Classification

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

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

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

21 Remarks

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

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

Acquisition Flight Certified by
TS SAMOY V UY
Signature over Printed Name
(PAF Representative)

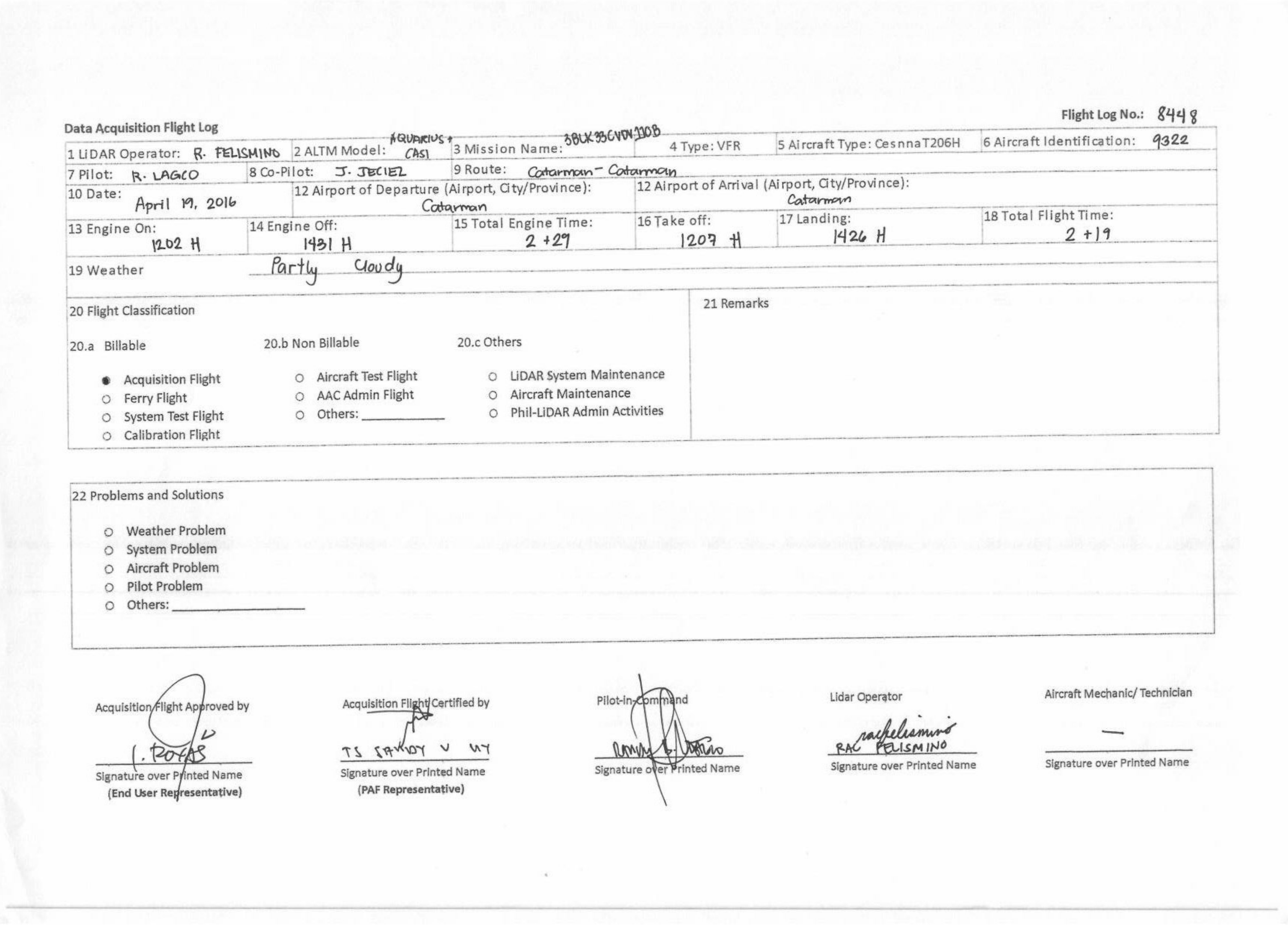
Pilot-in-Command
RANDY D. [illegible]
Signature over Printed Name

Lidar Operator
MCE BALIGUAS
Signature over Printed Name

Aircraft Mechanic/ Technician
—
Signature over Printed Name

Figure A-6.29. Flight Log for Mission 8447AC

30. Flight Log for 8448AC Mission



Data Acquisition Flight Log

Flight Log No.: 8448

1 LiDAR Operator: R. FELISMINO	2 ALTM Model: AQUARIUS + CASI	3 Mission Name: 3BLK33CVDV110B	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9322
7 Pilot: R. LAGCO	8 Co-Pilot: J. JECIEL	9 Route: Catarman- Catarman			
10 Date: April 19, 2016	12 Airport of Departure (Airport, City/Province): Catarman		12 Airport of Arrival (Airport, City/Province): Catarman		
13 Engine On: 1202 H	14 Engine Off: 1431 H	15 Total Engine Time: 2 +29	16 Take off: 1207 H	17 Landing: 1426 H	18 Total Flight Time: 2 +19
19 Weather	Partly Cloudy				

20 Flight Classification

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

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

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

21 Remarks

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

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

Acquisition Flight Certified by
TS SAYOY V UY
Signature over Printed Name
(PAF Representative)

Pilot-in-Command
Signature over Printed Name

Lidar Operator
RAC FELISMINO
Signature over Printed Name

Aircraft Mechanic/ Technician
Signature over Printed Name

Figure A-6.30. Flight Log for Mission 8448AC

Annex 7. Flight Status Reports

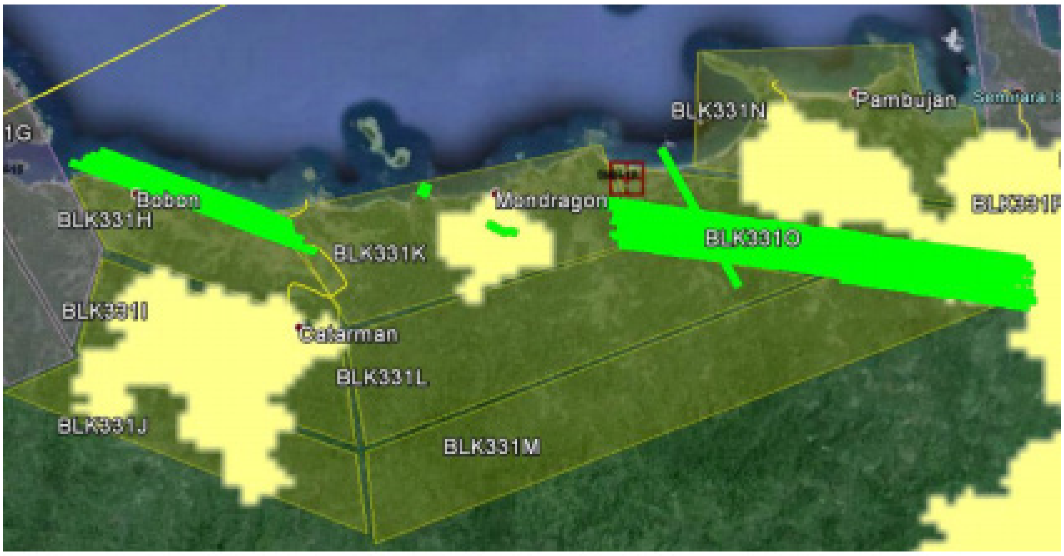
Table A-7.1. Flight Status Report

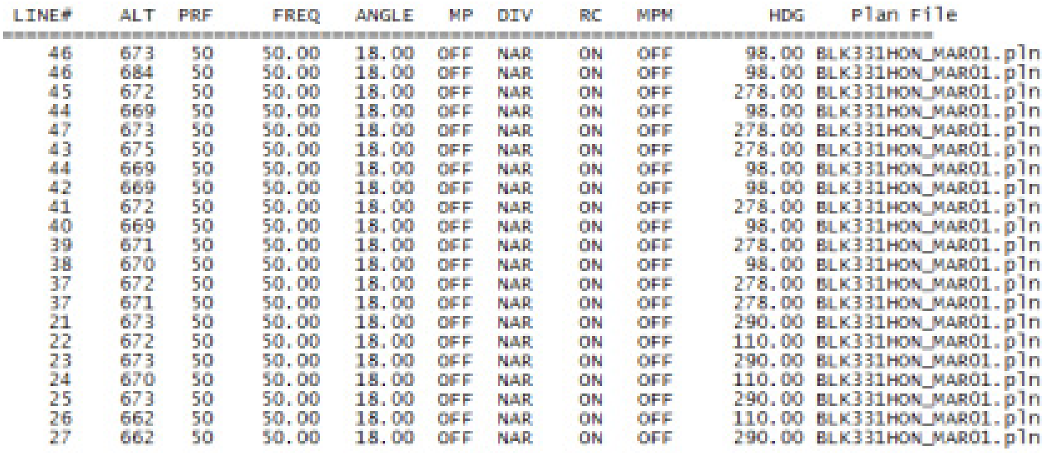
FLIGHT STATUS REPORT NORTHERN SAMAR					
FLIGHT NO	AREA	MISSION	OPERATOR	DATE FLOWN	REMARKS
7830AC	BLK331H & O	3BLK331HSO060A	MS REYES	01-MAR-15	SURVEYED 7 LINES FOR BLK331H AND 11 LINES FOR BLK331O.
7836AC	BLK 331O	3BLK331ON063A	MS REYES	04-MAR-15	SURVEYED 7 LINES FOR BLK 331O.
8154AC	BLK331 N &O	3BLK331NO222A	MS REYES	10-AUG-15	SURVEYED 13 LINES FOR BLK N AND O
8156AC	BLK331 L & N	3BLK331LNS223A	MC BALIGUAS	11-AUG-15	SURVEYED 17 LINES FOR BLK331N & L
8157AC	BLK331N2	3BLK331NS223B	MS REYES	11-AUG-15	SURVEYED 13 LINES FOR BLK331N
8158AC	BLK331P	3BLK331P224A	MS REYES	12-AUG-15	SURVEYED 14 LINES FOR BLK331P
8159AC	BLK331N & P	3BLK331NSPS224B	MC BALIGUAS	12-AUG-15	SURVEYED 8 LINES FOR BLK331N & P
8160AC	BLK331 PQRS	3BLK331PQRS225A	PJ ARCEO	13-AUG-15	URVEYED 8 LINES FOR BLK331P,Q,R & S
8180AC	BLK 33Q	3BLK33R235A	MV TONGA	AUG 23	COMPLETED BLK 33Q; 75.28 SQ.KM
8182AC	BLK 33R	3BLK33R236A	J. GONZALES	AUG 24	SURVEYED BLK 33R; 53.56 SQ.KM
8183AC	BLK 33TV	3BLK33STV236B	MV TONGA	AUG 24	SURVEYED BLK 33TV; 36.34 SQ.KM.
8184AC	BLK 33PS	3BLK33PS2237A	J. GONZALES	AUG 25	SURVEYED BLK 33PS; 15.8 SQ.KM
8186AC	BLK 33PS AND TS	3BLK33SPST238A	MV TONGA	AUG 26	SURVEYED BLK 33PTS; 71.47 SQ.KM
3913G	BLK33L, K	2BLK33LK099A	MCE BALIGUAS	8-Apr-16	Surveyed BLK33L and BLK33K
8426AC	BLK33B, C	3BLK33BC100A	MCE BALIGUAS	09 APR 2016	Surveyed 8 lines in BLK33B and 11 lines in BLK33C
3917G	BLK33E, G	2BLK33EG100A	A PAGADOR	09 APR 2016	COMPLETED BLK33E AND BLK33G
8427AC	BLK33B, C	3BLK33CS100B	R FELISMINO	09 APR 2016	Surveyed in BLK33C
8428AC	3BLK33C	3BLK33CSH101A	R FELISMINO	09 APR 2016	Surveyed 6 lines in BLK33C
8431AC	BLK33D	3BLK33D102A	MCE BALIGUAS	11 APR 2016	Completed BLK33D
8433AC	BLK33J, K	3BLK33KSJ103A	R FELISMINO	12 APR 2016	Surveyed 3 lines in BLK33K and 15 lines in BLK33J

8435AC	BLK33I, K	3BLK33IK104A	MCE BALIGUAS	13 APR 2016	Completed BLK33K and surveyed 8 lines in BLK33I
8437AC	BLK33A, I	3BLK33ISA105A	R FELISMINO	14 APR 2016	Completed BLK33I and surveyed BLK33A
8438AC	BLK33A	3BLK33AS105B	MCE BALIGUAS	14 APR 2016	Completed BLK33A
8441AC	BLK33N	3BLK33N107A	MCE BALIGUAS	16 APR 2016	Surveyed 26 lines in BLK33N
8442AC	BLK33M, N	3BLK33MNS107B	R FELISMINO	16 APR 2016	Completed BLK33N and surveyed 8 lines in BLK33M
8443AC	BLK33M	3BLK33MS108A	R FELISMINO	17 APR 2016	Completed BLK33M
8444AC	BLK33B, D	3BLK33BSDS108B	MCE BALIGUAS	17 APR 2016	Completed BLK33B and covered voids over BLK33D
8446AC	BLK33J, K	3BLK33JVKVS109B	MCE BALIGUAS	17 APR 2016	Covered voids over BLK33J and BLK33K
8447AC	BLK33I, J	3BLK33IVJV110A	MCE BALIGUAS	19 APR 2016	Covered scattered voids over survey area
8448AC	BLK33C, D	3BLK33CVDV110B	R FELISMINO	19 APR 2016	Covered voids over BLK33B and BLK33C

SWATH PER FLIGHT MISSION

Flight No.:	7830AC
Area:	BLK 331O
Mission Name:	3BLK331ON063A

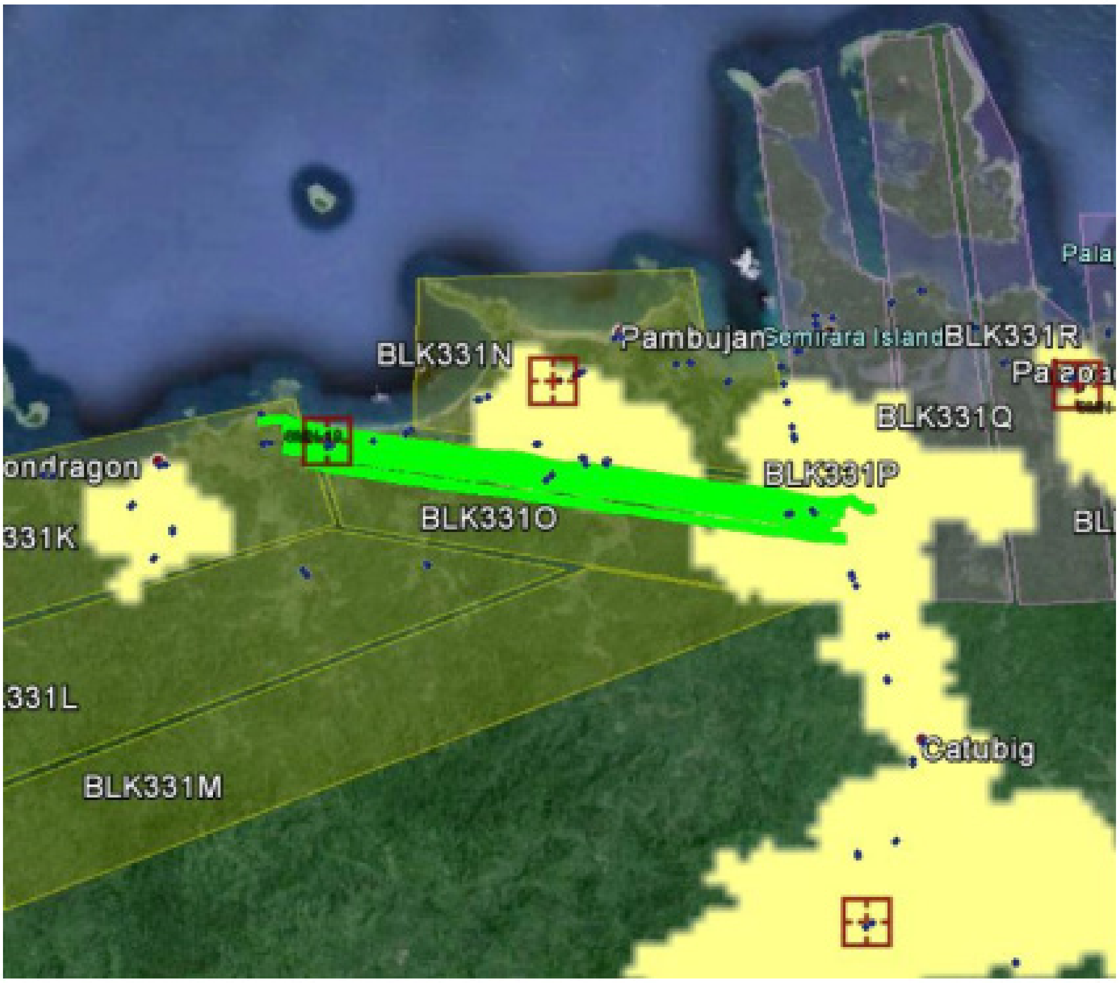


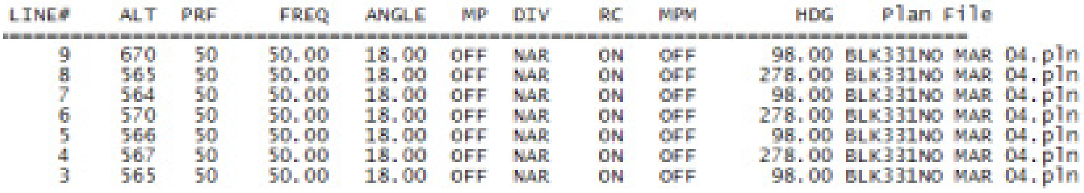


```
LINE#     ALT   PRF      FREQ    ANGLE    MP   DIV     RC    MPM          HDG     Plan File
==========================================================================================
   46     673    50     50.00    18.00   OFF   NAR     ON    OFF        98.00 BLK331HON_MAR01.pln
   46     684    50     50.00    18.00   OFF   NAR     ON    OFF        98.00 BLK331HON_MAR01.pln
   45     672    50     50.00    18.00   OFF   NAR     ON    OFF       278.00 BLK331HON_MAR01.pln
   44     669    50     50.00    18.00   OFF   NAR     ON    OFF        98.00 BLK331HON_MAR01.pln
   47     673    50     50.00    18.00   OFF   NAR     ON    OFF       278.00 BLK331HON_MAR01.pln
   43     675    50     50.00    18.00   OFF   NAR     ON    OFF       278.00 BLK331HON_MAR01.pln
   44     669    50     50.00    18.00   OFF   NAR     ON    OFF        98.00 BLK331HON_MAR01.pln
   42     669    50     50.00    18.00   OFF   NAR     ON    OFF        98.00 BLK331HON_MAR01.pln
   41     672    50     50.00    18.00   OFF   NAR     ON    OFF       278.00 BLK331HON_MAR01.pln
   40     669    50     50.00    18.00   OFF   NAR     ON    OFF        98.00 BLK331HON_MAR01.pln
   39     671    50     50.00    18.00   OFF   NAR     ON    OFF       278.00 BLK331HON_MAR01.pln
   38     670    50     50.00    18.00   OFF   NAR     ON    OFF        98.00 BLK331HON_MAR01.pln
   37     672    50     50.00    18.00   OFF   NAR     ON    OFF       278.00 BLK331HON_MAR01.pln
   37     671    50     50.00    18.00   OFF   NAR     ON    OFF       278.00 BLK331HON_MAR01.pln
   21     673    50     50.00    18.00   OFF   NAR     ON    OFF       290.00 BLK331HON_MAR01.pln
   22     672    50     50.00    18.00   OFF   NAR     ON    OFF       110.00 BLK331HON_MAR01.pln
   23     673    50     50.00    18.00   OFF   NAR     ON    OFF       290.00 BLK331HON_MAR01.pln
   24     670    50     50.00    18.00   OFF   NAR     ON    OFF       110.00 BLK331HON_MAR01.pln
   25     673    50     50.00    18.00   OFF   NAR     ON    OFF       290.00 BLK331HON_MAR01.pln
   26     662    50     50.00    18.00   OFF   NAR     ON    OFF       110.00 BLK331HON_MAR01.pln
   27     662    50     50.00    18.00   OFF   NAR     ON    OFF       290.00 BLK331HON_MAR01.pln
```

Figure A-7.1. Swath for Flight No. 7830AC

Flight No.:	7836AC
Area:	BLK 33Q
Mission Name:	3BLK33R235A





```
LINE#     ALT   PRF       FREQ    ANGLE     MP   DIV      RC    MPM          HDG      Plan File
==============================================================================================
    9     670    50      50.00    18.00    OFF   NAR      ON    OFF        98.00 BLK331NO MAR 04.pln
    8     565    50      50.00    18.00    OFF   NAR      ON    OFF       278.00 BLK331NO MAR 04.pln
    7     564    50      50.00    18.00    OFF   NAR      ON    OFF        98.00 BLK331NO MAR 04.pln
    6     570    50      50.00    18.00    OFF   NAR      ON    OFF       278.00 BLK331NO MAR 04.pln
    5     566    50      50.00    18.00    OFF   NAR      ON    OFF        98.00 BLK331NO MAR 04.pln
    4     567    50      50.00    18.00    OFF   NAR      ON    OFF       278.00 BLK331NO MAR 04.pln
    3     565    50      50.00    18.00    OFF   NAR      ON    OFF        98.00 BLK331NO MAR 04.pln
```

Figure A-7.2. Swath for Flight No. 7836AC

FLIGHT NO.: 8154
AREA: BLK N & O
MISSION NAME: 3BLK331NO222A
ALT: 500 m SCAN FREQ: 45 SCAN ANGLE: 20
SURVEYED AREA: 22.194 km²

Figure A-7.3. Swath for Flight No. 8154

FLIGHT NO.:	8156	
AREA:	BLK L & N	
MISSION NAME:	3BLK331LNS223A	
ALT: 500 m	SCAN FREQ: 45	SCAN ANGLE: 20
SURVEYED AREA:	81.745 km^2	

Figure A-7.4. Swath for Flight No. 8156

FLIGHT NO.:	8157	
AREA:	BLK 331N	
MISSION NAME:	3BLK331NS223B	
ALT: 500 m	SCAN FREQ: 45	SCAN ANGLE: 20
SURVEYED AREA:	63.5 km^2	

Figure A-7.5. Swath for Flight No. 8157

FLIGHT NO.:	8158	
AREA:	BLK 331P	
MISSION NAME:	3BLK331P224A	
ALT: 500 m	SCAN FREQ: 45	SCAN ANGLE: 20
SURVEYED AREA:	82.74 km^2	

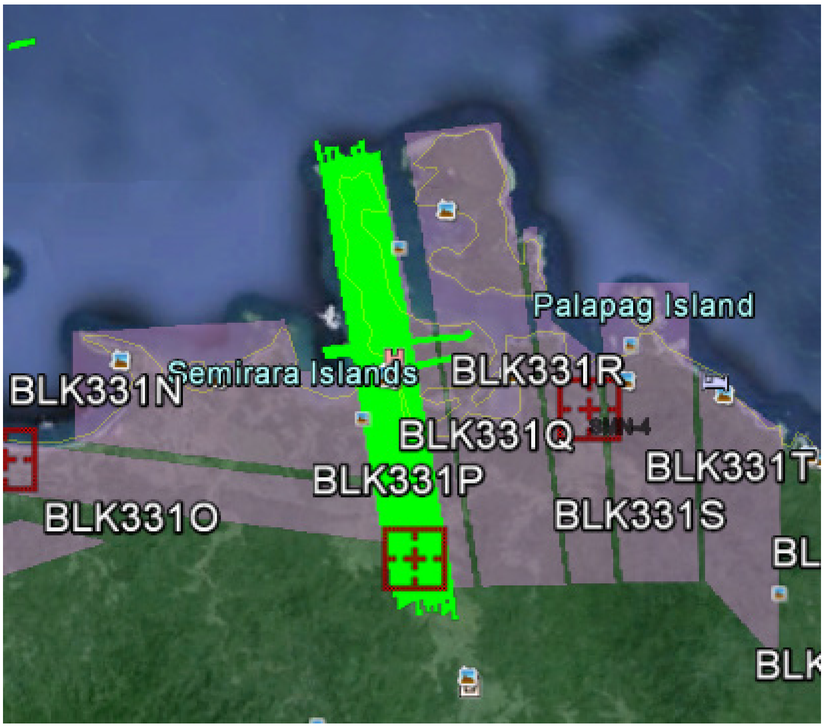


Figure A-7.6. Swath for Flight No. 8158

FLIGHT NO.: 8159
AREA: BLK N & P
MISSION NAME: 3BLK331NSPS224B
ALT: 500 m SCAN FREQ: 45 SCAN ANGLE: 20
SURVEYED AREA: 33.81 km^2

Figure A-7.7. Swath for Flight No. 8159

FLIGHT NO.: 8160
AREA: BLK PQRS
MISSION NAME: 3BLK331PQRS225A
ALT: 500 m SCAN FREQ: 45 SCAN ANGLE: 20
SURVEYED AREA: 40.40 km^2

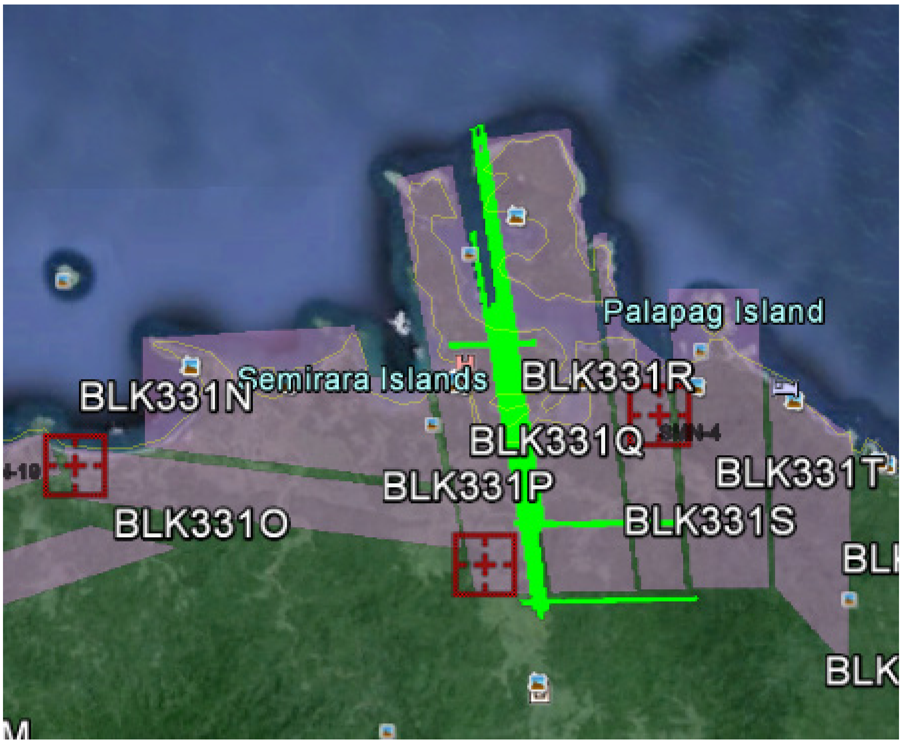
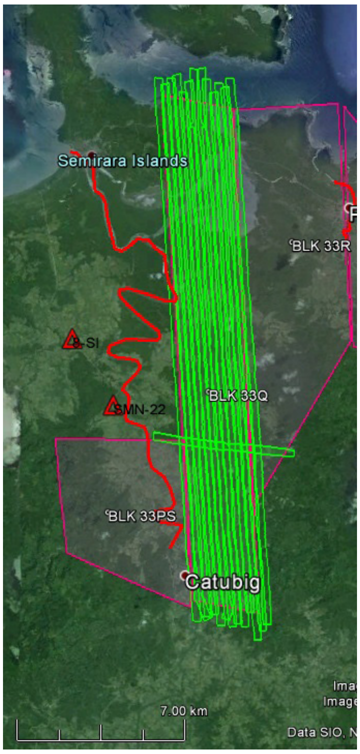
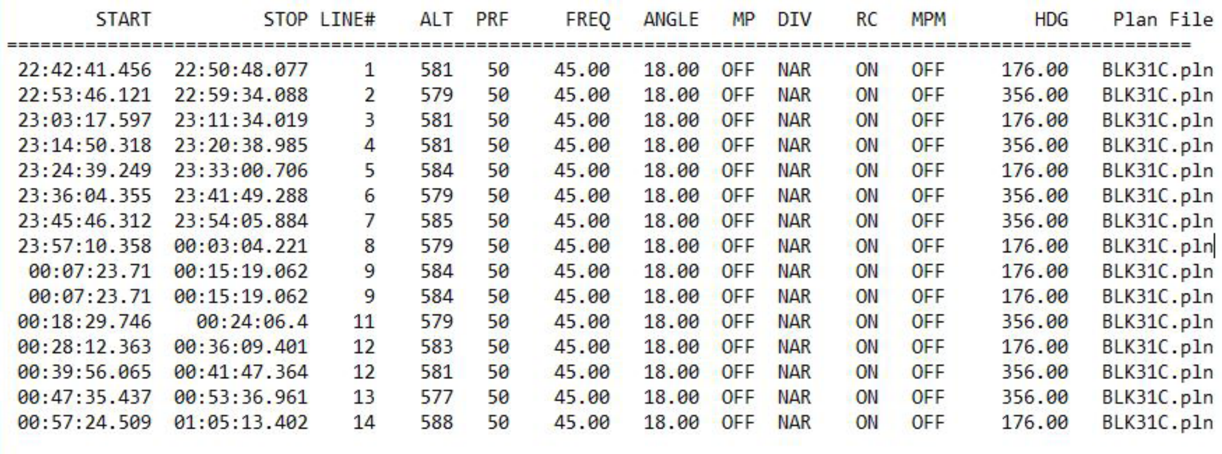


Figure A-7.8. Swath for Flight No. 8160

Flight No. : 8180AC
Area: BLK 33Q
Mission Name: 3BLK33R235A

SWATH



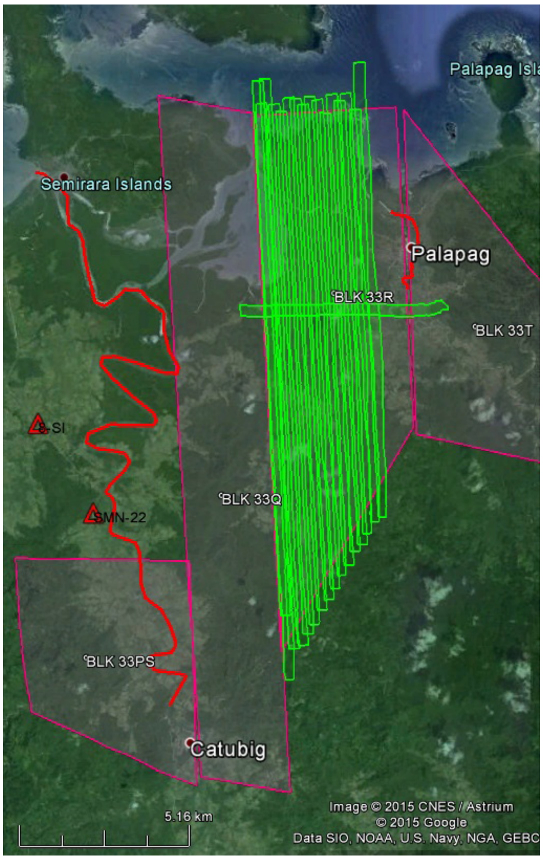


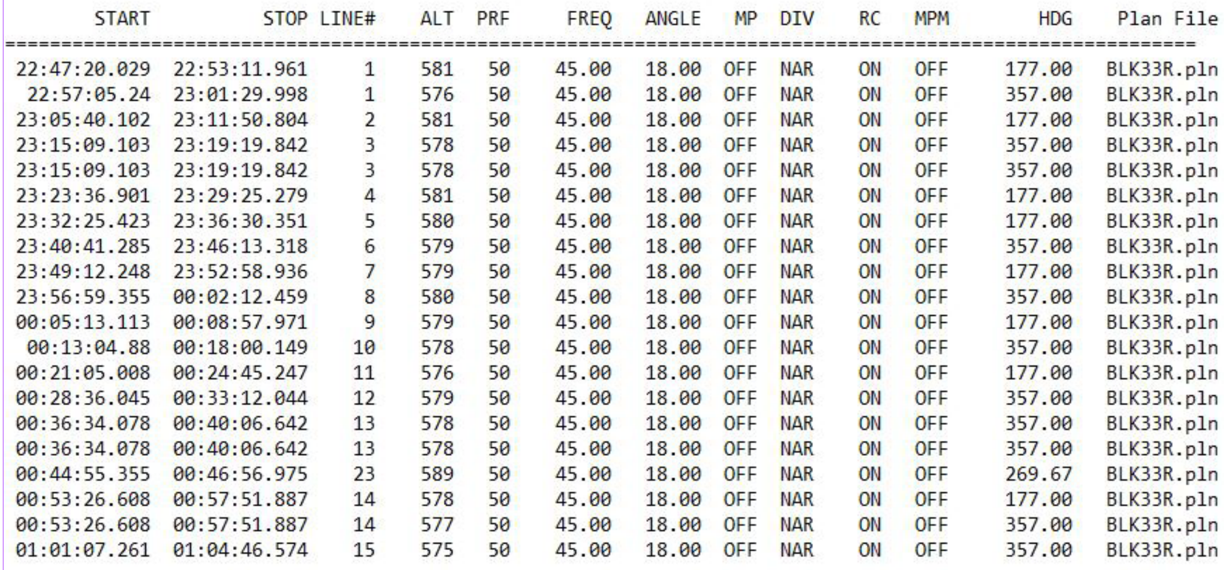
```
        START          STOP  LINE#    ALT   PRF     FREQ   ANGLE   MP  DIV     RC   MPM      HDG    Plan File
==========================================================================================================
 22:42:41.456  22:50:48.077     1     581   50    45.00   18.00  OFF  NAR     ON   OFF     176.00   BLK31C.pln
 22:53:46.121  22:59:34.088     2     579   50    45.00   18.00  OFF  NAR     ON   OFF     356.00   BLK31C.pln
 23:03:17.597  23:11:34.019     3     581   50    45.00   18.00  OFF  NAR     ON   OFF     176.00   BLK31C.pln
 23:14:50.318  23:20:38.985     4     581   50    45.00   18.00  OFF  NAR     ON   OFF     356.00   BLK31C.pln
 23:24:39.249  23:33:00.706     5     584   50    45.00   18.00  OFF  NAR     ON   OFF     176.00   BLK31C.pln
 23:36:04.355  23:41:49.288     6     579   50    45.00   18.00  OFF  NAR     ON   OFF     356.00   BLK31C.pln
 23:45:46.312  23:54:05.884     7     585   50    45.00   18.00  OFF  NAR     ON   OFF     356.00   BLK31C.pln
 23:57:10.358  00:03:04.221     8     579   50    45.00   18.00  OFF  NAR     ON   OFF     176.00   BLK31C.pln
  00:07:23.71  00:15:19.062     9     584   50    45.00   18.00  OFF  NAR     ON   OFF     176.00   BLK31C.pln
  00:07:23.71  00:15:19.062     9     584   50    45.00   18.00  OFF  NAR     ON   OFF     176.00   BLK31C.pln
 00:18:29.746    00:24:06.4    11     579   50    45.00   18.00  OFF  NAR     ON   OFF     356.00   BLK31C.pln
 00:28:12.363  00:36:09.401    12     583   50    45.00   18.00  OFF  NAR     ON   OFF     176.00   BLK31C.pln
 00:39:56.065  00:41:47.364    12     581   50    45.00   18.00  OFF  NAR     ON   OFF     356.00   BLK31C.pln
 00:47:35.437  00:53:36.961    13     577   50    45.00   18.00  OFF  NAR     ON   OFF     356.00   BLK31C.pln
 00:57:24.509  01:05:13.402    14     588   50    45.00   18.00  OFF  NAR     ON   OFF     176.00   BLK31C.pln
```

Figure A-7.9. Swath for Flight No. 8180AC

Flight No. :	8182AC
Area:	BLK 33R
Mission Name:	3BLK33R236A

SWATH



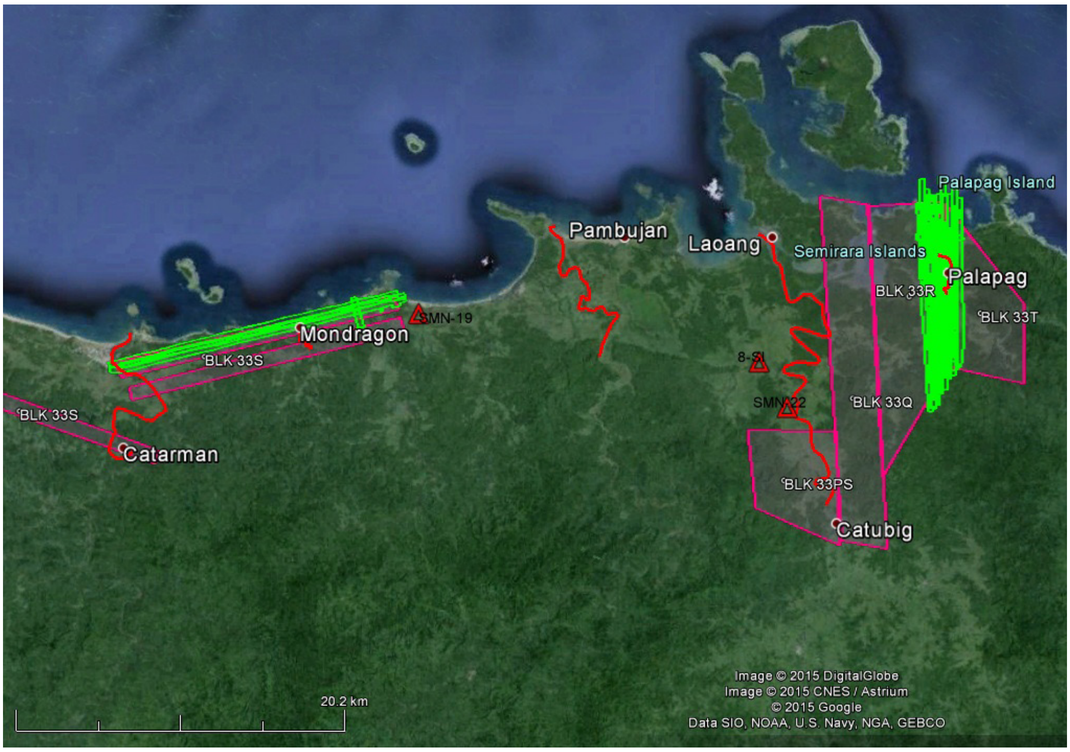


```
       START             STOP  LINE#   ALT  PRF     FREQ   ANGLE   MP  DIV    RC   MPM        HDG    Plan File
======================================================================================================
 22:47:20.029  22:53:11.961     1    581   50    45.00   18.00  OFF  NAR    ON   OFF     177.00   BLK33R.pln
  22:57:05.24  23:01:29.998     1    576   50    45.00   18.00  OFF  NAR    ON   OFF     357.00   BLK33R.pln
 23:05:40.102  23:11:50.804     2    581   50    45.00   18.00  OFF  NAR    ON   OFF     177.00   BLK33R.pln
 23:15:09.103  23:19:19.842     3    578   50    45.00   18.00  OFF  NAR    ON   OFF     357.00   BLK33R.pln
 23:15:09.103  23:19:19.842     3    578   50    45.00   18.00  OFF  NAR    ON   OFF     357.00   BLK33R.pln
 23:23:36.901  23:29:25.279     4    581   50    45.00   18.00  OFF  NAR    ON   OFF     177.00   BLK33R.pln
 23:32:25.423  23:36:30.351     5    580   50    45.00   18.00  OFF  NAR    ON   OFF     177.00   BLK33R.pln
 23:40:41.285  23:46:13.318     6    579   50    45.00   18.00  OFF  NAR    ON   OFF     357.00   BLK33R.pln
 23:49:12.248  23:52:58.936     7    579   50    45.00   18.00  OFF  NAR    ON   OFF     177.00   BLK33R.pln
 23:56:59.355  00:02:12.459     8    580   50    45.00   18.00  OFF  NAR    ON   OFF     357.00   BLK33R.pln
 00:05:13.113  00:08:57.971     9    579   50    45.00   18.00  OFF  NAR    ON   OFF     177.00   BLK33R.pln
  00:13:04.88  00:18:00.149    10    578   50    45.00   18.00  OFF  NAR    ON   OFF     357.00   BLK33R.pln
 00:21:05.008  00:24:45.247    11    576   50    45.00   18.00  OFF  NAR    ON   OFF     177.00   BLK33R.pln
 00:28:36.045  00:33:12.044    12    579   50    45.00   18.00  OFF  NAR    ON   OFF     357.00   BLK33R.pln
 00:36:34.078  00:40:06.642    13    578   50    45.00   18.00  OFF  NAR    ON   OFF     357.00   BLK33R.pln
 00:36:34.078  00:40:06.642    13    578   50    45.00   18.00  OFF  NAR    ON   OFF     357.00   BLK33R.pln
 00:44:55.355  00:46:56.975    23    589   50    45.00   18.00  OFF  NAR    ON   OFF     269.67   BLK33R.pln
 00:53:26.608  00:57:51.887    14    578   50    45.00   18.00  OFF  NAR    ON   OFF     177.00   BLK33R.pln
 00:53:26.608  00:57:51.887    14    577   50    45.00   18.00  OFF  NAR    ON   OFF     357.00   BLK33R.pln
 01:01:07.261  01:04:46.574    15    575   50    45.00   18.00  OFF  NAR    ON   OFF     357.00   BLK33R.pln
```

Figure A-7.10. Swath for Flight No. 8182AC

Flight No. : 8183AC
Area: BLK 33T
Mission Name: 3BLK33STV236B

SWATH

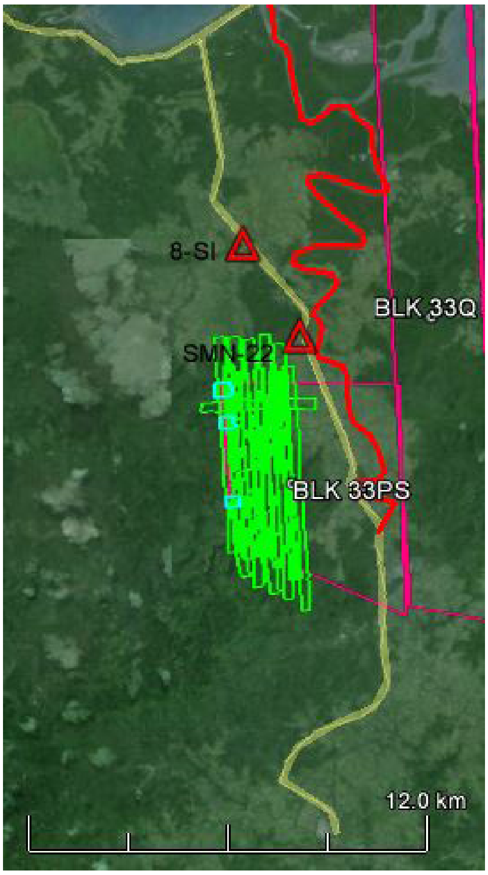


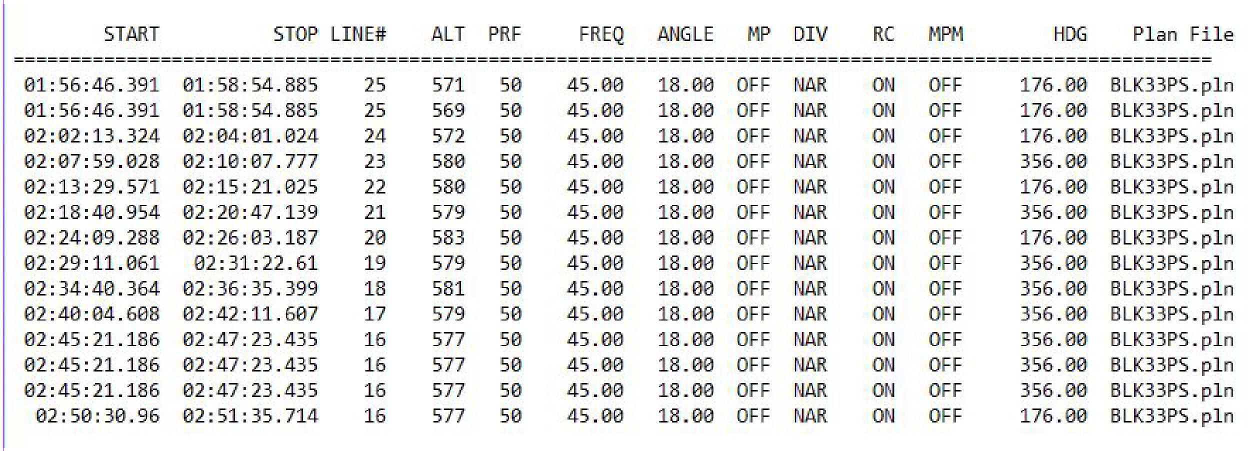
```
      START          STOP  LINE#    ALT  PRF     FREQ   ANGLE   MP  DIV    RC   MPM       HDG    Plan File
======================================================================================================
03:53:48.181  03:58:12.975    16    560   50    45.00   18.00  OFF  NAR    ON   OFF    177.00   BLK33R.pln
04:01:39.329  04:05:02.013    17    558   50    45.00   18.00  OFF  NAR    ON   OFF    357.00   BLK33R.pln
04:01:39.329  04:05:02.013    17    557   50    45.00   18.00  OFF  NAR    ON   OFF    357.00   BLK33R.pln
04:09:08.082  04:12:57.711    18    591   50    45.00   18.00  OFF  NAR    ON   OFF    177.00   BLK33R.pln
04:09:08.082  04:12:57.711    18    591   50    45.00   18.00  OFF  NAR    ON   OFF    177.00   BLK33R.pln
 04:16:42.75  04:19:51.434    19    544   50    45.00   18.00  OFF  NAR    ON   OFF    357.00   BLK33R.pln
 04:16:42.75  04:19:51.434    19    542   50    45.00   18.00  OFF  NAR    ON   OFF    357.00   BLK33R.pln
04:23:06.503  04:27:16.157    20    555   50    45.00   18.00  OFF  NAR    ON   OFF    177.00   BLK33R.pln
04:31:20.786   04:34:07.75     2    581   50    45.00   18.00  OFF  NAR    ON   OFF    358.00   BLK33S.pln
04:31:20.786   04:34:07.75     2    581   50    45.00   18.00  OFF  NAR    ON   OFF    358.00   BLK33S.pln
04:40:08.824  04:43:50.508    21    605   50    45.00   18.00  OFF  NAR    ON   OFF    180.00   BLK33S.pln
04:40:08.824  04:43:50.508    21    605   50    45.00   18.00  OFF  NAR    ON   OFF    180.00   BLK33S.pln
04:47:07.017  04:49:59.611    19    564   50    45.00   18.00  OFF  NAR    ON   OFF    360.00   BLK33S.pln
04:47:07.017  04:49:59.611    19    564   50    45.00   18.00  OFF  NAR    ON   OFF    360.00   BLK33S.pln
 04:56:12.09   04:57:10.23    19    564   50    45.00   18.00  OFF  NAR    ON   OFF    360.00   BLK33S.pln
 04:56:12.09   04:57:10.23    19    564   50    45.00   18.00  OFF  NAR    ON   OFF    360.00   BLK33S.pln
05:07:35.227  05:13:59.616     2    544   50    45.00   18.00  OFF  NAR    ON   OFF    256.00    voids.pln
 05:17:27.09  05:22:29.163     3    542   50    45.00   18.00  OFF  NAR    ON   OFF     76.00    voids.pln
05:26:34.092  05:27:21.617     2    605   50    45.00   18.00  OFF  NAR    ON   OFF     76.00    voids.pln
05:31:07.091  05:37:37.304     4    529   50    45.00   18.00  OFF  NAR    ON   OFF    256.00    voids.pln
05:31:07.091  05:37:37.304     4    529   50    45.00   18.00  OFF  NAR    ON   OFF    256.00    voids.pln
```

Figure A-7.11. Swath for Flight No. 8183AC

Flight No. :	8184AC
Area:	BLK 33PS
Mission Name:	3BLK33PS237A

SWATH





```
        START          STOP  LINE#    ALT   PRF      FREQ   ANGLE   MP   DIV     RC    MPM          HDG    Plan File
====================================================================================================================
 01:56:46.391  01:58:54.885     25    571    50     45.00   18.00  OFF   NAR     ON    OFF       176.00  BLK33PS.pln
 01:56:46.391  01:58:54.885     25    569    50     45.00   18.00  OFF   NAR     ON    OFF       176.00  BLK33PS.pln
 02:02:13.324  02:04:01.024     24    572    50     45.00   18.00  OFF   NAR     ON    OFF       176.00  BLK33PS.pln
 02:07:59.028  02:10:07.777     23    580    50     45.00   18.00  OFF   NAR     ON    OFF       356.00  BLK33PS.pln
 02:13:29.571  02:15:21.025     22    580    50     45.00   18.00  OFF   NAR     ON    OFF       176.00  BLK33PS.pln
 02:18:40.954  02:20:47.139     21    579    50     45.00   18.00  OFF   NAR     ON    OFF       356.00  BLK33PS.pln
 02:24:09.288  02:26:03.187     20    583    50     45.00   18.00  OFF   NAR     ON    OFF       176.00  BLK33PS.pln
 02:29:11.061   02:31:22.61     19    579    50     45.00   18.00  OFF   NAR     ON    OFF       356.00  BLK33PS.pln
 02:34:40.364  02:36:35.399     18    581    50     45.00   18.00  OFF   NAR     ON    OFF       356.00  BLK33PS.pln
 02:40:04.608  02:42:11.607     17    579    50     45.00   18.00  OFF   NAR     ON    OFF       356.00  BLK33PS.pln
 02:45:21.186  02:47:23.435     16    577    50     45.00   18.00  OFF   NAR     ON    OFF       356.00  BLK33PS.pln
 02:45:21.186  02:47:23.435     16    577    50     45.00   18.00  OFF   NAR     ON    OFF       356.00  BLK33PS.pln
 02:45:21.186  02:47:23.435     16    577    50     45.00   18.00  OFF   NAR     ON    OFF       356.00  BLK33PS.pln
  02:50:30.96  02:51:35.714     16    577    50     45.00   18.00  OFF   NAR     ON    OFF       176.00  BLK33PS.pln
```

Figure A-7.12. Swath for Flight No. 8184AC

Flight No. :	8186AC
Area:	BLK 33PS AND TS
Mission Name:	3BLK33SPSTS238A

SWATH

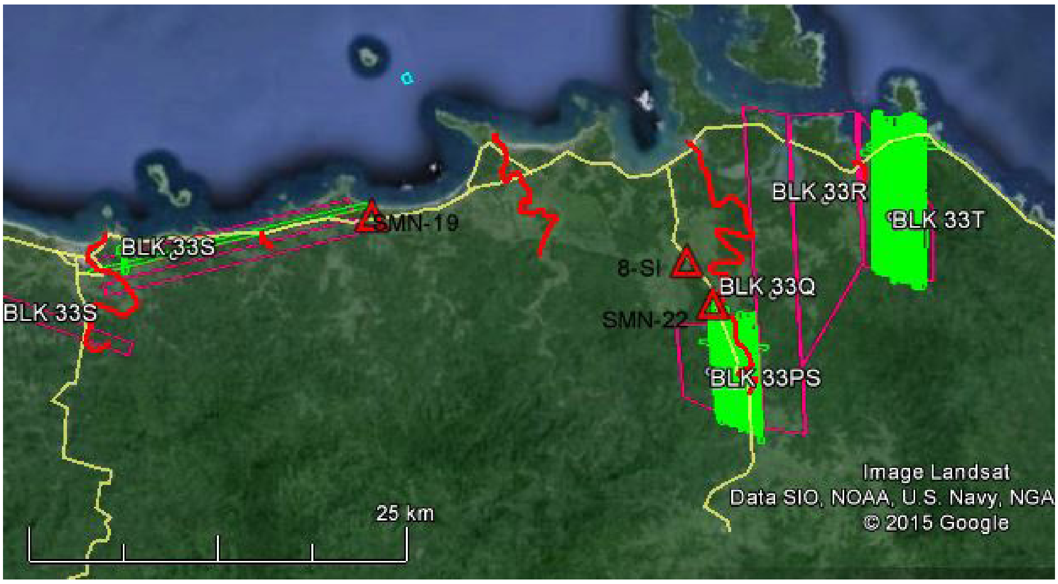
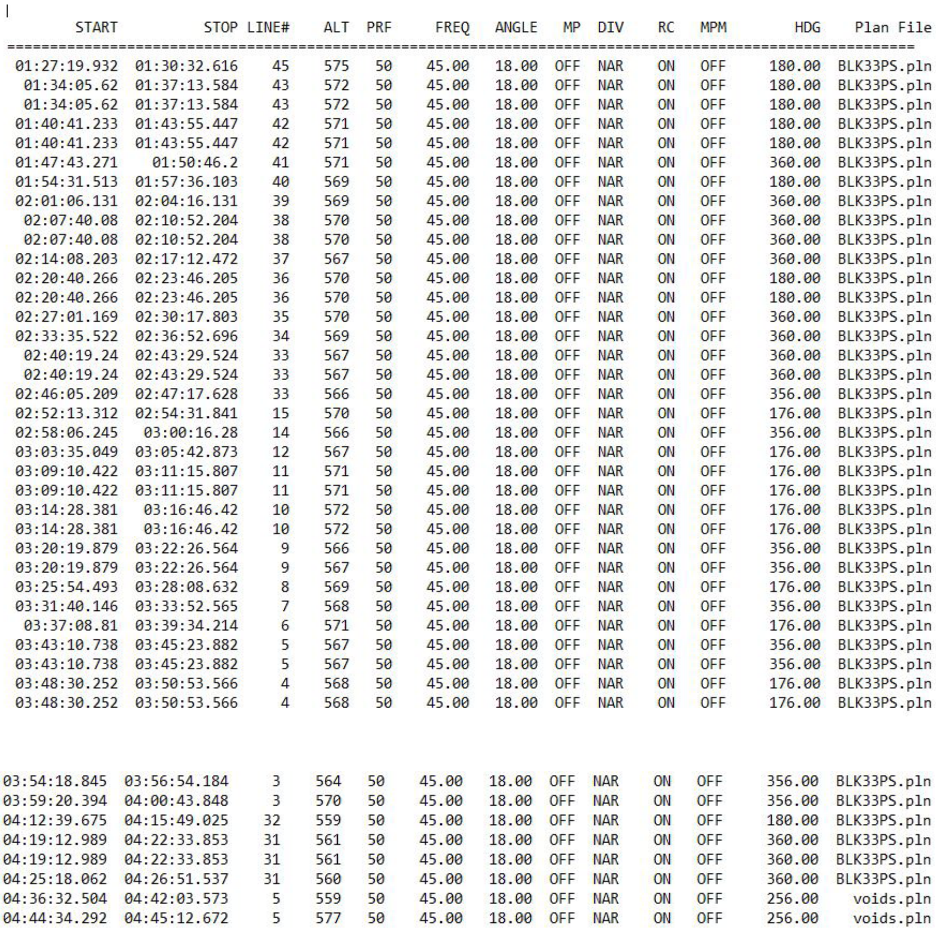


Figure A-7.13. Swath for Flight No. 8186AC



```
|
         START          STOP  LINE#    ALT   PRF      FREQ    ANGLE   MP  DIV     RC    MPM         HDG    Plan File
==========================================================================================================
  01:27:19.932  01:30:32.616     45    575    50     45.00    18.00  OFF  NAR     ON    OFF      180.00  BLK33PS.pln
   01:34:05.62  01:37:13.584     43    572    50     45.00    18.00  OFF  NAR     ON    OFF      180.00  BLK33PS.pln
   01:34:05.62  01:37:13.584     43    572    50     45.00    18.00  OFF  NAR     ON    OFF      180.00  BLK33PS.pln
  01:40:41.233  01:43:55.447     42    571    50     45.00    18.00  OFF  NAR     ON    OFF      180.00  BLK33PS.pln
  01:40:41.233  01:43:55.447     42    571    50     45.00    18.00  OFF  NAR     ON    OFF      180.00  BLK33PS.pln
  01:47:43.271    01:50:46.2     41    571    50     45.00    18.00  OFF  NAR     ON    OFF      360.00  BLK33PS.pln
  01:54:31.513  01:57:36.103     40    569    50     45.00    18.00  OFF  NAR     ON    OFF      180.00  BLK33PS.pln
  02:01:06.131  02:04:16.131     39    569    50     45.00    18.00  OFF  NAR     ON    OFF      360.00  BLK33PS.pln
   02:07:40.08  02:10:52.204     38    570    50     45.00    18.00  OFF  NAR     ON    OFF      360.00  BLK33PS.pln
   02:07:40.08  02:10:52.204     38    570    50     45.00    18.00  OFF  NAR     ON    OFF      360.00  BLK33PS.pln
  02:14:08.203  02:17:12.472     37    567    50     45.00    18.00  OFF  NAR     ON    OFF      360.00  BLK33PS.pln
  02:20:40.266  02:23:46.205     36    570    50     45.00    18.00  OFF  NAR     ON    OFF      180.00  BLK33PS.pln
  02:20:40.266  02:23:46.205     36    570    50     45.00    18.00  OFF  NAR     ON    OFF      180.00  BLK33PS.pln
  02:27:01.169  02:30:17.803     35    570    50     45.00    18.00  OFF  NAR     ON    OFF      360.00  BLK33PS.pln
  02:33:35.522  02:36:52.696     34    569    50     45.00    18.00  OFF  NAR     ON    OFF      360.00  BLK33PS.pln
   02:40:19.24  02:43:29.524     33    567    50     45.00    18.00  OFF  NAR     ON    OFF      360.00  BLK33PS.pln
   02:40:19.24  02:43:29.524     33    567    50     45.00    18.00  OFF  NAR     ON    OFF      360.00  BLK33PS.pln
  02:46:05.209  02:47:17.628     33    566    50     45.00    18.00  OFF  NAR     ON    OFF      356.00  BLK33PS.pln
  02:52:13.312  02:54:31.841     15    570    50     45.00    18.00  OFF  NAR     ON    OFF      176.00  BLK33PS.pln
  02:58:06.245   03:00:16.28     14    566    50     45.00    18.00  OFF  NAR     ON    OFF      356.00  BLK33PS.pln
  03:03:35.049  03:05:42.873     12    567    50     45.00    18.00  OFF  NAR     ON    OFF      176.00  BLK33PS.pln
  03:09:10.422  03:11:15.807     11    571    50     45.00    18.00  OFF  NAR     ON    OFF      176.00  BLK33PS.pln
  03:09:10.422  03:11:15.807     11    571    50     45.00    18.00  OFF  NAR     ON    OFF      176.00  BLK33PS.pln
  03:14:28.381   03:16:46.42     10    572    50     45.00    18.00  OFF  NAR     ON    OFF      176.00  BLK33PS.pln
  03:14:28.381   03:16:46.42     10    572    50     45.00    18.00  OFF  NAR     ON    OFF      176.00  BLK33PS.pln
  03:20:19.879  03:22:26.564      9    566    50     45.00    18.00  OFF  NAR     ON    OFF      356.00  BLK33PS.pln
  03:20:19.879  03:22:26.564      9    567    50     45.00    18.00  OFF  NAR     ON    OFF      356.00  BLK33PS.pln
  03:25:54.493  03:28:08.632      8    569    50     45.00    18.00  OFF  NAR     ON    OFF      176.00  BLK33PS.pln
  03:31:40.146  03:33:52.565      7    568    50     45.00    18.00  OFF  NAR     ON    OFF      356.00  BLK33PS.pln
   03:37:08.81  03:39:34.214      6    571    50     45.00    18.00  OFF  NAR     ON    OFF      176.00  BLK33PS.pln
  03:43:10.738  03:45:23.882      5    567    50     45.00    18.00  OFF  NAR     ON    OFF      356.00  BLK33PS.pln
  03:43:10.738  03:45:23.882      5    567    50     45.00    18.00  OFF  NAR     ON    OFF      356.00  BLK33PS.pln
  03:48:30.252  03:50:53.566      4    568    50     45.00    18.00  OFF  NAR     ON    OFF      176.00  BLK33PS.pln
  03:48:30.252  03:50:53.566      4    568    50     45.00    18.00  OFF  NAR     ON    OFF      176.00  BLK33PS.pln



03:54:18.845  03:56:54.184      3    564    50     45.00    18.00  OFF  NAR     ON    OFF      356.00  BLK33PS.pln
03:59:20.394  04:00:43.848      3    570    50     45.00    18.00  OFF  NAR     ON    OFF      356.00  BLK33PS.pln
04:12:39.675  04:15:49.025     32    559    50     45.00    18.00  OFF  NAR     ON    OFF      180.00  BLK33PS.pln
04:19:12.989  04:22:33.853     31    561    50     45.00    18.00  OFF  NAR     ON    OFF      360.00  BLK33PS.pln
04:19:12.989  04:22:33.853     31    561    50     45.00    18.00  OFF  NAR     ON    OFF      360.00  BLK33PS.pln
04:25:18.062  04:26:51.537     31    560    50     45.00    18.00  OFF  NAR     ON    OFF      360.00  BLK33PS.pln
04:36:32.504  04:42:03.573      5    559    50     45.00    18.00  OFF  NAR     ON    OFF      256.00    voids.pln
04:44:34.292  04:45:12.672      5    577    50     45.00    18.00  OFF  NAR     ON    OFF      256.00    voids.pln
```

FLIGHT NO.:	3913G
AREA:	BLK333L and K 139.98 km2
MISSION NAME:	2BLK33LK099A

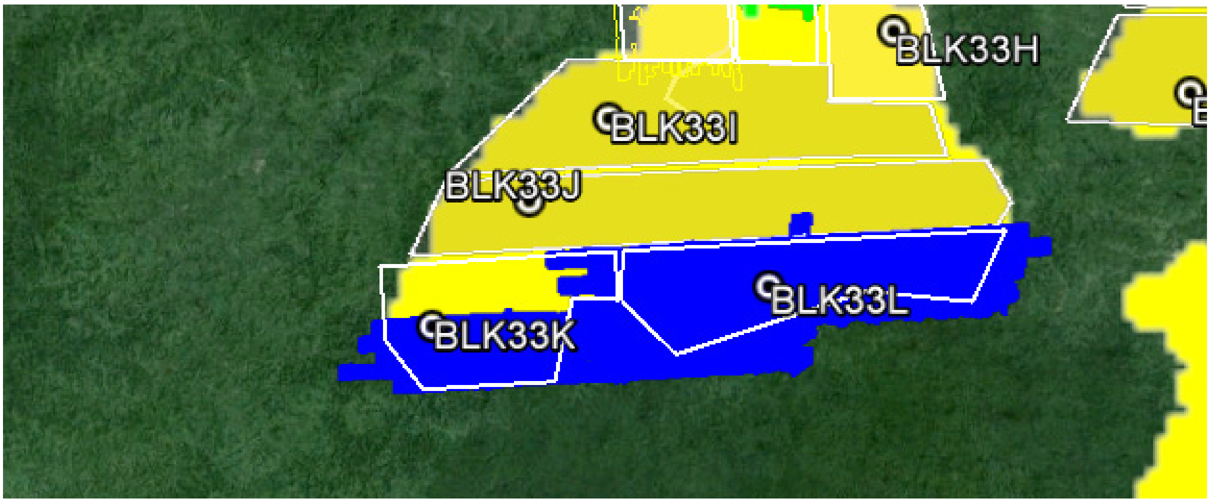


Figure A-7.14. Swath for Flight No. 3913G

FLIGHT NO.:	3917G	
AREA:	BLK33E, G	
MISSION NAME:	2BLK33EG100A	
ALT: 850m then 750m	SCAN FREQ: 40	SCAN ANGLE: 25
SURVEYED AREA:	119.023 km2	

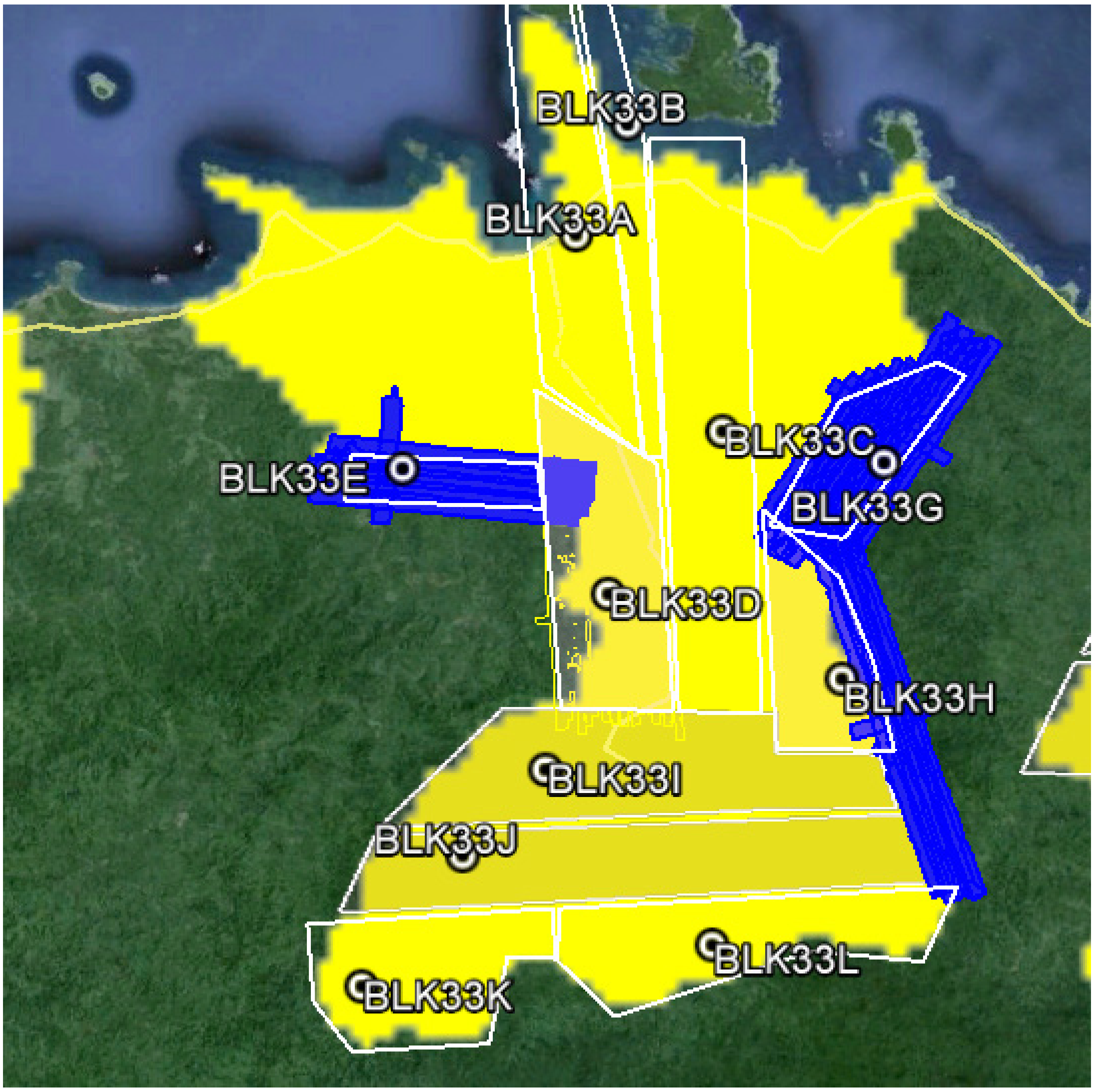


Figure A-7.15. Swath for Flight No. 3917G

FLIGHT NO.:	8427AC
AREA:	BLK33B, C
	101.68 km2
MISSION NAME:	3BLK33BC100A

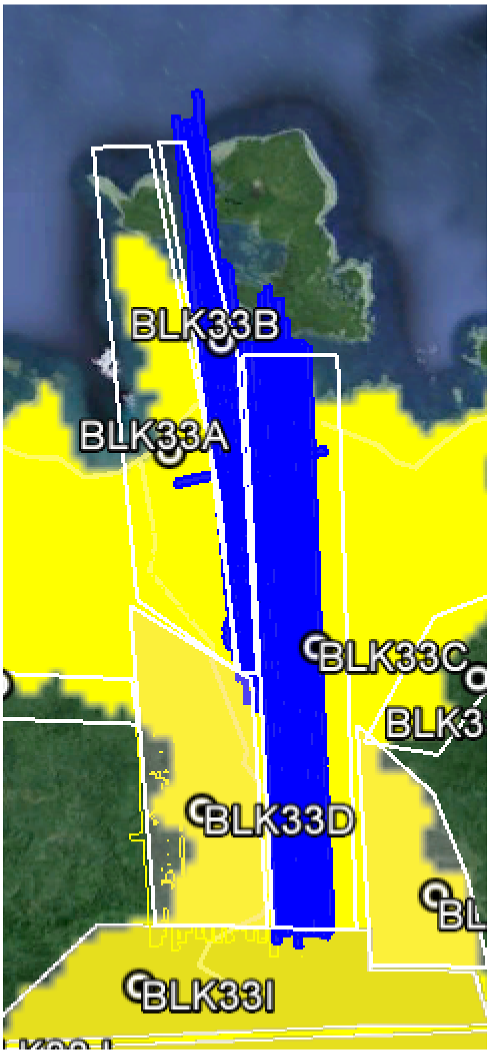


Figure A-7.16. Swath for Flight No. 8427AC

FLIGHT NO.:	8428AC
AREA:	BLK33C
	31.55 km2
MISSION NAME:	3BLK33CS100B

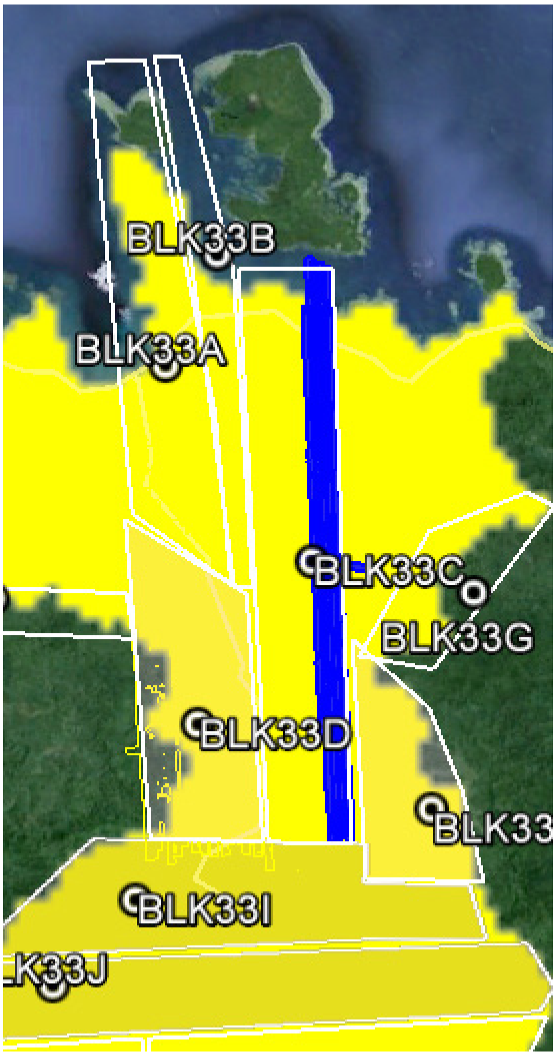


Figure A-7.17. Swath for Flight No. 8428AC

FLIGHT NO.: 8431AC
AREA: BLK33D
83.84 km2
MISSION NAME: 3BLK33D102A

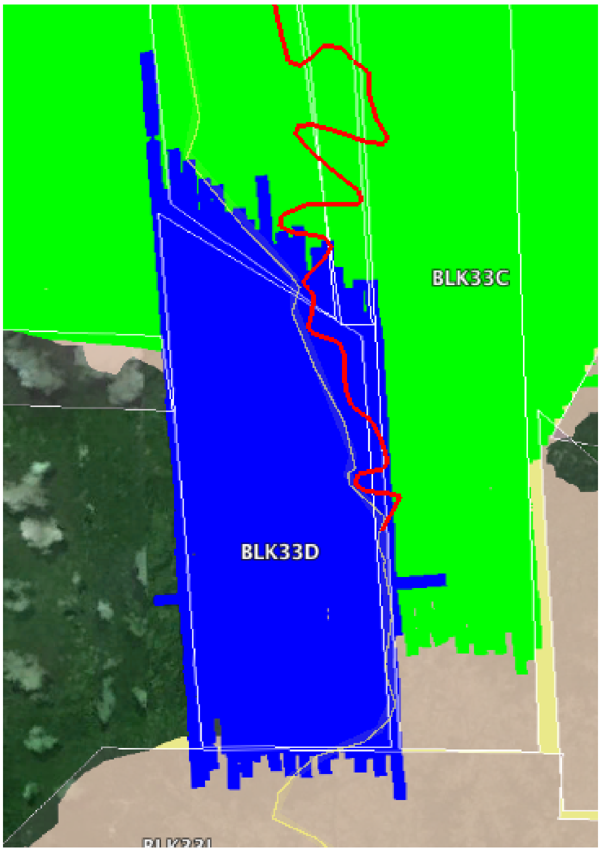


Figure A-7.18. Swath for Flight No. 8431AC

FLIGHT NO.:	8433AC
AREA:	BLK33J, K 125.73 km2
MISSION NAME:	3BLK33KSJ103A

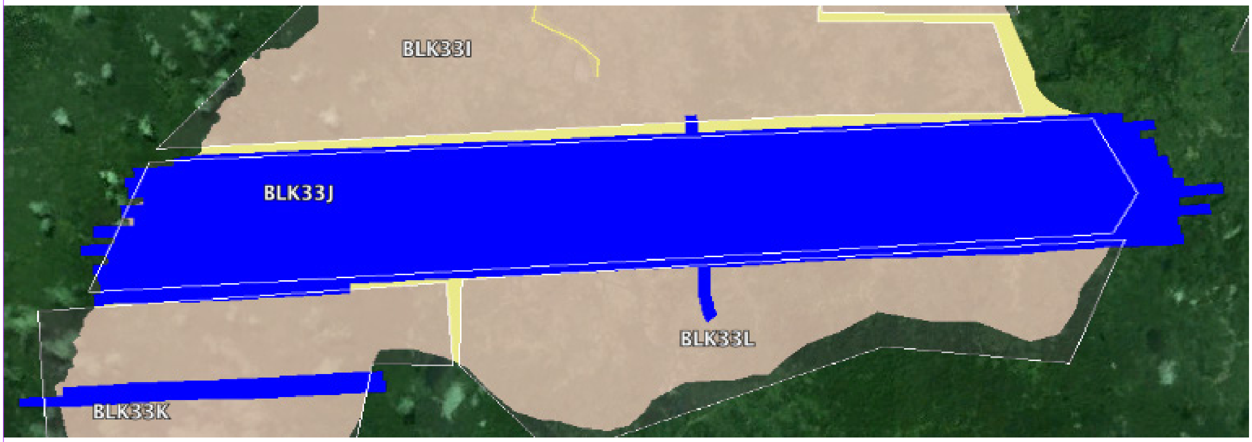


Figure A-7.19. Swath for Flight No. 8433AC

FLIGHT NO.:	8435AC
AREA:	BLK33I, K
	85.49 km2
MISSION NAME:	3BLK33IK104A

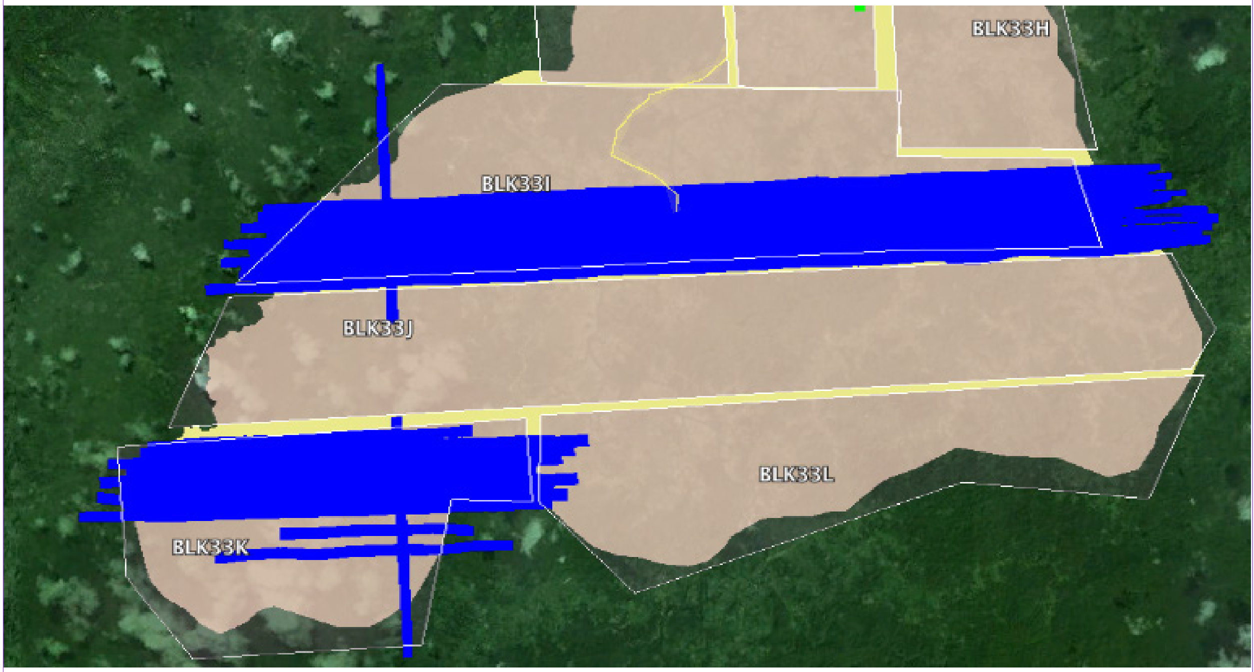


Figure A-7.20. Swath for Flight No. 8435AC

FLIGHT NO.:	8437AC
AREA:	BLK33A, I
	106.03 km2
MISSION NAME:	3BLK33ISA105A

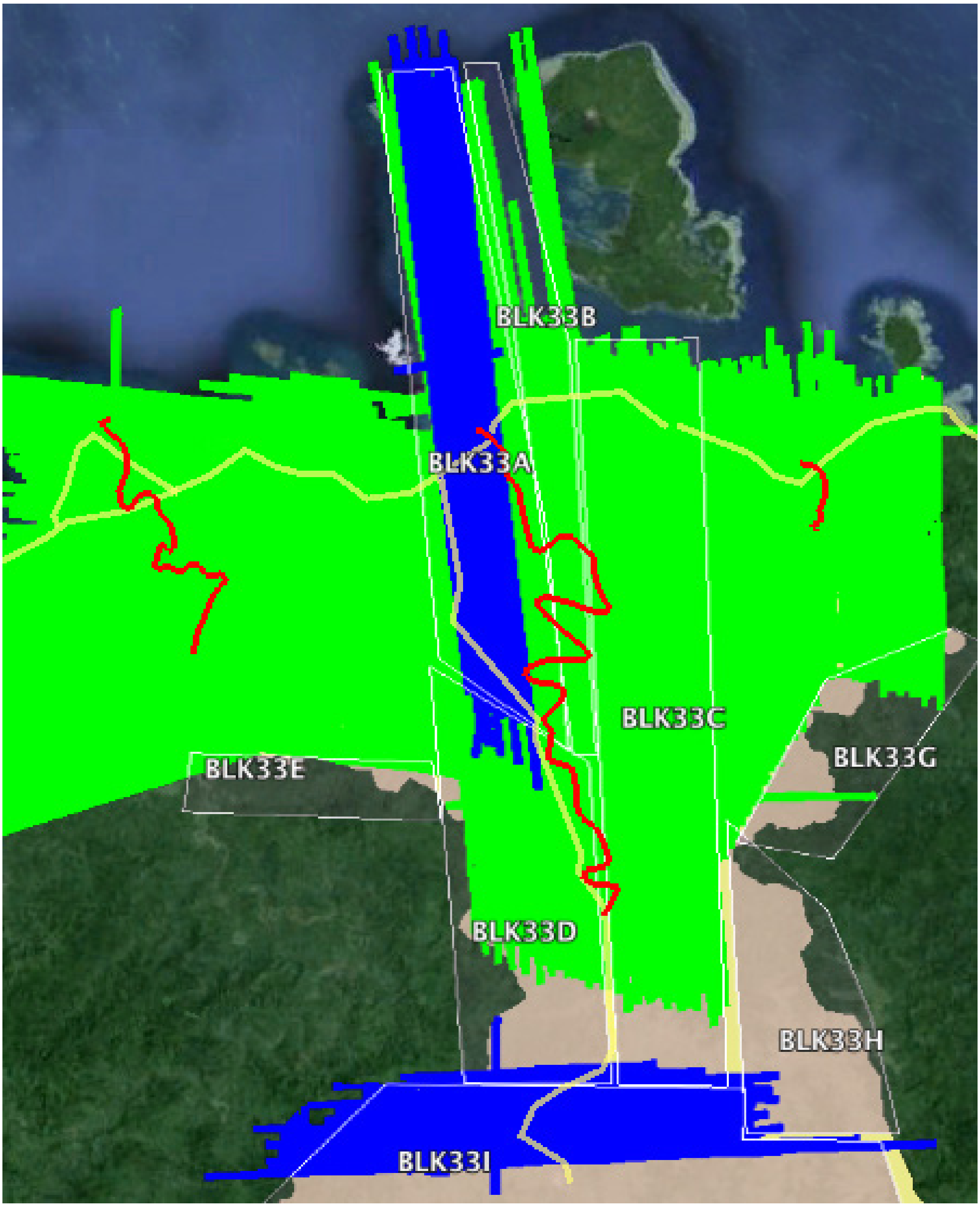


Figure A-7.21. Swath for Flight No. 8437AC

FLIGHT NO.:	8438AC
AREA:	BLK33A
	19.12 km2
MISSION NAME:	3BLK33AS105B

Figure A-7.22. Swath for Flight No. 8438AC

FLIGHT NO.:	8441AC
AREA:	BLK33N
	88.49 km2
MISSION NAME:	3BLK33N107A

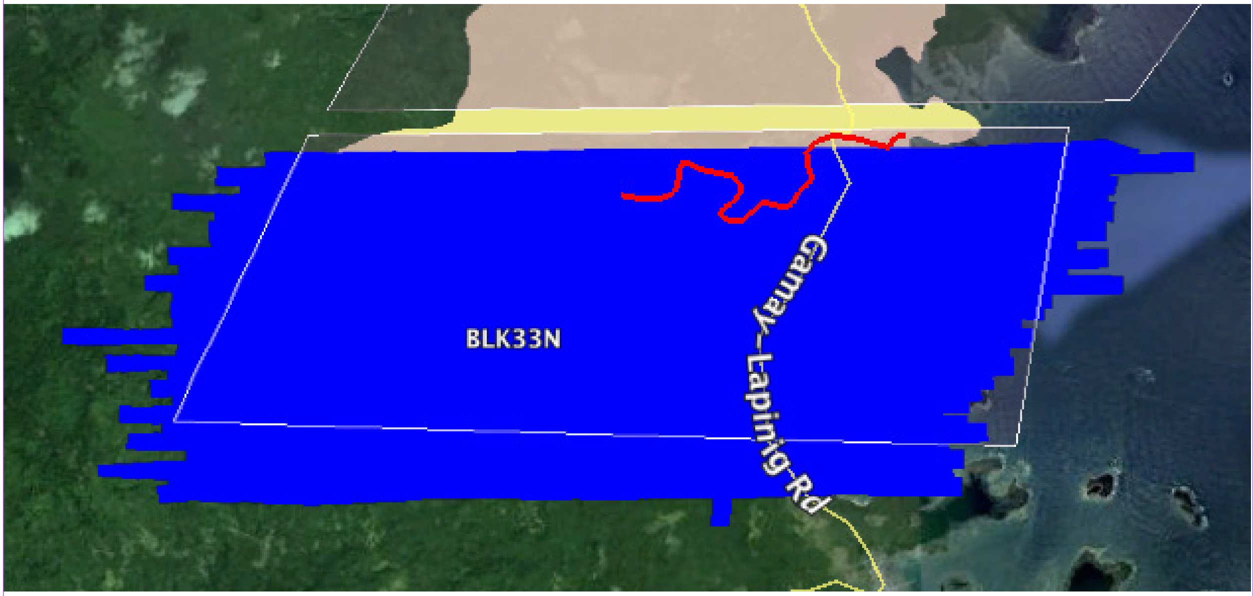


Figure A-7.23. Swath for Flight No. 8441AC

FLIGHT NO.:	8442AC
AREA:	BLK33M, N
	32.55 km2
MISSION NAME:	3BLK33MNS107B

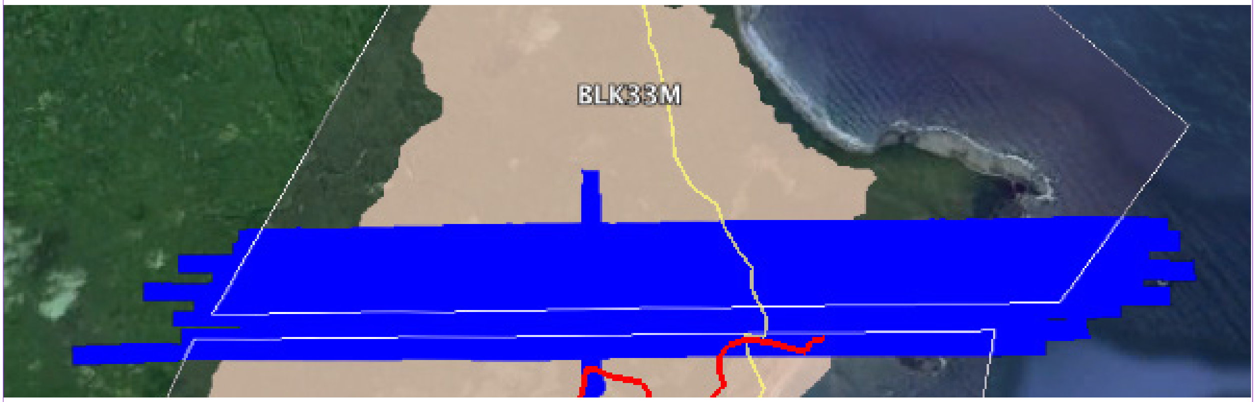


Figure A-7.24. Swath for Flight No. 8442AC

FLIGHT NO.:	8443AC
AREA:	BLK33M
	66.83 km2
MISSION NAME:	3BLK33MS108A

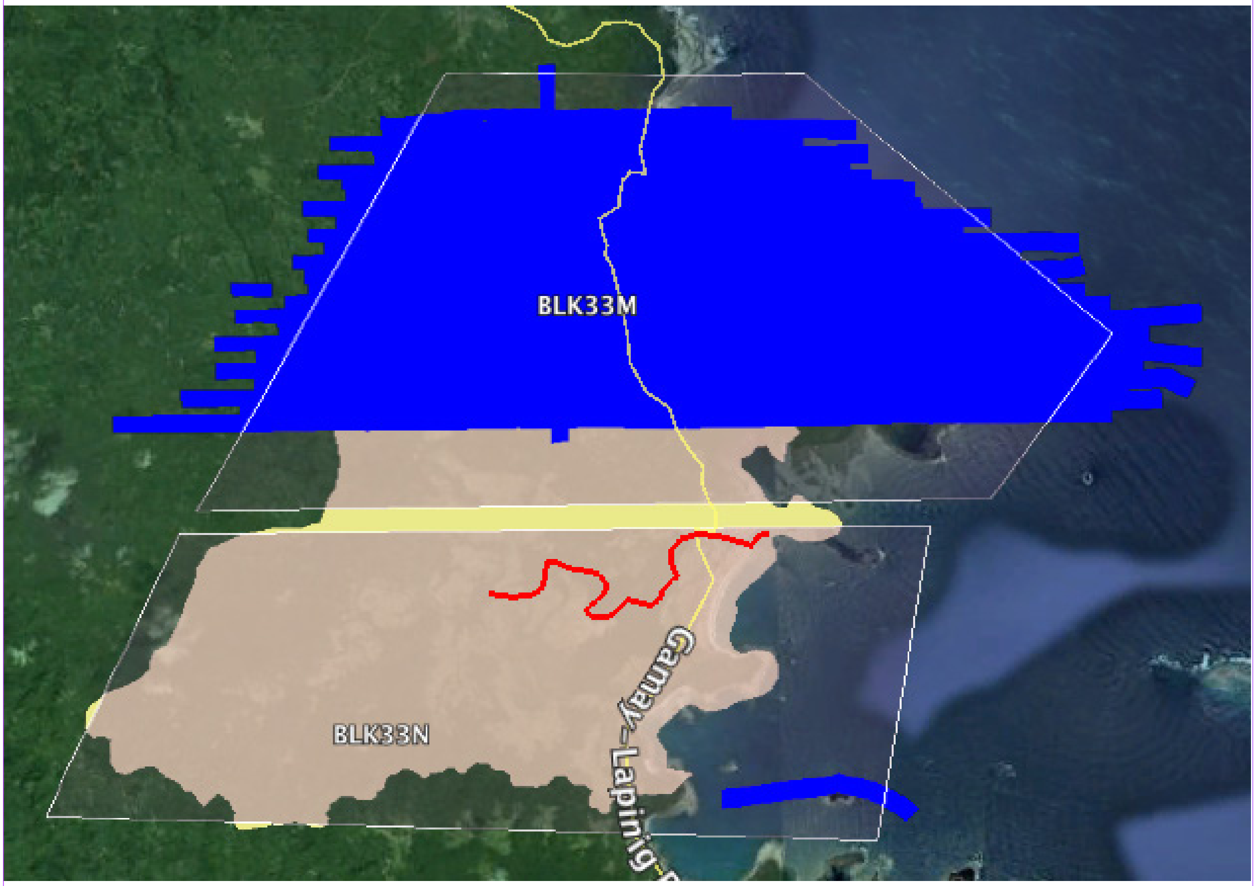


Figure A-7.25. Swath for Flight No. 8443AC

FLIGHT NO.: 8444AC
AREA: BLK33B,D
36.67 km2
MISSION NAME: 3BLK33BSDS108B

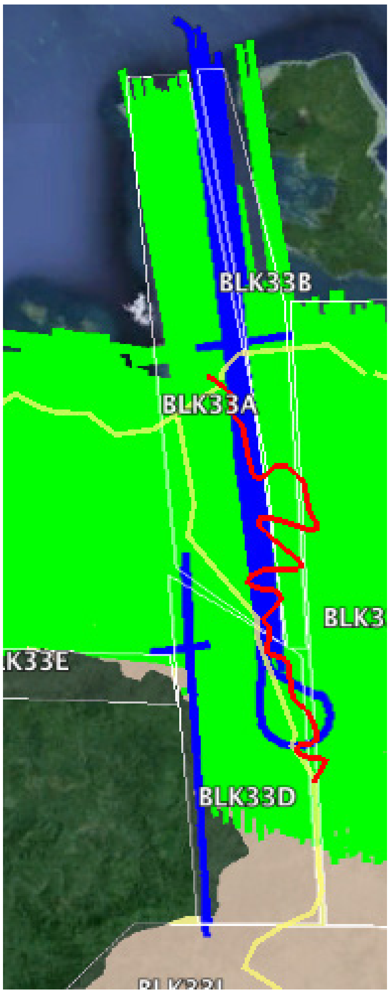


Figure A-7.26. Swath for Flight No. 8444AC

FLIGHT NO.:	8446AC
AREA:	BLK33J, K
	32.69 km2
MISSION NAME:	3BLK33JVKV109B

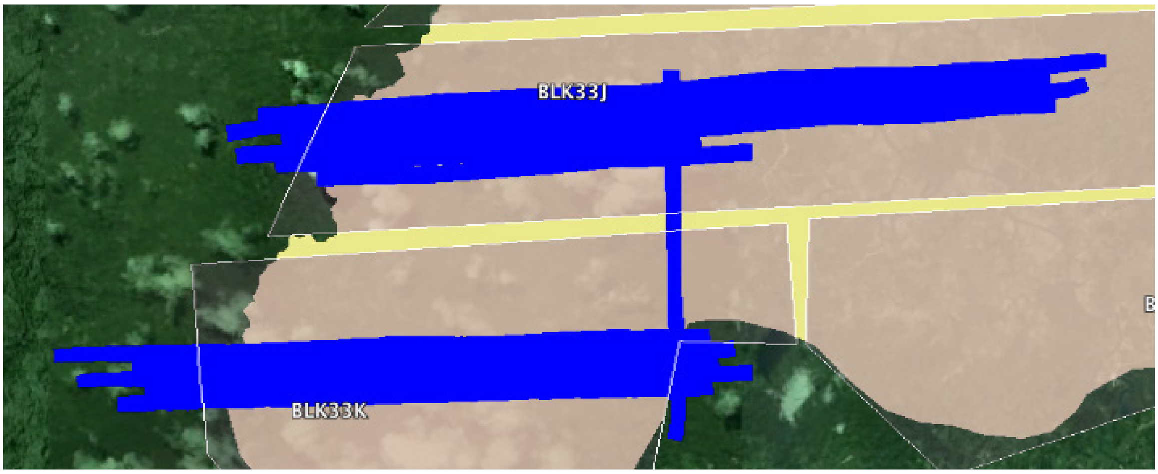


Figure A-7.27. Swath for Flight No. 8446AC

FLIGHT NO.:	8447AC
AREA:	BLK33I, J
	51.68 km2
MISSION NAME:	3BLK33IVJV110A

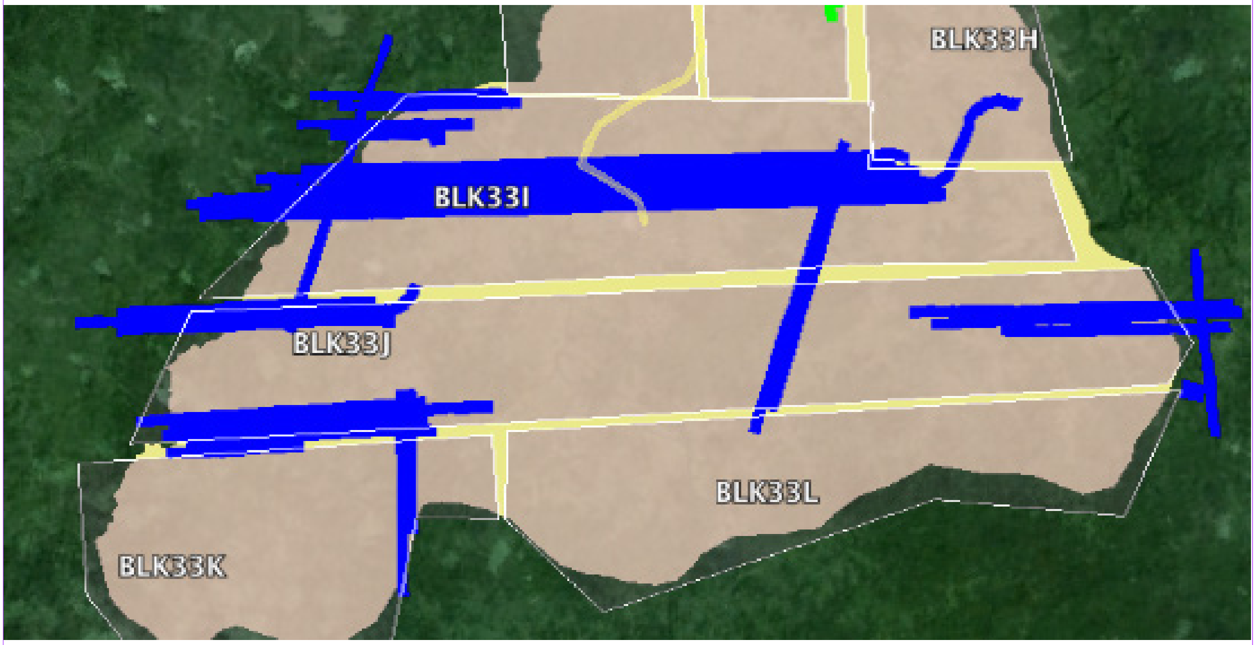


Figure A-7.28. Swath for Flight No. 8447AC

FLIGHT NO.: 8448AC
AREA: BLK33C, D,H
23.92 km2
MISSION NAME: 3BLK33CVDVHV110B

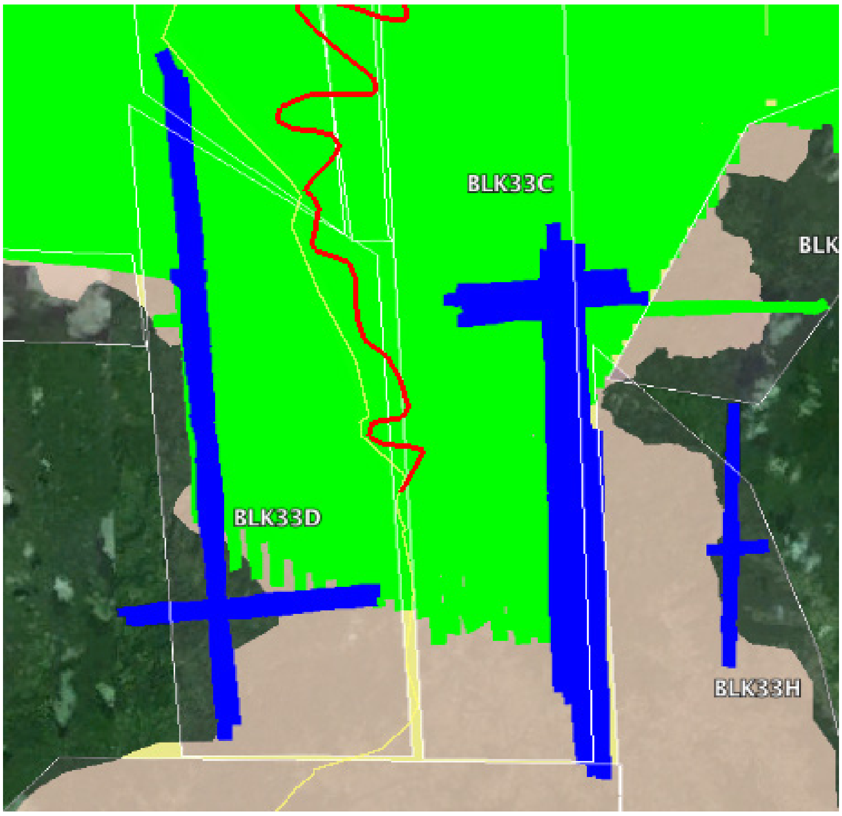


Figure A-7.29. Swath for Flight No. 8448AC

Annex 8. Mission Summary Reports

Table A-8.1. Mission Report for Mission Blk33R

Flight Area	Catarman
Mission Name	**Blk33R**
Inclusive Flights	8182AC
Range data size	9.06 GB
Base data size	12.5 MB
POS	213 MB
Image	N/A
Transfer date	September 16, 2015
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)	8.5
RMSE for East Position (<4.0 cm)	8.5
RMSE for Down Position (<8.0 cm)	1.75
Boresight correction stdev (<0.001deg)	0.001617
IMU attitude correction stdev (<0.001deg)	0.004697
GPS position stdev (<0.01m)	0.0147
Minimum % overlap (>25)	43.00
Ave point cloud density per sq.m. (>2.0)	2.17
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	80
Maximum Height	259.61 m
Minimum Height	46.93 m
Classification (# of points)	
Ground	27,458,375
Low vegetation	17,523,866
Medium vegetation	31,096,821
High vegetation	26,149,486
Building	311,790
Orthophoto	No
Processed by	Engr. Analyn Naldo, Engr. Christy Lubiano, Jovy Narisma

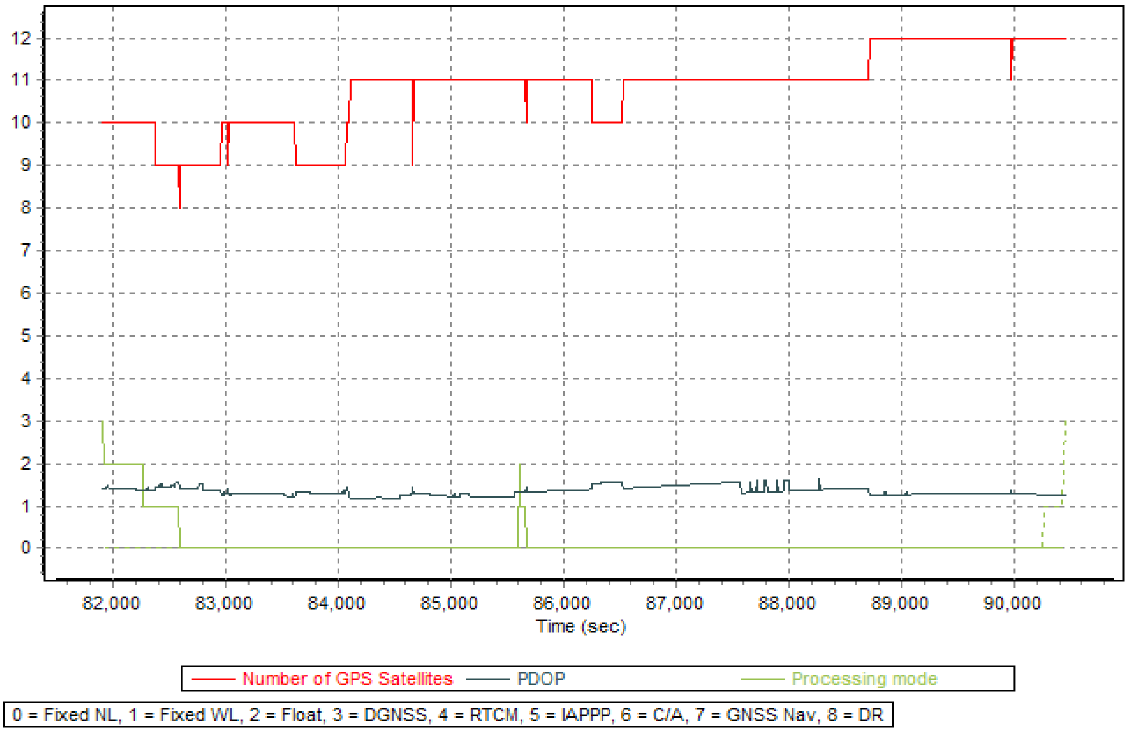


Figure A-8.1. Solution Status

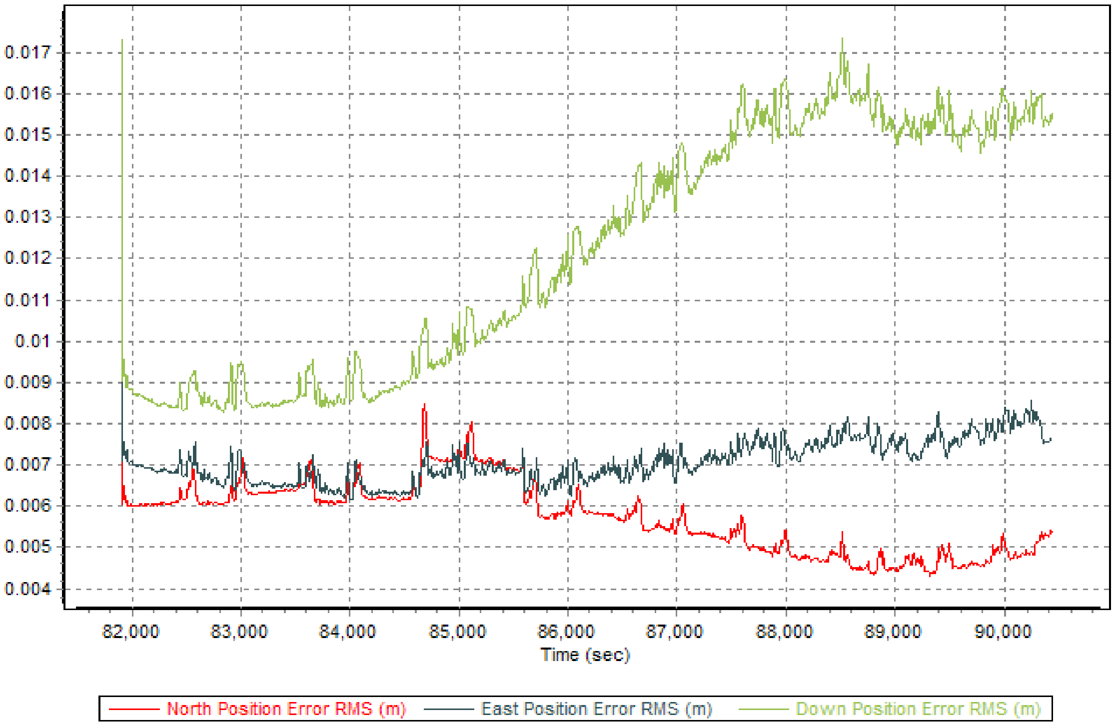


Figure A-8.2. Smoothed Performance Metric Parameters

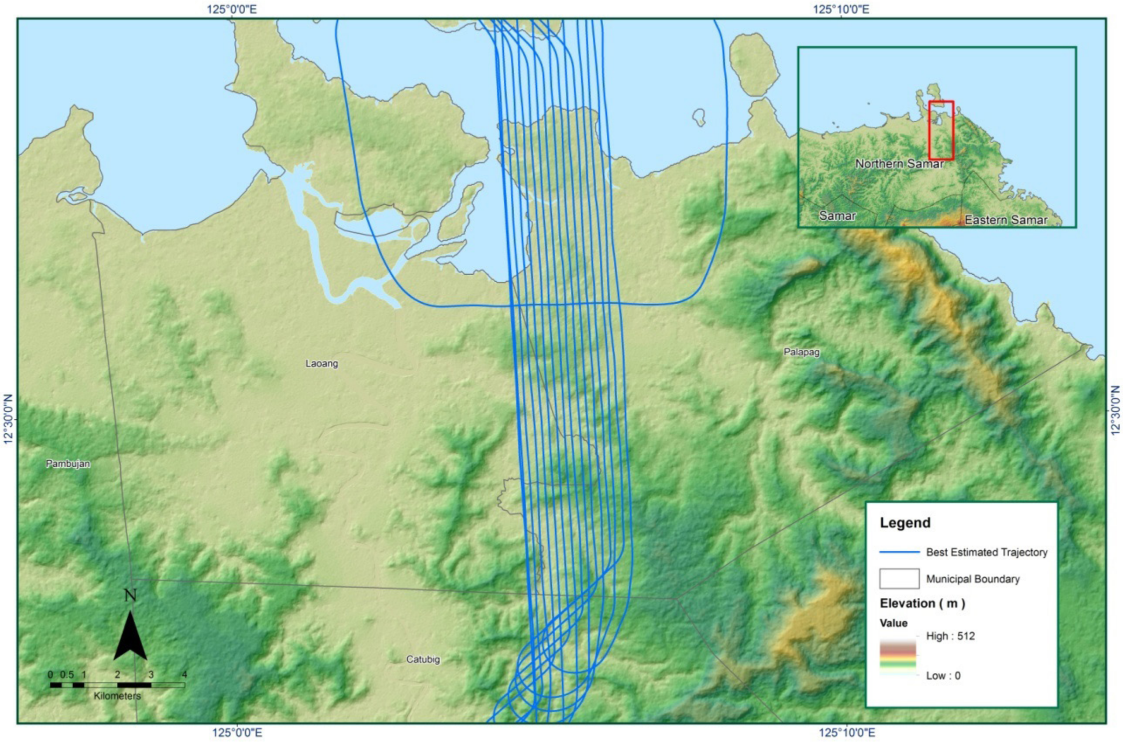


Figure A-8.3. Best Estimated Trajectory

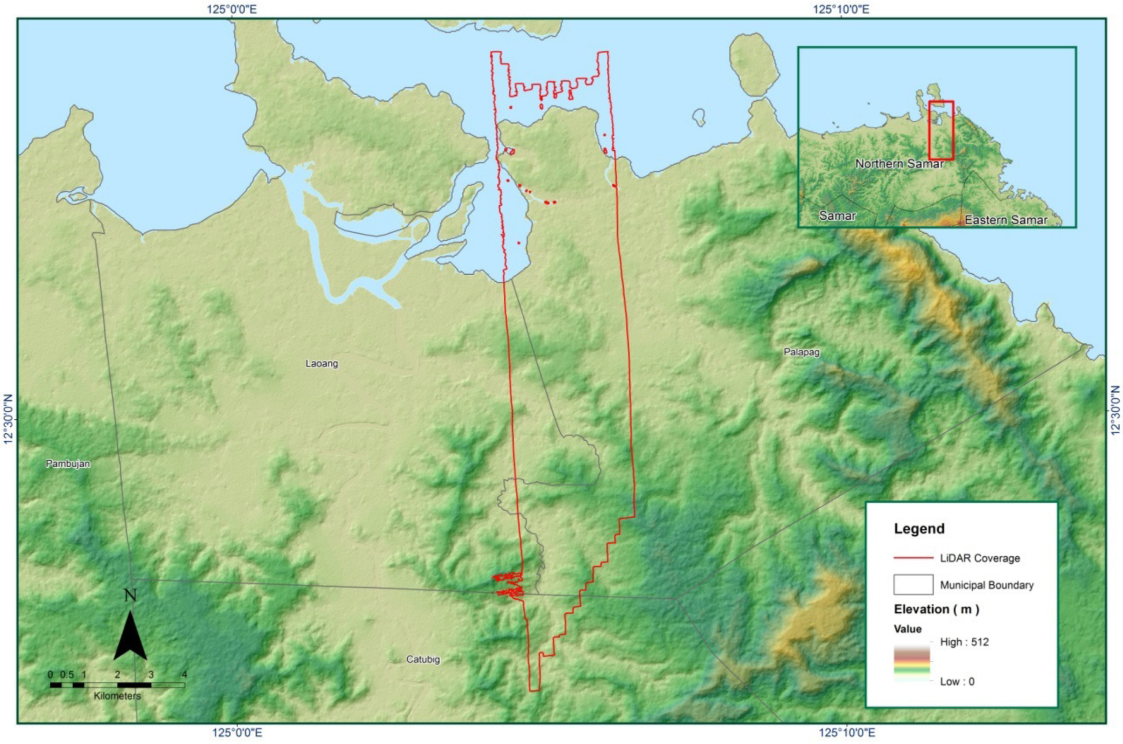


Figure A-8.4. Coverage of LiDAR data

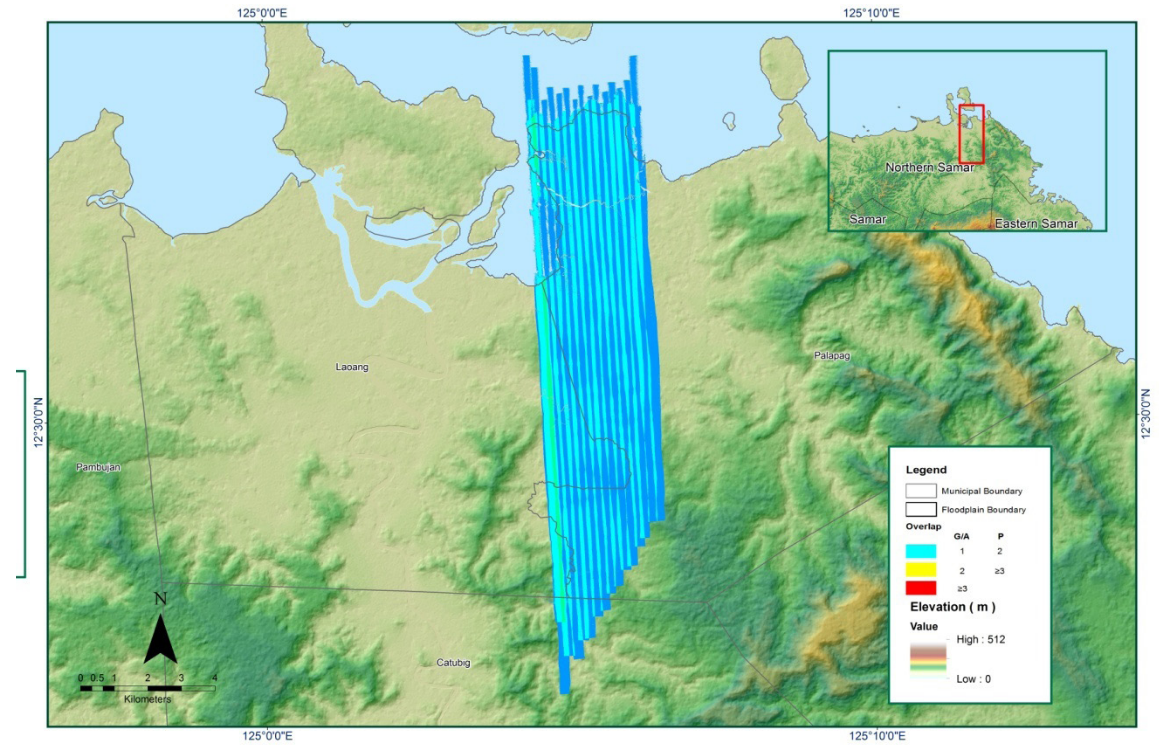


Figure A-8.5. Image of data overlap

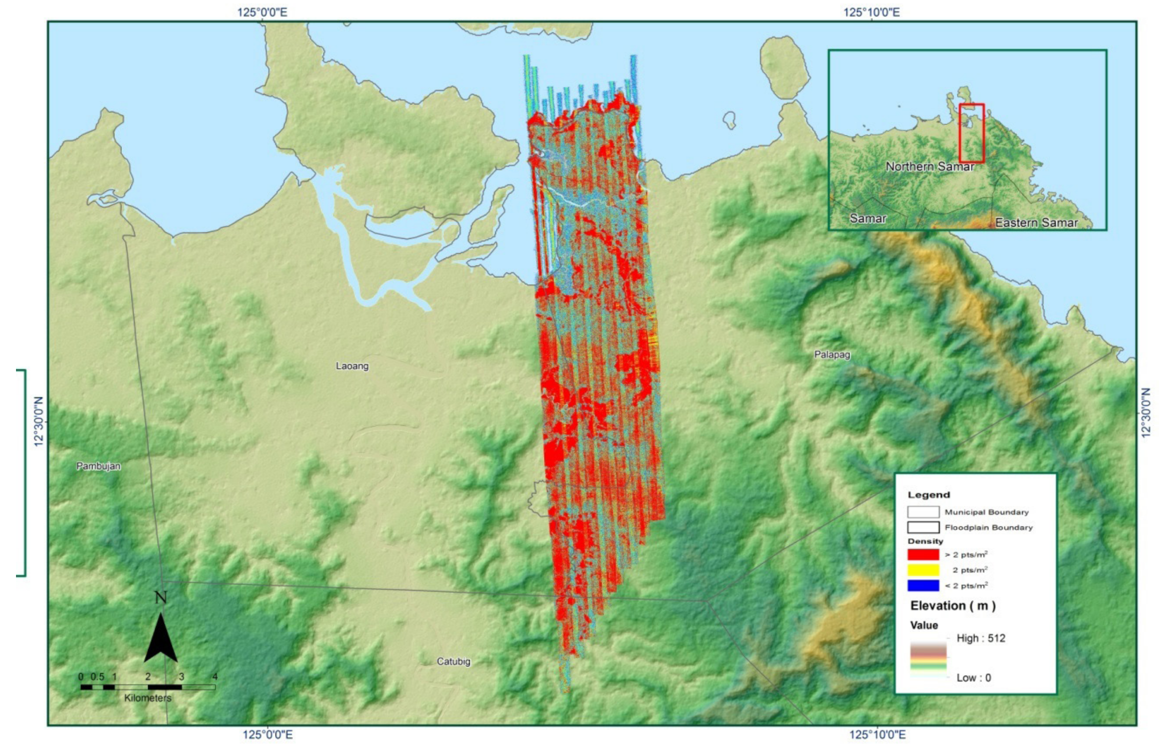


Figure A-8.6. Density map of merged LiDAR data

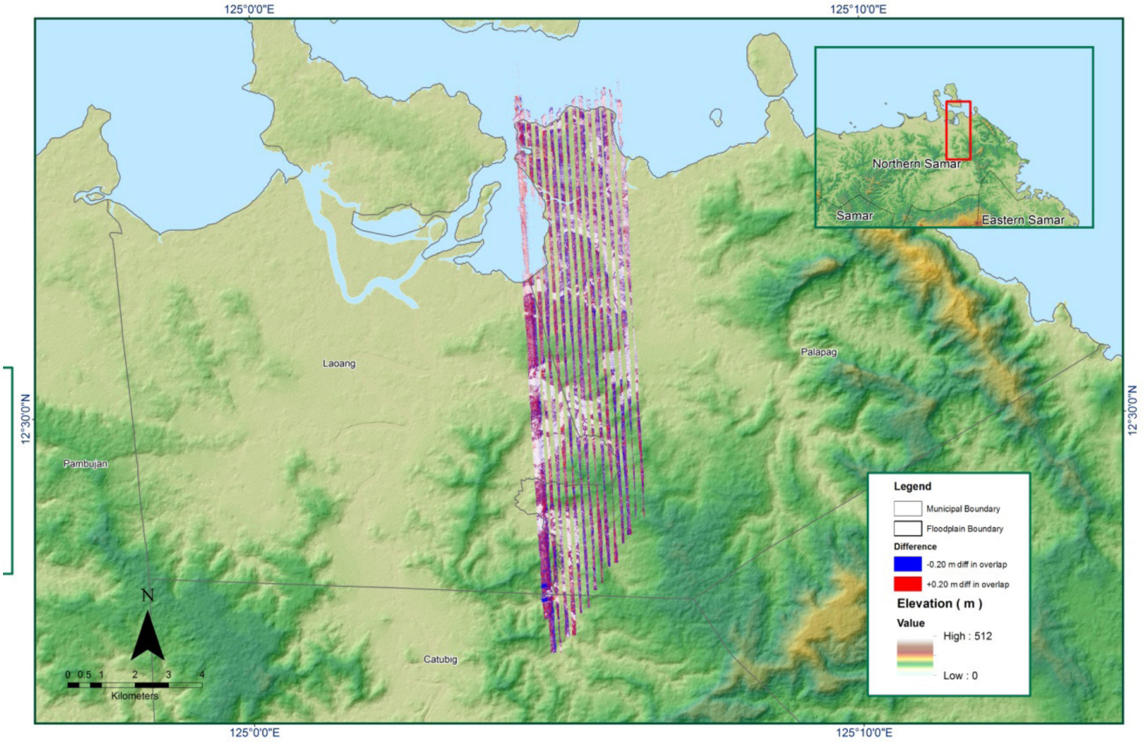


Figure A-8.7. Elevation difference between flight lines

Table A-8.2. Mission Report for Mission Blk33R_supplement

Flight Area	**Catarman**
Mission Name	**Blk33R_supplement**
Inclusive Flights	8183AC
Range data size	5.81 GB
Base data size	12.5 MB
POS	152 MB
Image	39.2 GB
Transfer date	September 16, 2015
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)	0.92
RMSE for East Position (<4.0 cm)	0.74
RMSE for Down Position (<8.0 cm)	2.0
Boresight correction stdev (<0.001deg)	0.006076
IMU attitude correction stdev (<0.001deg)	0.059937
GPS position stdev (<0.01m)	0.0033
Minimum % overlap (>25)	24.29
Ave point cloud density per sq.m. (>2.0)	2.31
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	29
Maximum Height	257.76 m
Minimum Height	49.03 m
Classification (# of points)	
Ground	14,710,746
Low vegetation	11,215,923
Medium vegetation	12,961,937
High vegetation	3,879,560
Building	265,392
Orthophoto	No
Processed by	Engr. Angelo Carlo Bongat, Engr. Christy Lubiano, Maria Tamsyn Malabanan

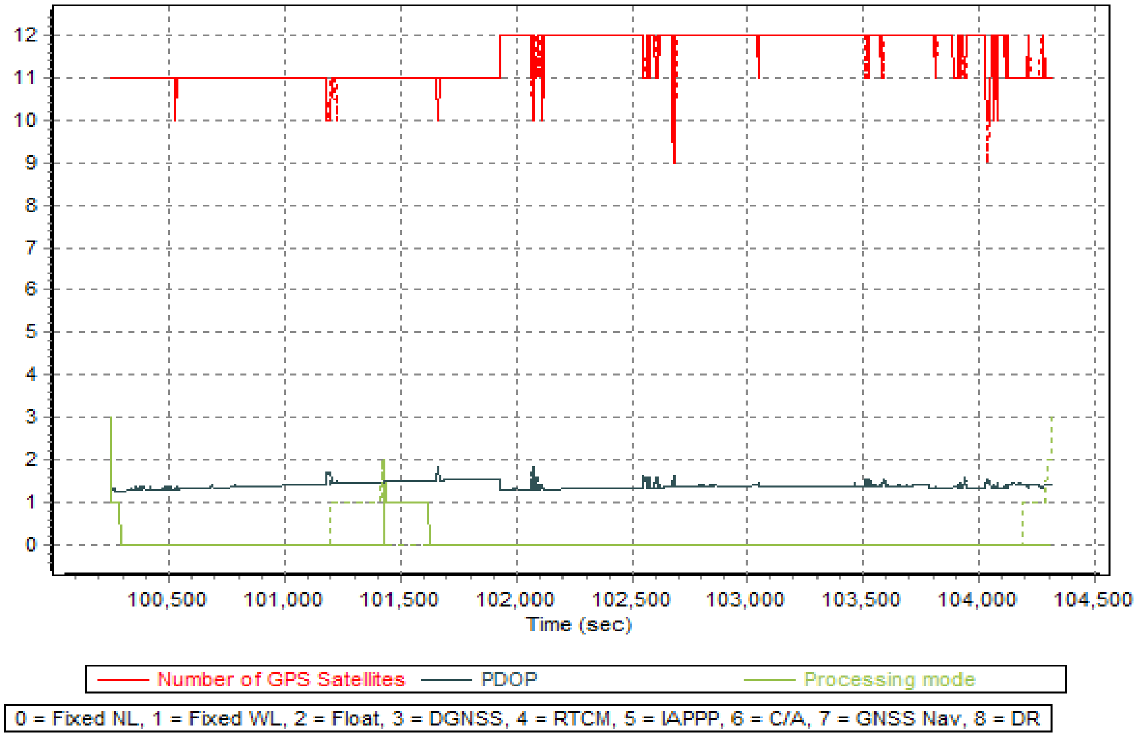


Figure A-8.8. Solution Status

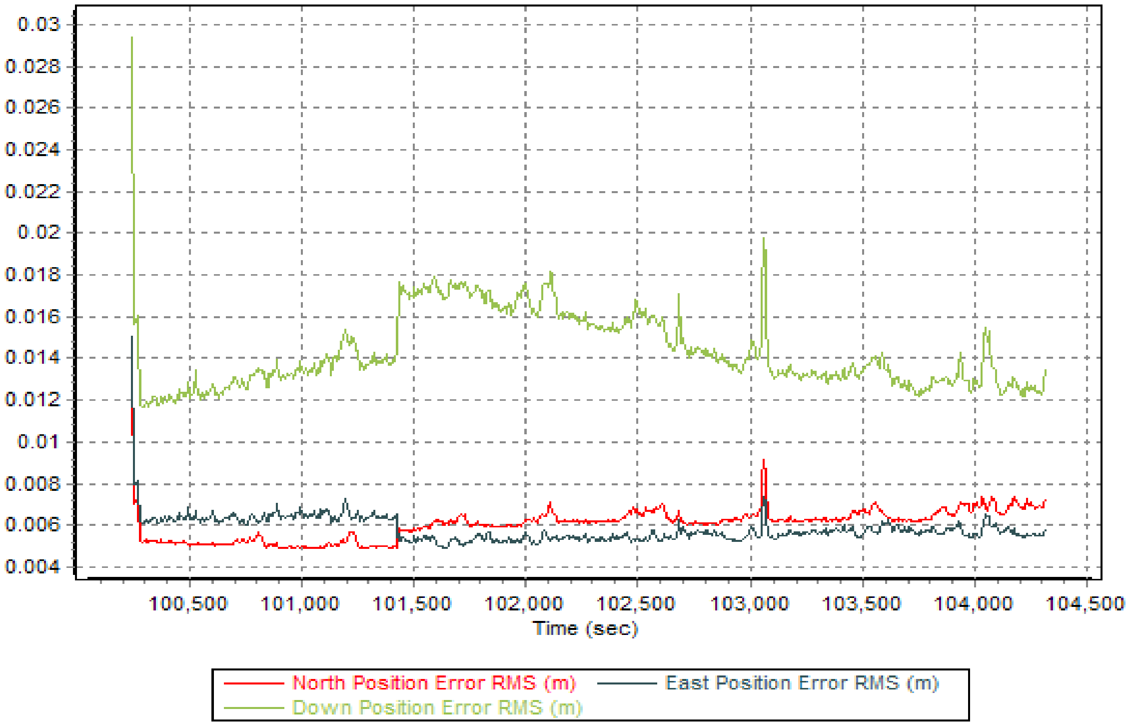


Figure A-8.9. Smoothed Performance Metric Parameters

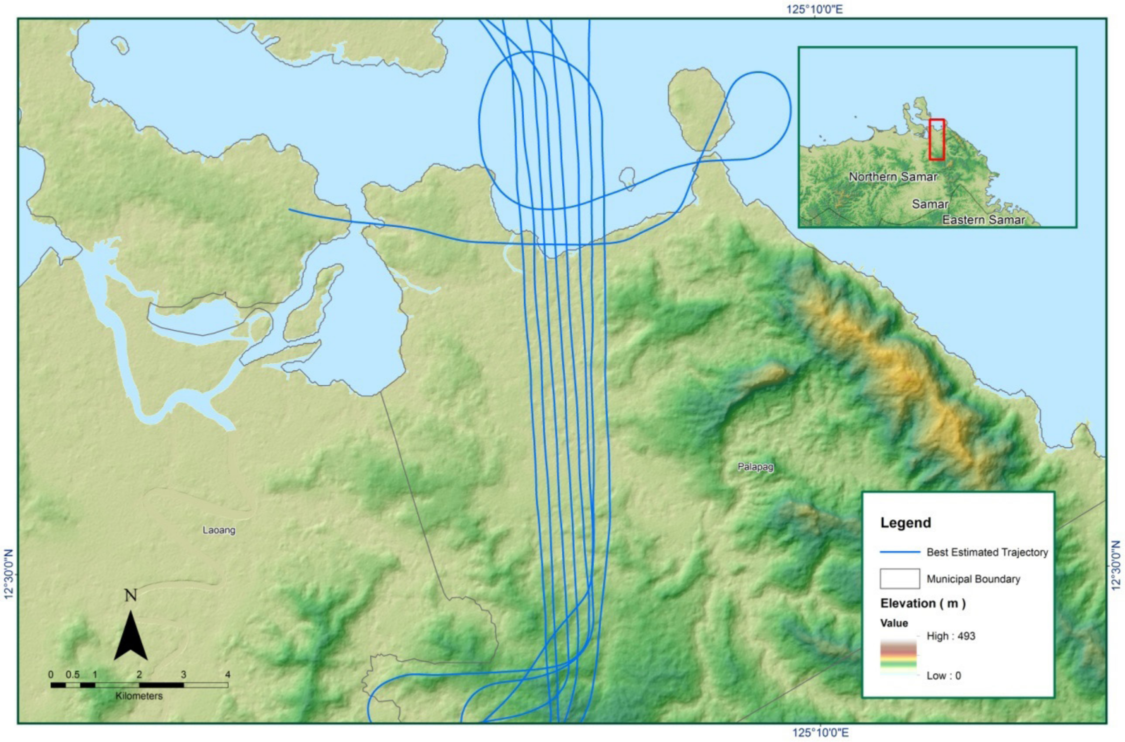


Figure A-8.10. Best Estimated Trajectory

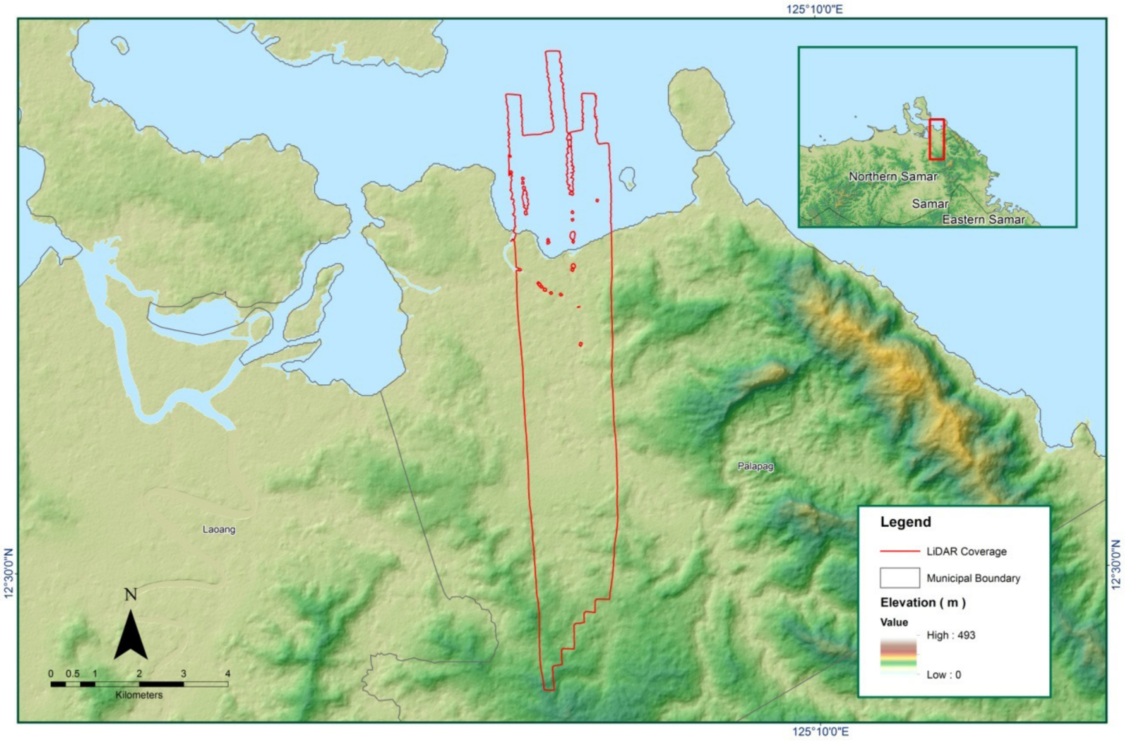


Figure A-8.11. Coverage of LiDAR data

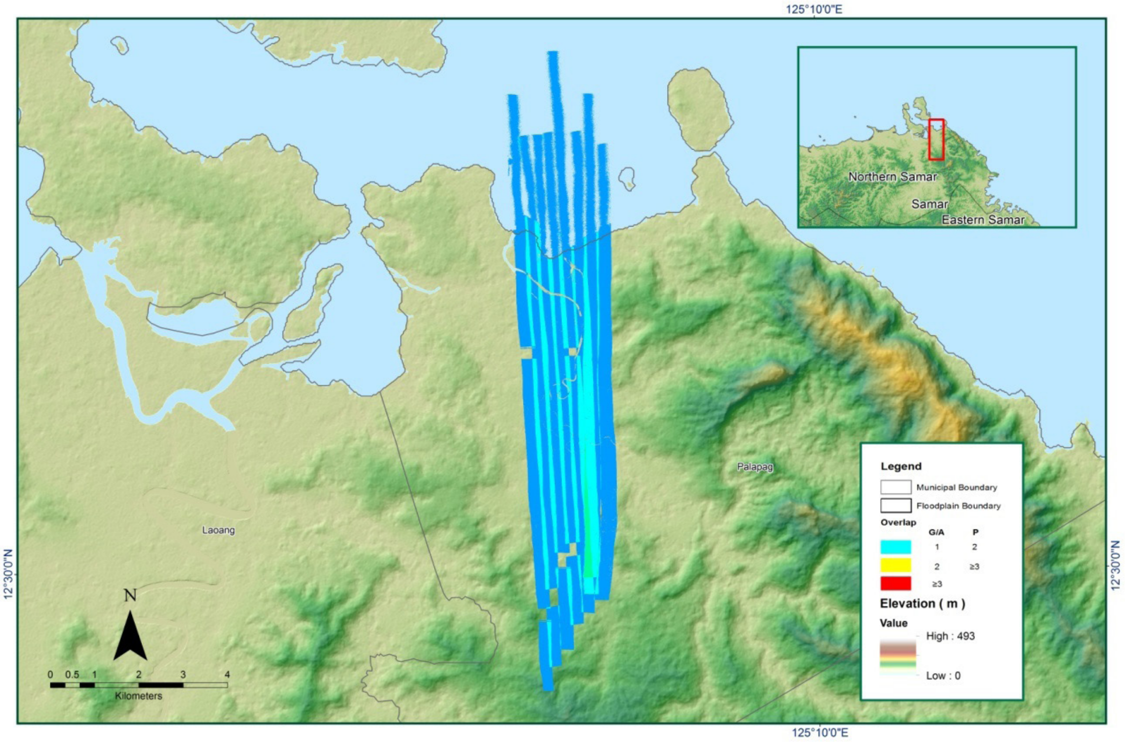


Figure A-8.12. Image of data overlap

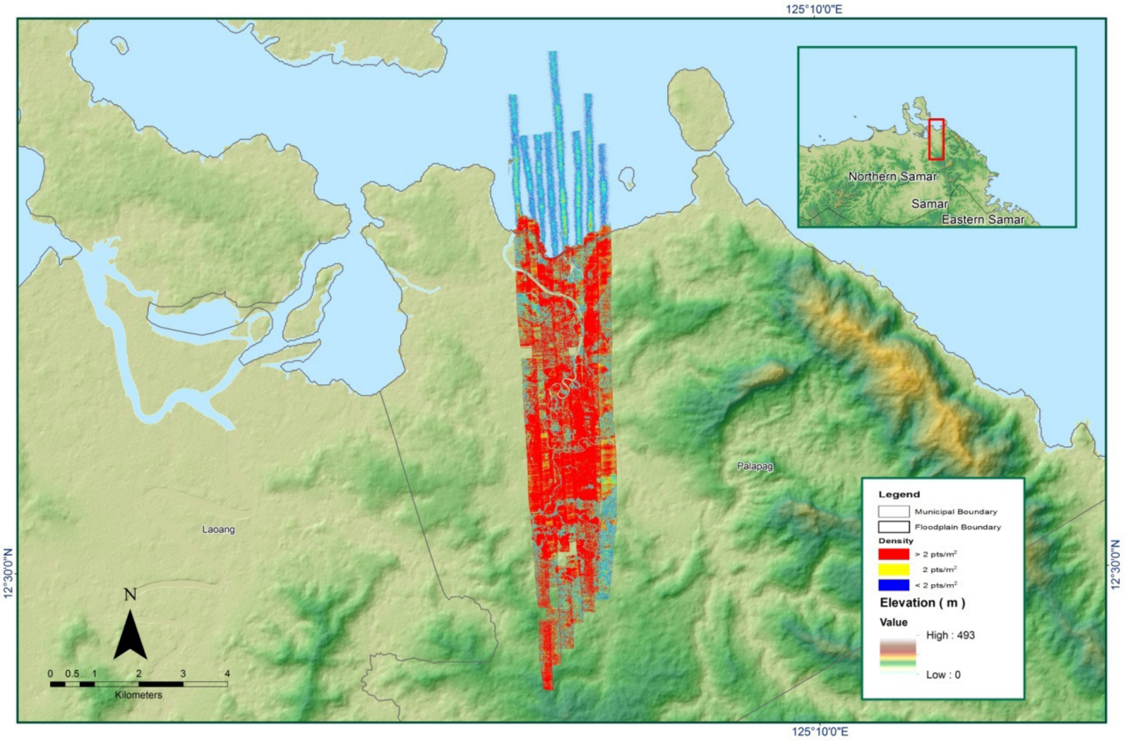


Figure A-8.13. Density map of merged LiDAR data

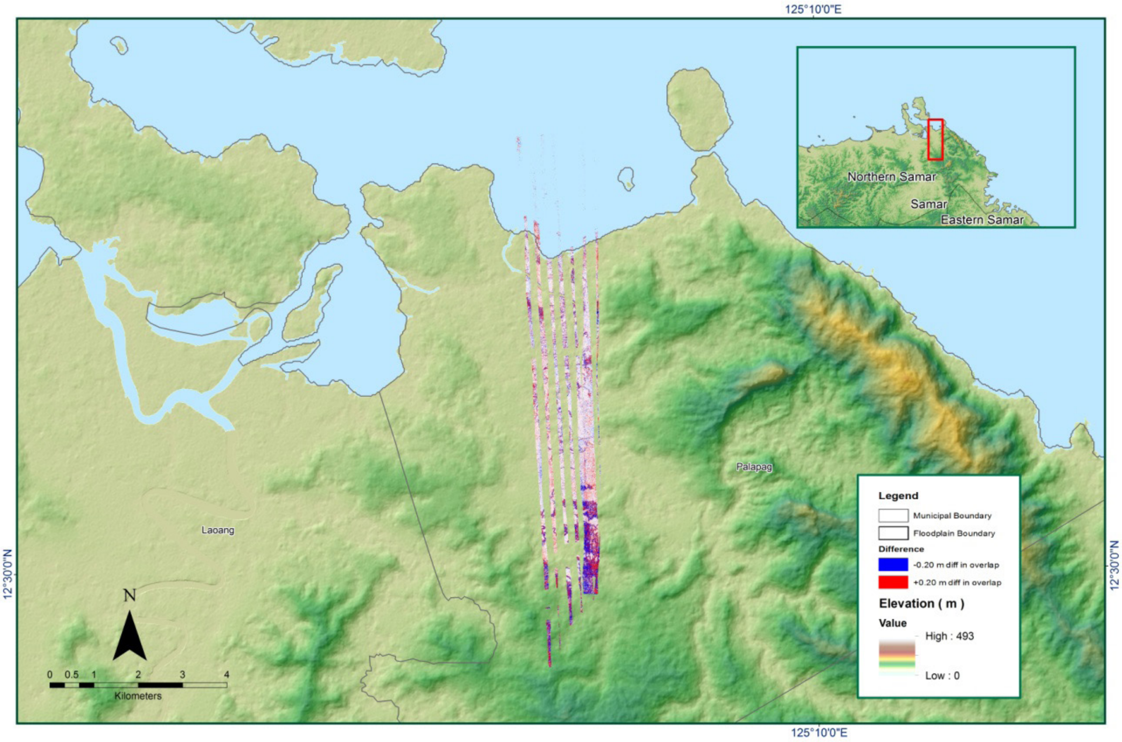


Figure A-8.14. Elevation difference between flight lines

Table A-8.3. Mission Report for Mission Blk33T

Flight Area	**Catarman**
Mission Name	**Blk33T**
Inclusive Flights	8186AC
Range data size	6.73 GB
Base data size	9.12 MB
POS	250 MB
Image	64.5 MB
Transfer date	September 16, 2015
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	No
Baseline Length (<30km)	Yes
Processing Mode (<=1)	No
Smoothed Performance Metrics (in cm)	
RMSE for North Position (<4.0 cm)	0.9375
RMSE for East Position (<4.0 cm)	1.0568
RMSE for Down Position (<8.0 cm)	2.2538
Boresight correction stdev (<0.001deg)	0.002200
IMU attitude correction stdev (<0.001deg)	0.005333
GPS position stdev (<0.01m)	0.0268
Minimum % overlap (>25)	25.19%
Ave point cloud density per sq.m. (>2.0)	2.36
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	49
Maximum Height	290.45
Minimum Height	46.45
Classification (# of points)	
Ground	18,534,697
Low vegetation	10,330,306
Medium vegetation	16,402,099
High vegetation	4,443,251
Building	-
Orthophoto	None
Processed by	Engr. Kenneth Solidum, Engr. Mark Joshua Salvacion, Kathryn Claudyn Zarate

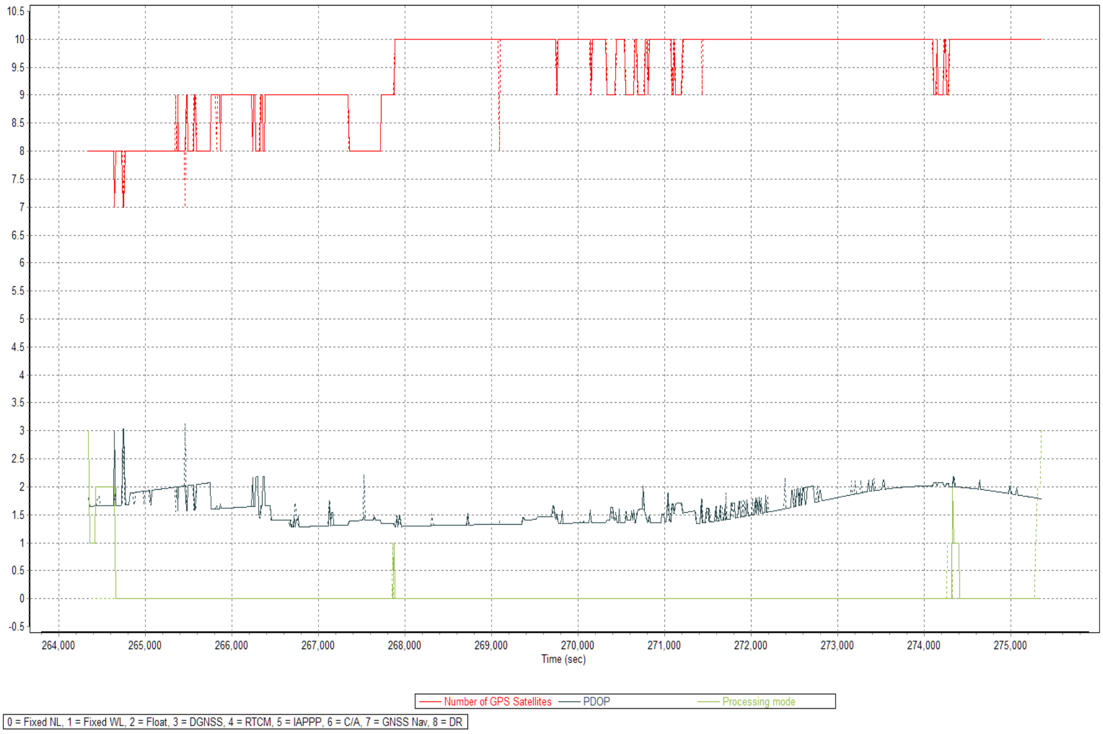


Figure A-8.15. Solution Status

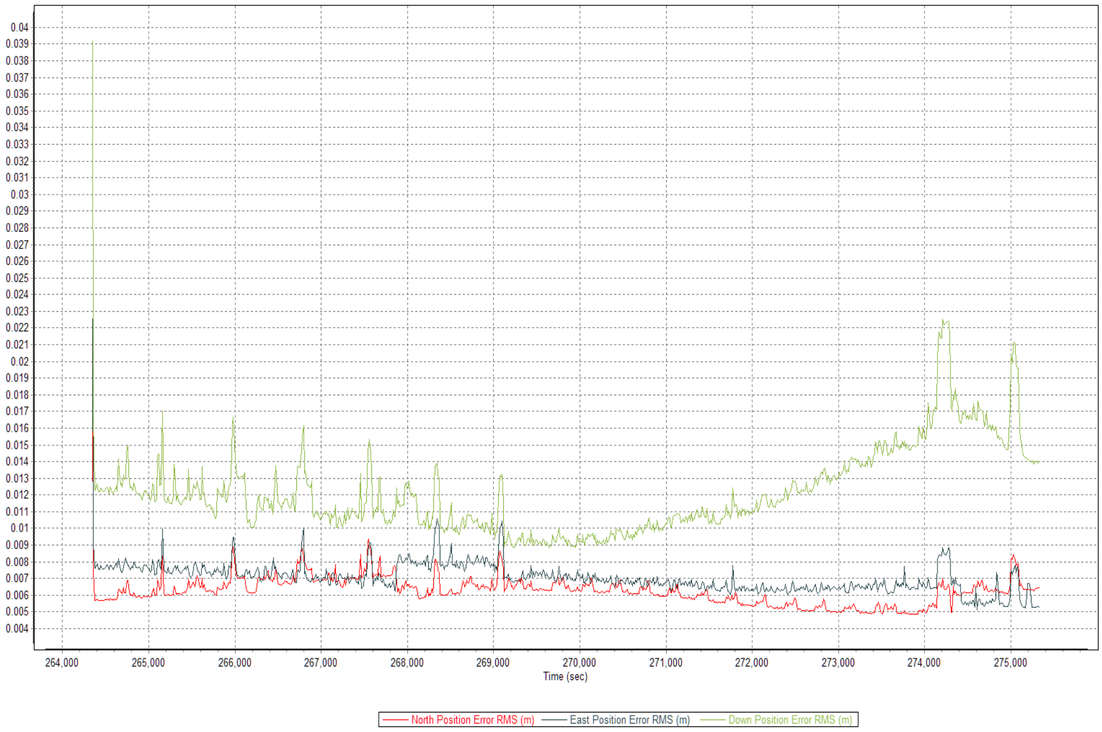


Figure A-8.16. Smoothed Performance Metric Parameters

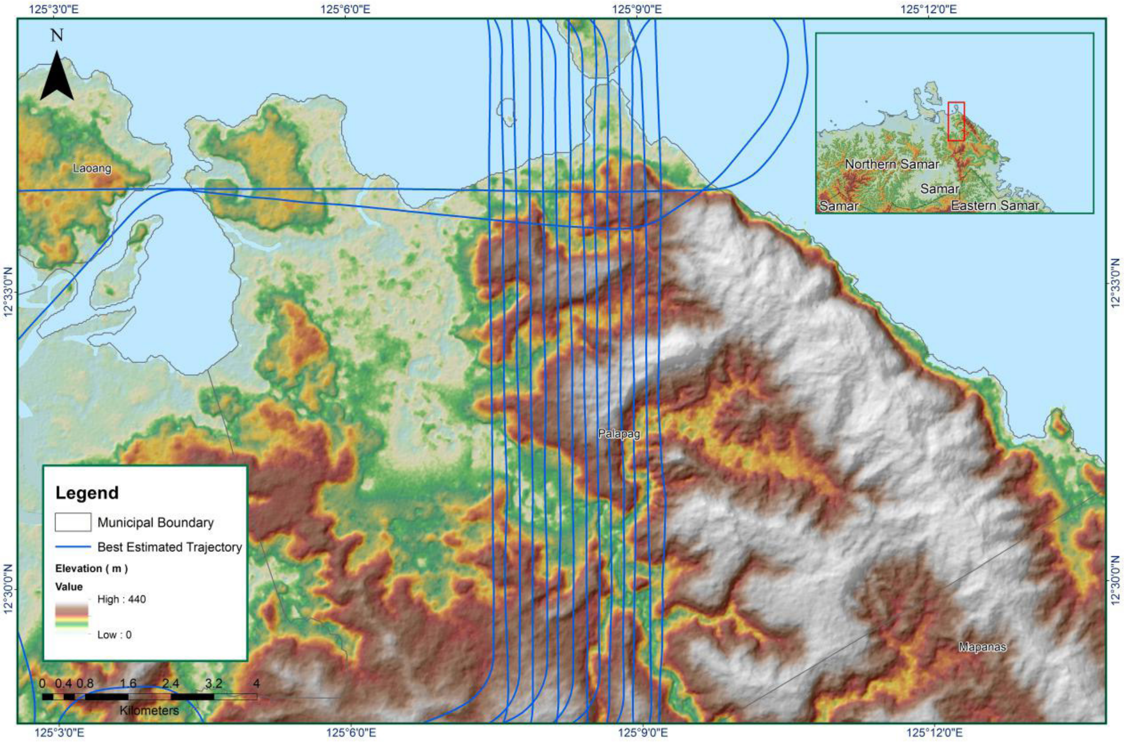


Figure A-8.17. Best Estimated Trajectory

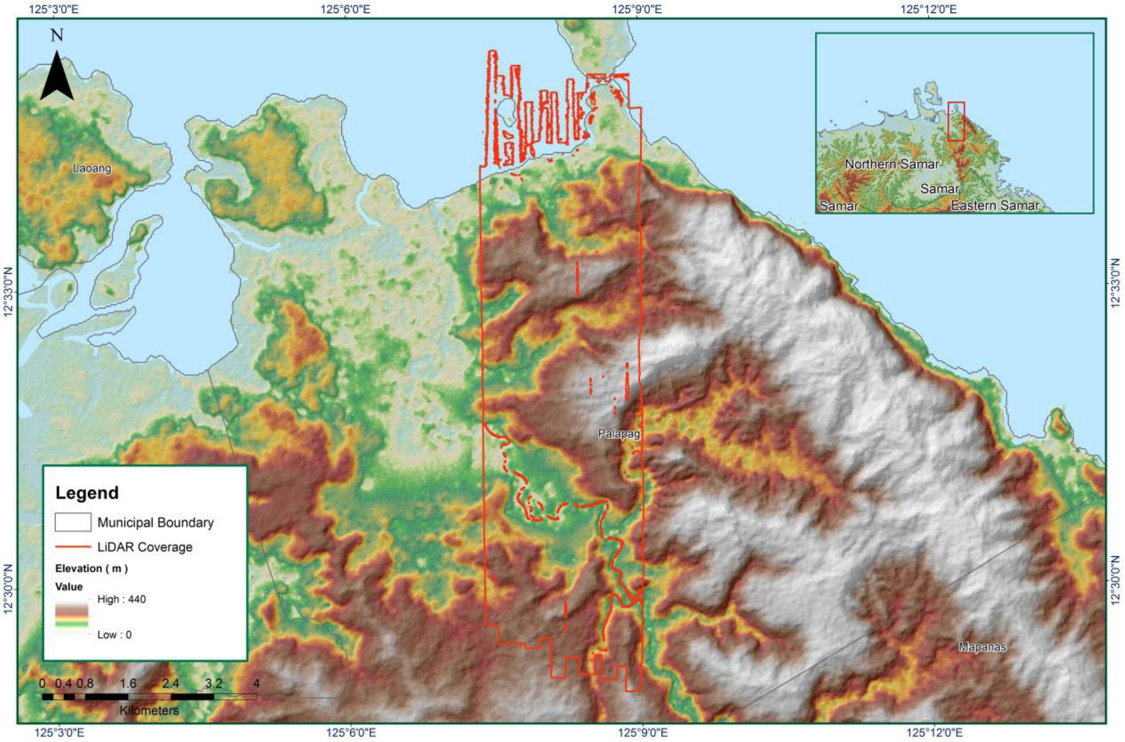


Figure A-8.18. Coverage of LiDAR data

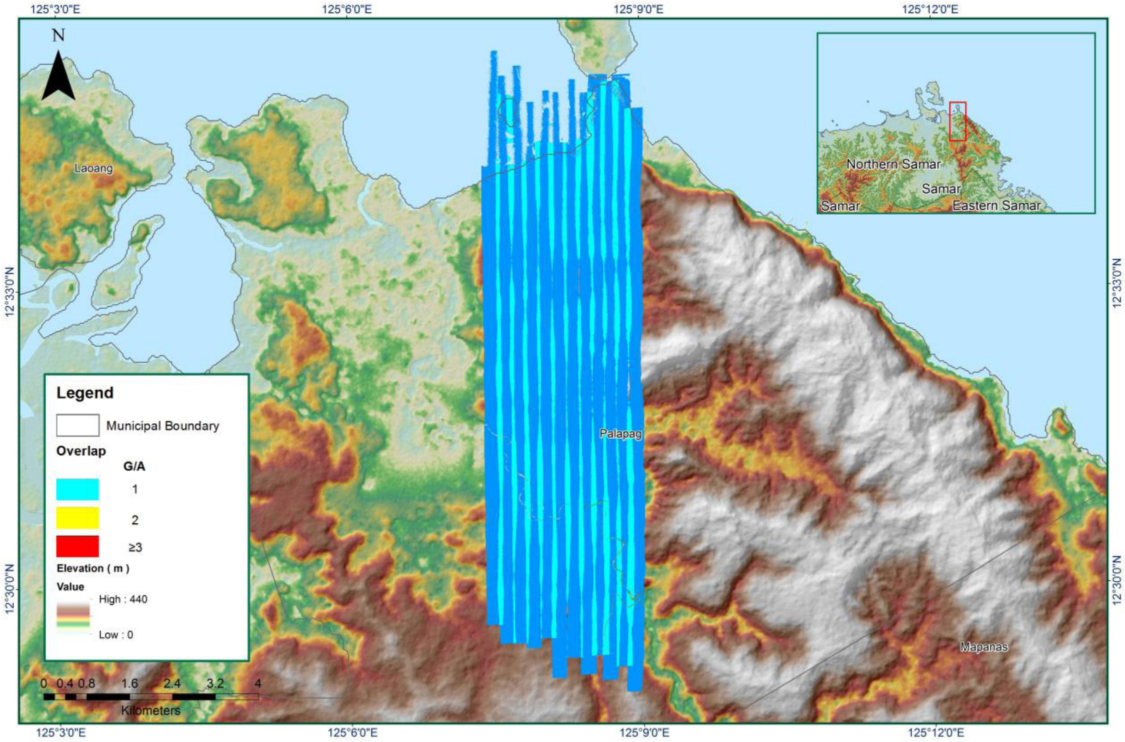


Figure A-8.19. Image of data overlap

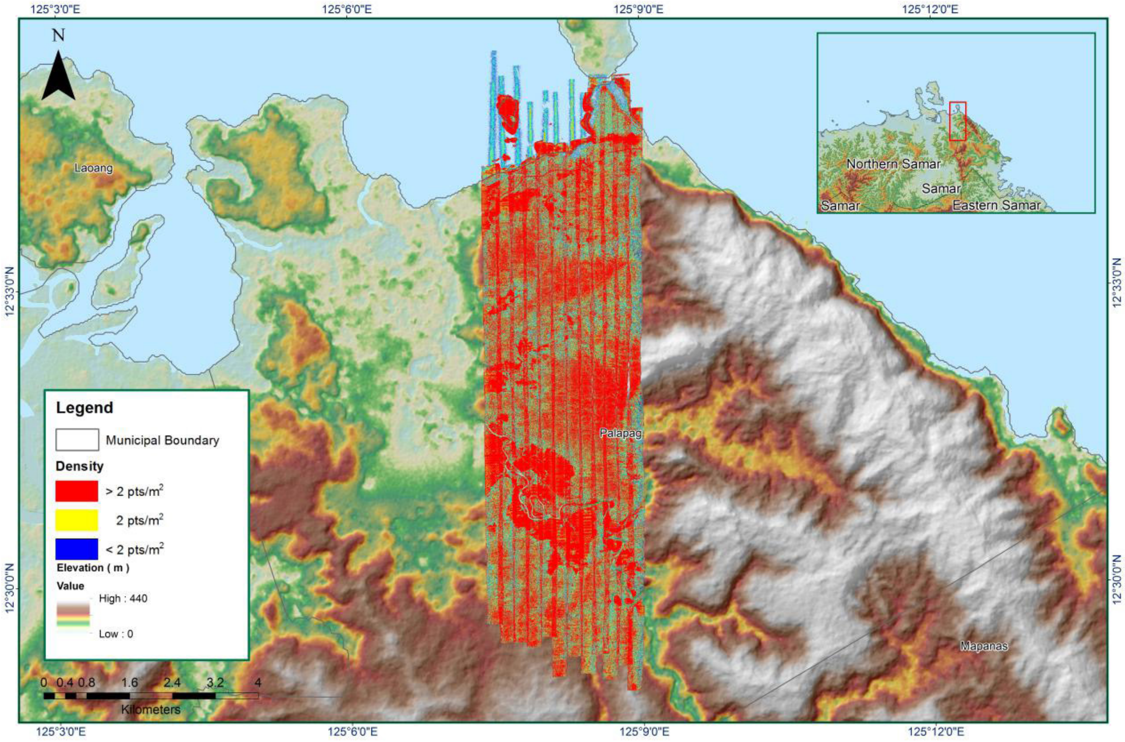


Figure A-8.20. Density Map of merged LiDAR data

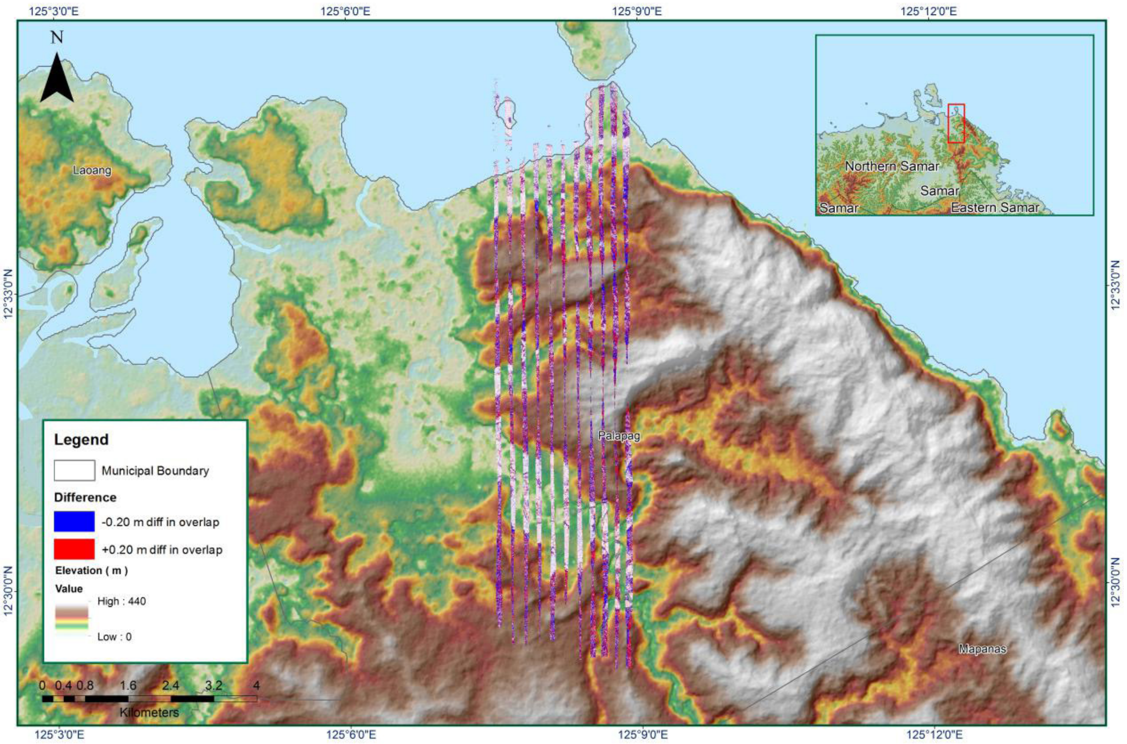


Figure A-8.21. Elevation Difference Between flight lines

Table A-8.4. Mission Report for Mission BLK 33T_supplement

Flight Area	**Catarman**
Mission Name	**BLK 33T_supplement**
Inclusive Flights	8186AC
Range data size	6.73 GB
POS	250 MB
Base data size	9.12 MB
Image	64.5 MB
Transfer date	September 16, 2015
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	No
Baseline Length (<30km)	Yes
Processing Mode (<=1)	No
Smoothed Performance Metrics (in cm)	
RMSE for North Position (<4.0 cm)	0.9 cm
RMSE for East Position (<4.0 cm)	1.1 cm
RMSE for Down Position (<8.0 cm)	2.2 cm
Boresight correction stdev (<0.001deg)	0.002200
IMU attitude correction stdev (<0.001deg)	0.005333
GPS position stdev (<0.01m)	0.0268
Minimum % overlap (>25)	7.29%
Ave point cloud density per sq.m. (>2.0)	2.13
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	25
Maximum Height	356.43
Minimum Height	43.3
Classification (# of points)	
Ground	2344560
Low vegetation	1245305
Medium vegetation	2895693
High vegetation	4096142
Building	9796
Orthophoto	No
Processed by	Engr. Kenneth A. Solidum, Engr. Antonio B. Chua Jr. Maria Tamsyn Malabanan

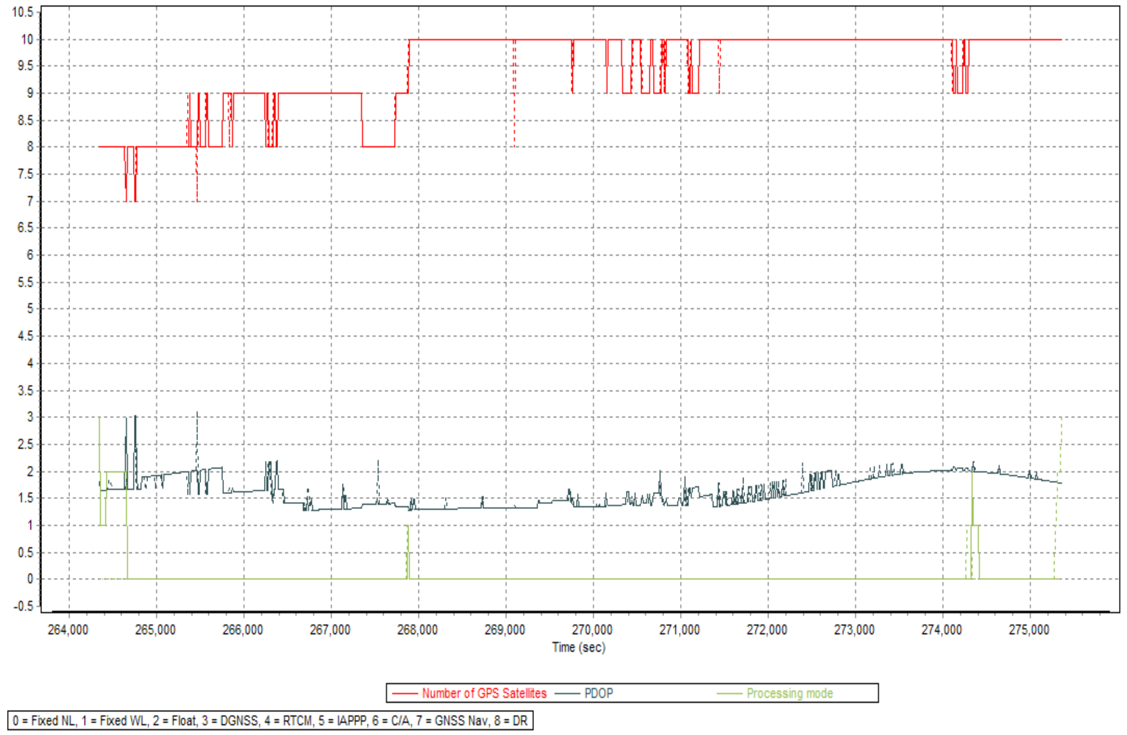


Figure A-8.22. Solution Status

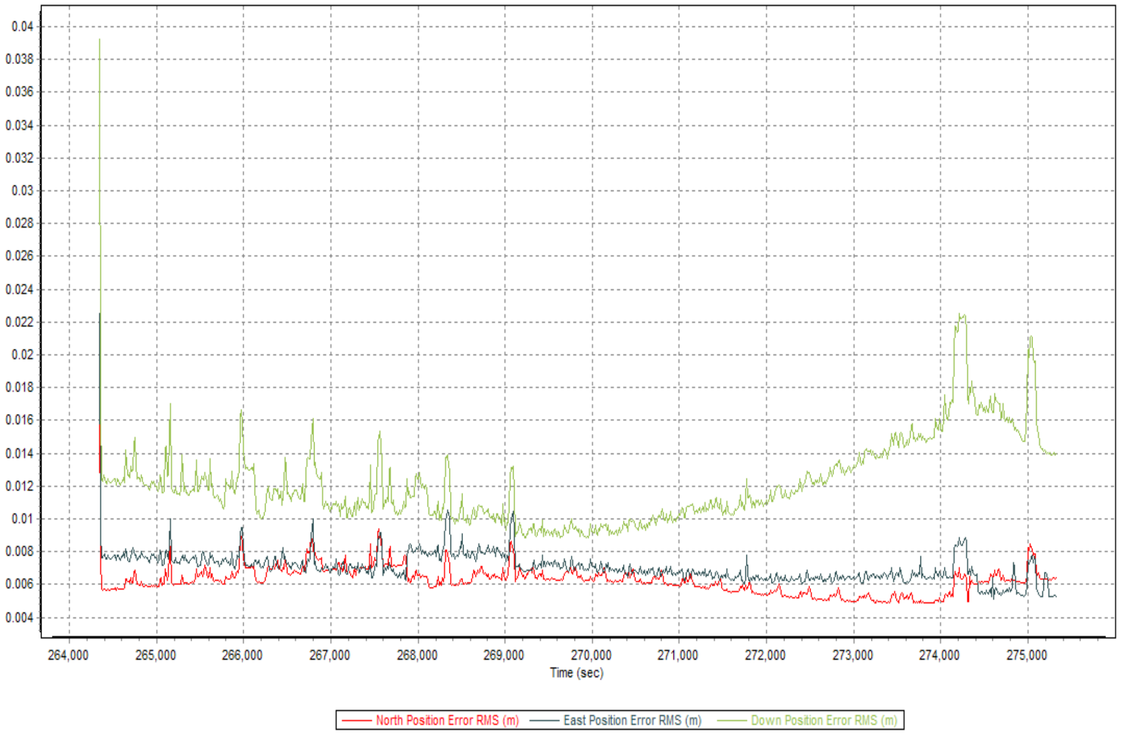


Figure A-8.23. Smoothed Performance Metric Parameters

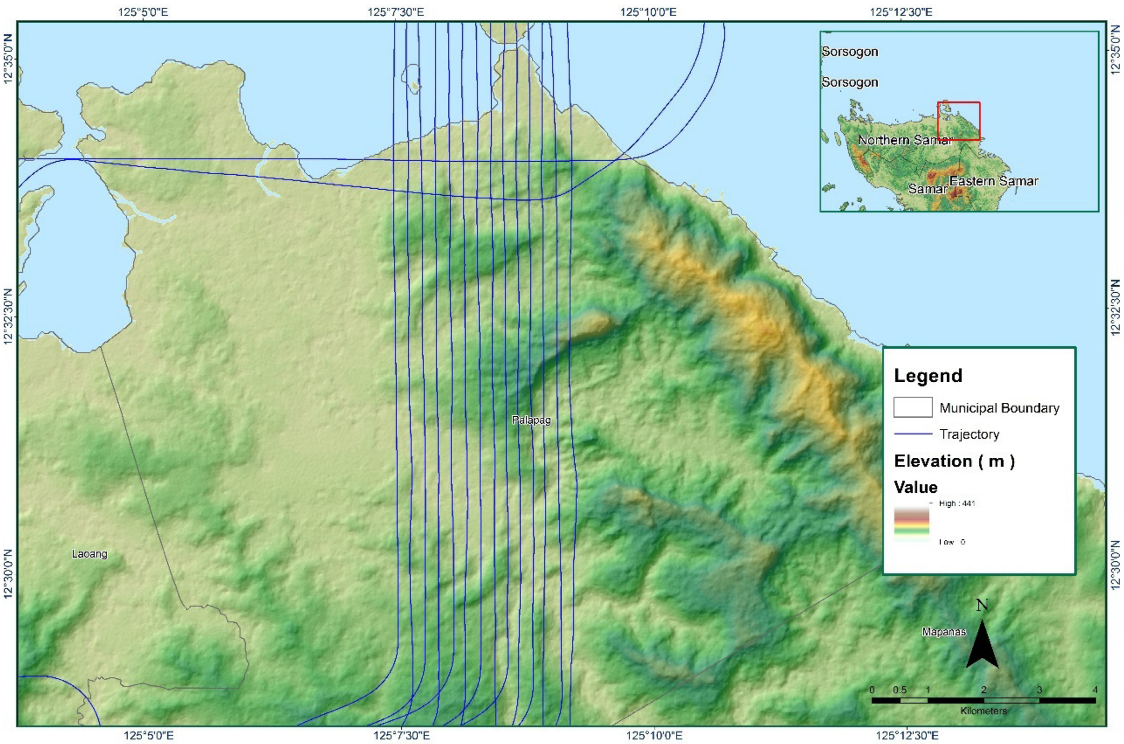


Figure A-8.24. Best Estimated Trajectory

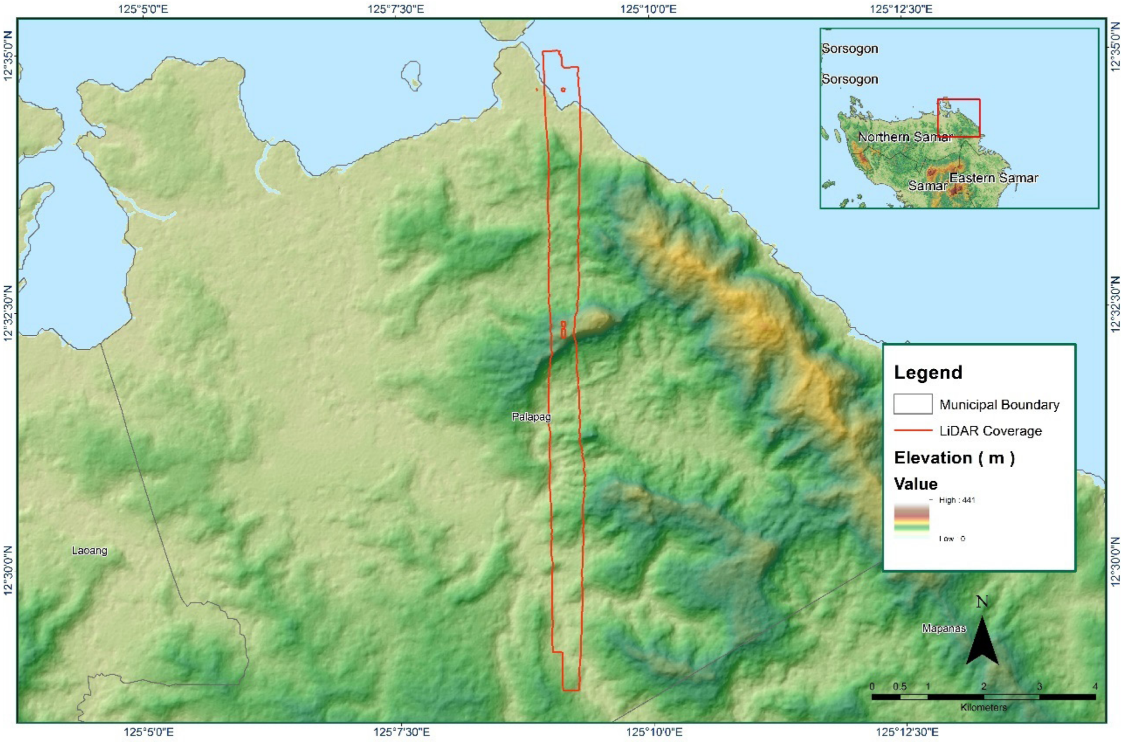


Figure A-8.25. Coverage of LIDAR data

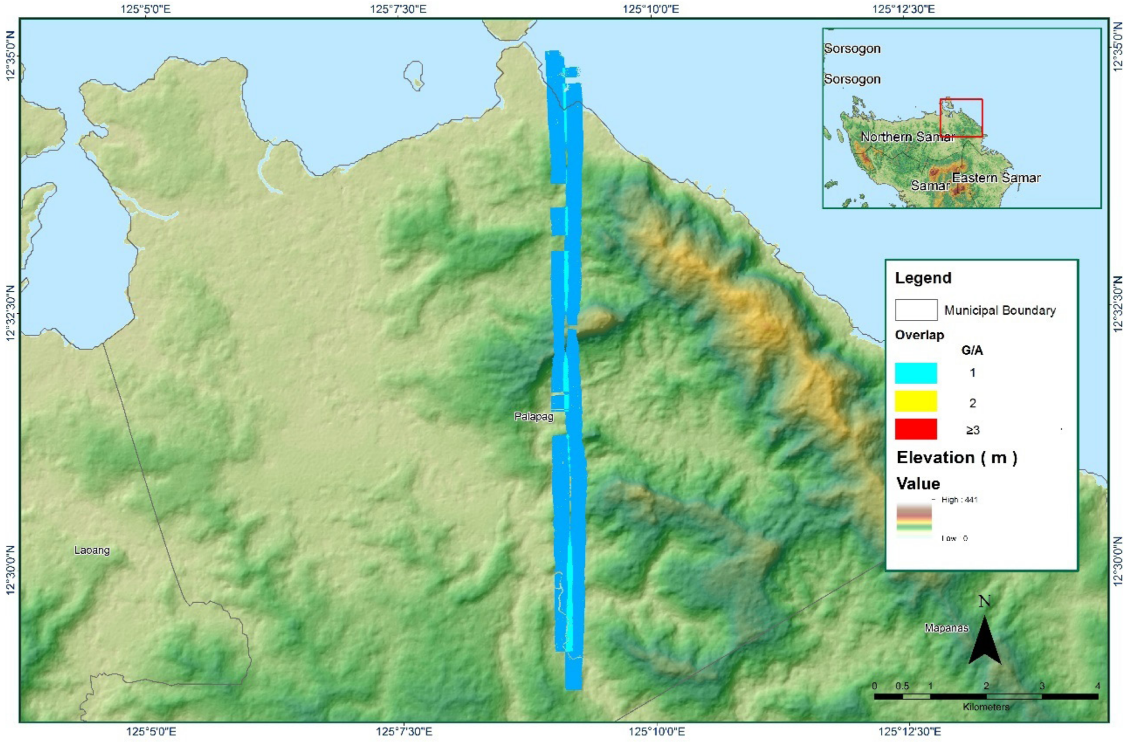


Figure A-8.26, Image of Data Overlap

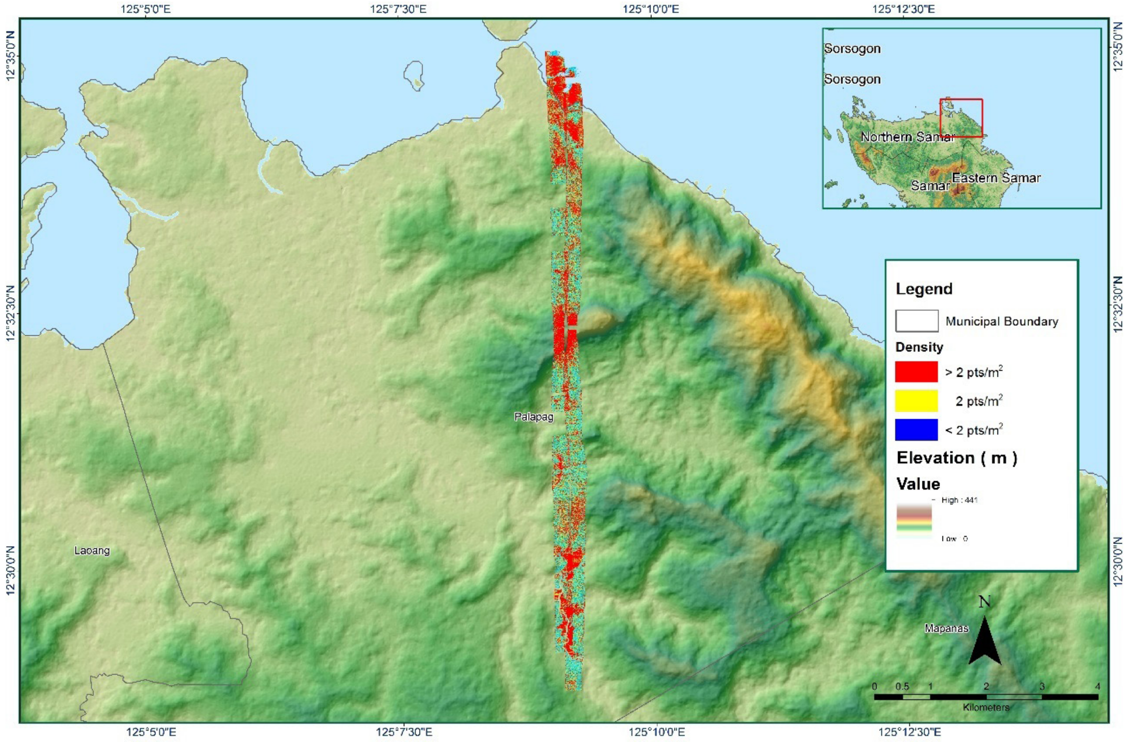


Figure A-8.27. Density map of merged LIDAR data

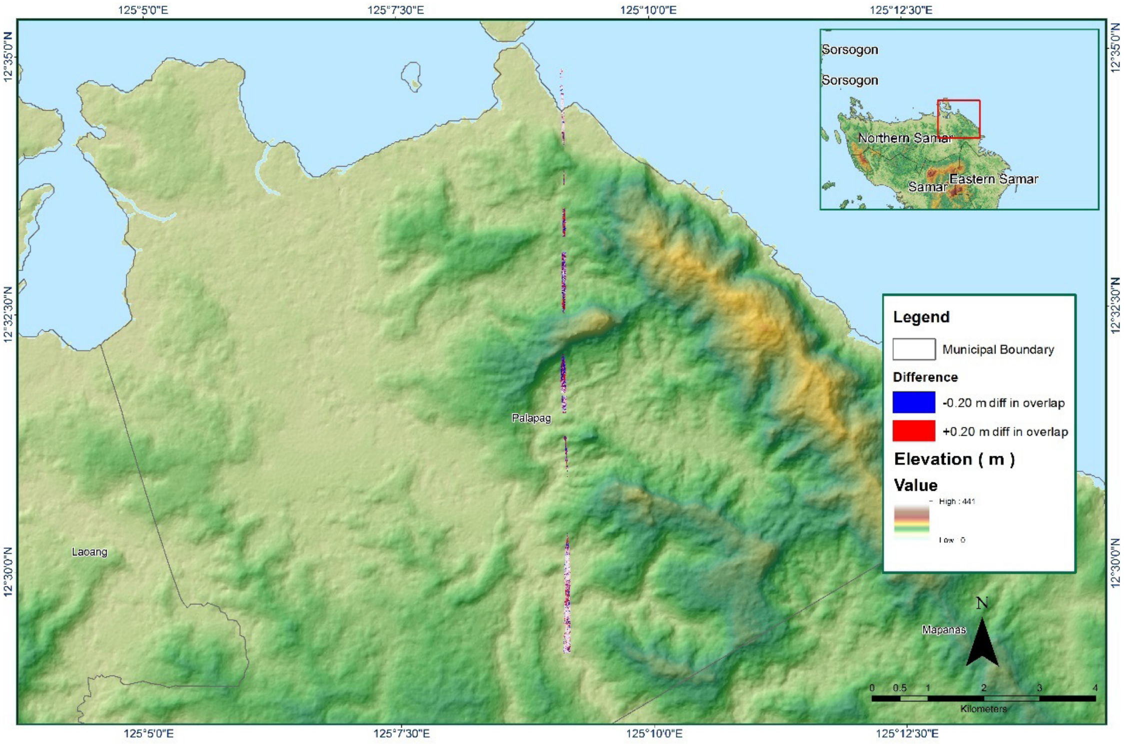


Figure A-8.28. Elevation difference between flight lines

Table A-8.5. Mission Report for Mission Blk33Q

Flight Area	**Catarman**
Mission Name	**Blk33Q**
Inclusive Flights	8180AC
Range data size	10.6 GB
Base data size	9.87 MB
POS	212 MB
Image	70.2 GB
Transfer date	September 16, 2015
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)	1.02
RMSE for East Position (<4.0 cm)	1.15
RMSE for Down Position (<8.0 cm)	2.4
Boresight correction stdev (<0.001deg)	0.00022
IMU attitude correction stdev (<0.001deg)	0.066526
GPS position stdev (<0.01m)	0.0223
Minimum % overlap (>25)	23.49
Ave point cloud density per sq.m. (>2.0)	2.01
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	107
Maximum Height	263.08 m
Minimum Height	53.32 m
Classification (# of points)	
Ground	15,461,146
Low vegetation	4,541,182
Medium vegetation	7,736,833
High vegetation	7,201,019
Building	148,669
Orthophoto	No
Processed by	Engr. Jommer Medina, Aljon Rei Araneta, Jovy Narisma

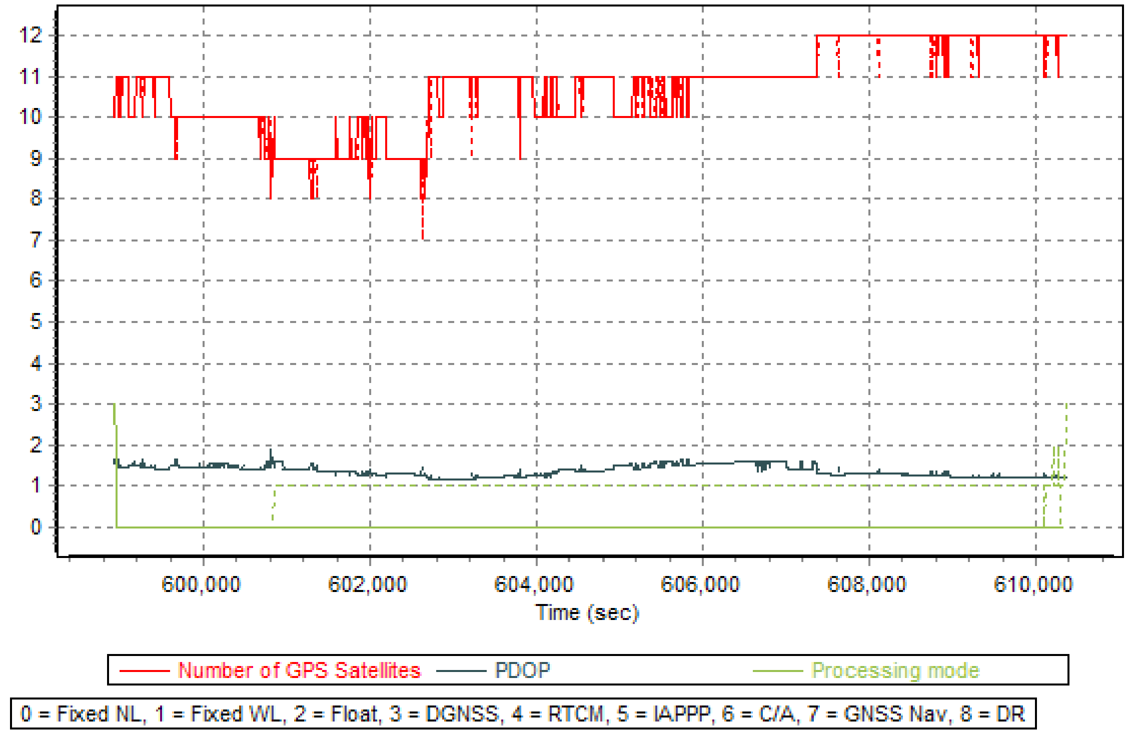


Figure A-8.29. Solution Status

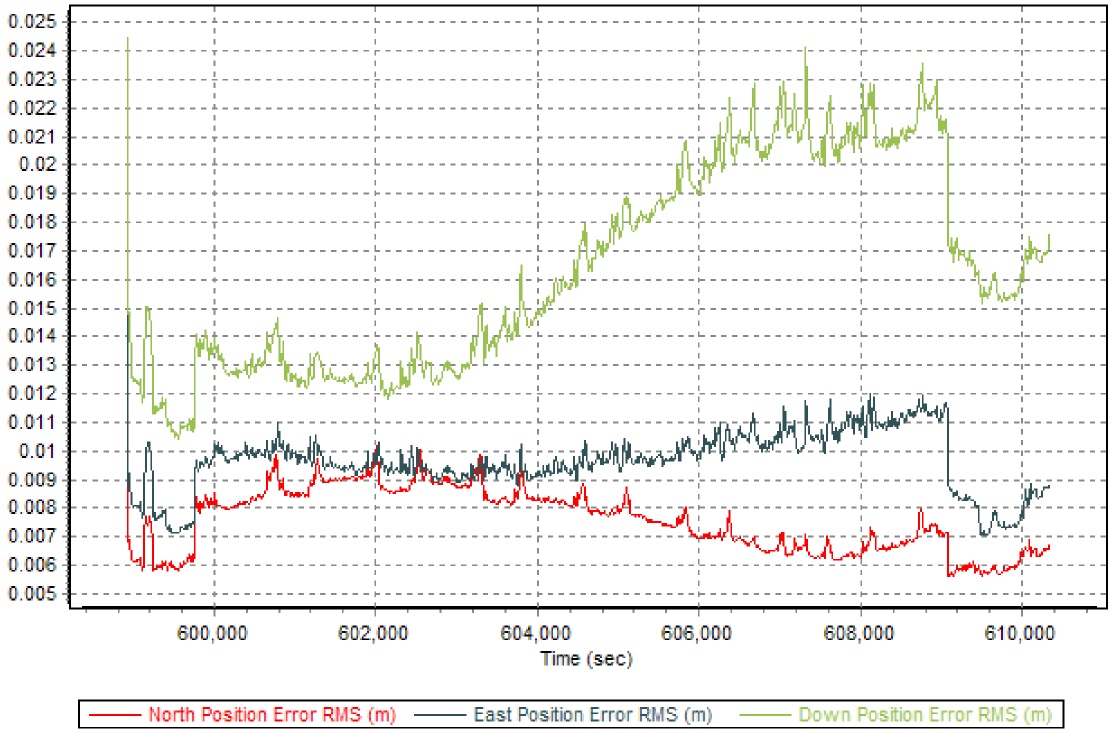


Figure A-8.30. Smoothed Performance Metric Parameters

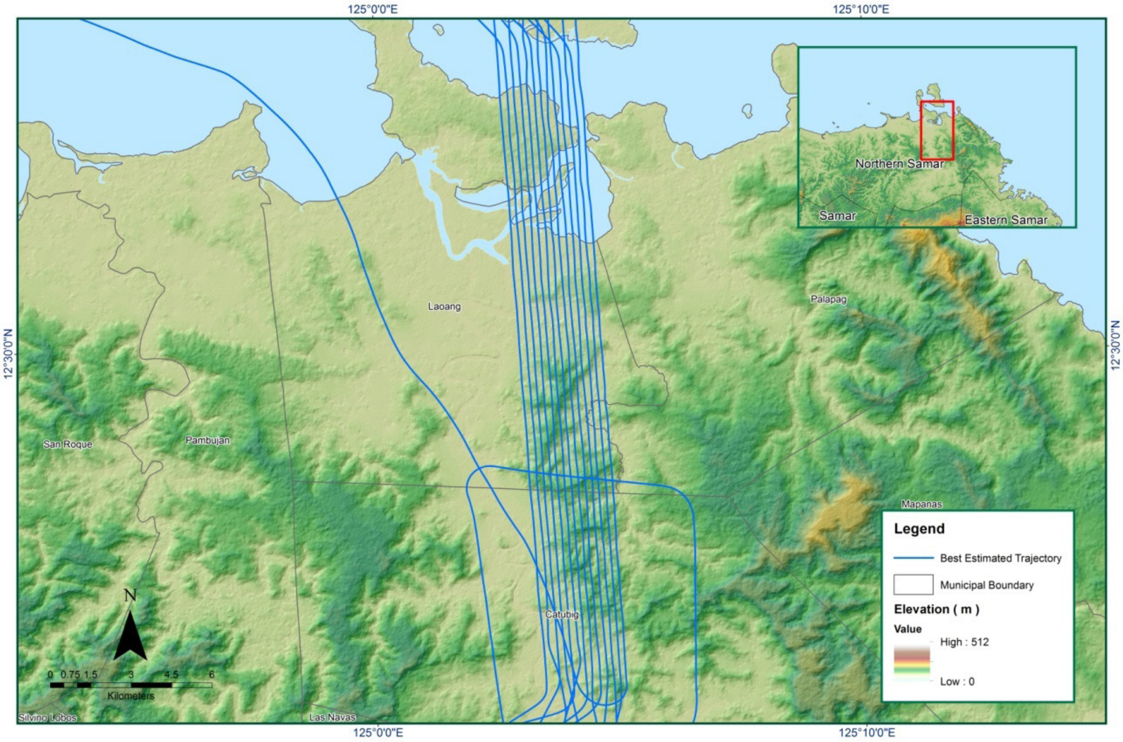


Figure A-8.31. Best Estimated Trajectory

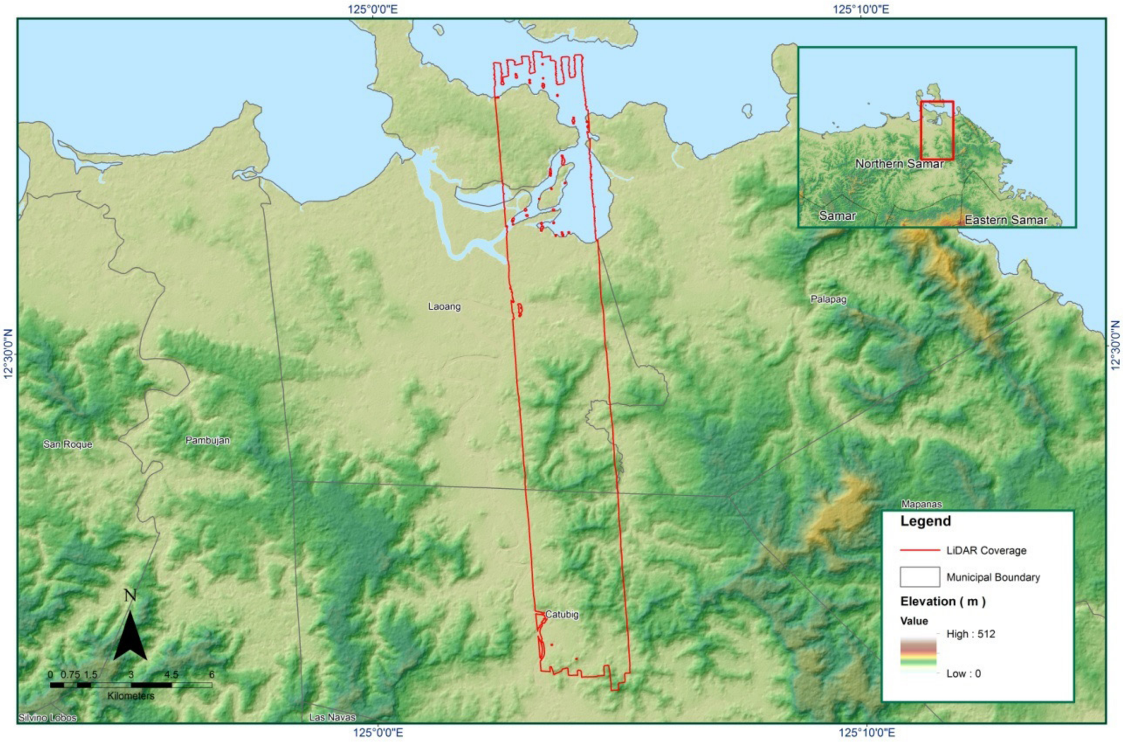


Figure A-8.32. Coverage of LiDAR data

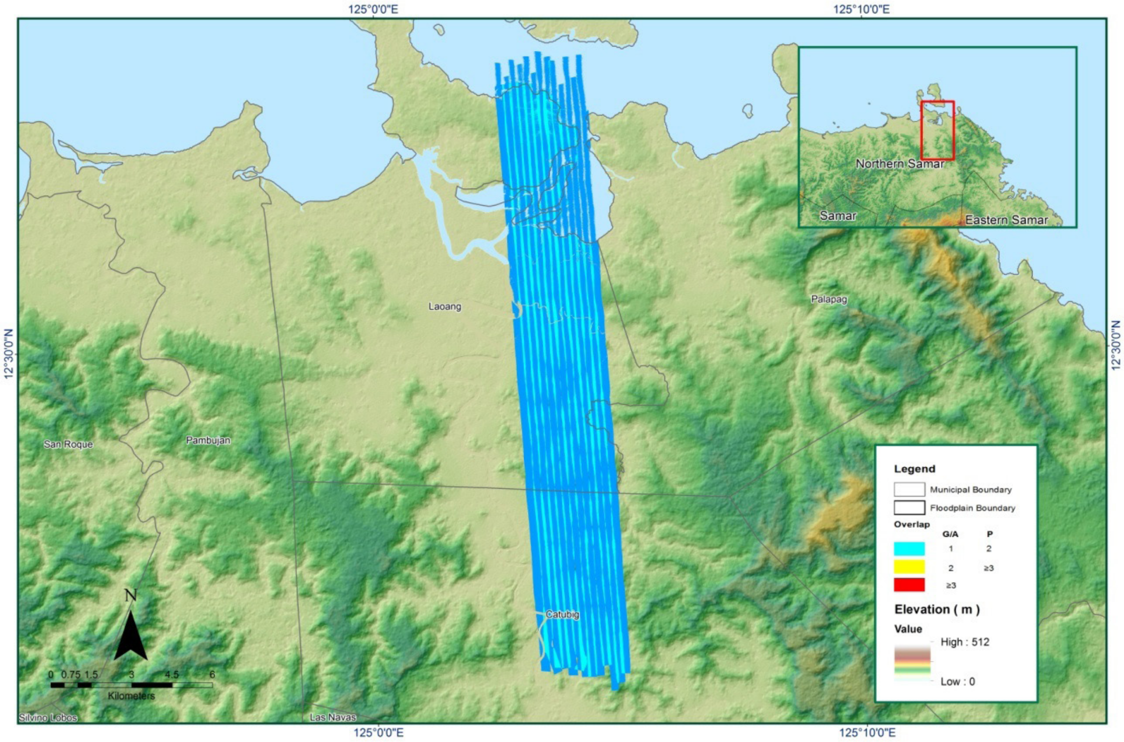


Figure A-8.33. Image of data overlap

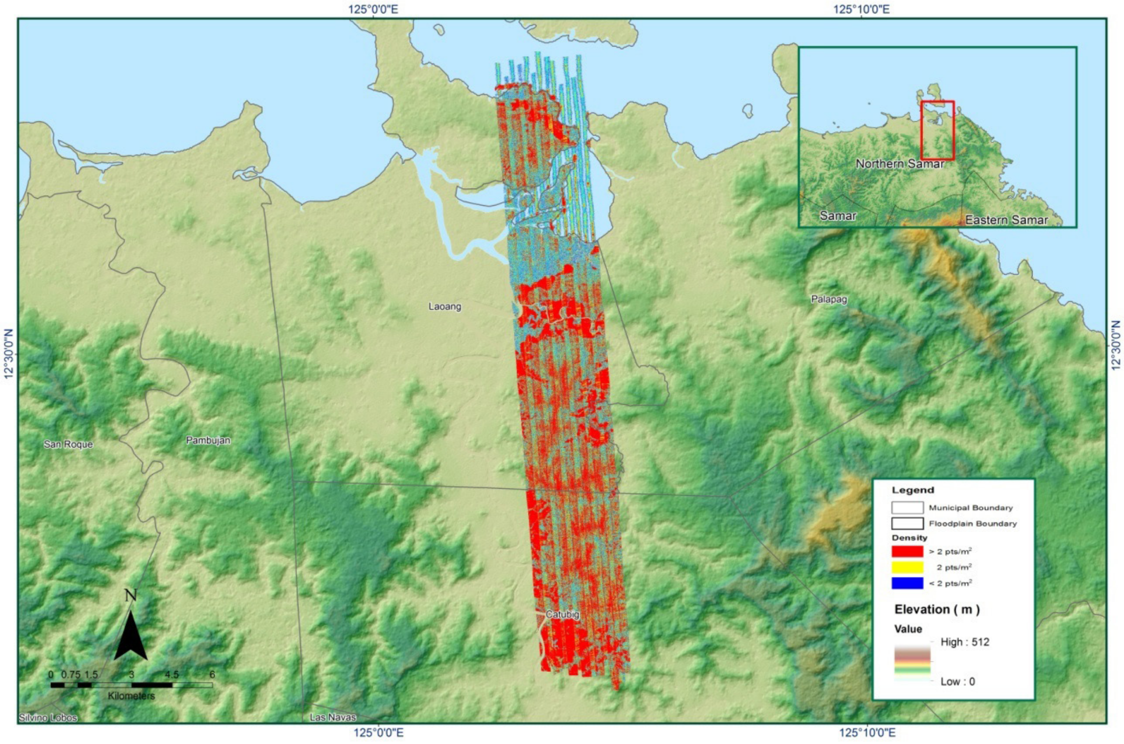


Figure A-8.34. Density map of merged LiDAR data

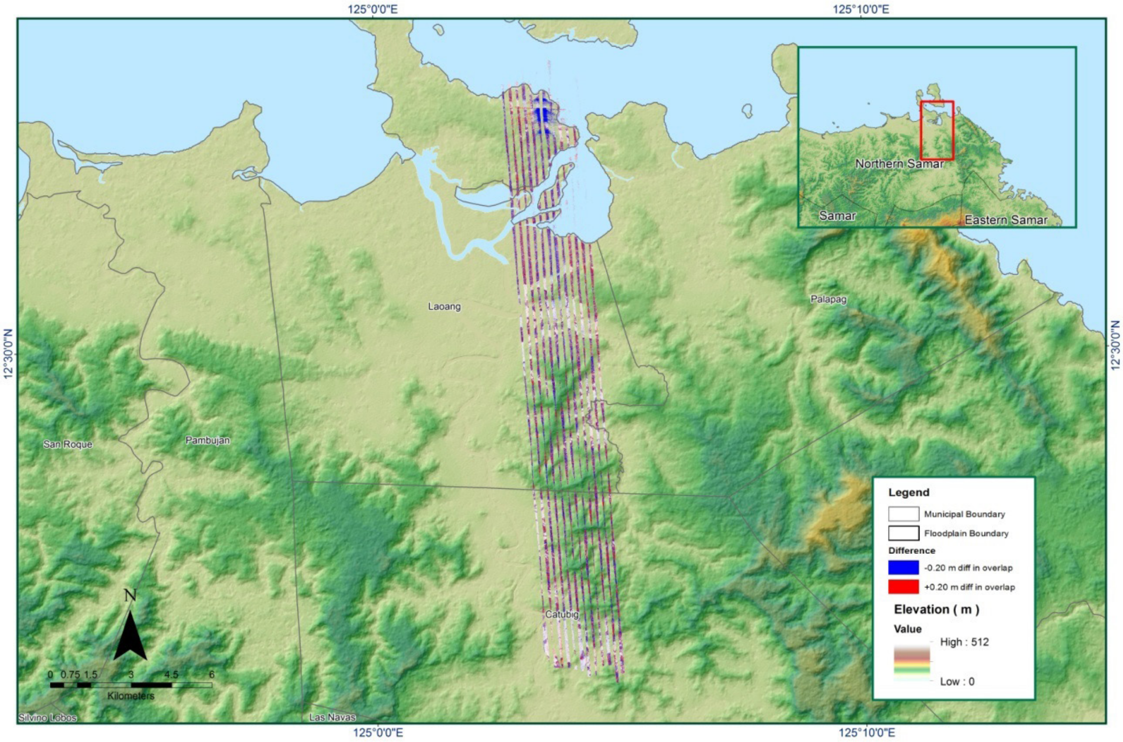


Figure A-8.35. Elevation difference between flight lines

Table A-8.6. Mission Report for Mission Blk33P_supplement

Flight Area	**Catarman**
Mission Name	**Blk33P_supplement**
Inclusive Flights	8184AC, 8186AC
Range data size	9.7 GB
Base data size	19.71 MB
POS	359 MB
Image	36.9 GB
Transfer date	September 16, 2015
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)	0.95
RMSE for East Position (<4.0 cm)	1.1
RMSE for Down Position (<8.0 cm)	2.4
Boresight correction stdev (<0.001deg)	0.002572
IMU attitude correction stdev (<0.001deg)	0.663990
GPS position stdev (<0.01m)	0.0484
Minimum % overlap (>25)	11.37
Ave point cloud density per sq.m. (>2.0)	2.02
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	56
Maximum Height	261.76 m
Minimum Height	53.30 m
Classification (# of points)	
Ground	10,690,203
Low vegetation	12,825,101
Medium vegetation	29,768,416
High vegetation	12,914,546
Building	324,684
Orthophoto	No
Processed by	Engr. Jennifer Saguran, Engr. Velina Angela Bemida, Jovy Narisma

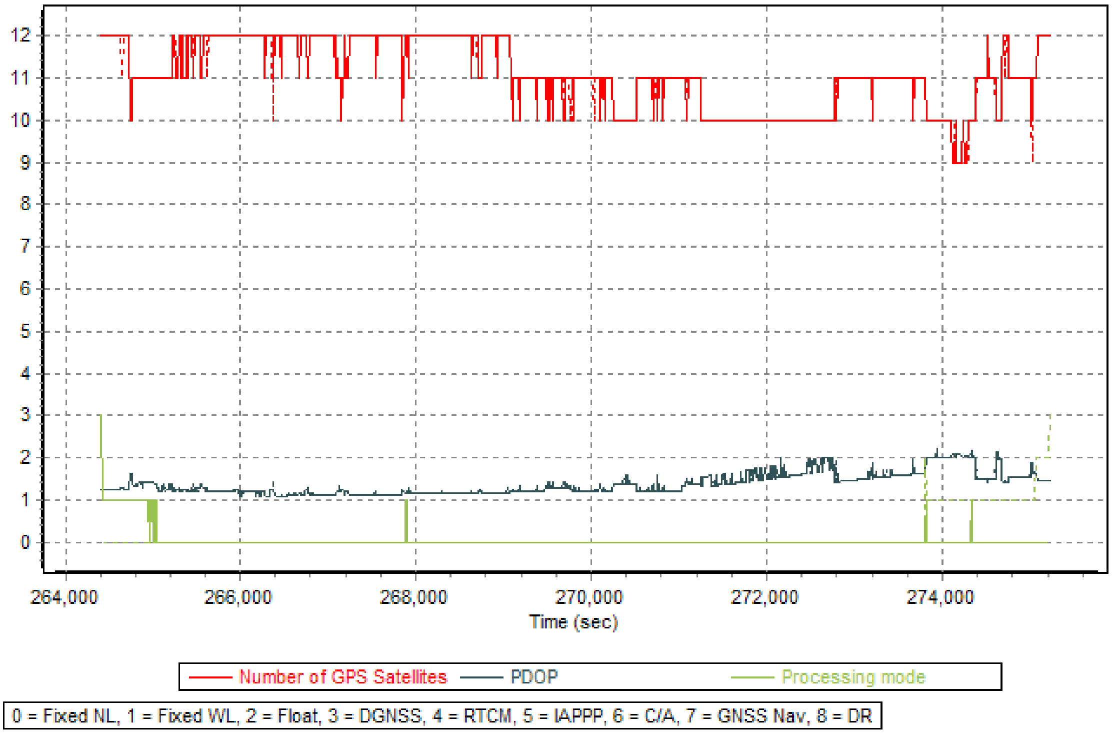


Figure A-8.36. Solution Status

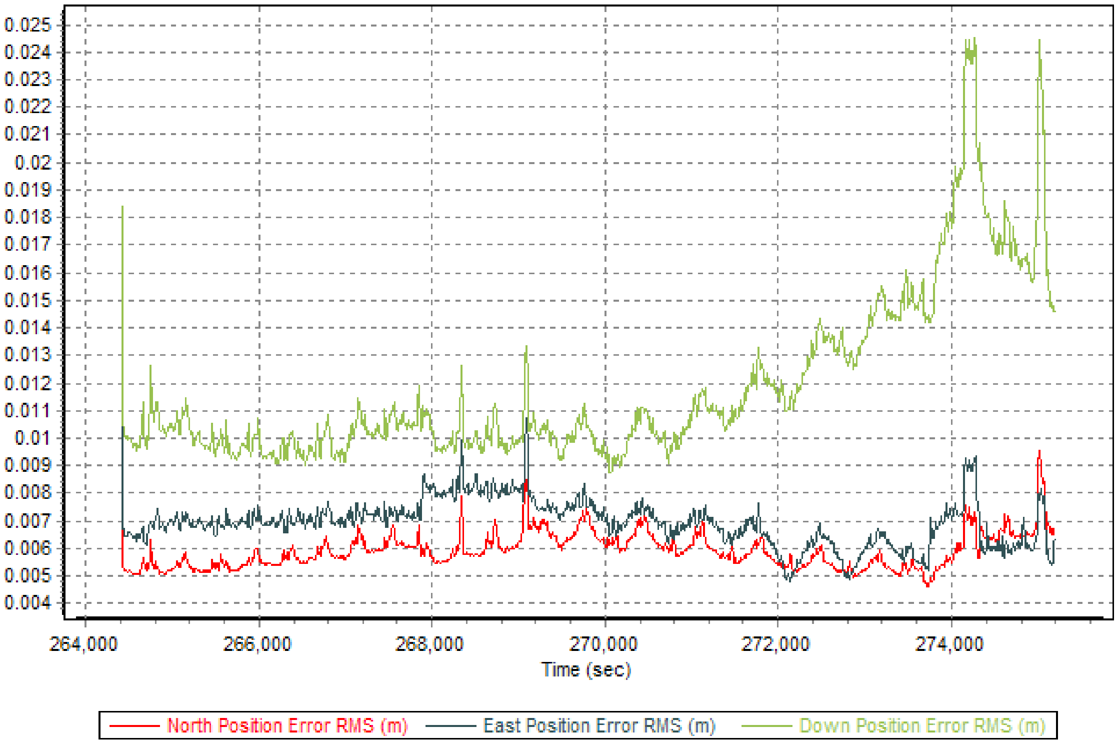


Figure A-8.37. Smoothed Performance Metric Parameters

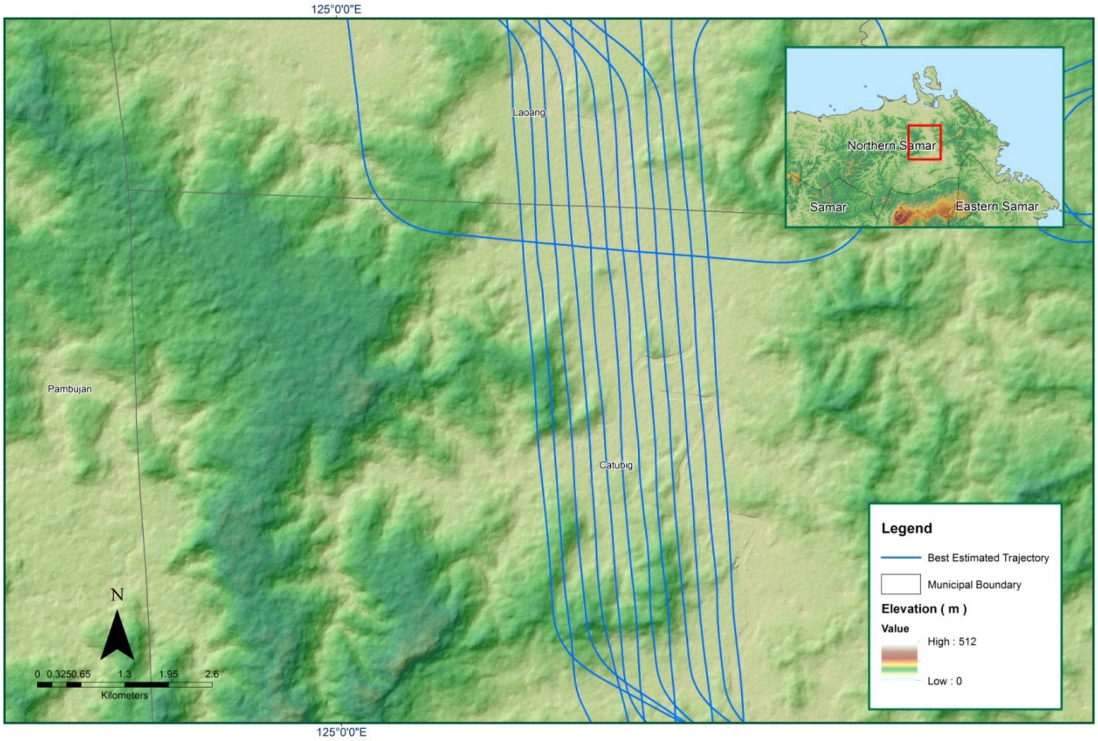


Figure A-8.38. Best Estimated Trajectory

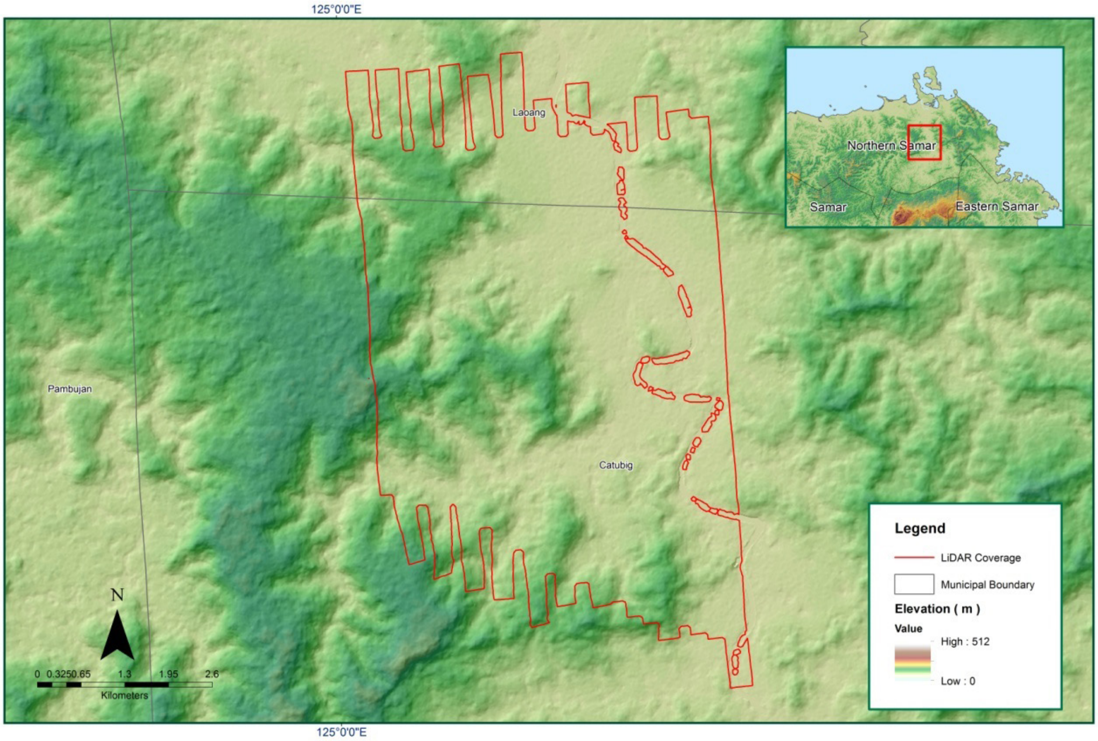


Figure A-8.39. Coverage of LiDAR data

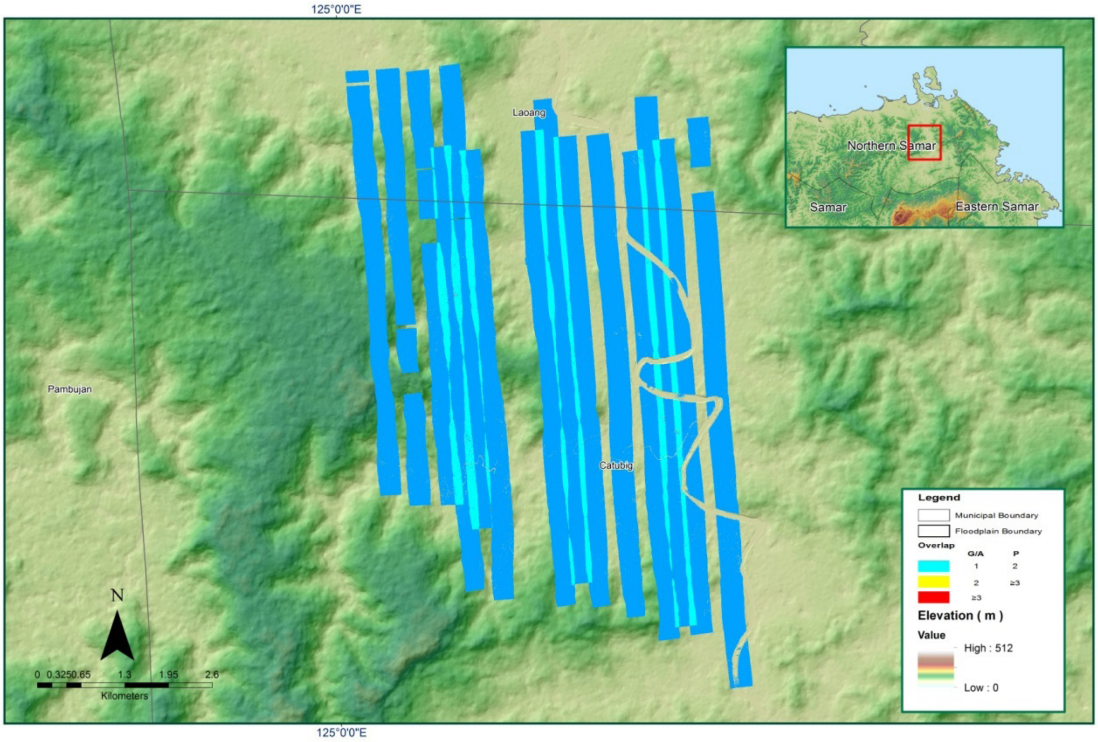


Figure A-8.40. Image of data overlap

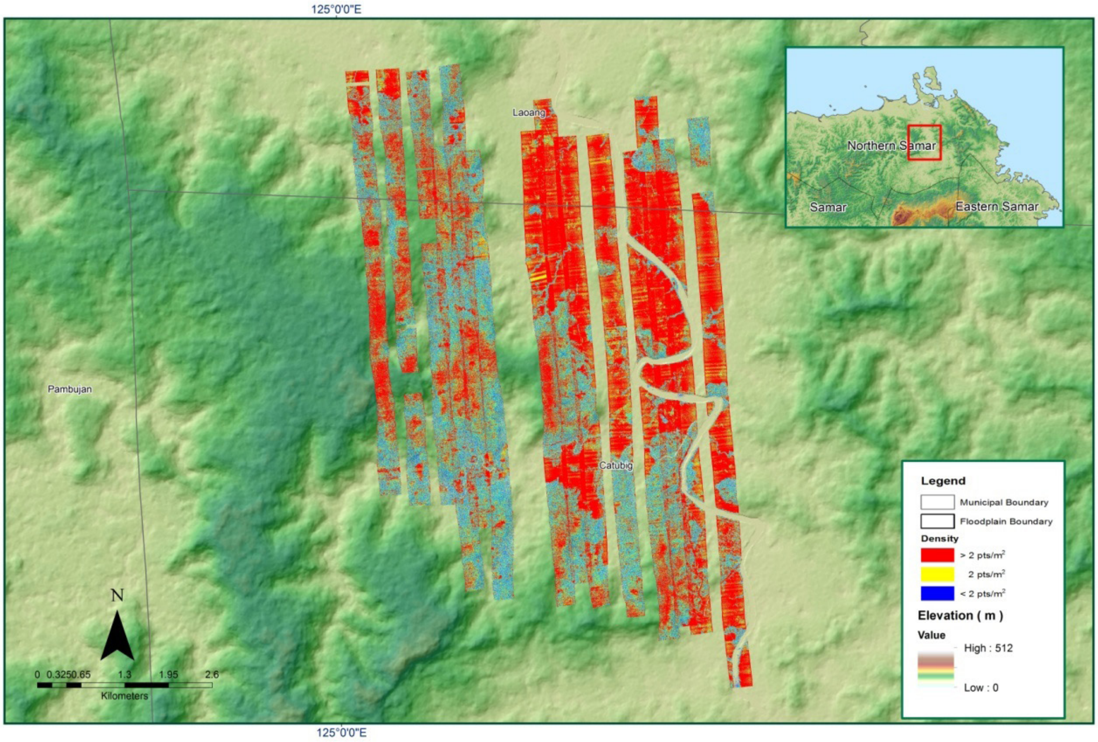


Figure A-8.41. Density map of merged LiDAR data

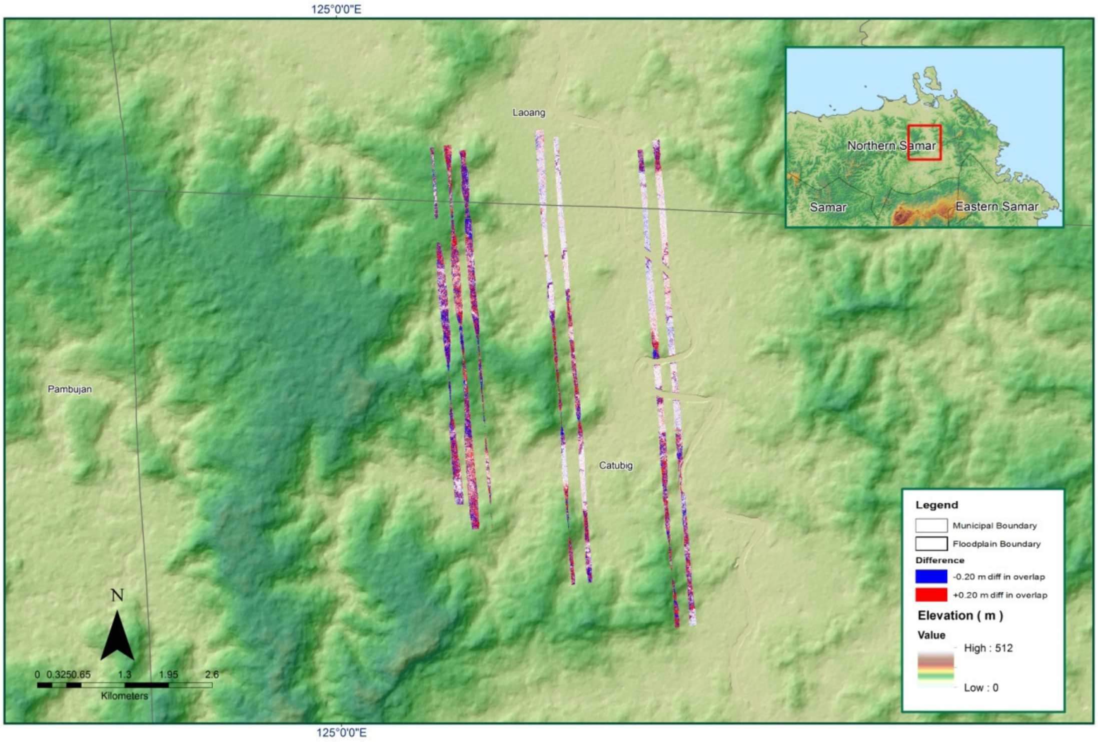


Figure A-8.42. Elevation difference between flight lines

Table A-8.7. Mission Report for Mission Blk331N

Flight Area	Catarman
Mission Name	**Blk331N**
Inclusive Flights	8157AC,8156AC
Range data size	25.4 GB
Base data size	67.7 MB
POS	386 MB
Image	NA
Transfer date	September 8, 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)	1.1653
RMSE for East Position (<4.0 cm)	1.2712
RMSE for Down Position (<8.0 cm)	3.085
Boresight correction stdev (<0.001deg)	0.001879
IMU attitude correction stdev (<0.001deg)	0.003677
GPS position stdev (<0.01m)	0.0030
Minimum % overlap (>25)	35.78%
Ave point cloud density per sq.m. (>2.0)	2.20
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	150
Maximum Height	164.21
Minimum Height	58.70
Classification (# of points)	
Ground	36,546,278
Low vegetation	39,124,561
Medium vegetation	75,292,893
High vegetation	20,120,535
Building	907,283
Orthophoto	None
Processed by	Engr. Regis Guhiting, Engr. Melanie Hingpit, Engr. Ma. Ailyn Olanda

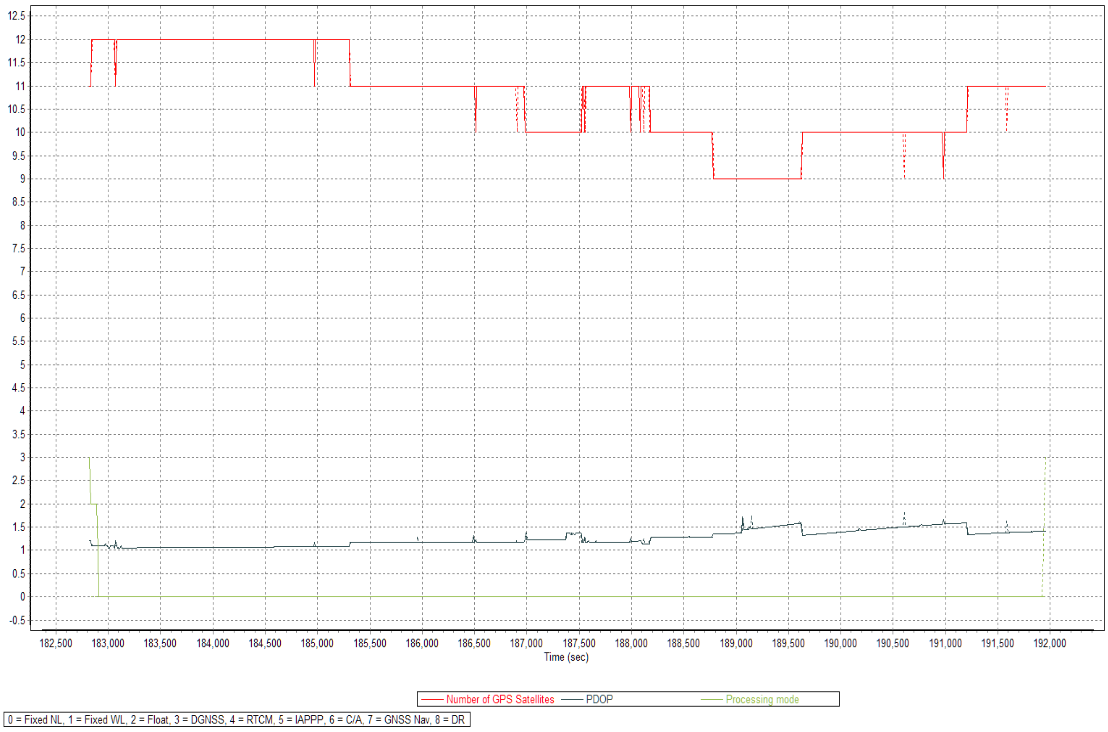


Figure A-8.43. Solution Status

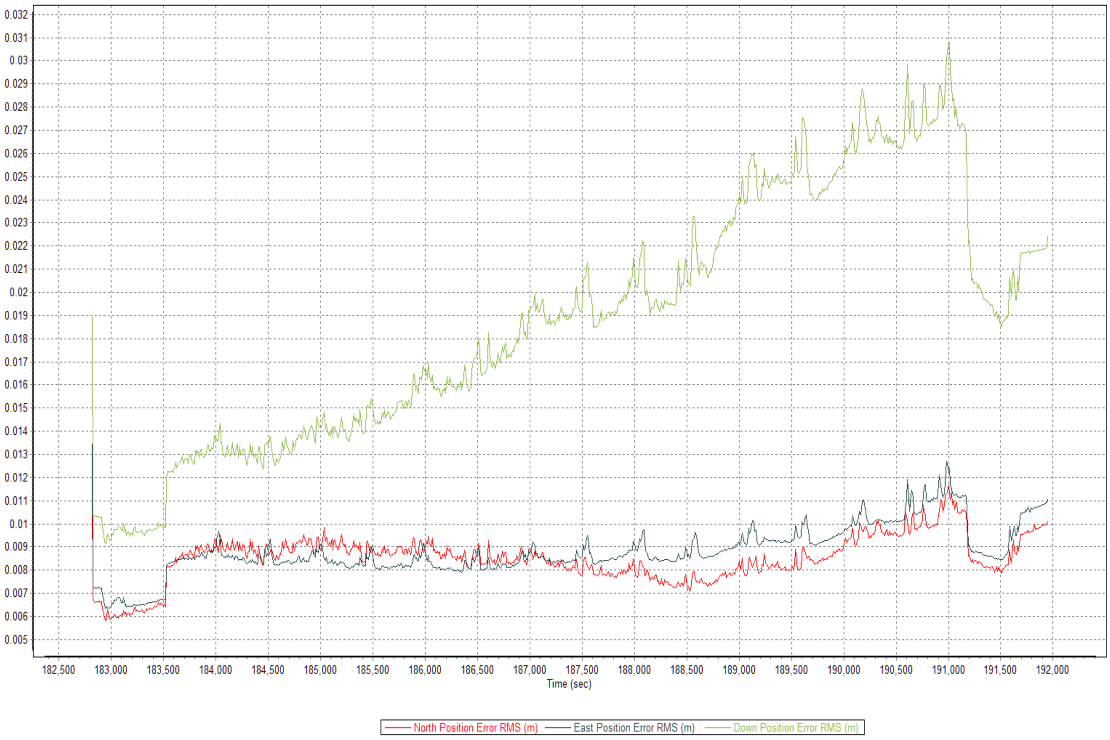


Figure A-8.44. Smoothed Performance Metric Parameters

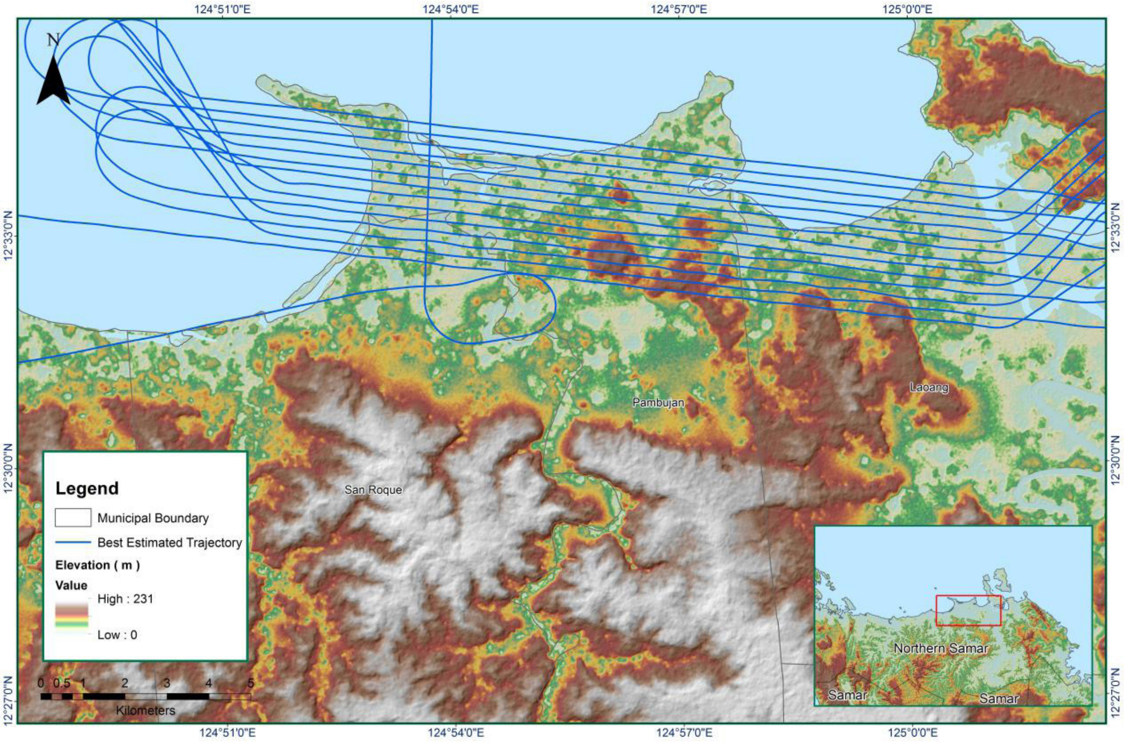


Figure A-8.45. Best Estimated Trajectory

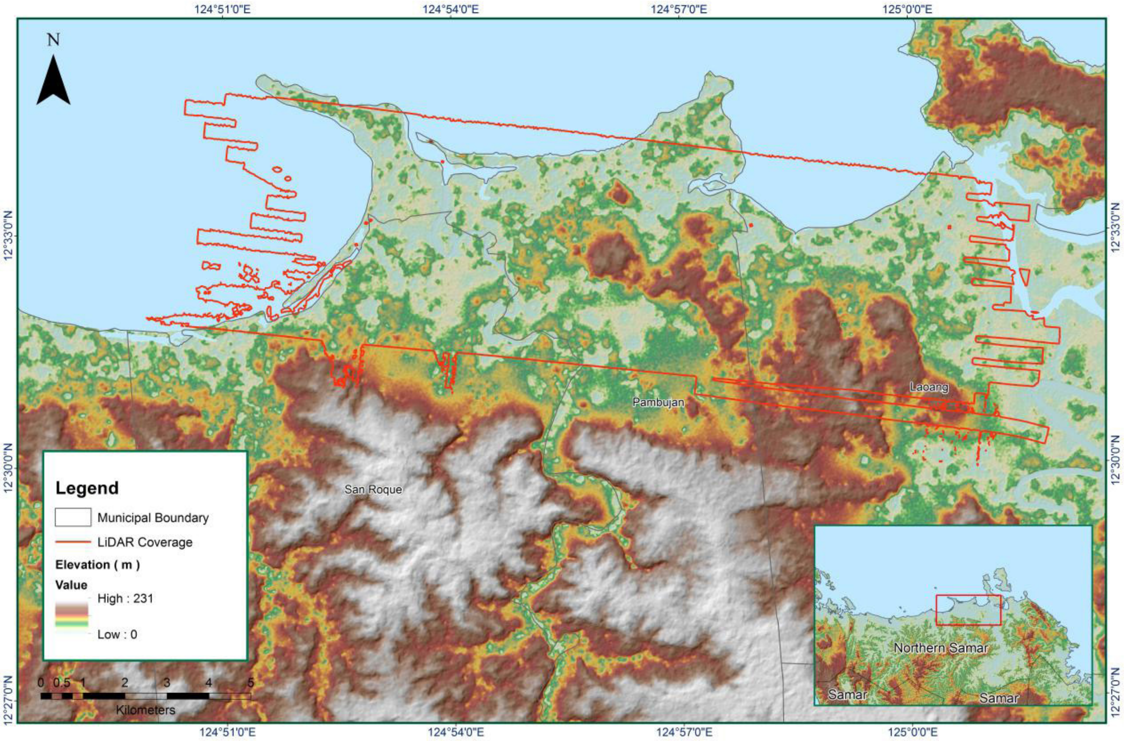


Figure A-8.46. Coverage of LiDAR data

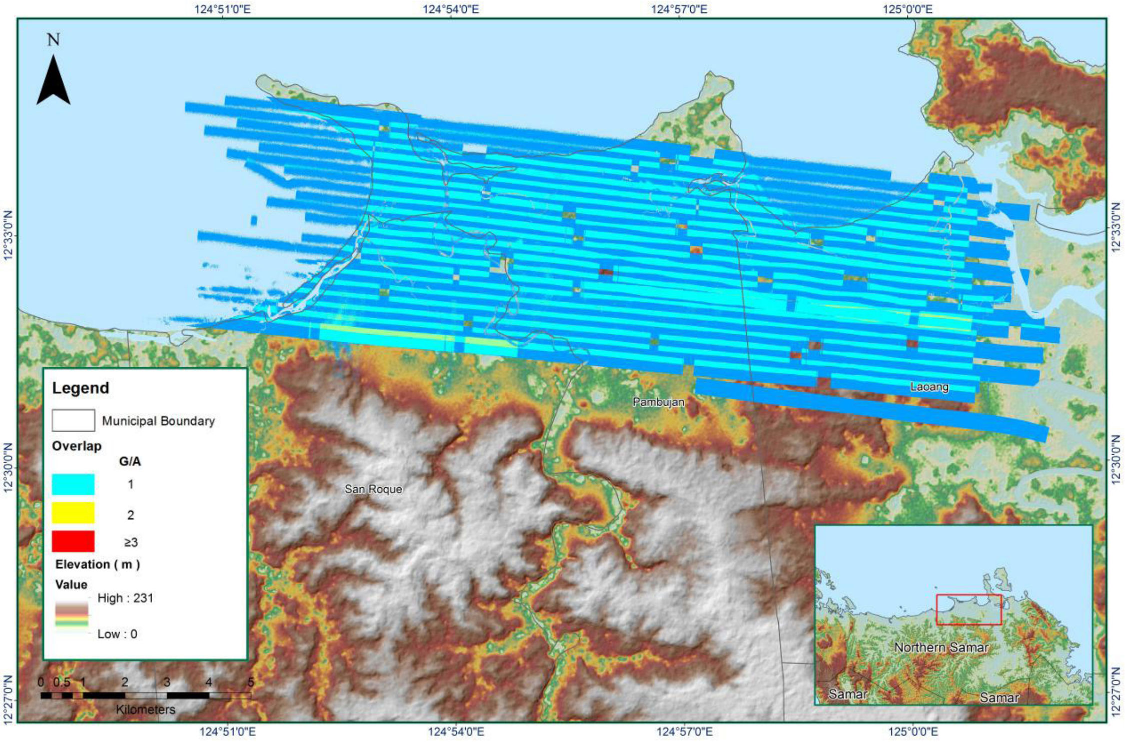


Figure A-8.47. Image of data overlap

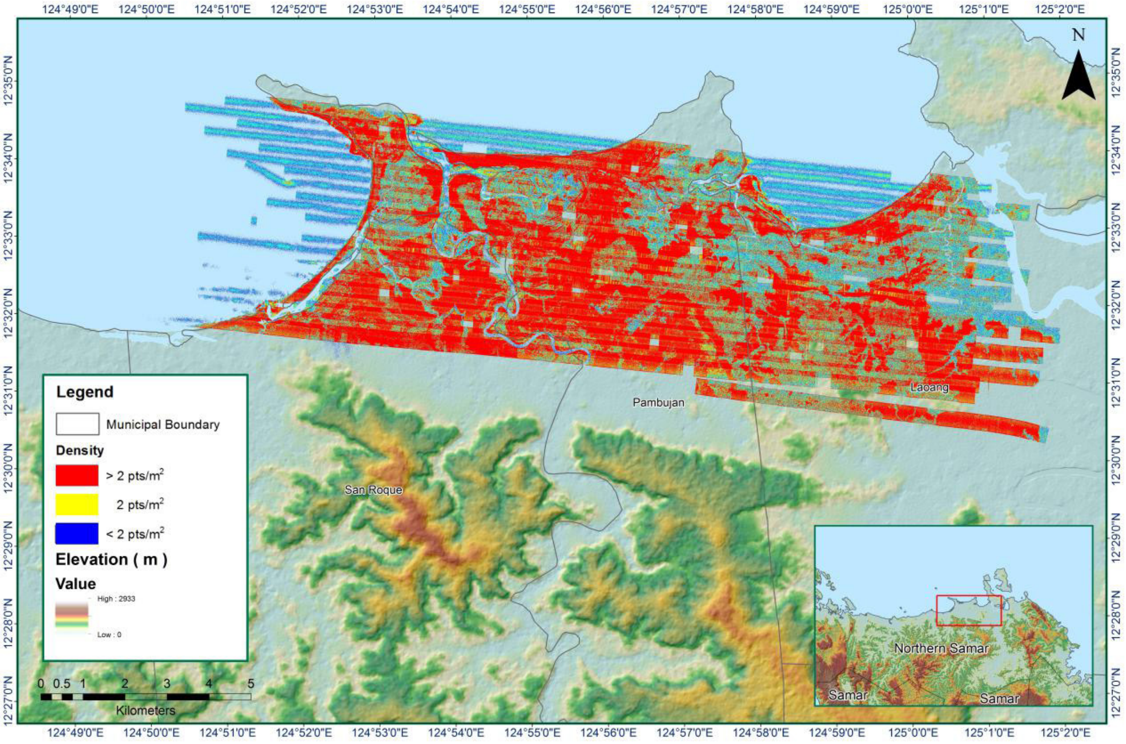


Figure A-8.48. Density Map of merged LiDAR data

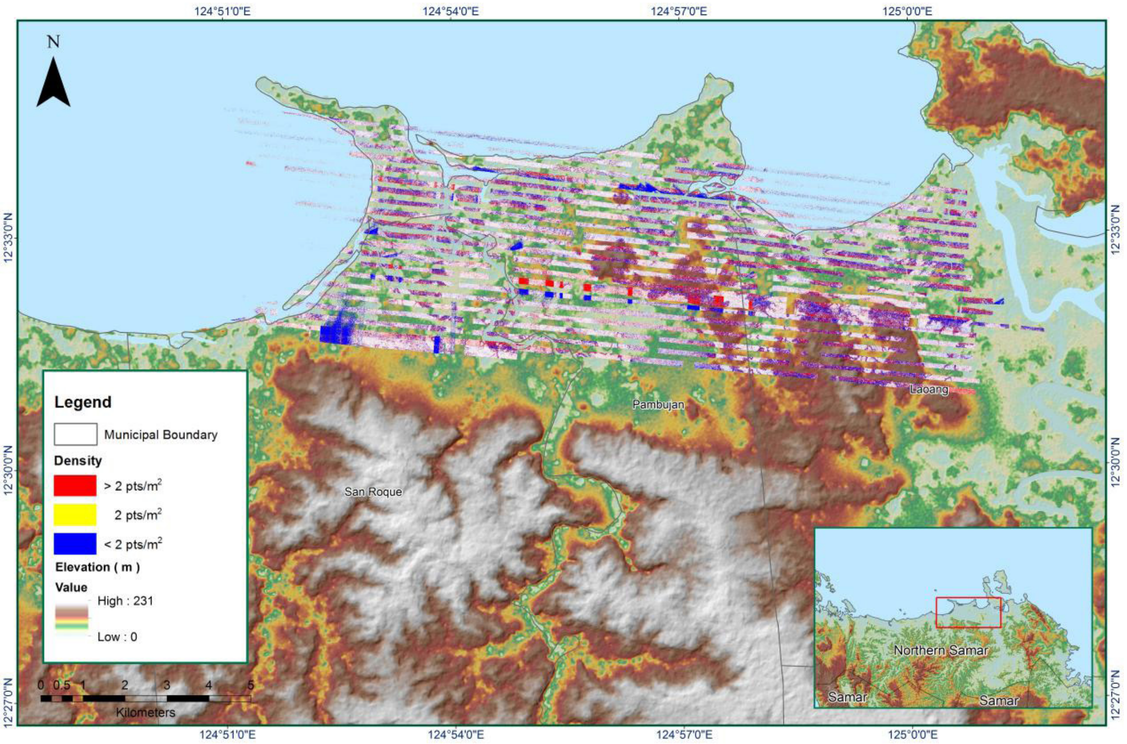


Figure A-8.49. Elevation Difference Between flight lines

Table A-8.8. Mission Report for Mission Blk331O

Flight Area	Catarman
Mission Name	**Blk331O**
Inclusive Flights	7830AC, 7836AC
Range data size	16.92 GB
POS	348 MB
Image	na
Transfer date	July 3, 2015
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)	1.0
RMSE for East Position (<4.0 cm)	1.36
RMSE for Down Position (<8.0 cm)	3.2
Boresight correction stdev (<0.001deg)	0.000468
IMU attitude correction stdev (<0.001deg)	0.001769
GPS position stdev (<0.01m)	0.0036
Minimum % overlap (>25)	38.89
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	146
Maximum Height	318.23 m
Minimum Height	55.58 m
Classification (# of points)	
Ground	97,621,027
Low vegetation	44,030,503
Medium vegetation	38,753,556
High vegetation	33,405,153
Building	2,661
Orthophoto	No
Processed by	Engr. Irish Cortez, Engr. Mark Joshua Salvacion, Engr. Krisha Marie Bautista

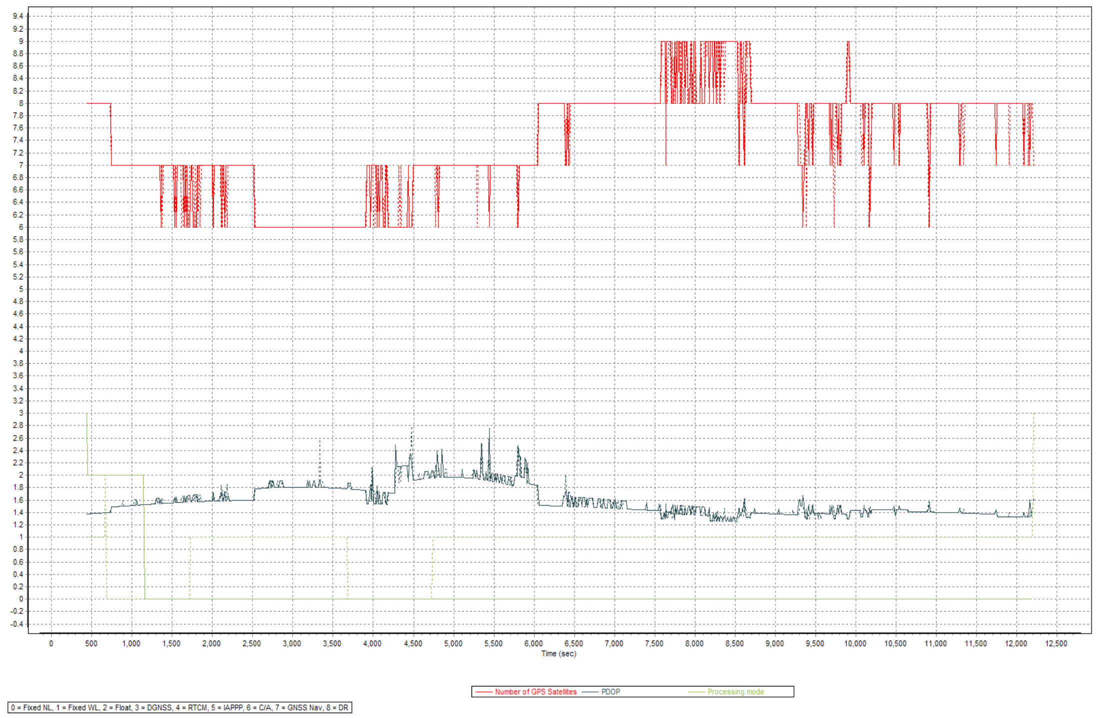


Figure A-8.50. Solution Status

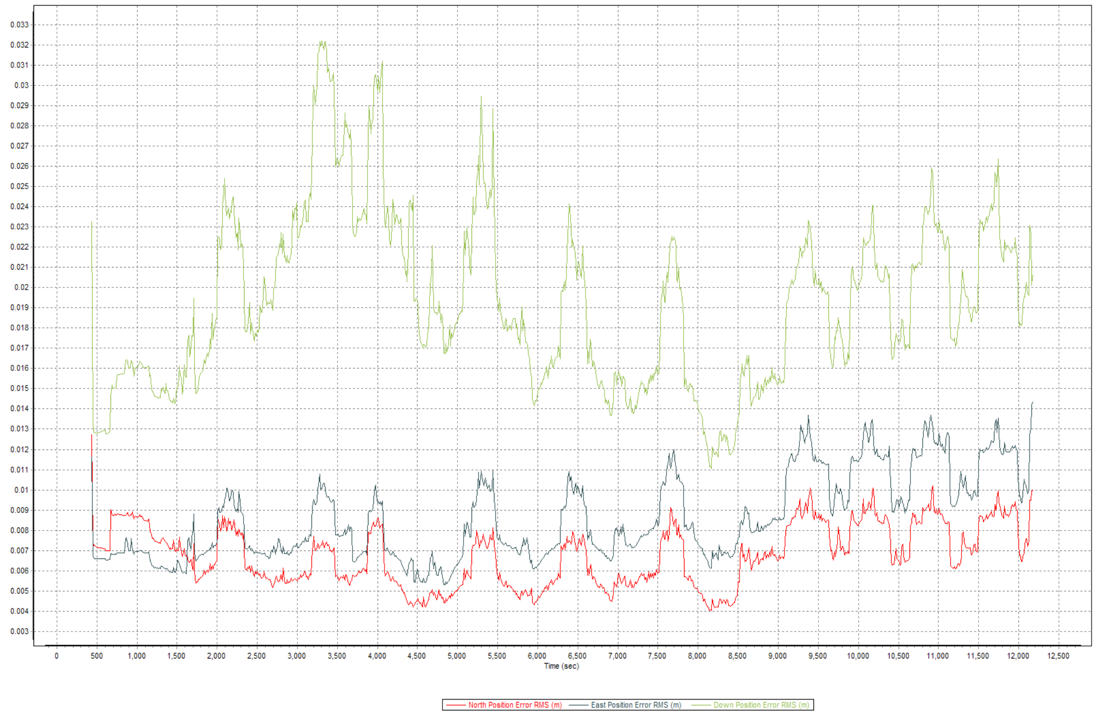


Figure A-8.51. Smoothed Performance Metric Parameters

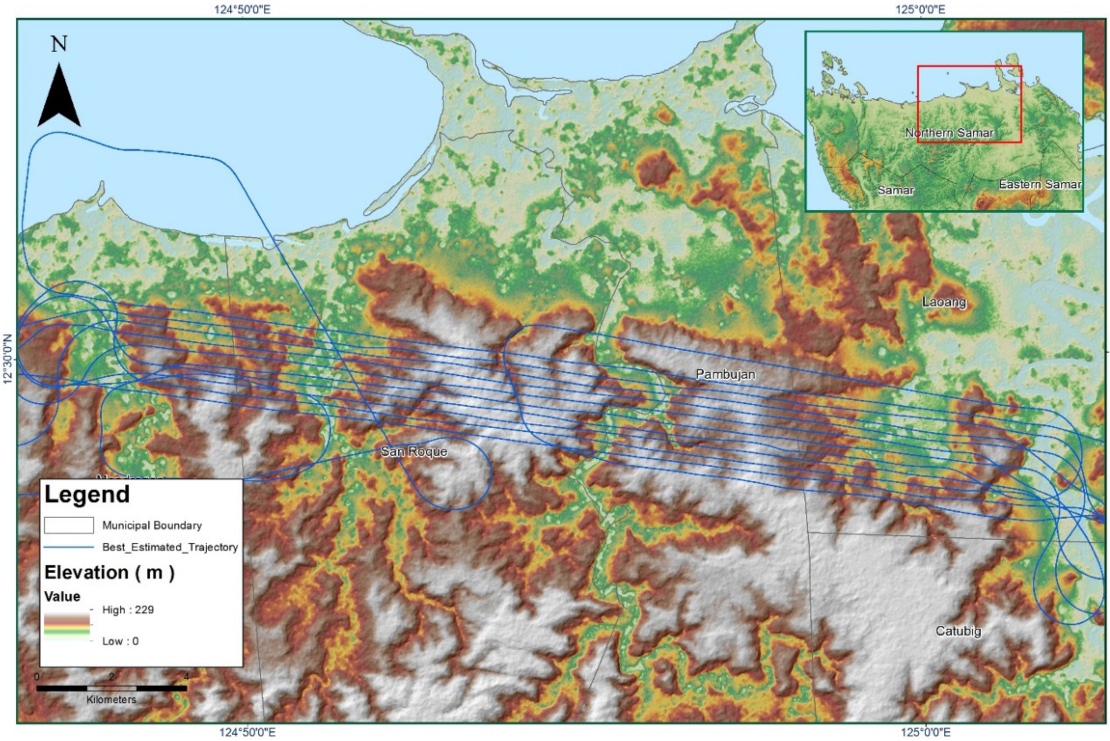


Figure A-8.52. Best Estimated Trajectory

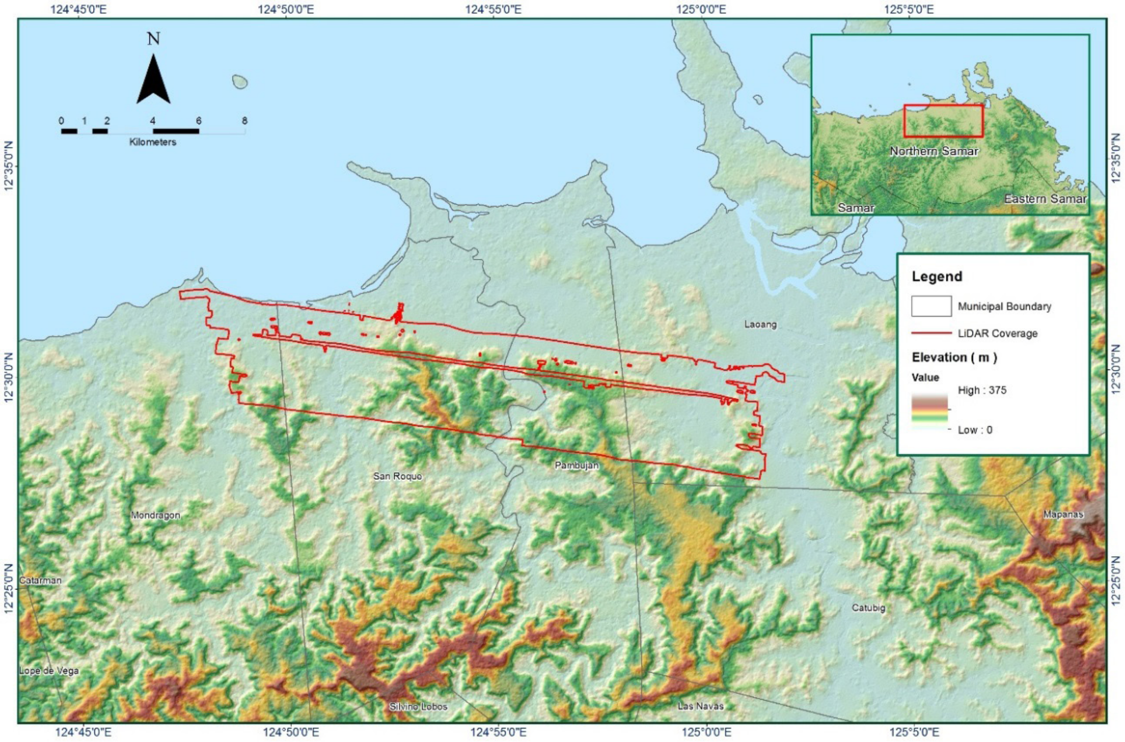


Figure A-8.53. Coverage of LiDAR data

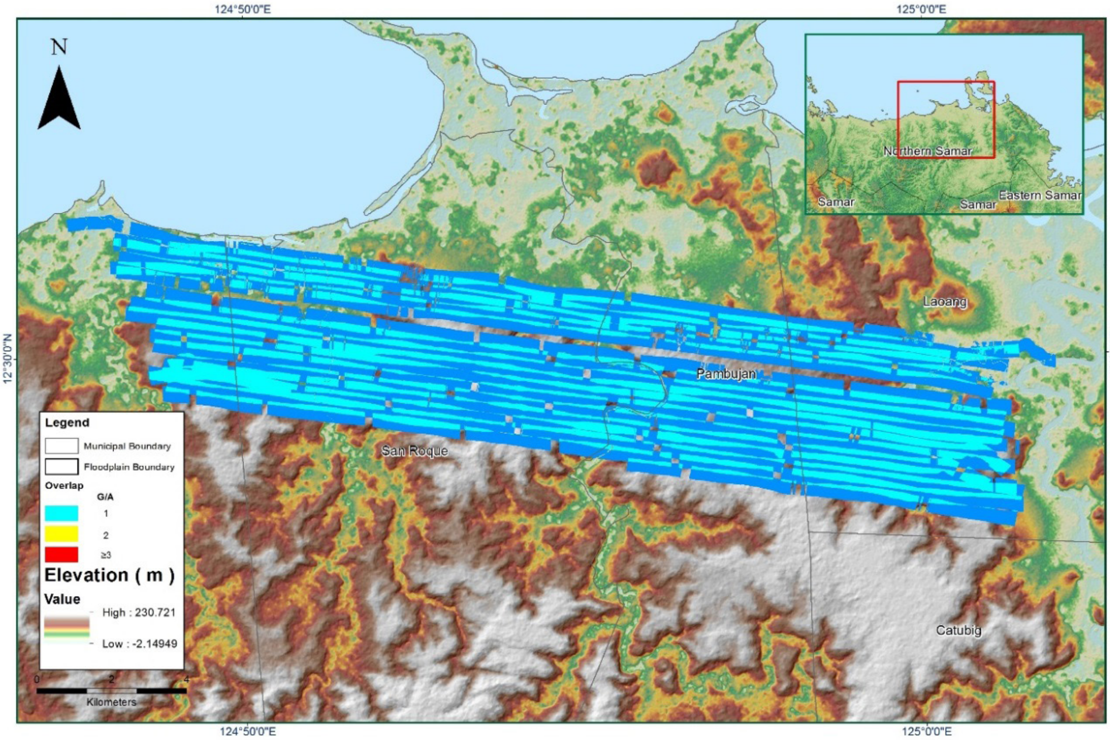


Figure A-8.54, Image of data overlap

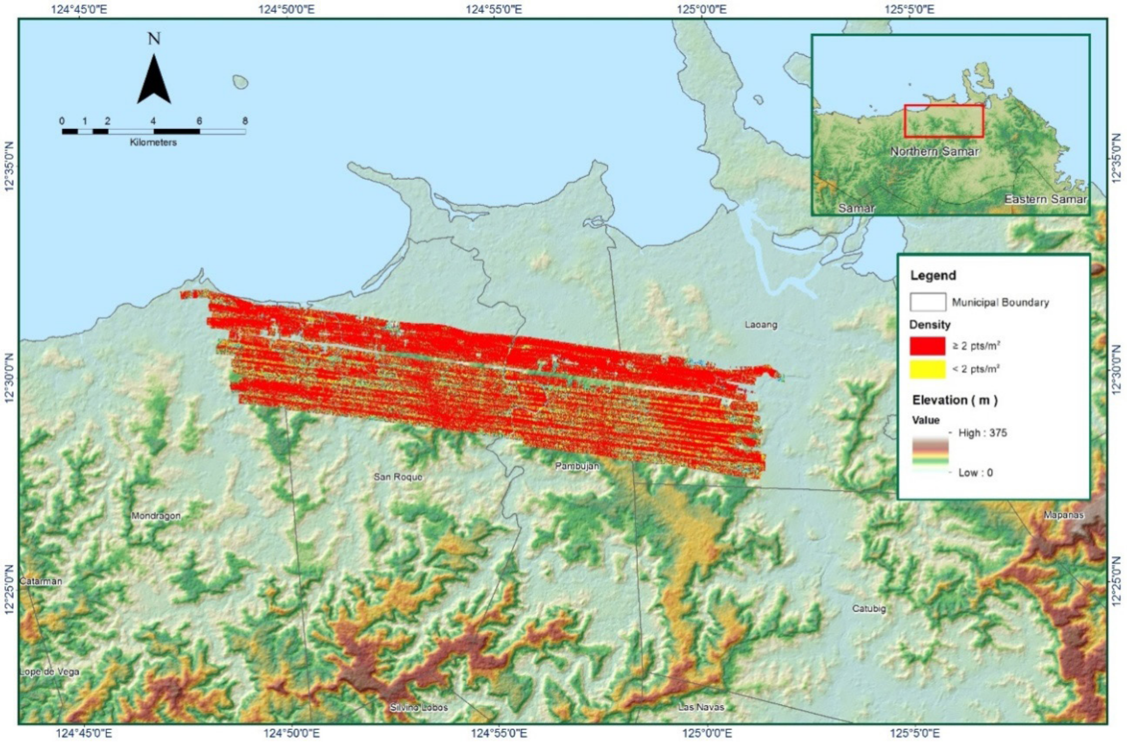


Figure A-8.55. Density map of merged LiDAR data

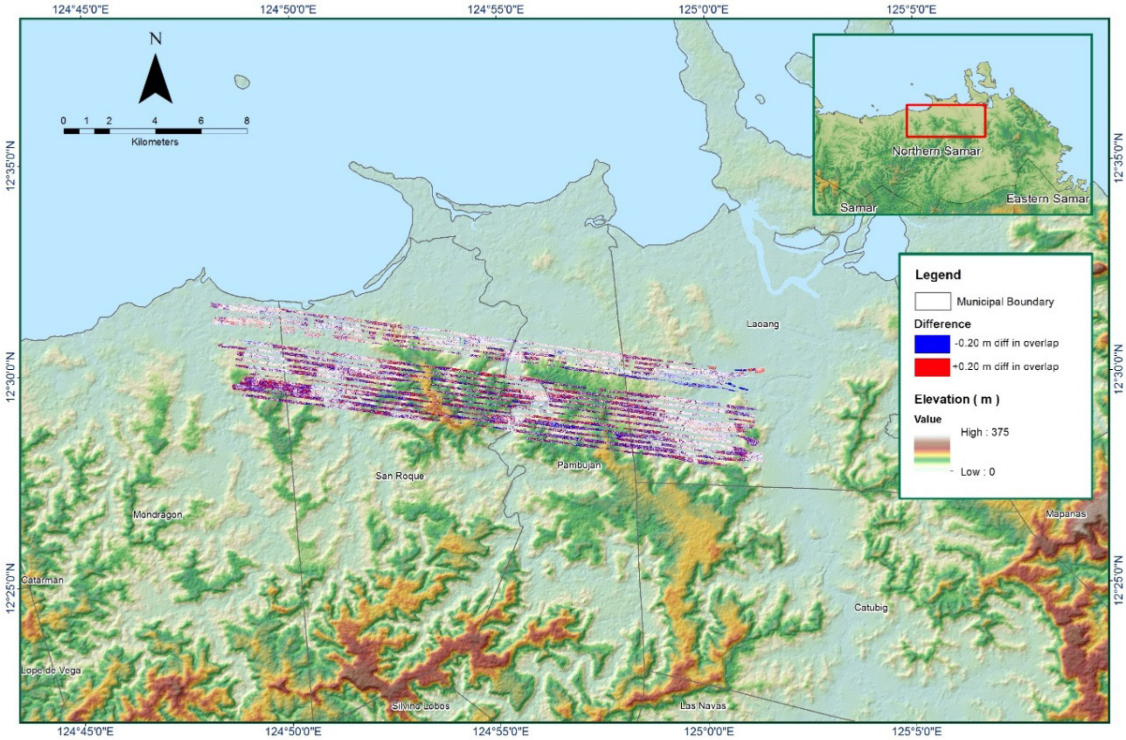


Figure A-8.56, Elevation difference between flight lines

Table A-8.9. Mission Report for Mission Blk331O_supplement

Flight Area	Catarman
Mission Name	Blk331O_supplement
Inclusive Flights	8154AC
Range data size	9.78 GB
Base data size	27.1 MB
POS	185 MB
Image	N/A
Transfer date	September 8, 2015
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)	0.9612
RMSE for East Position (<4.0 cm)	1.4965
RMSE for Down Position (<8.0 cm)	3.5715
Boresight correction stdev (<0.001deg)	0.000683
IMU attitude correction stdev (<0.001deg)	0.002528
GPS position stdev (<0.01m)	0.0034
Minimum % overlap (>25)	37.42%
Ave point cloud density per sq.m. (>2.0)	2.64
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	93
Maximum Height	253.49
Minimum Height	52.21
Classification (# of points)	
Ground	51,112,338
Low vegetation	29,763,575
Medium vegetation	29,143,624
High vegetation	5,682,557
Building	-
Orthophoto	None
Processed by	Engr. Irish Cortez, Engr. Mark Joshua Salvacion, Kathryn Claudyn Zarate

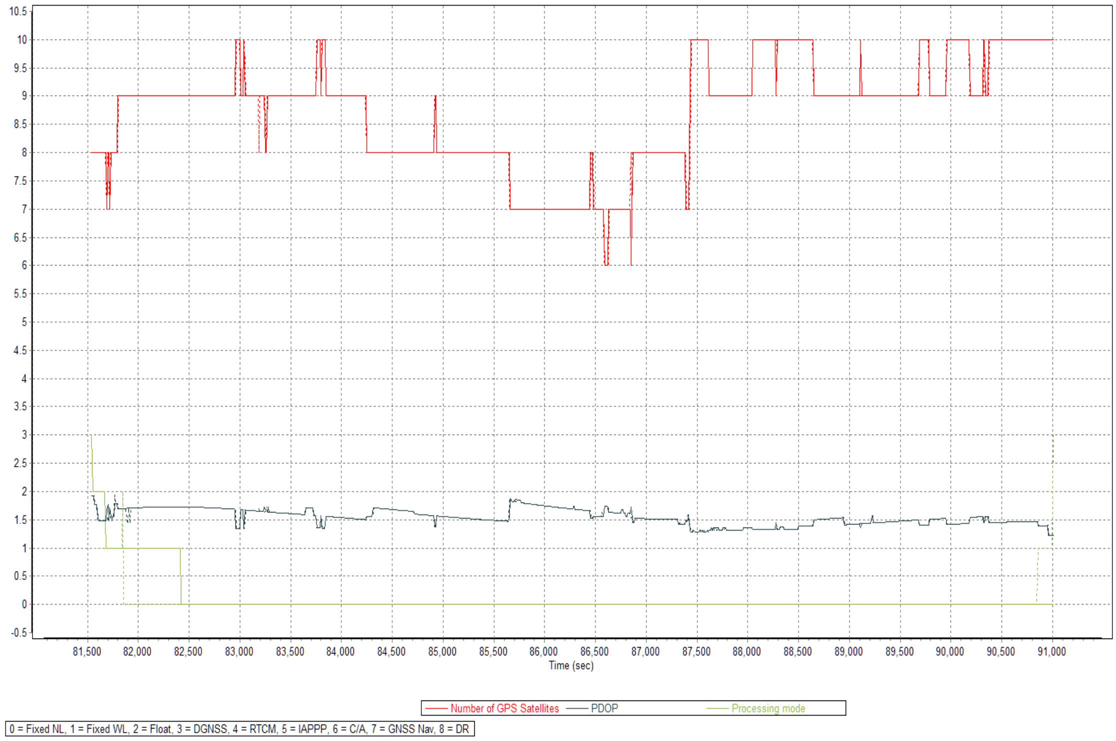


Figure A-8.57. Solution Status

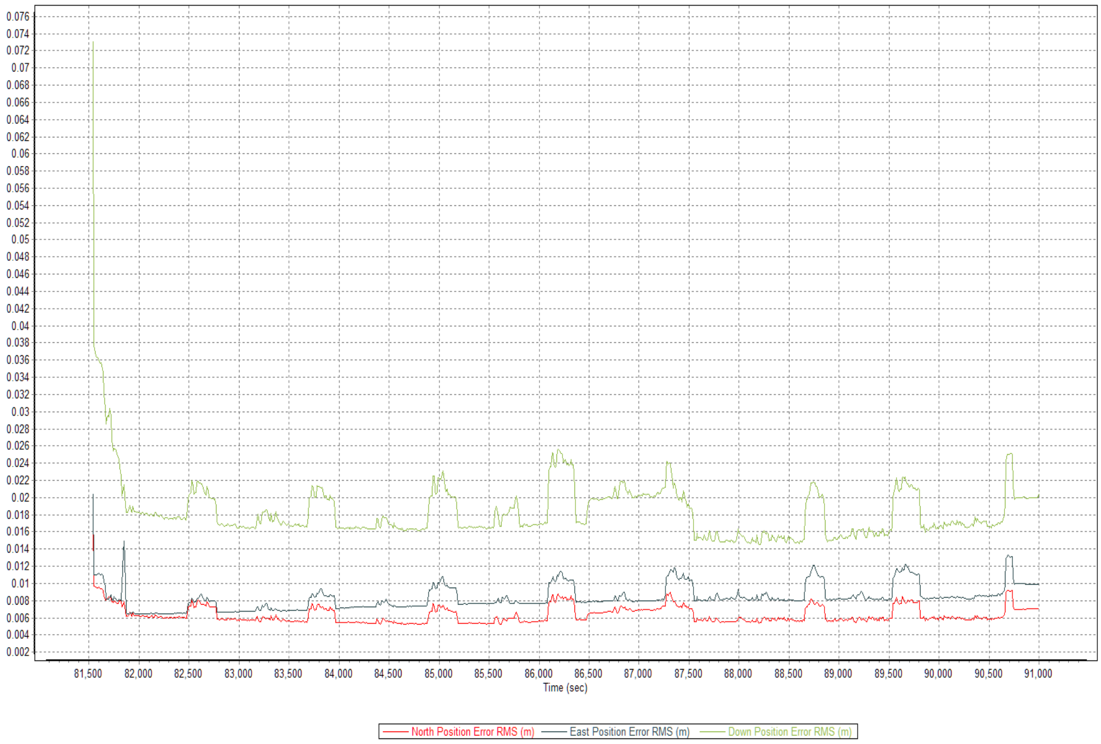


Figure A-8.58. Smoothed Performance Metric Parameters

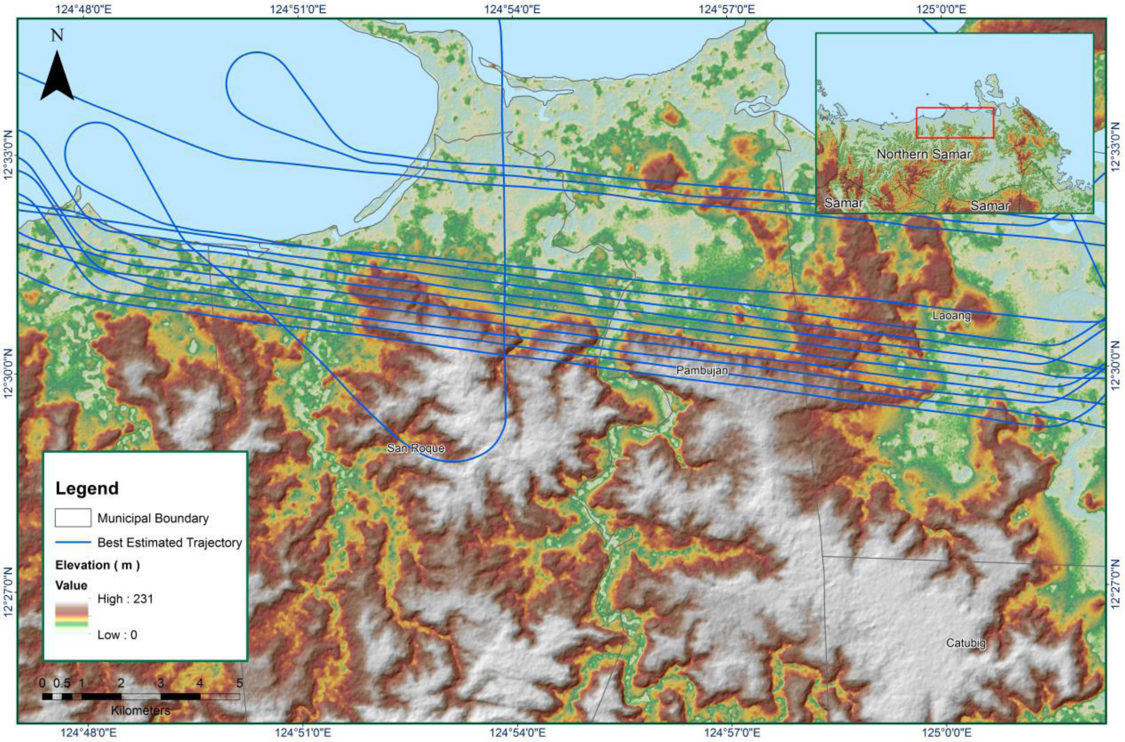


Figure A-8.59. Best Estimated Trajectory

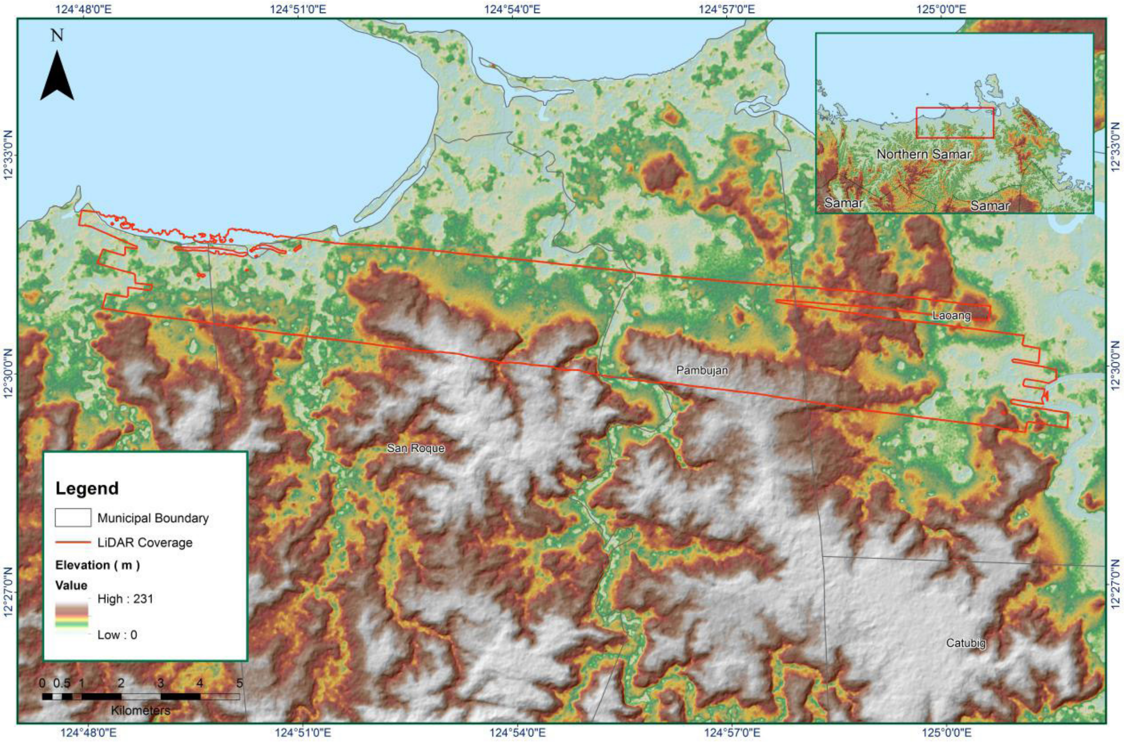


Figure A-8.60. Coverage of LiDAR data

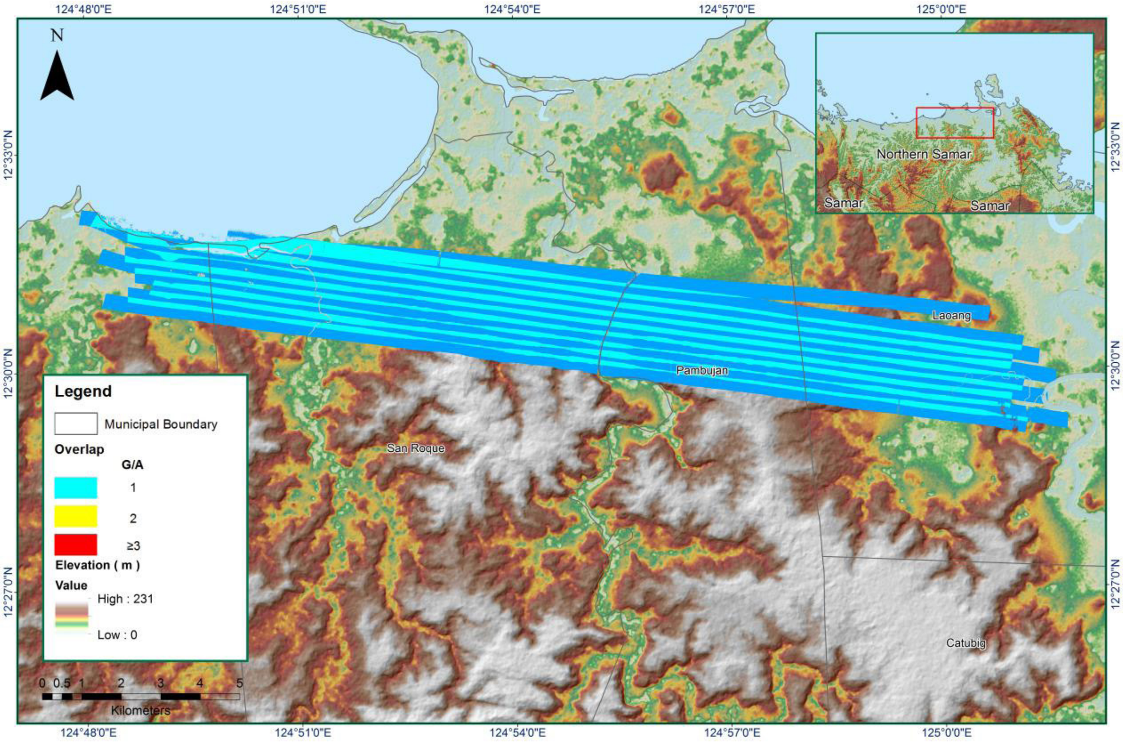


Figure A-8.61. Image of data overlap

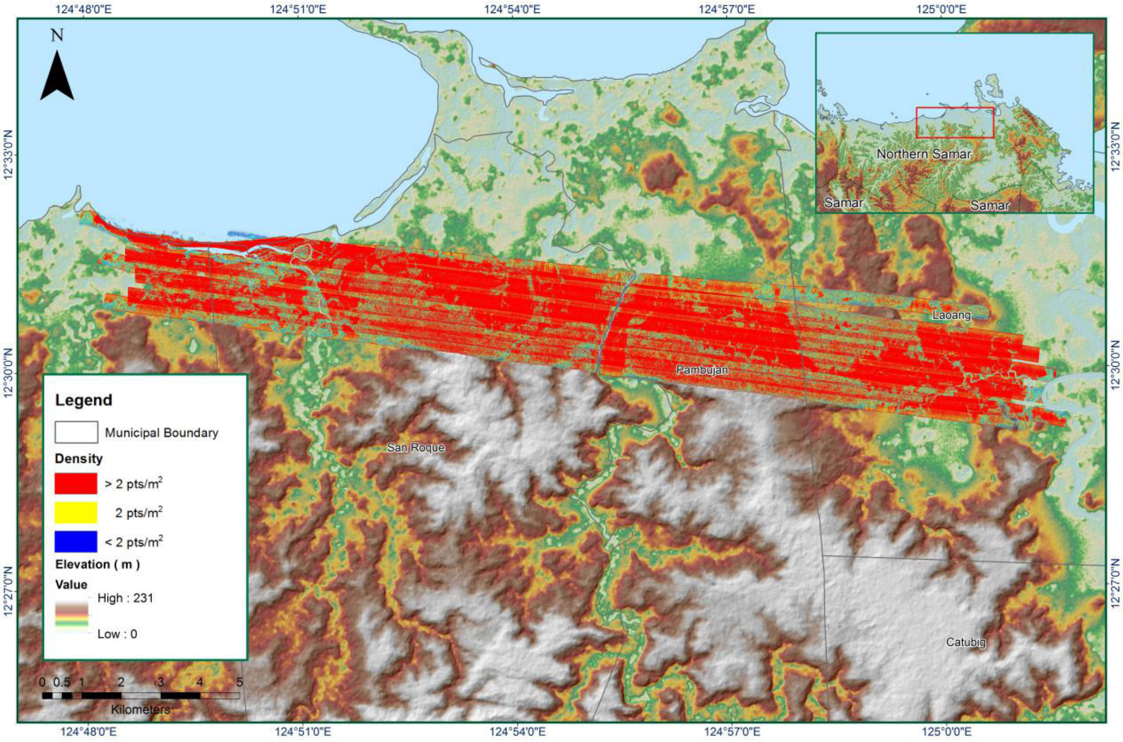


Figure A-8.62. Density Map of merged LiDAR data

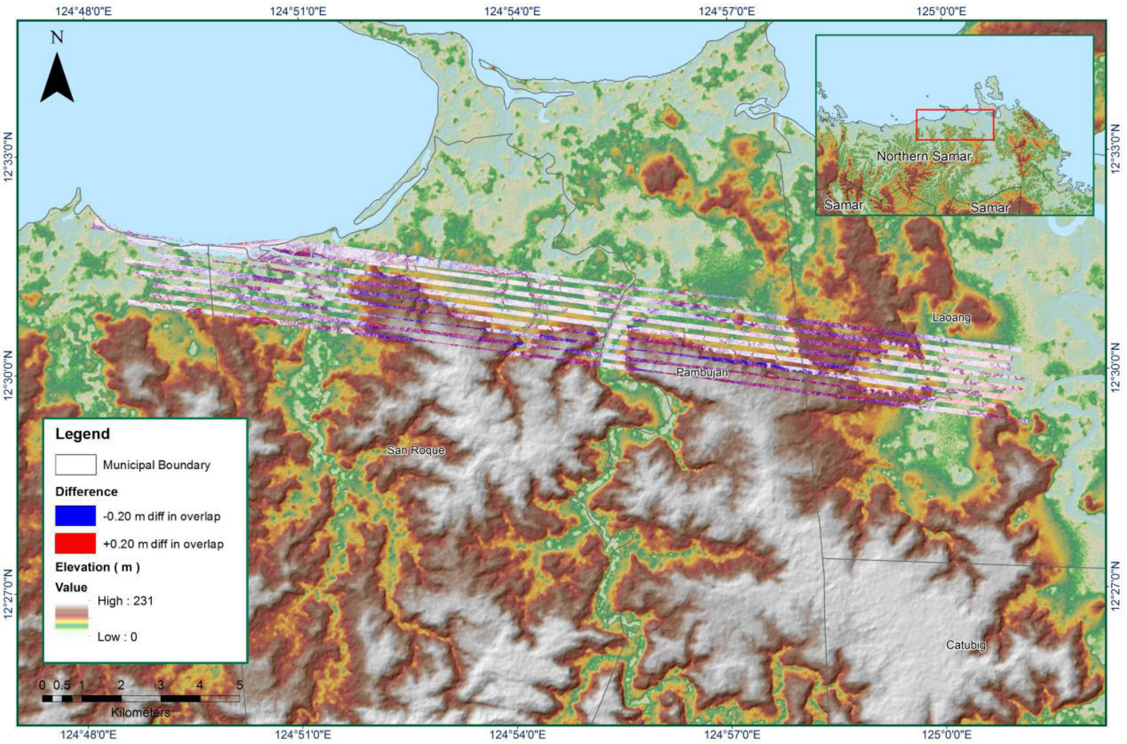


Figure A-8.63. Elevation Difference Between flight lines

Table A-8.10. Mission Report for Mission Blk331O

Flight Area	Catarman Reflights
Mission Name	**Blk 331O**
Inclusive Flights	3917G
Range data size	22.4 GB
POS data size	255 MB
Base data size	195 MB
Image	NA
Transfer date	May 11, 2016
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)	1.215
RMSE for East Position (<4.0 cm)	1.810
RMSE for Down Position (<8.0 cm)	3.612
Boresight correction stdev (<0.001deg)	0.000824
IMU attitude correction stdev (<0.001deg)	0.002066
GPS position stdev (<0.01m)	0.0129
Minimum % overlap (>25)	24.93%
Ave point cloud density per sq.m. (>2.0)	4.41
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	57
Maximum Height	282.75 m
Minimum Height	54.24 m
Classification (# of points)	
Ground	9,468,129
Low vegetation	4,080,365
Medium vegetation	53,608,692
High vegetation	68,936,471
Building	1,105
Orthophoto	No
Processed by	Engr. Kenneth Solidum, Aljon Rei Araneta, Jovy Narisma

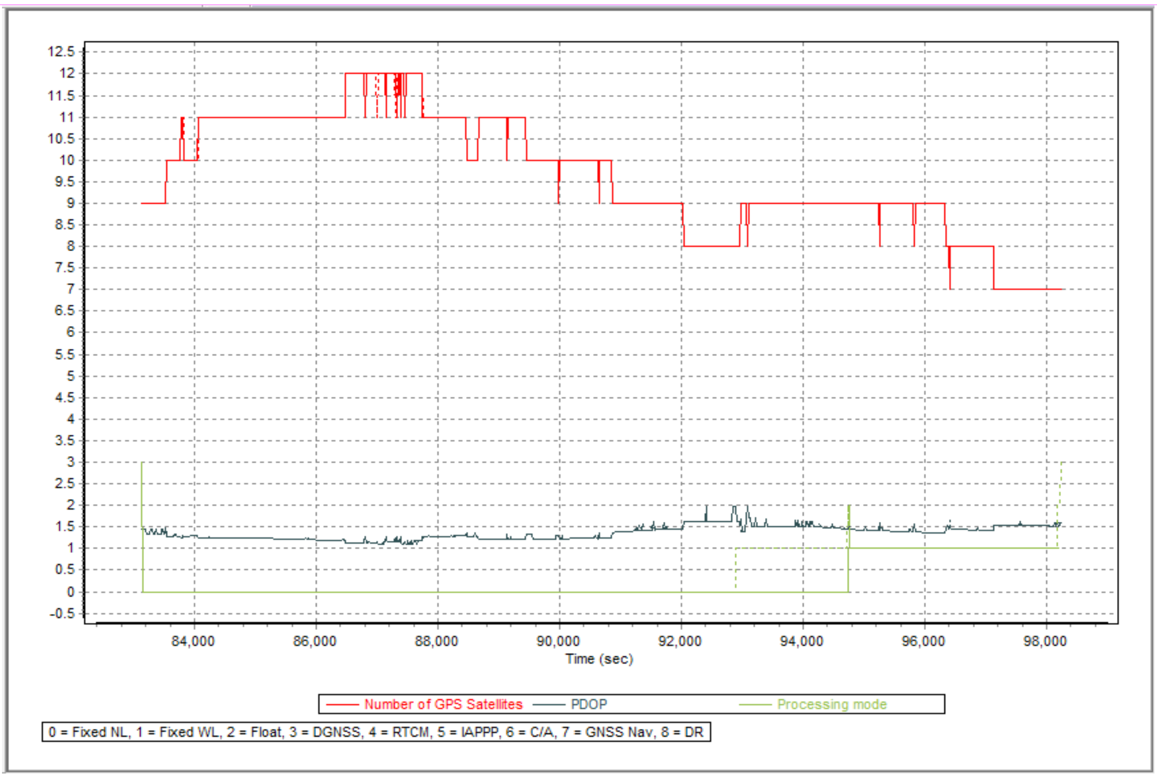


Figure A-8.64. Solution Status

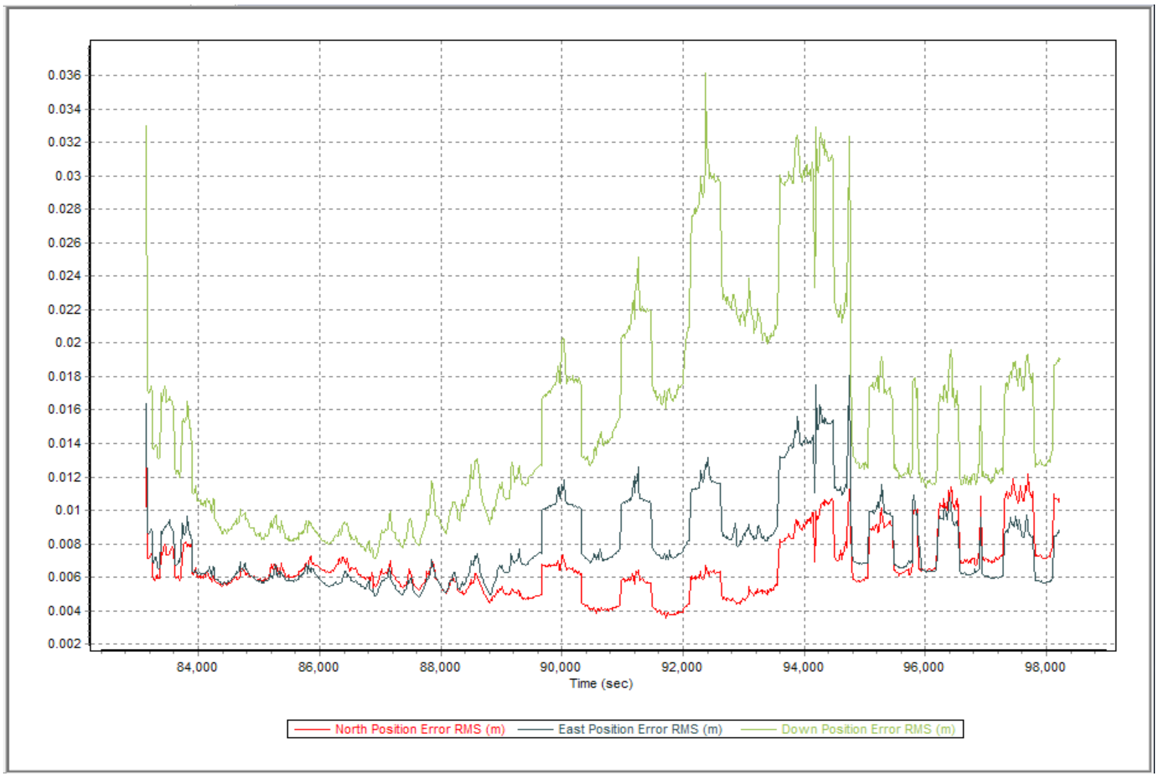


Figure A-8.65. Smoothed Performance Metric Parameters

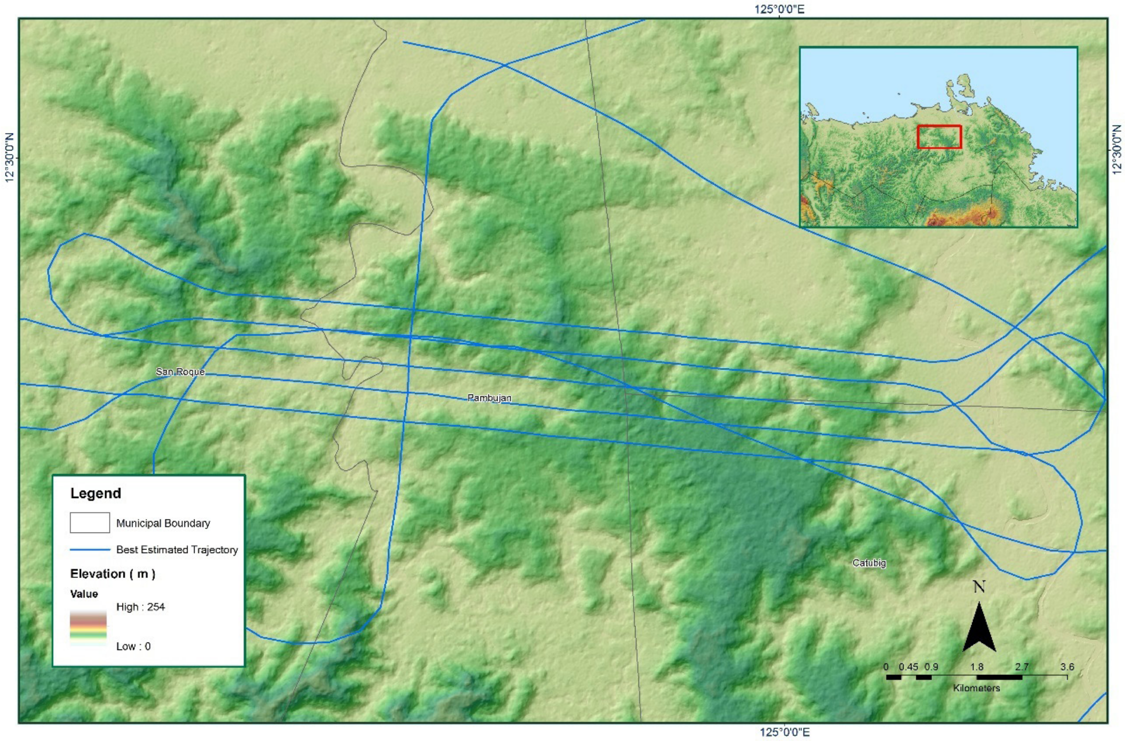


Figure A-8.66. Best Estimated Trajectory

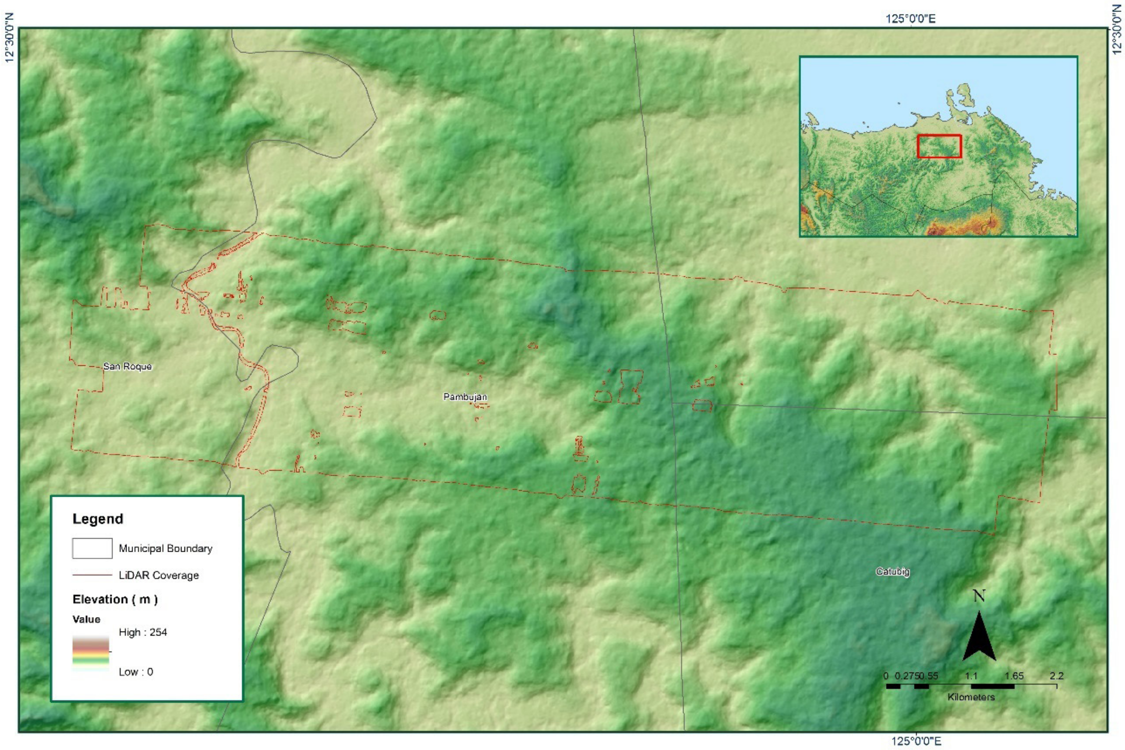


Figure A-8.67. Coverage of LiDAR Data

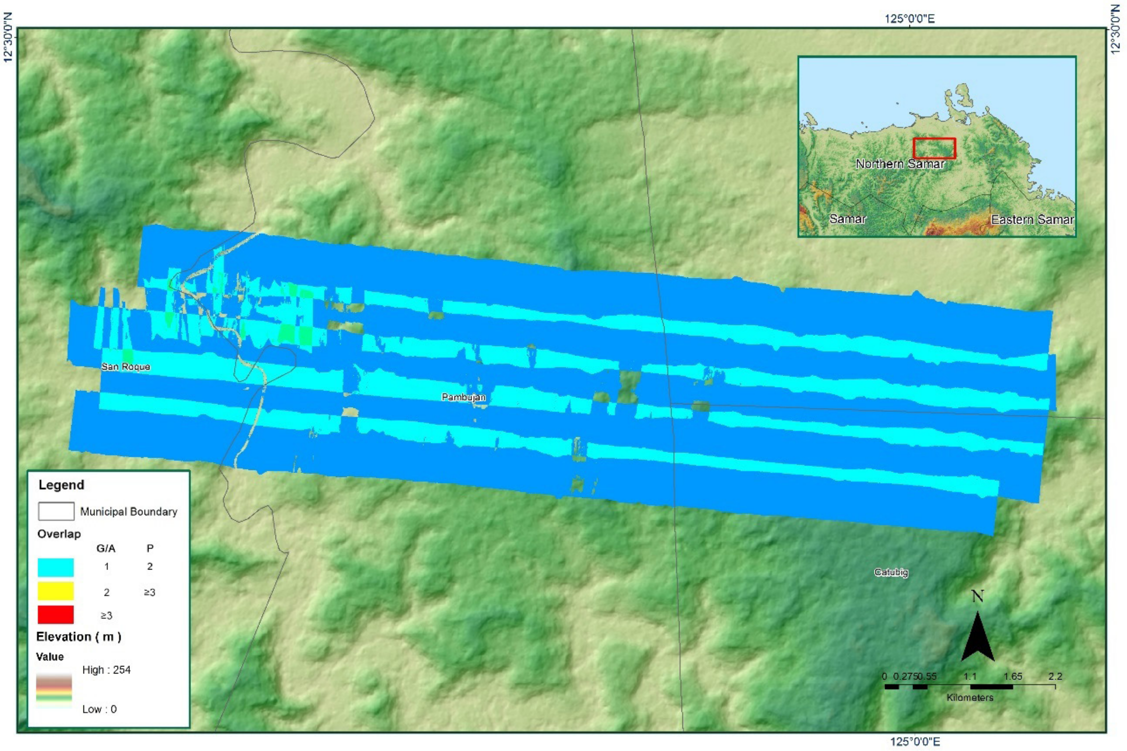


Figure A-8.68. Image of data overlap

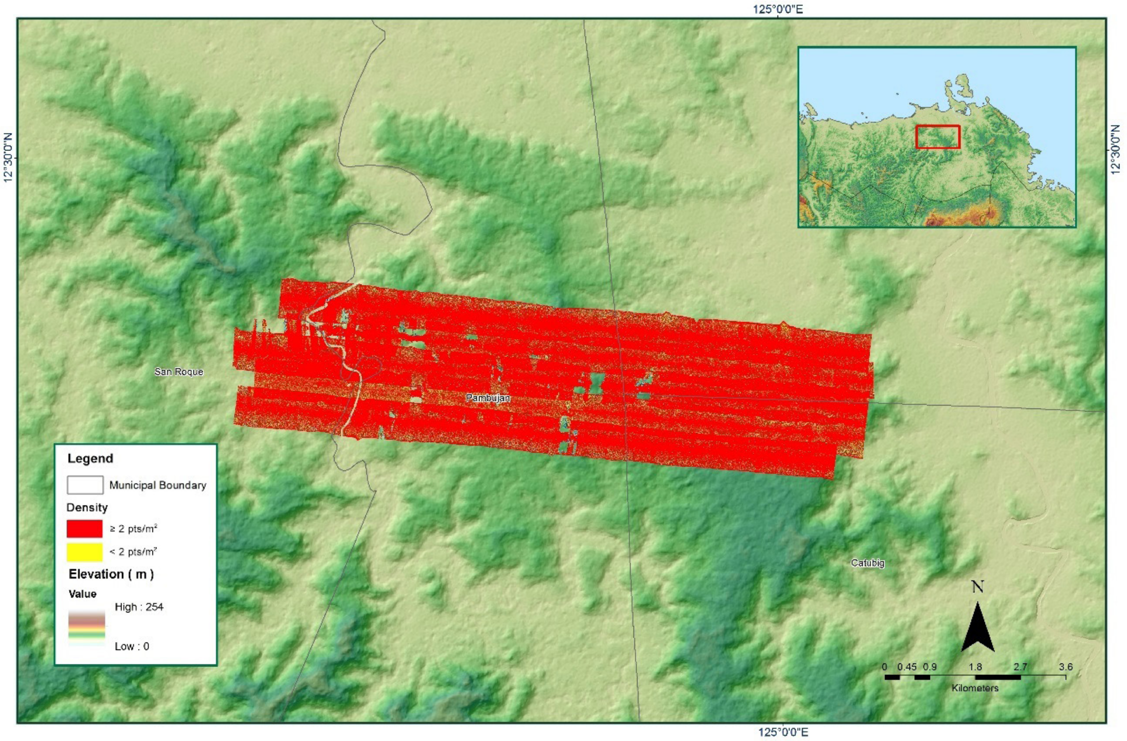


Figure A-8.69. Density map of merged LiDAR data

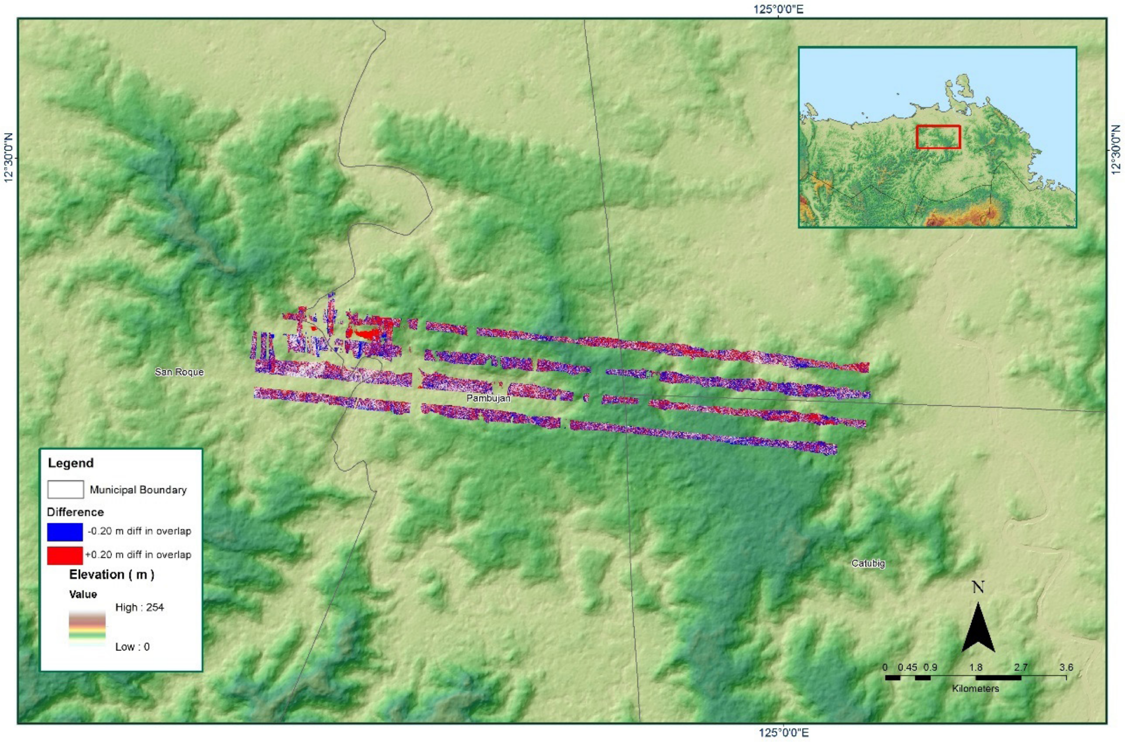


Figure A-8.70. Elevation difference between flight lines

Table A-8.11. Mission Report for Mission Blk 331P_supplement

Flight Area	**Catarman_Reflights**
Mission Name	Blk 331P_supplement
Inclusive Flights	8438AC
Range data size	3.11 GB
POS data size	53.7 MB
Base data size	175 MB
Image	15.8 MB
Transfer date	June 4, 2016
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)	0.89
RMSE for East Position (<4.0 cm)	1.055
RMSE for Down Position (<8.0 cm)	3.75
Boresight correction stdev (<0.001deg)	0.001103
IMU attitude correction stdev (<0.001deg)	0.003520
GPS position stdev (<0.01m)	0.0248
Minimum % overlap (>25)	35.82
Ave point cloud density per sq.m. (>2.0)	1.81
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	49
Maximum Height	132.74 m
Minimum Height	43.78 m
Classification (# of points)	
Ground	11,121,460
Low vegetation	8,502,938
Medium vegetation	5,828,995
High vegetation	1,905,952
Building	68,615
Orthophoto	No
Processed by	Engr. Analyn Naldo, Aljon Rei Araneta, Alex John Escobido

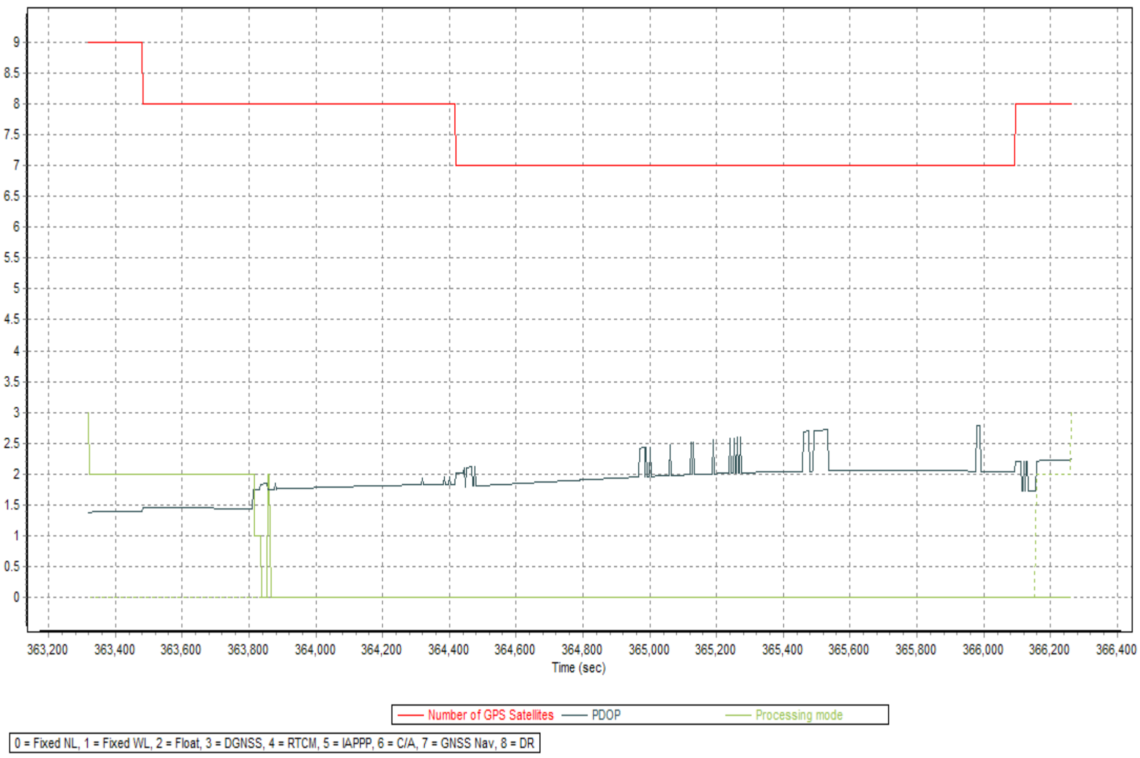


Figure A-8.71. Solution Status

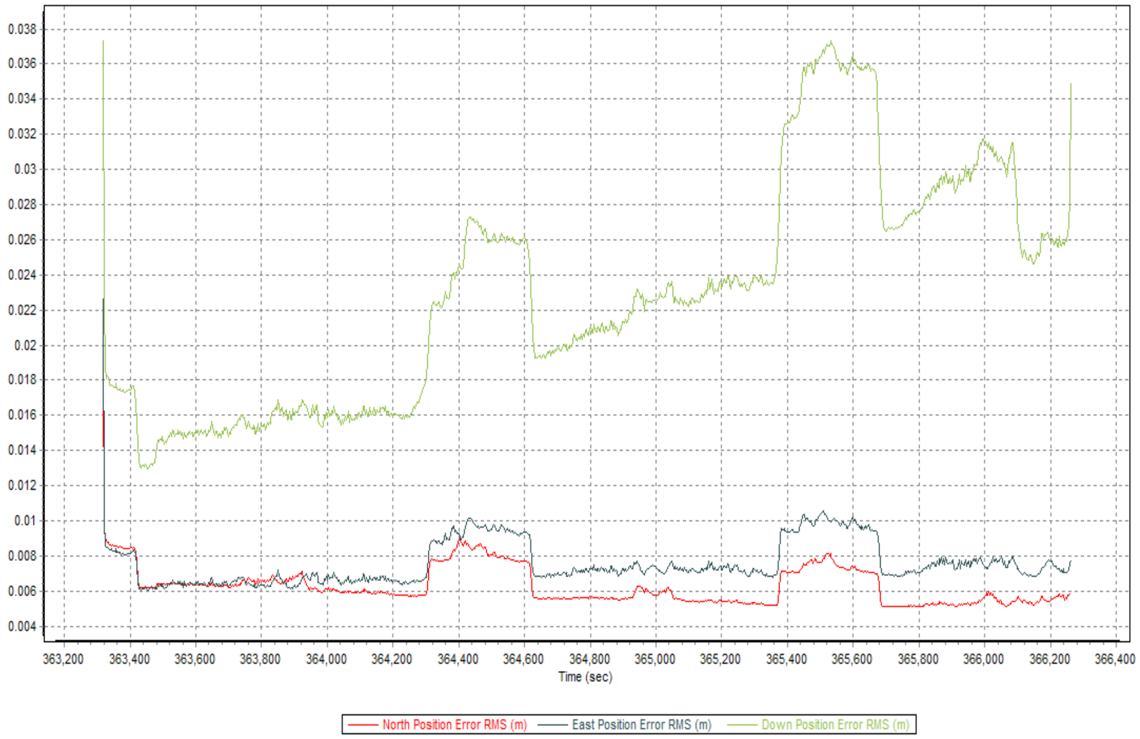


Figure A-8.72. Smoothed Performance Metric Parameters

Figure A-8.73. Best Estimated Trajectory

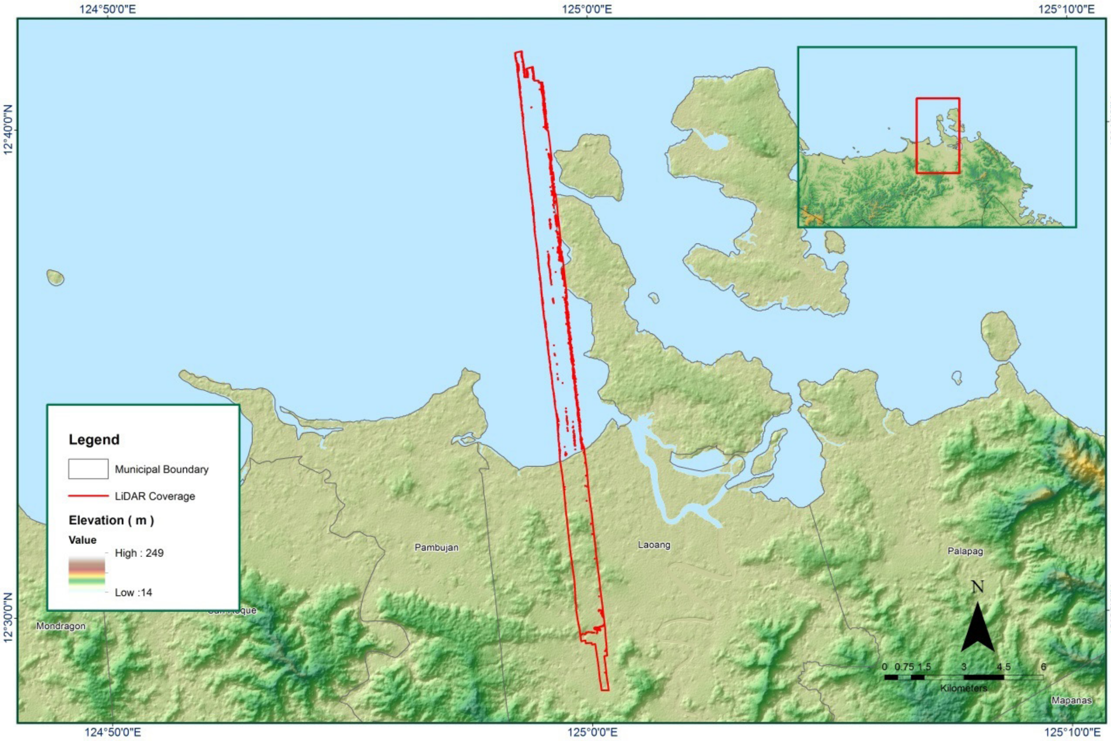


Figure A-8.74. Coverage of LiDAR Data

Figure A-8.75. Image of data overlap

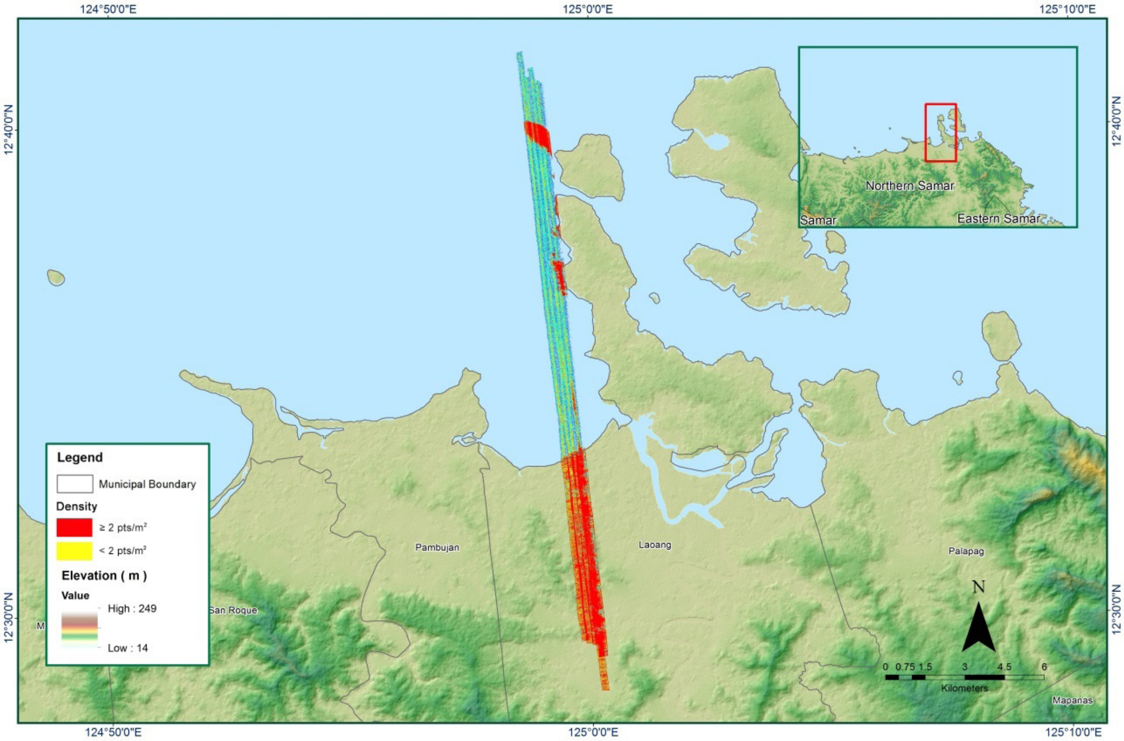


Figure A-8.76. Density map of merged LiDAR data

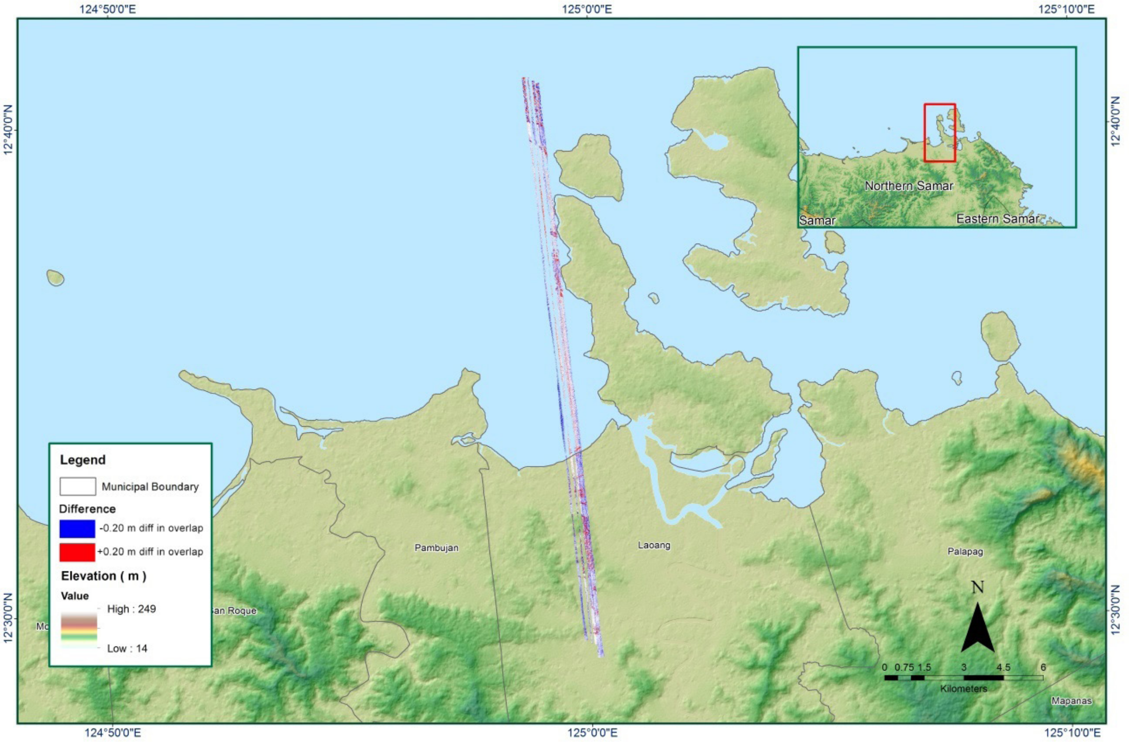


Figure A-8.77. Elevation difference between flight lines

Table A-8.12. Mission Report for Mission Blk 331P

Flight Area	**Catarman_Reflights**
Mission Name	**Blk 331P**
Inclusive Flights	8437AC
Range data size	14.5 GB
POS data size	268 MB
Base data size	175 MB
Image	64.7 MB
Transfer date	June 4, 2016
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)	1.01
RMSE for East Position (<4.0 cm)	1.31
RMSE for Down Position (<8.0 cm)	3.28
Boresight correction stdev (<0.001deg)	0.001103
IMU attitude correction stdev (<0.001deg)	0.003520
GPS position stdev (<0.01m)	0.0248
Minimum % overlap (>25)	31.27
Ave point cloud density per sq.m. (>2.0)	1.84
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	155
Maximum Height	389.81 m
Minimum Height	40.62 m
Classification (# of points)	
Ground	22,862,384
Low vegetation	8,184,695
Medium vegetation	6,978,747
High vegetation	1,898,879
Building	484,675
Orthophoto	No
Processed by	Engr. Analyn Naldo, Aljon Rei Araneta, Engr. Monalyne Rabino

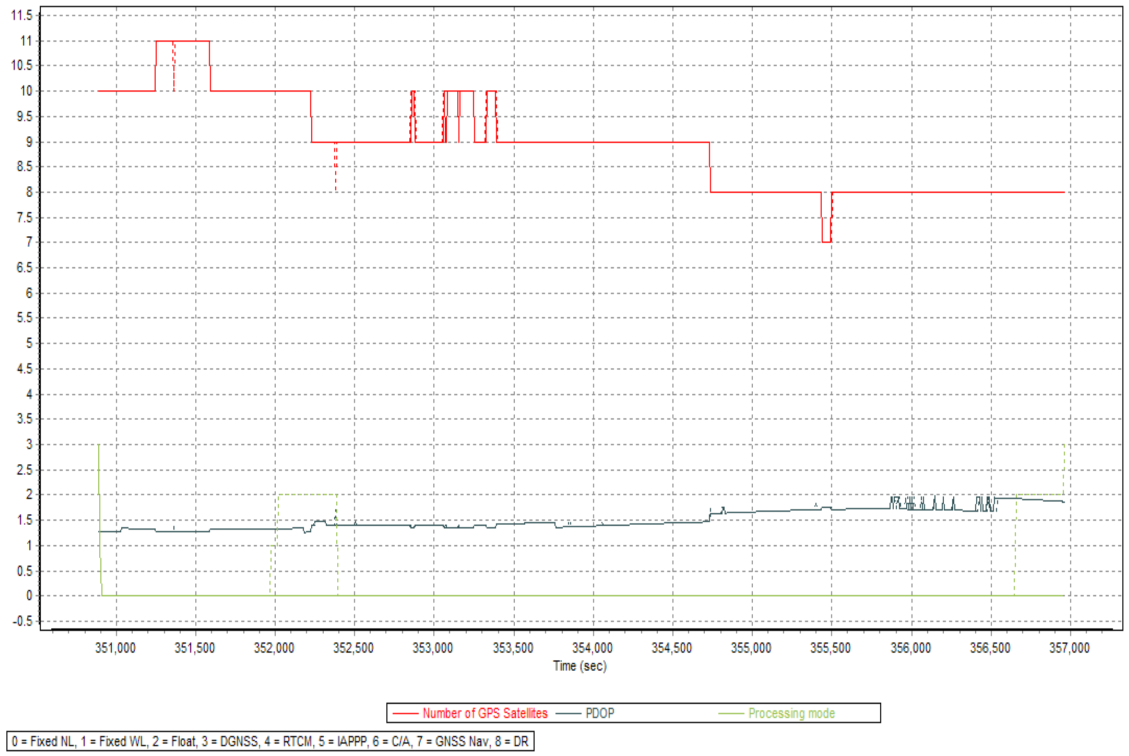


Figure A-8.78. Solution Status

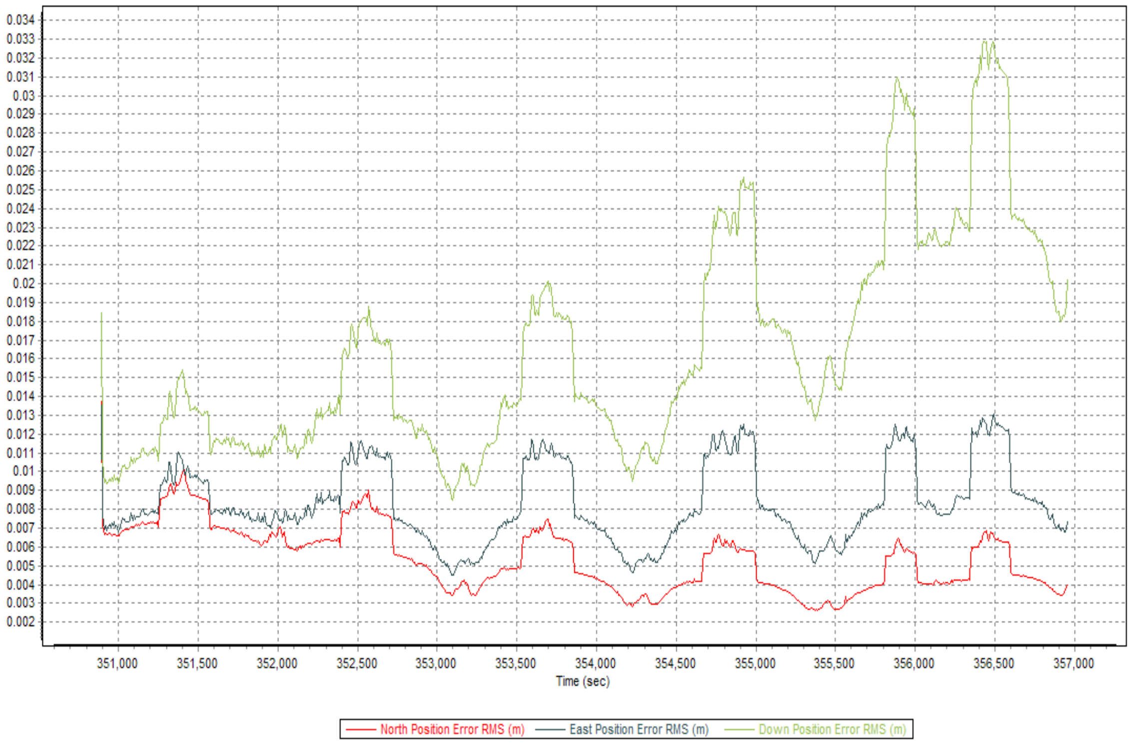


Figure A-8.79. Smoothed Performance Metric Parameters

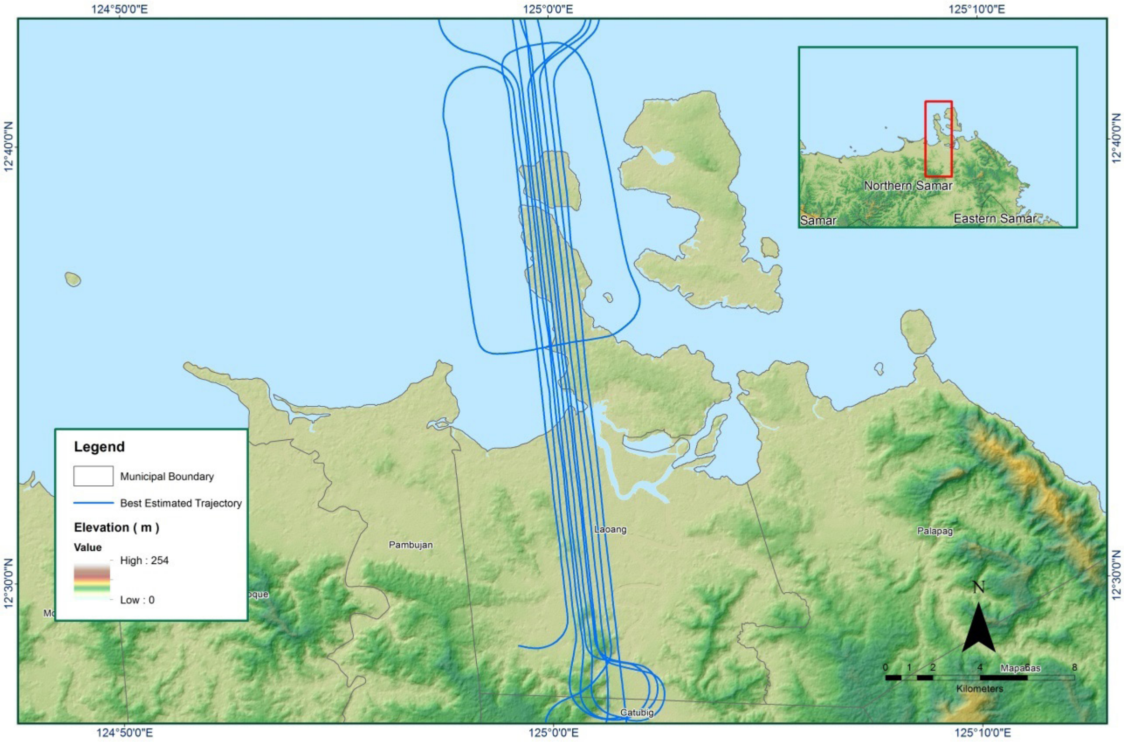


Figure A-8.80. Best Estimated Trajectory

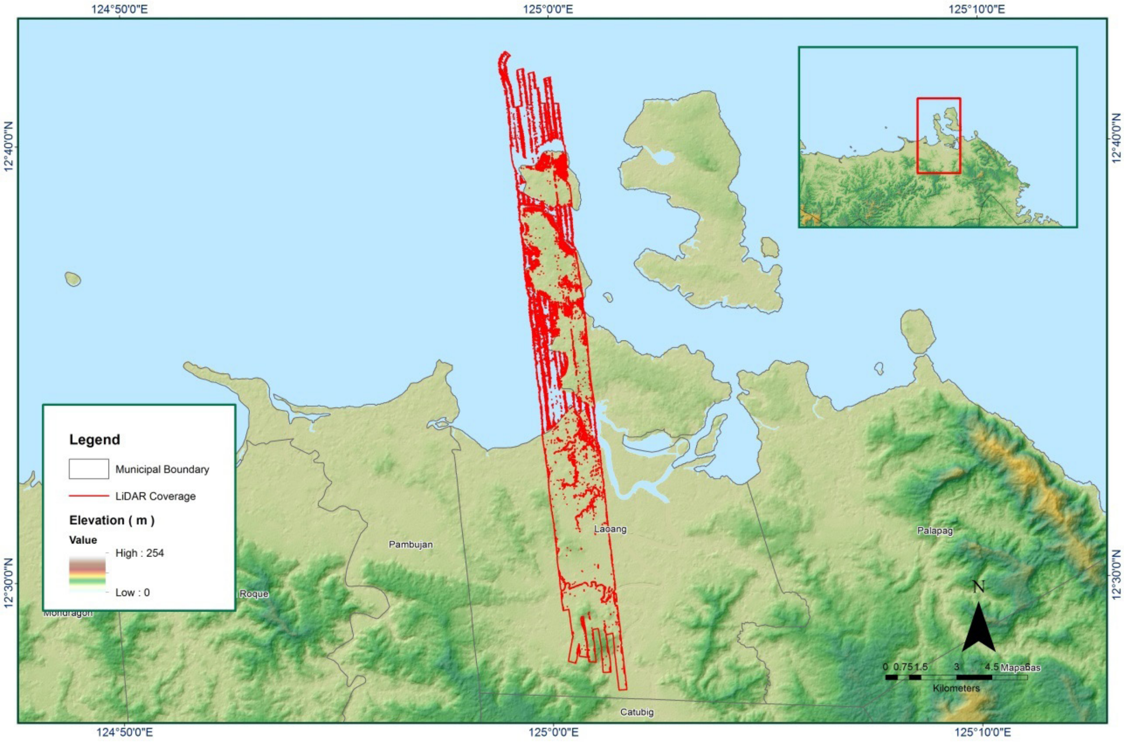


Figure A-8.81. Coverage of LiDAR Data

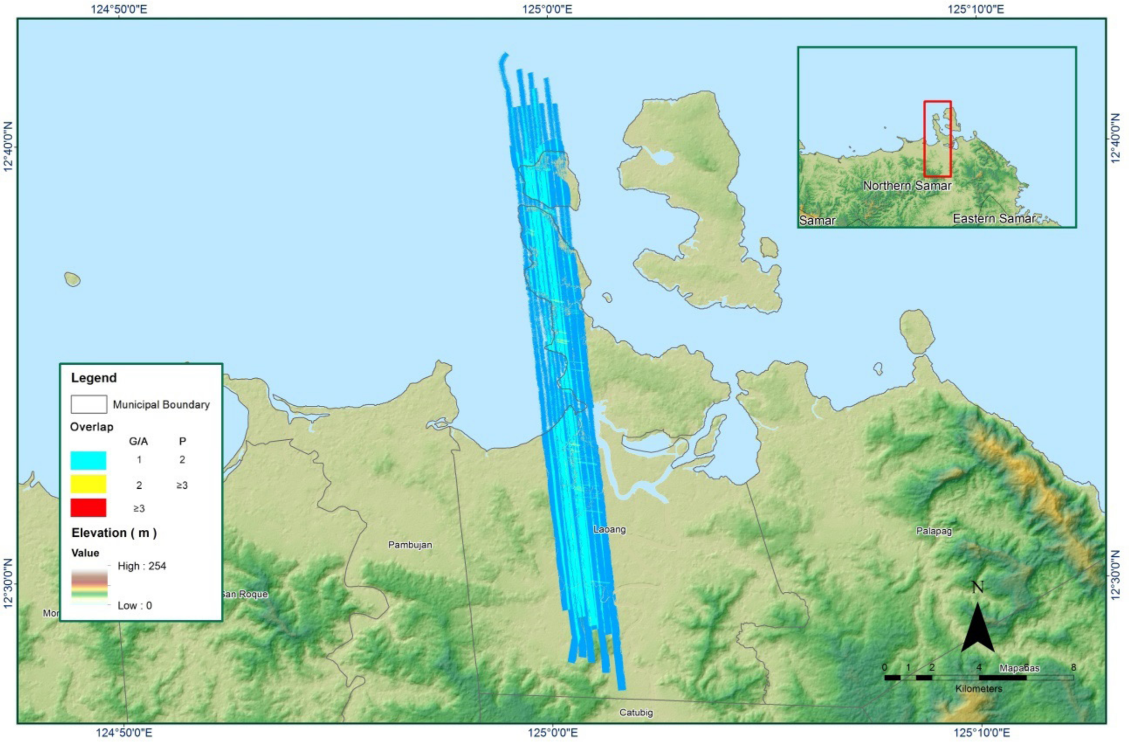


Figure A-8.82. Image of data overlap

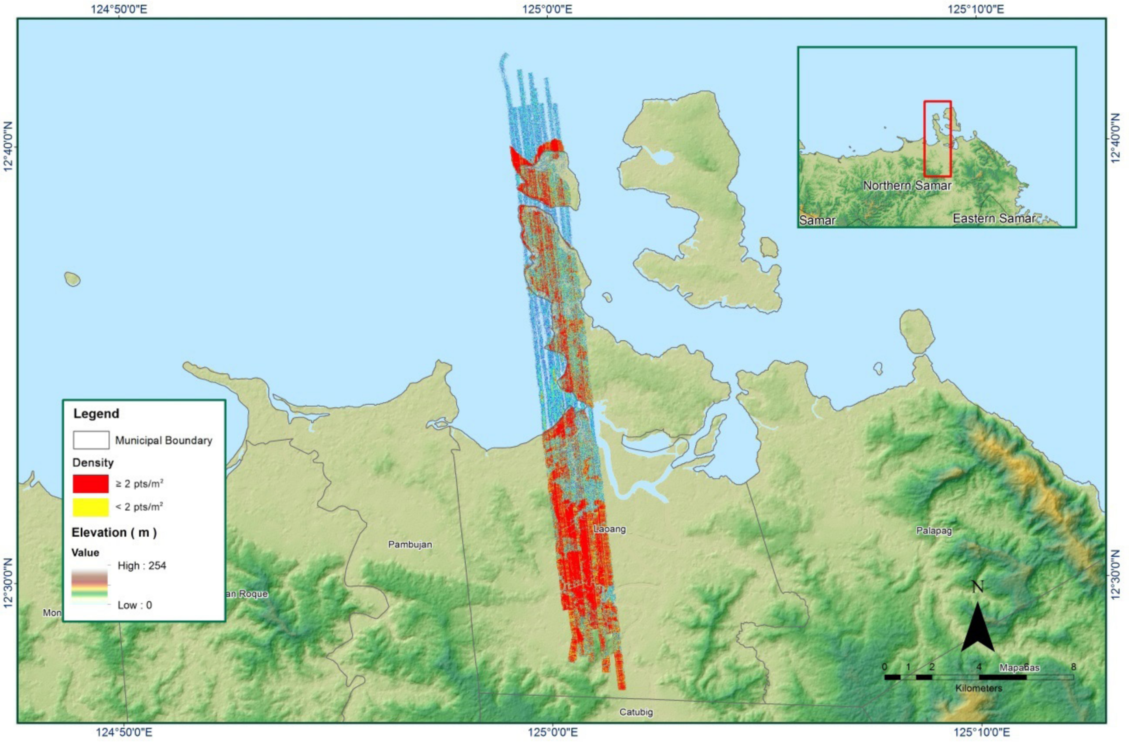


Figure A-8.83. Density map of merged LiDAR data

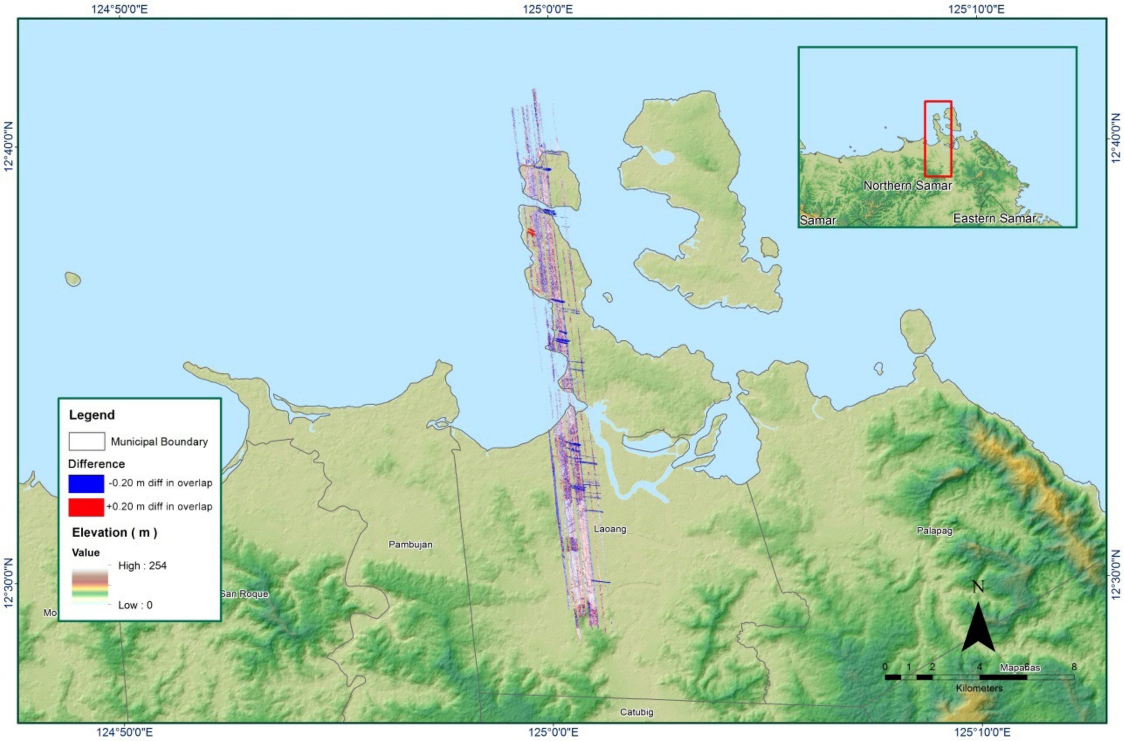


Figure A-8.84. Elevation difference between flight lines

Table A-8.13. Mission Report for Mission Blk 331P_additional

Flight Area	**Catarman_Reflights**
Mission Name	**Blk 331P_additional**
Inclusive Flights	8444AC
Range data size	6.53 GB
POS data size	90.5 MB
Base data size	89.9 MB
Image	NA
Transfer date	June 4, 2016
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)	0.96
RMSE for East Position (<4.0 cm)	1.15
RMSE for Down Position (<8.0 cm)	3.55
Boresight correction stdev (<0.001deg)	0.001113
IMU attitude correction stdev (<0.001deg)	0.001619
GPS position stdev (<0.01m)	0.0023
Minimum % overlap (>25)	24.76
Ave point cloud density per sq.m. (>2.0)	2.68
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	64
Maximum Height	140.01 m
Minimum Height	42.96 m
Classification (# of points)	
Ground	18,860,283
Low vegetation	16,932,036
Medium vegetation	22,803,385
High vegetation	11,366,282
Building	529,796
Orthophoto	No
Processed by	Engr. Sheila-Maye Santillan, Engr. Justine Francisco, Engr. Karl Adrian Vergara

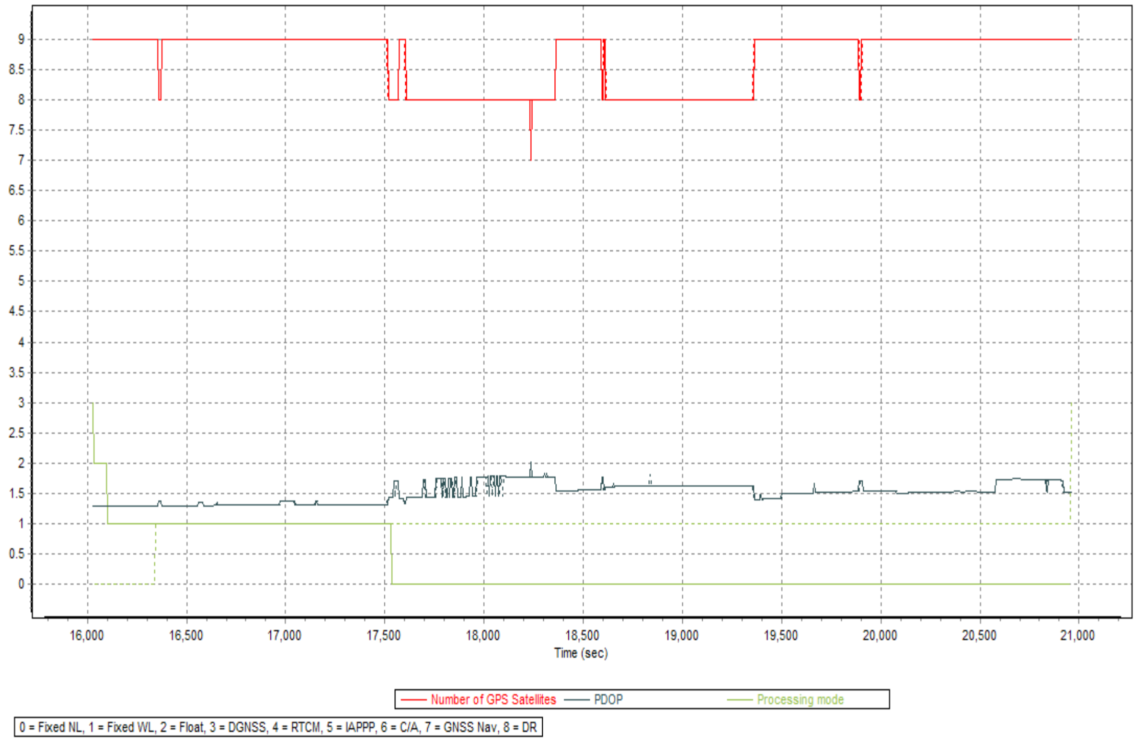


Figure A-8.85. Solution Status

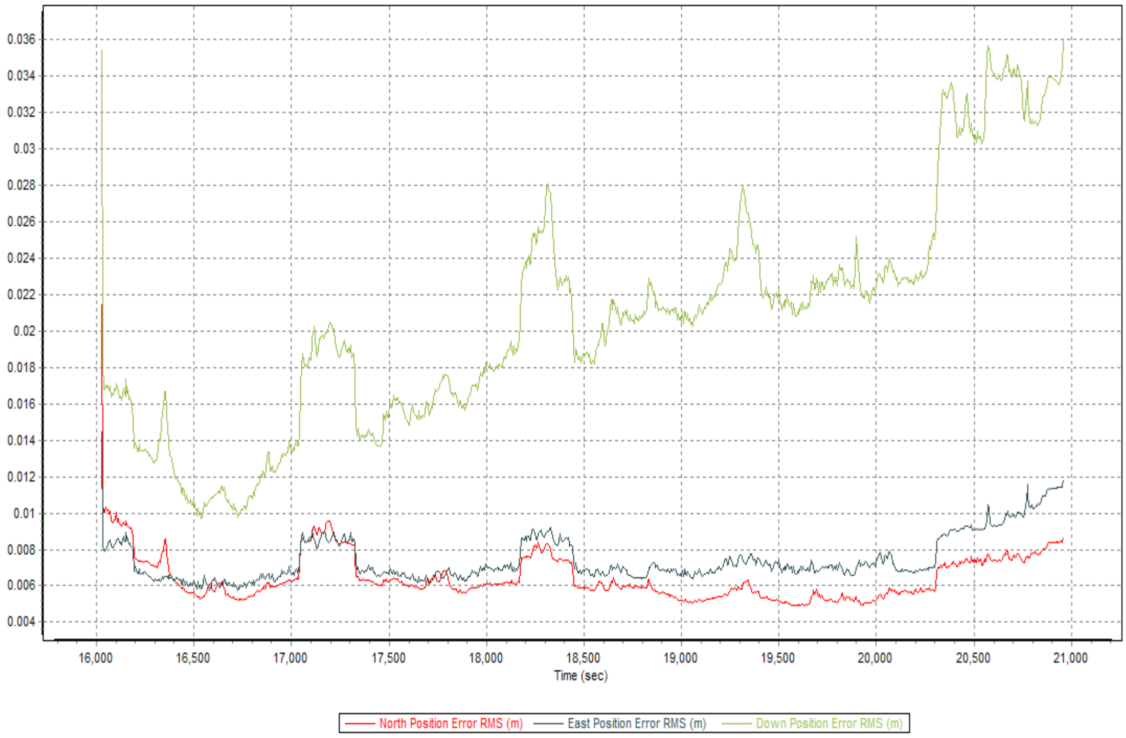


Figure A-8.86. Smoothed Performance Metric Parameters

Figure A-8.87. Best Estimated Trajectory

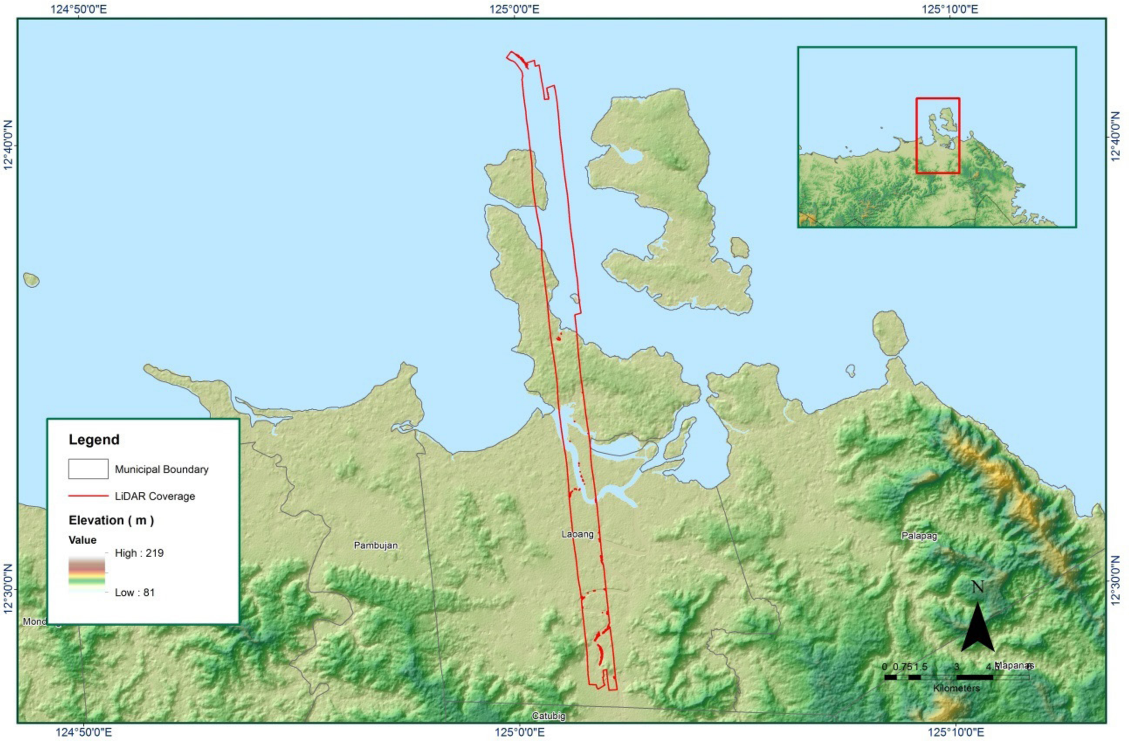


Figure A-8.88. Coverage of LiDAR Data

Figure A-8.89. Image of data overlap

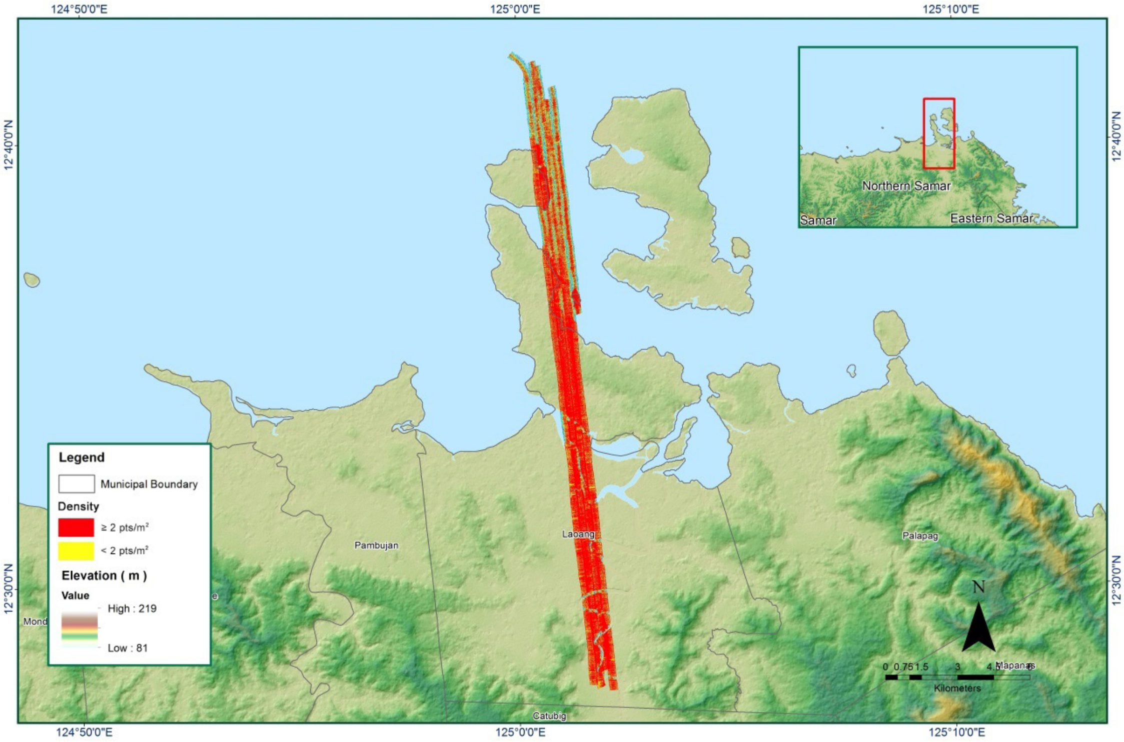


Figure A-8.90. Density map of merged LiDAR data

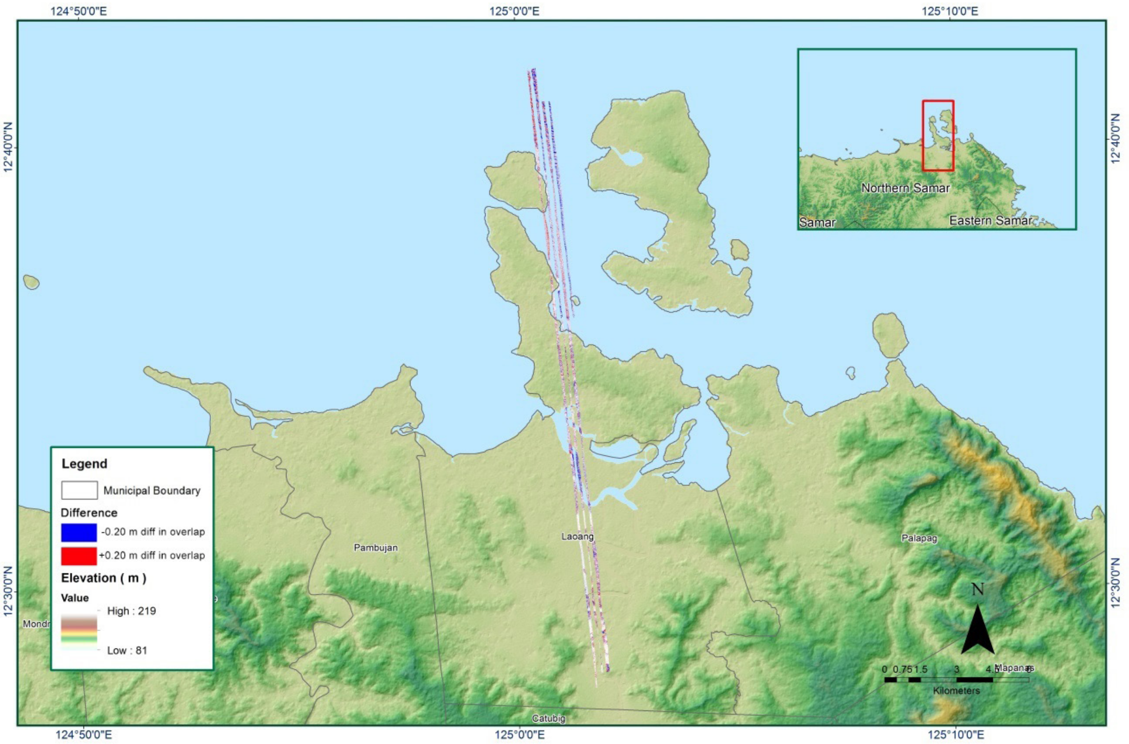


Figure A-8.91. Elevation difference between flight lines

Table A-8.14. Mission Report for Mission Blk 331QR

Flight Area	**Catarman_Reflights**
Mission Name	**Blk 331QR**
Inclusive Flights	8426AC, 8427AC
Range data size	19.23 GB
POS data size	364 MB
Base data size	390 MB
Image	85.4 MB
Transfer date	May 11, 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)	1.09
RMSE for East Position (<4.0 cm)	1.61
RMSE for Down Position (<8.0 cm)	3.35
Boresight correction stdev (<0.001deg)	0.000477
IMU attitude correction stdev (<0.001deg)	0.002325
GPS position stdev (<0.01m)	0.0032
Minimum % overlap (>25)	37.29
Ave point cloud density per sq.m. (>2.0)	3.92
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	202
Maximum Height	258.74 m
Minimum Height	30.45 m
Classification (# of points)	
Ground	131,837,691
Low vegetation	71,548,975
Medium vegetation	134,732,121
High vegetation	142,956,423
Building	1,946,574
Orthophoto	No
Processed by	Engr. Sheila-Maye Santillan, Engr. Velina Angela Bemida, Maria Tamsyn Malabanan

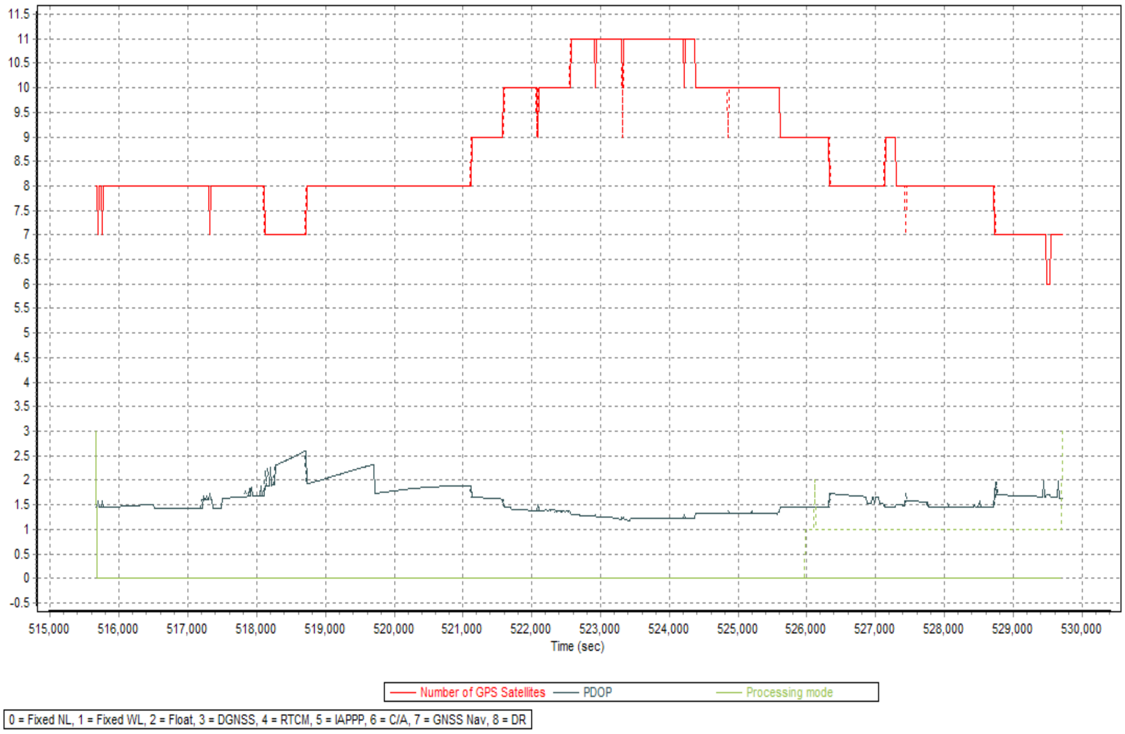


Figure A-8.92. Solution Status

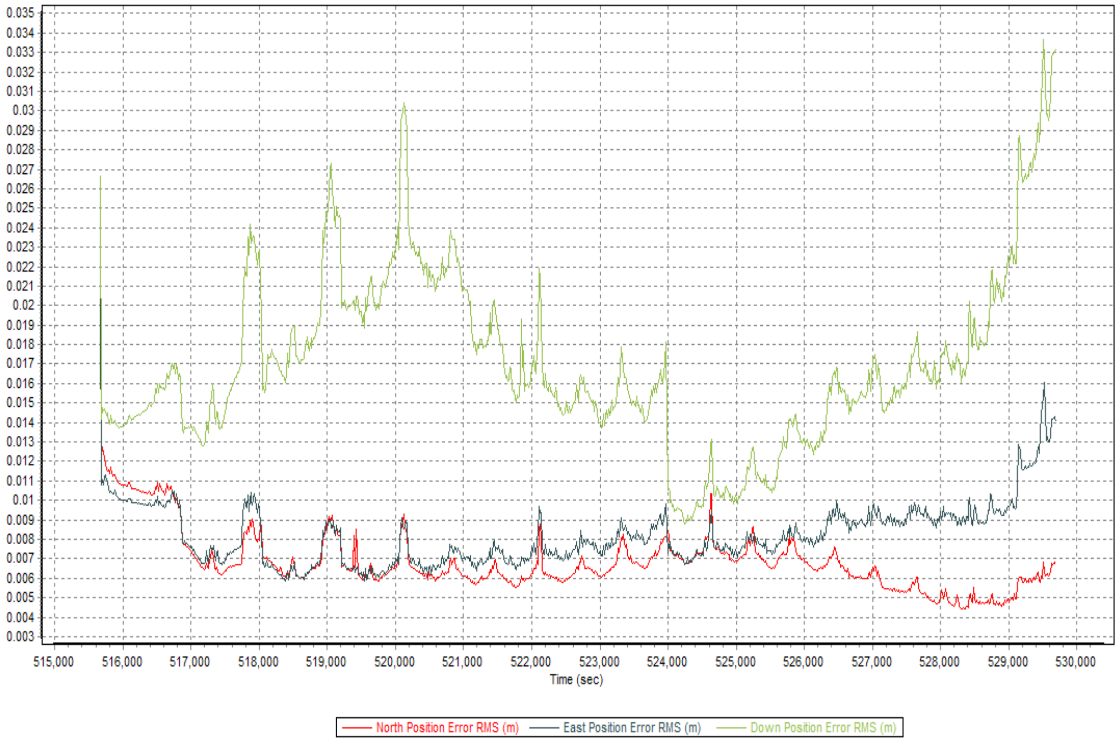


Figure A-8.93. Smoothed Performance Metric Parameters

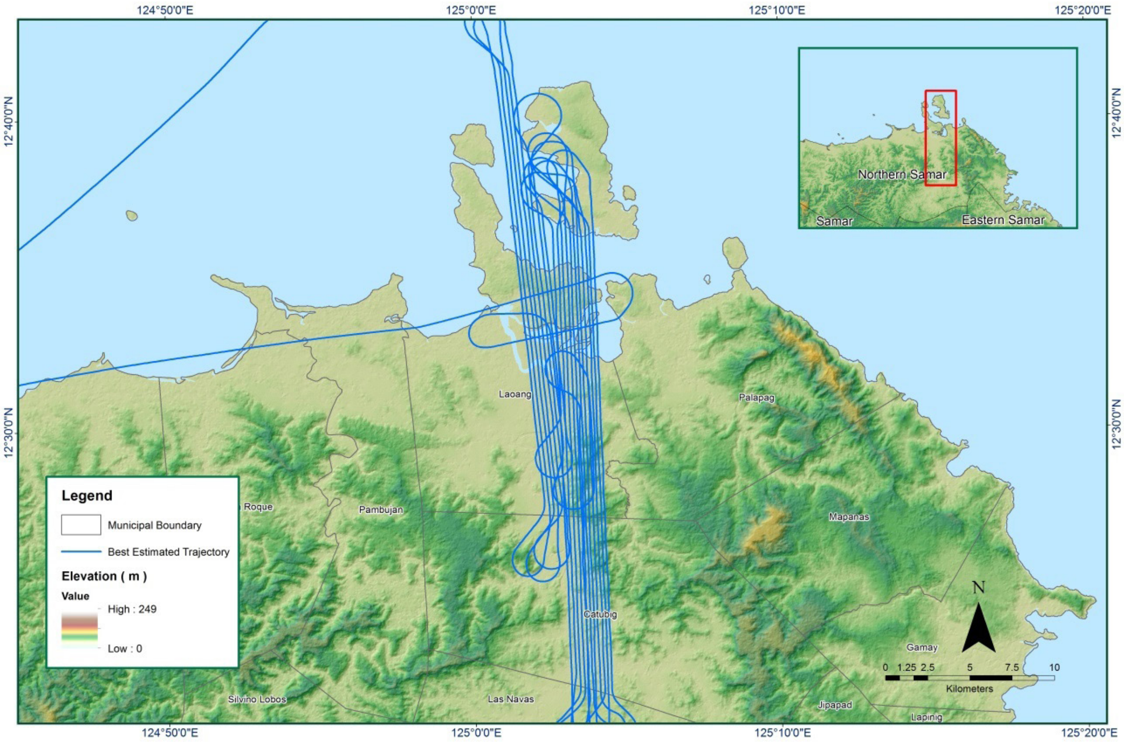


Figure A-8.94. Best Estimated Trajectory

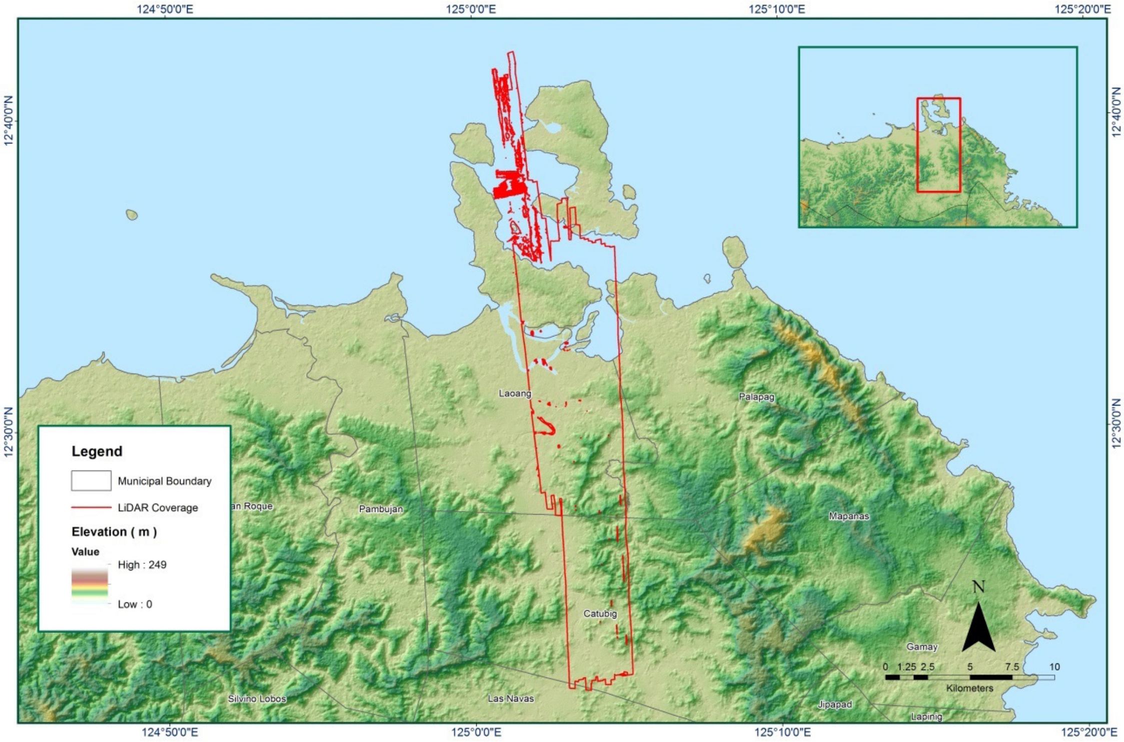


Figure A-8.95. Coverage of LiDAR Data

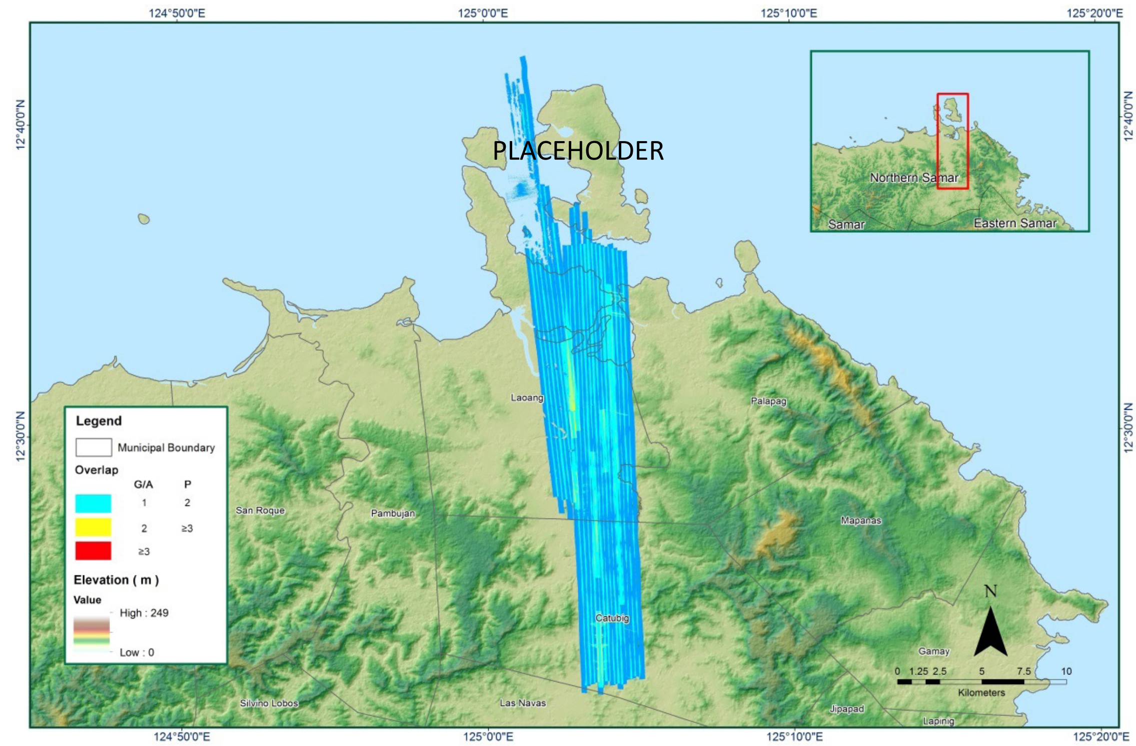


Figure A-8.96. Image of data overlap

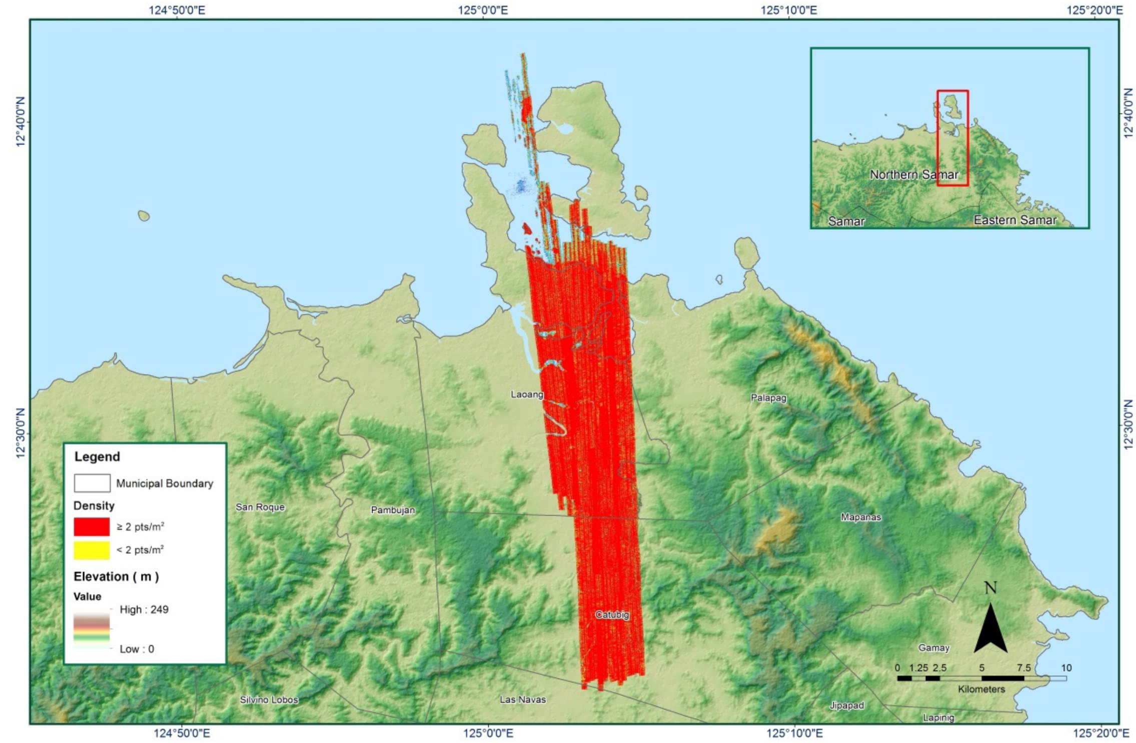


Figure A-8.97. Density map of merged LiDAR data

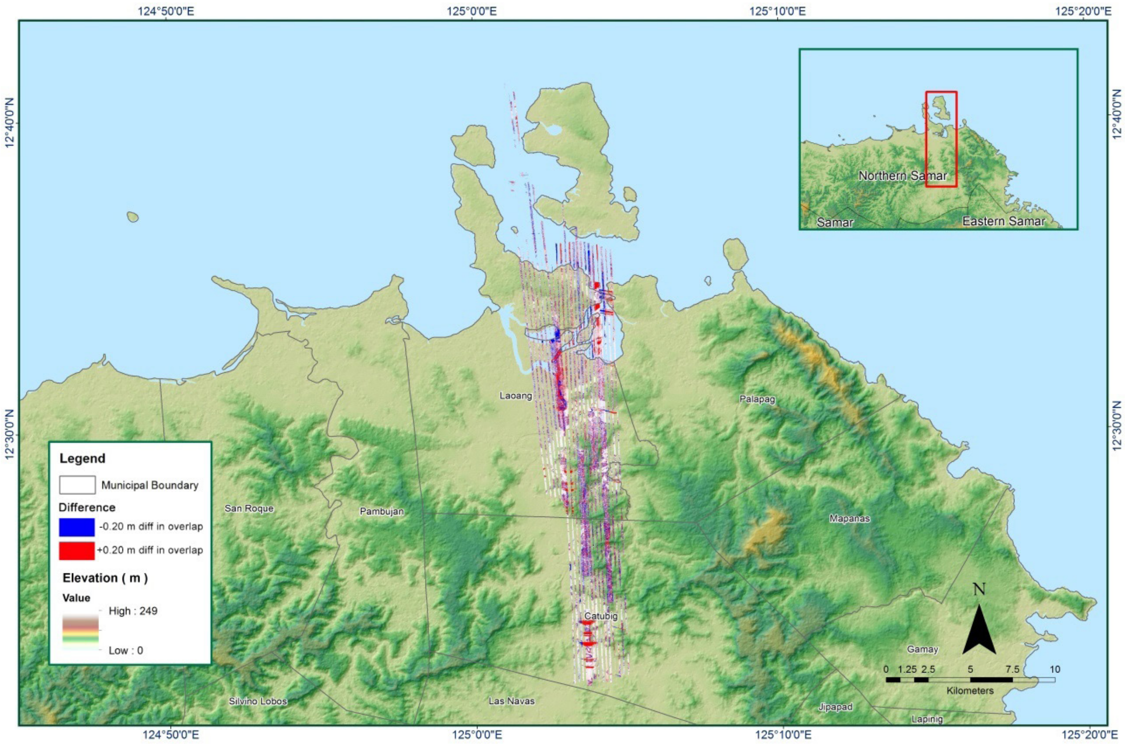


Figure A-8.98. Elevation difference between flight lines

Table A-8.15. Mission Report for Mission Blk 33V

Flight Area	Catarman Reflights
Mission Name	**Blk 33V**
Inclusive Flights	8428AC
Range data size	8.9 GB
POS data size	255 MB
Base data size	123 MB
Image	34.5 MB
Transfer date	May 11, 2016
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)	1.084
RMSE for East Position (<4.0 cm)	1.414
RMSE for Down Position (<8.0 cm)	2.458
Boresight correction stdev (<0.001deg)	NA
IMU attitude correction stdev (<0.001deg)	NA
GPS position stdev (<0.01m)	NA
Minimum % overlap (>25)	31.29%
Ave point cloud density per sq.m. (>2.0)	4.02
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	94
Maximum Height	305.94 m
Minimum Height	40.66 m
Classification (# of points)	
Ground	59,338,115
Low vegetation	26,696,360
Medium vegetation	48,936,170
High vegetation	85,681,014
Building	1,143,210
Orthophoto	No
Processed by	Engr. Irish Cortez, Engr. Velina Angela Bemida, Marie Denise Bueno

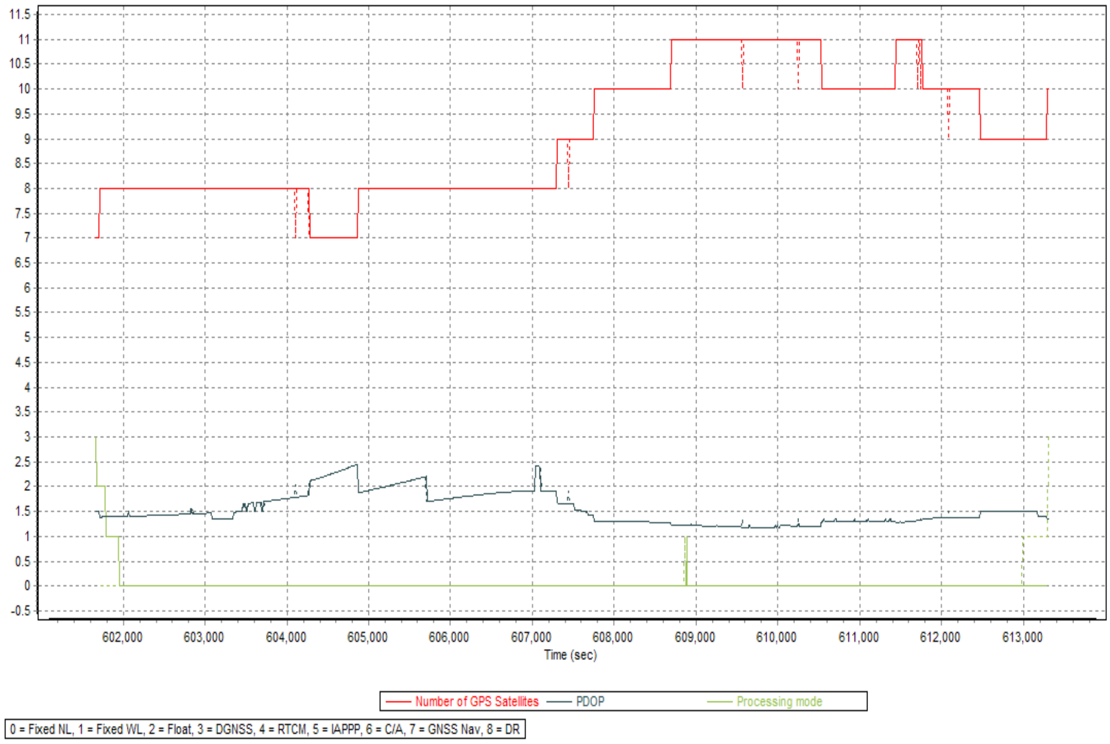


Figure A-8.99. Solution Status

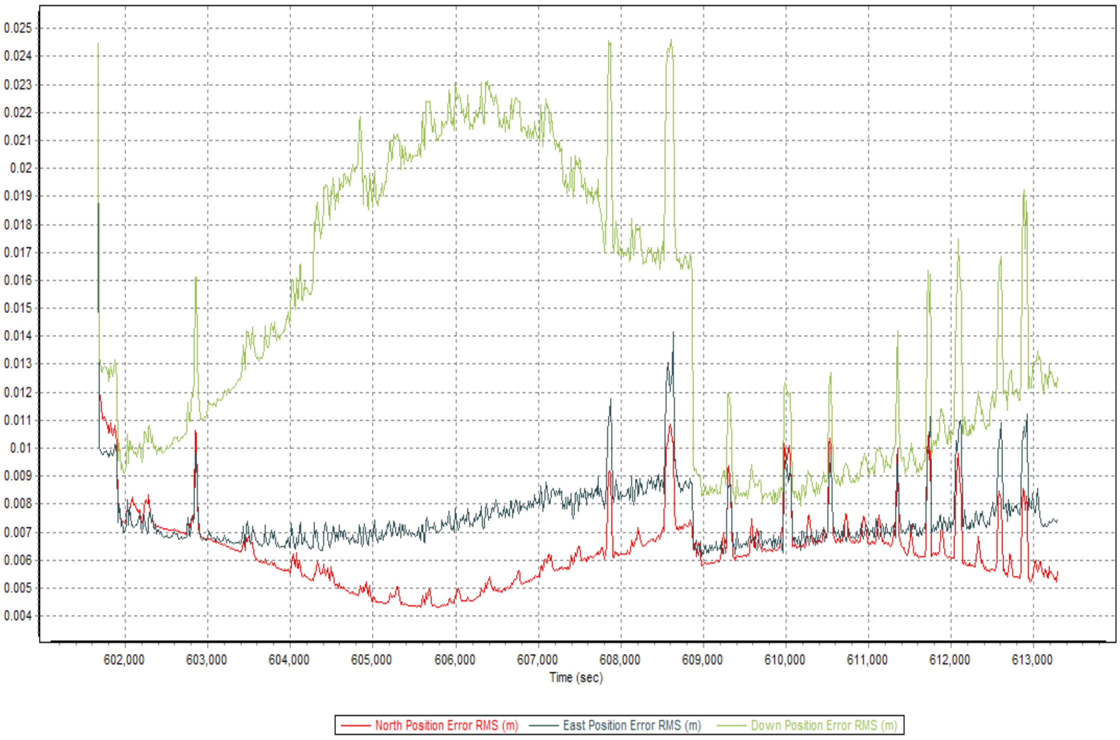


Figure A-8.100. Smoothed Performance Metric Parameters

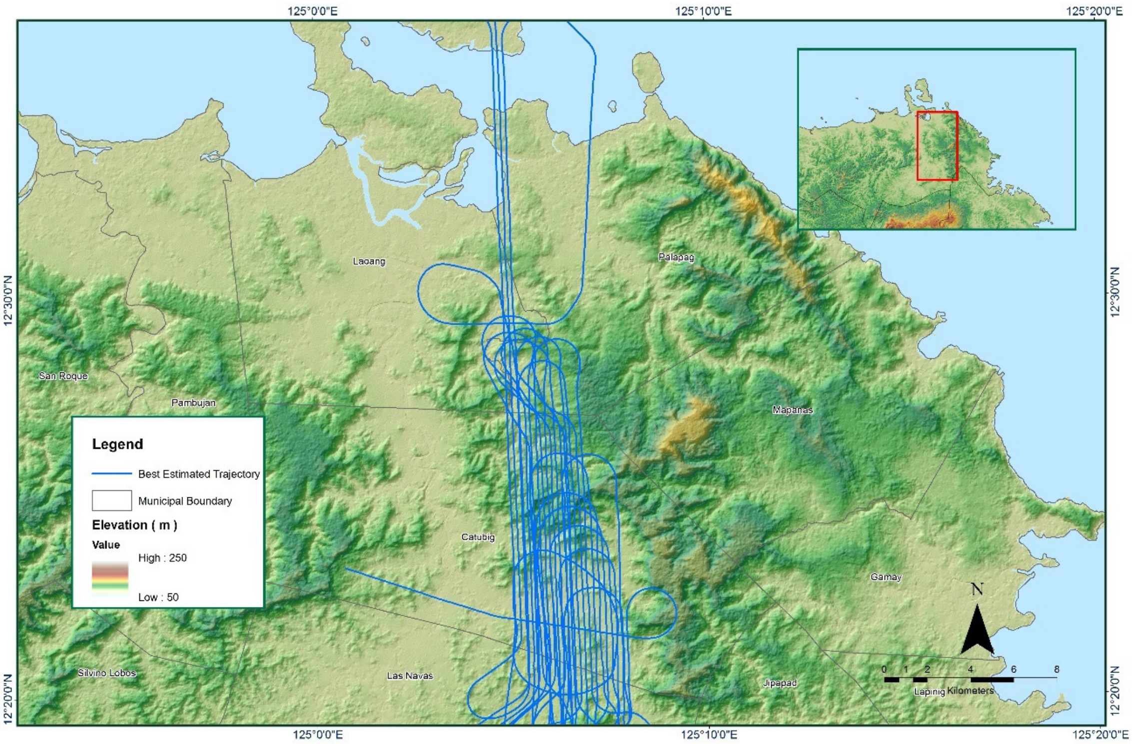


Figure A-8.101. Best Estimated Trajectory

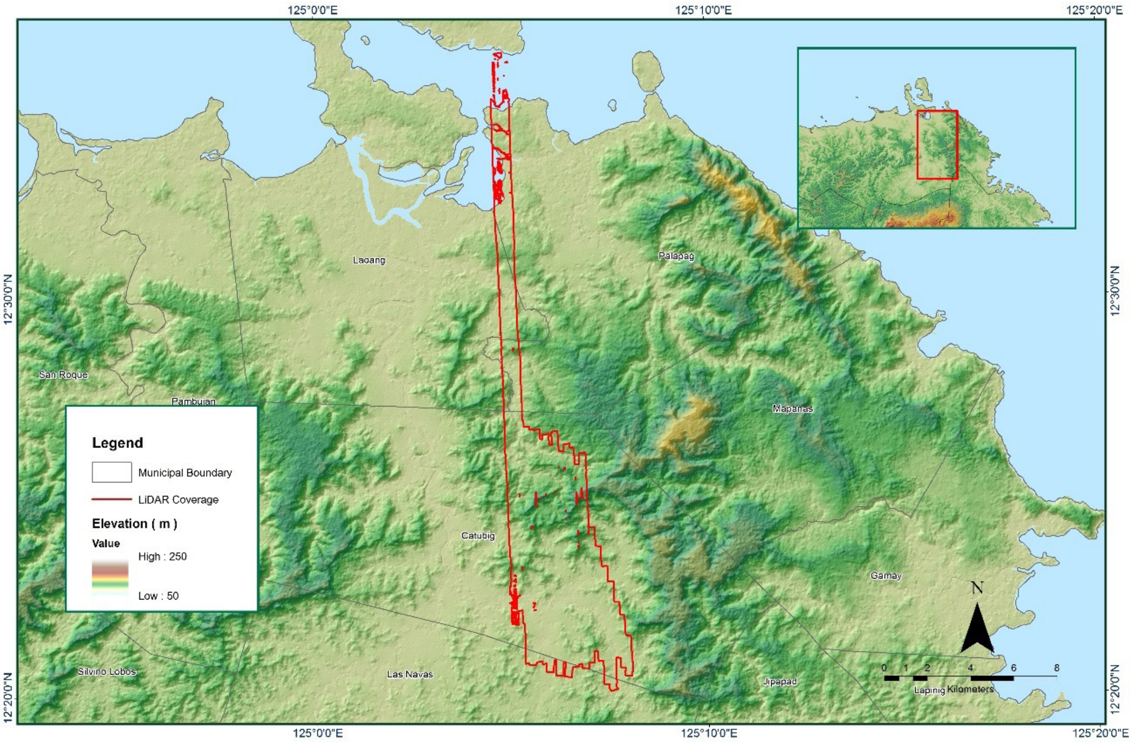


Figure A-8.102. Coverage of LiDAR Data

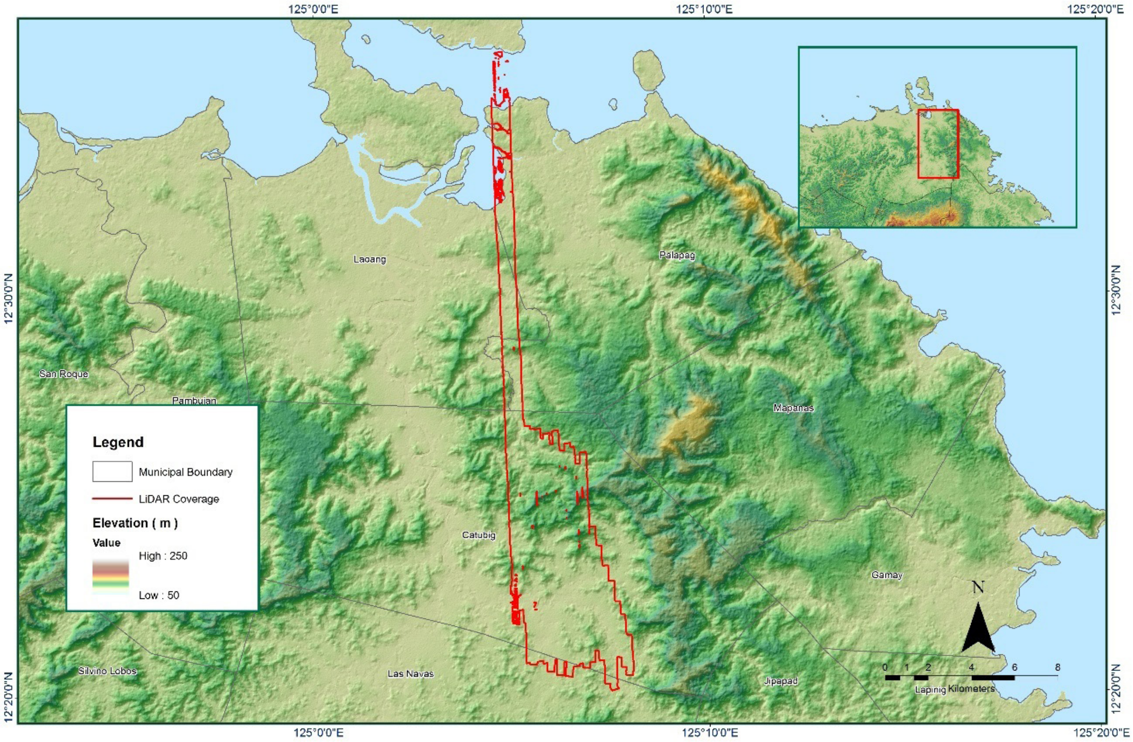


Figure A-8.103. Image of data overlap

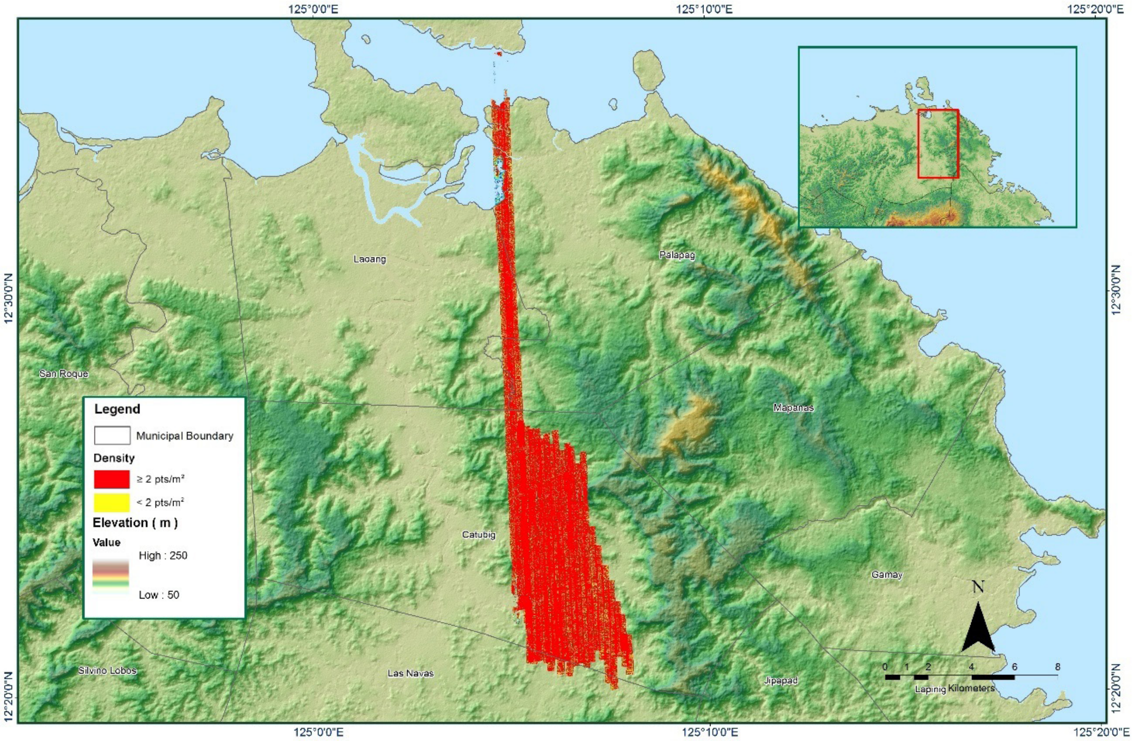


Figure A-8.104. Density map of merged LiDAR data

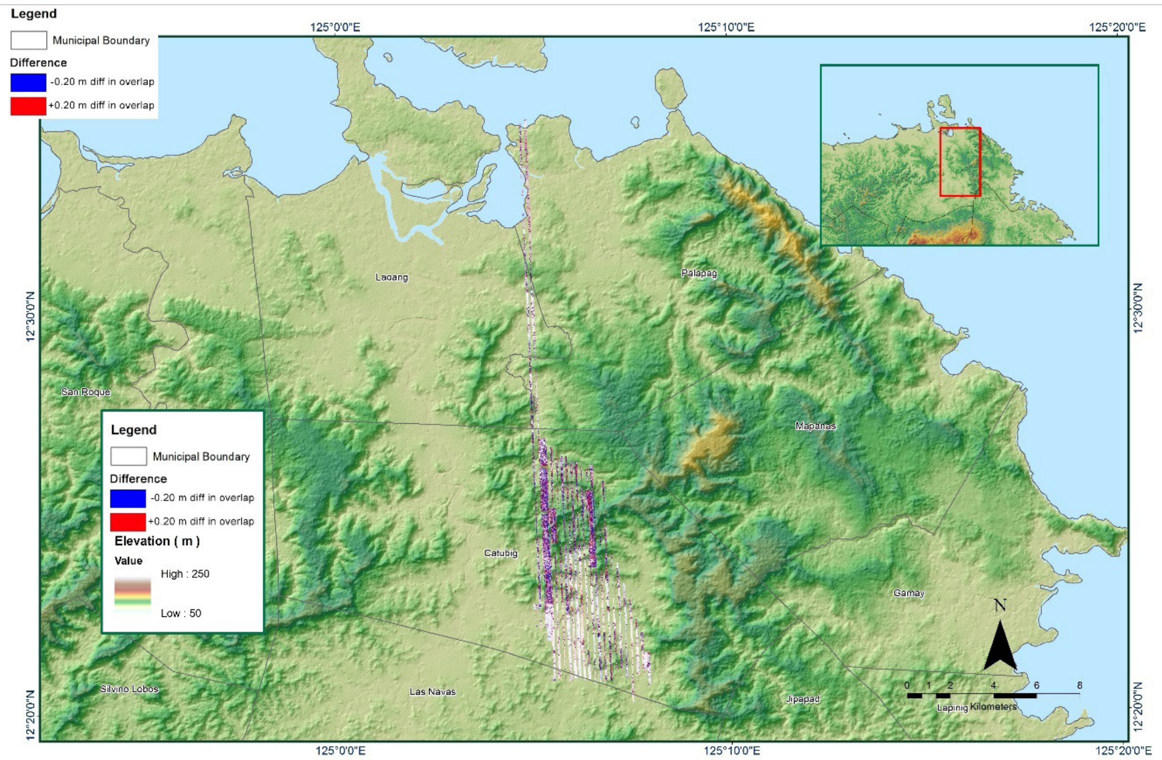


Figure A-8.105. Elevation difference between flight lines

Table A-8.16. Mission Report for Mission Blk 33W

Flight Area	Catarman Reflights
Mission Name	**Blk 33W**
Inclusive Flights	3913G
Range data size	14.1 GB
POS data size	163 MB
Base data size	184 MB
Image	NA
Transfer date	May 11, 2016
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)	1.215
RMSE for East Position (<4.0 cm)	1.810
RMSE for Down Position (<8.0 cm)	3.612
Boresight correction stdev (<0.001deg)	0.007389
IMU attitude correction stdev (<0.001deg)	0.035496
GPS position stdev (<0.01m)	0.0255
Minimum % overlap (>25)	27.77%
Ave point cloud density per sq.m. (>2.0)	3.54
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	170
Maximum Height	365.59 m
Minimum Height	57.17 m
Classification (# of points)	
Ground	56,834,412
Low vegetation	8,583,452
Medium vegetation	74,612,658
High vegetation	279,700,858
Building	267,913
Orthophoto	No
Processed by	Engr. Analyn Naldo, Engr. Velina Angela Bemida, Engr. Vincent Louise Azucena

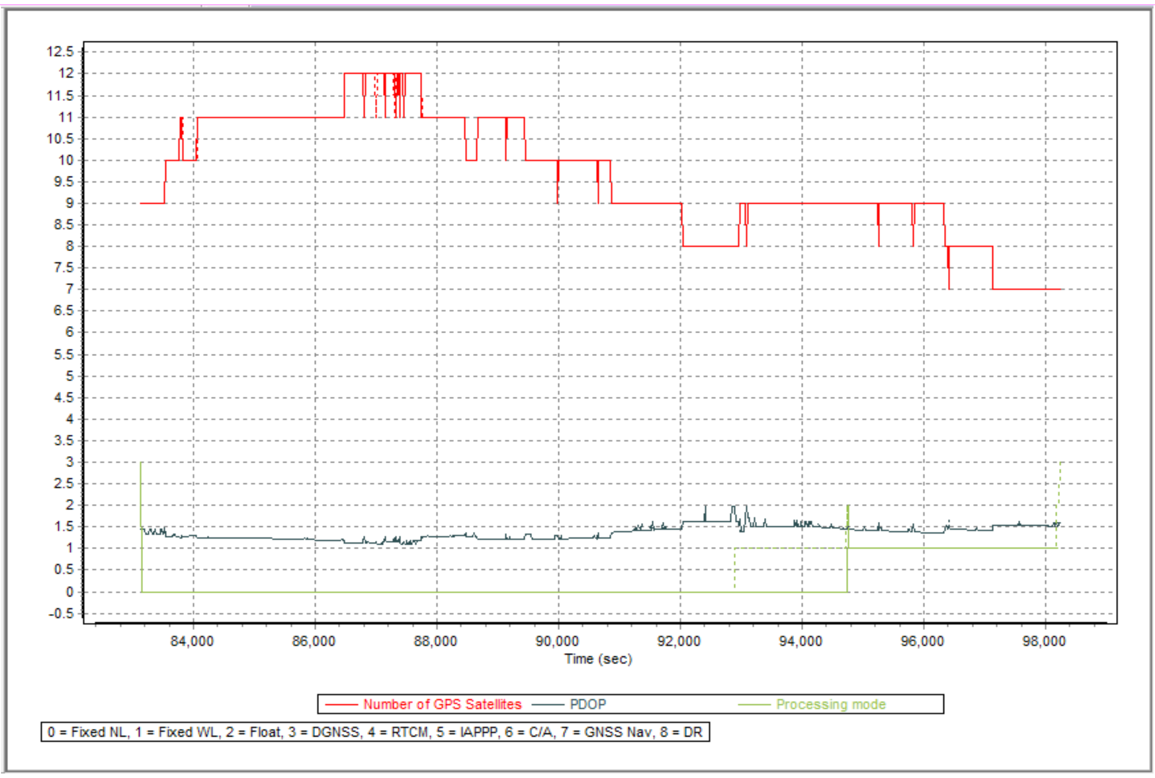


Figure A-8.106. Solution Status

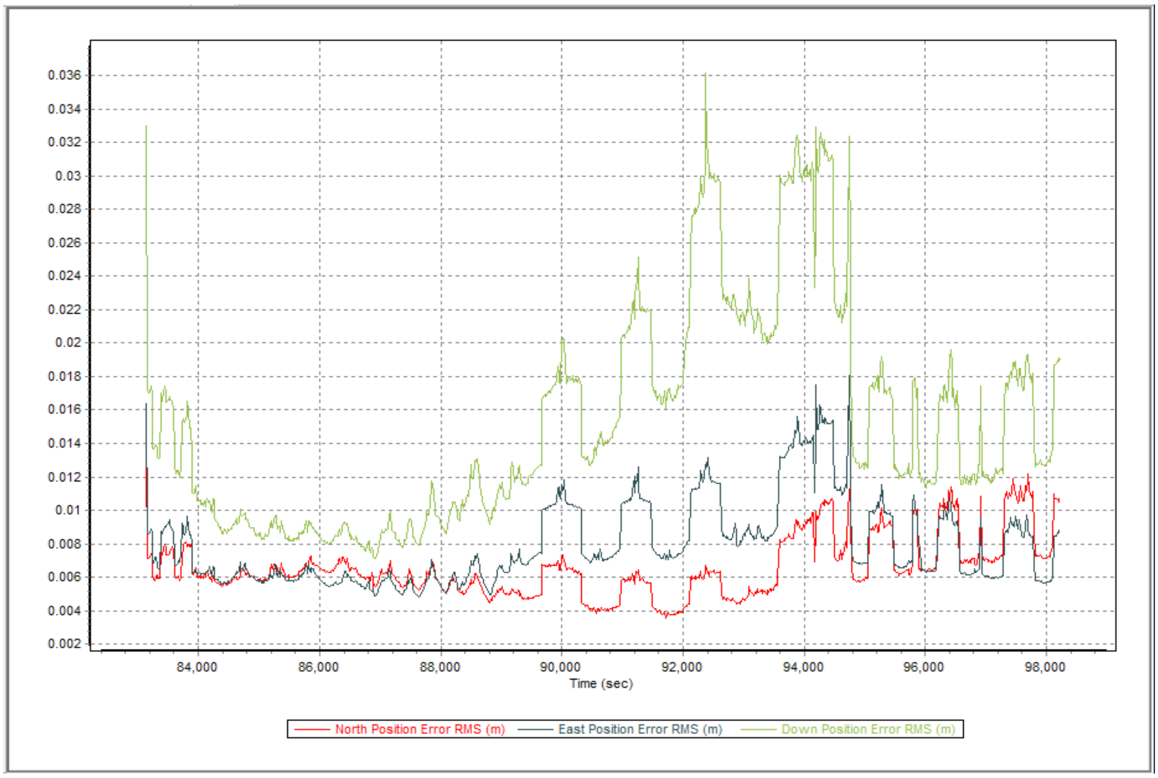


Figure A-8.107. Smoothed Performance Metric Parameters

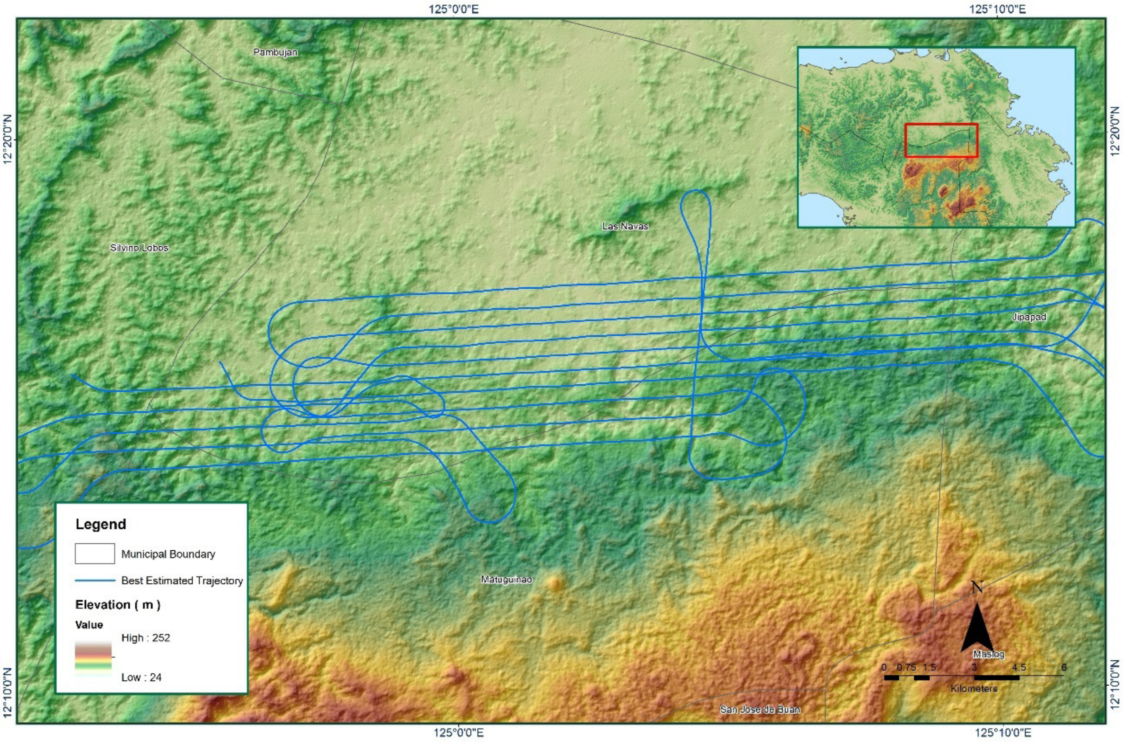


Figure A-8.108. Best Estimated Trajectory

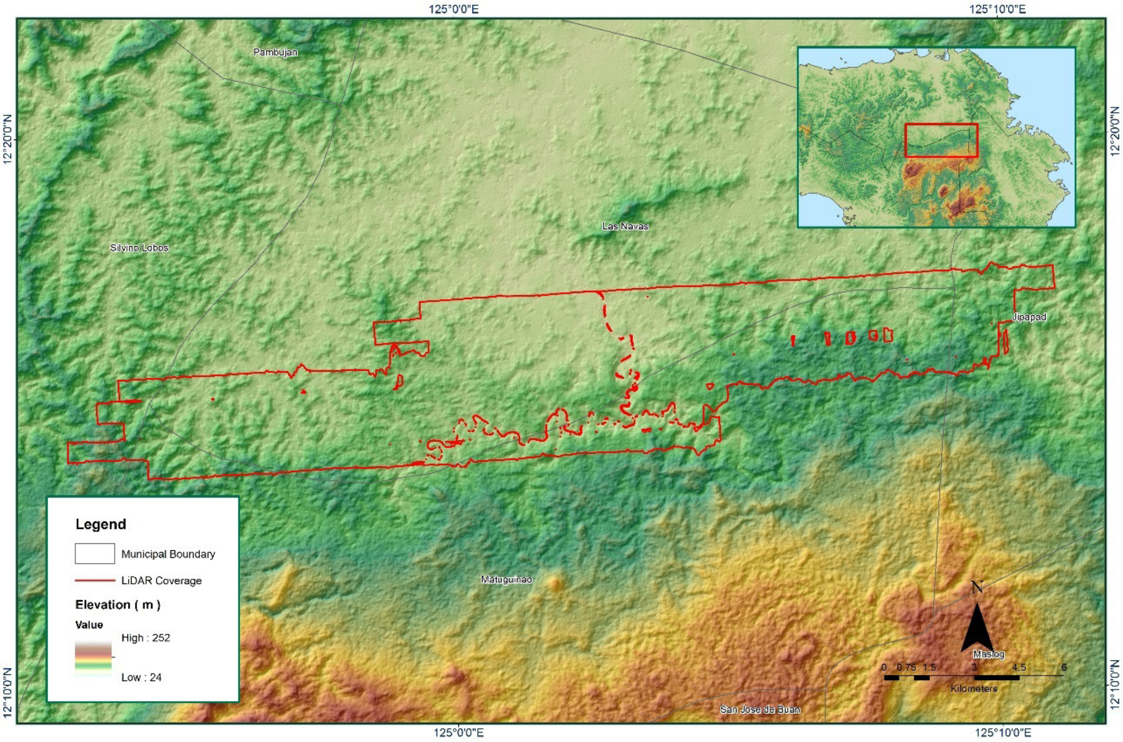


Figure A-8.109. Coverage of LiDAR Data

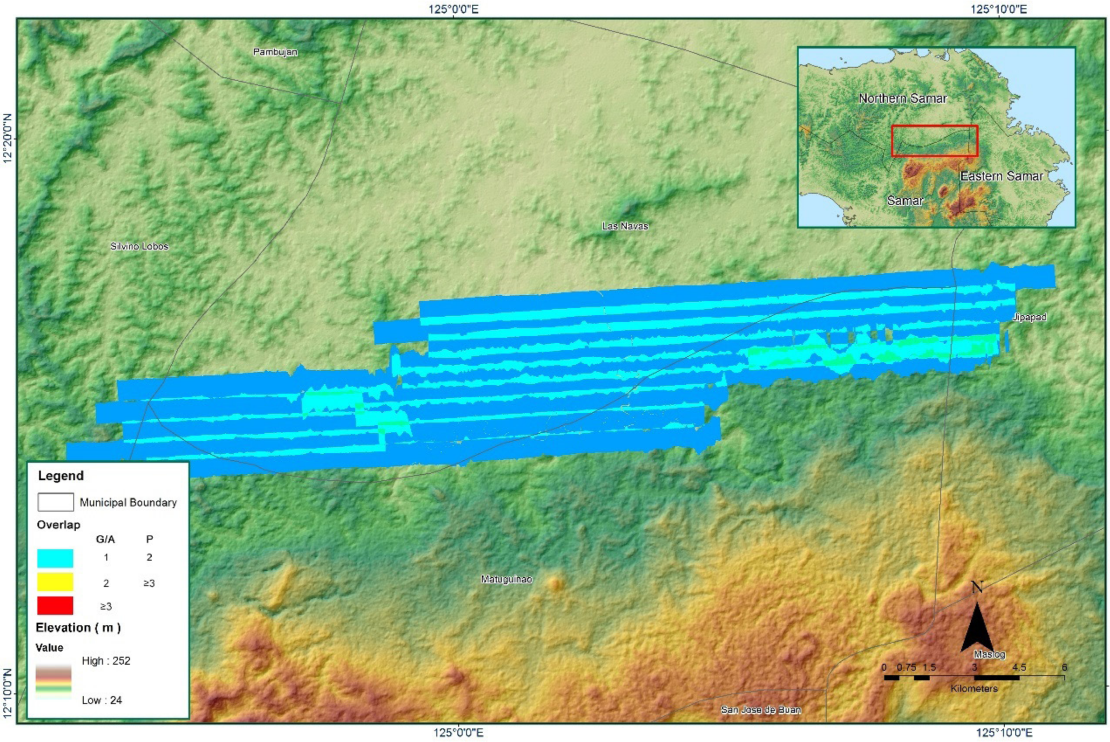


Figure A-8.110. Image of data overlap

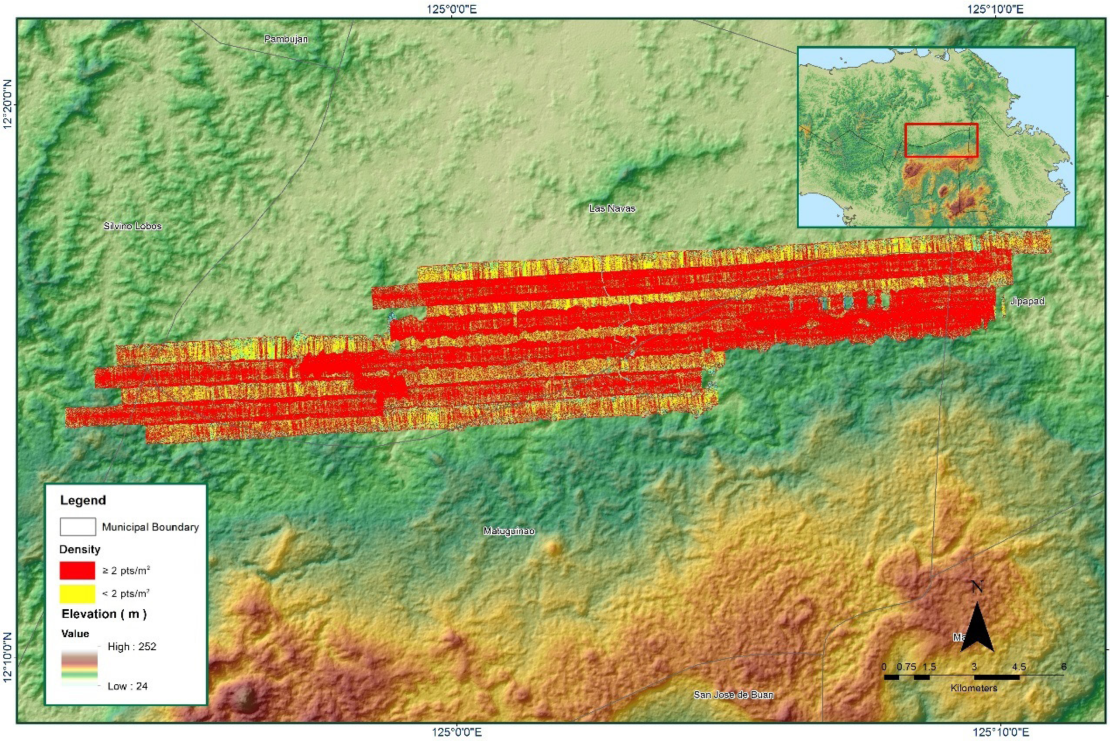


Figure A-8.111. Density map of merged LiDAR data

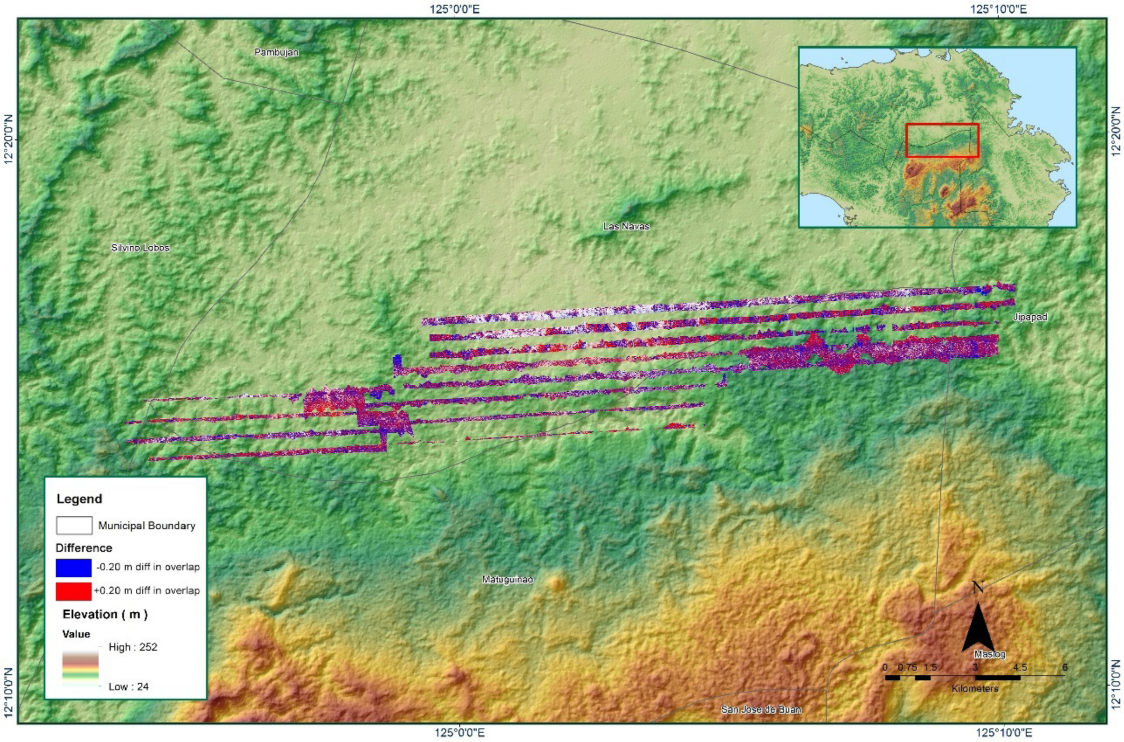


Figure A-8112. Elevation difference between flight lines

Table A-8.17. Mission Report for Mission Blk 33X

Flight Area	**Catarman Reflights**
Mission Name	**Blk 33X**
Inclusive Flights	8443AC
Range data size	10.7 GB
POS data size	249 MB
Base data size	89.9 MB
Image	43.8 MB
Transfer date	August 4, 2016
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)	1.215
RMSE for East Position (<4.0 cm)	1.810
RMSE for Down Position (<8.0 cm)	3.612
Boresight correction stdev (<0.001deg)	0.000733
IMU attitude correction stdev (<0.001deg)	0.004623
GPS position stdev (<0.01m)	0.0106
Minimum % overlap (>25)	34.54%
Ave point cloud density per sq.m. (>2.0)	3.68
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	104
Maximum Height	283.47 m
Minimum Height	37.25 m
Classification (# of points)	
Ground	51,194,759
Low vegetation	19,949,246
Medium vegetation	52,409,159
High vegetation	118,007,375
Building	1,979,529
Orthophoto	No
Processed by	Engr. Jennifer Saguran, Engr. Chelou Prado, Marie Denise Bueno

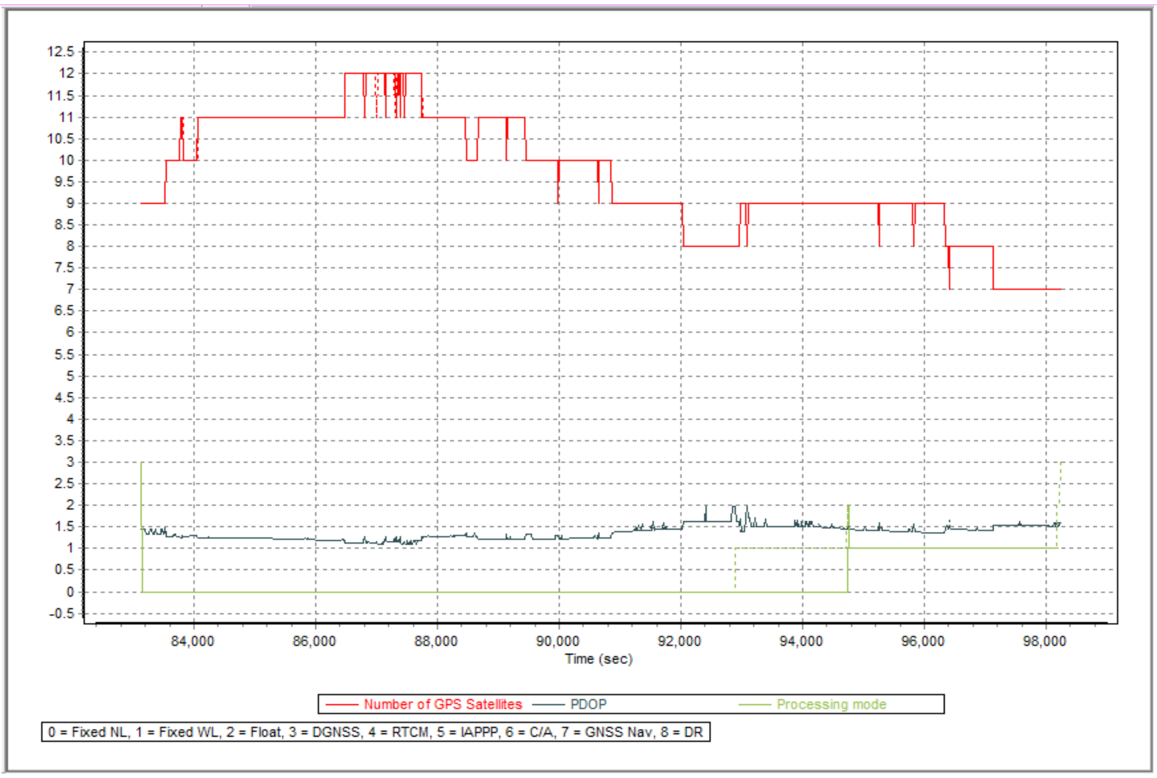


Figure A-8113. Solution Status

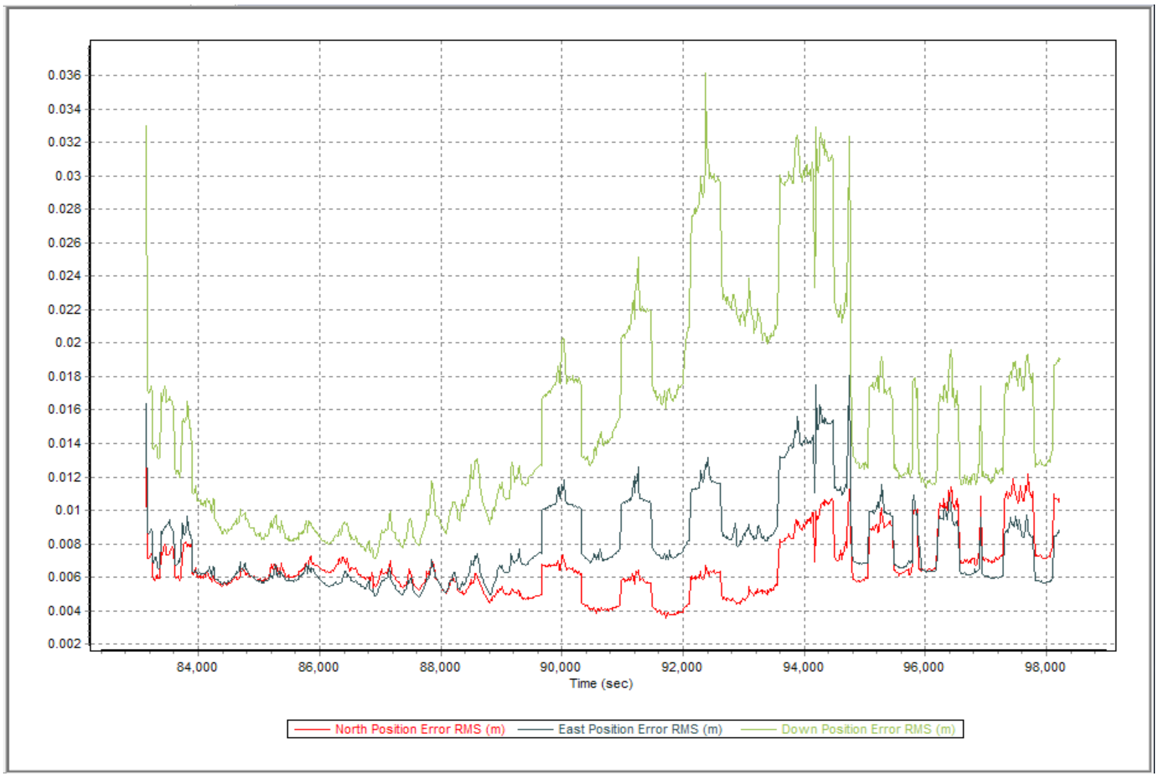


Figure A-8.114. Smoothed Performance Metric Parameters

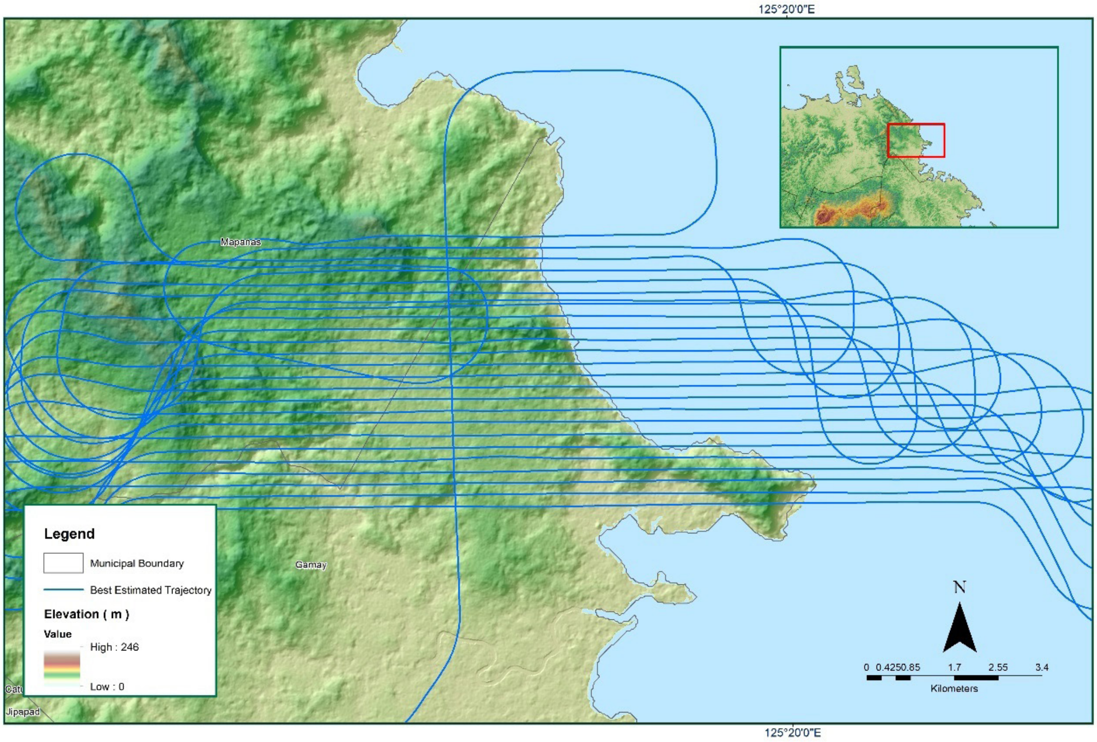


Figure A-8.115. Best Estimated Trajectory

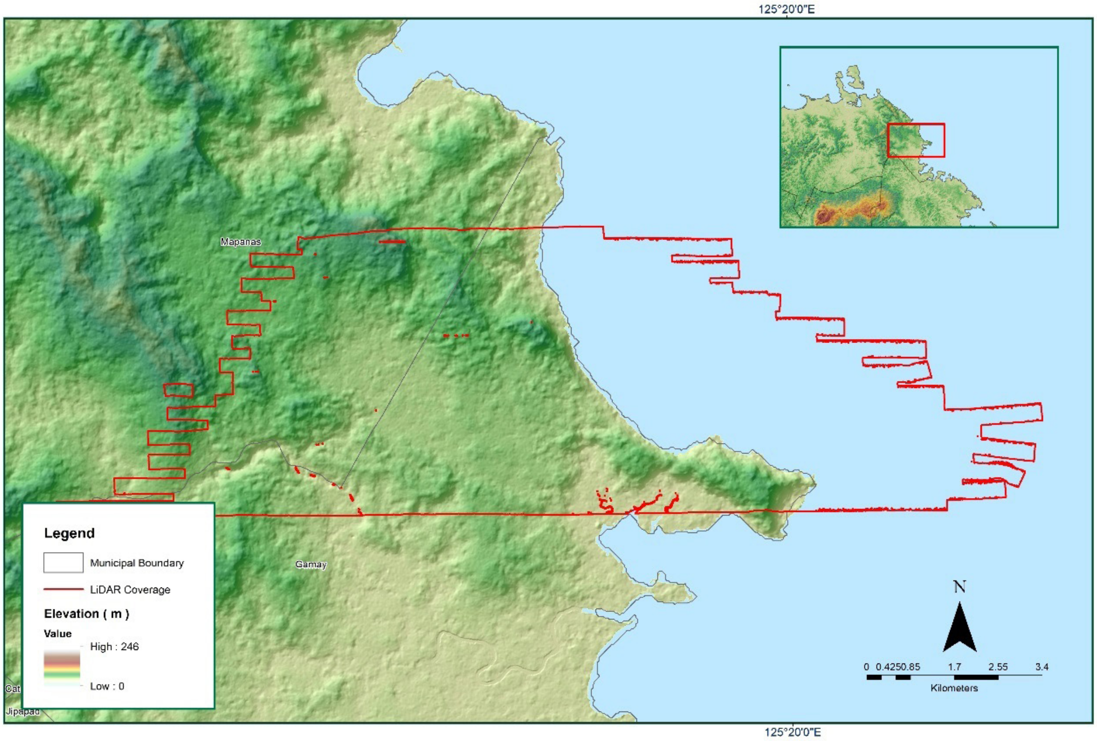


Figure A-8.116. Coverage of LiDAR Data

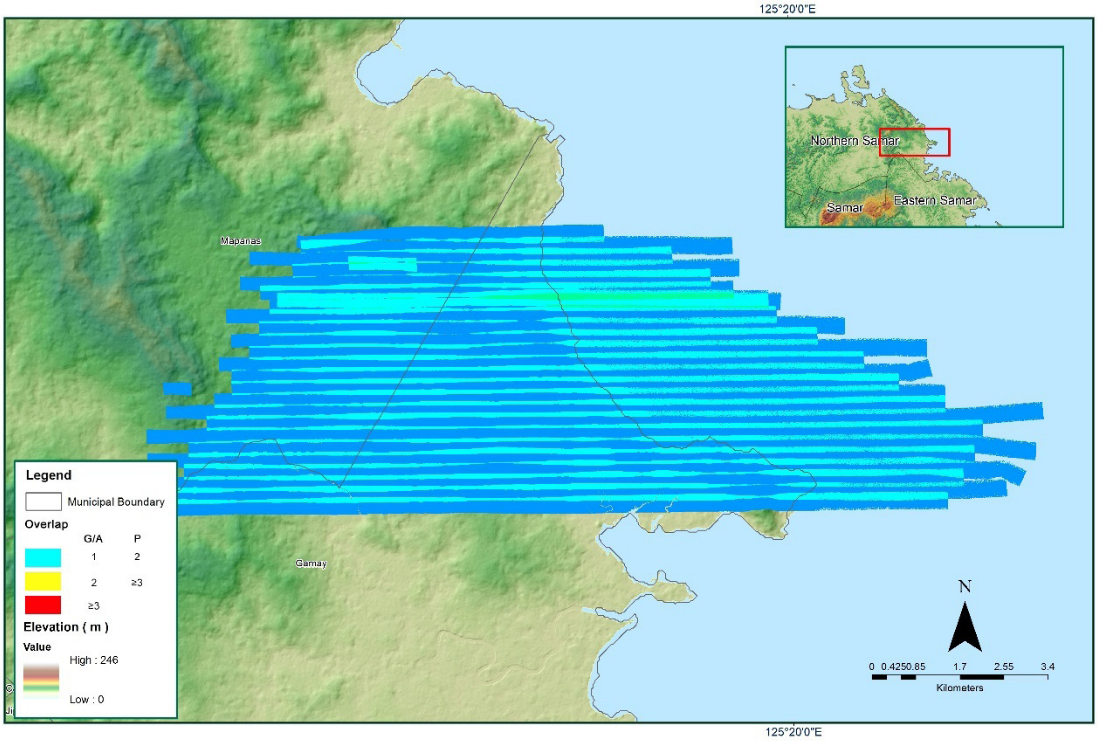


Figure A-8.117. Image of data overlap

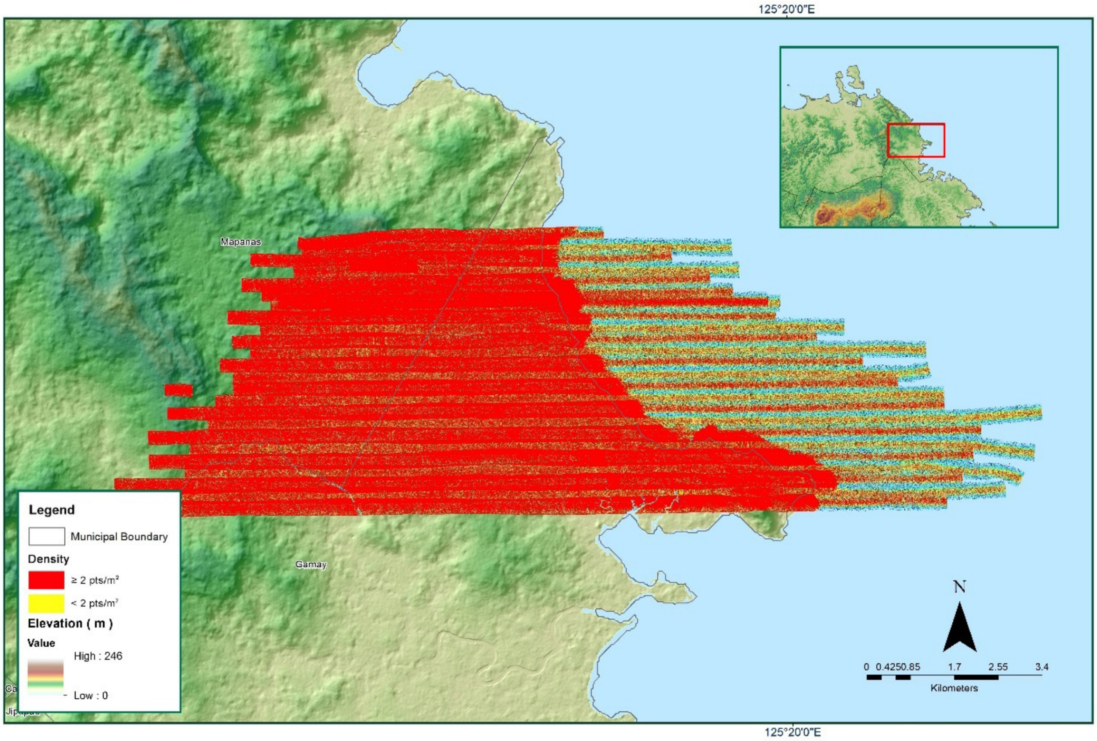


Figure A-8.118. Density map of merged LiDAR data

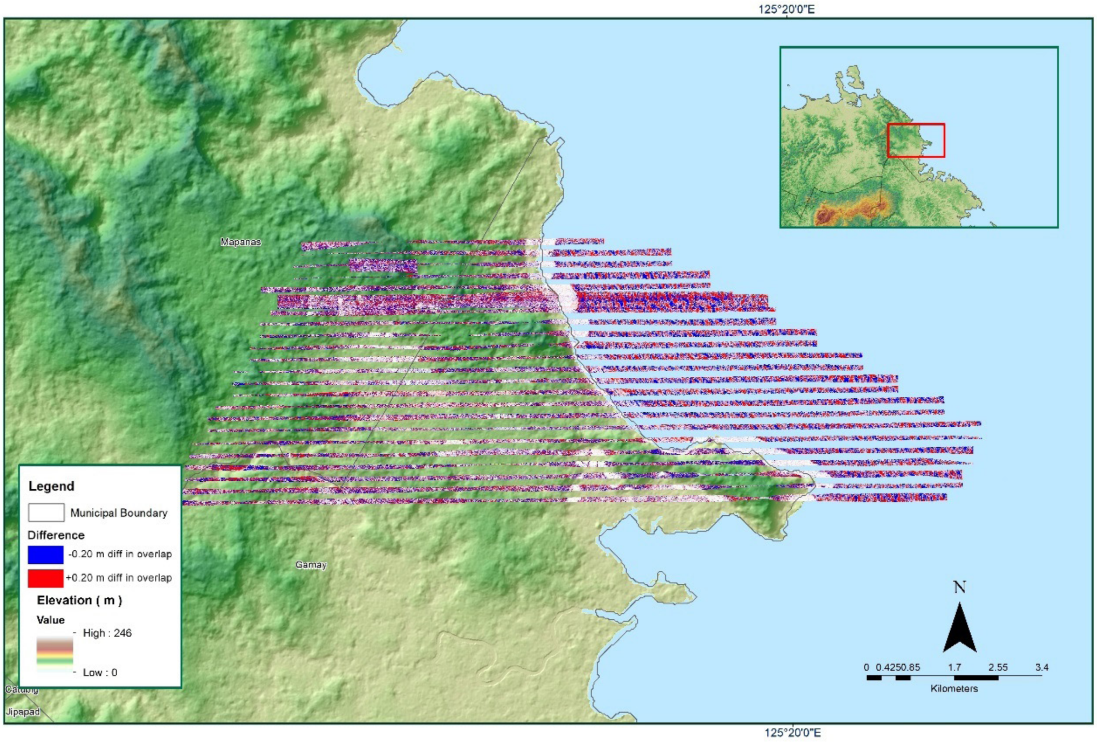


Figure A-8.119. Elevation difference between flight lines

Table A-8.18. Mission Report for Mission Blk 33Y

Flight Area	**Catarman Reflights**
Mission Name	**Blk 33Y**
Inclusive Flights	8441AC
Range data size	12.8 GB
POS data size	246 MB
Base data size	91.8 MB
Image	64.7 MB
Transfer date	August 4, 2016
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)	1.215
RMSE for East Position (<4.0 cm)	1.810
RMSE for Down Position (<8.0 cm)	3.612
Boresight correction stdev (<0.001deg)	0.000415
IMU attitude correction stdev (<0.001deg)	0.001983
GPS position stdev (<0.01m)	0.0083
Minimum % overlap (>25)	39.49%
Ave point cloud density per sq.m. (>2.0)	3.94
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	120
Maximum Height	286.55 m
Minimum Height	39.1 m
Classification (# of points)	
Ground	79,088,740
Low vegetation	35,252,922
Medium vegetation	61,825,140
High vegetation	151,550,762
Building	2,922,352
Orthophoto	No
Processed by	Engr. Jennifer Saguran, Engr. Edgardo Gubatanga Jr., Engr. Elainne Lopez

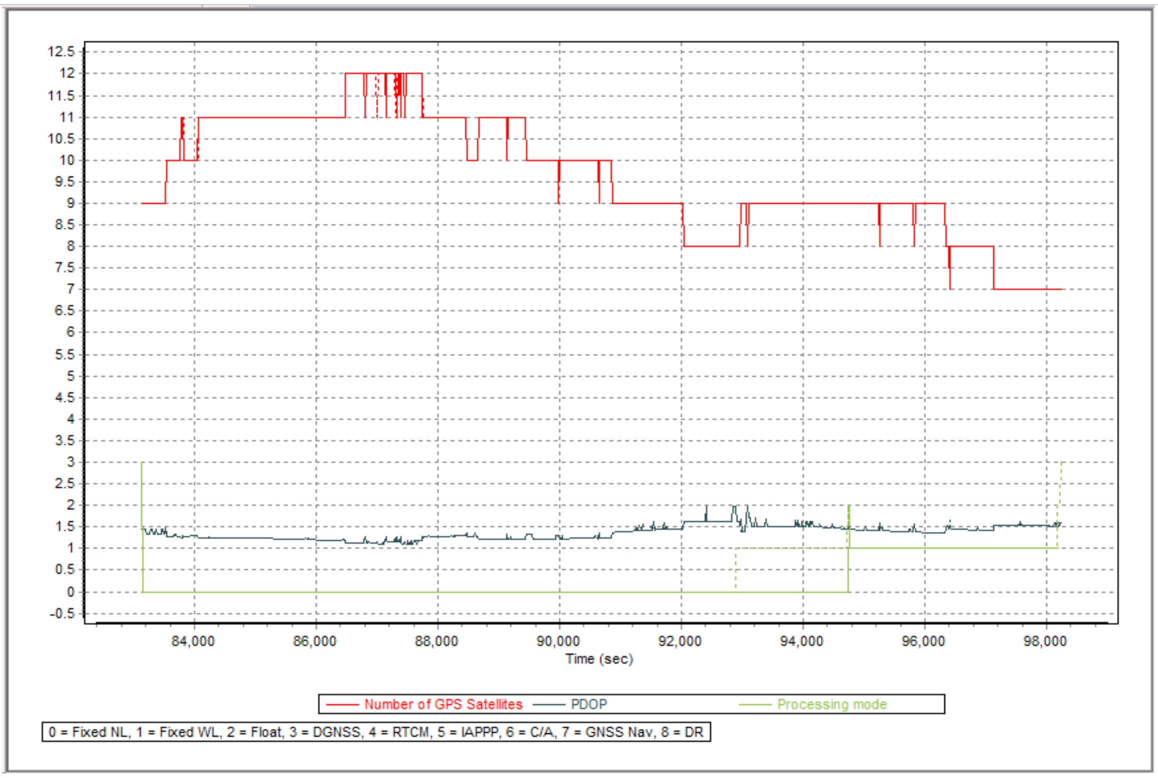


Figure A-8.120. Solution Status

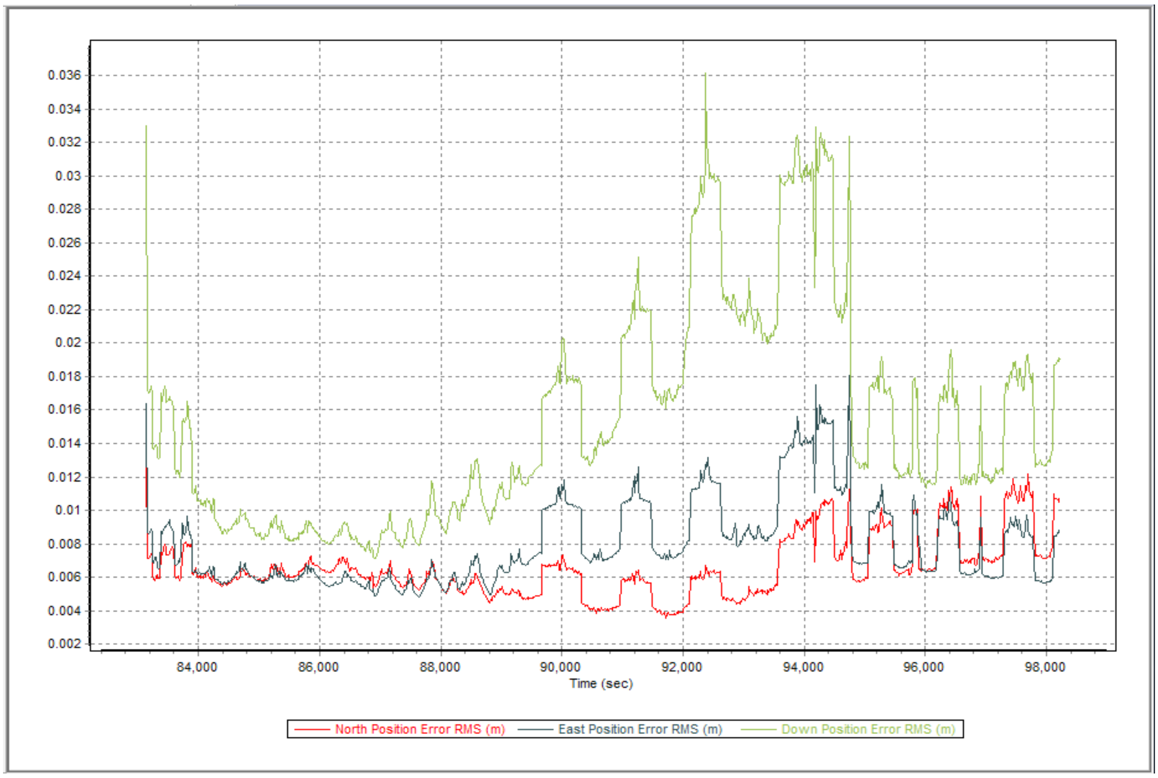


Figure A-8.121. Smoothed Performance Metric Parameters

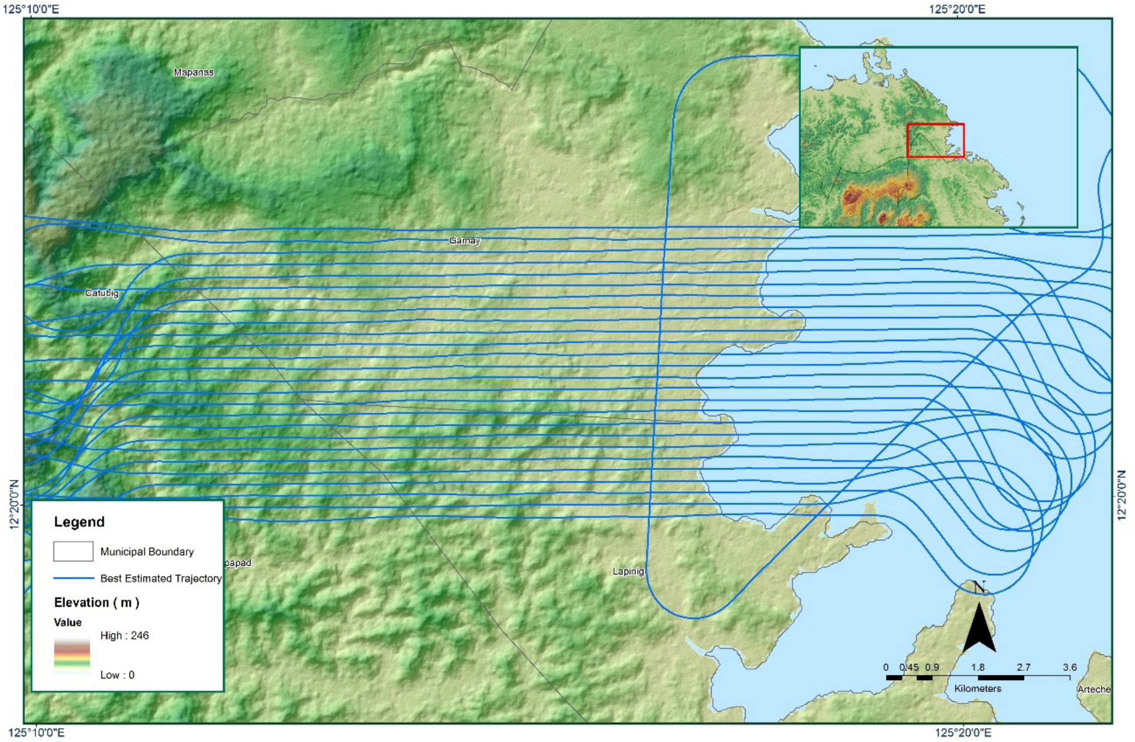


Figure A-8.122. Best Estimated Trajectory

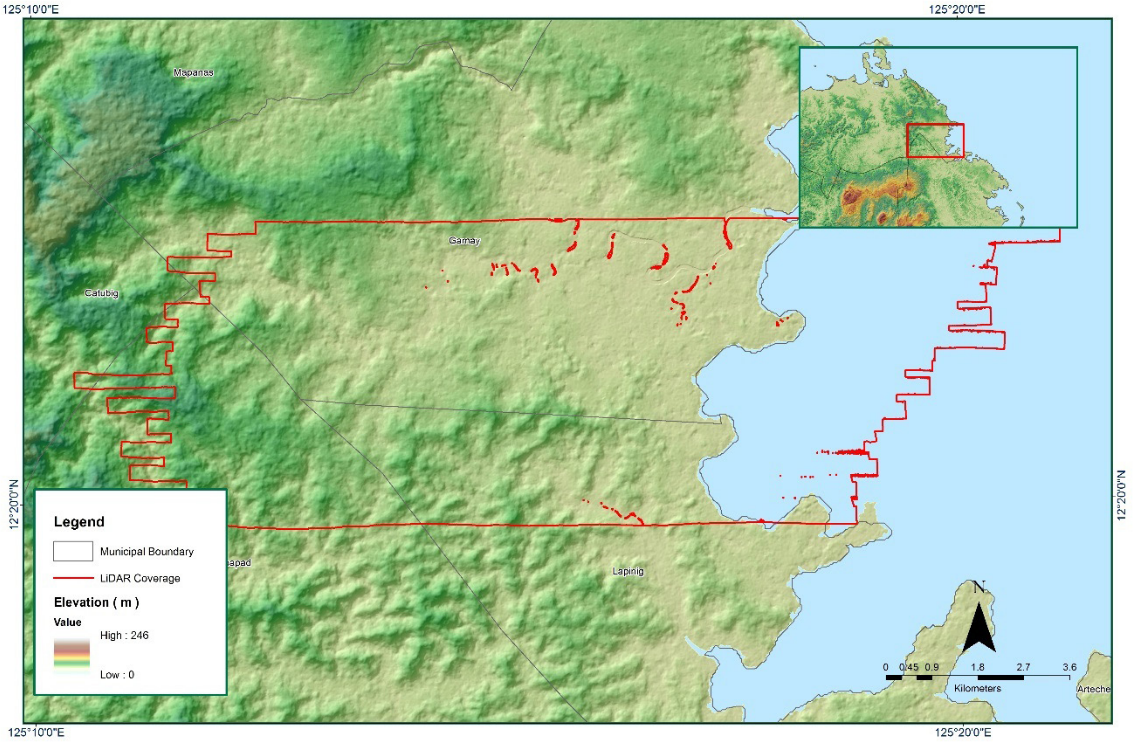


Figure A-8.123. Coverage of LiDAR Data

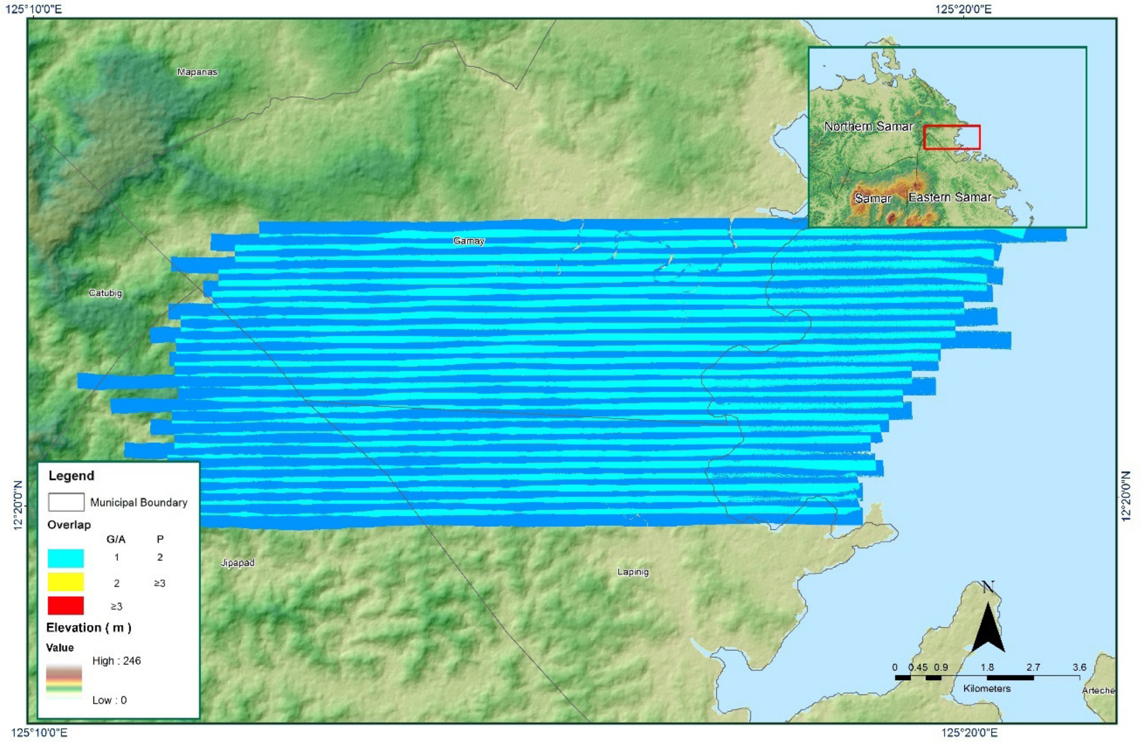


Figure A-8.124. Image of data overlap

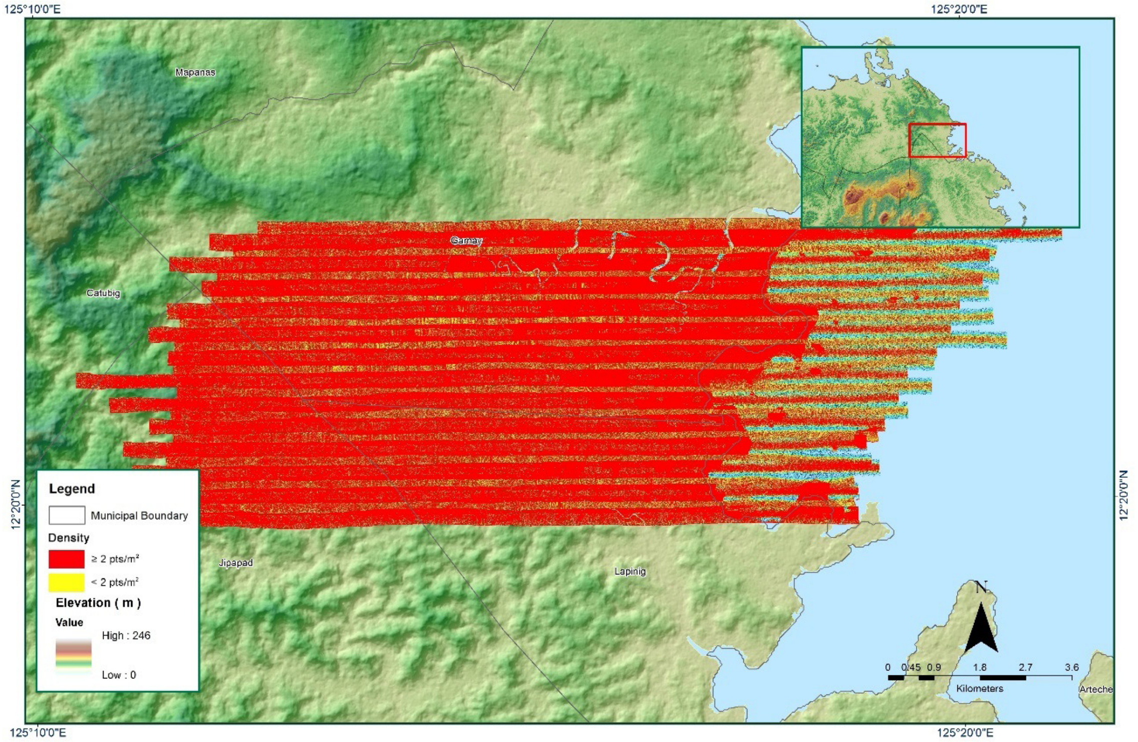


Figure A-8.125. Density map of merged LiDAR data

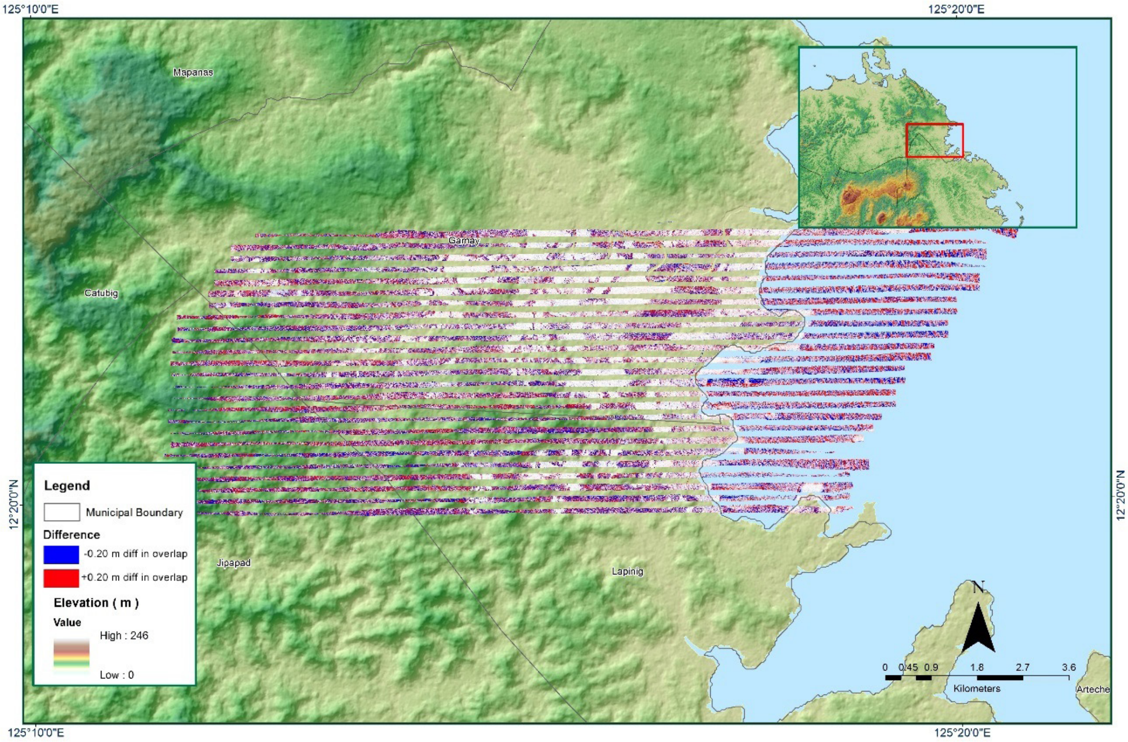


Figure A-8.126. Elevation difference between flight lines

Table A-8.19. Mission Report for Mission Blk 33Y_supplement

Flight Area	**Catarman Reflights**
Mission Name	**Blk 33Y_supplement**
Inclusive Flights	8442AC
Range data size	5.04 GB
POS data size	122 MB
Base data size	91.8 MB
Image	15.8 MB
Transfer date	August 4, 2016
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)	1.215
RMSE for East Position (<4.0 cm)	1.810
RMSE for Down Position (<8.0 cm)	3.612
Boresight correction stdev (<0.001deg)	0.000824
IMU attitude correction stdev (<0.001deg)	0.002066
GPS position stdev (<0.01m)	0.0129
Minimum % overlap (>25)	29.41%
Ave point cloud density per sq.m. (>2.0)	3.75
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	71
Maximum Height	243 m
Minimum Height	36.84 m
Classification (# of points)	
Ground	24,664,888
Low vegetation	15,843,803
Medium vegetation	27,631,021
High vegetation	50,739,496
Building	824,601
Orthophoto	No
Processed by	Engr. Jennifer Saguran, Engr. Velina Angela Bemida, Maria Tamsyn Malabanan

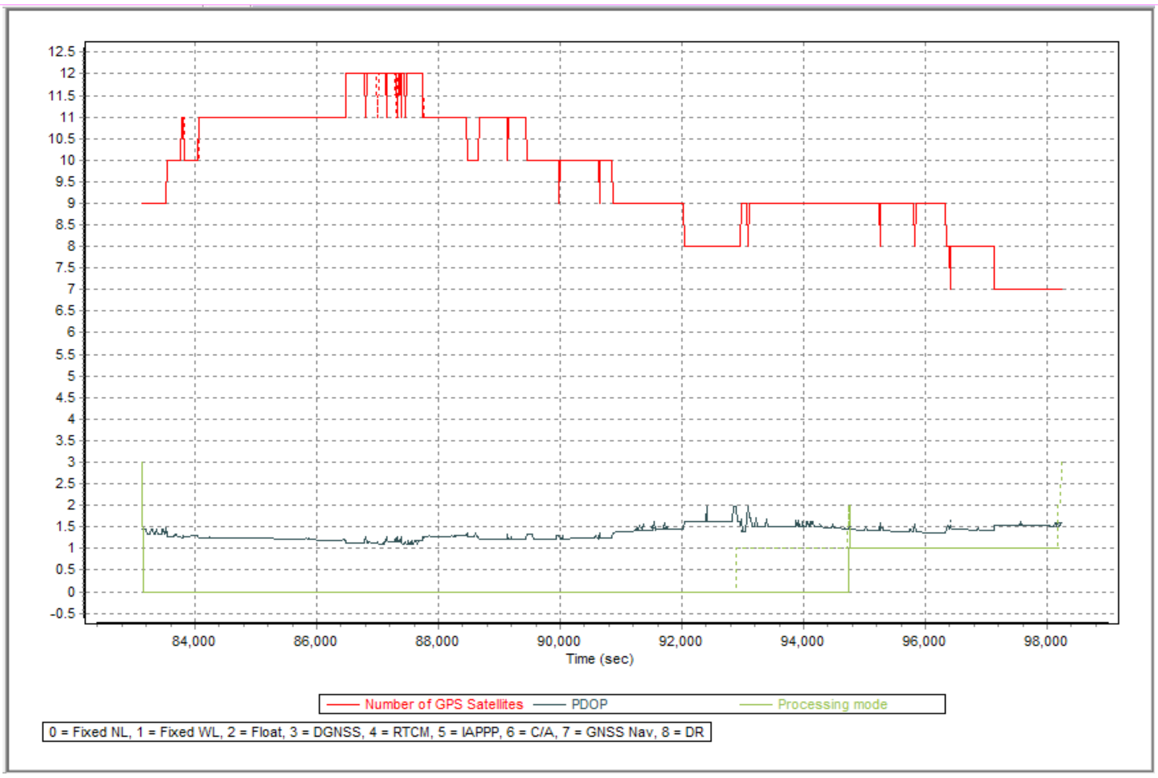


Figure A-8.127. Solution Status

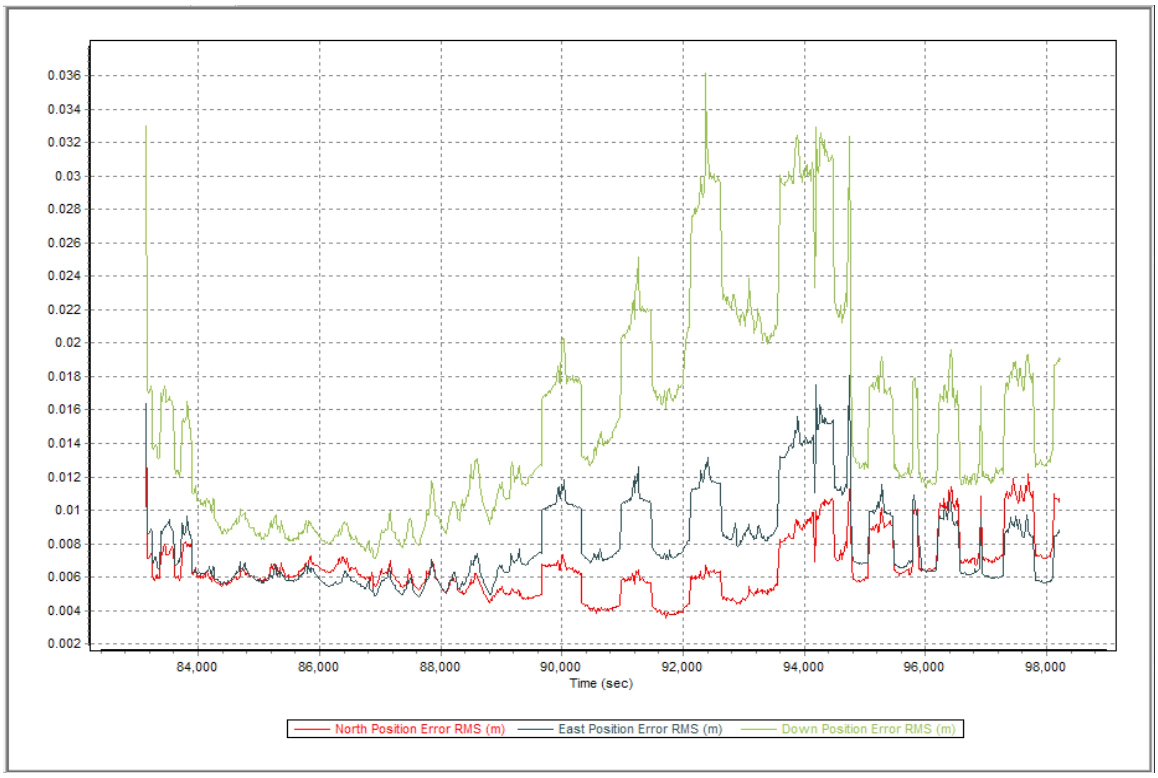


Figure A-8.128. Smoothed Performance Metric Parameters

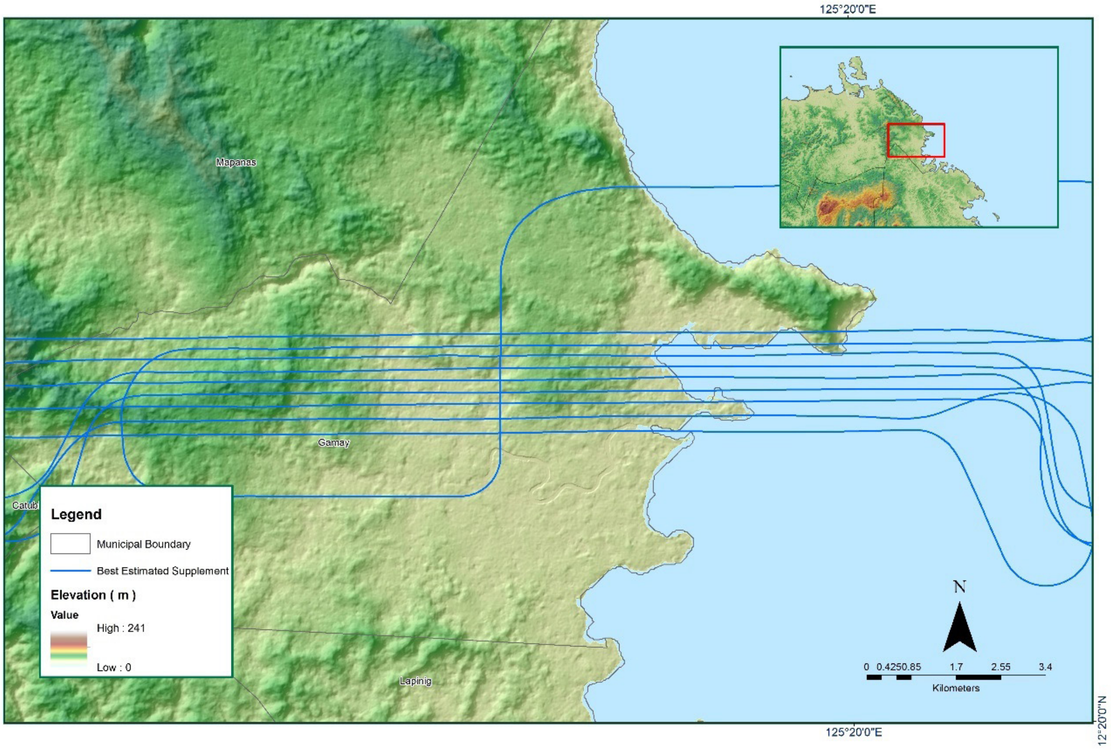


Figure A-8.129. Best Estimated Trajectory

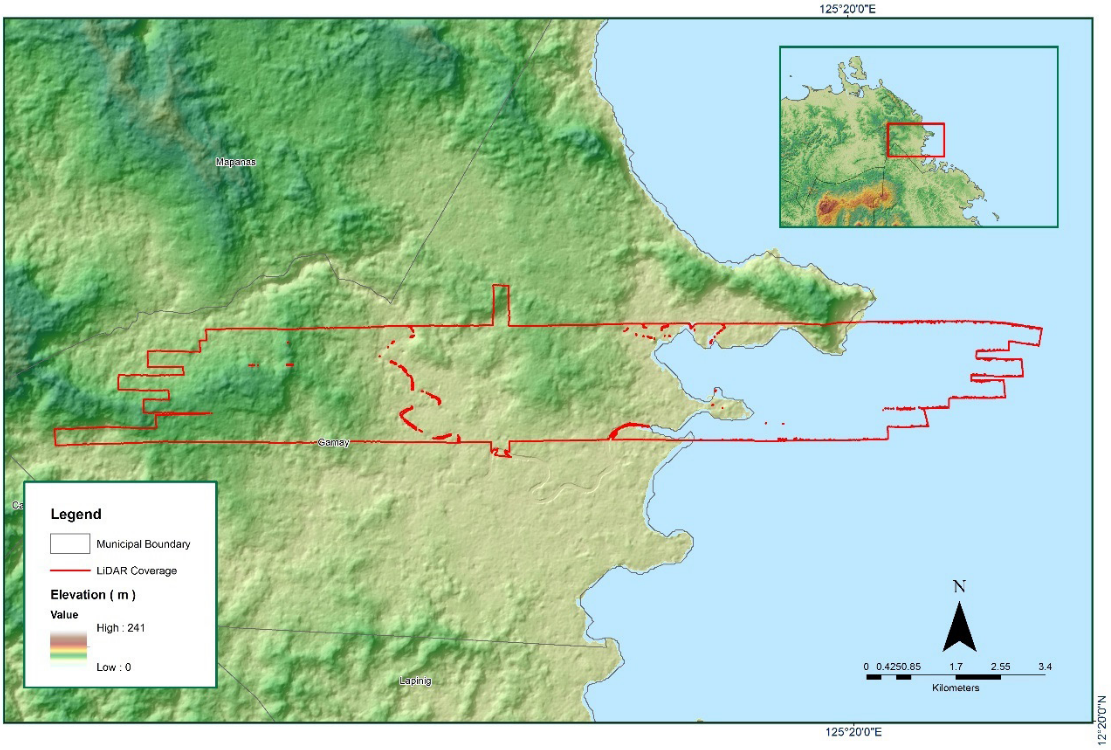
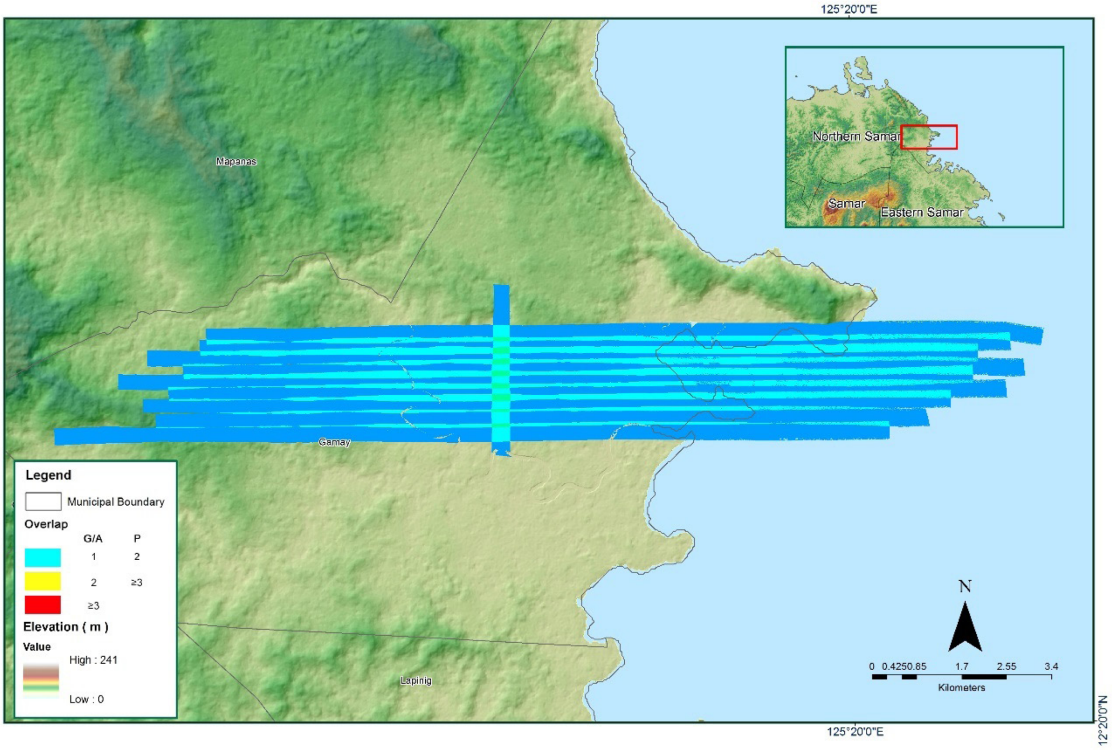


Figure A-8.130. Coverage of LiDAR Data



FigureA-8.131. Image of data overlap

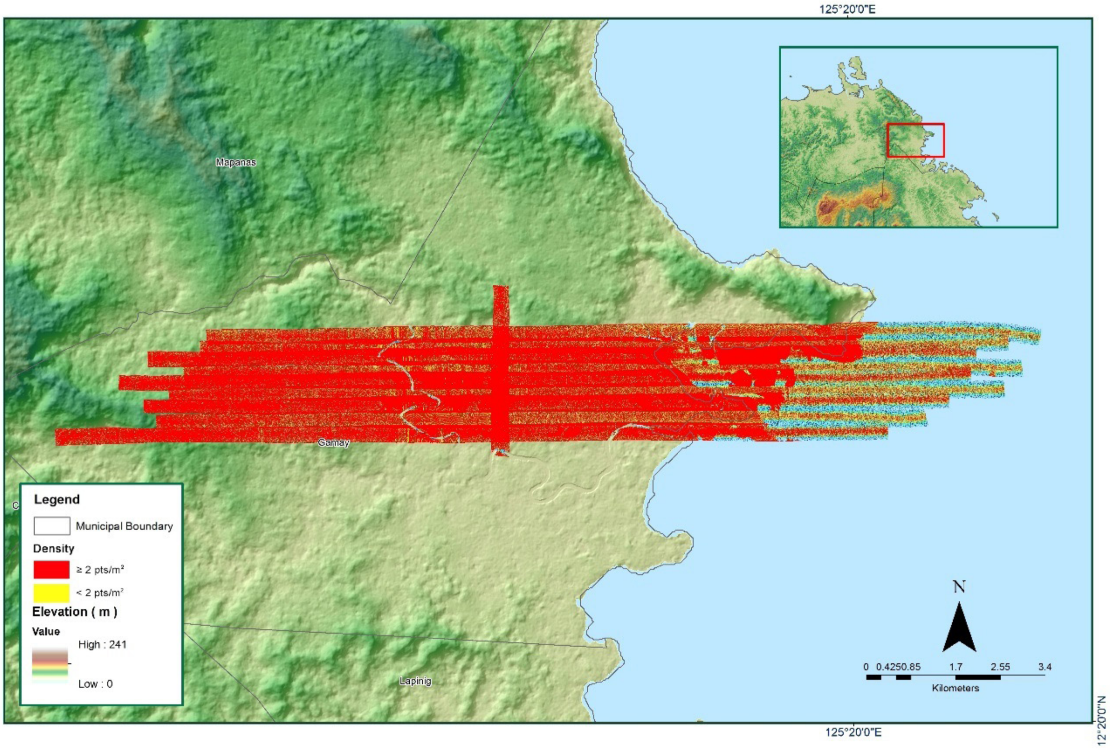


Figure A-8.132. Density map of merged LiDAR data

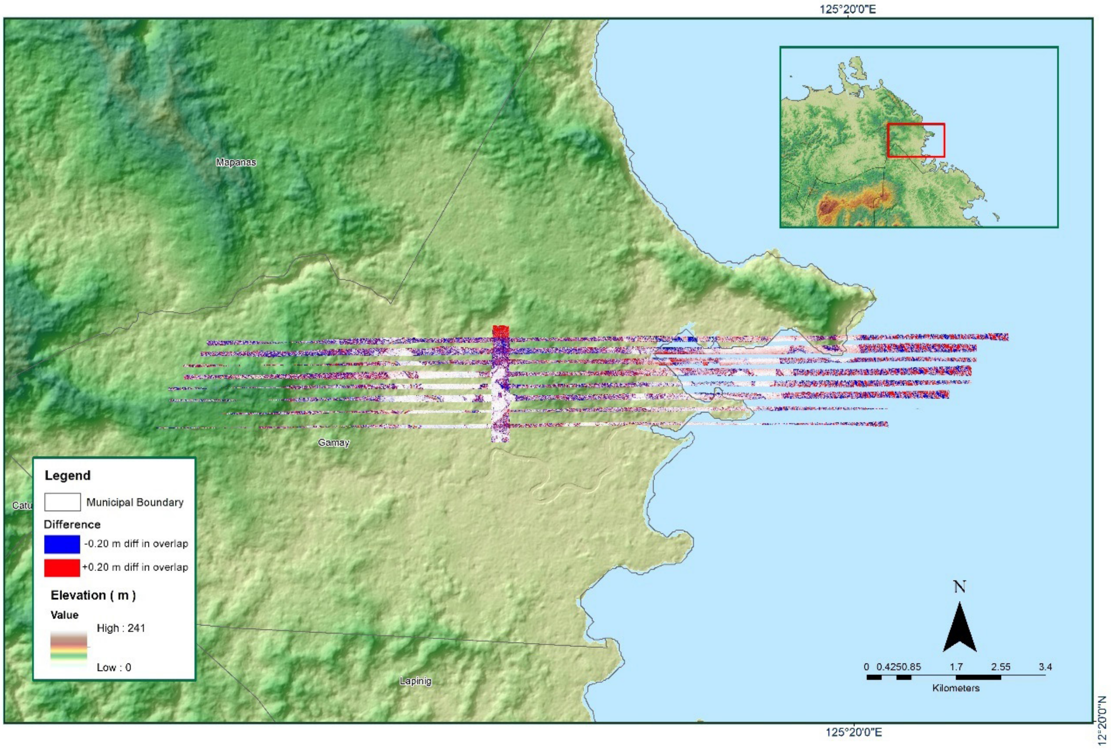


Figure A-8.133. Elevation difference between flight lines

Table A-8.20. Mission Report for Mission Blk 33T

Flight Area	**Catarman Reflights**
Mission Name	**Blk 33T**
Inclusive Flights	3971G
Range data size	22.4 GB
POS data size	255 MB
Base data size	195 MB
Image	NA
Transfer date	May 11, 2016
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)	1.215
RMSE for East Position (<4.0 cm)	1.810
RMSE for Down Position (<8.0 cm)	3.612
Boresight correction stdev (<0.001deg)	NA
IMU attitude correction stdev (<0.001deg)	NA
GPS position stdev (<0.01m)	NA
Minimum % overlap (>25)	47.26%
Ave point cloud density per sq.m. (>2.0)	6.24
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	76
Maximum Height	734.77 m
Minimum Height	60.09 m
Classification (# of points)	
Ground	28,287,661
Low vegetation	8,722,696
Medium vegetation	69,188,358
High vegetation	19,993,326
Building	0
Orthophoto	No
Processed by	Engr. Kenneth Solidum, Engr. Chelou Prado, Engr. Elainne Lopez

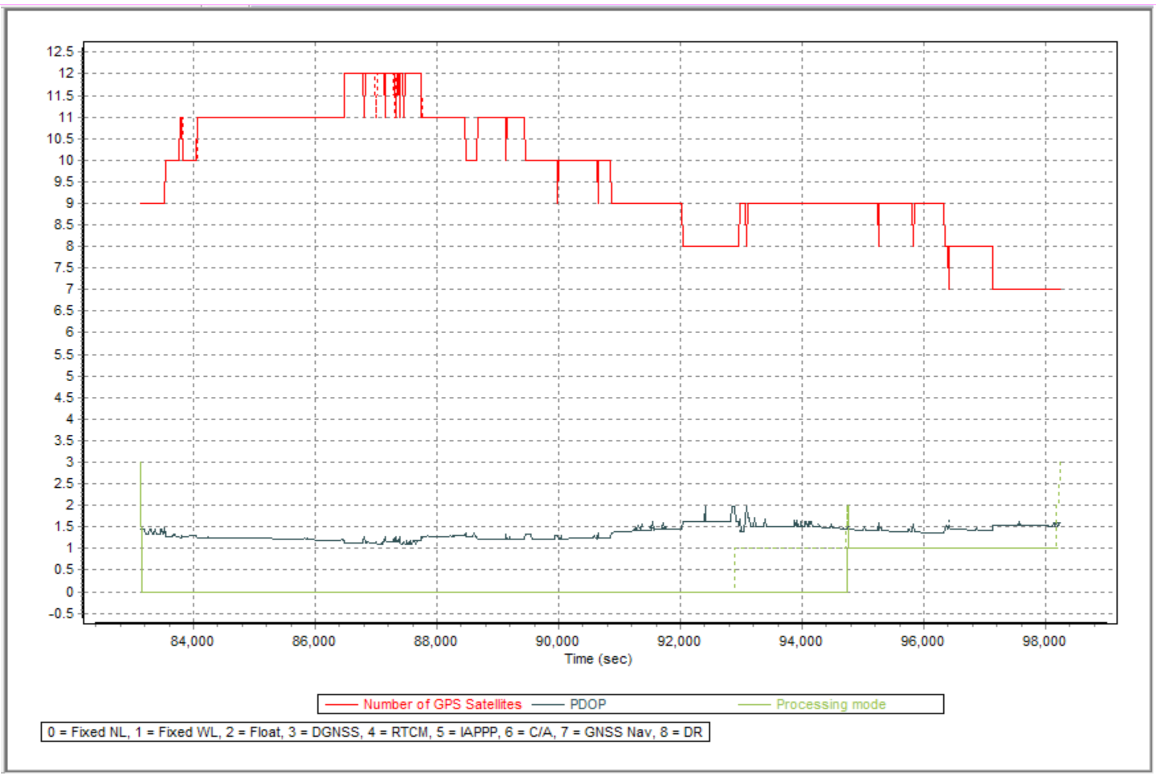


Figure A-8.134. Solution Status

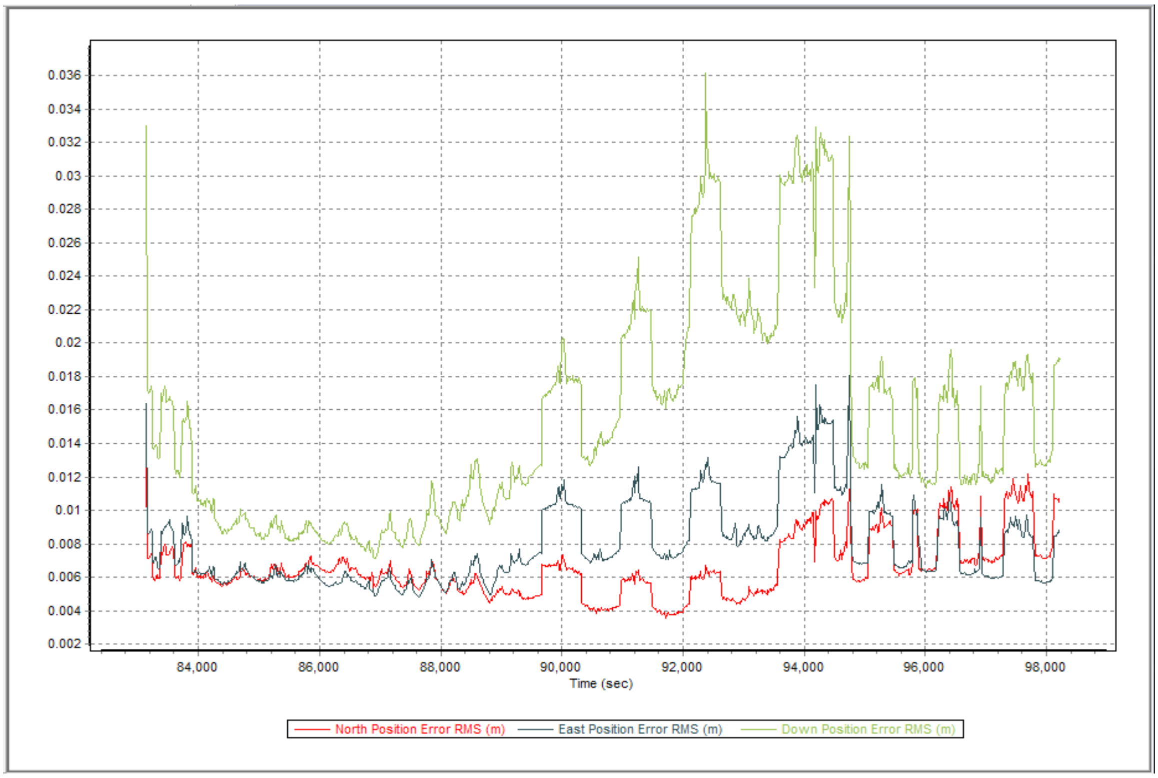


Figure A-8.135. Smoothed Performance Metric Parameters

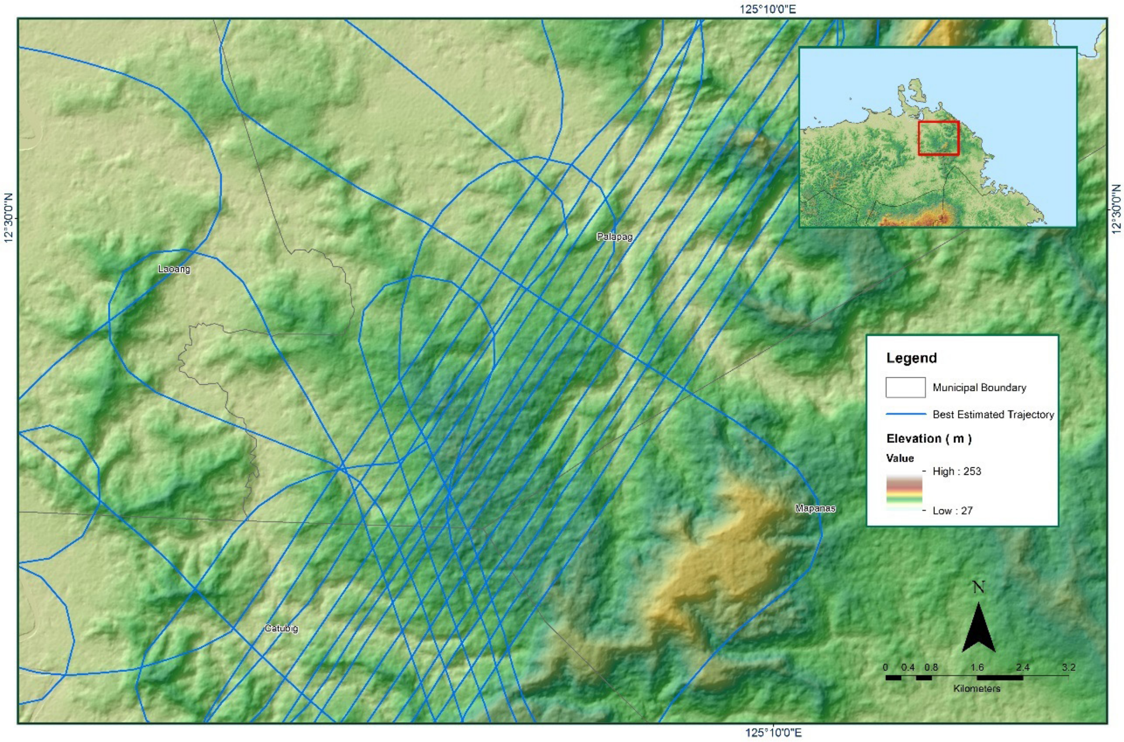


Figure A-8.136. Best Estimated Trajectory

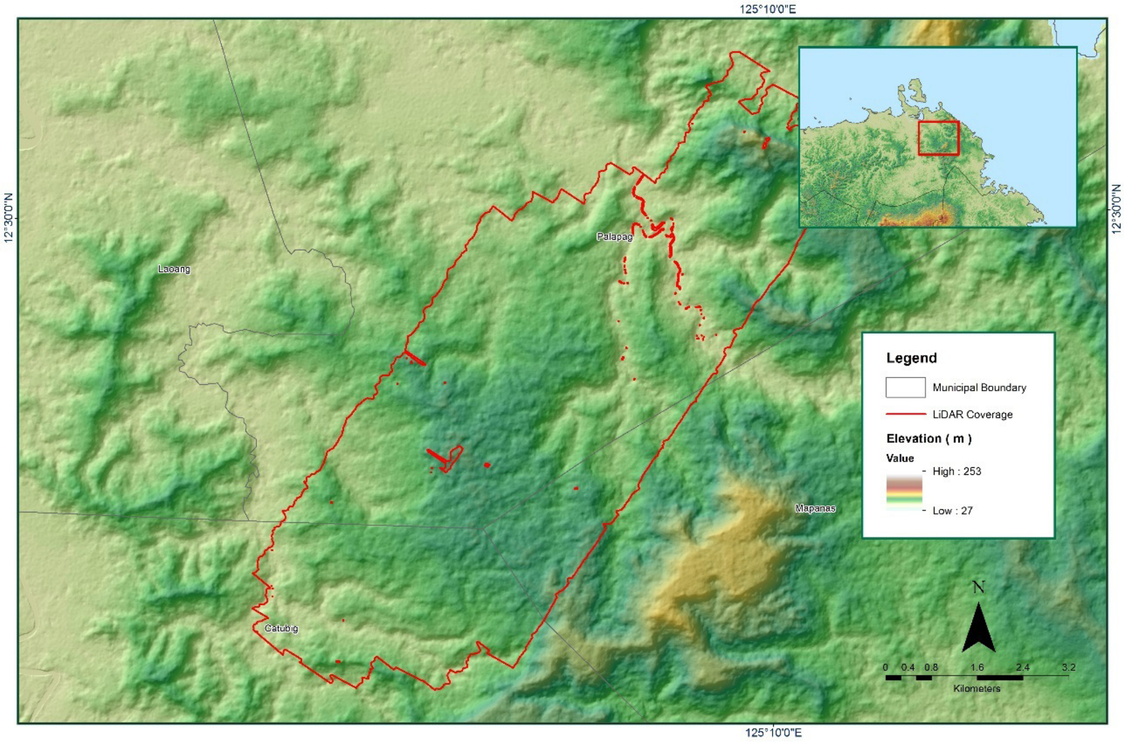


Figure A-8.137. Coverage of LiDAR Data

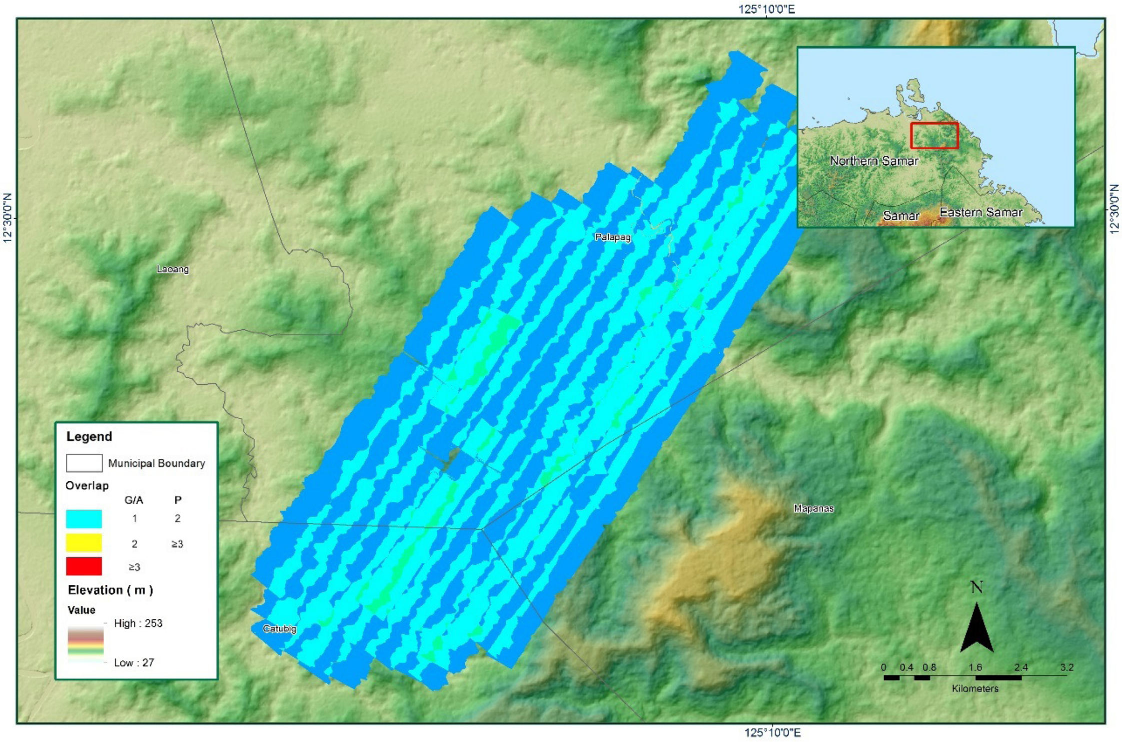


Figure A-8.138. Image of data overlap

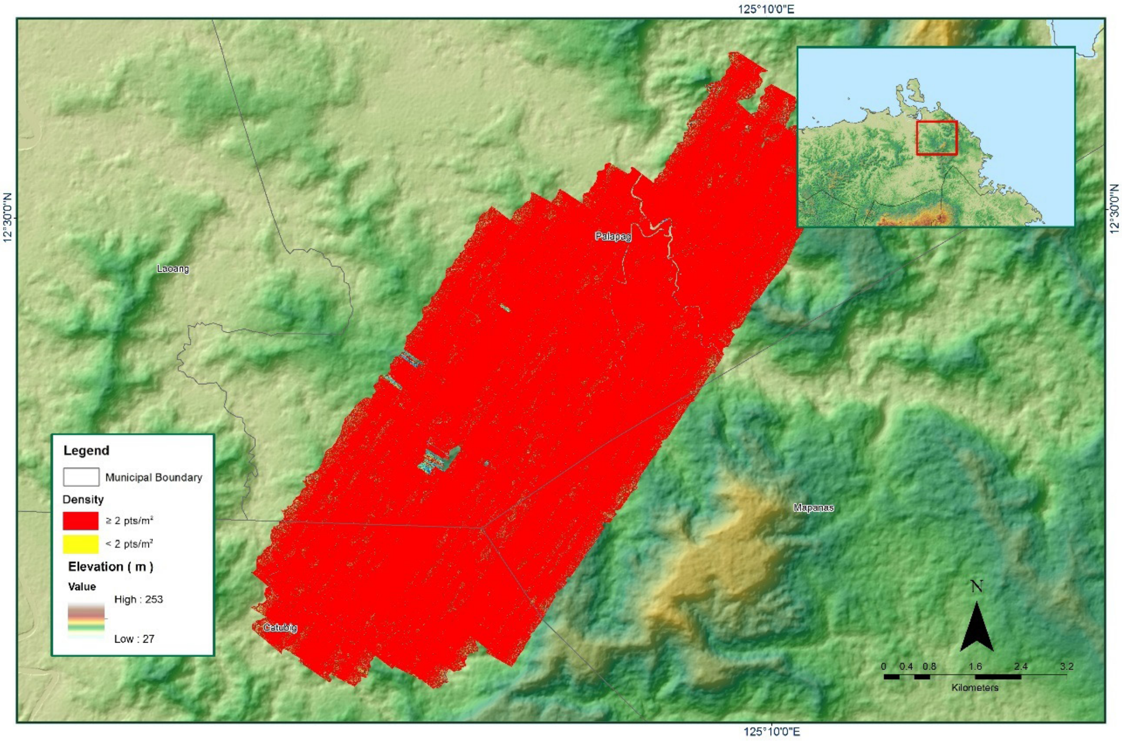


Figure A-8.139. Density map of merged LiDAR data

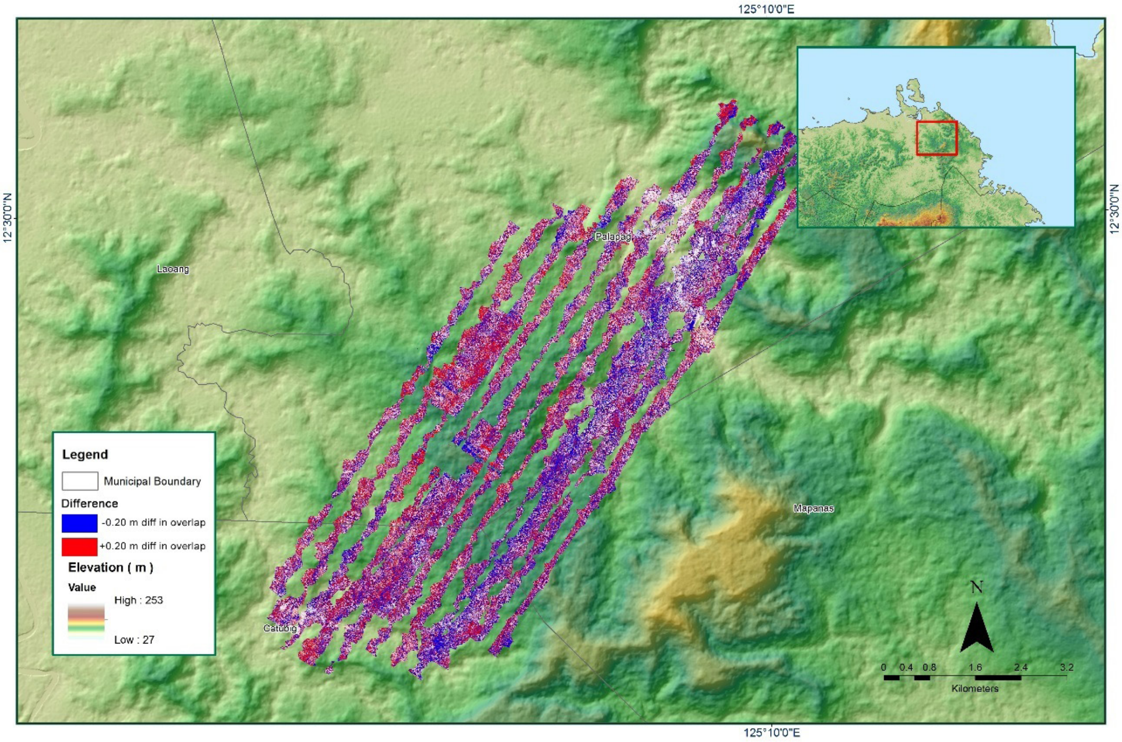


Figure A-8.140. Elevation difference between flight lines

Table A-8.21. Mission Report for Mission Blk 33U

Flight Area	**Catarman Reflights**
Mission Name	**Blk 33U**
Inclusive Flights	3917G
Range data size	22.4 GB
POS data size	255 MB
Base data size	195 MB
Image	NA
Transfer date	May 11, 2016
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)	1.215
RMSE for East Position (<4.0 cm)	1.810
RMSE for Down Position (<8.0 cm)	3.612
Boresight correction stdev (<0.001deg)	0.004863
IMU attitude correction stdev (<0.001deg)	0.016438
GPS position stdev (<0.01m)	0.0162
Minimum % overlap (>25)	40.34%
Ave point cloud density per sq.m. (>2.0)	6.17
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	63
Maximum Height	375.38 m
Minimum Height	61.44 m
Classification (# of points)	
Ground	21,804,943
Low vegetation	12,515,556
Medium vegetation	78,395,558
High vegetation	122,618,926
Building	49,789
Orthophoto	No
Processed by	Engr. Kenneth Solidum, Engr. Ma. Joanne Balaga, Engr. Elainne Lopez

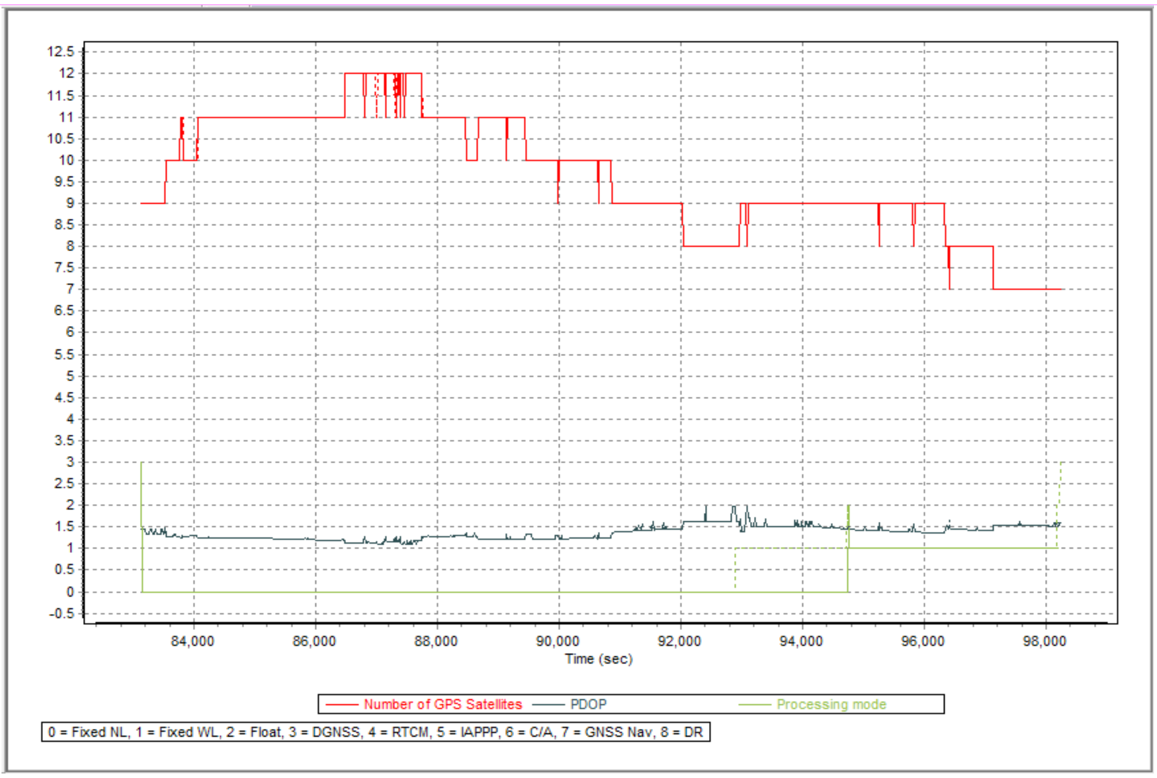


Figure A-8.141. Solution Status

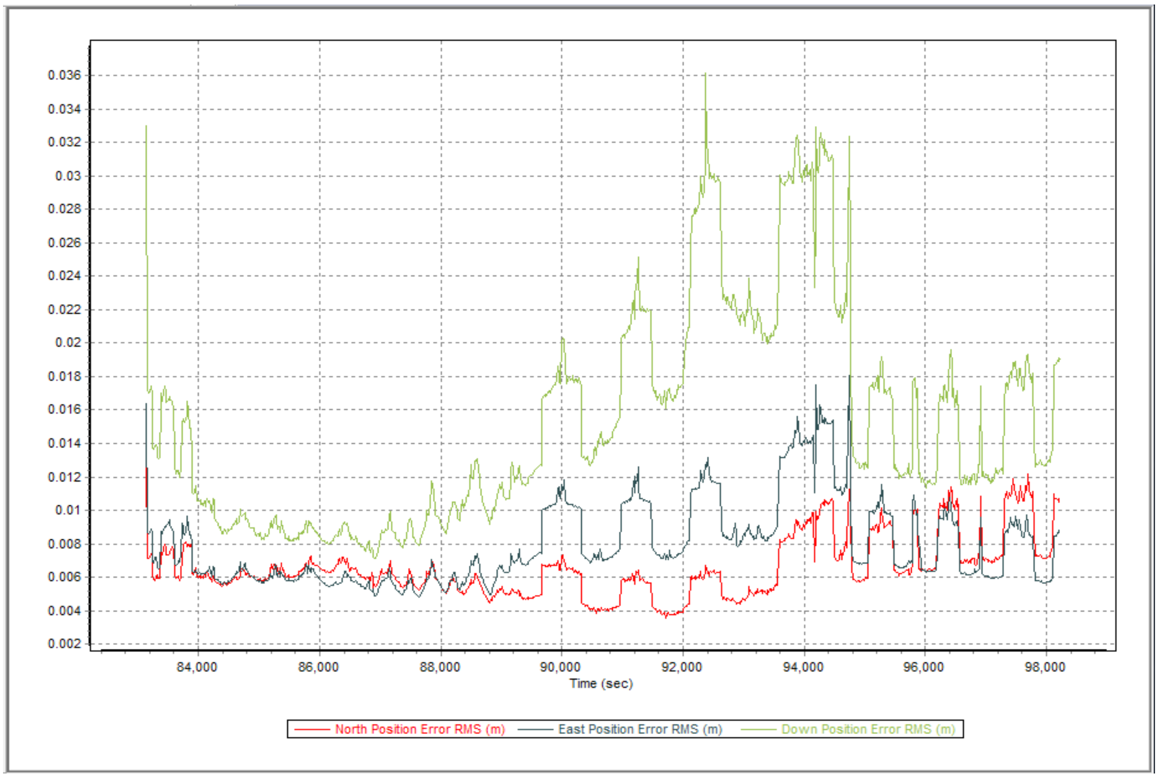


Figure A-8.142. Smoothed Performance Metric Parameters

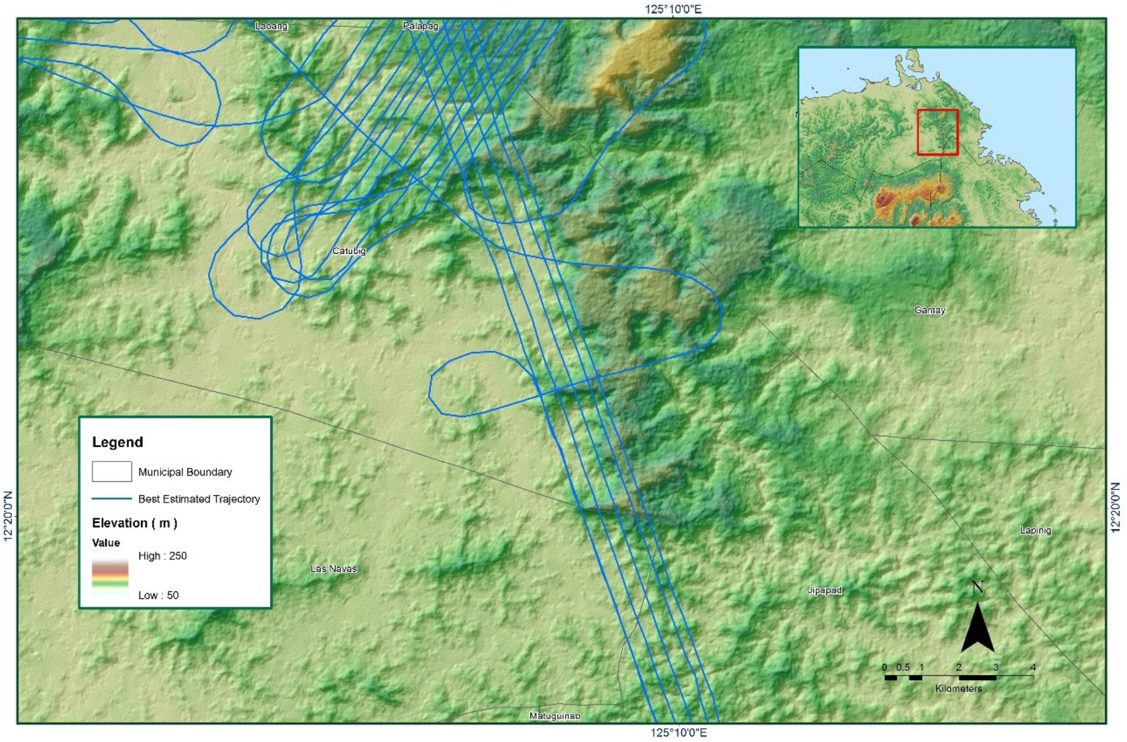


Figure A-8.143. Best Estimated Trajectory

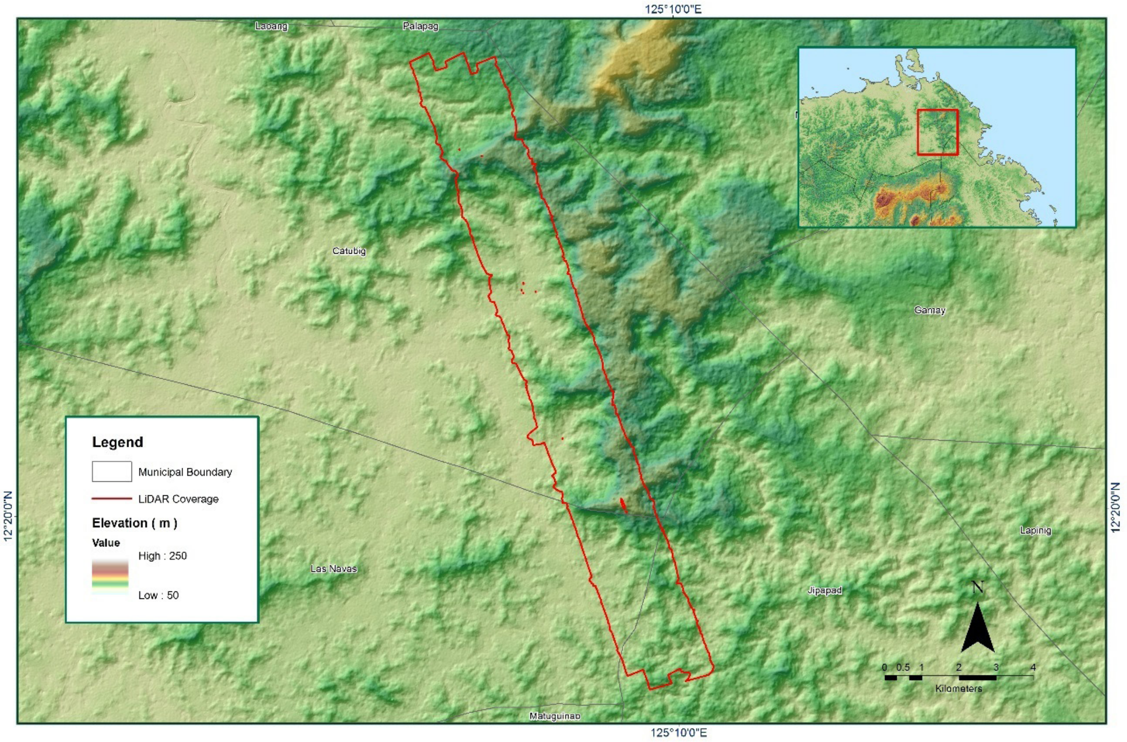


Figure A-8.144. Coverage of LiDAR Data

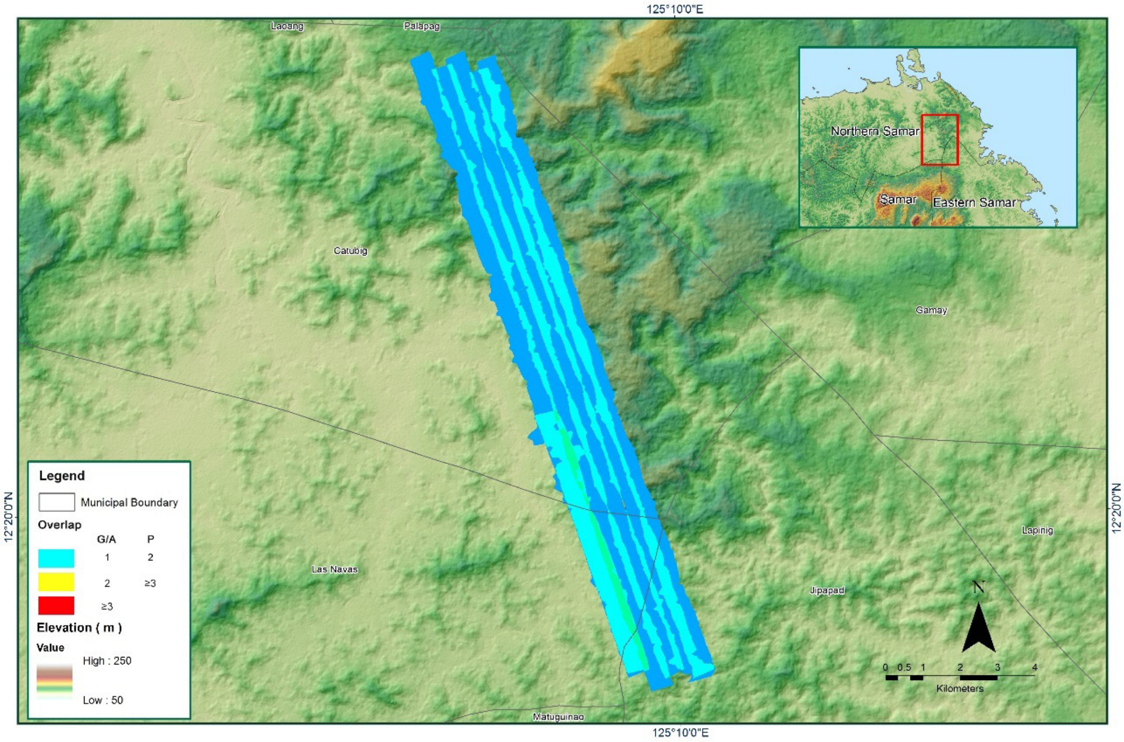


Figure A-8.145. Image of data overlap

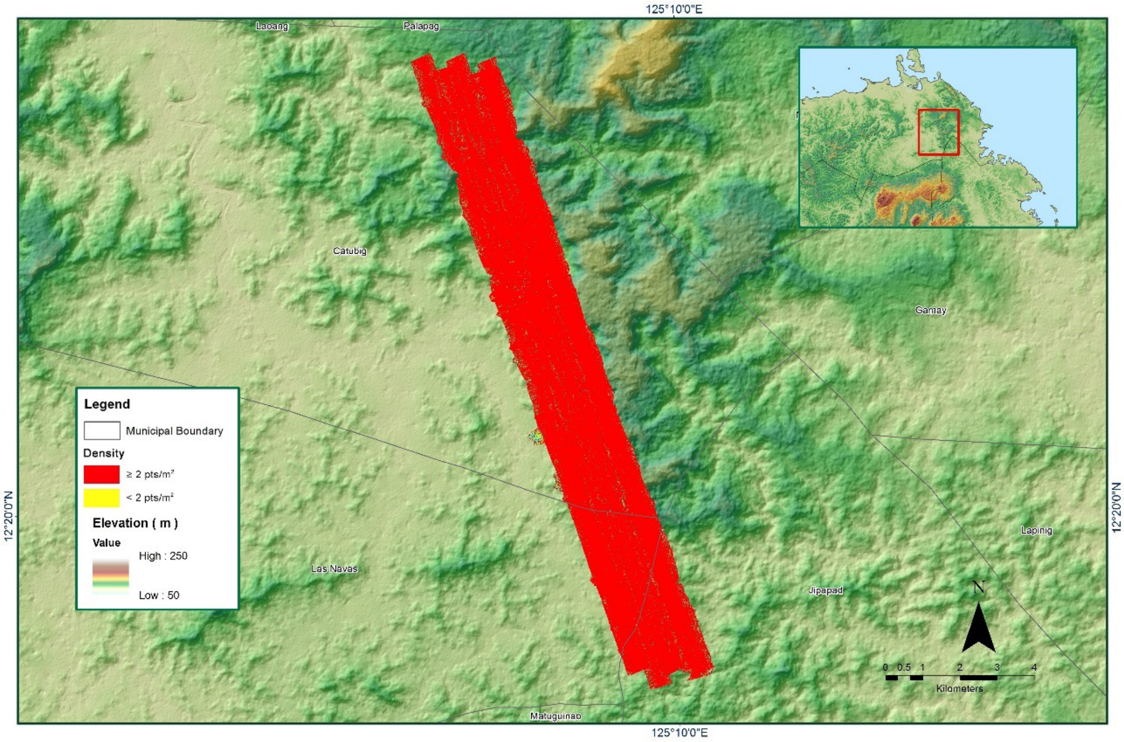


Figure A-8.146. Density map of merged LiDAR data

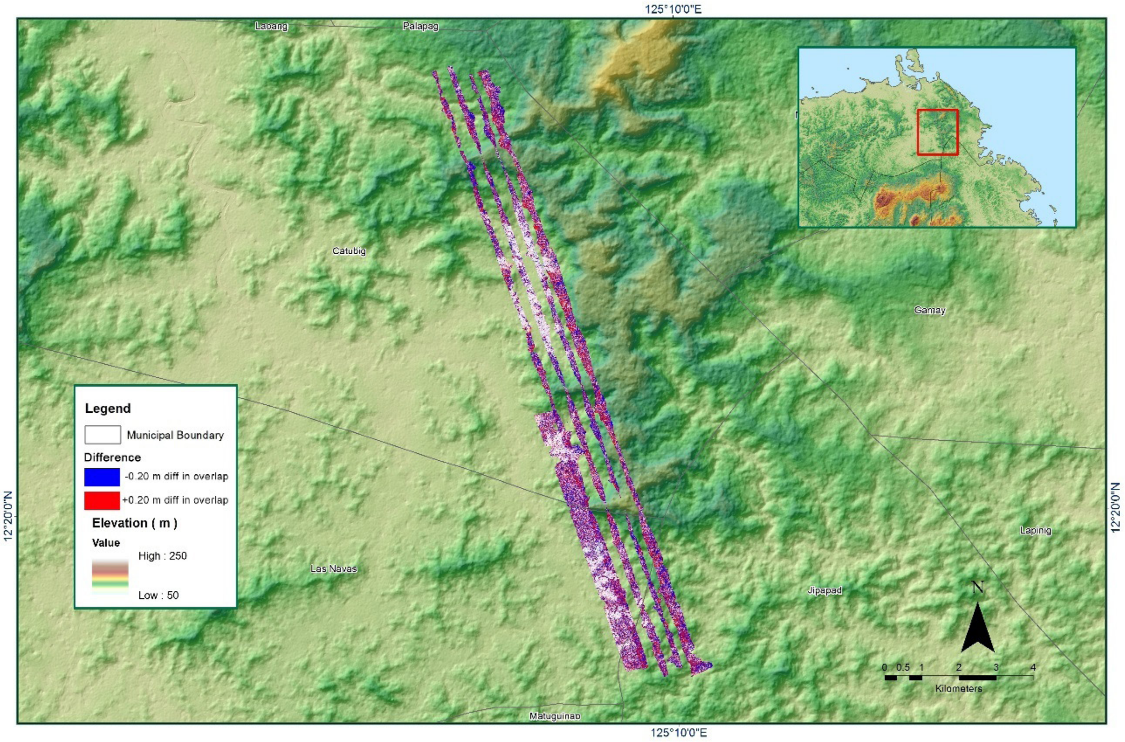


Figure A-8.147. Elevation difference between flight lines

Table A-8.22. Mission Report for Mission Blk 33P

Flight Area	**Catarman Reflights**
Mission Name	**Blk 33P**
Inclusive Flights	8431AC
Range data size	12.5 GB
POS data size	237 MB
Base data size	118 MB
Image	NA
Transfer date	August 4, 2016
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)	1.215
RMSE for East Position (<4.0 cm)	1.810
RMSE for Down Position (<8.0 cm)	3.612
Boresight correction stdev (<0.001deg)	0.000386
IMU attitude correction stdev (<0.001deg)	0.002274
GPS position stdev (<0.01m)	0.00072
Minimum % overlap (>25)	39.46%
Ave point cloud density per sq.m. (>2.0)	4.25
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	124
Maximum Height	359.03 m
Minimum Height	36.5 m
Classification (# of points)	
Ground	55,230,816
Low vegetation	53,022,783
Medium vegetation	86,171,794
High vegetation	134,845,707
Building	2,941,531
Orthophoto	No
Processed by	Engr. Kenneth Solidum, Engr. Merven Matthew Natino, Engr. Elainne Lopez

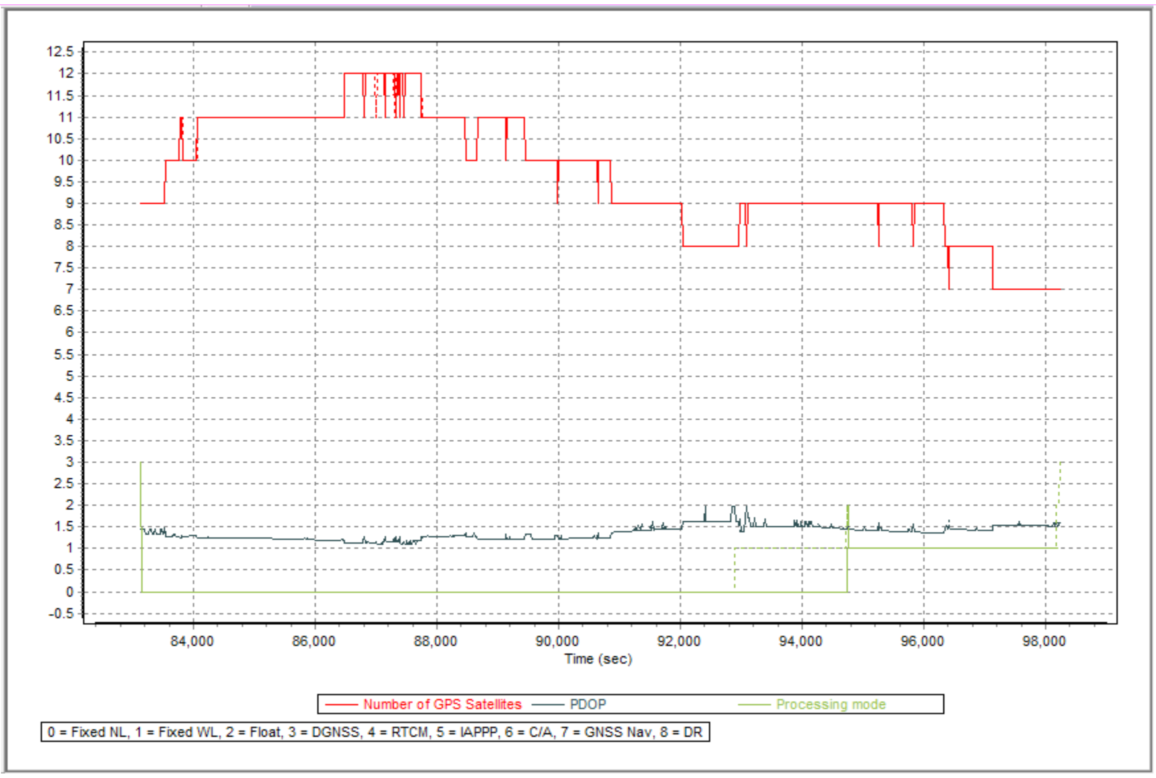


Figure A-8.148. Solution Status

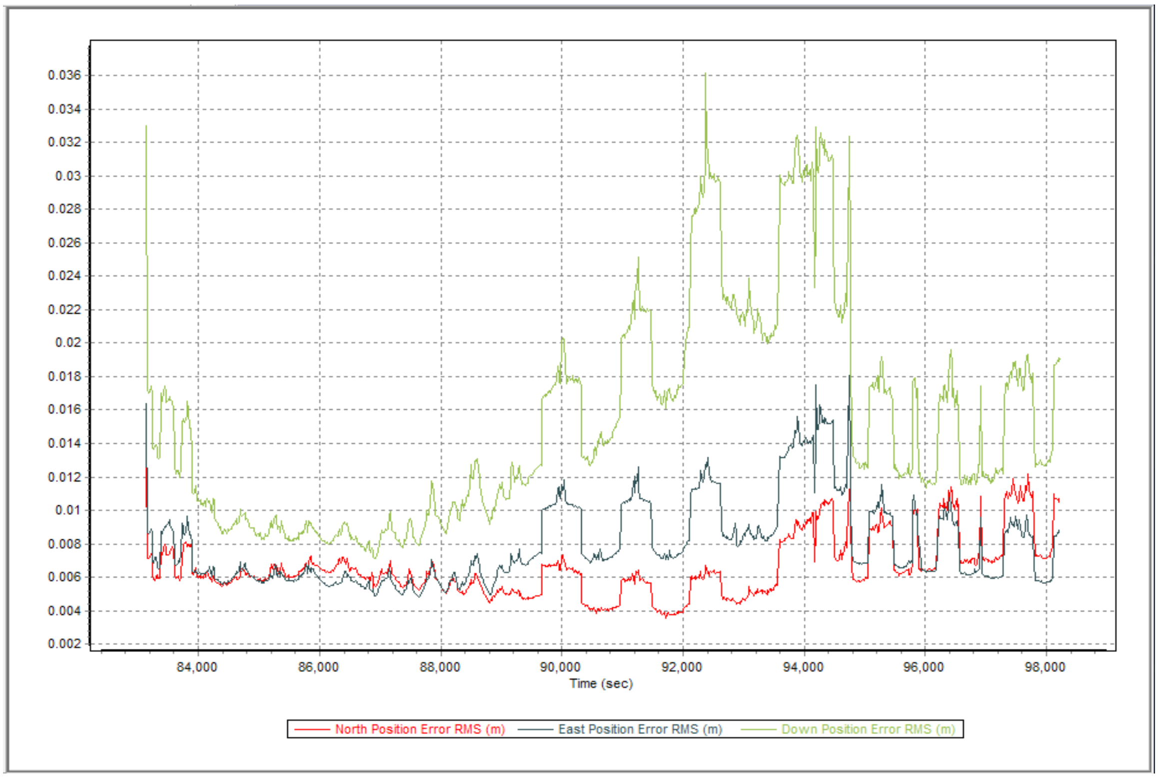


Figure A-8.149. Smoothed Performance Metric Parameters

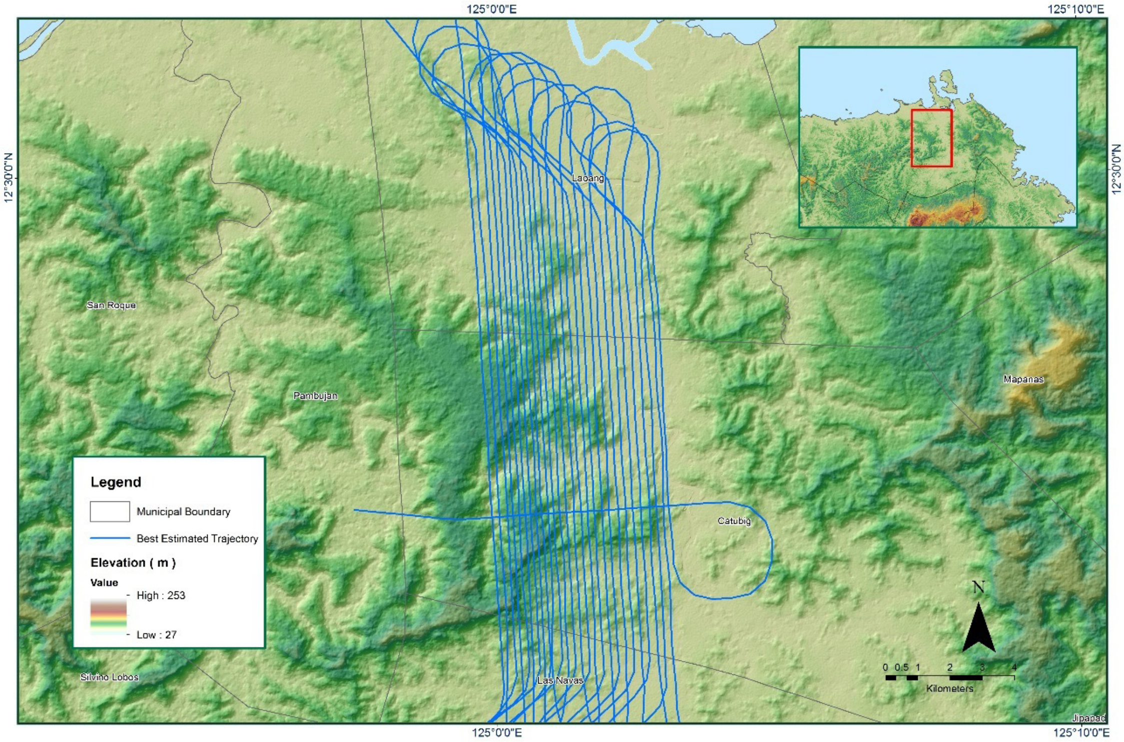


Figure A-8.150. Best Estimated Trajectory

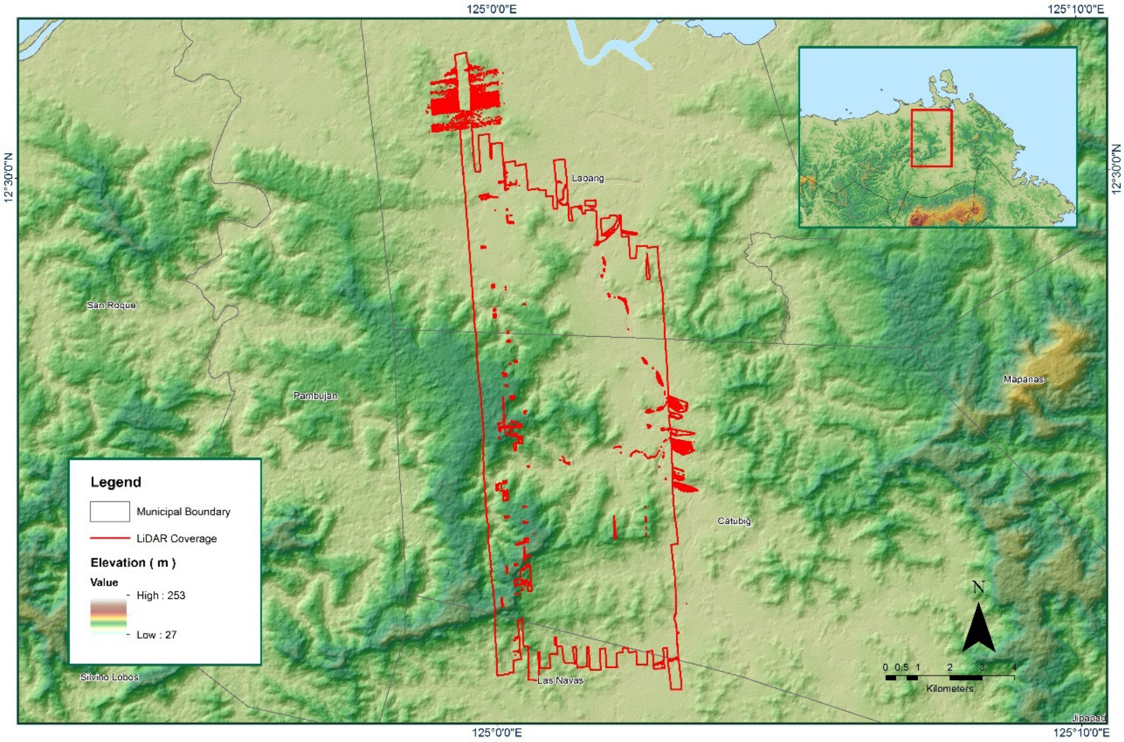


Figure A-8.151. Coverage of LiDAR Data

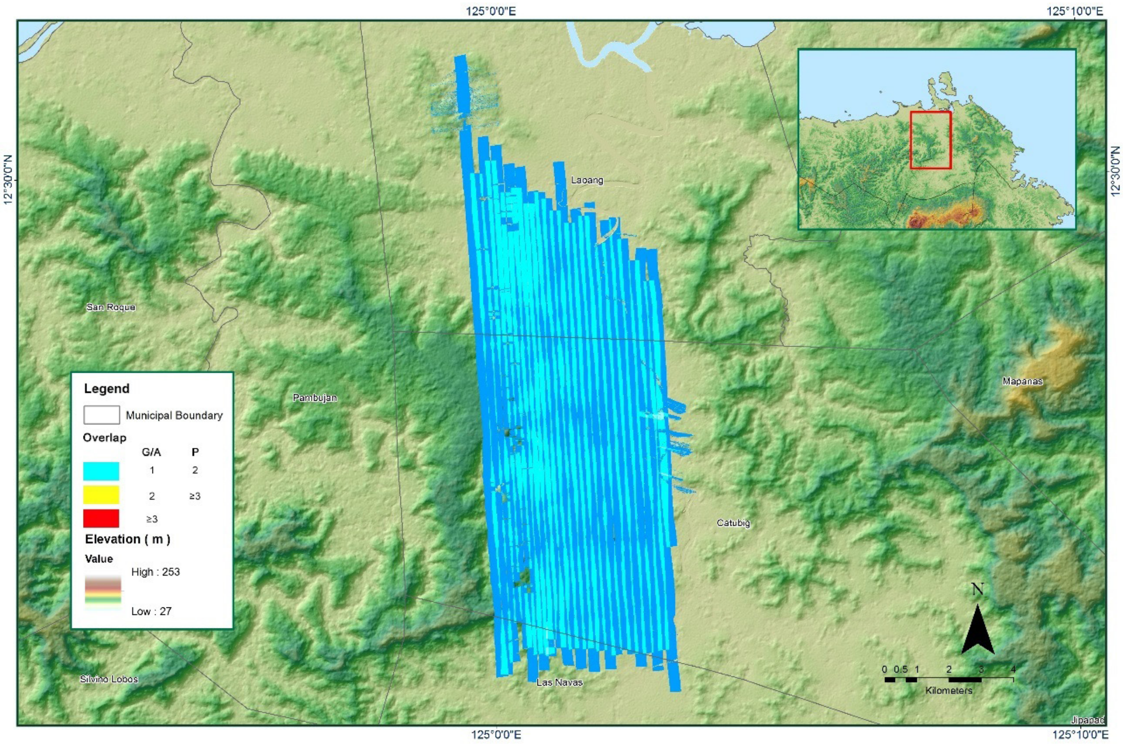


Figure A-8.152. Image of data overlap

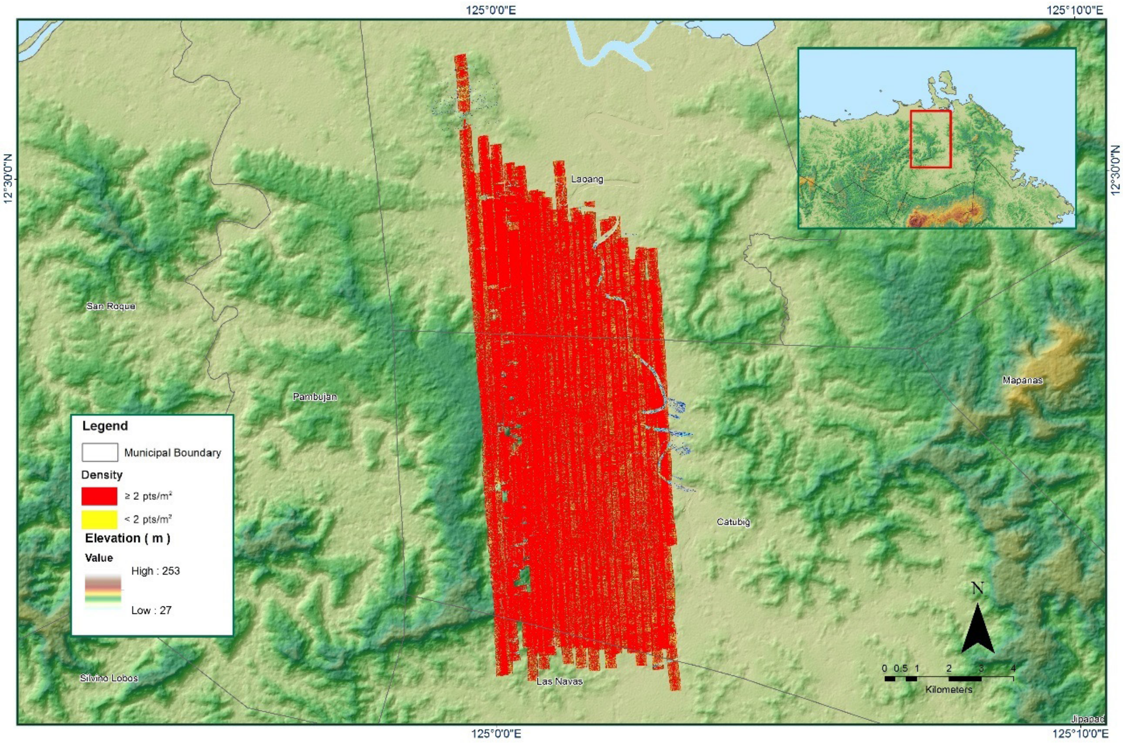


Figure A-8.153. Density map of merged LiDAR data

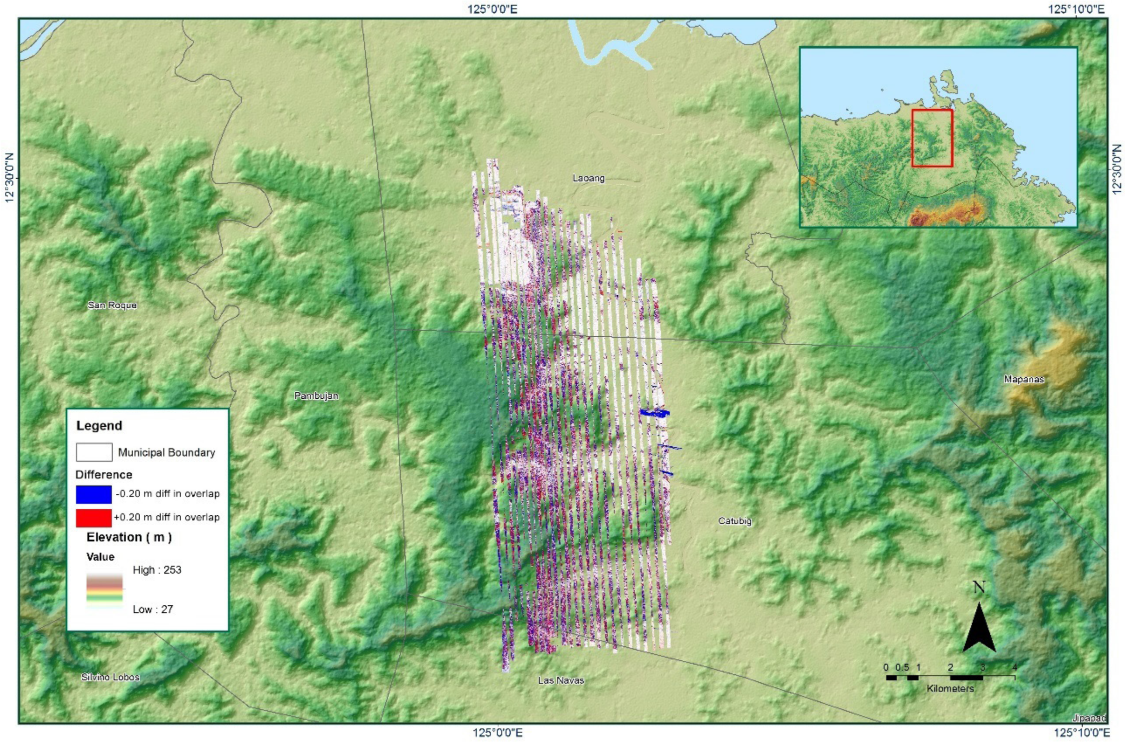


Figure A-8.154. Elevation difference between flight lines

Table A-8.23. Mission Report for Mission Blk331R_additional

Flight Area	**Catarman_Reflights**
Mission Name	Blk331R_additional
Inclusive Flights	8448AC
Range data size	4.52 GB
POS data size	132 MB
Base data size	86.7 MB
Image	NA
Transfer date	June 4, 2016
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)	0.91
RMSE for East Position (<4.0 cm)	1.27
RMSE for Down Position (<8.0 cm)	2.41
Boresight correction stdev (<0.001deg)	0.000945
IMU attitude correction stdev (<0.001deg)	0.003045
GPS position stdev (<0.01m)	0.0147
Minimum % overlap (>25)	26
Ave point cloud density per sq.m. (>2.0)	4.51
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	38
Maximum Height	259.06 m
Minimum Height	53.57 m
Classification (# of points)	
Ground	11,929,616
Low vegetation	4,932,890
Medium vegetation	15,281,795
High vegetation	29,590,863
Building	439,345
Orthophoto	No
Processed by	Engr. Analyn Naldo, Engr. Velina Angela Bemida, Engr. Melissa Fernandez

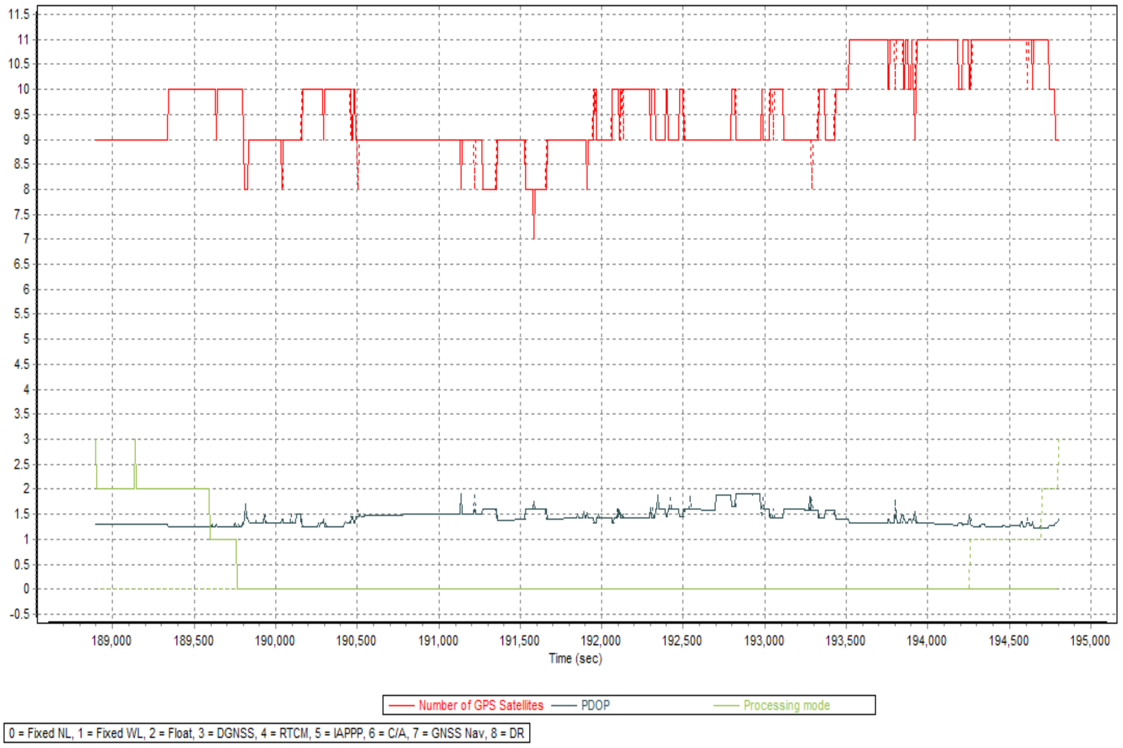


Figure A-8.155. Solution Status

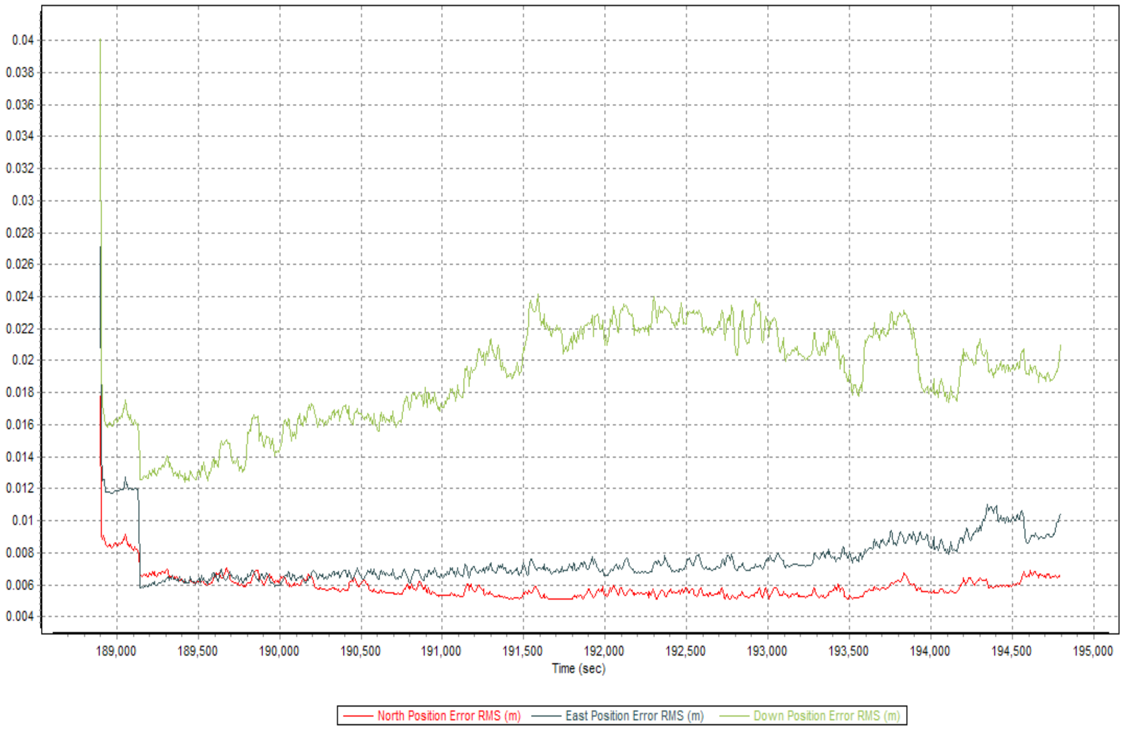


Figure A-8.156. Smoothed Performance Metric Parameters

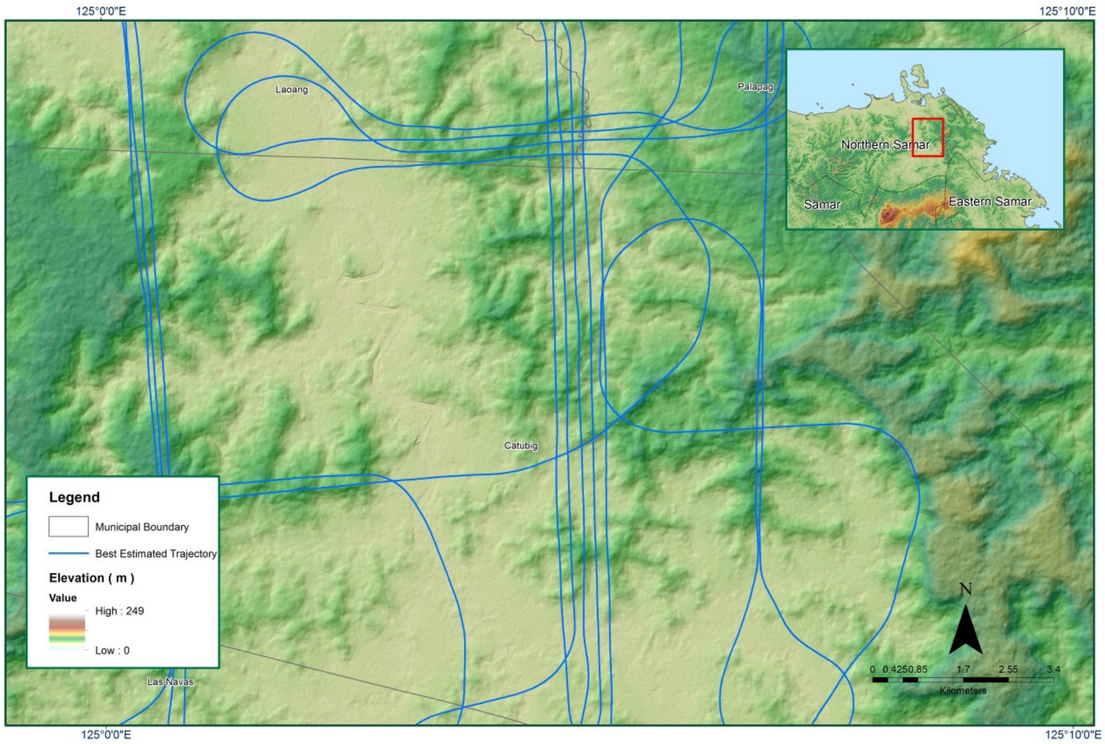


Figure A-8.157. Best Estimated Trajectory

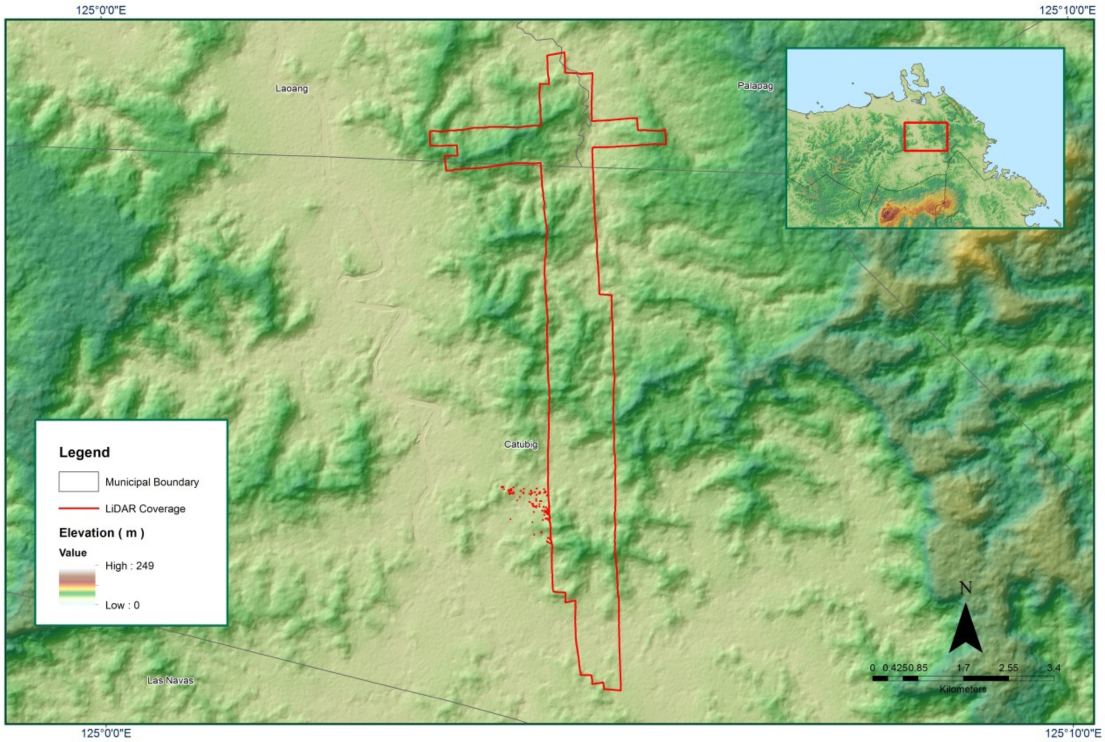


Figure A-8.158. Coverage of LiDAR Data

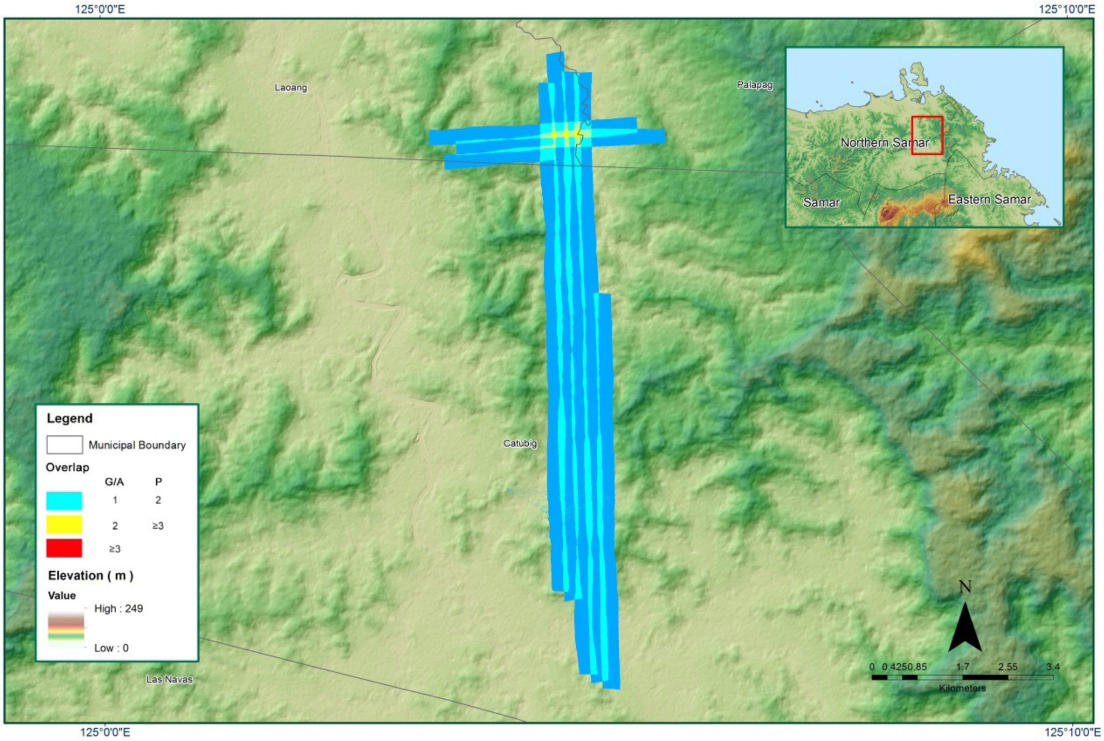


Figure A-8.159. Image of data overlap

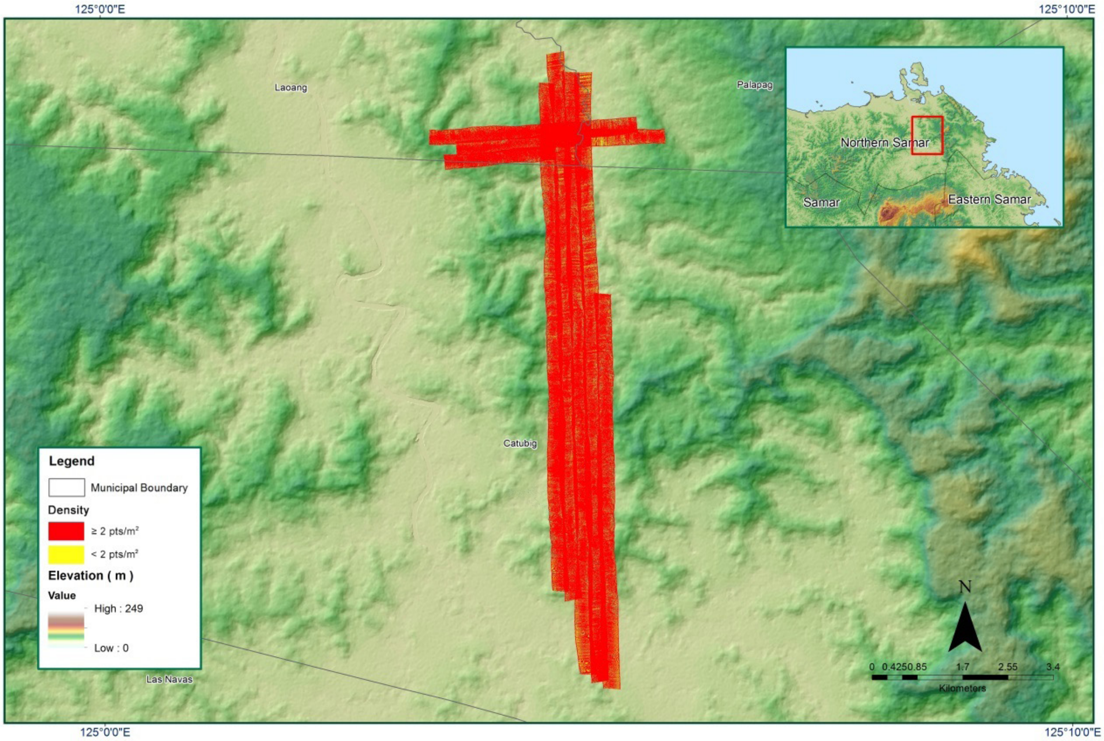


Figure A-8.160. Density map of merged LiDAR data

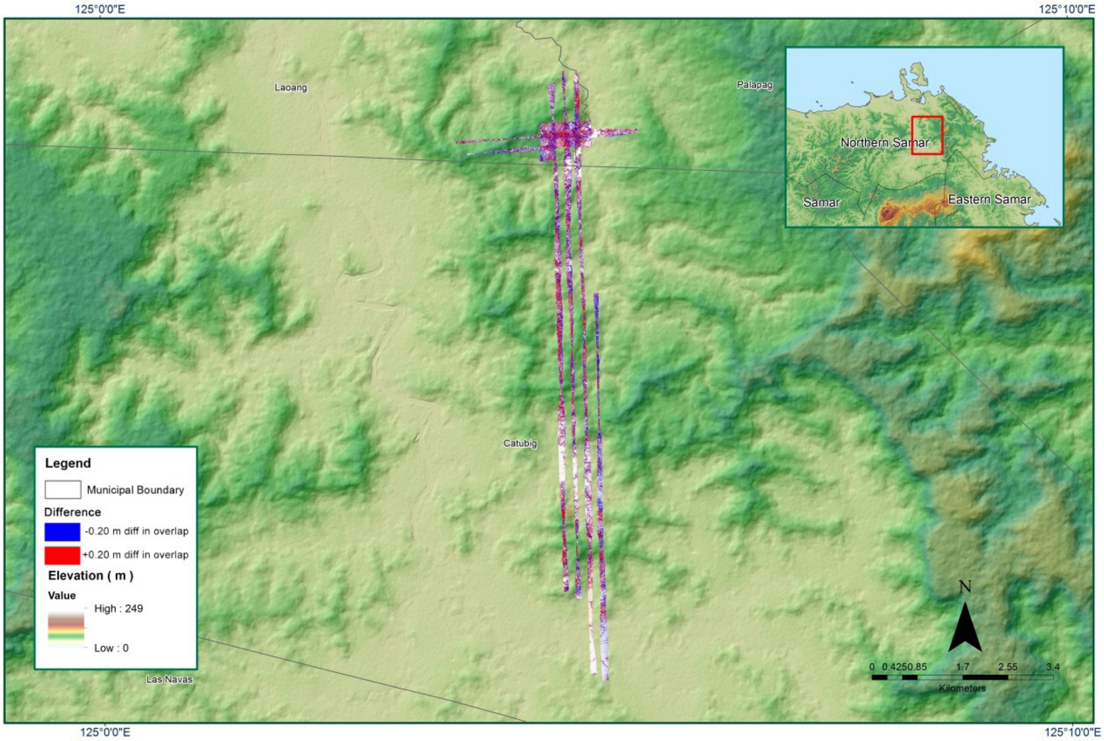


Figure A-8.161. Elevation difference between flight lines

Table A-8.24. Mission Report for Mission Blk331S_additional

Flight Area	**Catarman_Reflights**
Mission Name	**Blk331S_additional**
Inclusive Flights	8447AC
Range data size	9.16 GB
POS data size	226 MB
Base data size	56.7 MB
Image	19.5 MB
Transfer date	June 4, 2016
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)	1.18
RMSE for East Position (<4.0 cm)	1.41
RMSE for Down Position (<8.0 cm)	3.28
Boresight correction stdev (<0.001deg)	0.000687
IMU attitude correction stdev (<0.001deg)	0.441705
GPS position stdev (<0.01m)	0.0042
Minimum % overlap (>25)	43.92
Ave point cloud density per sq.m. (>2.0)	4.92
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	64
Maximum Height	321.85 m
Minimum Height	54.41 m
Classification (# of points)	
Ground	21,902,044
Low vegetation	24,584,954
Medium vegetation	27,710,995
High vegetation	66,578,770
Building	2,130,235
Orthophoto	No
Processed by	Engr. Sheila-Maye Santillan, Engr. Merven Matthew Natino, Jovy Narisma

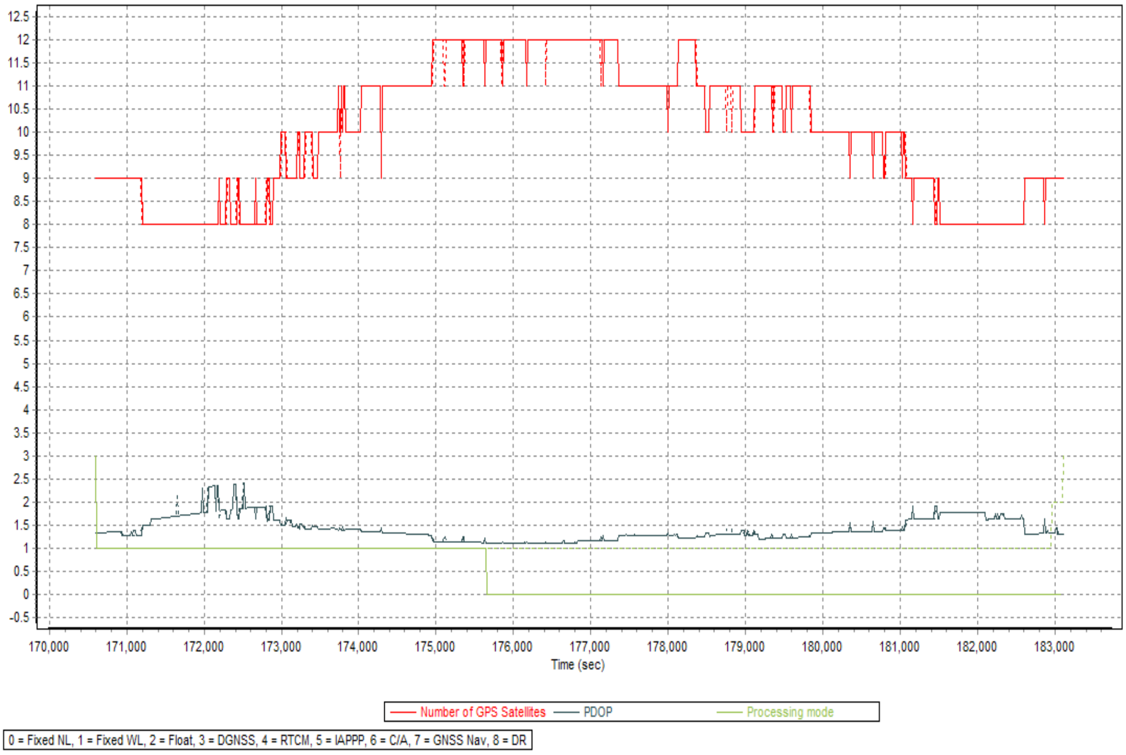


Figure A-8.162. Solution Status

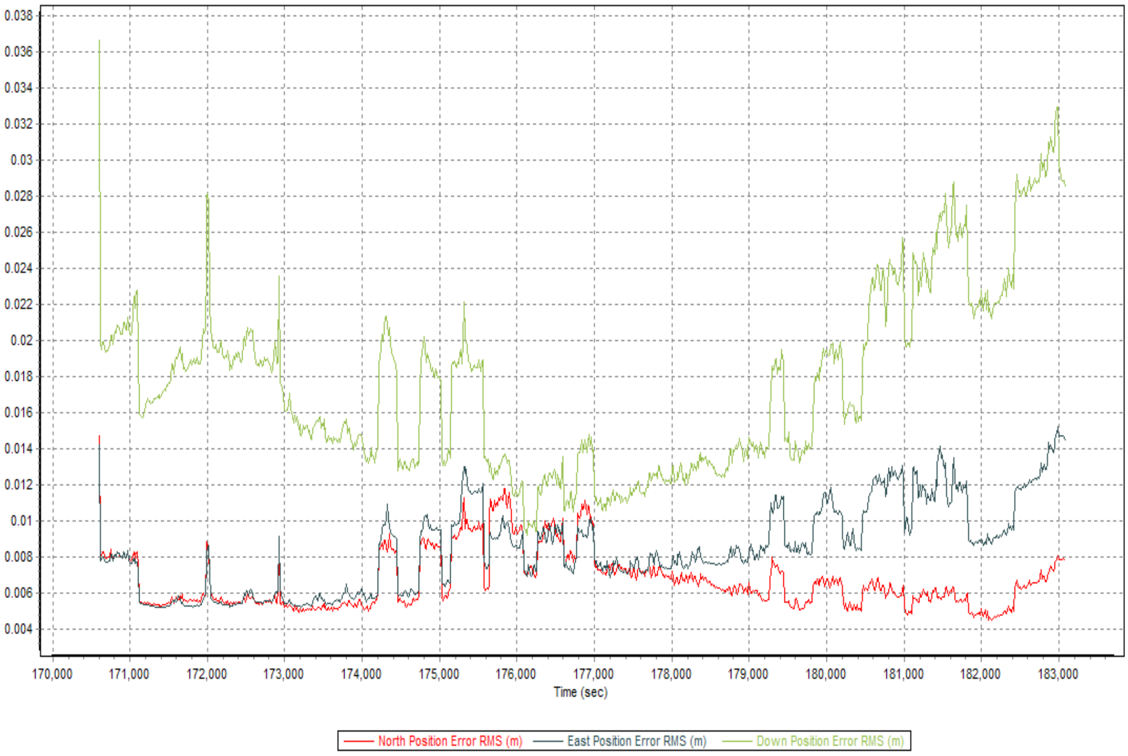


Figure A-8.163. Smoothed Performance Metric Parameters

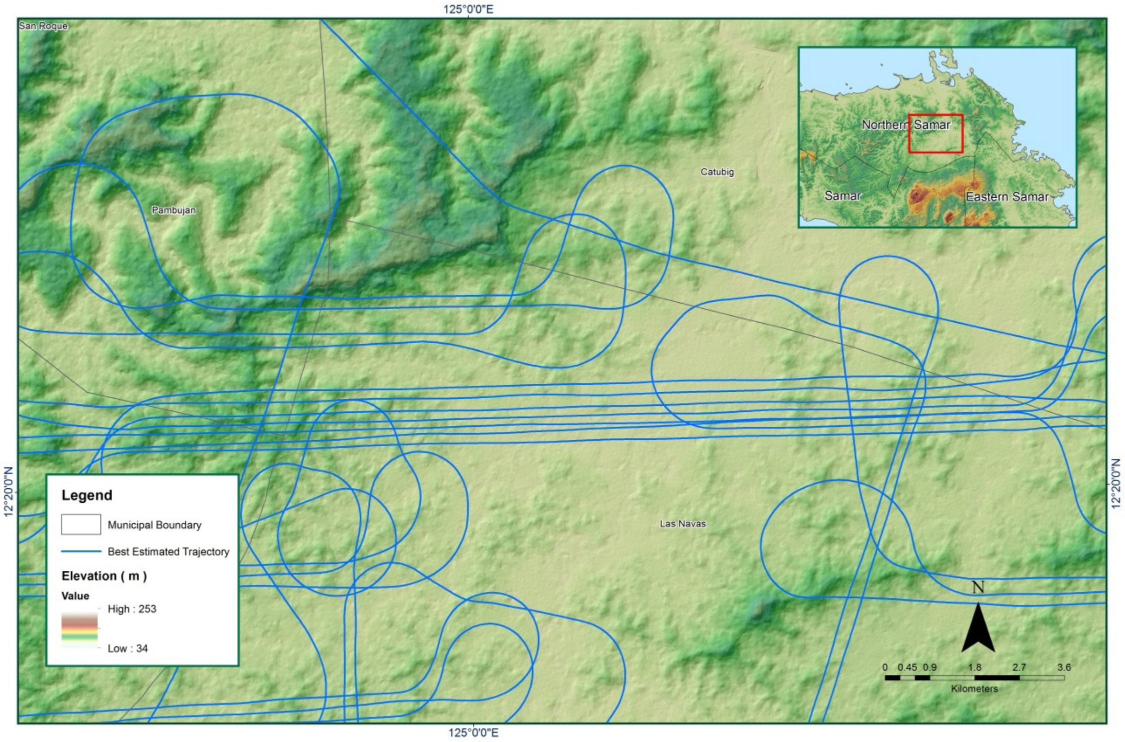


Figure A-8.164. Best Estimated Trajectory

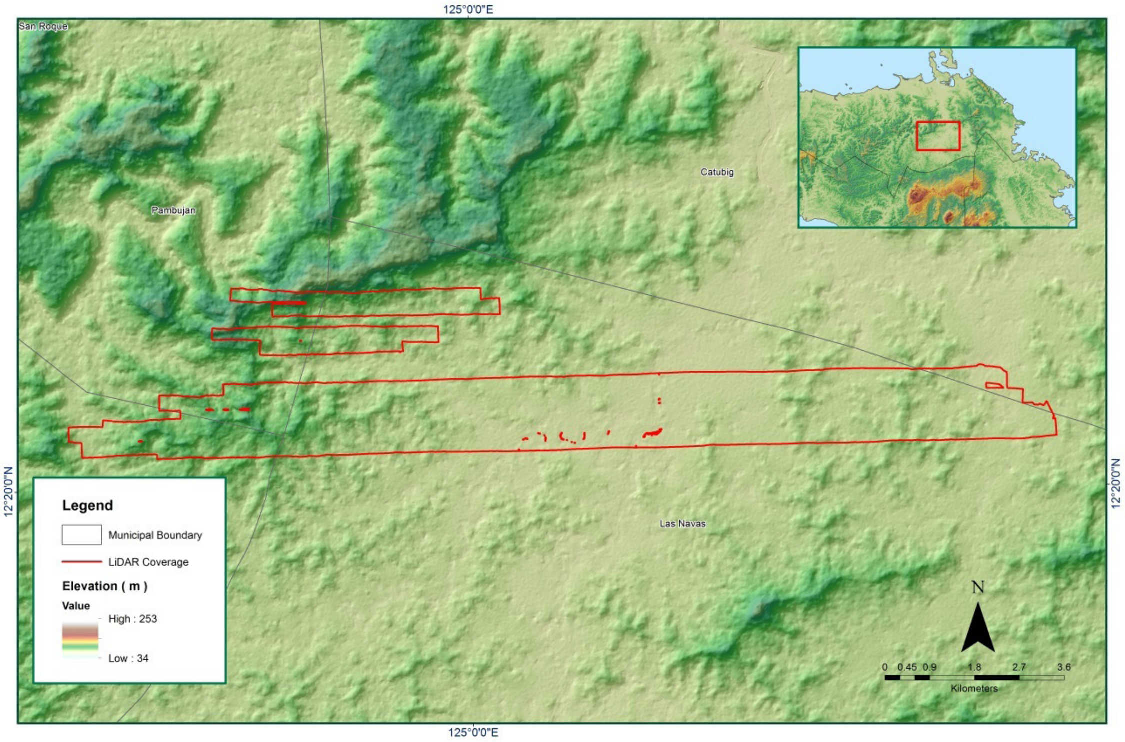


Figure A-8.165. Coverage of LiDAR Data

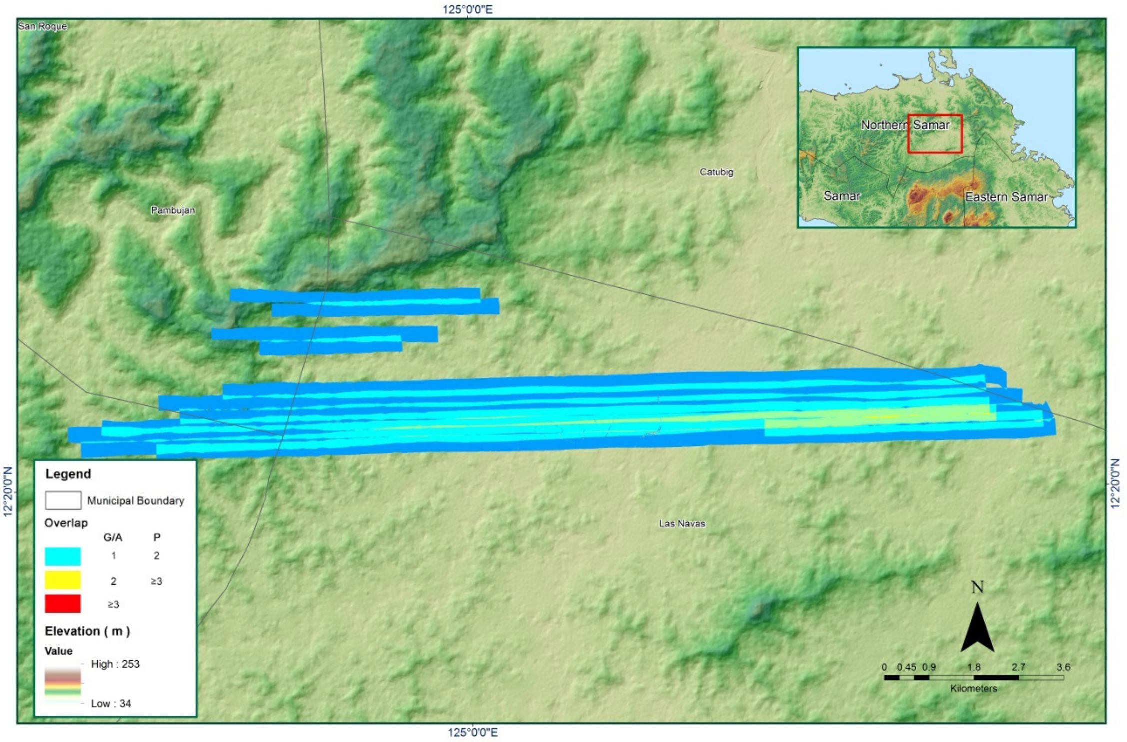


Figure A-8.166. Image of data overlap

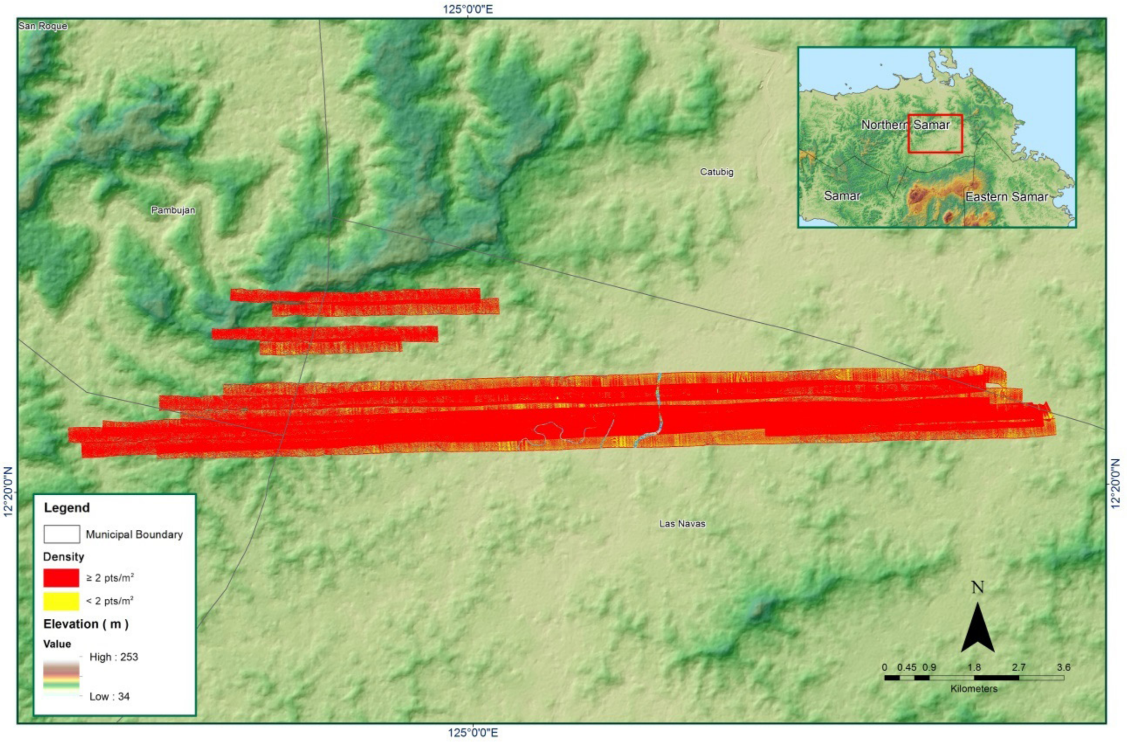


Figure A-8.167. Density map of merged LiDAR data

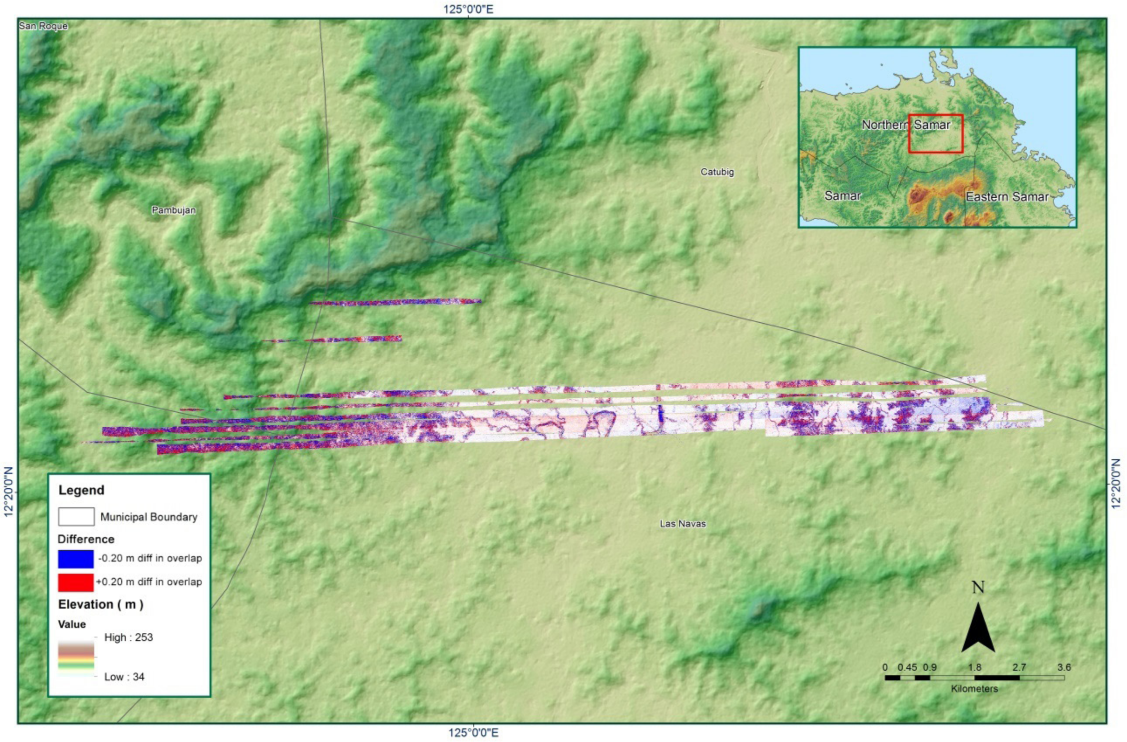


Figure A-8.168. Elevation difference between flight lines

Table A-8.25. Mission Report for Mission Blk 331T_additional

Flight Area	**Catarman_Reflights**
Mission Name	**Blk 331T_additional**
Inclusive Flights	8447AC
Range data size	9.16 GB
POS data size	226 MB
Base data size	86.7 MB
Image	19.5 MB
Transfer date	June 4, 2016
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)	1.18
RMSE for East Position (<4.0 cm)	1.52
RMSE for Down Position (<8.0 cm)	3.30
Boresight correction stdev (<0.001deg)	0.002200
IMU attitude correction stdev (<0.001deg)	0.023276
GPS position stdev (<0.01m)	0.0031
Minimum % overlap (>25)	19.61
Ave point cloud density per sq.m. (>2.0)	4.11
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	56
Maximum Height	248.42 m
Minimum Height	64.05 m
Classification (# of points)	
Ground	13,130,446
Low vegetation	5,423,631
Medium vegetation	14,804,580
High vegetation	46,747,577
Building	816,139
Orthophoto	No
Processed by	Engr. Sheila-Maye Santillan, Engr. Velina Angela Bemida, Engr. Elainne Lopez

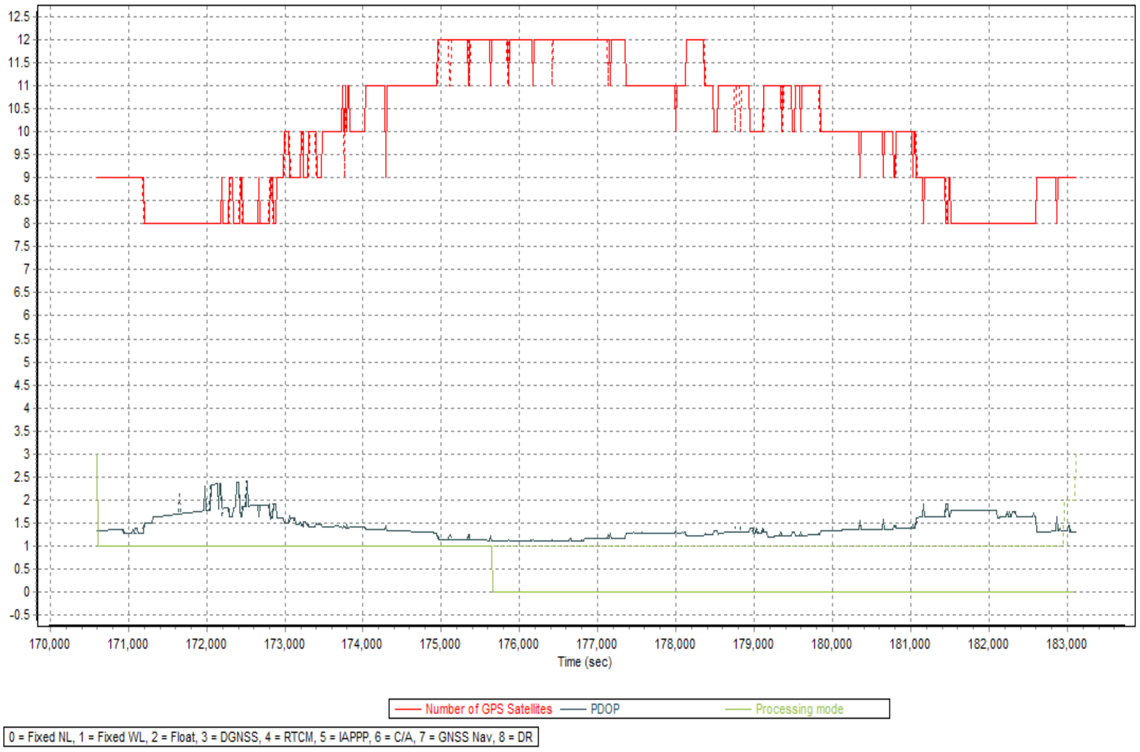


Figure A-8.169. Solution Status

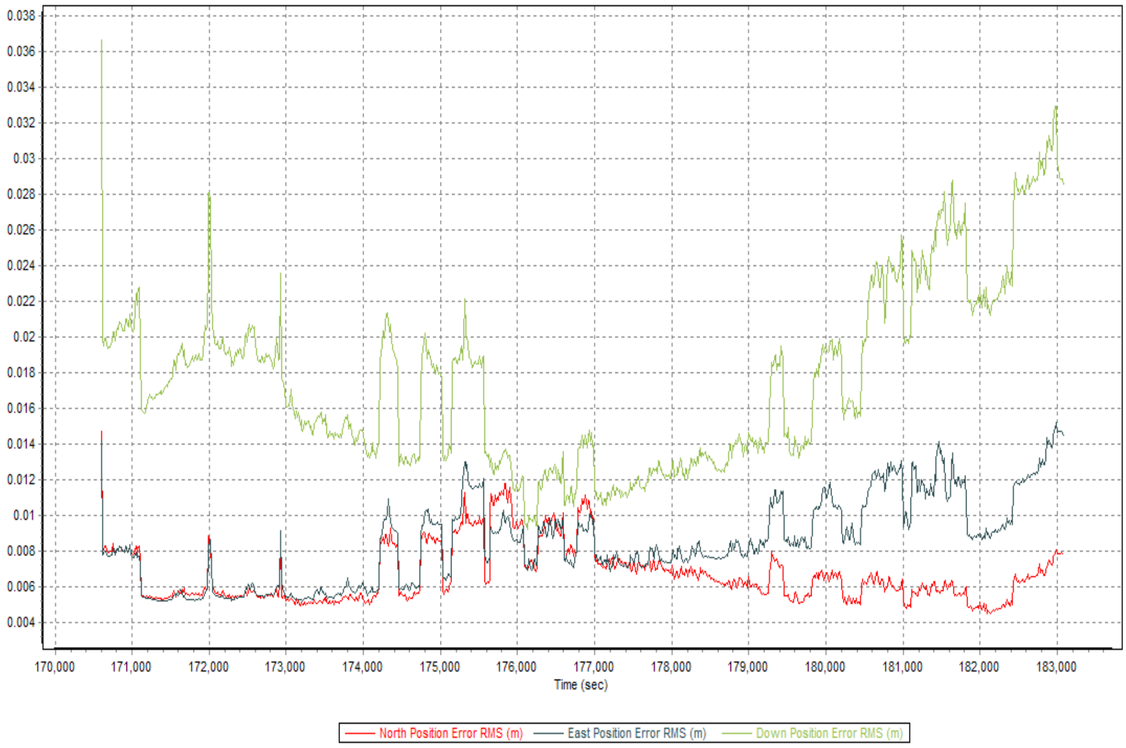


Figure A-8.170. Smoothed Performance Metric Parameters

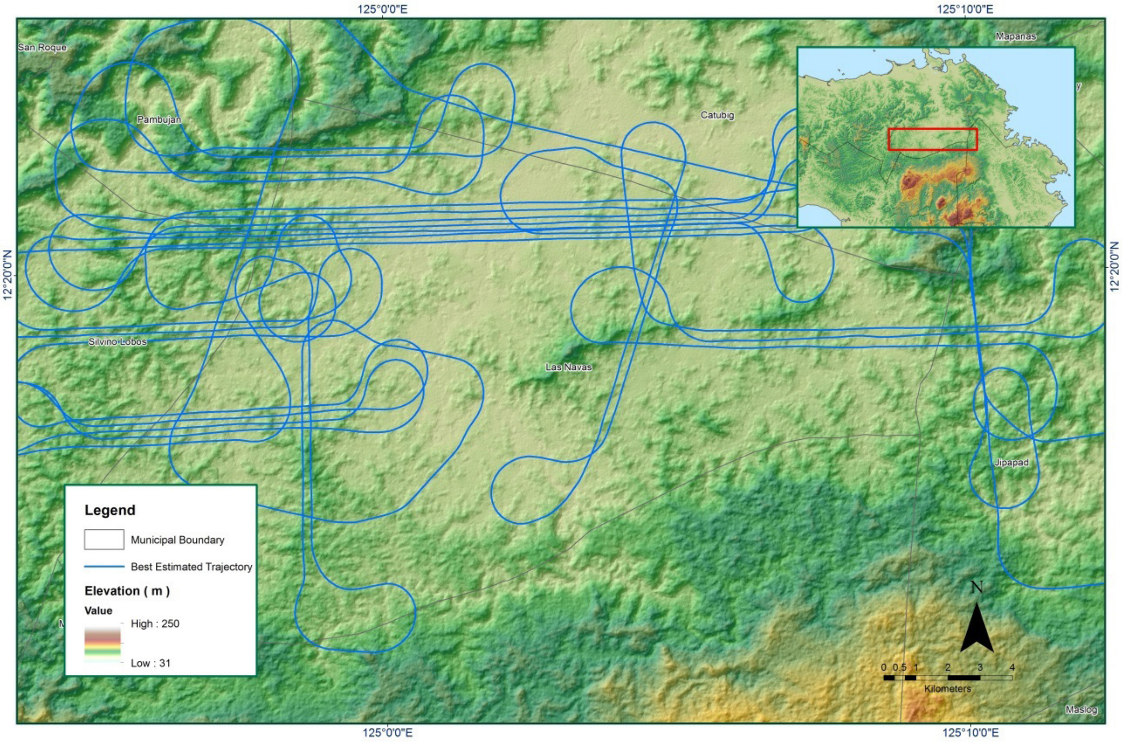


Figure A-8.171. Best Estimated Trajectory

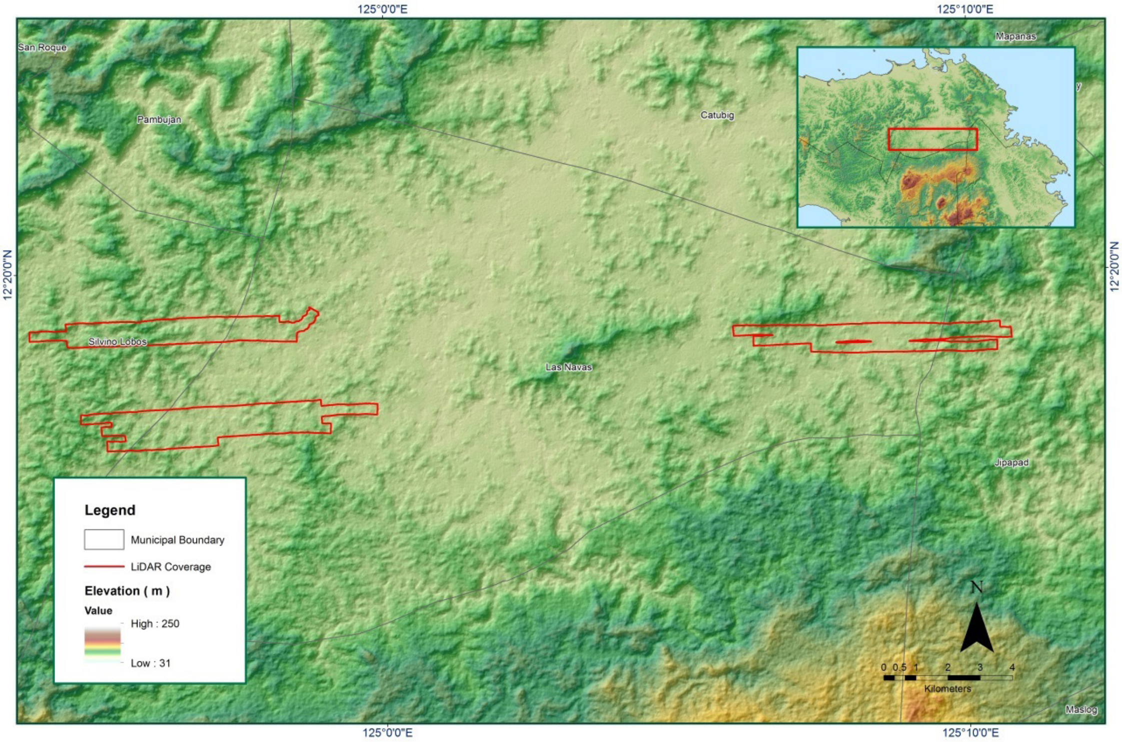


Figure A-8.172. Coverage of LiDAR Data

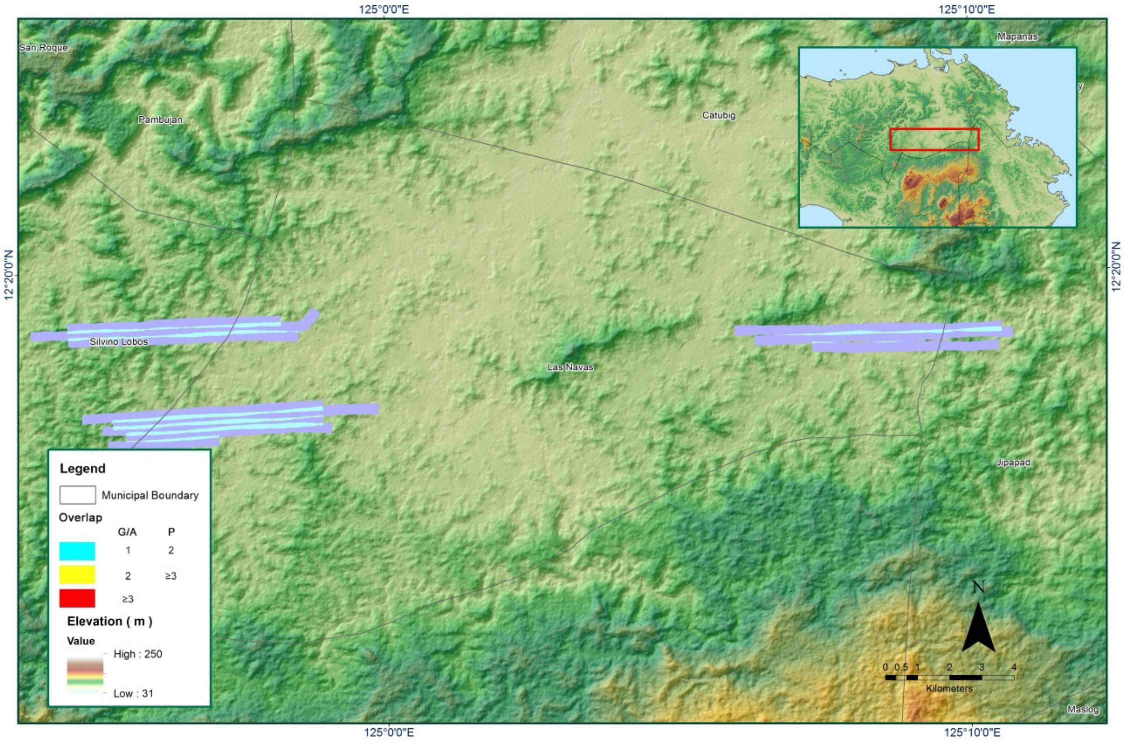


Figure A-8.173. Image of data overlap

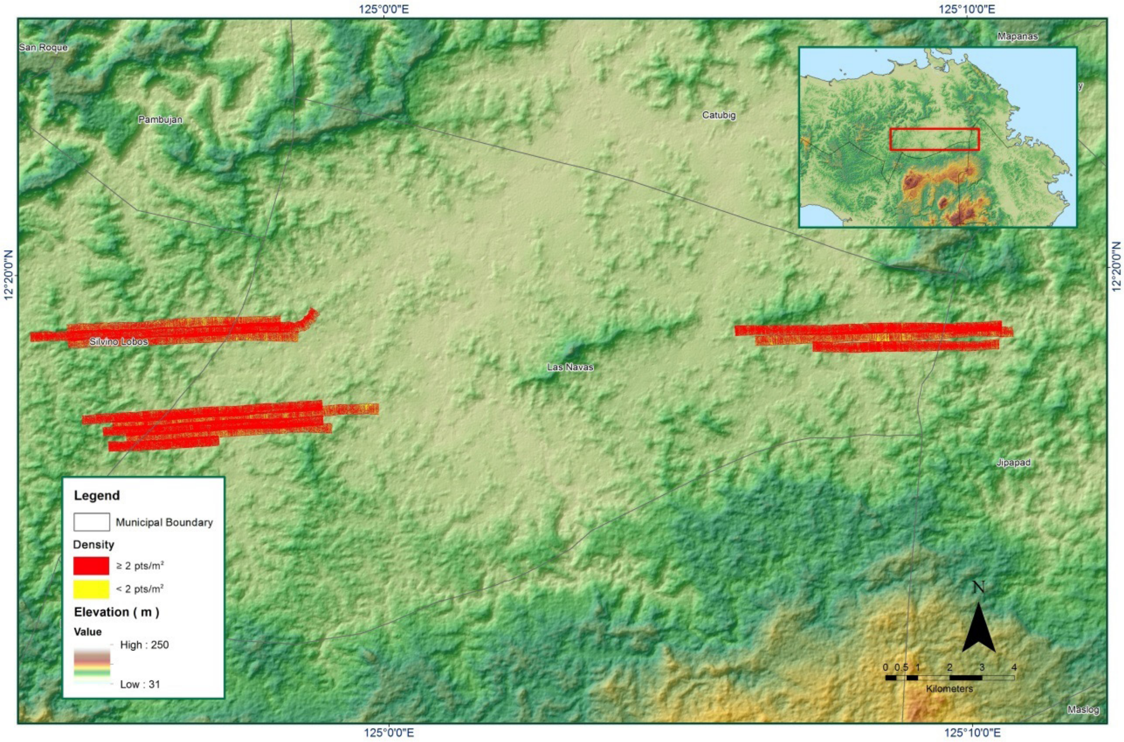


Figure A-8.174. Density map of merged LiDAR data

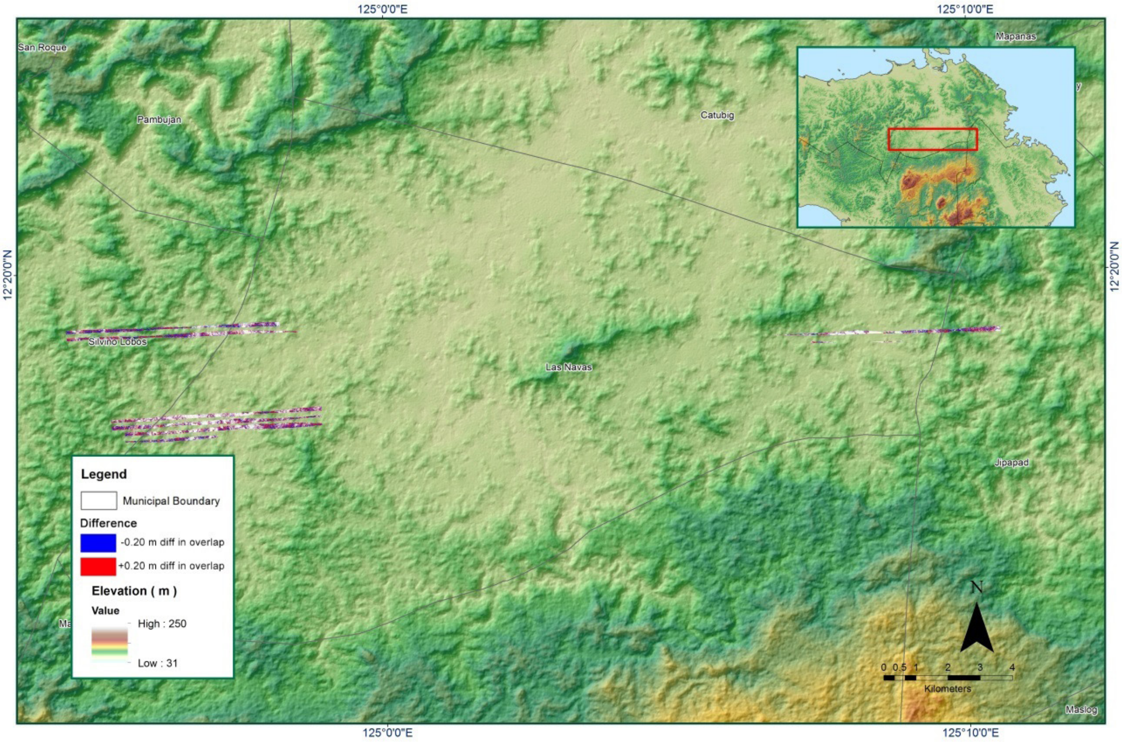


Figure A-8.175. Elevation difference between flight lines

Table A-8.26. Mission Report for Mission Blk 331U_additional

Flight Area	**Catarman_Reflights**
Mission Name	**Blk 331U_additional**
Inclusive Flights	8446AC
Range data size	4.64 GB
POS data size	128 MB
Base data size	77.8 MB
Image	19.5 MB
Transfer date	June 4, 2016
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)	1.01
RMSE for East Position (<4.0 cm)	1.18
RMSE for Down Position (<8.0 cm)	3.82
Boresight correction stdev (<0.001deg)	0.000910
IMU attitude correction stdev (<0.001deg)	0.000253
GPS position stdev (<0.01m)	0.0404
Minimum % overlap (>25)	23.00
Ave point cloud density per sq.m. (>2.0)	4.1
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	37
Maximum Height	258.63 m
Minimum Height	73.22 m
Classification (# of points)	
Ground	11,168,621
Low vegetation	2,354,960
Medium vegetation	8,733,973
High vegetation	31,492,896
Building	821,514
Orthophoto	No
Processed by	Engr. Analyn Naldo, Engr. Velina Angela Bemida, Engr. Ma. Ailyn Olanda

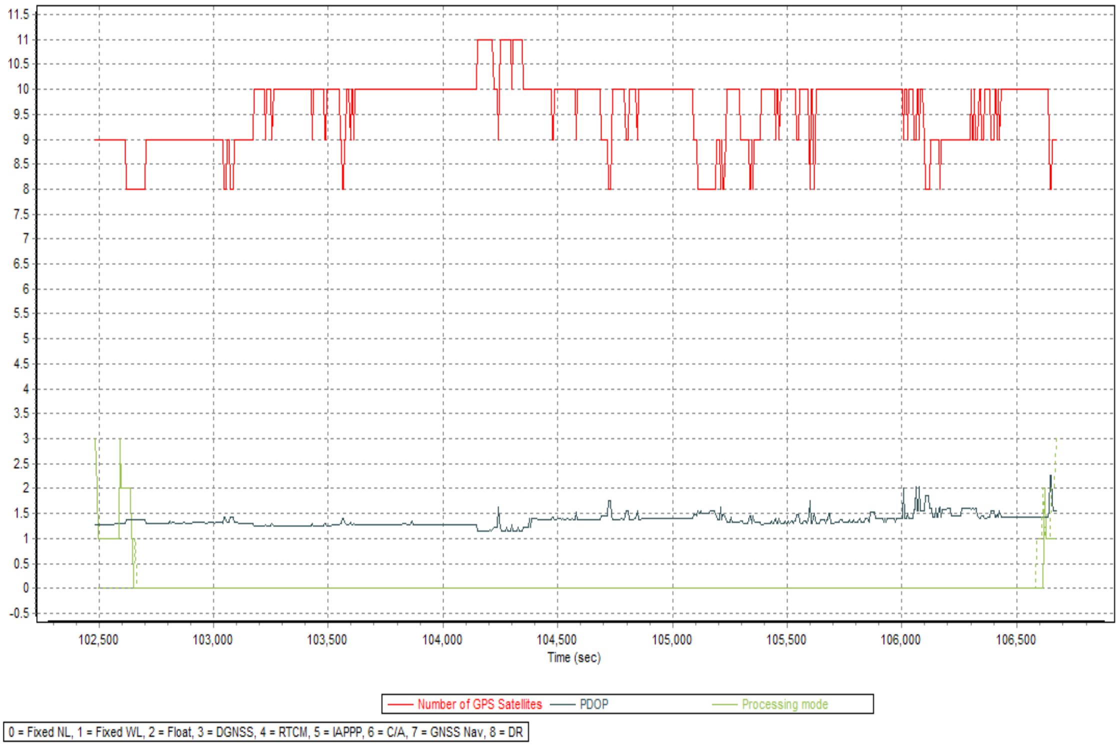


Figure A-8.176. Solution Status

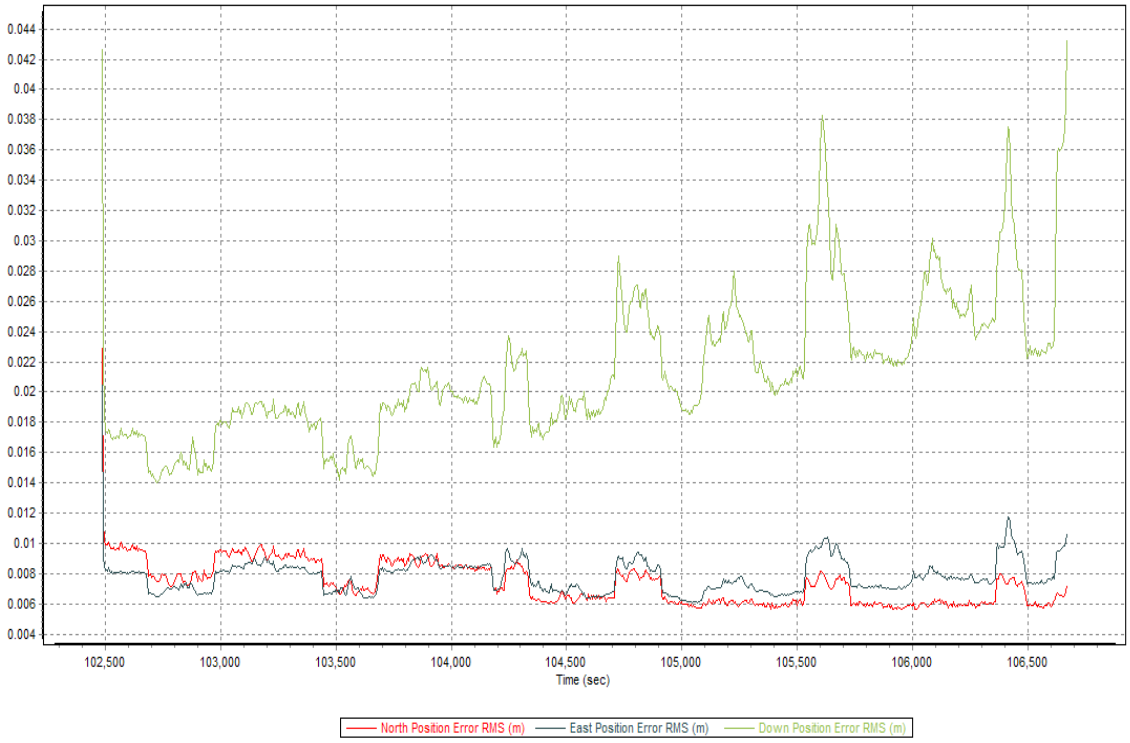


Figure A-8.177. Smoothed Performance Metric Parameters

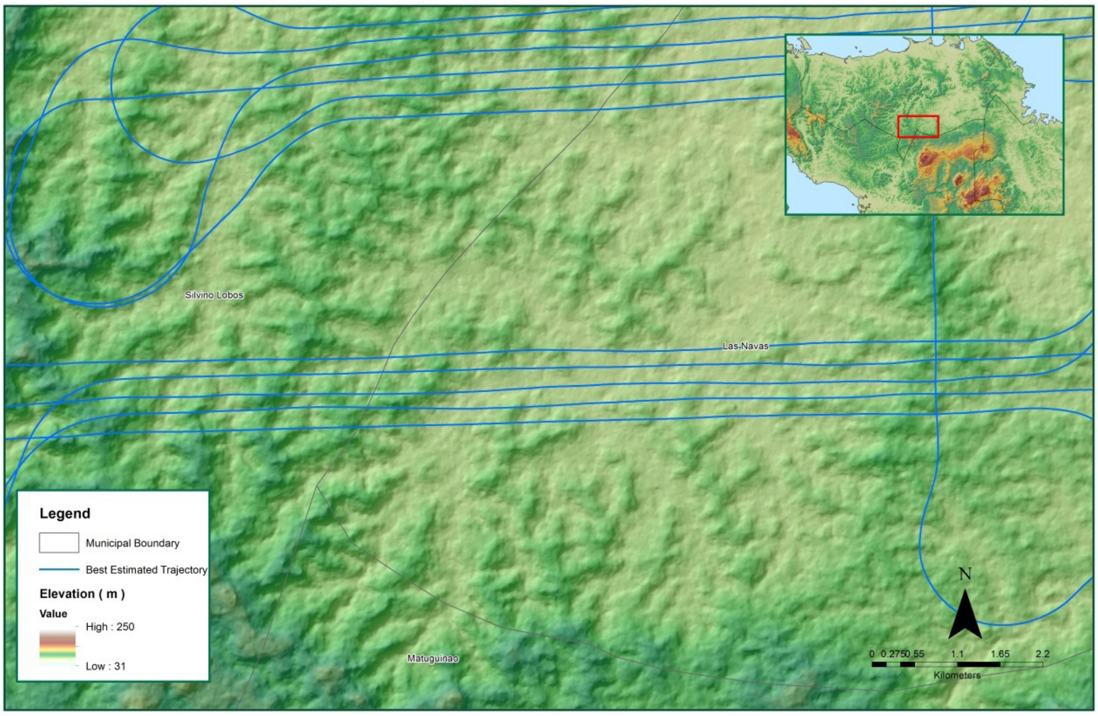


Figure A-8.178. Best Estimated Trajectory

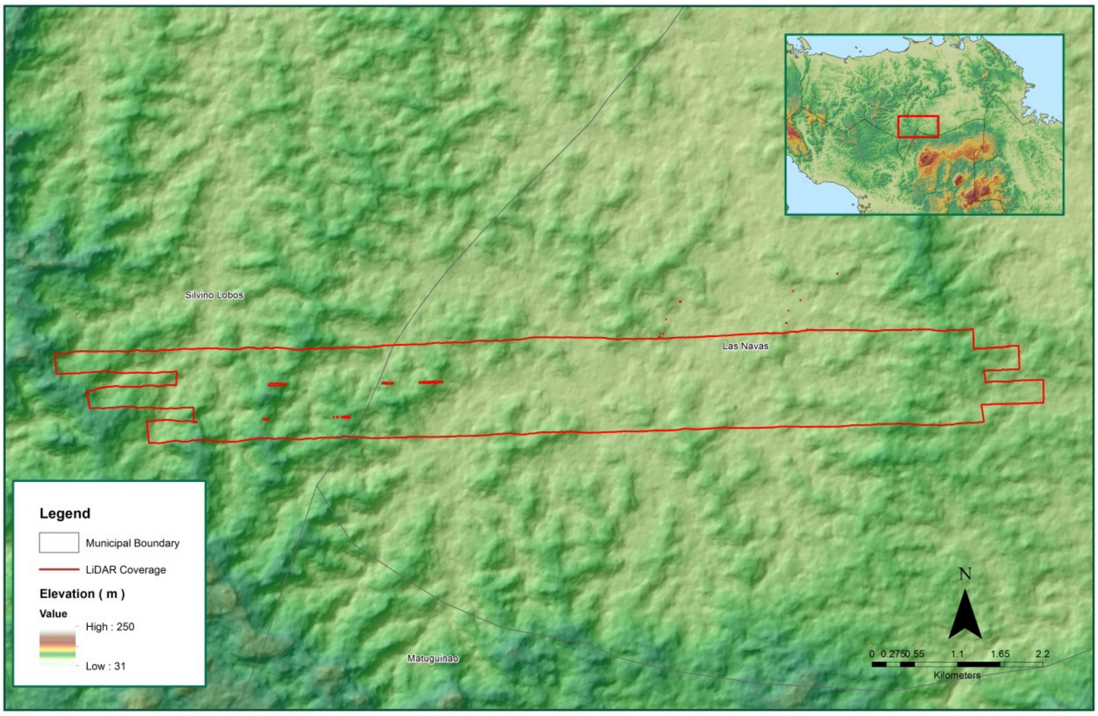


Figure A-8.179. Coverage of LiDAR Data

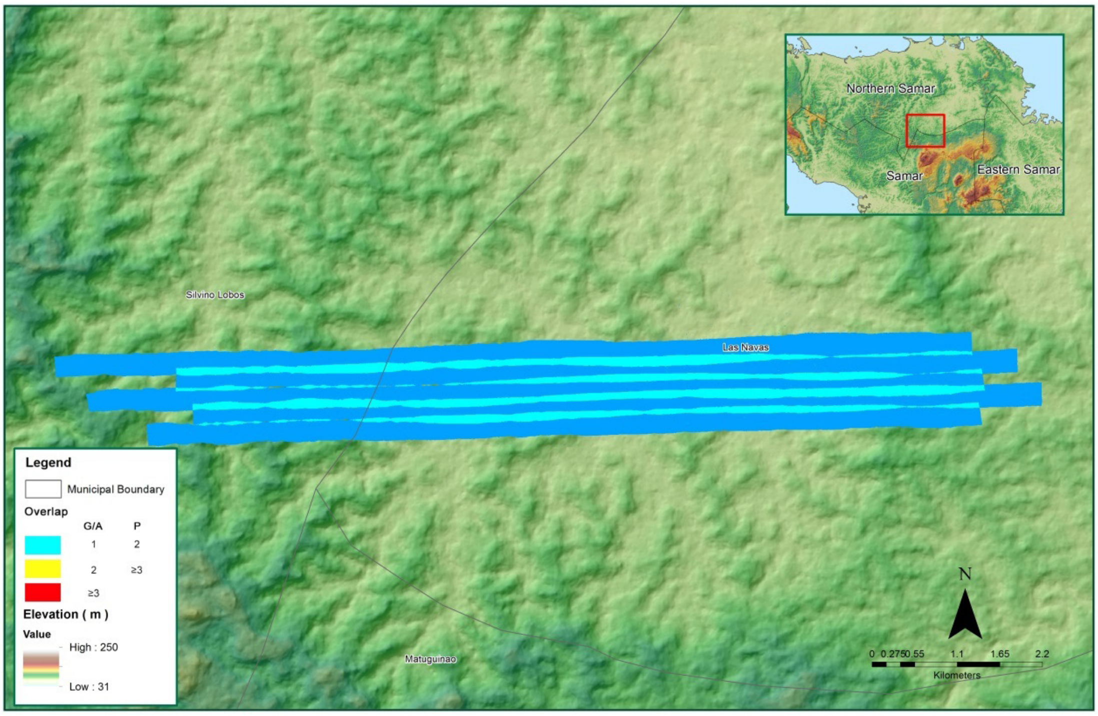


Figure A-8.180. Image of data overlap

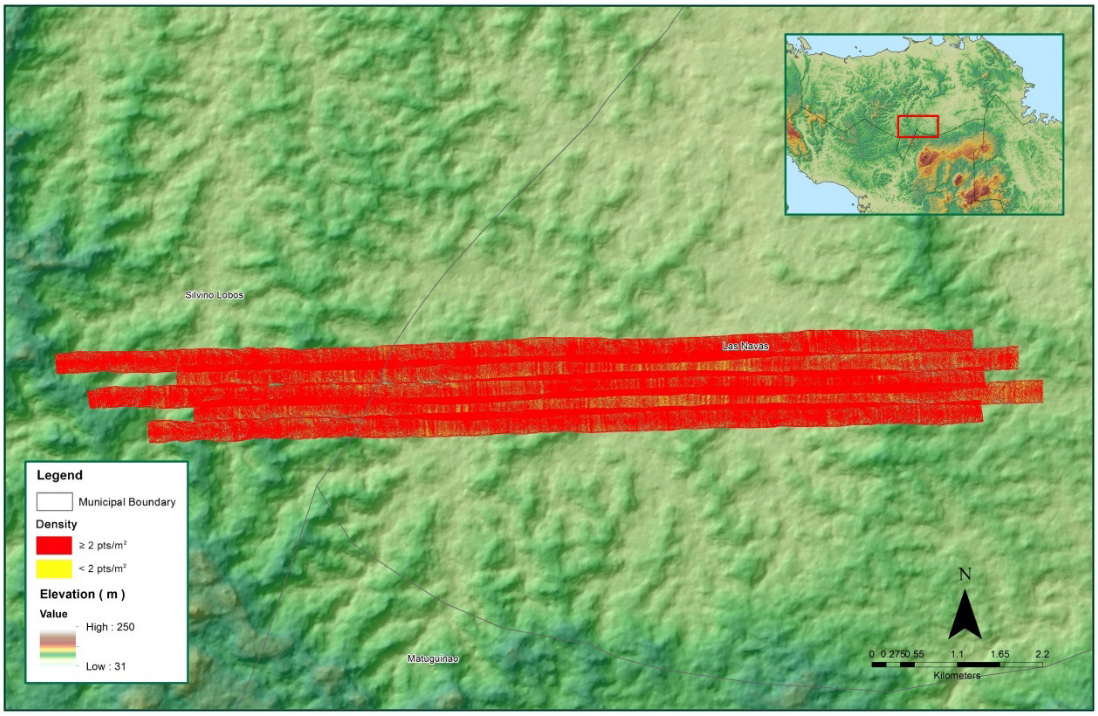


Figure A-8.181. Density map of merged LiDAR data

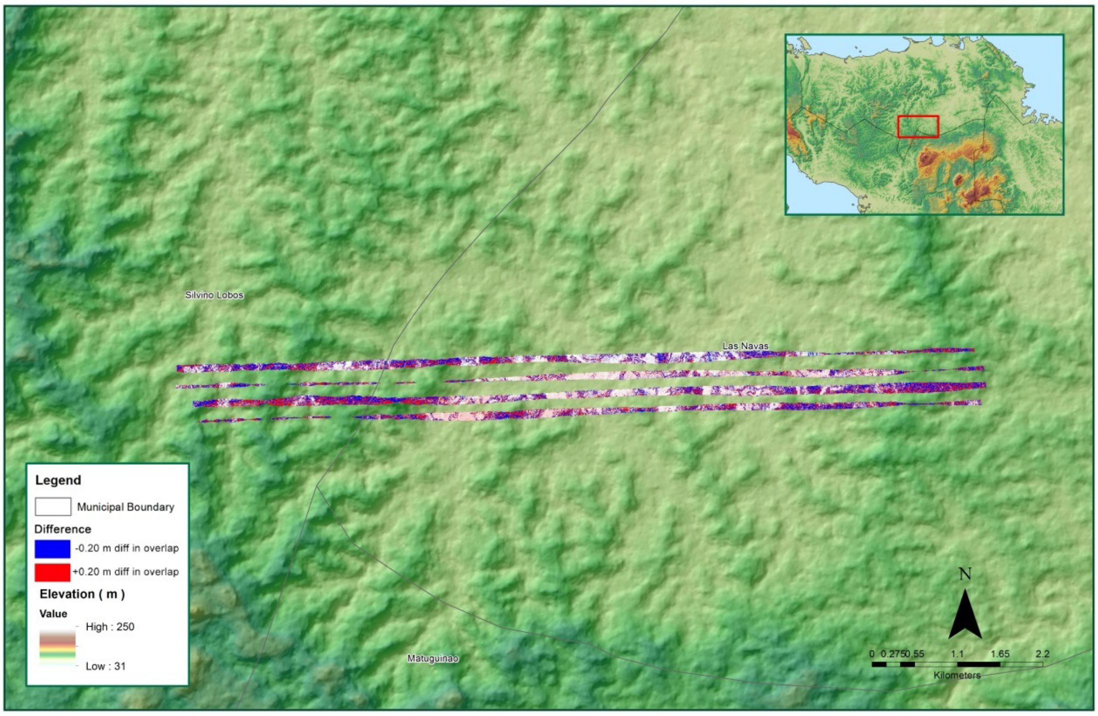


Figure A-8.182. Elevation difference between flight lines

Table A-8.27. Mission Report for Mission 33W_additional

Flight Area	**Catarman_Reflight**
Mission Name	**33W_additional**
Inclusive Flights	3913G
Range data size	14.1 GB
POS	163 MB
Base data size	184 MB
Image	NA
Transfer date	May 11, 2016
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)	1.3 cm
RMSE for East Position (<4.0 cm)	1.1 cm
RMSE for Down Position (<8.0 cm)	3.3 cm
Boresight correction stdev (<0.001deg)	0.007389
IMU attitude correction stdev (<0.001deg)	0.035496
GPS position stdev (<0.01m)	0.0221
Minimum % overlap (>25)	27.77%
Ave point cloud density per sq.m. (>2.0)	2.71
Elevation difference between strips (<0.20 m)	Yes
Number of 1km x 1km blocks	44
Maximum Height	261.13
Minimum Height	56.45
Classification (# of points)	
Ground	10091117
Low vegetation	3351405
Medium vegetation	11240304
High vegetation	21435057
Building	8837
Orthophoto	No
Processed by	Engr. Analyn M. Naldo, Engr. Harmond Santos, Engr. Gladys Mae Apat

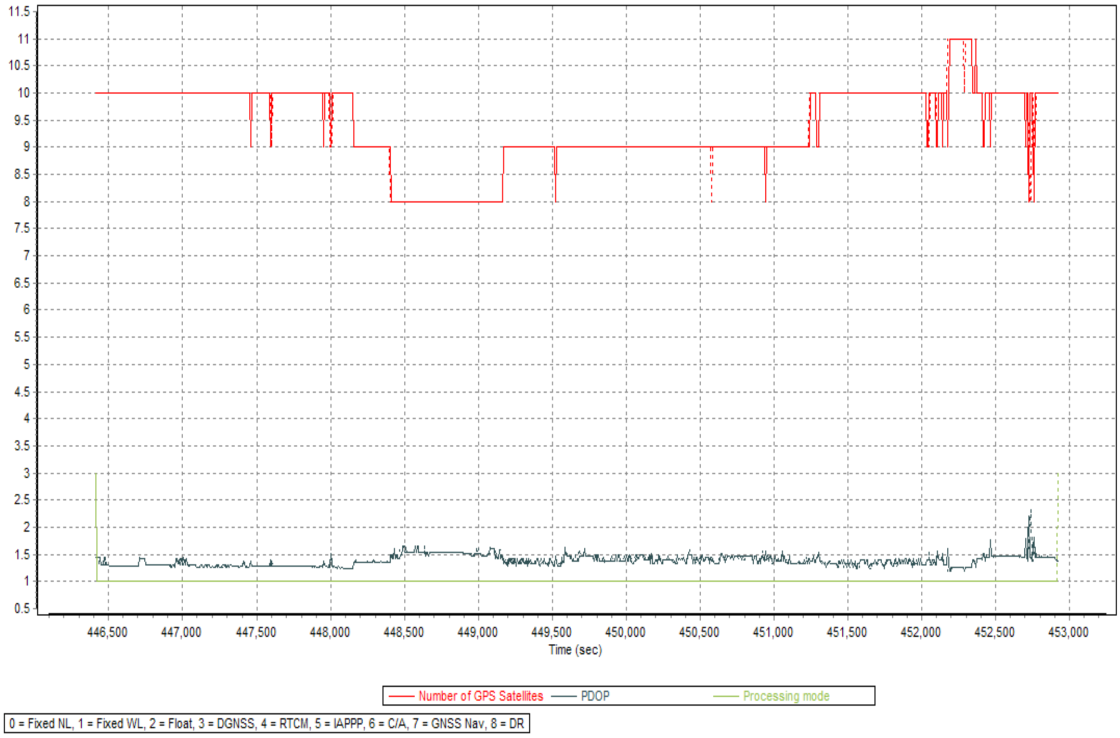


Figure A-8.183. Solution Status

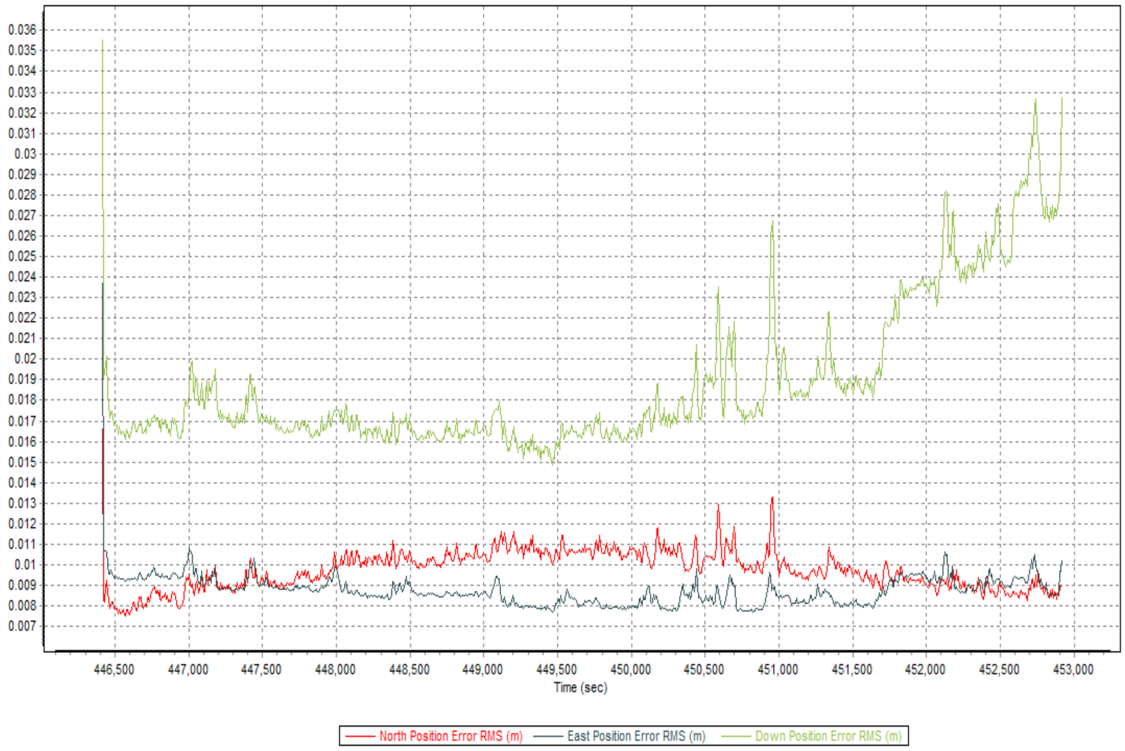


Figure A-8.184. Smoothed Performance Metric Parameters

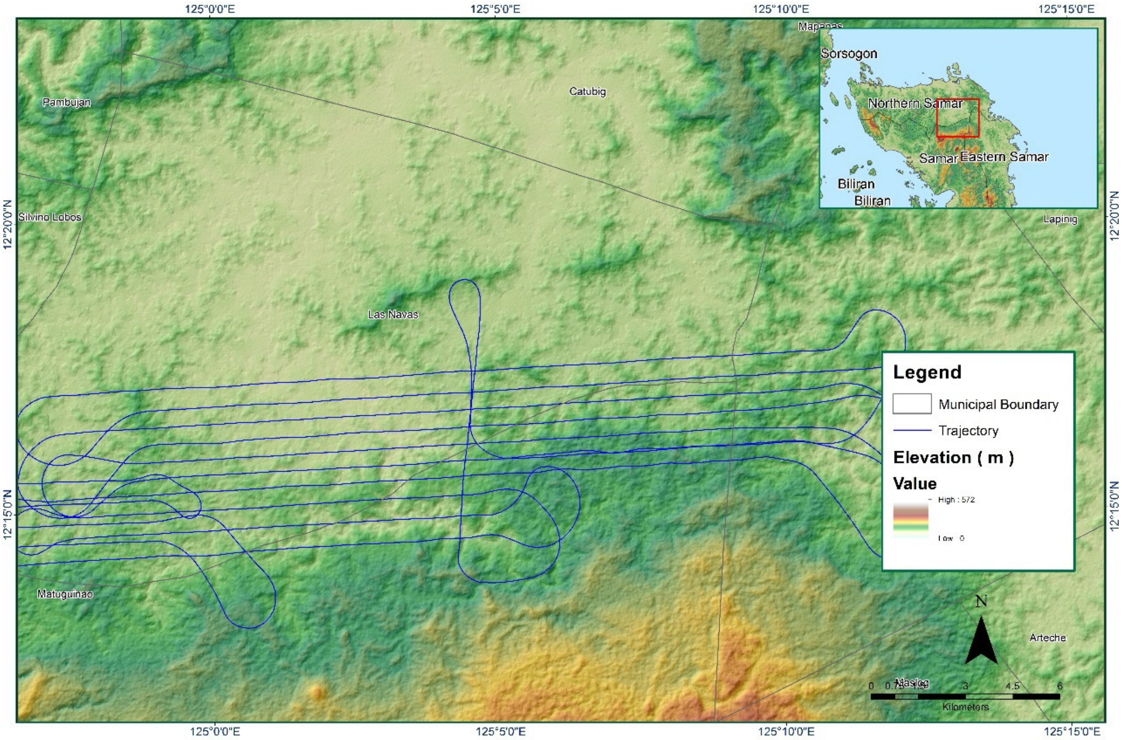


Figure A-8.185. Best Estimated Trajectory

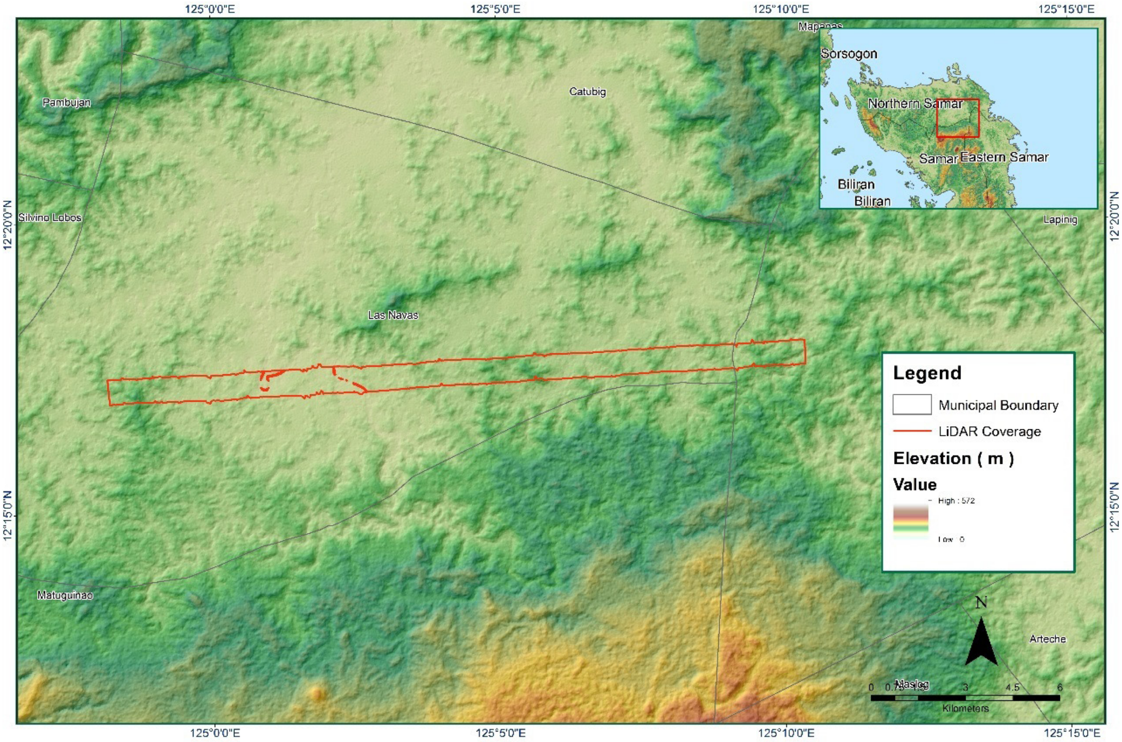


Figure A-8.186. Coverage of LIDAR data

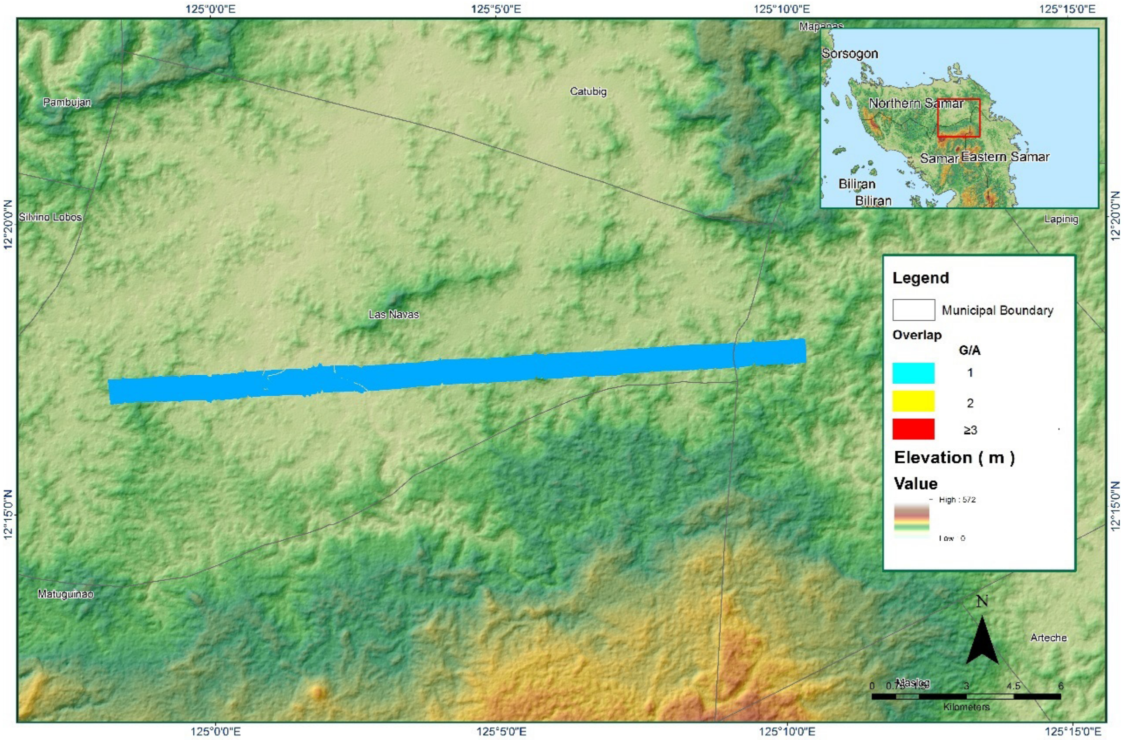


Figure A-8.187. Image of Data Overlap

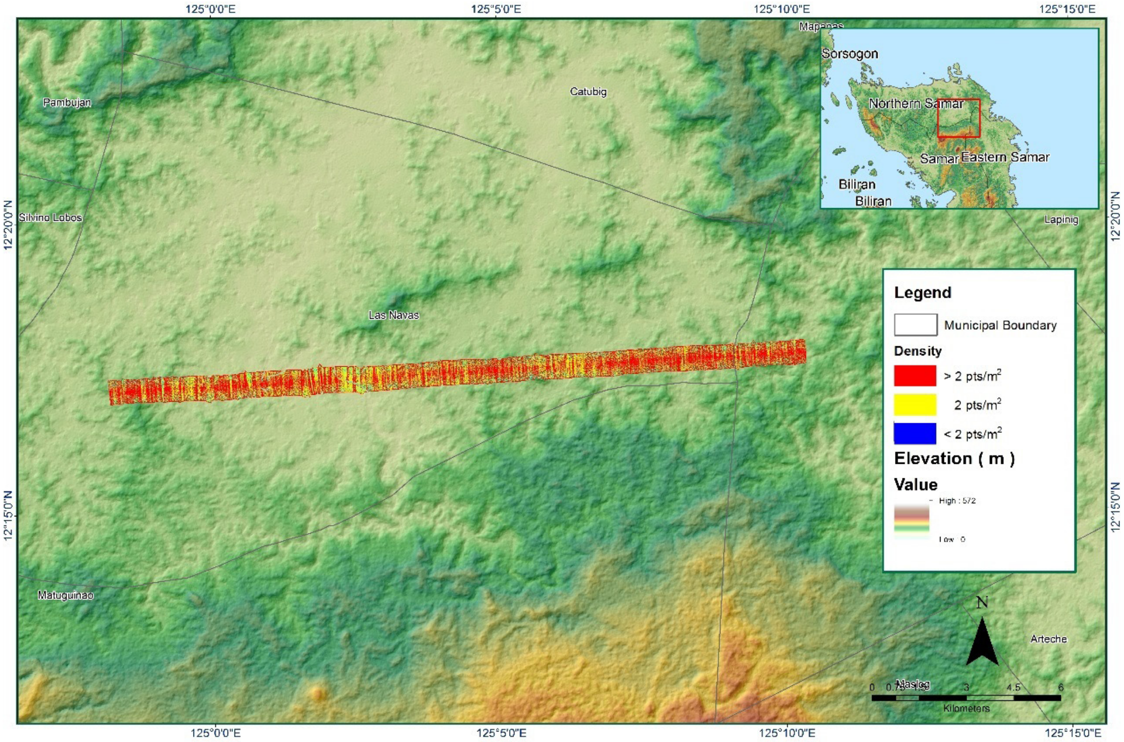


Figure A-8.188. Density map of merged LIDAR data

Figure A-8.189. Elevation difference between flight lines

Annex 9. Catubig Model Basin Parameters

Table A-9.1. Catubig Model Basin Parameters

Sub-basin	SCS Curve Number			Clark Unit Hydrograph		Recession Baseflow				
	Initial Abstraction	Curve Number	Impervious	Time of Concentration	Storage Coefficient	Initial Type	Initial Discharge (m3/s)	Recession Constant	Threshold Type	Ratio to Peak
W260	6.2787	78	0	2.636	1.0755	Discharge	4.112	0.4	Ratio to Peak	0.48
W270	7.7403	78	0	4.1778	1.70453	Discharge	6.3953	0.4	Ratio to Peak	0.48
W280	11.887	78	0	2.2006	0.89786	Discharge	6.6183	0.4	Ratio to Peak	0.48
W290	12.375	78	0	1.8043	0.73616	Discharge	6.9127	0.4	Ratio to Peak	0.48
W300	10.492	78	0	4.9132	1.8504	Discharge	6.5381	0.4	Ratio to Peak	0.48
W310	10.547	78	0	0.21171	0.34551	Discharge	4.4583	0.4	Ratio to Peak	0.48
W320	13.68	78	0	0.7278	1.1877	Discharge	10.703	0.4	Ratio to Peak	0.48
W330	23.357132	78	0	1.1113	1.81362	Discharge	2.8297	0.4	Ratio to Peak	0.48
W340	21.521	78	0	1.3396	2.18622	Discharge	8.2853	0.4	Ratio to Peak	0.48
W350	33.867	78	0	3.664	5.98	Discharge	4.7879	0.4	Ratio to Peak	0.48
W360	17	78	0	0.8947	1.46017	Discharge	4.2985	0.4	Ratio to Peak	0.48
W370	34.068	68	0	1.3587	2.21748	Discharge	19.462	0.4	Ratio to Peak	0.48
W380	36.876	68	0	1.7271	2.8187	Discharge	7.3825	0.4	Ratio to Peak	0.48
W390	27.705	68	0	9.7093	15.8456	Discharge	5.1267	0.4	Ratio to Peak	0.48
W400	35.102983	68	0	5.8087	9.47979	Discharge	4.4743	0.4	Ratio to Peak	0.48
W410	35.982	68	0	6.9182	11.29046	Discharge	19.784822	0.4	Ratio to Peak	0.48
W420	33.867	68	0	5.7064	9.31	Discharge	10.15	0.4	Ratio to Peak	0.48
W430	33.867	68	0	2.4417	3.98	Discharge	4.9814	0.4	Ratio to Peak	0.48
W440	33.867	68	0	5.9523	9.71	Discharge	6.7648	0.4	Ratio to Peak	0.48
W450	33.867	72	0	6.9728	11.38	Discharge	1.6348	0.4	Ratio to Peak	0.48
W460	33.867	88	0	3.5146	5.74	Discharge	5.3884	0.4	Ratio to Peak	0.48
W470	33.867	88	0	4.8772	7.96	Discharge	2.191	0.4	Ratio to Peak	0.48
W480	33.867	88	0	11.6931	19.08	Discharge	4.1498	0.4	Ratio to Peak	0.48

Sub-basin	SCS Curve Number			Clark Unit Hydrograph		Recession Baseflow				
	Initial Abstraction	Curve Number	Impervious	Time of Concentration	Storage Coefficient	Initial Type	Initial Discharge (m3/s)	Recession Constant	Threshold Type	Ratio to Peak
W490	33.867	88	0	5.9603	9.73	Discharge	8.4089	0.4	Ratio to Peak	0.48
W500	33.867	88	0	5.3355	8.71	Discharge	0.46105	0.4	Ratio to Peak	0.48

Annex 10. Catubig Model Reach Parameters

Table A-10.1. Catubig Model Reach Parameters

Reach	Time Step Method	Length	Slope	Manning’s n	Shape	Width	Side Slope
R10	Automatic Fixed Interval	704.47	0.010608	0.04	Trapezoid	70.932	45
R30	Automatic Fixed Interval	5827.4	0.000250275	0.04	Trapezoid	54.488	45
R50	Automatic Fixed Interval	2562.2	0.0016713	0.04	Trapezoid	43.846	45
R60	Automatic Fixed Interval	1495.9	0.000250275	0.04	Trapezoid	41.234	45
R100	Automatic Fixed Interval	6910.8	0.0027958	0.04	Trapezoid	39.58	45
R110	Automatic Fixed Interval	5093.2	0.0019849	0.04	Trapezoid	26.052	45
R120	Automatic Fixed Interval	4839.7	0.000250275	0.04	Trapezoid	18.146	45
R130	Automatic Fixed Interval	7307.2	0.0091268	0.04	Trapezoid	20.342	45
R140	Automatic Fixed Interval	16426	0.0043083	0.04	Trapezoid	10.06	45
R160	Automatic Fixed Interval	2330.7	0.0734835	0.04	Trapezoid	10.06	45
R170	Automatic Fixed Interval	4644.2	0.0178226	0.04	Trapezoid	7.628	45
R200	Automatic Fixed Interval	6818.5	0.0194253	0.04	Trapezoid	17.376	45

Annex 11. Catubig Field Validation Points

Table A-11.1. Catubig Field Validation Points

GPS Code	Coordinates		Model Var (m)	Validation Points (m)	Error	Event/Date	Rain Return / Scenario
	Latitude	Longitude					
255	12.51745	125.0304	2	1	1	Heavy Rainfall/December 16-17, 2016	100-Year
256	12.52227	125.0313	1.07	1	0.07	Heavy Rainfall/December 16-17, 2016	100-Year
257	12.52275	125.0317	0.85	1	-0.15	Heavy Rainfall/December 16-17, 2016	100-Year
259	12.52419	125.0314	0.85	1	-0.15	Heavy Rainfall/December 16-17, 2016	100-Year
263	12.33555	125.0304	4.63	1.5	3.13	Heavy Rainfall/December 16-17, 2016	100-Year
264	12.3468	125.0353	2.62	0.5	2.12	Heavy Rainfall/December 16-17, 2016	100-Year
273	12.34913	125.0349	2.69	0.5	2.19	Heavy Rainfall/December 16-17, 2016	100-Year
283	12.34987	125.0355	2.42	1	1.42	Heavy Rainfall/December 16-17, 2016	100-Year
293	12.35118	125.0355	2.54	1.5	1.04	Heavy Rainfall/December 16-17, 2016	100-Year
303	12.35906	125.0389	3.41	2	1.41	Heavy Rainfall/December 16-17, 2016	100-Year
322	12.36257	125.0478	2.98	2	0.98	Heavy Rainfall/December 16-17, 2016	100-Year
333	12.36209	125.0481	3.95	2	1.95	Heavy Rainfall/December 16-17, 2016	100-Year
343	12.36281	125.0488	3.92	2	1.92	Heavy Rainfall/December 16-17, 2016	100-Year
353	12.3628	125.0498	4.34	2	2.34	Heavy Rainfall/December 16-17, 2016	100-Year
363	12.34503	125.032	3.56	1	2.56	Heavy Rainfall/December 16-17, 2016	100-Year
383	12.34853	125.0258	0.03	0	0.03	Heavy Rainfall/December 16-17, 2016	100-Year
393	12.35011	125.0225	2.85	0	2.85	Heavy Rainfall/December 16-17, 2016	100-Year
403	12.35047	125.0213	2.32	0	2.32	Heavy Rainfall/December 16-17, 2016	100-Year
414	12.33574	125.0341	1.04	1.5	-0.46	Heavy Rainfall/December 16-17, 2016	100-Year
415	12.35077	125.0195	2.32	0	2.32	Heavy Rainfall/December 16-17, 2016	100-Year
423	12.35279	125.0202	0.03	0	0.03	Heavy Rainfall/December 16-17, 2016	100-Year
433	12.34527	125.0341	6.65	0.5	6.15	Heavy Rainfall/December 16-17, 2016	100-Year
443	12.34672	125.0342	6.57	0.5	6.07	Heavy Rainfall/December 16-17, 2016	100-Year
453	12.36449	125.0263	0.03	0.5	-0.47	Heavy Rainfall/December 16-17, 2016	100-Year

463	12.36392	125.0273	0.63	0.5	0.13	Heavy Rainfall/December 16-17, 2016	100-Year
473	12.36517	125.0269	0.03	0.5	-0.47	Heavy Rainfall/December 16-17, 2016	100-Year
482	12.36168	125.0299	0.52	0.5	0.02	Heavy Rainfall/December 16-17, 2016	100-Year
493	12.35965	125.0372	2.18	2	0.18	Heavy Rainfall/December 16-17, 2016	100-Year
503	12.36777	125.0381	2	0	2	Heavy Rainfall/December 16-17, 2016	100-Year
514	12.33527	125.0355	2.68	1.5	1.18	Heavy Rainfall/December 16-17, 2016	100-Year
515	12.36806	125.0397	2.83	0	2.83	Heavy Rainfall/December 16-17, 2016	100-Year
523	12.36891	125.0417	3	0	3	Heavy Rainfall/December 16-17, 2016	100-Year
543	12.3733	125.0477	3.36	0	3.36	Heavy Rainfall/December 16-17, 2016	100-Year
553	12.37549	125.0493	3.82	1	2.82	Heavy Rainfall/December 16-17, 2016	100-Year
563	12.37646	125.05	5.74	1	4.74	Heavy Rainfall/December 16-17, 2016	100-Year
573	12.3766	125.0493	1.29	1	0.29	Heavy Rainfall/December 16-17, 2016	100-Year
583	12.37658	125.0507	3.47	0	3.47	Heavy Rainfall/December 16-17, 2016	100-Year
614	12.33815	125.0301	7.28	1.5	5.78	Heavy Rainfall/December 16-17, 2016	100-Year
615	12.38705	125.0477	0.21	0	0.21	Heavy Rainfall/December 16-17, 2016	100-Year
623	12.38856	125.0479	0.98	0	0.98	Heavy Rainfall/December 16-17, 2016	100-Year
633	12.38984	125.0478	0.08	0	0.08	Heavy Rainfall/December 16-17, 2016	100-Year
643	12.39041	125.0487	0.6	0	0.6	Heavy Rainfall/December 16-17, 2016	100-Year
653	12.39124	125.048	0.63	0	0.63	Heavy Rainfall/December 16-17, 2016	100-Year
663	12.38831	125.0532	2.13	3	-0.87	Heavy Rainfall/December 16-17, 2016	100-Year
673	12.3881	125.0533	4.62	3	1.62	Heavy Rainfall/December 16-17, 2016	100-Year
714	12.3393	125.0303	8.23	1.5	6.73	Heavy Rainfall/December 16-17, 2016	100-Year
715	12.38768	125.0542	3.87	3	0.87	Heavy Rainfall/December 16-17, 2016	100-Year
733	12.39449	125.0486	1.12	0	1.12	Heavy Rainfall/December 16-17, 2016	100-Year
743	12.39664	125.049	1.21	0	1.21	Heavy Rainfall/December 16-17, 2016	100-Year
753	12.39777	125.0488	0.24	0	0.24	Heavy Rainfall/December 16-17, 2016	100-Year
763	12.39935	125.0491	0.13	0	0.13	Heavy Rainfall/December 16-17, 2016	100-Year
783	12.40205	125.0489	0.07	1.2	-1.13	Heavy Rainfall/December 16-17, 2016	100-Year

793	12.40286	125.0512	0.34	1.2	-0.86	Heavy Rainfall/December 16-17, 2016	100-Year
803	12.40261	125.0548	3.62	1.2	2.42	Heavy Rainfall/December 16-17, 2016	100-Year
814	12.34103	125.0305	3.8	1.5	2.3	Heavy Rainfall/December 16-17, 2016	100-Year
823	12.40355	125.0547	3.17	1.2	1.97	Heavy Rainfall/December 16-17, 2016	100-Year
833	12.404	125.0521	2.3	1.2	1.1	Heavy Rainfall/December 16-17, 2016	100-Year
843	12.40501	125.0541	3.45	1.2	2.25	Heavy Rainfall/December 16-17, 2016	100-Year
863	12.40583	125.0542	3.34	1.2	2.14	Heavy Rainfall/December 16-17, 2016	100-Year
873	12.40731	125.0547	3.18	1.2	1.98	Heavy Rainfall/December 16-17, 2016	100-Year
903	12.41051	125.0566	2.7	1.2	1.5	Heavy Rainfall/December 16-17, 2016	100-Year
914	12.41108	125.056	1.35	1.2	0.15	Heavy Rainfall/December 16-17, 2016	100-Year
933	12.41154	125.0542	0.89	0	0.89	Heavy Rainfall/December 16-17, 2016	100-Year
943	12.41184	125.053	0.87	1.2	-0.33	Heavy Rainfall/December 16-17, 2016	100-Year
953	12.41232	125.0514	2.01	0	2.01	Heavy Rainfall/December 16-17, 2016	100-Year
963	12.41251	125.0507	0.63	0	0.63	Heavy Rainfall/December 16-17, 2016	100-Year
973	12.41131	125.0508	0.03	0	0.03	Heavy Rainfall/December 16-17, 2016	100-Year
983	12.41038	125.0506	0.04	0	0.04	Heavy Rainfall/December 16-17, 2016	100-Year
1003	12.41061	125.0549	2.7	1.2	1.5	Heavy Rainfall/December 16-17, 2016	100-Year
1014	12.34078	125.0309	2.92	1.5	1.42	Heavy Rainfall/December 16-17, 2016	100-Year
1023	12.40953	125.0552	3.08	1.2	1.88	Heavy Rainfall/December 16-17, 2016	100-Year
1033	12.41023	125.054	1.08	1.2	-0.12	Heavy Rainfall/December 16-17, 2016	100-Year
1043	12.4102	125.0531	1.1	1.2	-0.1	Heavy Rainfall/December 16-17, 2016	100-Year
1053	12.4094	125.0543	1.1	1.2	-0.1	Heavy Rainfall/December 16-17, 2016	100-Year
1083	12.40952	125.0532	1.69	1.2	0.49	Heavy Rainfall/December 16-17, 2016	100-Year
1104	12.33367	125.0306	4.03	1.5	2.53	Heavy Rainfall/December 16-17, 2016	100-Year
1105	12.40935	125.0516	0.38	0	0.38	Heavy Rainfall/December 16-17, 2016	100-Year
1115	12.40879	125.0507	0.32	0	0.32	Heavy Rainfall/December 16-17, 2016	100-Year
1123	12.40787	125.0494	0.06	0	0.06	Heavy Rainfall/December 16-17, 2016	100-Year
1133	12.40926	125.0487	0.11	0	0.11	Heavy Rainfall/December 16-17, 2016	100-Year

1143	12.41063	125.0493	0.2	0	0.2	Heavy Rainfall/December 16-17, 2016	100-Year
1153	12.41433	125.0468	0.77	0	0.77	Heavy Rainfall/December 16-17, 2016	100-Year
1173	12.41498	125.0466	4.21	0	4.21	Heavy Rainfall/December 16-17, 2016	100-Year
1203	12.41561	125.0452	2.1	0	2.1	Heavy Rainfall/December 16-17, 2016	100-Year
1215	12.4166	125.0462	5.3	0	5.3	Heavy Rainfall/December 16-17, 2016	100-Year
1223	12.42253	125.048	4.79	0.5	4.29	Heavy Rainfall/December 16-17, 2016	100-Year
1243	12.42376	125.047	3	0.5	2.5	Heavy Rainfall/December 16-17, 2016	100-Year
1253	12.42632	125.0435	1.24	0.5	0.74	Heavy Rainfall/December 16-17, 2016	100-Year
1263	12.43007	125.0392	1.05	1.5	-0.45	Heavy Rainfall/December 16-17, 2016	100-Year
1273	12.4305	125.0399	4.22	1.5	2.72	Heavy Rainfall/December 16-17, 2016	100-Year
1283	12.43133	125.0392	1.78	1.5	0.28	Heavy Rainfall/December 16-17, 2016	100-Year
1293	12.43196	125.0391	2.39	1.5	0.89	Heavy Rainfall/December 16-17, 2016	100-Year
1314	12.34016	125.0308	2.88	1.5	1.38	Heavy Rainfall/December 16-17, 2016	100-Year
1315	12.43339	125.039	2.57	0	2.57	Heavy Rainfall/December 16-17, 2016	100-Year
1323	12.43394	125.0398	4.12	1.5	2.62	Heavy Rainfall/December 16-17, 2016	100-Year
1353	12.43244	125.0397	4.17	1.5	2.67	Heavy Rainfall/December 16-17, 2016	100-Year
1393	12.43379	125.0408	2.96	1.5	1.46	Heavy Rainfall/December 16-17, 2016	100-Year
1403	12.43484	125.0407	0.03	1.5	-1.47	Heavy Rainfall/December 16-17, 2016	100-Year
1415	12.43551	125.0407	0.03	1.5	-1.47	Heavy Rainfall/December 16-17, 2016	100-Year
1423	12.43744	125.0403	0.03	0.5	-0.47	Heavy Rainfall/December 16-17, 2016	100-Year
1433	12.43822	125.041	0.05	0.5	-0.45	Heavy Rainfall/December 16-17, 2016	100-Year
1443	12.4407	125.0466	3.75	2	1.75	Heavy Rainfall/December 16-17, 2016	100-Year
1453	12.43929	125.047	3.43	2	1.43	Heavy Rainfall/December 16-17, 2016	100-Year
1463	12.4442	125.039	1.17	1	0.17	Heavy Rainfall/December 16-17, 2016	100-Year
1473	12.44887	125.036	1.61	1	0.61	Heavy Rainfall/December 16-17, 2016	100-Year
1483	12.44918	125.0369	1.63	1	0.63	Heavy Rainfall/December 16-17, 2016	100-Year
1493	12.45002	125.0365	1.85	1	0.85	Heavy Rainfall/December 16-17, 2016	100-Year
1503	12.45004	125.0372	1.83	1	0.83	Heavy Rainfall/December 16-17, 2016	100-Year

1533	12.44983	125.0381	3.35	1	2.35	Heavy Rainfall/December 16-17, 2016	100-Year
1553	12.4489	125.0394	1.5	1	0.5	Heavy Rainfall/December 16-17, 2016	100-Year
1563	12.45048	125.0351	1.48	0	1.48	Heavy Rainfall/December 16-17, 2016	100-Year
1573	12.44838	125.0349	1.37	0	1.37	Heavy Rainfall/December 16-17, 2016	100-Year
1583	12.45124	125.0349	2.28	0	2.28	Heavy Rainfall/December 16-17, 2016	100-Year
1593	12.45146	125.0364	1.78	0	1.78	Heavy Rainfall/December 16-17, 2016	100-Year
1603	12.45484	125.0329	1.14	0.5	0.64	Heavy Rainfall/December 16-17, 2016	100-Year
1615	12.4616	125.0298	2.26	0.5	1.76	Heavy Rainfall/December 16-17, 2016	100-Year
1623	12.46548	125.0279	1.76	0.5	1.26	Heavy Rainfall/December 16-17, 2016	100-Year
1633	12.46713	125.0274	1.82	0.5	1.32	Heavy Rainfall/December 16-17, 2016	100-Year
1643	12.46767	125.0289	1.4	0.5	0.9	Heavy Rainfall/December 16-17, 2016	100-Year
1653	12.46854	125.0267	0.99	0.5	0.49	Heavy Rainfall/December 16-17, 2016	100-Year
1663	12.4716	125.0254	1.03	1	0.03	Heavy Rainfall/December 16-17, 2016	100-Year
1673	12.47226	125.0249	0.04	1	-0.96	Heavy Rainfall/December 16-17, 2016	100-Year
1683	12.47255	125.0238	0.03	0	0.03	Heavy Rainfall/December 16-17, 2016	100-Year
1693	12.47295	125.0244	0.03	1	-0.97	Heavy Rainfall/December 16-17, 2016	100-Year
1714	12.3389	125.0313	3.06	1.5	1.56	Heavy Rainfall/December 16-17, 2016	100-Year
1715	12.47489	125.0252	0.03	1	-0.97	Heavy Rainfall/December 16-17, 2016	100-Year
1723	12.47555	125.0256	0.22	1	-0.78	Heavy Rainfall/December 16-17, 2016	100-Year
1743	12.47884	125.0272	0.03	1	-0.97	Heavy Rainfall/December 16-17, 2016	100-Year
1753	12.47958	125.026	0.03	1	-0.97	Heavy Rainfall/December 16-17, 2016	100-Year
1763	12.48052	125.0254	0.11	0	0.11	Heavy Rainfall/December 16-17, 2016	100-Year
1773	12.48112	125.0249	0.03	0	0.03	Heavy Rainfall/December 16-17, 2016	100-Year
1783	12.48178	125.0238	0.03	0	0.03	Heavy Rainfall/December 16-17, 2016	100-Year
1803	12.48563	125.0195	0.03	0	0.03	Heavy Rainfall/December 16-17, 2016	100-Year
1815	12.48784	125.0176	0.06	0	0.06	Heavy Rainfall/December 16-17, 2016	100-Year
1823	12.48903	125.0185	0.11	0	0.11	Heavy Rainfall/December 16-17, 2016	100-Year
1833	12.48972	125.0194	0.3	0	0.3	Heavy Rainfall/December 16-17, 2016	100-Year

1853	12.49045	125.0209	0.07	0	0.07	Heavy Rainfall/December 16-17, 2016	100-Year
1863	12.49086	125.0216	0.04	1	-0.96	Heavy Rainfall/December 16-17, 2016	100-Year
1893	12.49189	125.0214	0.14	1	-0.86	Heavy Rainfall/December 16-17, 2016	100-Year
1914	12.3377	125.0325	2.17	1.5	0.67	Heavy Rainfall/December 16-17, 2016	100-Year
1915	12.49258	125.0224	1.23	1	0.23	Heavy Rainfall/December 16-17, 2016	100-Year
1933	12.48876	125.0166	0.03	0	0.03	Heavy Rainfall/December 16-17, 2016	100-Year
1943	12.49029	125.0152	0.37	0	0.37	Heavy Rainfall/December 16-17, 2016	100-Year
1953	12.50605	125.0024	1.22	0	1.22	Heavy Rainfall/December 16-17, 2016	100-Year
1963	12.50853	125.0004	1.61	0	1.61	Heavy Rainfall/December 16-17, 2016	100-Year
1973	12.51368	125.0019	0.57	0	0.57	Heavy Rainfall/December 16-17, 2016	100-Year
1983	12.52095	125.0033	0.03	0	0.03	Heavy Rainfall/December 16-17, 2016	100-Year
1993	12.52315	125.0104	0.38	0.5	-0.12	Heavy Rainfall/December 16-17, 2016	100-Year
2003	12.52442	125.013	0.4	0.5	-0.1	Heavy Rainfall/December 16-17, 2016	100-Year
2014	12.33784	125.0311	2.45	1.5	0.95	Heavy Rainfall/December 16-17, 2016	100-Year
2015	12.52613	125.0145	0.32	0.5	-0.18	Heavy Rainfall/December 16-17, 2016	100-Year
2023	12.52693	125.0141	0.46	0.5	-0.04	Heavy Rainfall/December 16-17, 2016	100-Year
2033	12.53723	125.0005	0.44	0	0.44	Heavy Rainfall/December 16-17, 2016	100-Year
2043	12.53838	125.0019	0.11	0	0.11	Heavy Rainfall/December 16-17, 2016	100-Year
2053	12.53896	125.0001	0.33	0	0.33	Heavy Rainfall/December 16-17, 2016	100-Year
2063	12.54012	125.0009	0.1	0	0.1	Heavy Rainfall/December 16-17, 2016	100-Year
2073	12.54059	125.0021	0.41	0	0.41	Heavy Rainfall/December 16-17, 2016	100-Year
2082	12.54461	124.9989	0.9	0	0.9	Heavy Rainfall/December 16-17, 2016	100-Year
2093	12.54686	124.9998	0.08	0	0.08	Heavy Rainfall/December 16-17, 2016	100-Year
2103	12.54859	124.9982	0.49	0	0.49	Heavy Rainfall/December 16-17, 2016	100-Year
2114	12.33822	125.0346	3.07	1.5	1.57	Heavy Rainfall/December 16-17, 2016	100-Year
2115	12.55353	124.998	0.09	0	0.09	Heavy Rainfall/December 16-17, 2016	100-Year
2123	12.55501	124.9998	0.05	0	0.05	Heavy Rainfall/December 16-17, 2016	100-Year
2133	12.55807	125.0043	0.05	0	0.05	Heavy Rainfall/December 16-17, 2016	100-Year

2143	12.55965	125.0057	0.07	0	0.07	Heavy Rainfall/December 16-17, 2016	100-Year
2153	12.55948	125.0078	0.13	0	0.13	Heavy Rainfall/December 16-17, 2016	100-Year
2163	12.56162	125.0075	0.11	0.5	-0.39	Heavy Rainfall/December 16-17, 2016	100-Year
2173	12.56306	125.0079	0.11	0.5	-0.39	Heavy Rainfall/December 16-17, 2016	100-Year
2183	12.56213	125.0092	0.12	0.5	-0.38	Heavy Rainfall/December 16-17, 2016	100-Year
2193	12.5626	125.0108	0.26	0	0.26	Heavy Rainfall/December 16-17, 2016	100-Year
2203	12.5634	125.0125	0.08	0.5	-0.42	Heavy Rainfall/December 16-17, 2016	100-Year
2214	12.34312	125.0349	3.3	0.5	2.8	Heavy Rainfall/December 16-17, 2016	100-Year
2215	12.56228	125.0134	0.09	0.5	-0.41	Heavy Rainfall/December 16-17, 2016	100-Year
2223	12.56136	125.0142	0.03	0.5	-0.47	Heavy Rainfall/December 16-17, 2016	100-Year
2233	12.56012	125.0145	0.05	0.5	-0.45	Heavy Rainfall/December 16-17, 2016	100-Year
2414	12.34248	125.0356	3.5	0.5	3	Heavy Rainfall/December 16-17, 2016	100-Year
2483	12.55906	125.0068	0.1	0	0.1	Heavy Rainfall/December 16-17, 2016	100-Year
2493	12.51504	125.0257	0.03	2	-1.97	Heavy Rainfall/December 16-17, 2016	100-Year
2503	12.51404	125.0257	0.07	2	-1.93	Heavy Rainfall/December 16-17, 2016	100-Year
2510	12.34544	125.0355	2.9	0.5	2.4	Heavy Rainfall/December 16-17, 2016	100-Year
2511	12.51347	125.0263	0.03	2	-1.97	Heavy Rainfall/December 16-17, 2016	100-Year
2531	12.51673	125.0273	0.86	2	-1.14	Heavy Rainfall/December 16-17, 2016	100-Year
2541	12.51736	125.0286	2	2	0	Heavy Rainfall/December 16-17, 2016	100-Year

Annex 12. Educational Institutions Affected by Flooding in Catubig Floodplain

Table A-12.1. Educational Institutions Affected by Flooding in the Catubig Floodplain – Municipality of Catubig, Northern Samar

NORTHERN SAMAR				
CATUBIG				
Building Name	**Barangay**	**Rainfall Scenario**		
		5-year	**25-year**	**100-year**
Anongo Elementary School	Anongo			
Brgy. Anongo Day Care Center	Anongo	Low	Low	Medium
Catubig Central Elementary School	Barangay 1	Medium	Medium	Medium
Brgy. 8 Day Care Center	Barangay 7		Medium	Medium
Bonifacio Elementary School	Bonifacio	High	High	High
Brgy. Bonifacio Auditorium	Bonifacio	High	High	High
Catubig Valley National High School	Cagbugna	Medium	Medium	High
UEP PRM Campus	Cagbugna			
Barangay Cagbugna Day Care Center	Cagmanaba			
Barangay Cagmanaba Day Care Center	Cagmanaba			
Cagmanaba Elementary School	Cagmanaba		Low	Medium
Barangay Cagugubngan Day Care Center	Cagogobngan	High	High	High
Cagugubngan Elementary School	Cagogobngan	High	High	High
Canuctan Elementary School	Calingnan	Medium	Medium	High
Catubig Central Elementary School	Calingnan			Low
Elementary School	Calingnan		Medium	Medium
Canuctan Elementary School	Canuctan	Medium	Medium	High
Barangay Claro M. Recto Day Care Center	Claro M. Recto			
Claro M. Recto Elementary School	Claro M. Recto			
D. Mercader Elementary School	D. Mercader	Medium	Medium	High
Elementary School Stage	D. Mercader	Medium	Medium	High
Barangay Guibuangan Day Care Center	Guibwangan	Low	Medium	High
Guibuangan Elementary School	Guibwangan			
Brgy. Hiparayan Day Care Center	Hiparayan	Low	Medium	Medium
Hiparayan Elementary School	Hiparayan	Low	Medium	Medium
Inoburan Elementary School	Inoburan	Medium	High	High
Barangay Irawahan Day Care Center	Irawahan	Medium	Medium	Medium
Irawahan Elementary School	Irawahan	Medium	Medium	High
Viena Maria Elementary School	Irawahan	High	High	High
Brgy. Oleras Day Care Center	Lenoyahan	Medium	High	High
Oleras Elementary School	Lenoyahan	Medium	Medium	High
Oleras Elementary School Stage	Lenoyahan	Medium	Medium	High
Oleras National High School	Lenoyahan	Medium	Medium	High
Barangay Mag-ongon Day Care Center	Magongon			Low
Mag-ongon Elementary School	Magongon			
Barangay Manering Day Care Center	Manering	High	High	High
Nabulo Elementary School	Nabulo	High	High	High

NORTHERN SAMAR				
CATUBIG				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
Barangay Nabulo Day Care Center	Nahulid	High	High	High
Nabulo Elementary School	Nahulid	High	High	High
Barangay Osmeña Day Care Center	Osmeña	Medium	Medium	Medium
Osmeña Elementary School	Osmeña	Low	Medium	Medium
Barangay Guibuangan Day Care Center	Sagudsuron	Medium	High	High
Barangay Sagudsuron Day Care Center	Sagudsuron			
Sagudsuron Elementary School	Sagudsuron			
Barangay San Antonio Day Care Center	San Antonio			
Hibubullao National High School	San Antonio			
San Antonio Elementary School	San Antonio			
San Francisco Elementary School	San Francisco			
Barangay San Francisco Day Care Center	San Francisco			
Barangay Nahulid Day Care Center	San Jose	Medium	Medium	Medium
Barangay San Jose Day Care Center	San Jose	Low	Medium	Medium
Hibubullao Central Elementary School	San Jose	Medium	High	High
Hibubullao National High School	San Jose			
Nahulid Elementary School	San Jose		Low	Medium
Barangay Libon Day Care Center	Sulitan			Low
Libon Elementary School	Sulitan			
Barangay D. Mercader Day Care Center	Tangbo	Medium	High	High
Brgy. Cagdara-o Day Care Center	Tangbo			
Cagdara-o Elementary School	Tangbo	Low	Low	Low
Lenoy-Ahan Elementary School	Tangbo	Low	Medium	High
Opong Elementary School	Tangbo	High	High	High
Barangay Tongodnon Day Care Center	Tungodnon	Medium	Medium	Medium
Tongodnon Elementary School	Tungodnon			

Table A-12.2. Educational Institutions Affected by Flooding in the Catubig Floodplain – Municipality of Laoang, Northern Samar

NORTHERN SAMAR				
LAOANG				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
Barangay Tangbo Day Care Center	Abaton	Medium	Medium	High
Tangbo Elementary School	Abaton	Medium	Medium	Medium
Atipolo Elementary School	Atipolo	Low	Low	Low
Bawang Elementary School	Bawang	Medium	High	High
Brgy. Bawang Day Care Center	Bawang	Low	Medium	Medium
Brgy. San Antonio Day Care Center	Bawang			
Son-og Elementary School	Bawang	Medium	Medium	Medium
Bobolosan Elementary School	Bobolosan	Medium	Medium	Medium
Bobolosan Elementary School Abandoned	Bobolosan	Low	Low	Low
Brgy. Bobolosan Day Care Center	Bobolosan			
Bongliw Elementary School	Bongliw	Low	Medium	Medium
Brgy. Bongliw Day Care Center	Bongliw			
Brgy. Burabod Day Care Center	Burabud	Low	Low	Low
Burabod Elementary School	Burabud			
Burabod Elementary School Stage	Burabud			
Brgy. Cabago-an Day Care Center	Cabago-An			
Cabago-an Elementary School	Cabago-An			
Brgy. Cabulaloan Day Care Center	Cabulaloan	Low	Low	Low
Cabulaloan Elementary School	Cabulaloan	Medium	Medium	Medium
Catigbian Elementary School	Cabulaloan	Medium	Medium	Medium
Catigbian National High School	Cabulaloan	Low	Medium	Medium
Brgy. Cangcahipos Day Care Center	Cangcahipos	Low	Medium	Medium
Cangcahipos Elementary School	Cangcahipos	Medium	Medium	Medium
Brgy. Catigbian Day Care Center	Catigbian			
Catigbian Elementary School	Catigbian	Medium	Medium	Medium
Brgy. EJ Dulay Day Care Center	E. J. Dulay	Low	Medium	High
Bayog Elementary School	La Perla			Low
Bayog Elementary School Stage	La Perla	Medium	Medium	High
Brgy. La Perla Day Care Center	La Perla	Low	Medium	Medium
La Perla National High School	La Perla	Low	Low	Low
Brgy. Lawaan New Day Care Center	Lawaan	Low	Low	Low
Brgy. Lawaan Old Day Care Center	Lawaan	Low	Low	Low
Lawaan Elementary School	Lawaan			Low
Brgy. Rawis Day Care Center	Rawis			
Junction Elementary School	Rawis			
Lagrimas Learning and Nurture Center, Inc.	Rawis			
Rawis Central School	Rawis			
Rawis National High School	Rawis			
Rawis National High School Stage	Rawis			
UAP Cable Television	Rawis			

NORTHERN SAMAR				
LAOANG				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
Day Care Center	Rombang			
Rombang Elementary School	Rombang	Low	Medium	Medium
Brgy. Sibunot Day Care Center	Sibunot			
Sibunot Elementary School	Sibunot			
Brgy. Kawilan Day Care Center	Simora			
Brgy. Simora Day Care Center	Simora			
Kawilan Elementary School	Simora	Medium	Medium	Medium
Simora Elementary School	Simora			
Simora Elementary School Stage	Simora			
Brgy. Talisay Day Care Center	Talisay			
Talisay Elementary School	Talisay			
Brgy. Tarusan Day Care Center	Tarusan	Low	Medium	Medium
Tarusan Primary School	Tarusan	Low	Medium	Medium
Tinoblan Elementary School	Tinoblan	Medium	Medium	High
Tinoblan National High School	Tinoblan	Medium	Medium	High
Brgy. Vigo Day Care Center	Vigo			Low
Vigo Elementary School	Vigo		Low	Medium
Vigo National High School	Vigo			Low
Elementary School	Yapas	Low	Low	Low

Table A-12.3. Educational Institutions Affected by Flooding in the Catubig Floodplain – Municipality of Las Navas, Northern Samar

NORTHERN SAMAR				
LAS NAVAS				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
Brgy. Bugay Day Care Center	Bugay	Medium	Medium	High
Bugay Elementary School	Bugay	Medium	Medium	High
Brgy. Bukid Day Care Center	Bukid	Low	Low	Medium
Brgy. Bukid Day Care Center	Bukid	Low	Low	Medium
Bukid Elementary School	Bukid		Low	Low
Bukid National High School	Bukid	Low	Medium	Medium
Brgy. Bulao Day Care Center Site	Bulao			Low
Brgy. Cuenco Day Care Center	Caputoan		Low	Medium
Brgy. Epaw Day Care Center	Epaw		Medium	High
Las Navas Agro-Industrial School	Quirino District	High	High	High
Brgy. Rebong Day Care Center	Rebong	High	High	High
Las Navas Agro-Industrial School	Rebong	High	High	High
Las Navas National High School	Rebong	Medium	Medium	High
Rebong Elementary School	Rebong	High	High	High
TESDA	Rebong	Medium	Medium	High
	San Isidro	High	High	High
	San Miguel	Medium	Medium	Medium
Brgy. San Miguel Day Care Center	San Miguel	Medium	Medium	Medium
Brgy. Tagan-ayan Day Care Center	Tagan-Ayan	Low	Low	Medium
	Victory		Medium	Medium

Table A-12.4. Educational Institutions Affected by Flooding in the Catubig Floodplain – Municipality of Palapag, Northern Samar

NORTHERN SAMAR				
PALAPAG				
Building Name	**Barangay**	**Rainfall Scenario**		
		5-year	**25-year**	**100-year**
Aquino Elementary School	Asum			
Rombang Elementary School	Jangtud			
Brgy. Magsaysay Day Care Center	Magsaysay			
Bukid Elementary School	Magsaysay			
Brgy. Manajao Day Care Center	Manajao		Low	Low
Brgy. Tinampo Day Care Center	Manajao			
Manajao Elementary School	Manajao	Low	Low	Low
Brgy. Mabaras Day Care Center	Matambag			
Mabaras Elementary School	Matambag			
Tinampo Elementary School	Monbon			
Rombang Elementary School	Nagbobtac			
Brgy. Campedico Day Care Center	Natawo	Medium	High	High
Brgy. Natawo Day Care Center	Natawo		Low	Low
Brgy. Sinalaran Day Care Center	Natawo			
Campedico Elementary School	Natawo	Medium	Medium	Medium
Natawo Elementary School	Natawo			
Sinalaran Elementary School	Natawo			
Brgy. Pangpang Day Care Center	Pangpang			
Pangpang Integrated School	Pangpang			
Barangay P. Rebadulla Day Care Center	Simora	Medium	High	High
EJ Dulay Elementary School	Simora	Medium	Medium	High
P. Rebadulla Elementary School	Simora			
Sinalaran Elementary School	Sinalaran			
Tinampo Elementary School	Sumoroy			Low
Aquino Elementary School	Tinampo			

Annex 13. Medical Institutions Affected by Flooding in Catubig Floodplain

Table A-13.1. Medical Institutions Affected by Flooding in the Catubig Floodplain

NORTHERN SAMAR				
CATUBIG				
Building Name	**Barangay**	**Rainfall Scenario**		
		5-year	**25-year**	**100-year**
Brgy. Campedico Health Center	Mabaras	Medium	High	High
Brgy. Magsaysay Health Center	Magsaysay			
Brgy. Manajao Health Center	Manajao		Low	Low
Brgy. Mabaras Health Center	Matambag			
Brgy. Rombang Health Center	Nagbobtac			
Brgy. Pangpang Health Center	Pangpang			
Brgy. Sinalaran Health Center	Sinalaran			