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

LiDAR Surveys and Flood Mapping of Laoag River

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for Applied Geodesy and Photogrammetry
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LIST OF ACRONYMS AND ABBREVIATIONS

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

CHAPTER 1. OVERVIEW OF THE PROGRAM AND LAOAGRIVER

1.1 Background of the Phil-LiDAR 1 Program

The University of the Philippines Training Center for Applied Geodesy and Photogrammetry (UP-TCAGP) launched a research program in 2014 entitled “Nationwide Hazard Mapping using LiDAR” or Phil-LiDAR 1, supported by the Department of Science and Technology (DOST) Grants-in-Aid (GiA) Program. The program was primarily aimed at acquiring a national elevation and resource dataset at sufficient resolution to produce information necessary to support the different phases of disaster management. Particularly, it targeted to operationalize the development of flood hazard models that would produce updated and detailed flood hazard maps for the major river systems in the country.

Also, the program was aimed at producing an up-to-date and detailed national elevation dataset suitable for 1:5,000 scale mapping, with 50 cm and 20 cm horizontal and vertical accuracies, respectively. These accuracies were achieved through the use of the state-of-the-art Light Detection and Ranging (LiDAR) airborne technology procured by the project through DOST. The methods 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)

The implementing partner universityfor the Phil-LiDAR 1 Program is the University of the Philippines Baguio (UPB). UPB 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 12 river basins in the Cordillera Administrative Region. The university is located in Baguio City.

1.2 Overview of the Laoag River Basin

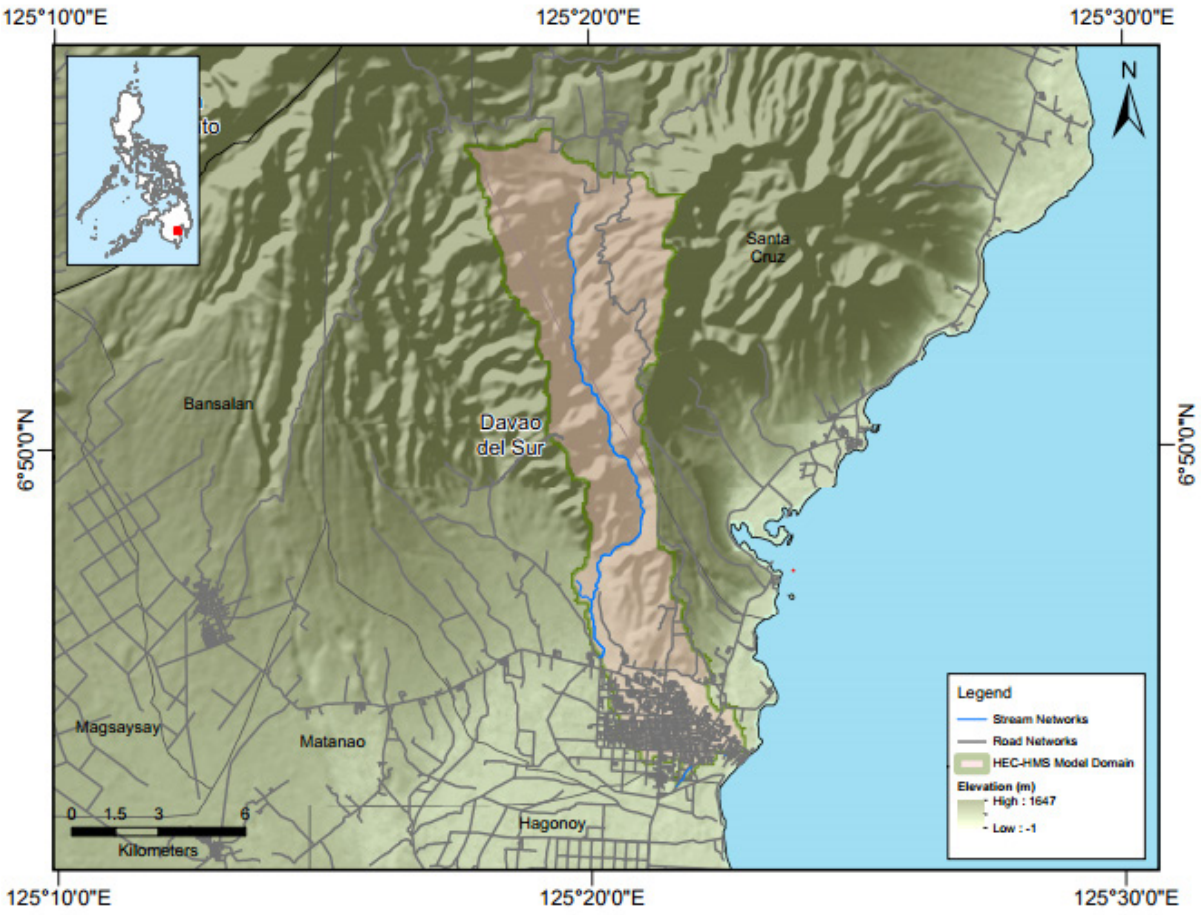

Figure 1. Map of Digos River Basin.

CHAPTER 2. LIDAR ACQUISITION OF THE DIGOS FLOODPLAIN

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

2.1 Flight Plans

Plans were made to acquire LiDAR data within the delineated priority area for Laoag floodplain in Ilocos Norte. These missions were planned for 12 lines that run for at most four and a half (4.5) hours including take-off, landing and turning time. The flight planning parameters for the LiDAR system are found in Table 1. Figure 2 shows the flight plan for Laoag floodplain survey.

Table 1.Flight planning parameters for Gemini LiDAR system

Block Name	Flying Height (m AGL)	Overlap (%)	Field of View (θ)	Pulse Repetition Frequency (PRF) (kHz)	Scan Frequency (Hz)	Average Speed (kts)	Average Turn Time (Minutes)
BLK04F	1100	25	30	100	50	120	5
BLK05A	1200	25	40	100	50	120	5
BLK05B	1100	25	30	100	50	120	5
	1400	30	40	100	50	120	5
	1500	30	40	100	50	120	5
BLK05C	1200	25	40	100	50	120	5
	1400	30	40	100	50	120	5
BLK05D	1300, 1400,1500	30	40	100	50	120	5
BLK05E	1000	25	40	100	50	120	5
BLK05F	1000	25,30	40	100	50	120	5
BLK05G	1000	25,30	40	100	40	120	5
BLK05H	1000	45	40	100	50	120	5
BLK05I	1000	45	40	100	50	120	5
BLK05J	1500	30	30	100	50	120	5
BLK05K	1300,1400,1500	30	40	100	50	120	5
BLK05L	1350	30	40	100	50	120	5

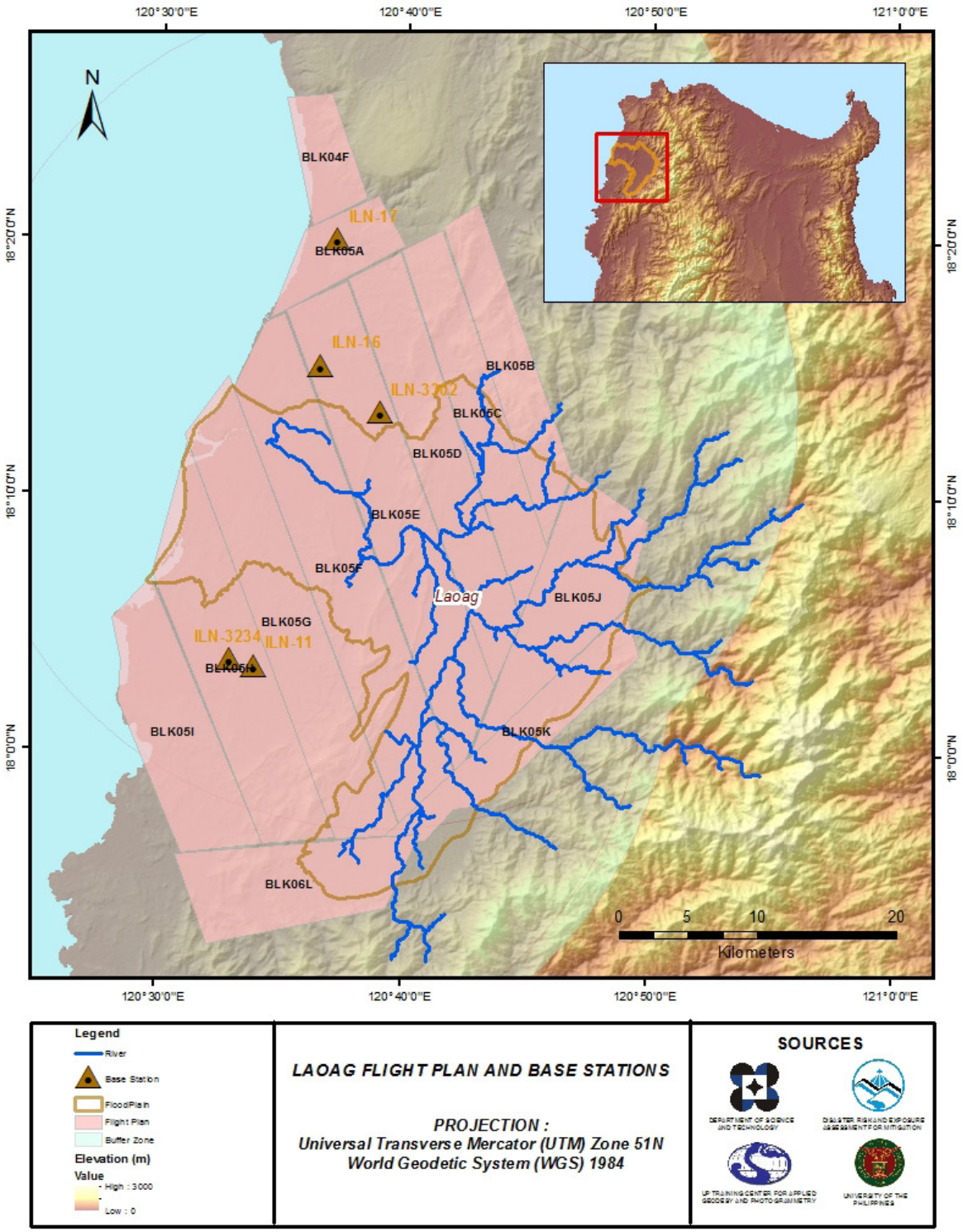


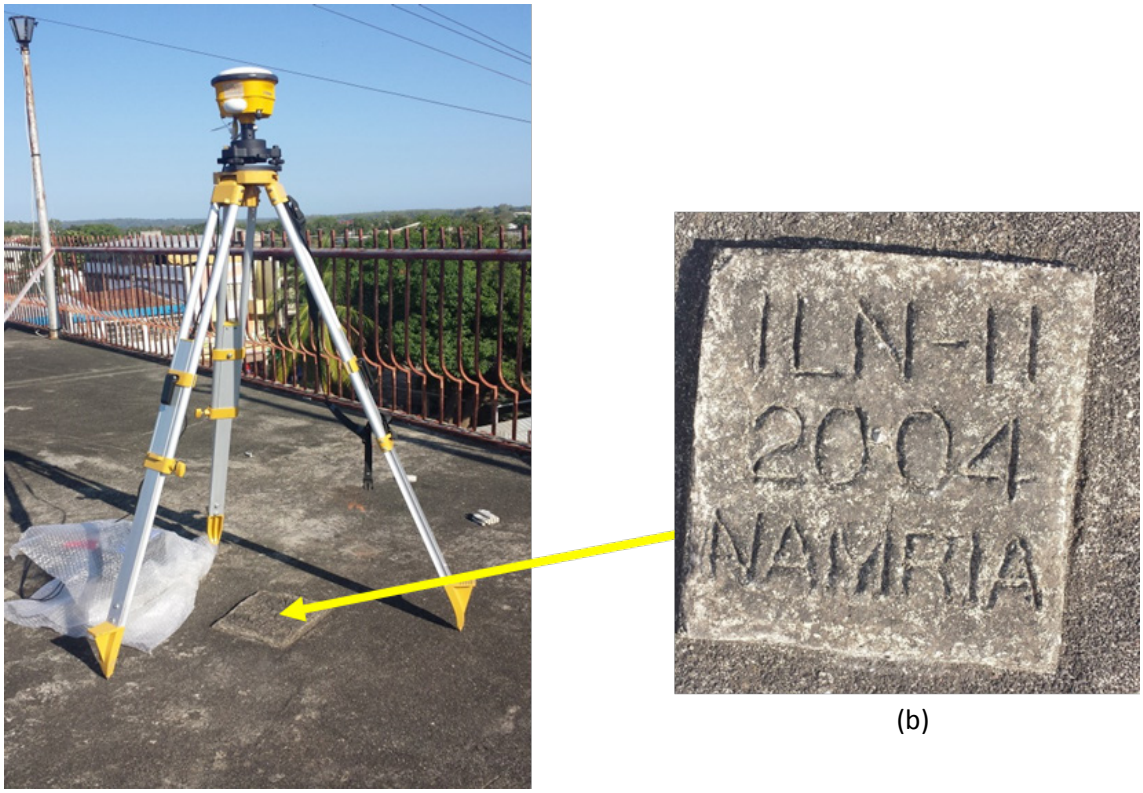
Figure 2. Flight plan and base stations used for Laoag floodplain.

(b)

2.2 Ground Base Stations

The project team was able to recover five (5) NAMRIA ground control points: ILN-11, ILN-16 and ILN-17 which are of second (2nd) order accuracy and ILN-3234 AND ILN-3302, which are of fourth (4th) order accuracy. These were used as base stations during flight operations for the entire duration of the survey (February 21- March 2, 2014). Base stations were observed using dual frequency GPS receivers, TRIMBLE SPS 882 AND 985. Flight plans and location of base stations used during the aerial LiDAR acquisition in Laoag floodplain are shown in Figure 2.The certification for the NAMRIA reference points are found in Annex 2

Figure 4 to Figure 7 show the recovered NAMRIA reference points within the area. Table 2 to Table 5 show the details about the following NAMRIA control stations and established points while Table 6 shows the list of all ground control points occupied during the acquisition with the corresponding dates of utilization.



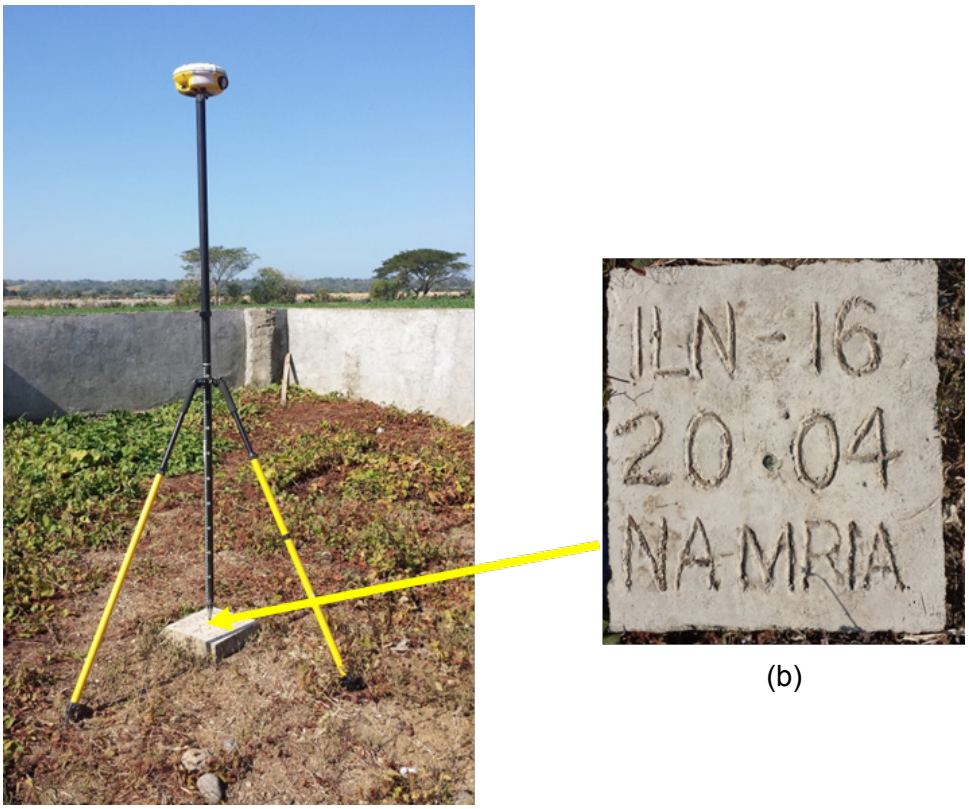
(a) (b)

Figure 3.GPS set-up over ILN-11 located on the rooftop of Batac Municipal Hall Building in Batac Ilocos Norte (a) and NAMRIA reference point ILN-11 (b) as recovered by the field team.

Table 2.Details of the recovered NAMRIA horizontal control point ILN-11 used as base station for the LiDAR data acquisition.

Station Name	ILN-11	
Order of Accuracy	2nd Order	
Relative Error (horizontal positioning)	1:50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	18°3'26.86785" North 120°33'49.91547" East 42.96000 meters

Grid Coordinates, Philippine Transverse Mercator Zone 3 (PTM Zone 3 PRS 92)	Easting Northing	453,827.436 meters 1,998,122.81 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	18°3'20.64522" North 120°33'54.52048" East 74.87400 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting Northing	242,121.13 meters 1,998,122.81 meters



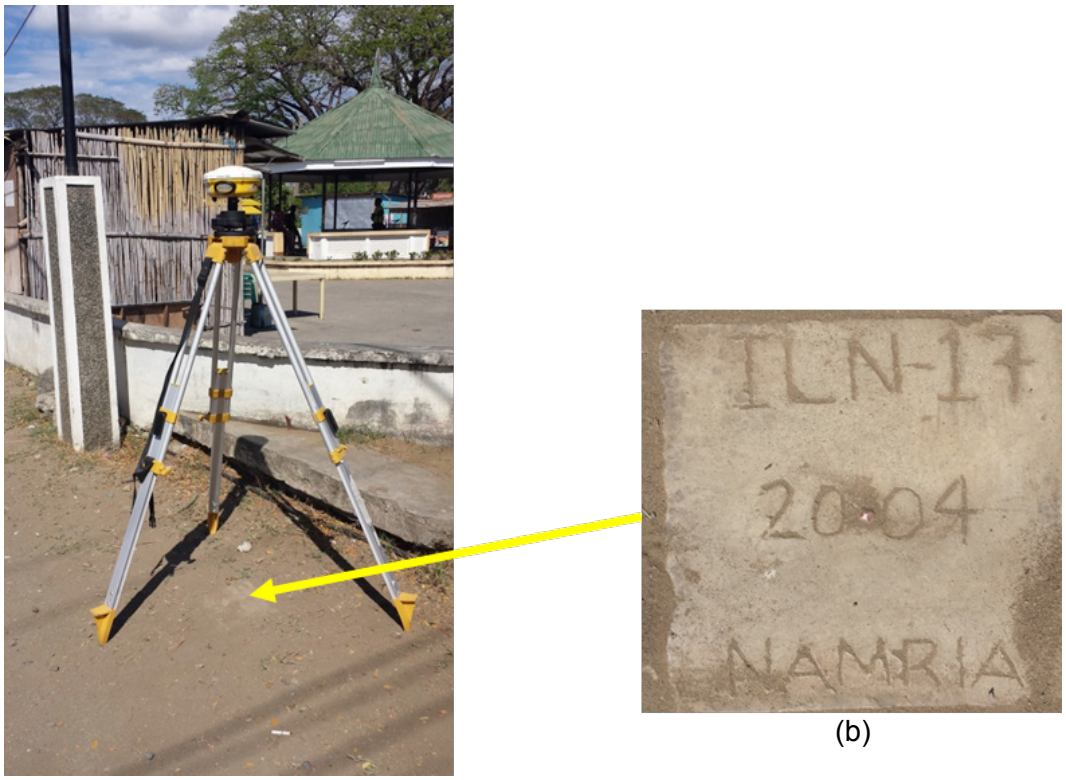
(a) (b)

Figure 4.GPS set-up over ILN-16 located inside Bacarra Central Elementary School in Bacarra, Ilocos Norte (a) and NAMRIA reference point ILN-16 (b) as recovered by the field team.

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

Station Name	ILN-16	
Order of Accuracy	2nd Order	
Relative Error (horizontal positioning)	1:50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	18°15'10.11635" North 120°36'24.06955" East 22.50000 meters
Grid Coordinates, Philippine Transverse Mercator Zone 3 (PTM Zone 3 PRS 92)	Easting Northing	458,407.057 meters 2,018,785.646 meters

Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	18°15'3.85580" North 120°36'28.65812" East 53.87800 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting Northing	246,937.75 meters 2,019,690.45 meters



(a) (b)

Figure 5.GPS set-up over ILN-17 located inside the park in front of Pasuquin Municipal Hall in Pasuquin Ilocos Norte (a) and NAMRIA reference point ILN-17 (b) as recovered by the field team.

Table 4.Details of the recovered NAMRIA horizontal control point ILN-17 used as base station for the LiDAR data acquisition.

Station Name	ILN-17	
Order of Accuracy	2nd Order	
Relative Error (horizontal positioning)	1:50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	18°20'6.62958" North 120°37'1.30945" East 16.73900 m
Grid Coordinates, Philippine Transverse Mercator Zone 3 (PTM Zone 3 PRS 92)	Easting Northing	459,520.118 m 2,027,898.996 m
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	18°20'0.3524" North 120°37'5.89113" East 47.87100 m

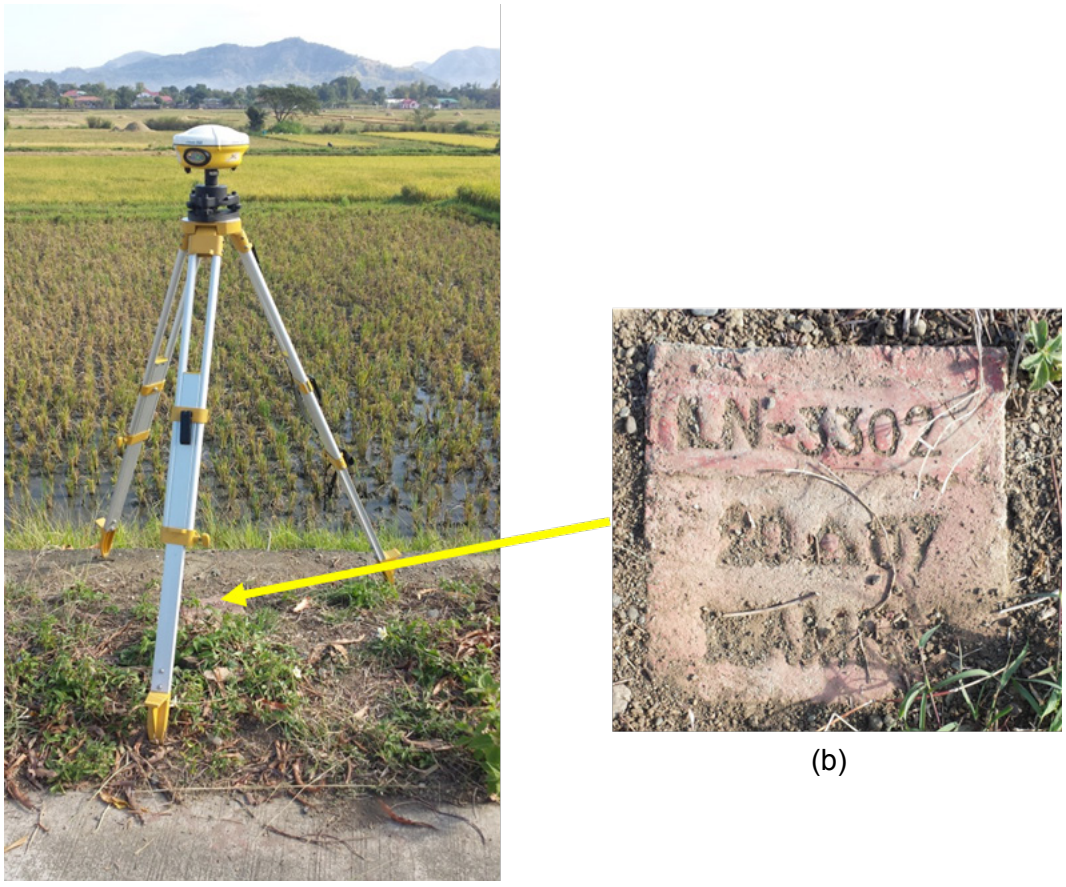
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting	248,151.17 m
	Northing	2,028,794.85 m

(a) (b)

Figure 6.GPS set-up over ILN-3234 located in front of the Administration Building of Mariano Marcos Memorial University in Batac Ilocos Norte (a) and NAMRIA reference point ILN-3234 (b) as recovered by the field team.

Table 5. Details of the recovered NAMRIA horizontal control point ILN-3234 used as base station for the LiDAR data acquisition.

Station Name	ILN-3234	
Order of Accuracy	4th Order	
Relative Error (horizontal positioning)	1:10,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude	18°3'41.82025" North
	Longitude	120°32'3.1072" East
	Ellipsoidal Height	22.632 m
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting	452,075.694 m
	Northing	1,997,640.111 m
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude	18°3'35.59528" North
	Longitude	120°32'54.91553" East
	Ellipsoidal Height	54.492 m
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting	240,373.73 m
	Northing	1,998,605.86 m



(a) (b)

Figure 7.GPS set-up over ILN-3302 located near the public market of Barangay San Nicolas in Vintar Ilocos Norte (a) and NAMRIA reference point ILN-3302 (b) as recovered by the field team.

Table 6. Details of the recovered NAMRIA horizontal control point ILN-3302 used as base station for the LiDAR data acquisition.

Station Name	ILN-3302	
Order of Accuracy	4th Order	
Relative Error (horizontal positioning)	1:10,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	18°13'22.82114" North 120°38'50.91391" East 37.535 m
Grid Coordinates, Philippine Transverse Mercator Zone 5 (PTM Zone 5 PRS 92)	Easting Northing	462,714.303 m 2,015,478.316 m
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	18°13'16.56953" North 120°38'55.50479" East 69.108 m
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N PRS 92)	Easting Northing	251, 210.34 m 2,016,334.86 m

Table 7.Ground Control Points used during LiDAR data acquisition.

Date Surveyed	Flight Number	Mission Name	Ground Control Points
21-Feb-14	7085G	2BLK05G052A	ILN-11, ILN-3234
22-Feb-14	7086G	2BLK05H053A	ILN-11, ILN-3234
22-Feb-14	7087G	2BLK05GS053B & 2BLK05F053B	ILN-11, ILN-3234
23-Feb-14	7088G	2BLKFS054A & 2BLKE054A	ILN-11, ILN-3234
23-Feb-14	7089G	2BLK05I054B	ILN-11, ILN-3234
24-Feb-14	7090G	2BLK05L055A	ILN-11, ILN-3234
24-Feb-14	7091G	2BLK05ES055B & 2BLK05D055B	ILN-11, ILN-16
25-Feb-14	7092G	2BLK05DS056A & 2BLK05K056A	ILN-11, ILN-16
25-Feb-14	7093G	2BLK05C&A056B	ILN-11, ILN-16
26-Feb-14	7094G	2BLK05B057A & 2BLK05AS05B & 2BLK04F057A	ILN-16, ILN-3302
27-Feb-14	7096G	2BLK05J058A	ILN-16, ILN-17, ILN-3302
2-Mar-14	7103GC	2CASITEST061B	ILN-3234

2.3Flight Missions

Twelve (12) missions were conducted to complete LiDAR data acquisition in Laoag Floodplain, for a total of forty-one hours and forty-eight minutes (41+48) of flying time for RP-C9322. All missions were acquired using the Gemini LiDAR systems. Table 8 shows the total area of actual coverage and the corresponding flying hours per mission, while Table 9 presents the actual parameters used during the LiDAR data acquisition.

Table 8.Flight Missions for LiDAR Data Acquisition in Laoag 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
21-Feb-14	7085G	147	129.54	73.57	55.97	NA	2	59
22-Feb-14	7086G	124	176.08	36.44	139.64	NA	3	53

22-Feb-14	7087G	269	253.85	154.01	99.84	NA	4	17
23-Feb-14	7088G	330	170.84	123.42	47.42	NA	3	41
23-Feb-14	7089G	117	142.39	0.22	142.17	NA	3	29
24-Feb-14	7090G	190	133	41.89	611.78	NA	2	53
24-Feb-14	7091G	159	163.16	97.64	556.03	NA	3	47
25-Feb-14	7092G	255.76	209.11	143.82	65.29	NA	3	41
25-Feb-14	7093G	193.58	201.70	90.53	111.17	NA	3	23
26-Feb-14	7094G	208.74	163.09	16.92	146.17	NA	3	59
27-Feb-14	7096G	124.22	134.67	115.62	19.05	NA	3	17
2-Mar-14	7103GC	61.05	73	39.14	33.86	NA	2	29
TOTAL		2179.35	1950.43	933.22	2028.39	NA	41	48

Table 9.Actual Parameters used during LiDAR Data Acquisiton

Flight Number	Flying Height (m AGL)	Overlap (%)	FOV (θ)	PRF (khz)	Scan Frequency (Hz)	Average Speed (kts)	Average Turn Time (Minutes)
7085G	1000	25	40	100	40	120	5
7086G	1000	45	40	100	50	120	5
7087G	1000	30	40	100	50	120	5
7088G	1000	25	40	100	50	120	5
7089G	1000	45	40	100	50	120	5
7090G	1350	30	40	100	50	120	5
7091G	1000, 1400	25, 30	40	100	50	120	5
7092G	1300,1400,1500	30	40	100	50	120	5
7093G	1200,1400	25,30	40	100	50	120	5
7094G	1100,1200,1500	25,30	30,40	100	50	120	5
7096G	1500	30	40	100	50	120	5
7103GC	1000	30	40	100	50	120	5

2.4Survey Coverage

Laoag floodplain is located in the province of Ilocos Norte. Municipalities of Bacarra, Laoag, Marcos, Paoay, San Nicolas, Sarrat, Dingras, Batac and Banna were completely covered by the survey. The list of municipalities and cities surveyed, with at least one (1) square kilometer coverage, is shown in Table 10. The actual coverage of the LiDAR acquisition for Laoag Floodplain is presented in Figure 8.

Table 10.List of municipalities and cities surveyed during Laoag floodplain LiDAR survey.

Province	Municipality/ City	Area of Municipality/City (km^2)	Total Area Surveyed (km^2)	Percentage of Area Surveyed
Ilocos Norte	Bacarra	47.1	47.1	100%
	Laoag	114.36	114.36	100%
	Marcos	73.57	73.57	100%
	Paoay	71.62	71.62	100%
	San Nicolas	40.23	40.23	100%
	Sarrat	92.25	92.25	100%
	Dingras	90.65	90.64	100%
	Batac	134.62	134.6	100%
	Banna	89.62	89.57	100%
	Currimao	32.97	31.04	94%
	Pinili	63.18	56.8	90%
	Piddig	128.57	99.68	78%
	Pasuquin	154.16	92.03	60%
	Solsona	153.14	82.15	54%
	Badoc	77.07	30.08	39%
	Vintar	497.39	161.09	32%
	Nueva Era	619	61.45	10%
	Carasi	190.24	6.99	4%
Ilocos Sur	Sinait	73.77	4.03	5%
	Total	**2,743.51**	**1,379.28**	**50.27%**

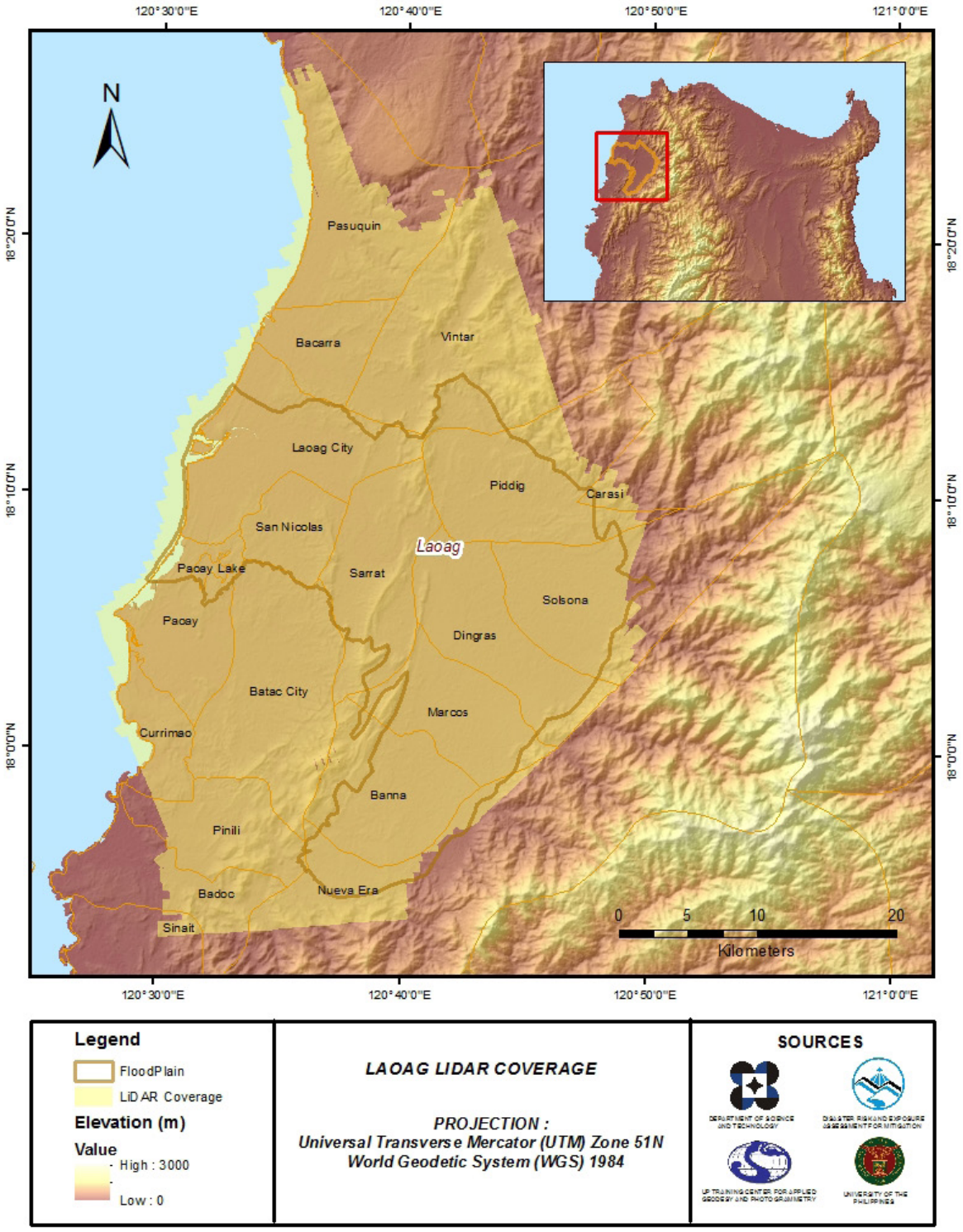


Figure 8.Actual LiDAR survey coverage for Laoag floodplain.

CHAPTER 3. LIDAR DATA PROCESSING OF THE LAOAG FLOODPLAIN

Engr. Ma. Rosario Concepcion O. Ang, Engr. John Louie D. Fabila, Engr. Sarah Jane D. Samalburo , Engr. Harmond F. Santos , Jovy Anne S. Narisma , Engr. Ma. Ailyn L. Olanda, Engr. Velina Angela S. Bemida, Engr. Kenneth A. Solidum , Engr. Jommer M. Medina, Carl Joshua S. Lacsina

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

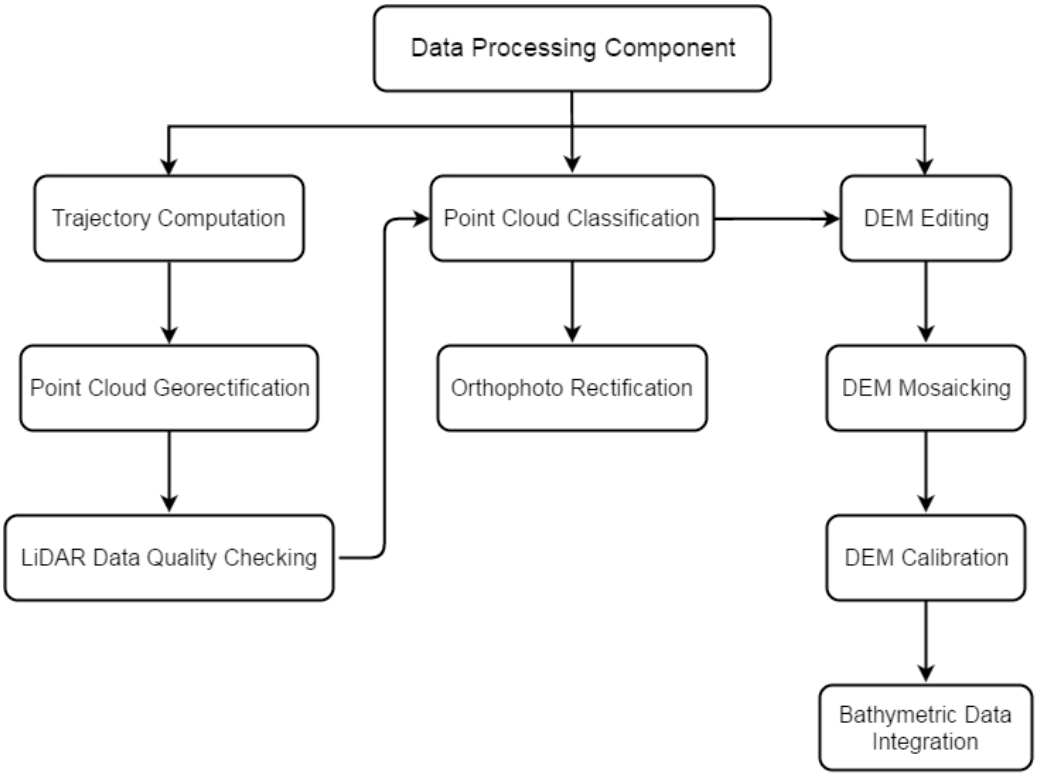


Figure 9. Schematic Diagram for Data Pre-Processing Component

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

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

These processes are summarized in the flowchart shown in Figure 9.

3.2 Transmittal of Acquired LiDAR Data

Data transfer sheets for all the LiDAR missions for Laoag floodplain can be found in Annex 5. Missions flown during the first survey conducted on February 2014 used the Airborne LiDAR Terrain Mapper (ALTM™ Optech Inc.) Gemini system over the municipalities of Banna, Marcos, Dingras, Piddig, San Nicolas, Sarrat, and Solsana, and Laoag City, Ilocos Norte. The Data Acquisition Component (DAC) transferred a total of 185.77 Gigabytes of Range data, 1.992 Gigabytes of POS data, 110.592 Megabytes of GPS base station data, and 28.5 Gigabytes of raw image data to the data server on July 28, 2015. The Data Pre-processing Component (DPPC) verified the completeness of the transferred data. The whole dataset for Laoag was fully transferred on July 28, 2015, as indicated on the Data Transfer Sheets for Laoag floodplain.

3.3 Trajectory Computation

The *Smoothed Performance Metric*parameters of the computed trajectory for flight 7096G, one of the Laoagflights, which is the North, East, and Down position RMSE values are shown in Figure B-2. The x-axis corresponds to the time of flight, which is measured by the number of seconds from the midnight of the start of the GPS week, which on that week fell onFebruary 27, 2014 00:00AM. The y-axis is the RMSE value for that particular position.

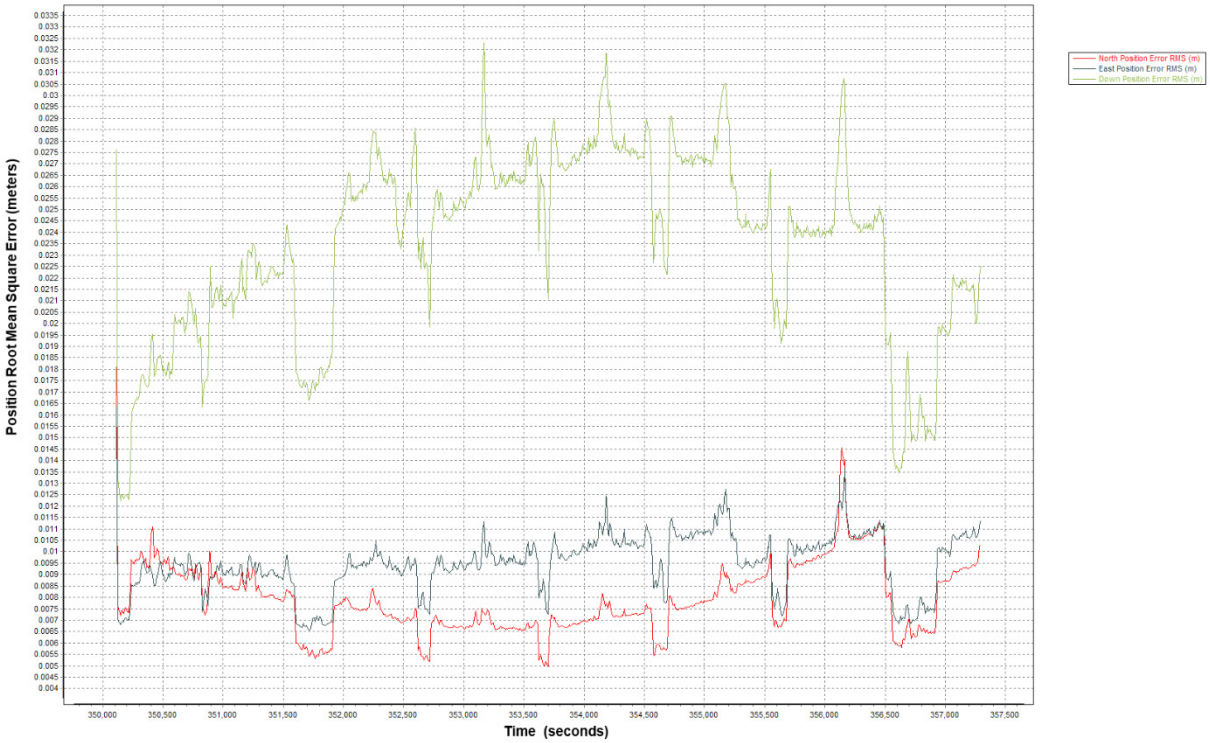


Figure 10. Smoothed Performance Metric Parameters of a Laoag Flight 7096G.

The time of flight was from 350000 seconds to 357500 seconds, which corresponds to morning of February 27, 2014. The initial spike that is seen on the data corresponds to the time that the aircraft was getting into position to start the acquisition, and the POS system starts computing for the position and orientation of the aircraft. Redundant measurements from the POS system quickly minimized the RMSE value of the positions. The periodic increase in RMSE values from an otherwise smoothly curving RMSE values

correspond to the turn-around period of the aircraft, when the aircraft makes a turn to start a new flight line. Figure 10 shows that the North position RMSE peaks at 1.45 centimeters, the East position RMSE peaks at 1.37 centimeters, and the Down position RMSE peaks at 3.23 centimeters, which are within the prescribed accuracies described in the methodology.

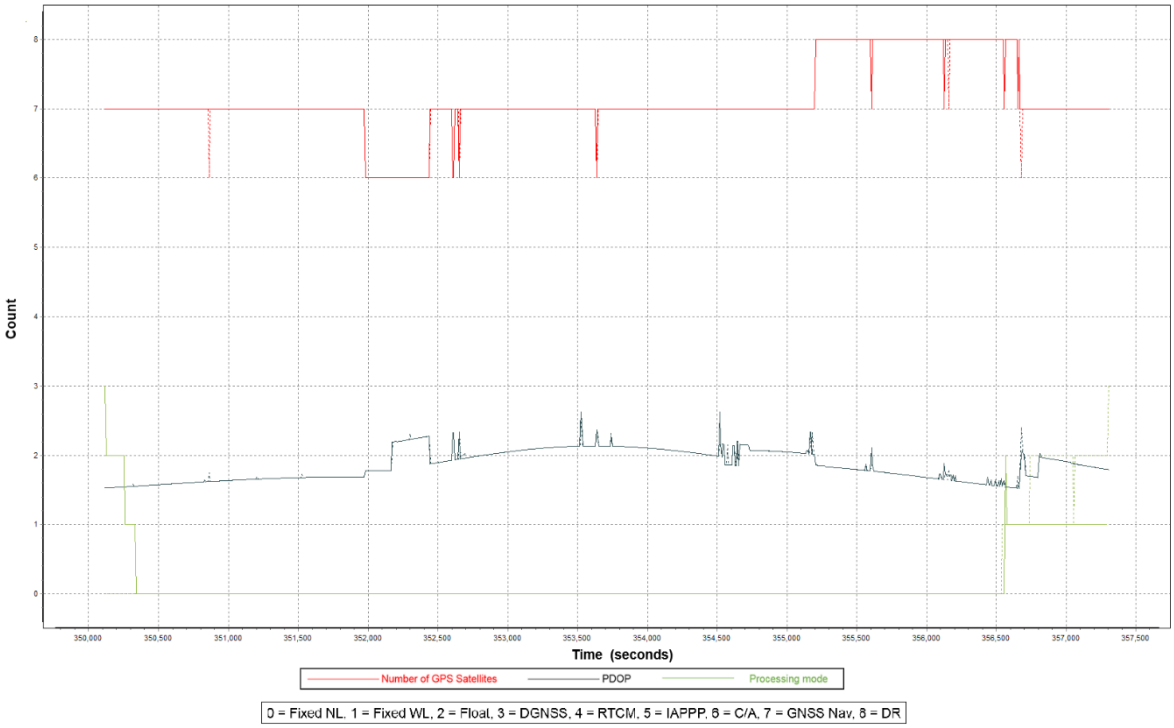


Figure 11. Solution Status Parameters of Laoag Flight 7096G.

The S*olution Status*parameters of flight 7096G, one of the Laoagflights, which are the number of GPS satellites, Positional Dilution of Precision (PDOP), and the GPS processing mode used, are shown in Figure B-3. The graphs indicate that the number of satellites during the acquisition did not go down to 6. Majority of the time, the number of satellites tracked was between 6 and 8. The PDOP value also did not go above the value of 3, which indicates optimal GPS geometry. The processing mode stayed at the value of 0 for majority of the survey. The value of 0 corresponds to a Fixed, Narrow-Lane mode, which is the optimum carrier-cycle integer ambiguity resolution technique available for POSPAC MMS. All of the parameters adhered to the accuracy requirements for optimal trajectory solutions, as indicated in the methodology. The computed best estimated trajectory for all Laoag flights is shown in Figure 12.

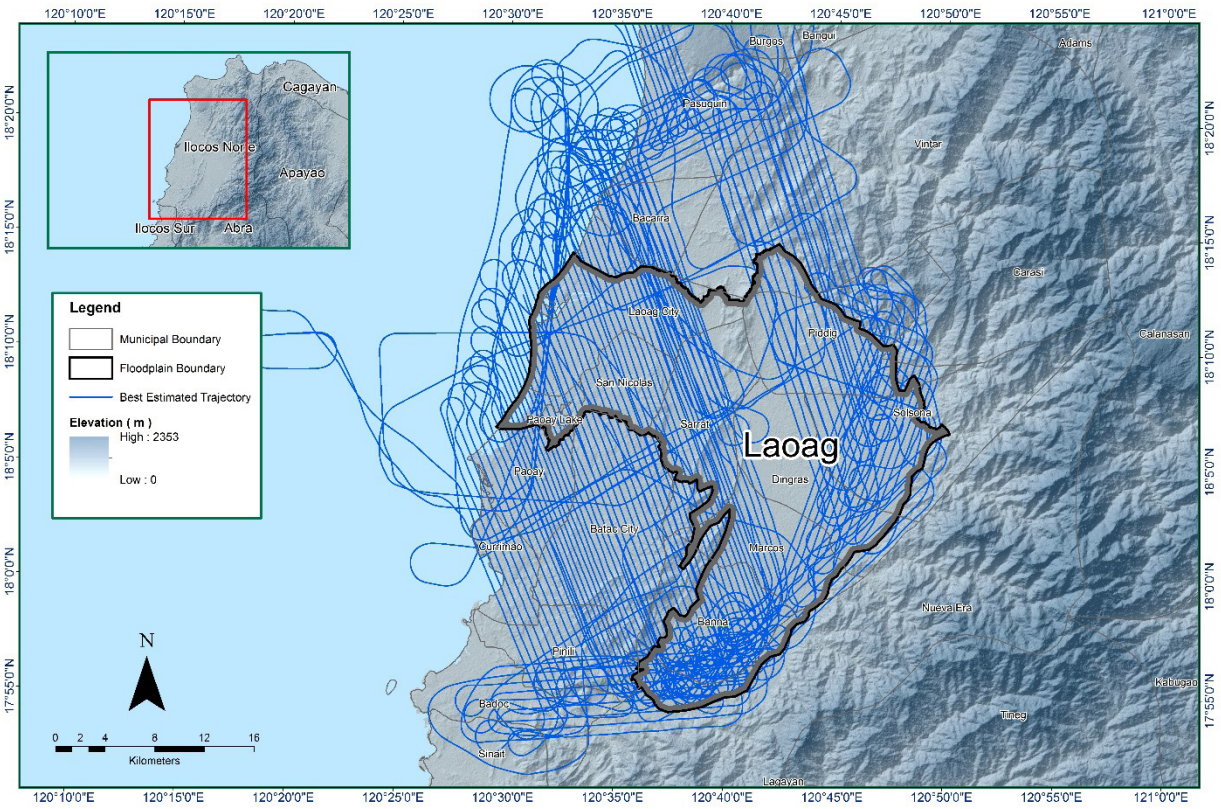


Figure 12. The best estimated trajectory of the LiDar missions conducted over the Laoag floodplain.

3.4 LiDAR Point Cloud Computation

The produced LAS data contains 154flight lines, with each flight line containing one channel, since the Gemini system contains one channel only. The summary of the self-calibration results obtained from LiDAR processing in LiDAR Mapping Suite (LMS) software for all flights over Laoag floodplain are given in Table 11.

Table 11.Self-Calibration Results values for Laoag flights.

Parameter	Absolute Value	Computed Value
Boresight Correction stdev	(<0.001degrees)	0.000199
IMU Attitude Correction Roll and Pitch Corrections stdev	(<0.001degrees)	0.000345
GPS Position Z-correction stdev	(<0.01meters)	0.0079

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

3.5 LiDAR Data Quality Checking

The boundary of the processed LiDAR data on top of a SAR Elevation Data over Laoag Floodplain is shown in Figure 13. The map shows gaps in the LiDAR coverage that are attributed to cloud coverage.

Parameter	Absolute Value	Computed Value
Boresight Correction stdev	(<0.001degrees)	0.000199
IMU Attitude Correction Roll and Pitch Corrections stdev	(<0.001degrees)	0.000345
GPS Position Z-correction stdev	(<0.01meters)	0.0079

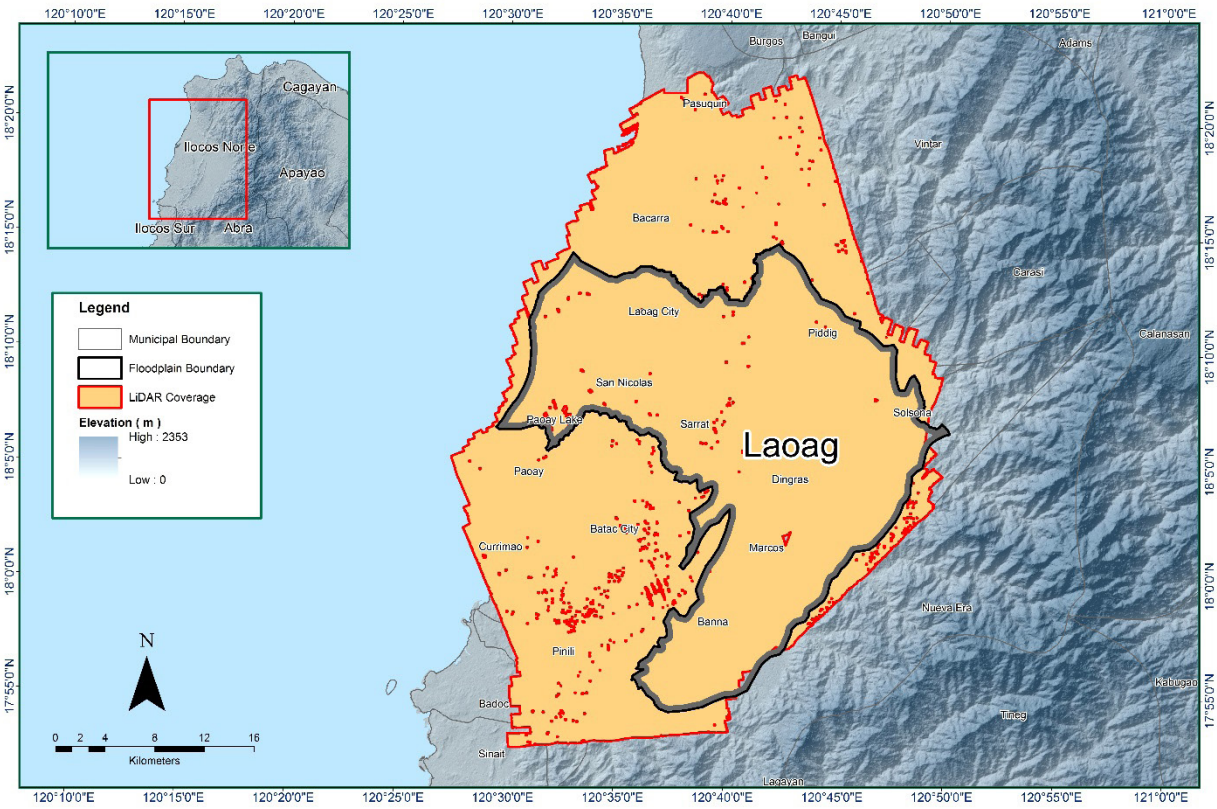


Figure 13.Boundary of the processed LiDAR data over Laoag Floodplain

The total area covered by the Laoag missions is 1950.21 sq.km that is comprised of twelve (12) flight acquisitions grouped and merged into fifteen (15) blocks as shown in Table 12.

Table 12.List of LiDAR blocks for Laoag floodplain.

LiDAR Blocks	Flight Numbers	Area (sq. km)
Ilocos_Blk05A	7093G 7094G	174.75
Ilocos_Blk05B	7094G	112.07
Ilocos_Blk05C	7093G	155.84
Ilocos_Blk05D	7092G	91.81
Ilocos_Blk05D_supplement_E_supplement	7091G	146.47
Ilocos_Blk05E_supplement	7103GC	71.30
Ilocos_Blk05EF	7088G	163.33
Ilocos_Blk05EF_additional	7087G	71.30
Ilocos_Blk05FG_additional	7087G	78.48
Ilocos_Blk05G	7085G	120.95
Ilocos_Blk05H	7086G	167.44
Ilocos_Blk05I	7089G	132.33
Ilocos_Blk05J	7096G	131.03
Ilocos_Blk05K	7092G	109.13
Ilocos_Blk05L	7090G	131.13
	TOTAL	**1950.21 sq.km**

The overlap data for the merged LiDAR blocks, showing the number of channels that pass through a particular location is shown in Figure 14. Since the Gemini system employs one channel, we would expect

an average value of 1 (blue) for areas where there is limited overlap, and a value of 2 (yellow) or more (red) for areas with three or more overlapping flight lines.

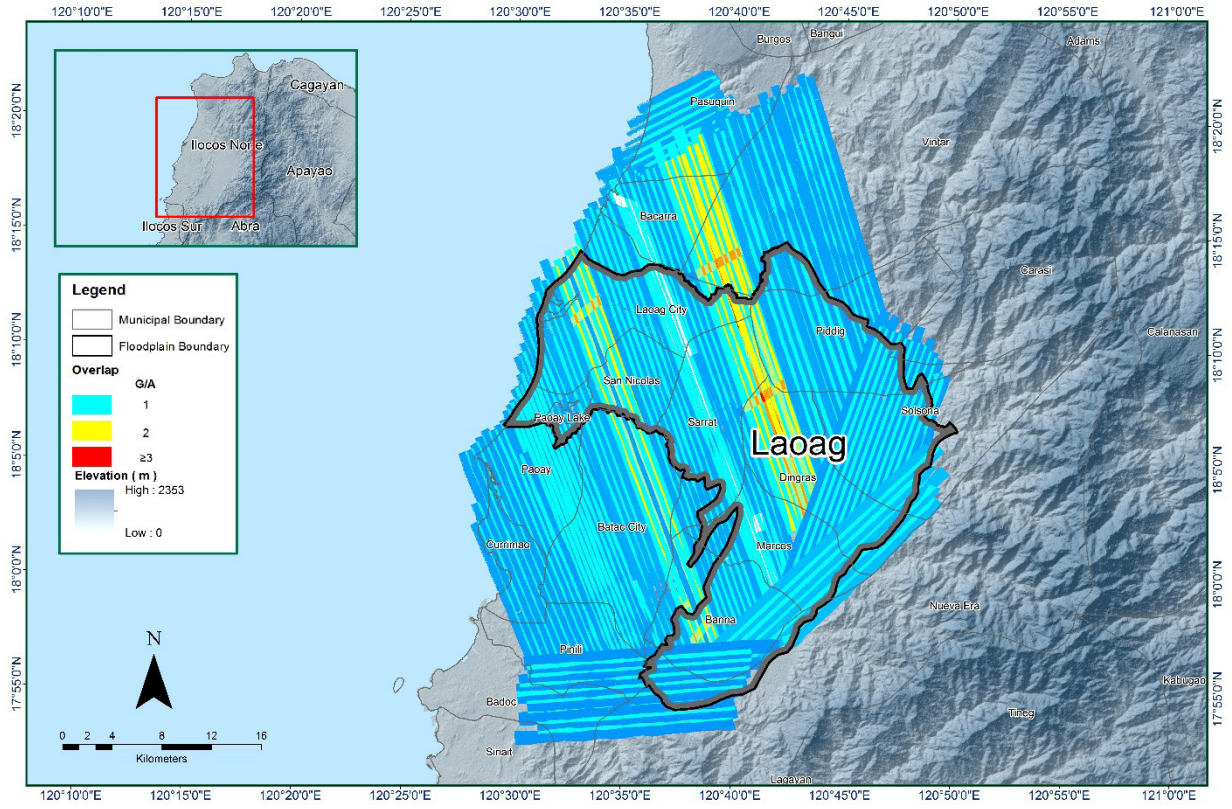


Figure 14.Image of data overlap for Laoag floodplain.

The overlap statistics per block for the Laoag floodplain can be found in Annex B-1. One pixel corresponds to 25.0 square meters on the ground. For this area, the minimum and maximum percent overlaps are 25.13% and 98.51% respectively, which passed the 25.13% requirement.

The density map for the merged LiDAR data, with the red parts showing the portions of the data that satisfy the 2 points per square meter criterion is shown in Figure 15. It was determined that all LiDAR data for Laoag floodplain satisfy the point density requirement, and the average density for the entire survey area is 2.82 points per square meter.

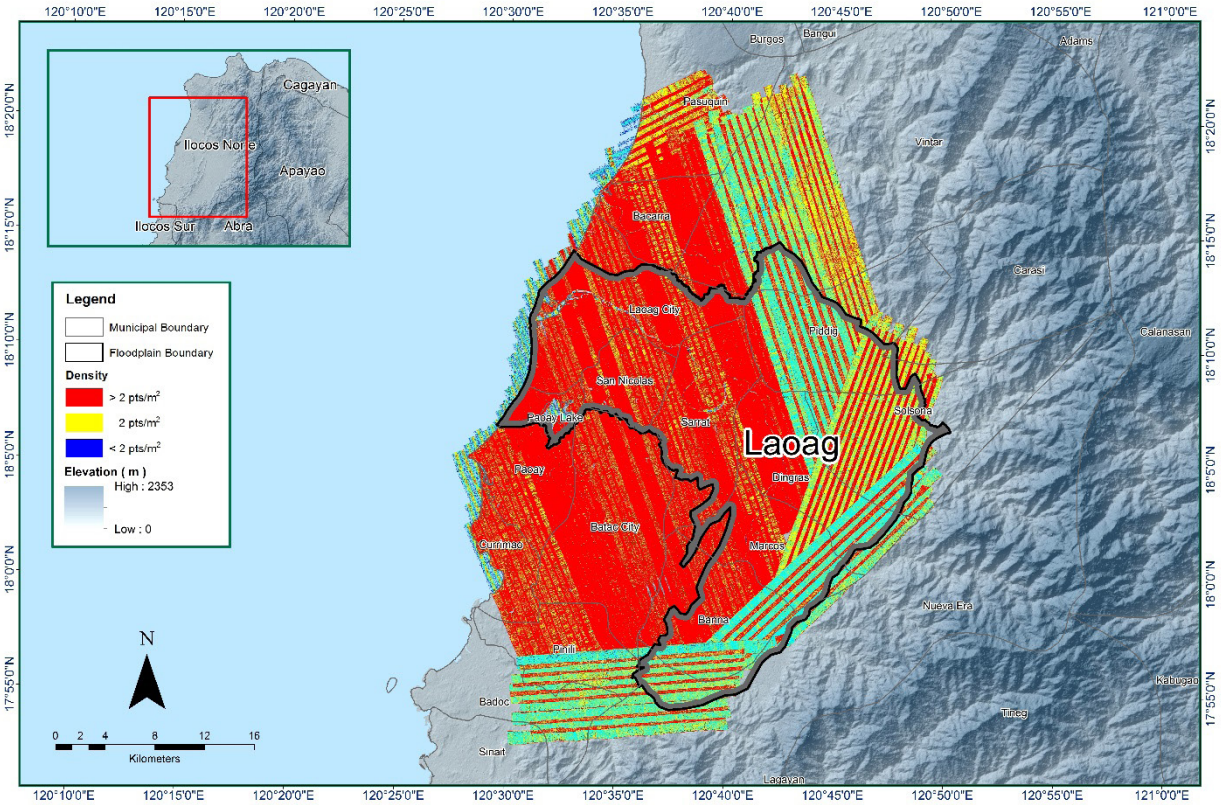


Figure 15. Density map of merged LiDAR data for Laoag floodplain.

The elevation difference between overlaps of adjacent flight lines is shown in Figure B-8. The default color range is from blue to red, where bright blue areas correspond to portions where elevations of a previous flight line, identified by its acquisition time, are higher by more than 0.20m relative to elevations of its adjacent flight line. Bright red areas indicate portions where elevations of a previous flight line are lower by more than 0.20m relative to elevations of its adjacent flight line. Areas with bright red or bright blue need to be investigated further using Quick Terrain Modeler software.

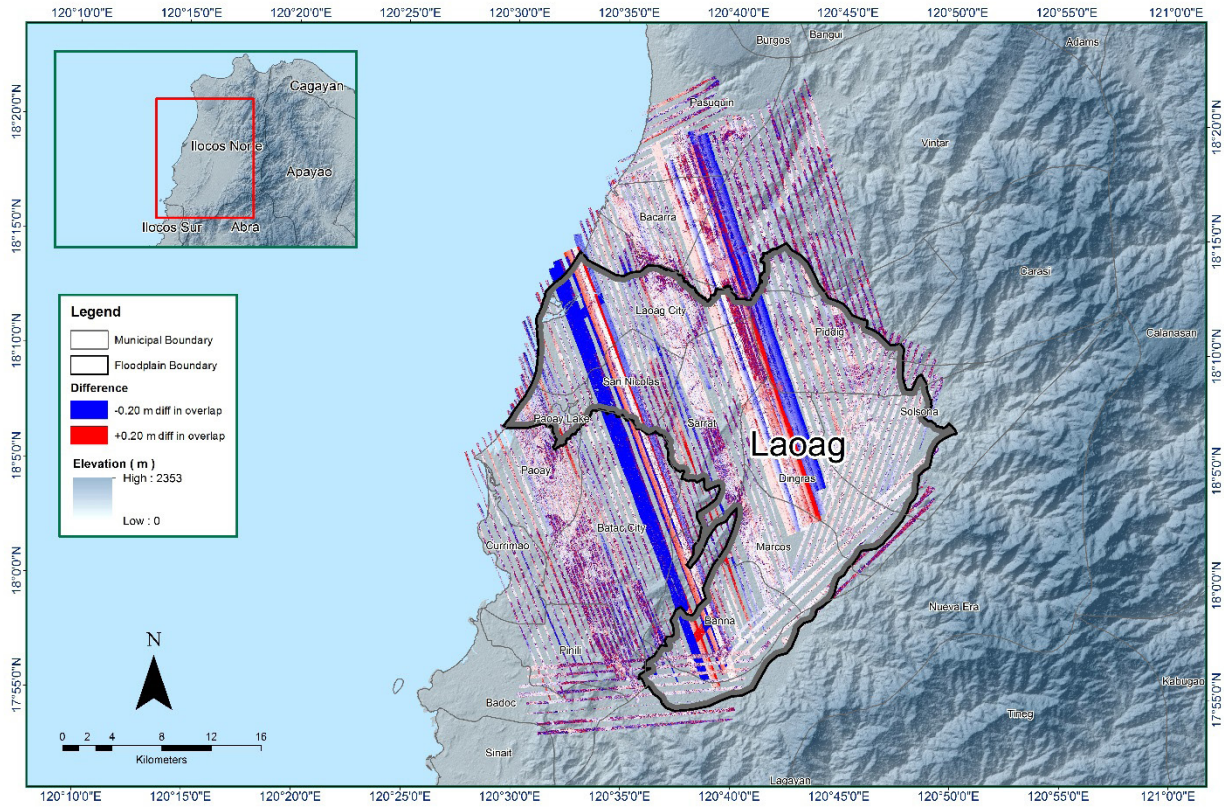


Figure 16. Elevation difference map between flight lines for Laoag floodplain.

A screen capture of the processed LAS data from a Laoag flight 7096G loaded in QT Modeler is shown in Figure 17. The upper left image shows the elevations of the points from two overlapping flight strips traversed by the profile, illustrated by a dashed red line. The x-axis corresponds to the length of the profile. It is evident that there are differences in elevation, but the differences do not exceed the 20-centimeter mark. This profiling was repeated until the quality of the LiDAR data becomes satisfactory. No reprocessing was done for this LiDAR dataset.

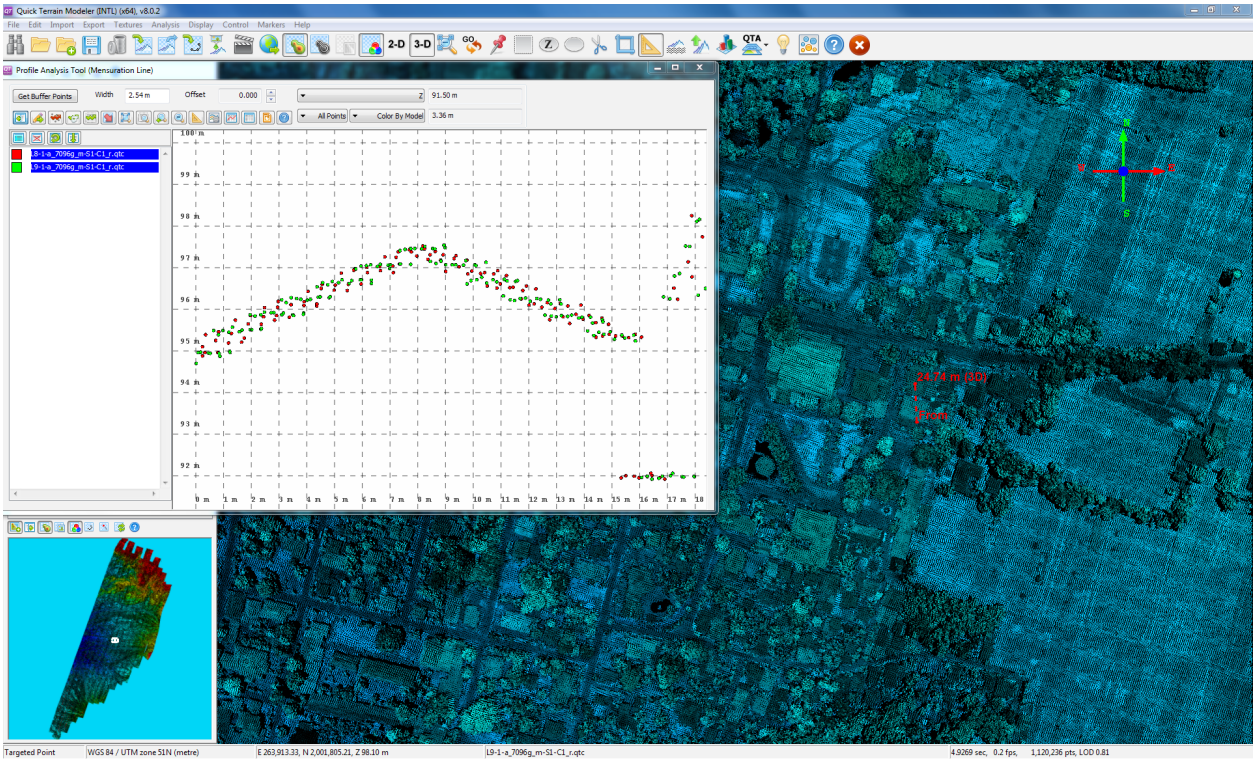


Figure 17. Quality checking for a Laoag flight 7096G using the Profile Tool of QT Modeler.

3.6 LiDAR Point Cloud Classification and Rasterization

Table 13. Laoag classification results in TerraScan.

Pertinent Class	Total Number of Points
Ground	918,349,794
Low Vegetation	1,129,890,442
Medium Vegetation	1,345,408,091
High Vegetation	1,720,636,203
Building	69,105,667

The tile system that TerraScan employed for the LiDAR data and the final classification image for a block in Laoag floodplain is shown in Figure 18. A total of 2,685 1km by 1km tiles were produced. The number of points classified to the pertinent categories is illustrated in Table 13. The point cloud has a maximum and minimum height of 589.13 meters and 38.82 meters respectively.

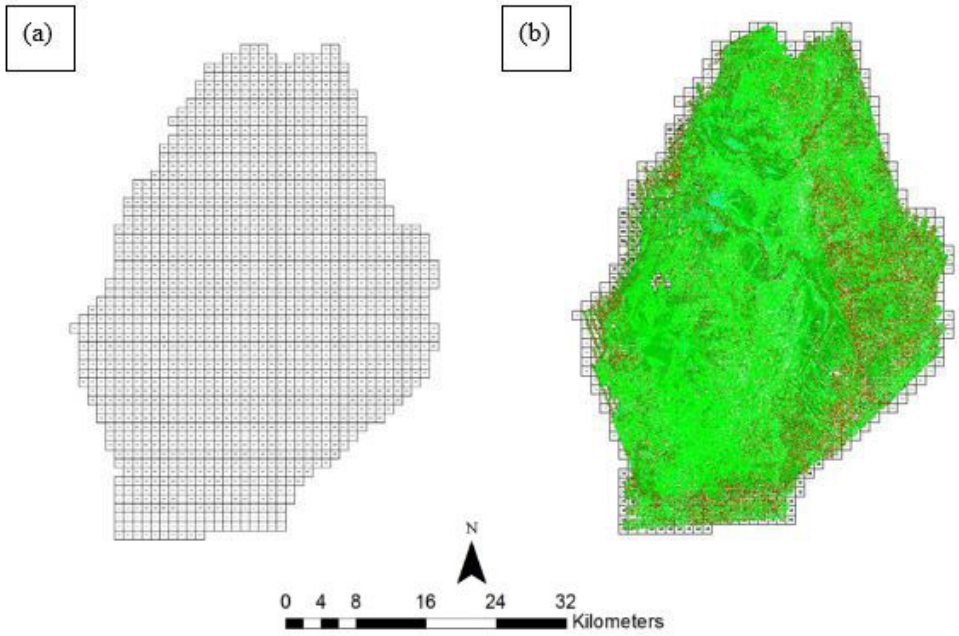


Figure 18. Tiles for Laoag floodplain (a) and classification results (b) in TerraScan.

An isometric view of an area before and after running the classification routines is shown in Figure 19. The ground points are in orange, the vegetation is in different shades of green, and the buildings are in cyan. It can be seen that residential structures adjacent or even below canopy are classified correctly, due to the density of the LiDAR data.

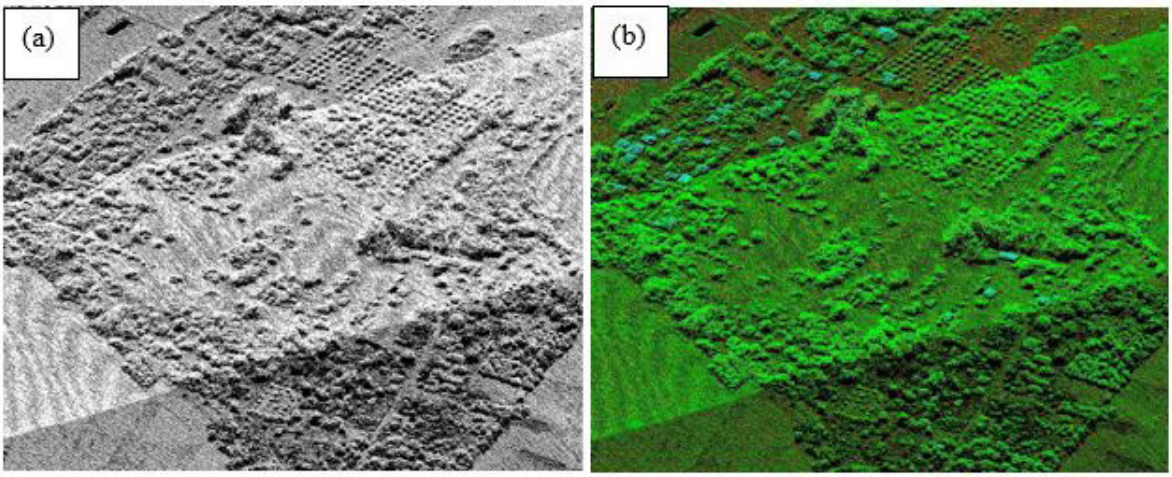


Figure 19. Point cloud before (a) and after (b) classification.

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

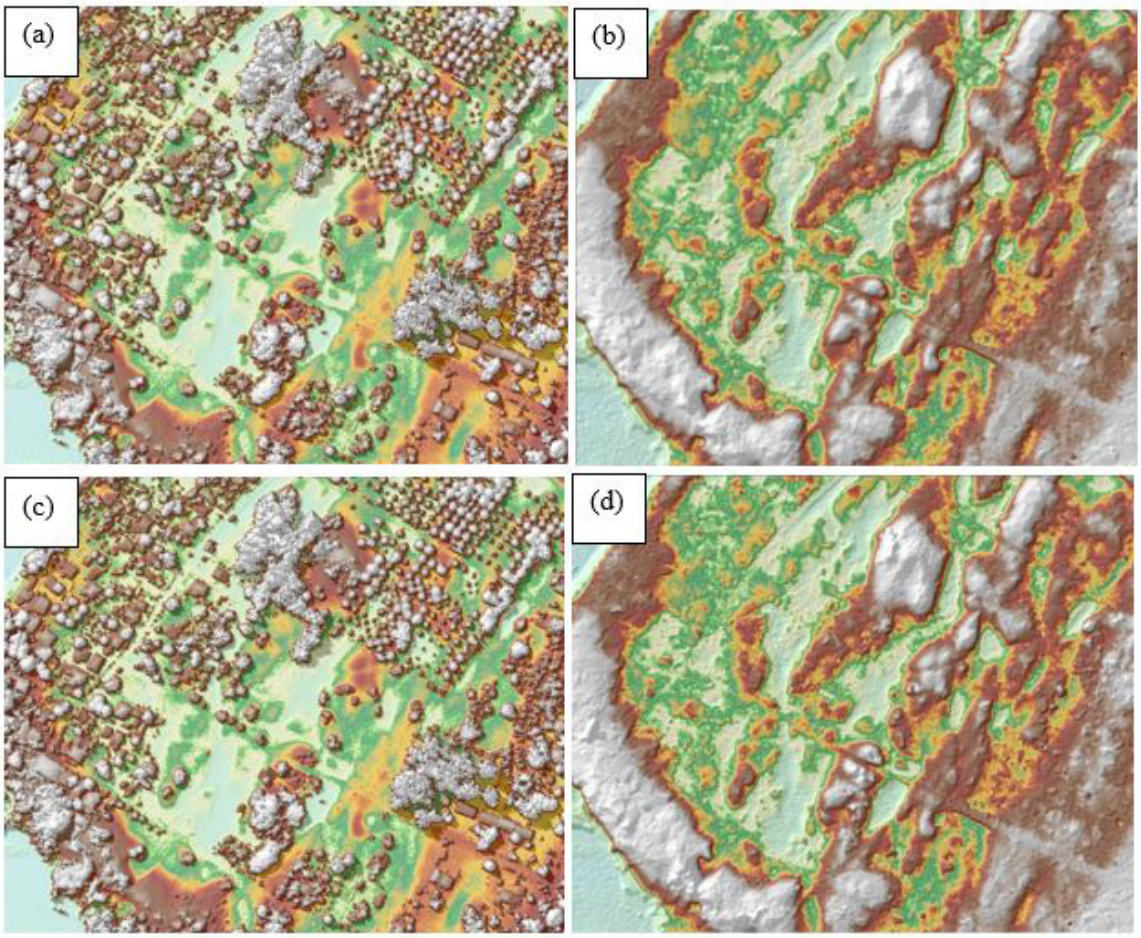


Figure 20. The production of last return DSM (a) and DTM (b), first return DSM (c) and secondary DTM (d) in some portion of Laoag floodplain.

3.7 LiDAR Image Processing and Orthophotograph Rectification

There are no available orthophotographs for Laoag floodplain.

3.8 DEM Editing and Hydro-Correction

Fifteen (15) mission blocks were processed for Laoag flood plain. These blocks are composed of Ilocos and Leyte blocks with a total area of 1,950.21 square kilometers. Table 14 shows the name and corresponding area of each block in square kilometers.

Table 14.LiDAR blocks with its corresponding area.

LiDAR Blocks	Area (sq.km)
Ilocos_Blk05A	174.75
Ilocos_Blk05B	112.07
Ilocos_Blk05C	155.84
Ilocos_Blk05D	91.81
Ilocos_Blk05D_supplement_E_supplement	146.47
Ilocos_Blk05EF	164.15
Ilocos_Blk05EF_additional	163.33
Ilocos_Blk05E_supplement	71.30
Ilocos_Blk05FG_addional	78.48
Ilocos_Blk05G_new	120.95
Ilocos_Blk05H	167.44
Ilocos_Blk05I	132.33
Ilocos_Blk05J	131.03
Ilocos_Blk05K	109.13
Ilocos_Blk05L	131.13
TOTAL	**1950.21 sq.km**

Portions of DTM before and after manual editing are shown in Figure 21. The bridge (Figure 21a) is also considered to be an impedance to the flow of water along the river and has to be removed (Figure 21b) in order to hydrologically correct the river. The paddy field (Figure 21c) has been misclassified and removed during classification process and has to be retrieved to complete the surface (Figure 21d) to allow the correct flow of water. Another example is a building that is still present in the DTM after classification (Figure 21e) and has to be removed through manual editing (Figure 21f).

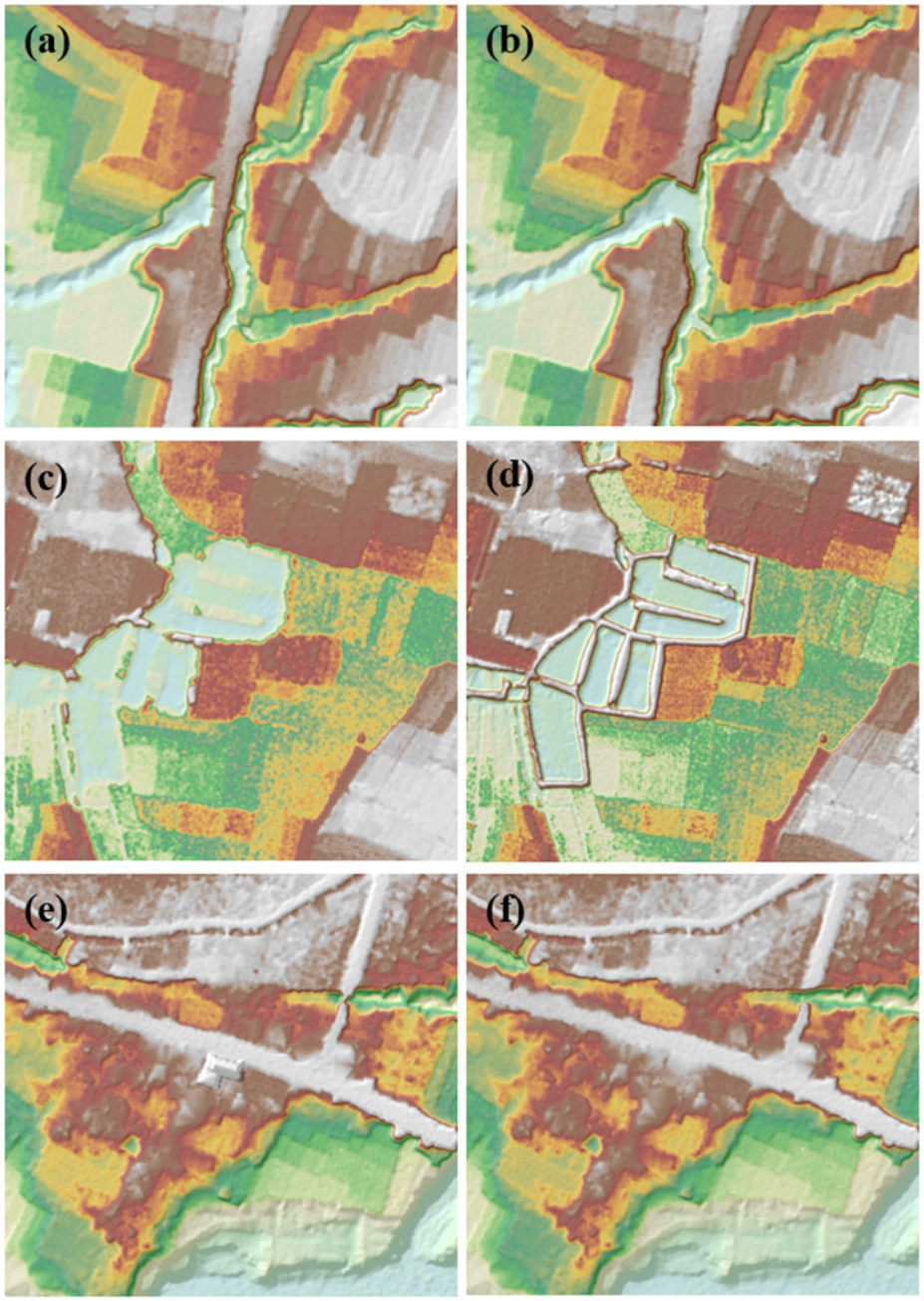


Figure 21.Portions in the DTM of Laoag floodplain – a bridge before (a) and after (b) manual editing; a paddy field before (c) and after (d) data retrieval; and a building before (e) and after (f) manual editing.

3.9 Mosaicking of Blocks

Ilocos_Blk5A was used as the reference block at the start of mosaicking because it was referred to a base station with an acceptable order of accuracy.

Mosaicked LiDAR DTM for Laoag floodplain is shown in Figure 22. It can be seen that the entire Laoag floodplain is 99.25% covered by LiDAR data.

Table 15.Shift Values of each LiDAR Block of Laoag floodplain.

Mission Blocks	Shift Values (meters)		
	x	y	z
Ilocos_Blk05A	0.00	0.00	0.00
Ilocos_Blk05B	0.00	0.00	-0.18
Ilocos_Blk05C	0.00	0.00	-0.07
Ilocos_Blk05D	0.00	0.00	-0.14
Ilocos_Blk05D_supplement_E_supplement	0.00	0.00	0.36
Ilocos_Blk05E_supplement	0.00	0.00	0.00
Ilocos_Blk05EF	0.00	0.00	0.17
Ilocos_Blk05EF_additional	-1.20	1.40	-0.30
Ilocos_Blk05FG_addional	0.30	-4.75	-0.62
Ilocos_Blk05G_new	-1.00	1.50	-0.25
Ilocos_Blk05H	1.10	-4.90	0.00
Ilocos_Blk05I	0.11	-3.90	0.00
Ilocos_Blk05J	0.00	0.00	0.00
Ilocos_Blk05K	0.00	0.00	-0.15
Ilocos_Blk05L	0.00	0.00	-0.36

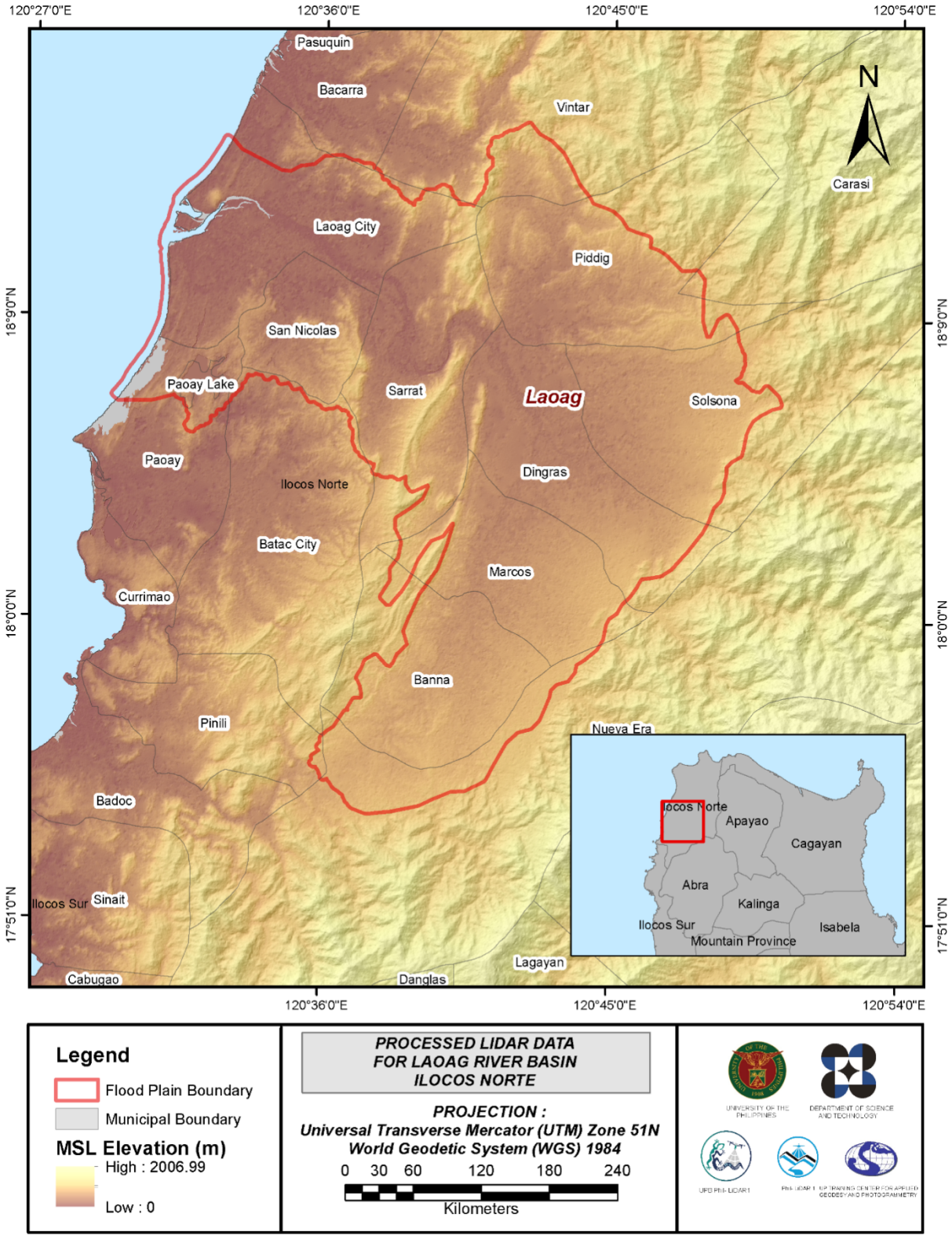


Figure 22.Map of Processed LiDAR Data for Laoag Flood Plain.

3.10 Calibration and Validation of Mosaicked LiDAR Digital Elevation Model

The extent of the validation survey done by the Data Validation and Bathymetry Component (DVBC) in Laoag to collect points with which the LiDAR dataset is validated is shown in Figure 23. A total of 2,276 survey points were used for calibration and validation of Laoag LiDAR data. Random selection of 80% of the survey points, resulting to 1,821 points, were used for calibration. A good correlation between the uncalibrated mosaicked LiDAR elevation values and the ground survey elevation values is shown in Figure 24. Statistical values were computed from extracted LiDAR values using the selected points to assess the quality of data and obtain the value for vertical adjustment. The computed height difference between the LiDAR DTM and calibration elevation values is 4.90 meters with a standard deviation of 0.18 meters. Calibration of Laoag LiDAR data was done by subtracting the height difference value, 4.90 meters, to Laoag mosaicked LiDAR data. Table 16 shows the statistical values of the compared elevation values between LiDAR data and calibration data.

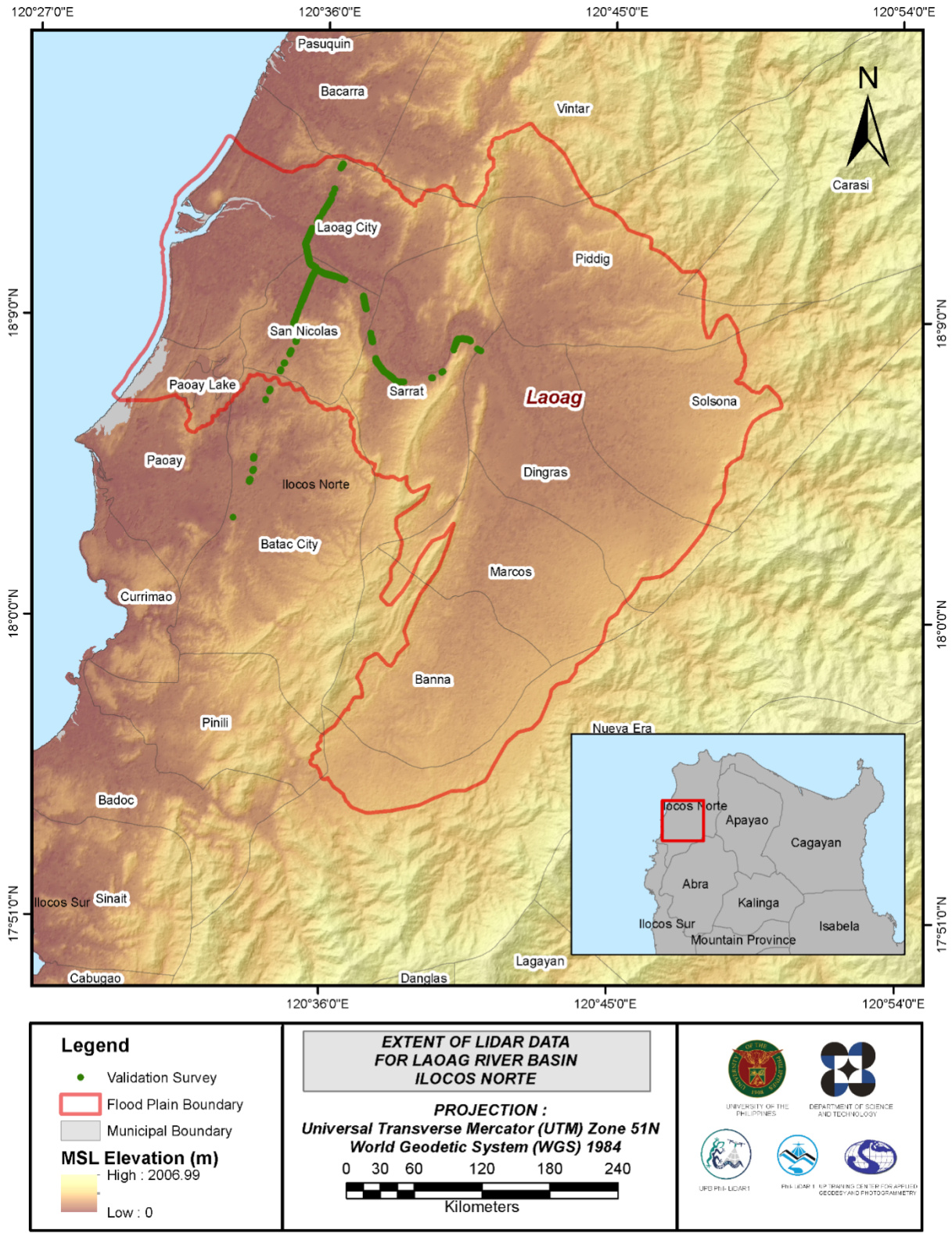


Figure 23.. Map of Laoag Flood Plain with validation survey points in green.

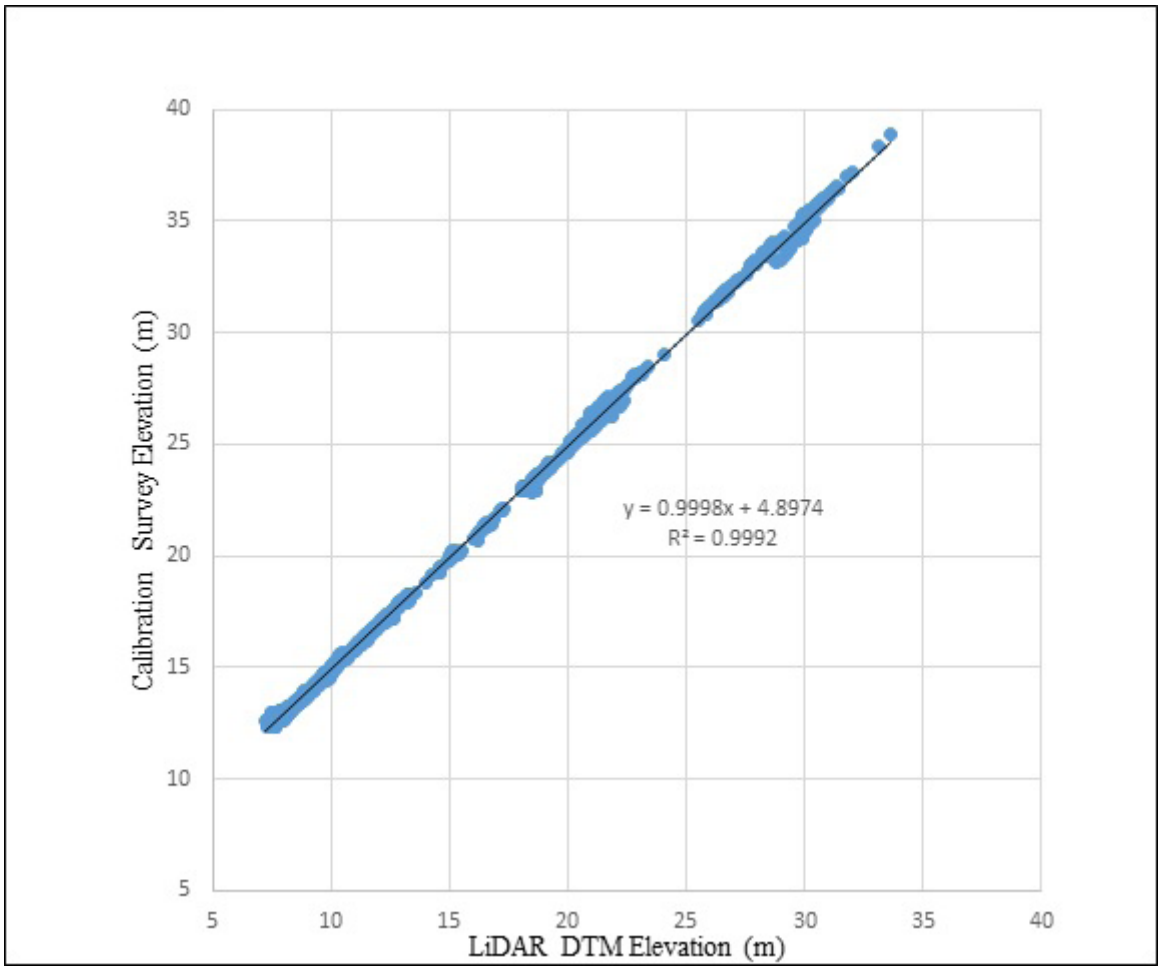


Figure 24.. Correlation plot between calibration survey points and LiDAR data.

Table 16.Calibration Statistical Measures.

Calibration Statistical Measures	Value (meters)
Height Difference	4.90
Standard Deviation	0.18
Average	-4.89
Minimum	-5.26
Maximum	-4.53

The remaining 20% of the total survey points, resulting to 241 points, were used for the validation of calibrated Laoag DTM. A good correlation between the calibrated mosaicked LiDAR elevation values and the ground survey elevation, which reflects the quality of the LiDAR DTM is shown in Figure 25. The computed RMSE between the calibrated LiDAR DTM and validation elevation values is 0.08meters with a standard deviation of 0.03meters, as shown in Table 17.

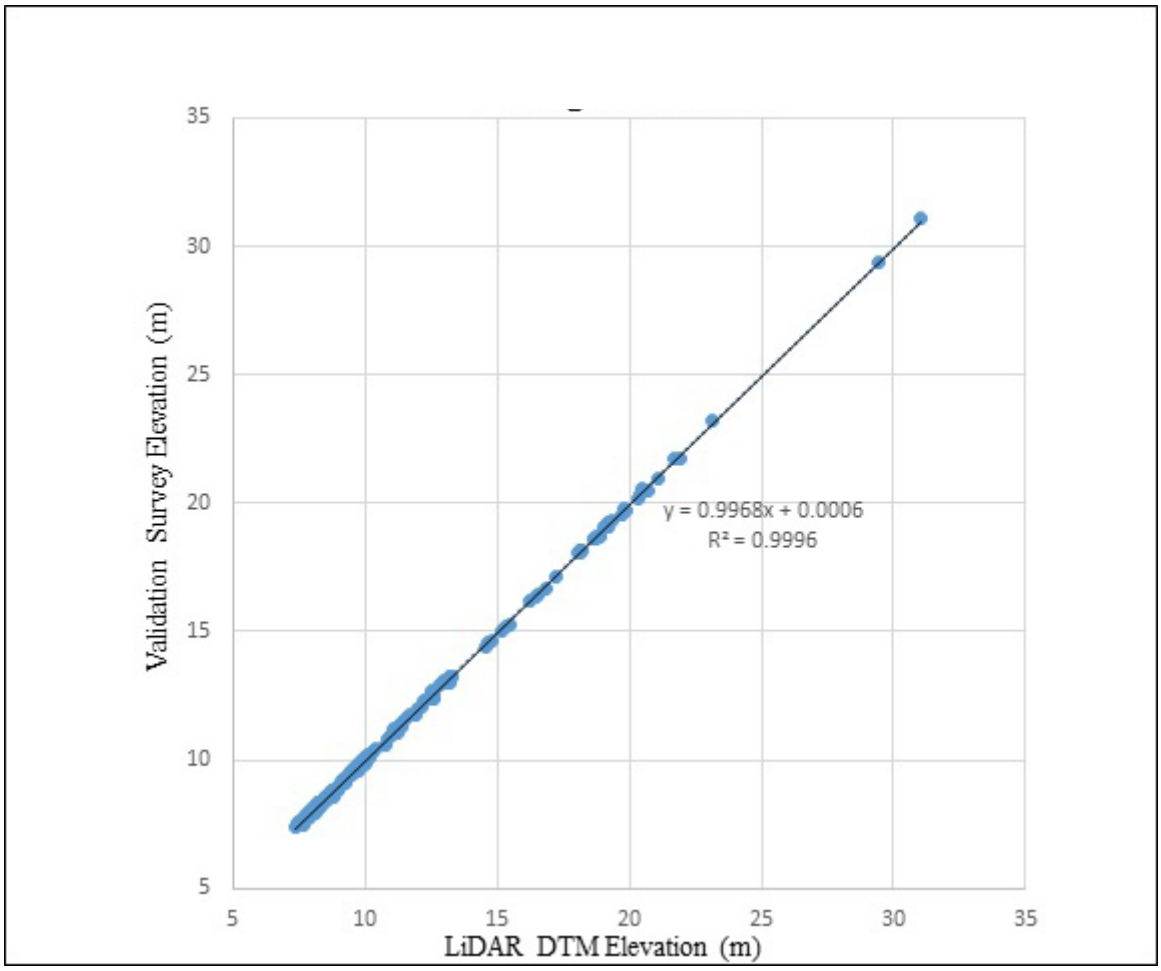


Figure 25.Correlation plot between validation survey points and LiDAR data.

Table 17.Validation Statistical Measures.

Validation Statistical Measures	Value (meters)
RMSE	0.08
Standard Deviation	0.03
Average	0.08
Minimum	-0.12
Maximum	0.19

3.11 Integration of Bathymetric Data into the LiDAR Digital Terrain Model

For bathy integration, only centerline data was available for Laoag with 5049 bathymetric survey points. The resulting raster surface produced was done by Local Polynomial interpolation method. After burning the bathymetric data to the calibrated DTM, assessment of the interpolated surface is represented by the computed RMSE value of 0.28 meters. The extent of the bathymetric survey done by the Data Validation and Bathymetry Component (DVBC) in Laoag integrated with the processed LiDAR DEM is shown in Figure 26.

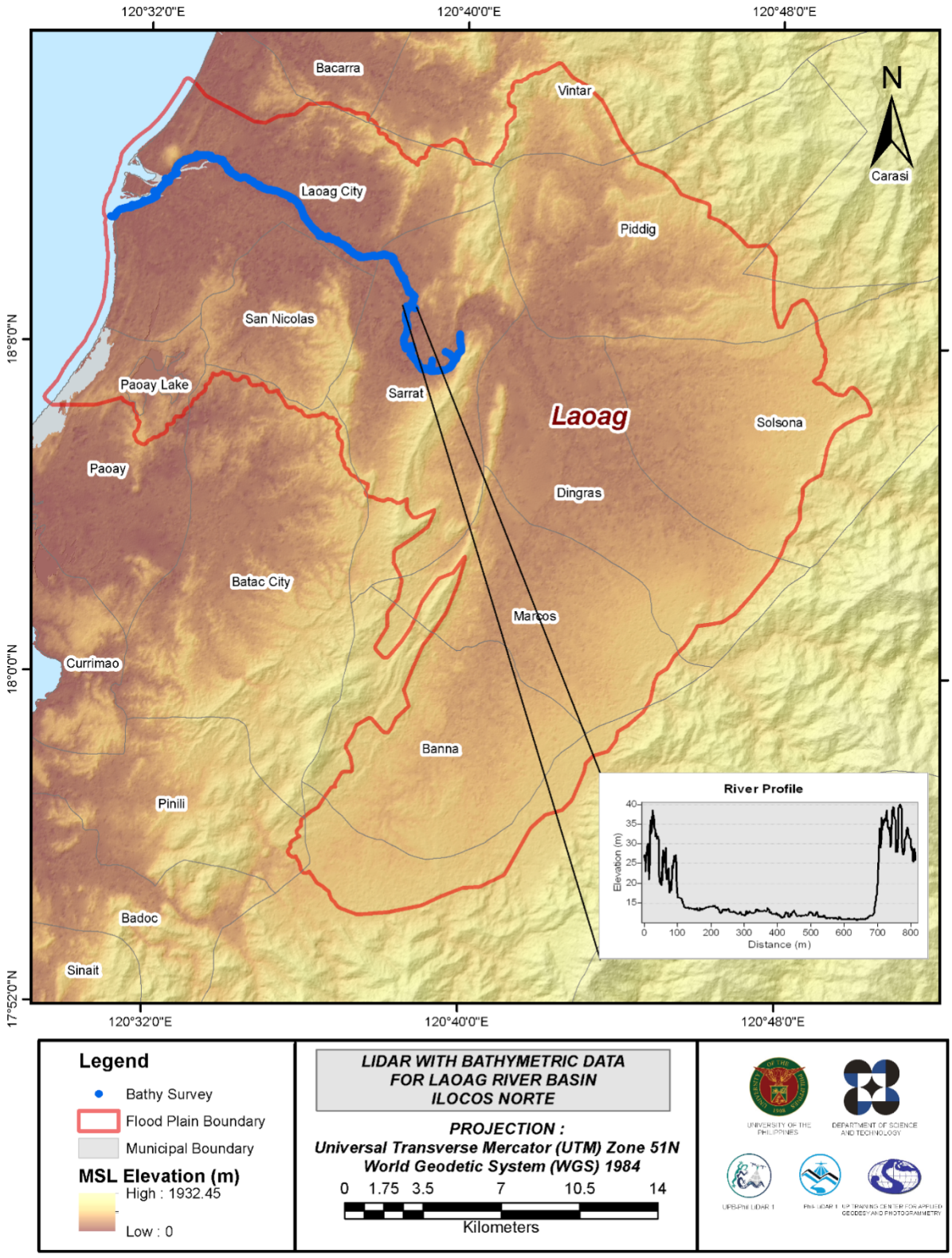


Figure 26.Map of Laoag Flood Plain with bathymetric survey points shown in blue.

3.12 Feature Extraction

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

3.12.1 Quality Checking of Digitized Features' Boundary

Laoag floodplain, including its 200 m buffer, has a total area of 687.27 sq km. For this area, a total of 21.0 sq km, corresponding to a total of 1,522 building features, are considered for QC. Figure 27 shows the QC blocks for Laoag floodplain.

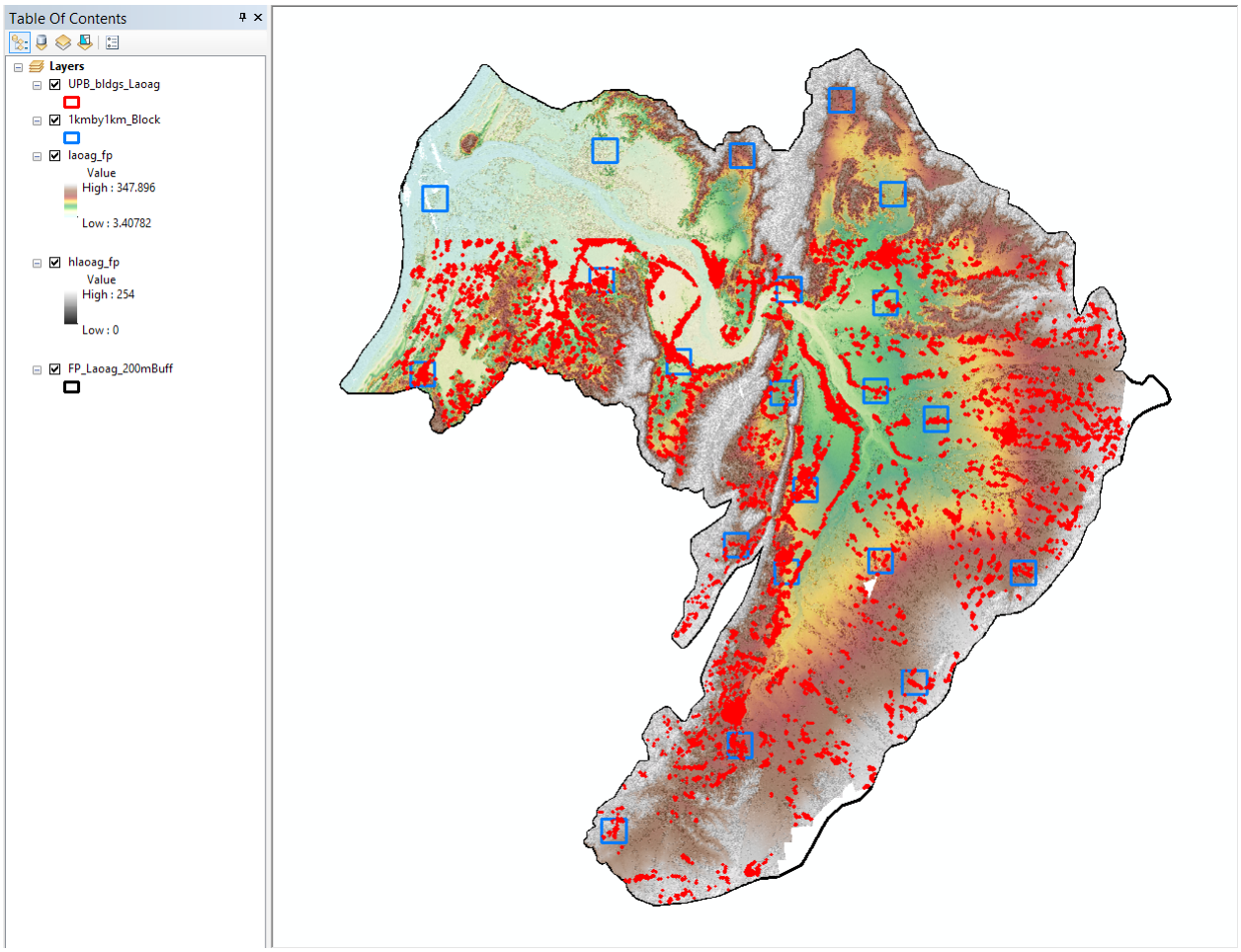


Figure 27.QC blocks for Laoag building features.

Quality checking of Laoag building features resulted in the ratings shown in Table 18.

Table 18. Quality Checking Ratings for Laoag Building Features.

FLOODPLAIN	COMPLETENESS	CORRECTNESS	QUALITY	REMARKS
Laoag	99.86	100.00	98.22	PASSED

3.12.2 Height Extraction

Height extraction was done for 71,982 building features in Laoag floodplain. Of these building features, 1438 building features were filtered out after height extraction, resulting to 70,544 buildings with height attributes. The lowest building height is at 2.00 m, while the highest building is at 18.15 m.

3.12.3 Feature Attribution

Data collected from various sources which includes OpenStreetMap and Google Maps/Earth were used in the attribution of building features. Areas where there is no available data were subjected for field attribution using ESRI's Collector App. The app can be accessed offline and data collected can be synced to ArcGIS Online when WiFi or mobile data is available.

Table 19 summarizes the number of building features per type. On the other hand, Table 20 shows the total length of each road type, while Table 21 shows the number of water features extracted per type.

Table 19.Building Features Extracted for Laoag Floodplain.

Facility Type	No. of Features
Residential	68,368
School	1,006
Market	77
Agricultural/Agro-Industrial Facilities	57
Medical Institutions	66
Barangay Hall	48
Military Institution	0
Sports Center/Gymnasium/Covered Court	28
Telecommunication Facilities	4
Transport Terminal	58
Warehouse	33
Power Plant/Substation	0
NGO/CSO Offices	19
Police Station	8
Water Supply/Sewerage	5
Religious Institutions	117
Bank	28
Factory	3
Gas Station	37
Fire Station	5
Other Government Offices	75
Other Commercial Establishments	502
Total	**70,544**

Table 20.Total Length of Extracted Roads for Laoag Floodplain.

Floodplain	Road Network Length (km)					Total
	Barangay Road	City/Municipal Road	Provincial Road	National Road	Others	
Laoag	596.36	521.17	77.44	58.37	0.00	**1,253.34**

Table 21.Number of Extracted Water Bodies for Laoag Floodplain.

Floodplain	Water Body Type					Total
	Rivers/ Streams	Lakes/ Ponds	Sea	Dam	Fish Pen	
Laoag	40	1	0	0	0	**41**

A total of 94 bridges and culverts over small channels that are part of the river network were also extracted for the floodplain.

3.12.4 Final Quality Checking of Extracted Features

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

Figure 28 shows the Digital Surface Model (DSM) of Laoag floodplain overlaid with its ground features.

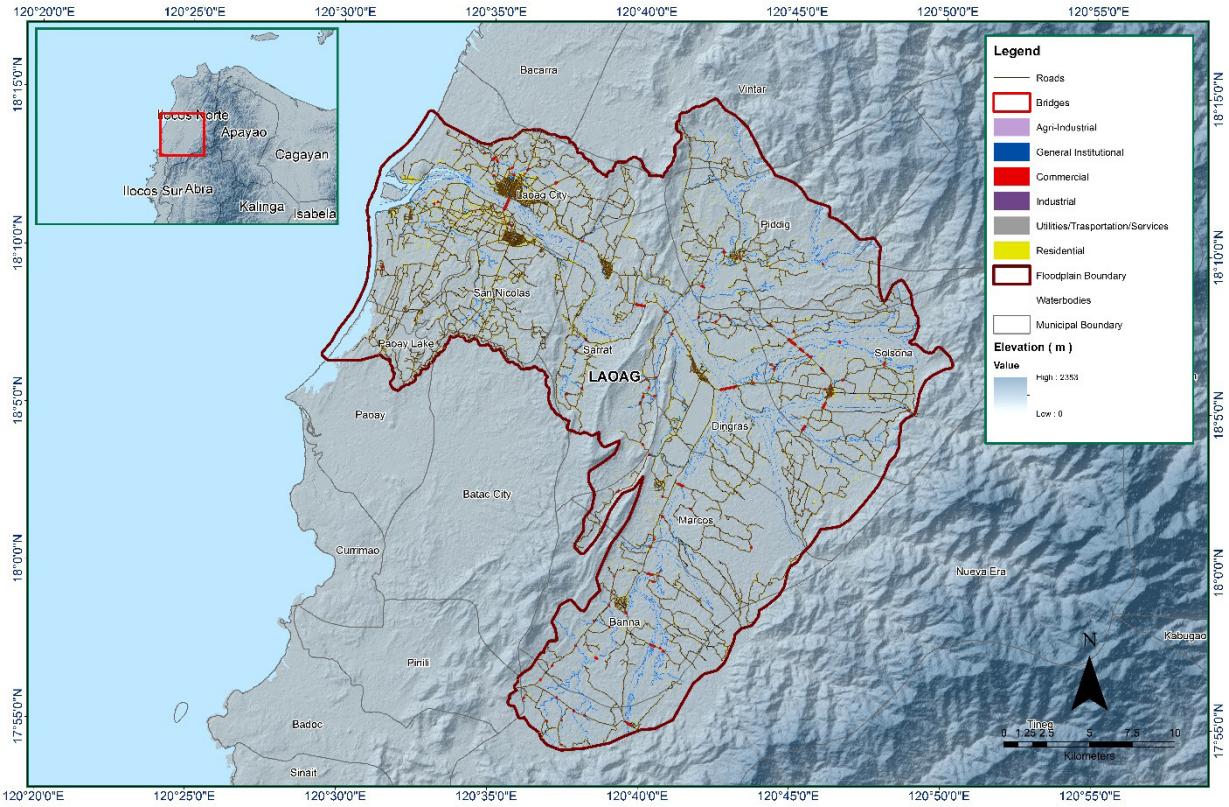


Figure 28.Extracted features for Laoag floodplain.

CHAPTER 4. LIDAR VALIDATION SURVEY AND MEASUREMENTS OF THE LAOAG RIVER BASIN

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

Laoag River Basin is located in the province of Ilocos Norte, surrounded by the municipalities of Solsona, Dingras, Marcos, and Piddig in the upstream, and Sarrat, Laoag City, and San Nicolas in the downstream. The catchment basin has an approximate area of 1,319 km^2 and an estimated run off of 3,225 MCM according to DENR-RBCO.

Its main stem, Laoag River, is one of the three (3) river systems in Ilocos Region. A total of 79,343 people are residing in the immediate vicinity of the Laoag River flood plain. This population is distributed among the 62 barangays in the City of Laoag and municipalities of Sarrat and San Nicolas.There was no significant flooding that happened in Laoag River for the past years.

In line with this, DVBC conducted a field survey in Laoag River from January 28 to February 11, 2015 with the following scope of work: reconnaissance; control survey for the establishment of a control point; cross-section, bridge as-built and water level marking in MSL of Sarrat Bridge in Brgy. San Marcos, Municipality of Sarrat, Ilocos Norte; ground validation data acquisition of about 20 km; and bathymetric survey from Brgy. San Marcos, Sarrat, Ilocos Norte to the mouth of the river in Brgy. 43-B Gabu Norte East, Laoag City, Ilocos Norte, with an estimated length of 25.03 km using an OHMEX™ Single Beam Echo Sounder and GNSS PPK survey technique.

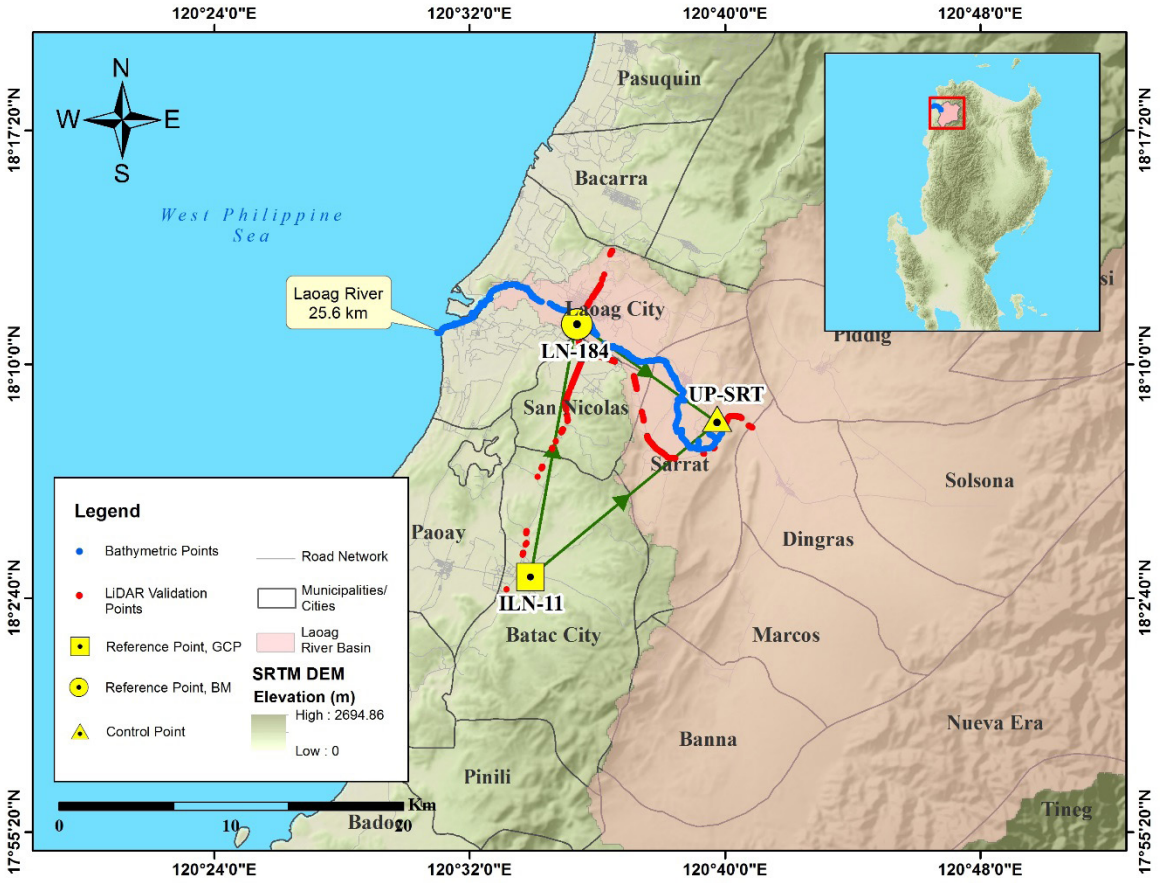


Figure 29.Survey extent for Laoag River Basin

4.2 Control Survey

The GNSS network used for Laoag River Basin is composed of a single loop established on February 4, 2015 occupying the following reference points: ILN-11, a first order GCP in Brgy. Ricarte Poblacion, Batac City; andLN-184, a first order BM in Brgy. No. 51-A Nangalisan East, Laog City, all in Ilocos Norte.

One (1) control point was established along the approach of bridge, namely: UP-SRT, located at Sarrat Bridge, Brgy. San Marcos, Municipality of Sarrat, Ilocos Norte.

The summary of references and control points and its location is summarized in Table 22 while the GNSS network established is illustrated in Figure 30

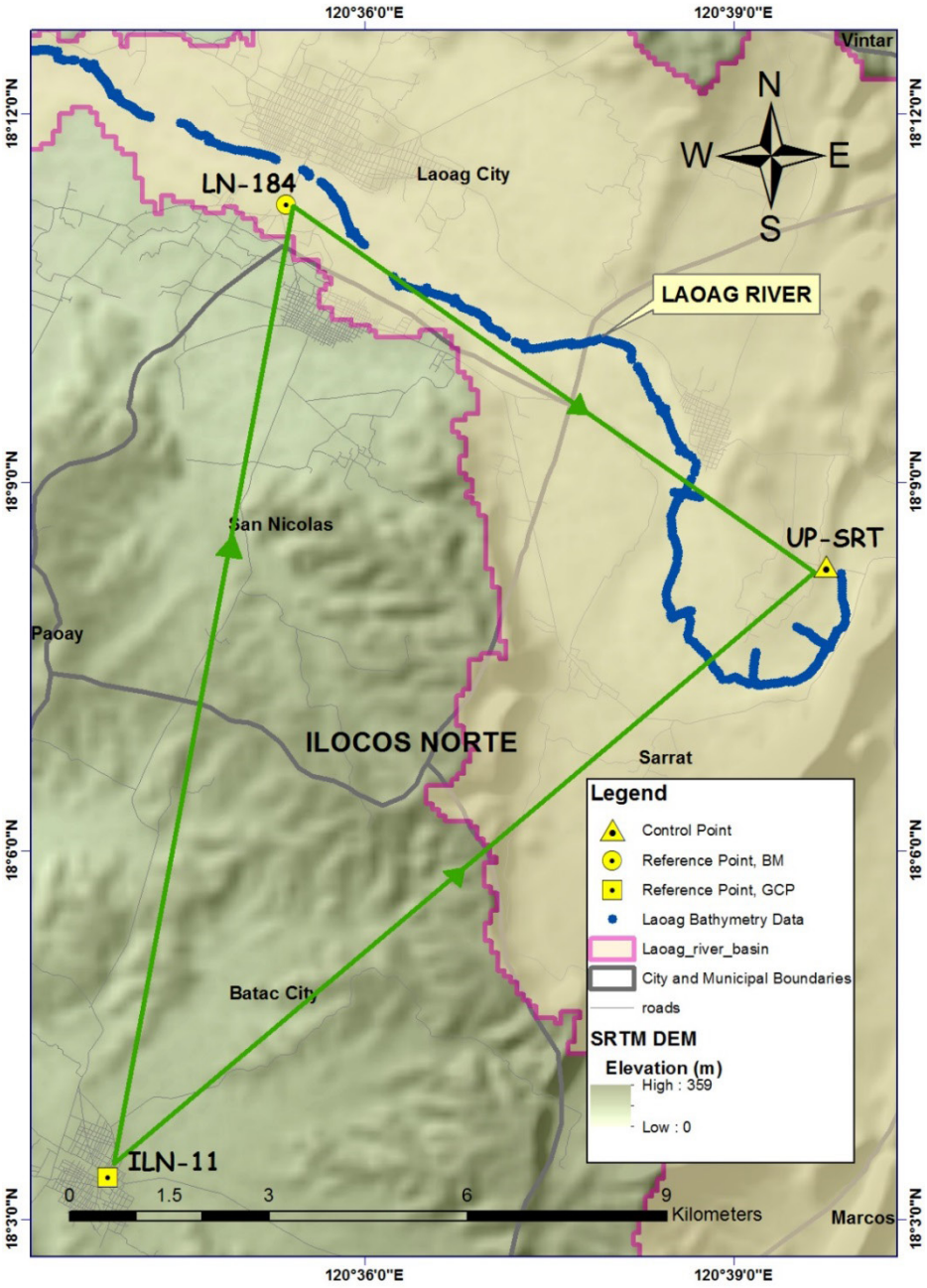


Figure 30.GNSS Network of Laoag River field Survey

Table 22.List of Reference and Control points used in Laoag River BasinSurvey.

(Source: NAMRIA, UP-TCAGP)

Control Point	Order of Accuracy	Geographic Coordinates (WGS 84)				
		Latitude	Longitude	Ellipsoid Height (m)	Elevation in MSL (m)	Date Established
LN-184	1st order, BM	-	-	49.22	12.678	2007
ILN-11	1st order, GCP	18°03'20.64552"	120°33'54.52048"	69.613	-	2004
UP-SRT	UP Established	-	-	-	-	2015

The GPS setups made in the location of the reference and control points are exhibited in Figure 31 toFigure 33.

Figure 31.Base setup, Trimble® SPS 852, at ILN-11 located on the rooftop of the Batac City Hall inBrgy. Ricarte Poblacion, Batac City, Ilocos Norte

Figure 32.GNSS receiver setup, Trimble® SPS 882 at BM LN-184 on the approach of Gilbert Bridge in Brgy. No. 51-A, Nangalisan East, Laog City, Ilocos Norte.

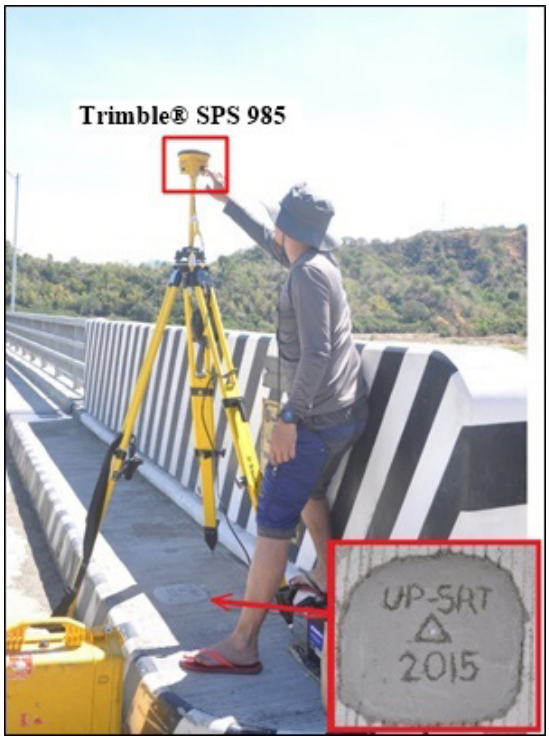


Figure 33.GNSS receiver setup, Trimble® SPS 985 at UP-SRT at Sarrat Bridge inBrgy. San Marcos, Municipality of Sarrat, Ilocos Norte.

4.3 Baseline Processing

GNSS Baselines were processed simultaneously in TBC by observing that all baselines have fixed solutions with horizontal and vertical precisions within +/-20cm and +/-10cm requirement, respectively. In case where one or more baselines did not meet all of these criteria, masking is performed. Masking is done by removing/masking portions of these baseline data using the same processing software. It is repeatedly processed until all baseline requirements are met. If the reiteration yields out of the required accuracy, resurvey is initiated. Baseline processing result of control points in Laoag River Basin is summarized in Table 23 generated TBC software.

Table 23.Baseline Processing Report for Laoag River survey

Observation	Date of Observation	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
UPSRT --- LN184	02-04-2015	Fixed	0.003	0.015	305°08'44"	9465.918	-19.930
LN184 --- UPSRT	02-04-2015	Fixed	0.006	0.021	125°07'21"	9465.916	19.975
ILN11 --- UPSRT	02-04-2015	Fixed	0.004	0.016	48°22'30"	13790.462	-0.448
ILN11 --- LN184	02-04-2015	Fixed	0.008	0.025	9°57'44"	14828.958	-20.388

As shown in Table 23, a total of four (4) baselines were processed and all of them passed the required accuracy set by the project.

4.4Network Adjustment

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

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

Where:

x_e is the Easting Error,
y_e is the Northing Error, and
z_e is the Elevation Error

The three (3) control points, ILN-11, LN-184 and UP-SRT were occupied and observed simultaneously to form a GNSS loop. Coordinates of ILN-11 and elevation values of LN-184 held fixed during the processing of the control points as presented in Table 24. Through these reference points, the coordinates and elevation of the unknown control points were computed.

Table 24.Control Point Constraints

Point ID	Type	East σ (Meter)	North σ (Meter)	Height σ (Meter)	Elevation σ (Meter)
ILN-11	Global	Fixed	Fixed		
LN-184	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 25. All fixed control points have no values for grid and elevation errors.

Table 25.Adjusted Grid Coordinates

Point ID	Easting (Meter)	Easting Error (Meter)	Northing (Meter)	Northing Error (Meter)	Elevation (Meter)	Elevation Error (Meter)	Constraint
ILN-11	242257.819	?	1998049.985	?	32.761	0.097	LL
LN-184	245017.255	0.019	2012626.167	0.013	12.678	?	e
UP-SRT	252690.427	0.017	2007076.912	0.012	31.954	0.068	

The network is fixed at reference points. The list of adjusted grid coordinates of the network is shown inTable 26.Using the equation for horizontal and for the vertical; below is the computation for accuracy that passed the required precision:

a. **ILN-11**

Horizontal accuracy = Fixed

Vertical accuracy = 9.7 cm < 10 cm

b. **LN-184**

Horizontal accuracy = $\sqrt{((1.9)^2 + (1.3)^2}$

= $\sqrt{(3.61+ 1.69)}$

= 2.3 cm < 20 cm

Vertical accuracy = Fixed

c. **UP-SRT**

Horizontal accuracy = $\sqrt{((1.7)^2 + (1.2)^2}$

= $\sqrt{(2.89 + 1.44)}$

= 2.1 cm < 20 cm

Vertical accuracy = 6.8 cm < 10 cm

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

Table 26.Adjusted Geodetic Coordinates

Point ID	Latitude	Longitude	Height (Meter)	Height Error (Meter)	Constraint
ILN11	N18°03'20.64552"	E120°33'54.52048"	69.613	0.097	LL
LN184	N18°11'15.68970"	E120°35'21.81725"	49.220	?	e
UPSRT	N18°08'18.50472"	E120°39'45.20843"	69.166	0.068	

The corresponding geodetic coordinates of the observed points are within the required accuracy as shown in Table 26. Based on the result of the computation, the accuracy conditions are satisfied; hence, the required accuracy for the program was met.

The summary of reference and control points used is indicated in Table 27.

Table 27.References and Control Points used and its location (Source: NAMRIA, UP-TCAGP)

Control Point	Order of Accuracy	Geographic Coordinates (WGS 84)			UTM Zone 51		
		Latitude	Longitude	Ellipsoid Height (m)	Northing	Easting	Elevation in MSL (m)
LN-184	1st order, BM	18°11'15.68970"	120°35'21.81725"	49.22	2012626.167	245017.255	2012626
ILN-11	1st order, GCP	18°03'20.64552"	120°33'54.52048"	69.613	1998049.985	242257.819	1998050
UP-SRT	UP Established	18°08'18.50472"	120°39'45.20843"	69.166	2007076.912	252690.274	2007077

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

Cross-section survey was conducted on January 29, 2015 at the downstream side of Sarrat Bridge in Brgy. San Marcos, Municipality of Sarrat, Ilocos Norte. PPK technique was applied using a survey grade GPS, Trimble® SPS 882, to acquire the cross-section points of the river as shown in Figure 34.

Figure 34.(a) Cross-Section survey at Sarrat Bridge and (b) conduct of the bridge as-built survey

In addition to cross-section survey, the as-built features of the bridge was also determined to get the distance of piers and abutments from the bridge approach. The bridge deck was measured using meter tapes to get its high chord and low chord.

The cross-sectional line for Sarrat Bridge is about 645 m with a total of 67 points acquired using UP-established point UP-SRT. Figure 36 and Figure 37 show the summary of gathered cross-section and as-built data.

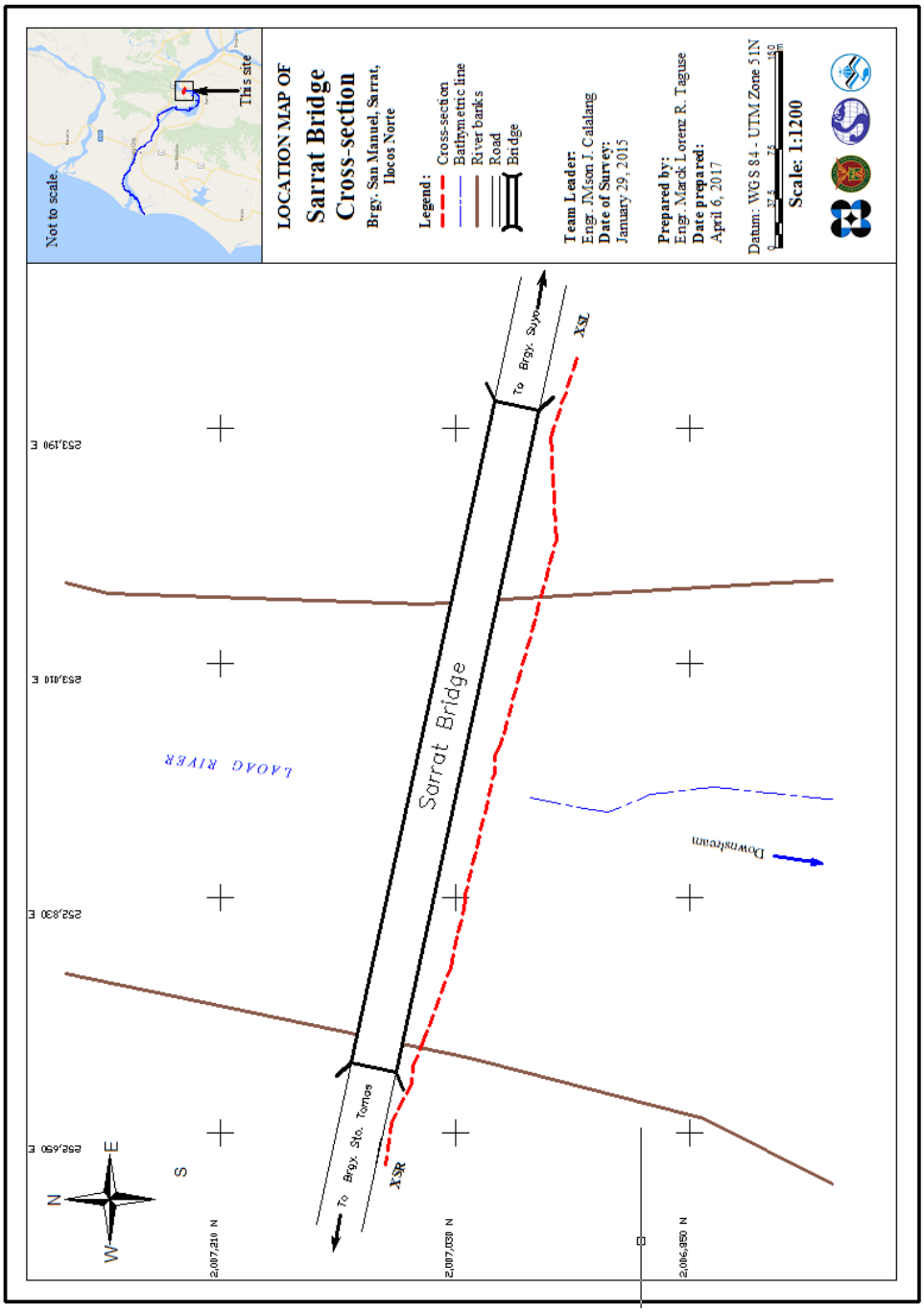


Figure 35.Sarrat bridge cross-section location map

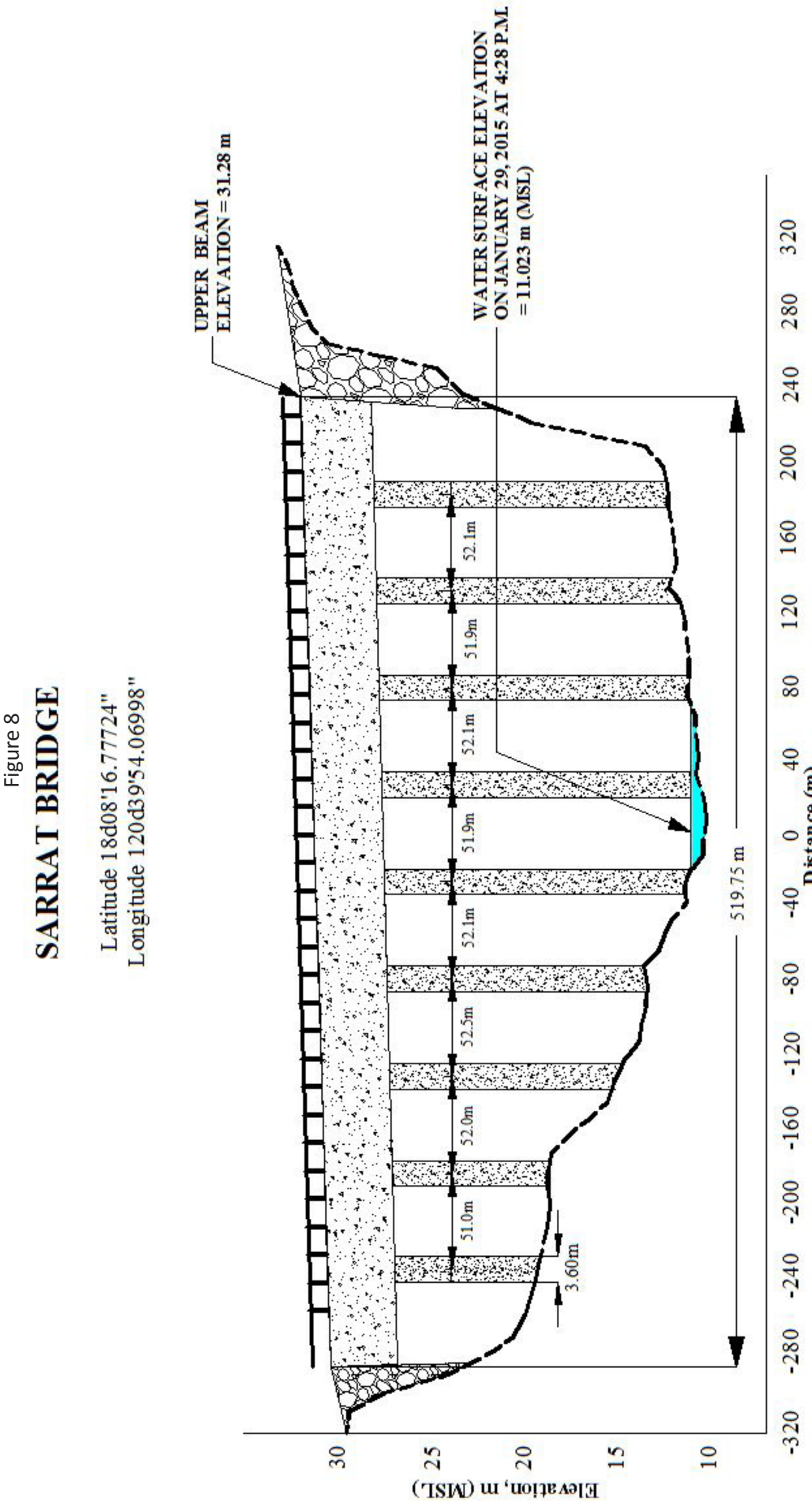


Figure 37. Sarrat Bridge cross-section diagram

Bridge Data Form

Bridge Name: Sarrat Bridge **Date: 01/29/15**

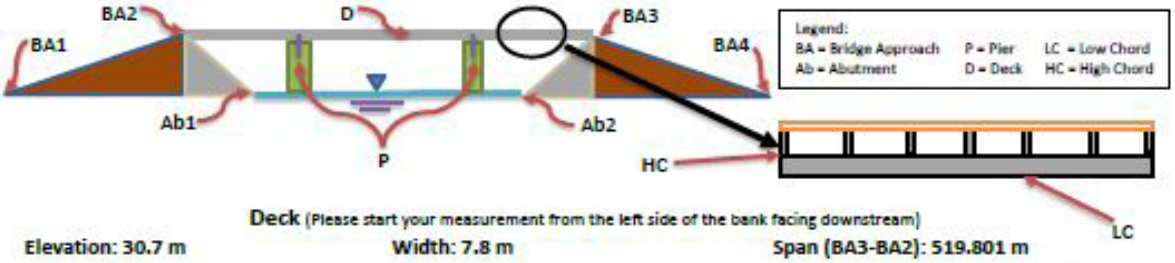
River Name: Laoag River **Time: 5:03 PM**

Location (Brgy, City,Region): San Manuel, Sarrat, Ilocos

Survey Team: JMson Calalang, Bernice Furagganan, Rodel Alberto

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

Latitude: 18d 08' 18.50429" **Longitude:** 120d 39' 45.20810"



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

Elevation: 30.7 m **Width: 7.8 m** **Span (BA3-BA2): 519.801 m**

	Station (Distance from BA1) (m)	High Chord Elevation (m) MSL	Low Chord Elevation (m) MSL
1	87.991	30.636	26.836
2	243.718	30.965	27.165
3	347.680	31.282	27.482
4	451.692	31.605	27.805

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

	Station(Distance from BA1) (m)	Elevation (m) MSL		Station(Distance from BA1) (m)	Elevation (m) MSL
BA1	0	30.056	BA3	555.744	31.896
BA2	35.99249	30.314	BA4	674.340	31.689

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

	Station (Distance from BA1) (m)	Elevation (m) MSL
Ab1	36.5712	24.8838
Ab2	41.31583	21.7198

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

Shape: Rectangular Number of Piers: 9

	Station (Distance from BA1) (m)	Elevation (m) MSL	Pier Width (m)
Pier 1	87.9911	30.4808	3.6
Pier 2	139.5047	30.6358	3.6
Pier 3	191.5224	30.7798	3.6
Pier 4	243.7183	30.9648	3.6
Pier 5	295.818	31.1378	3.6
Pier 6	347.6794	31.2818	3.6
Pier 7	399.8046	31.4318	3.6
Pier 8	451.6912	31.6048	3.6
Pier 9	503.6658	31.7378	3.6

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

Figure 38.Sarrat Bridge Data form

The water surface elevation of Laoag River at its left and right banks was acquired using PPK survey technique on January 29, 2015 at 4:28:01 AM. The resulting water surface elevation data of 11.023 m above MSL was marked at the piers of Sarrat Bridge (Figure 39). The markings on the bridge piers shall serve as a reference for flow data gathering and depth gauge deployment of UP Baguio PHIL-LIDAR 1.

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Figure 39. Water Level Marking for Sarrat Bridge

4.6 Validation Points Acquisition Survey

Validation points acquisition survey was conducted from February 9 to 10, 2015 using a survey-grade GNSS Rover receiver mounted on a pole which was attached in front of the vehicle as shown in Figure 40. It was secured with a nylon rope to ensure that it was horizontally and vertically balanced. The antenna height was measured from the ground up to the bottom of the notch of the Trimble® SPS 985 GNSS Rover receiver. The survey was conducted using PPK technique on a continuous topo mode.

The distance surveyed is approximately 20 km from Laoag to Batac City and from the Municipality of San Nicolas to Sarrat. The control point LN-184 was used as the GNSS base station during the conduct of the ground validation survey.

Figure 40. Validation points acquisition survey setup: Trimble® SPS 985 is mounted in a 2-m pole and attached in front of the vehicle

The survey acquired 1,819 ground validation points with an approximate length of 20 km using the base station LN-184, as shown in the map in Figure 41.

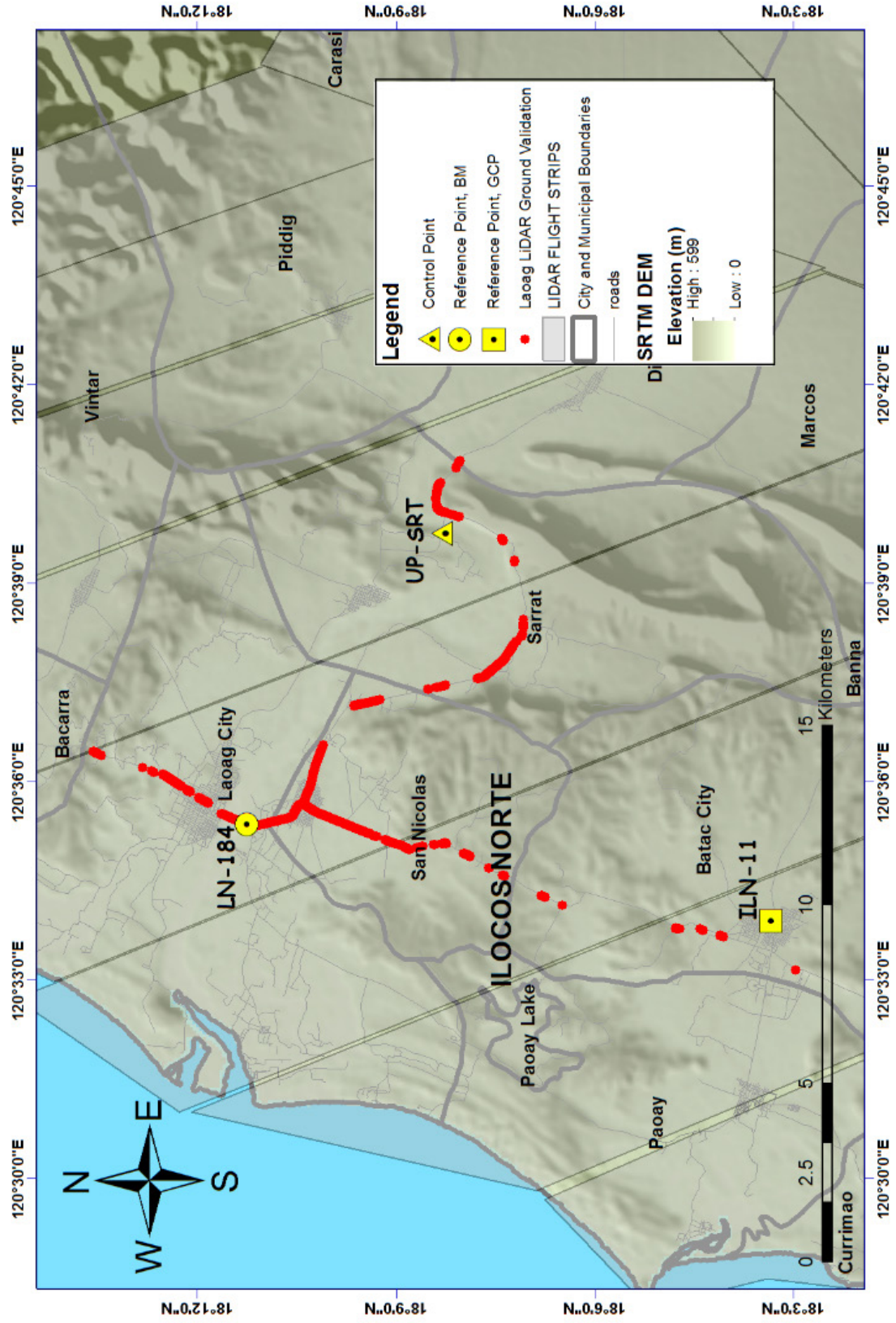

Figure 41.Validation points acquisition survey along LaoagRiver Basin

4.7 River Bathymetric Survey

Bathymetric survey was conducted on February 7, 2015 in using Trimble® SPS 822 GNSS PPK survey technique implementing continuous topo mode and an OHMEX™ Single Beam Echo Sounder mounted on a boat as shown in Figure C-13C. The survey started in Brgy. 46 Nalbo, Laoag City with coordinates 18°11'58.14508" 120°34'15.36284" down to the mouth of the river in Brgy. No 35 Gabu Sur, also in Laoag City with coordinates 18°10'59.63598" 120°31'01.03550".

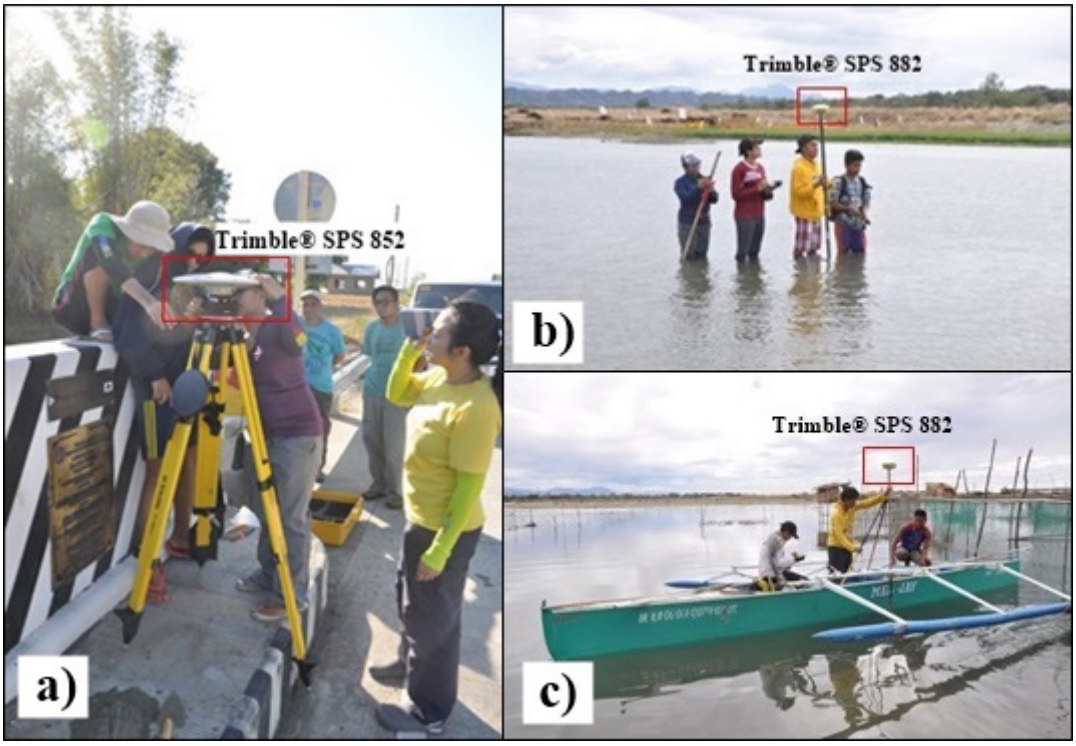

Figure 42. Bathymetric survey setup: (a) Base station at UP-SRT, (b) manual bathymetry at Laoag River, and (c) Bathymetry using echo sounder at downstream portion of Laoag River.

Manual bathymetric survey on the other hand was conducted from February 5, 6 and 11, 2015 using Trimble® SPS 822 receiver in GNSS PPK technique as shown in Figure 42b. The survey started at Sarrat Bridge in Brgy. San Marcos, Municipality of Sarrat with coordinates 18°08'15.20140"120°39'52.61189" traversed down by foot and ended at the starting point of bathymetric survey using boat. The control points UP-SRT and LN-184 were both used as the GNSS base station all throughout the bathymetric survey.

There are 4,856 bathymetric points gathered in Laoag River. A CAD drawing was also produced to illustrate the Laoag River profile (Figure 43). An elevation drop of 10 m in MSL was observed within the approximate distance of 25 km. The highest elevation value observed was 15.252 m in MSL located in Brgy. Santo Tomas while the lowest elevation observed was -6.868 m below MSL located at the mouth of the river.

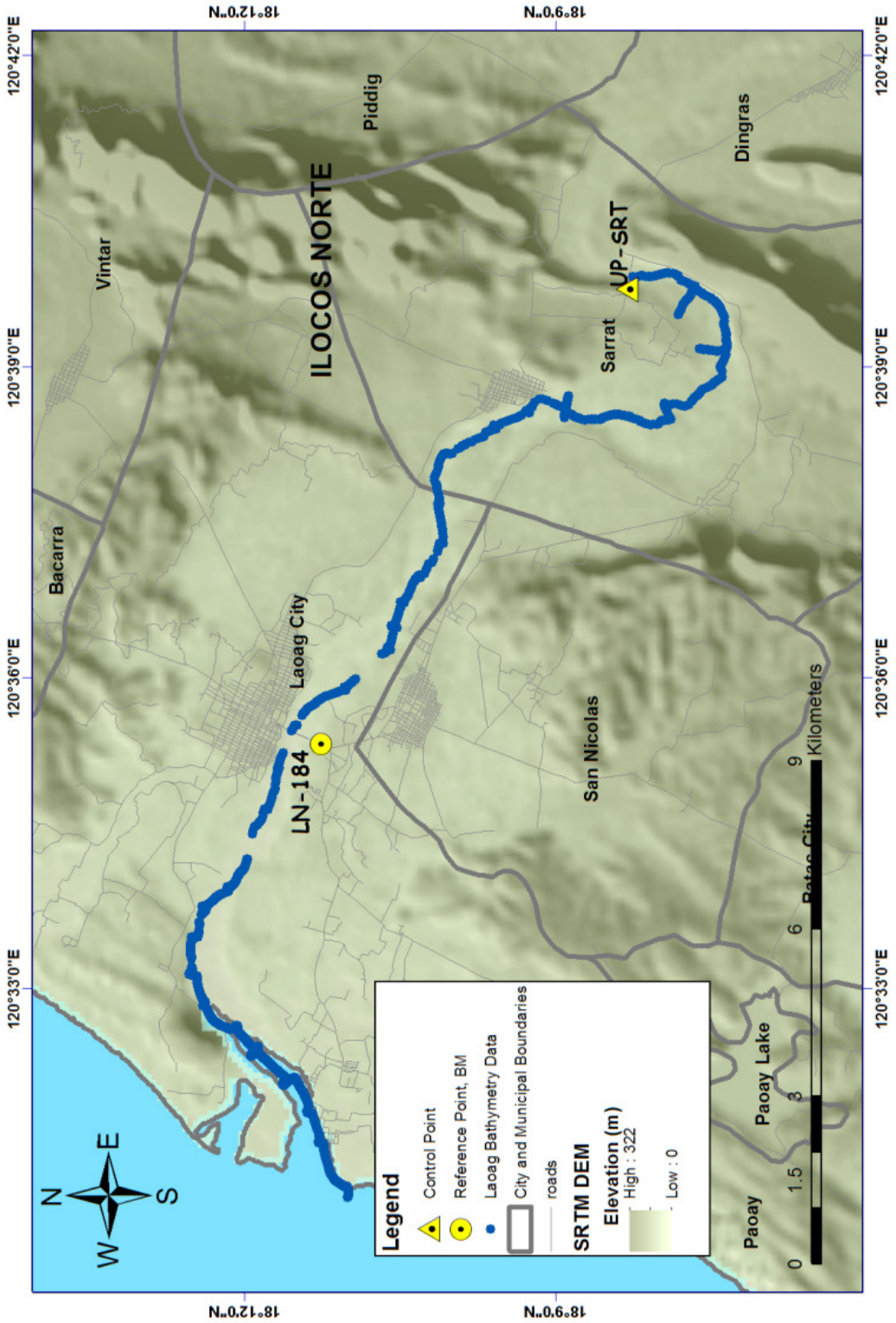

Figure 43.Bathymetric points gathered along Laoag River

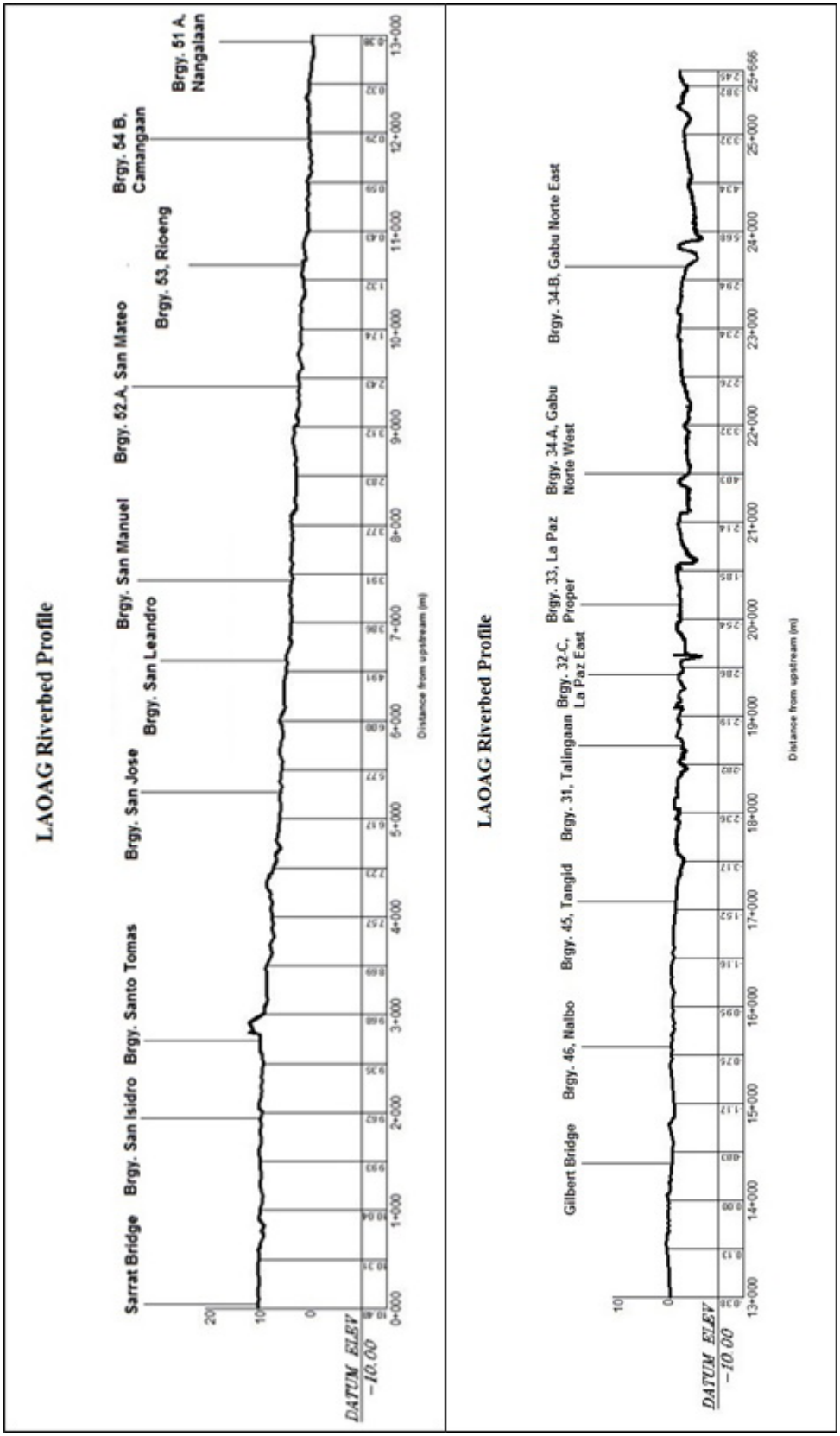

Figure 44.Riverbed Profile of Laoag River

CHAPTER 5. FLOOD MODELING AND MAPPING

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

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

5.1 Data Used for Hydrologic Modeling

5.1.1 Hydrometry and Rating Curves

Components and data that affect the hydrologic cycle of the river basin was monitored, collected, and analyzed. Rainfall, water level, and flow in a certain period of time, which may affect the hydrologic cycle of the Laoagriver were monitored, collected and analyzed.

5.1.2 Precipitation

Precipitation data was taken from an automatic rain gauge (ARG) installed by the Department of Science and Technology – Advanced Science and Technology Institute (DOST-ASTI). This rain gauge is the Cauplasan Bridge ARG (18°5'40.79" N, 120°42'45.98" E), located in Dingras, Ilocos Norte, as shown in Figure 45. The precipitation data collection started from July 2, 2015 at 12:00 AM to July 8, 2015 at 11:50 PM with a 10-minute recording interval.

The total precipitation for this event in Cauplasan Bridge ARG was 97.2 mm. It has a peak rainfall of 10 mm. on July 5, 2015 at 12:10 PM. The lag time between the peak rainfall and discharge is 2 hours and 10 minutes.

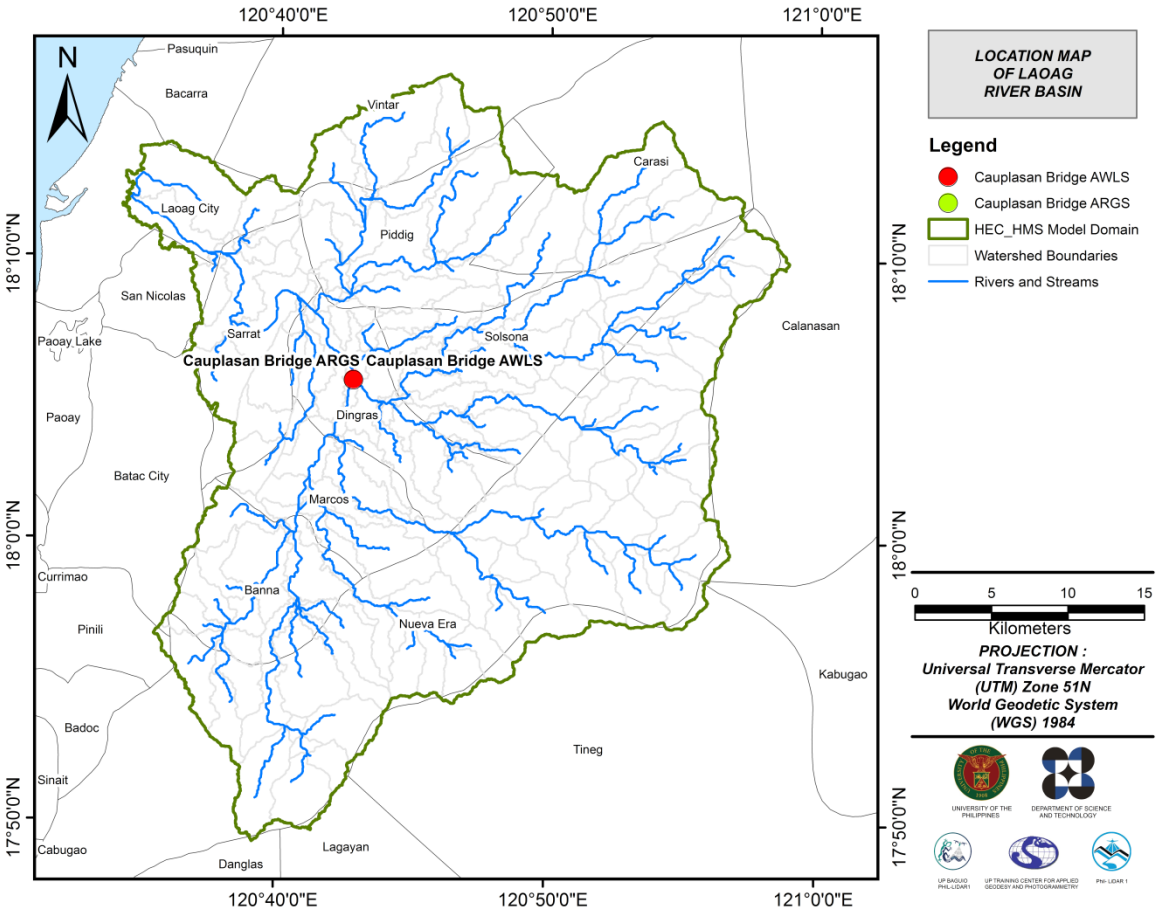

Figure 45.The location map of Laoag HEC-HMS model used for calibration

5.1.3Rating Curves and River Outflow

A rating curve was developed at the same location, at Cauplasan Bridge, Dingras, Ilocos Norte (18°5’40.79” N, 120°42’45.98” E). It gives the relationship between the observed water level from the Cauplasan Bridge and outflow of the watershed at this location.

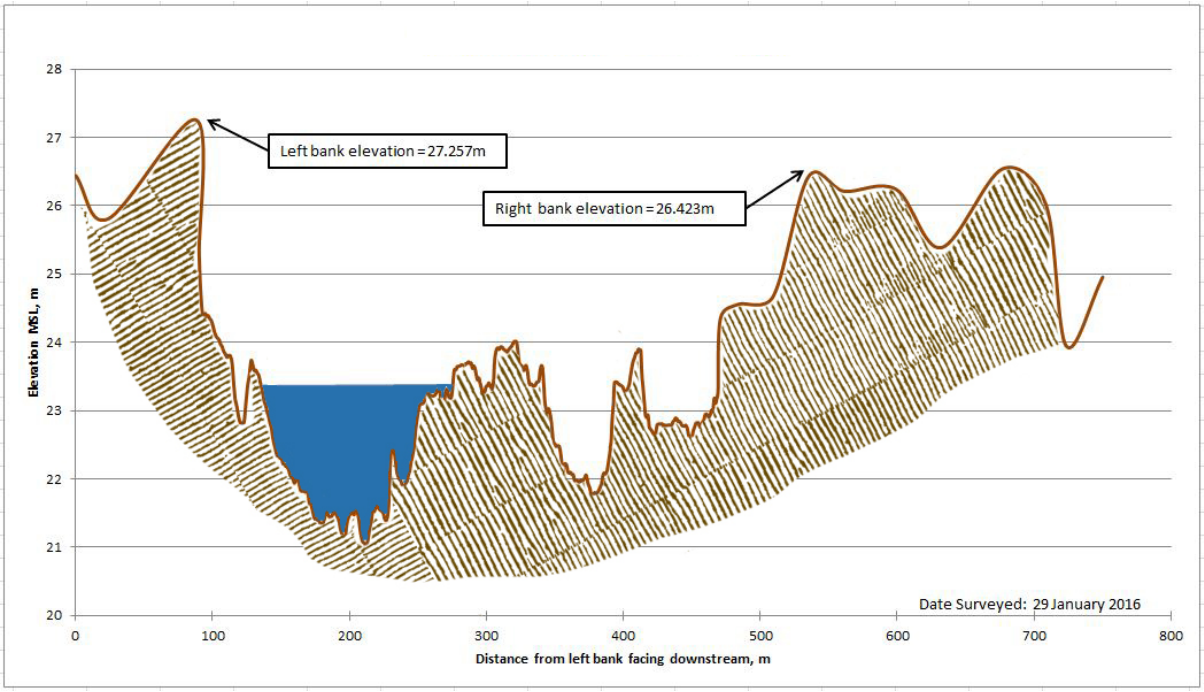

Figure 46.Cross-Section Plot of Cauplasan Bridge

For Cauplasan Bridge, the rating curve is expressed as $Q = 1.3878e^{0.8908h}$ as shown in Figure 47.

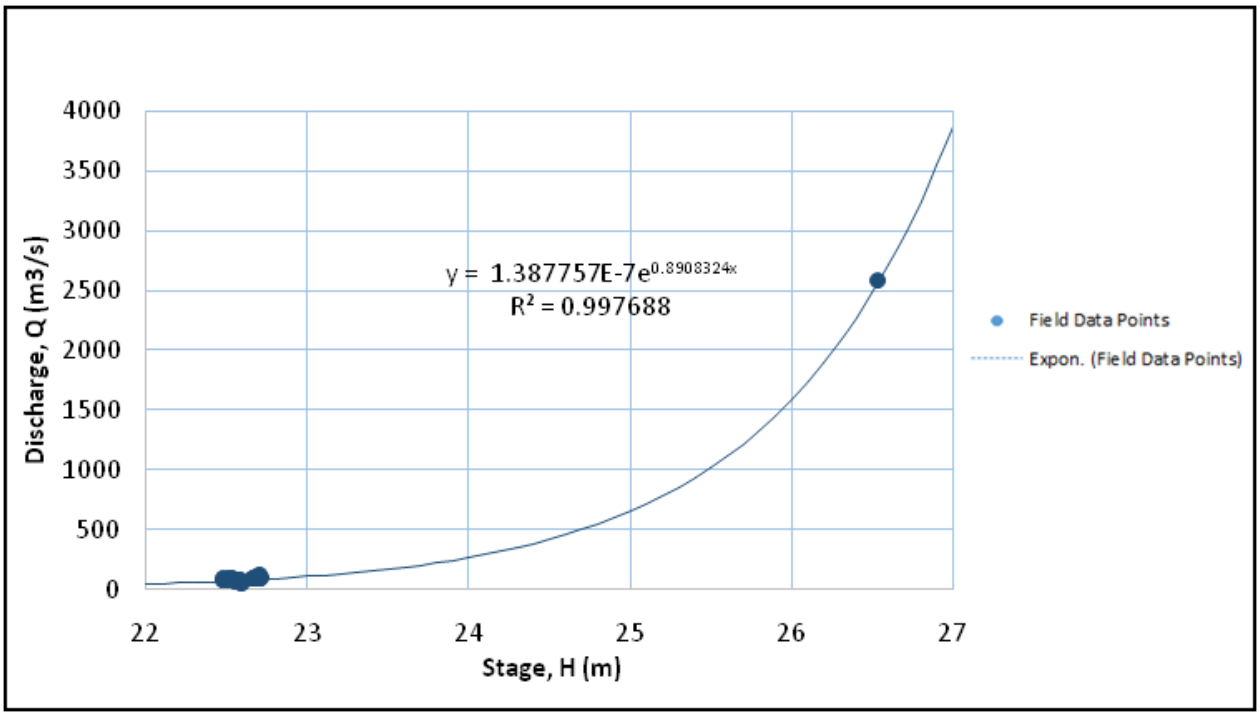

Figure 47.Rating Curve at Cauplasan Bridge, Dingras, Ilocos Norte

The rating curve equation was used to compute for the river outflow at Cauplasan Bridge for the calibration of the HEC-HMS model for Laoag, as shown in Figure 48. The total rainfall for this event is 97.2 mm and the peak discharge is 388.7 m^3/s at 2:20 PM of July 5, 2015.

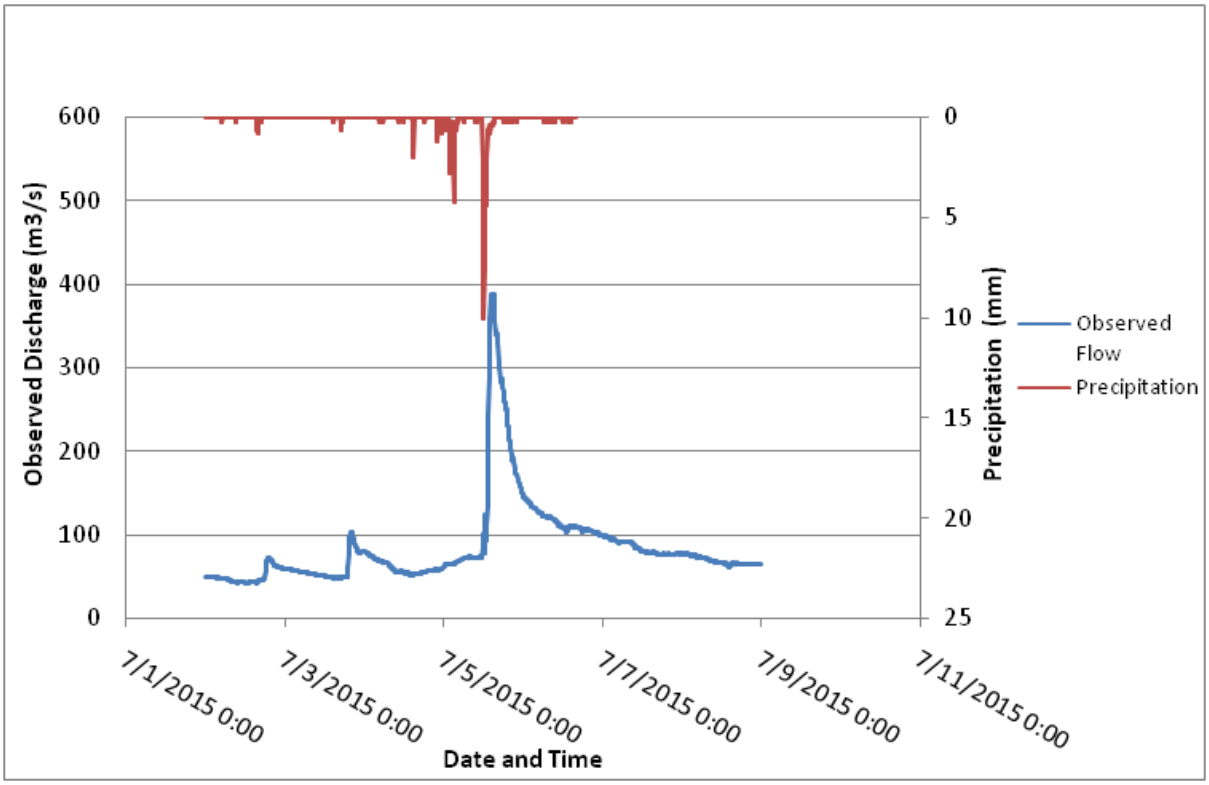

Figure 48.Rainfall and outflow data at Cauplasan Bridge used for modeling

5.2RIDF Station

The Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) computed for Rainfall Intensity Duration Frequency (RIDF) values for the Laoag Rain Gauge. The RIDF rainfall amount for 24 hours was converted to a synthetic storm by interpolating and re-arranging the values in such a way a certain peak value will be attained at a certain time. This station is chosen based on its proximity to the Laoag watershed. The extreme values for this watershed were computed based on a 59-year record.

Table 28.RIDF values for Laoag 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	22.7	35.4	45.7	62.5	89	110.9	148.5	187.8	232.8
5	31.4	48	61.5	87.1	124.6	157.8	211.7	266.3	331.7
10	37.2	56.3	71.9	103.5	148.2	189	253.6	318.3	397.1
15	40.5	61	77.8	112.7	161.6	206.5	277.2	347.7	434
20	42.8	64.3	81.9	119.1	170.9	218.8	293.7	368.2	459.9
25	44.5	66.8	85.1	124.1	178.1	228.3	306.4	384.1	479.8
50	50	74.6	94.8	139.4	200.2	257.4	345.7	432.8	541.1
100	55.3	82.4	104.5	154.6	222.2	286.4	384.6	481.2	602

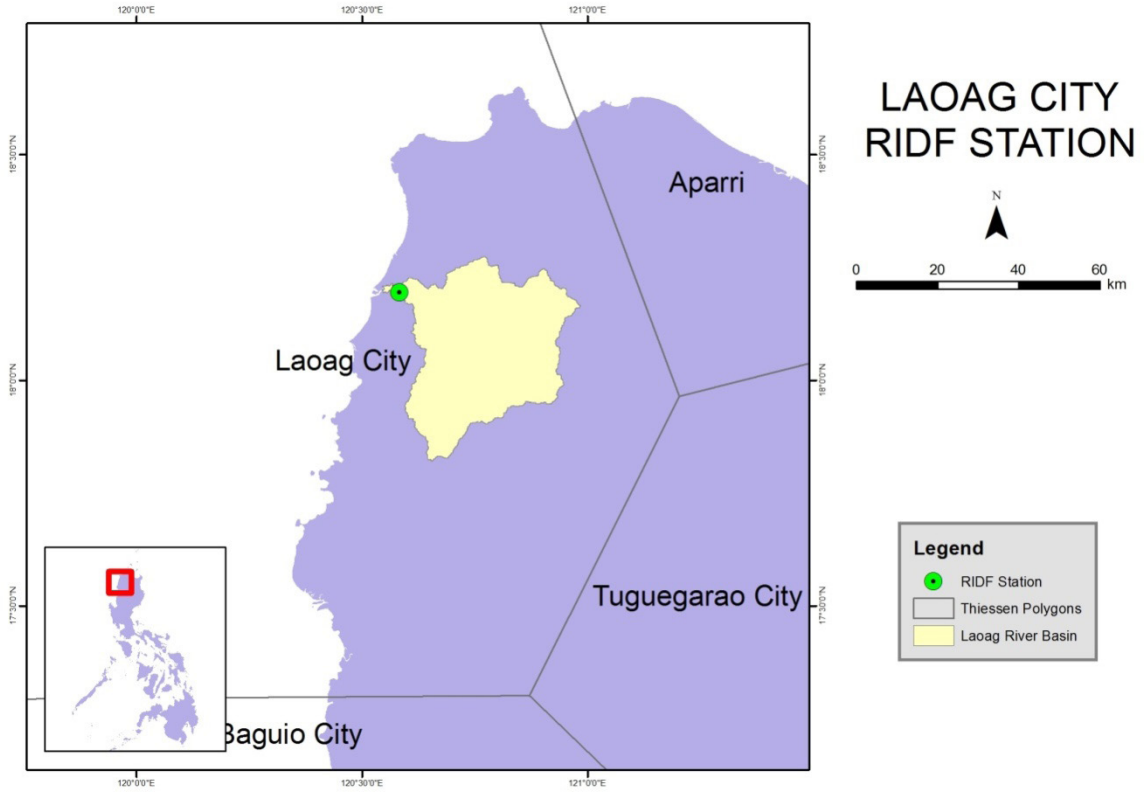

Figure 49. Location of Laoag RIDF Station relative to Laoag River Basin

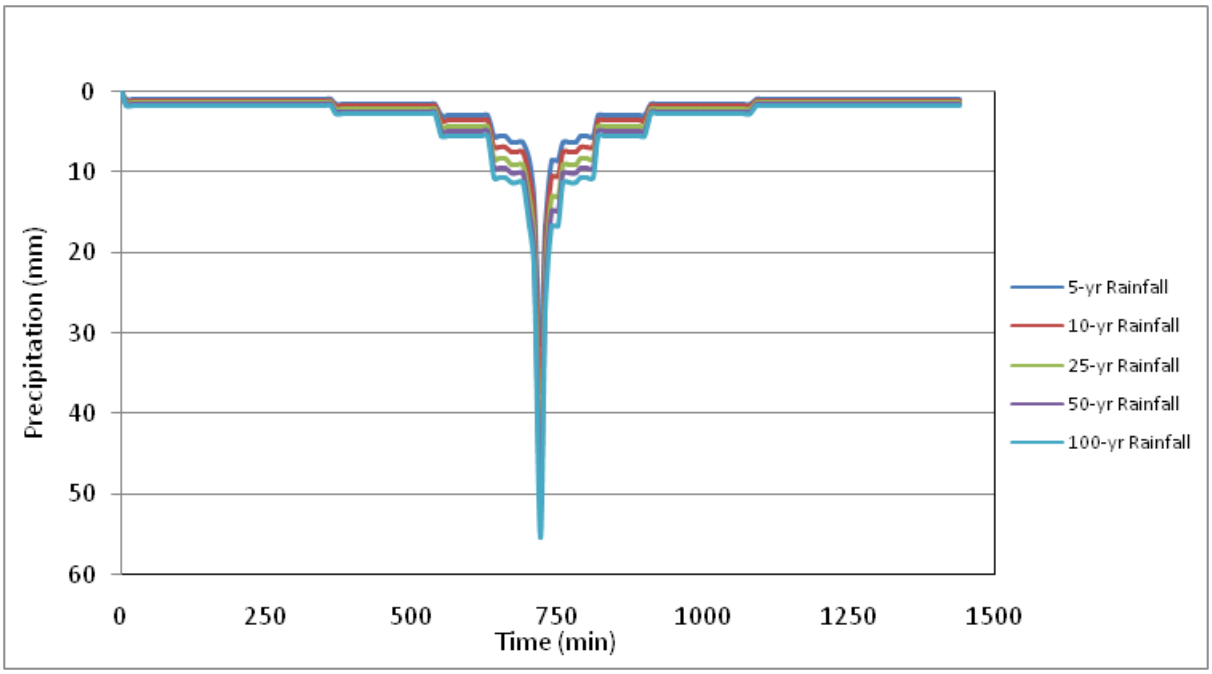

Figure 50.Synthetic storm generated for a 24-hr period rainfall for various return periods

5.3HMS Model

The soil dataset was taken before 2004 by the Bureau of Soils and Water Management (BSWM), under the Department of Agriculture (DA). The land cover dataset file is from the National Mapping and Resource information Authority (NAMRIA). The soil and land cover of the Laoag River Basin are shown in Figures 51 and 52, respectively.

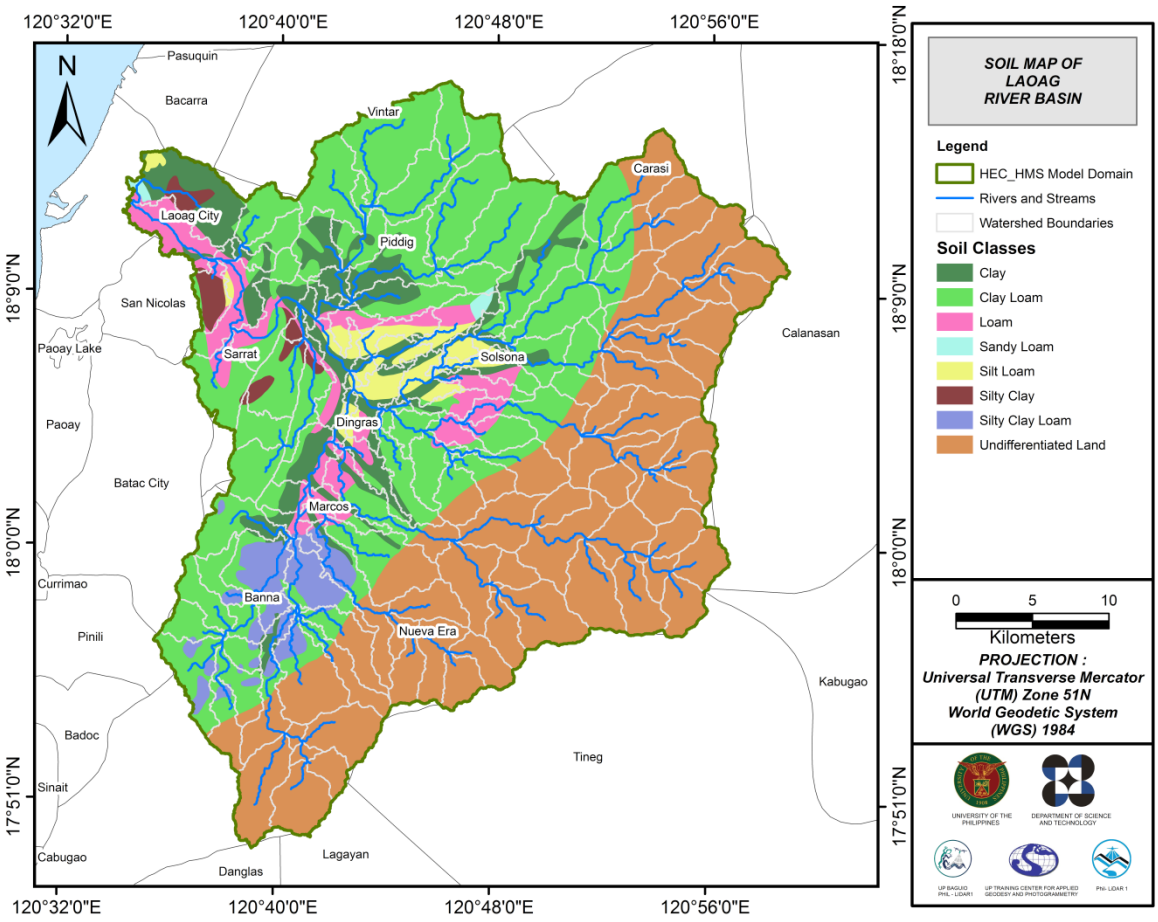

Figure 51.Soil Map of Laoag River Basin

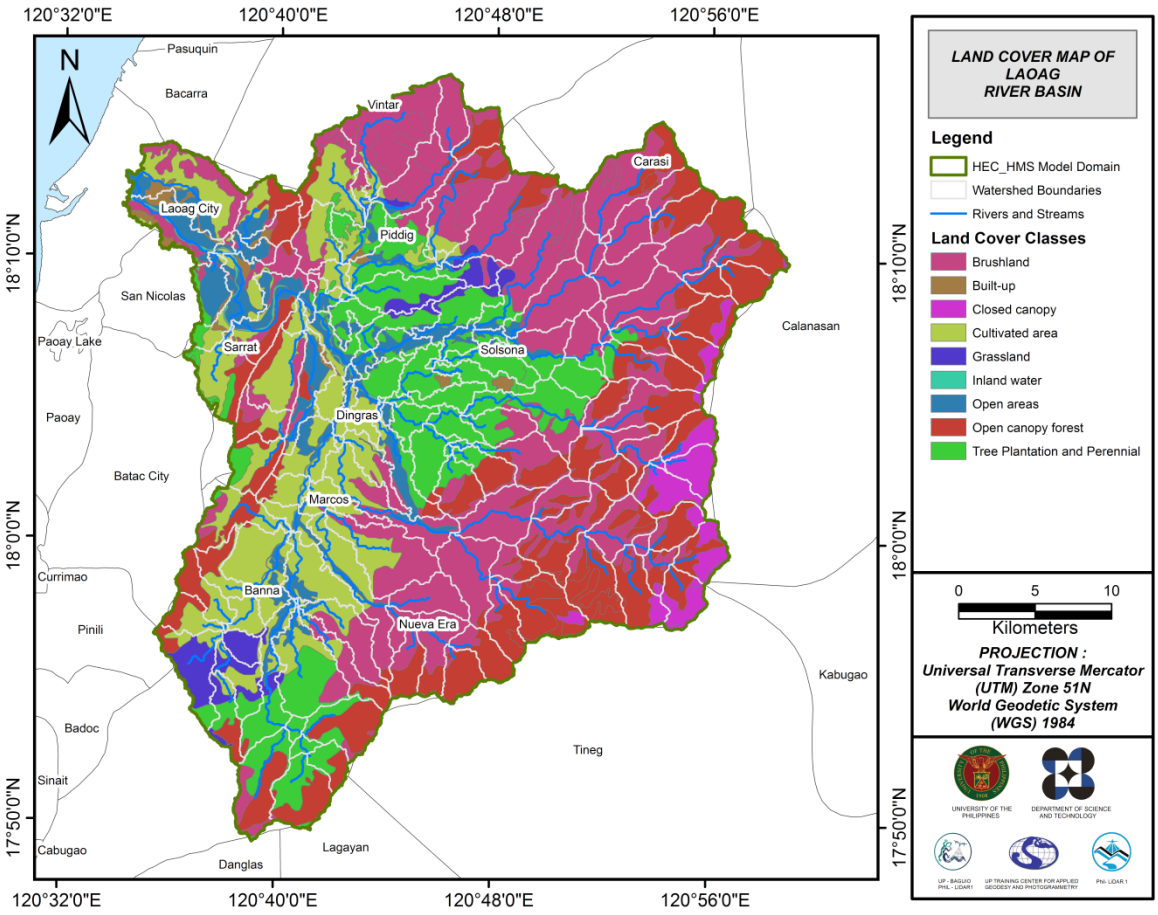

Figure 52.Land Cover Map of Laoag River Basin (Source: NAMRIA)

For Laoag, eight soil classes were identified. These are clay, clay loam, loam, sandy loam, silt loam, silty clay, silty clay loam and undifferentiated land. Moreover, nine land cover classes were identified. These are brushlands, built-up areas, closed canopy, cultivated areas, grasslands, inland water, open areas, open canopy forests, and tree plantations.

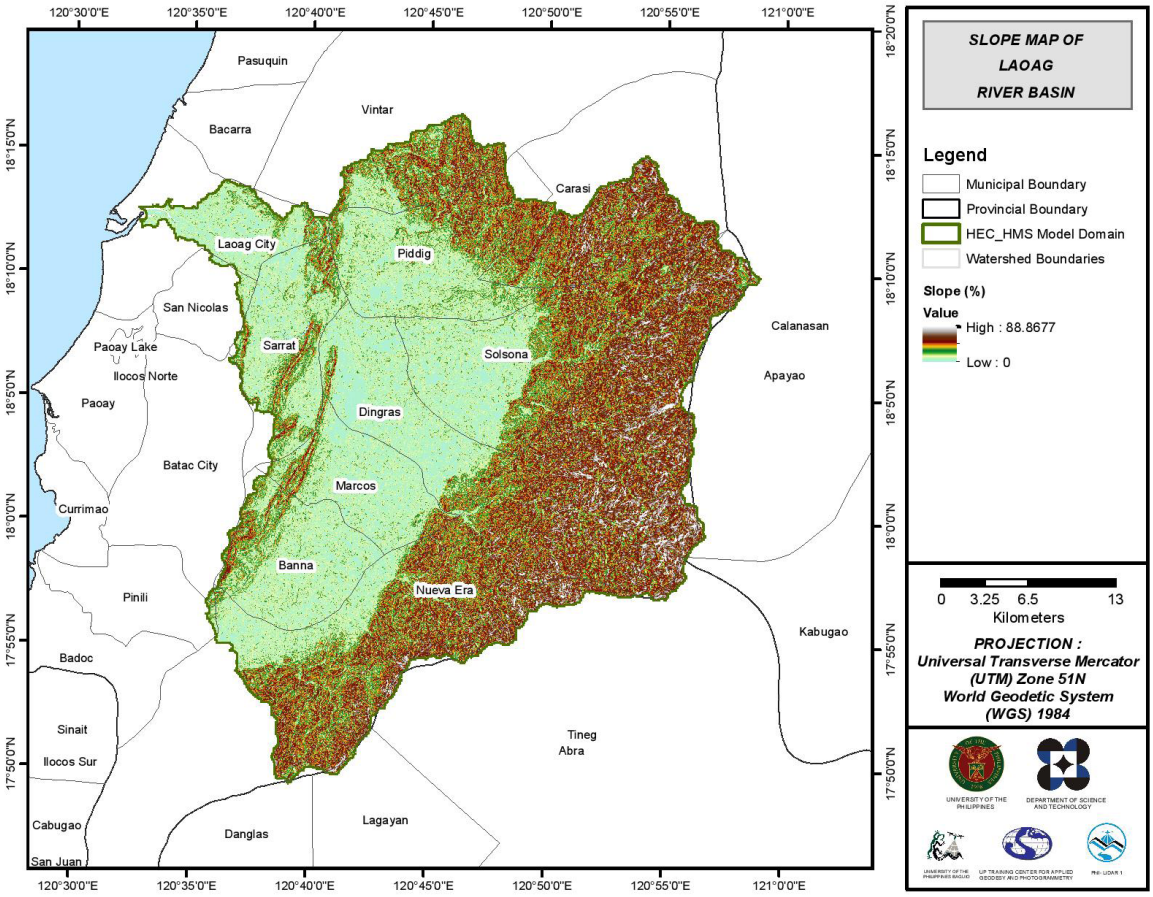

Figure 53.Slope Map of Laoag River Basin

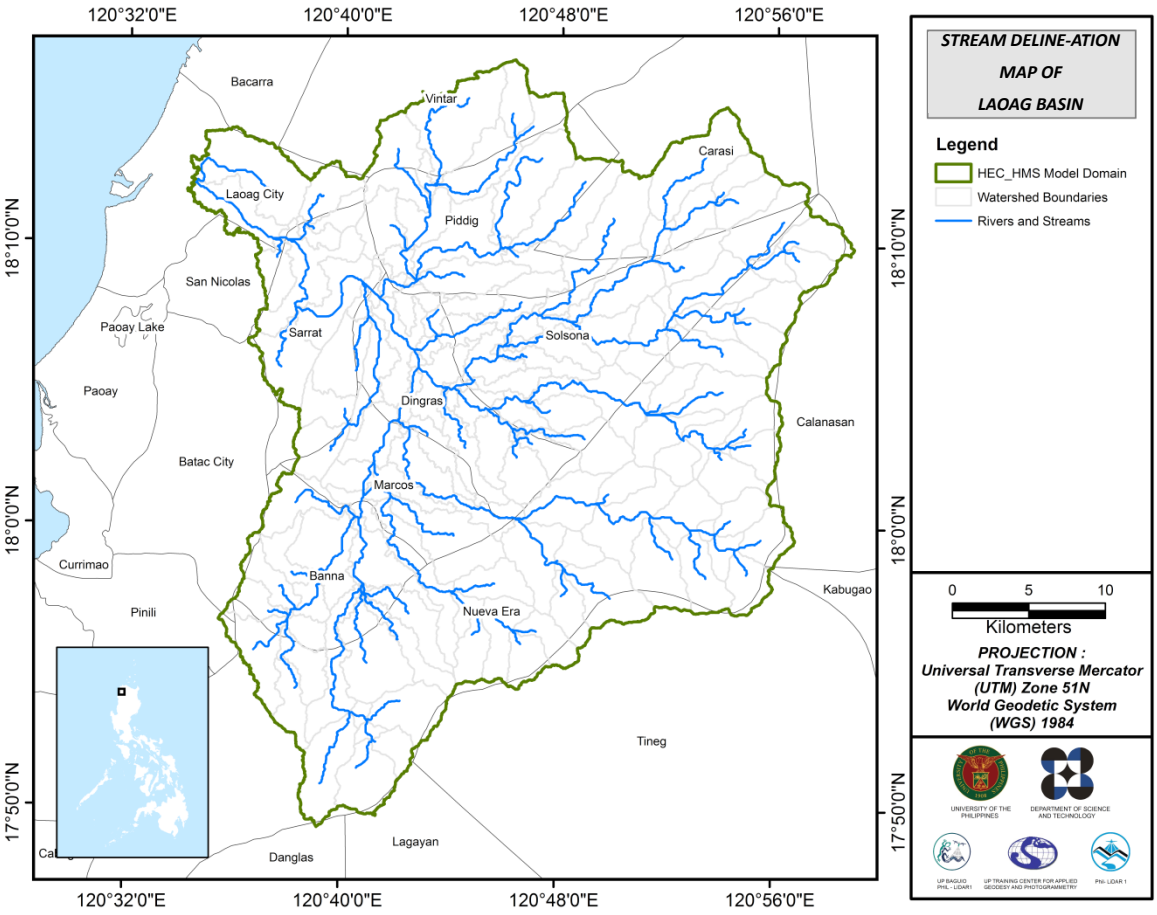

Figure 54.Stream Delineation Map of Laoag River Basin

Using the SAR-based DEM, the Laoag basin was delineated and further subdivided into subbasins. The model consists of 93 sub basins, 43 reaches, and 47 junctions, as shown in Figure 55. The main outlet is 831.

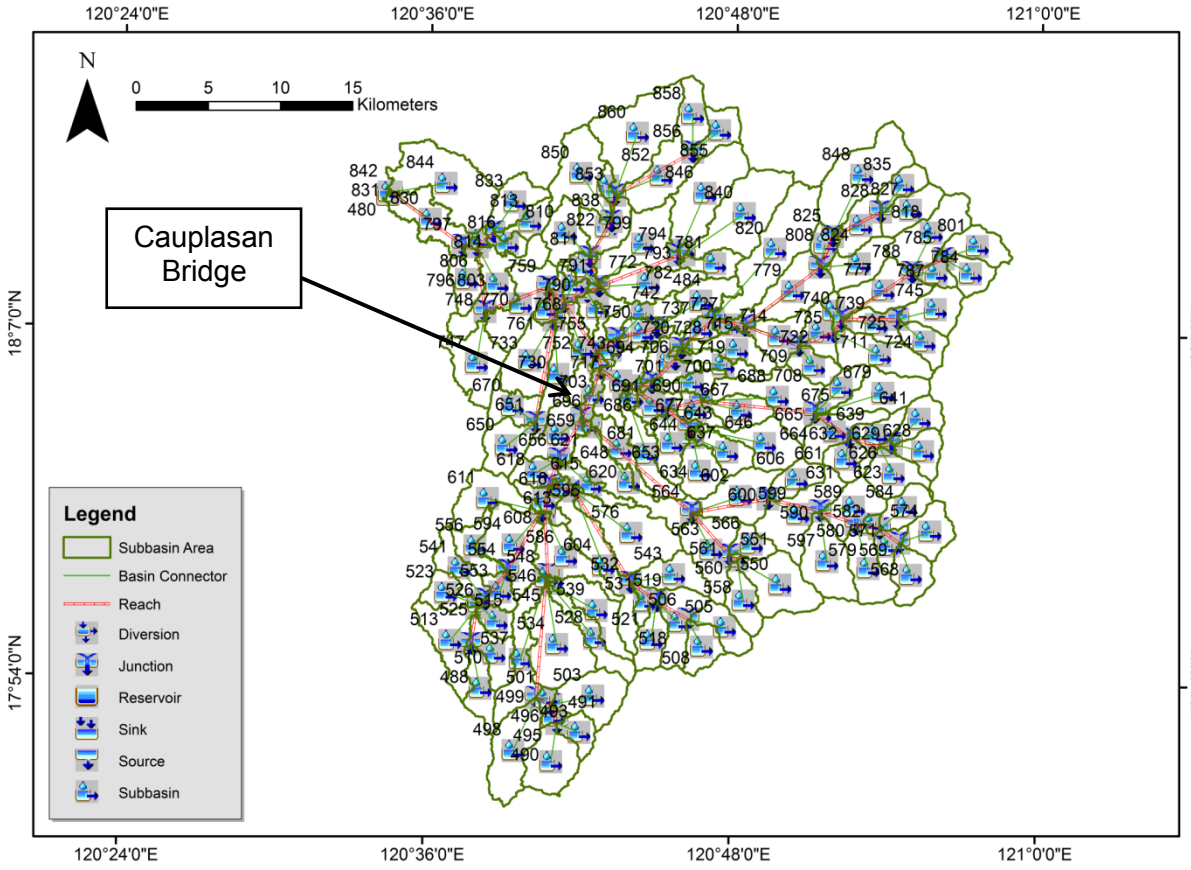

Figure 55.The Laoag river basin model generated using HEC-HMS.

5.4 Cross-Section Data

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

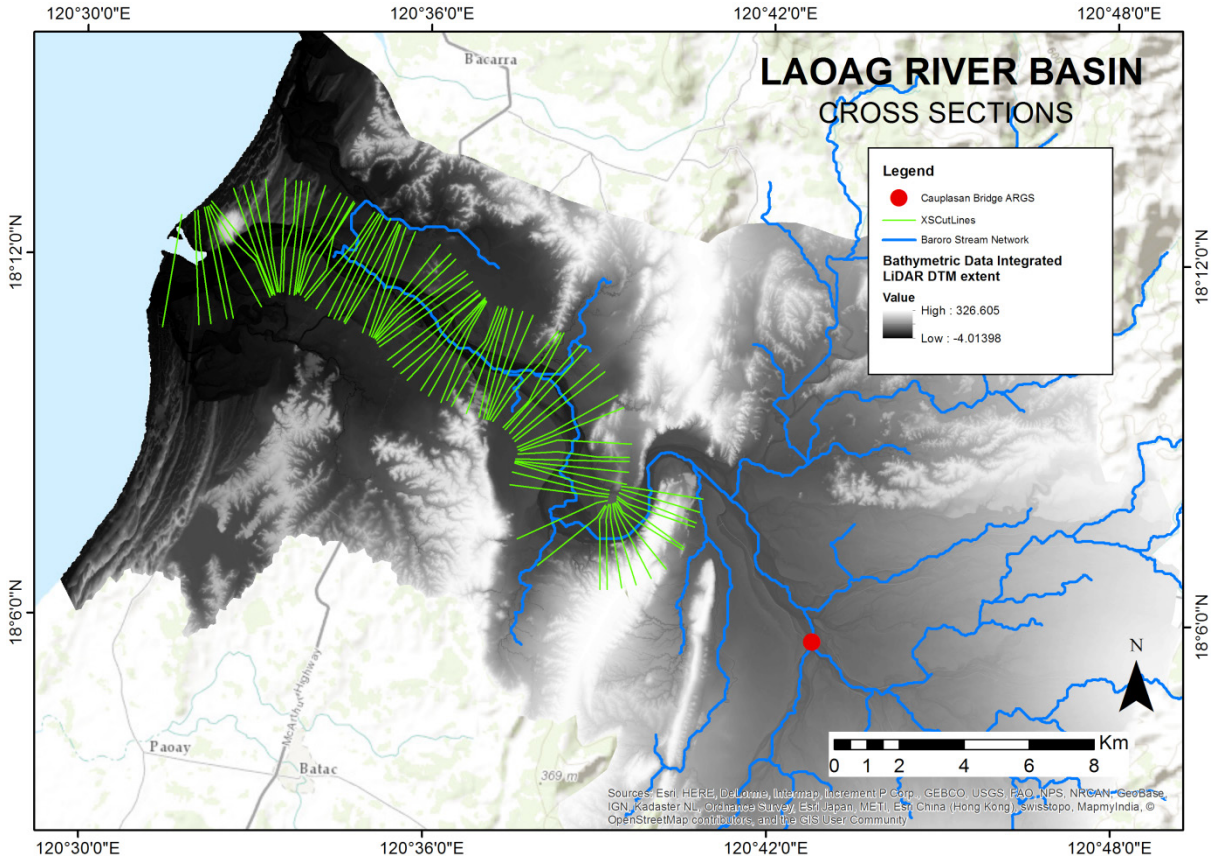

Figure 56. River cross-section of Laoag River generated through Arcmap HEC GeoRAS tool

5.5 Flo 2D Model

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

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

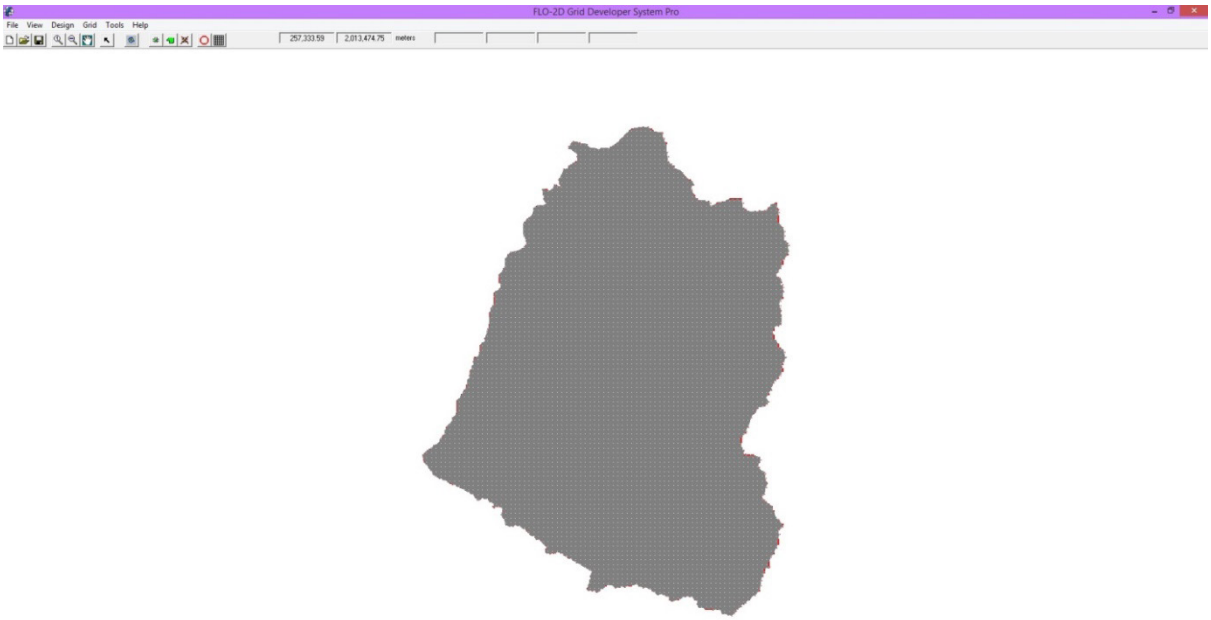

Figure 57. A screenshot of the river subcatchment with the computational area to be modeled in FLO-2D Grid Developer System Pro (FLO-2D GDS Pro)

The simulation is then run through FLO-2D GDS Pro. This particular model had a computer run time of 25.62598 hours. After the simulation, FLO-2D Mapper Pro is used to transform the simulation results into spatial data that shows flood hazard levels, as well as the extent and inundation of the flood. Assigning the appropriate flood depth and velocity values for Low, Medium, and High creates the following food hazard map. Most of the default values given by FLO-2D Mapper Pro are used, except for those in the Low hazard level. For this particular level, the minimum h (Maximum depth) is set at 0.2 m while the minimum vh (Product of maximum velocity (v) times maximum depth (h)) is set at 0 m^2/s.The generated hazard maps for Laoag are in Figures 61, 63, and 65.

The creation of a flood hazard map from the model also automatically creates a flow depth map depicting the maximum amount of inundation for every grid element. The legend used by default in Flo-2D Mapper is not a good representation of the range of flood inundation values, so a different legend is used for the layout. In this particular model, the inundated parts cover a maximum land area of 21903900.00 m^2.The generated flood depth maps for Laoag are in Figures 62, 64, and 66.

There is a total of 13129620.12 m^3 of water entering the model. Of this amount, 13129620.12 $m^3$is due to rainfall while 0.00 m^3 is inflow from other areas outside the model. 1795428.50 m^3 of this water is lost to infiltration and interception, while 1905883.92 m^3 is stored by the flood plain. The rest, amounting up to 9428306.77 m^3,is outflow.

5.6 Results of HMS Calibration

After calibrating the Laoag HEC-HMS river basin model, its accuracy was measured against the observed values. Laoag Model Basin Parameters are in Annex 9. Figure 58 shows the comparison between the two discharge data.

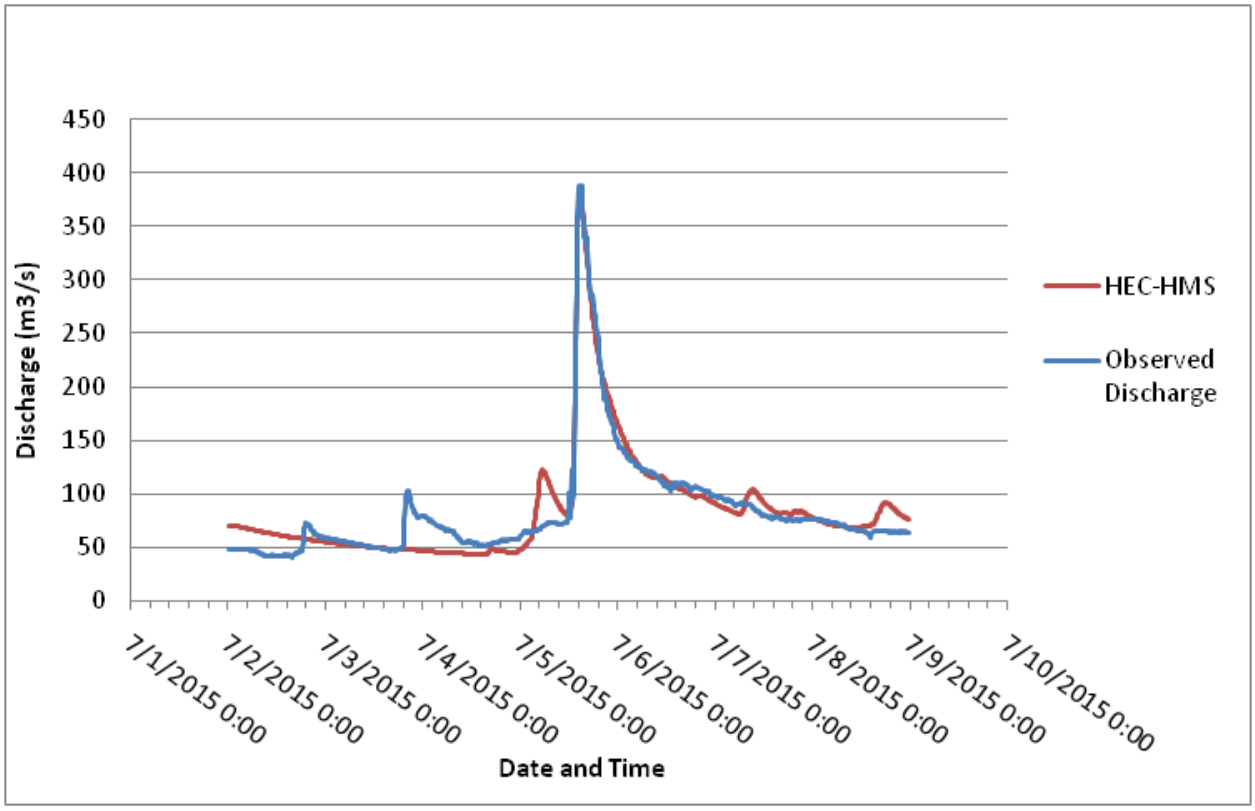

Figure 58.Outflow Hydrograph of Laoag produced by the HEC-HMS model compared with observed outflow

Enumerated in Table 29 are the adjusted ranges of values of the parameters used in calibrating the model.

Table 29.Range of Calibrated Values for Laoag

Hydrologic Element	Calculation Type	Method	Parameter	Range of Calibrated Values
Basin	Loss	SCS Curve Number	Initial Abstraction (mm)	0.478 – 8.5
			Curve Number	44.8 – 99
	Transform	Clark Unit Hydrograph	Time of Concentration (hr)	0.0167 – 1.7
			Storage Coefficient (hr)	0.128 – 20.82
	Baseflow	Recession	Recession Constant	0.21 - 1
			Ratio to Peak	0.077 – 0.42
Reach	Routing	Muskingum-Cunge	Manning's Coefficient	0.004 – 0.034

Initial abstraction defines the amount of precipitation that must fall before surface runoff. The magnitude of the outflow hydrograph increases as initial abstraction decreases. The range of values from 0.478 mm to 8.5 mm means that there is a small initial fraction of the storm depth after which runoff begins, increasing the river outflow.

The curve number is the estimate of the precipitation excess of soil cover, land use, and antecedent moisture. The magnitude of the outflow hydrograph increases as curve number increases. The range of 65 to 90 for curve number is advisable for Philippine watersheds depending on the soil and land cover of the area (M. Horritt, personal communication, 2012). For Laoag, the basin consists mainly of closed canopies and tree plantations and the soil consists of mostly undifferentiated land and clay loam.

Time of concentration and storage coefficient are the travel time and index of temporary storage of runoff in a watershed. The range of calibrated values from 0.0167 hours to 20.82 hours determines the reaction time of the model with respect to the rainfall. The peak magnitude of the hydrograph also decreases when these parameters are increased.

Recession constant is the rate at which baseflow recedes between storm events and ratio to peak is the ratio of the baseflow discharge to the peak discharge. Recession constant values within the range of 0.21 to 1 indicate that the discharge leaving every subbasin within Digos recede differ significantly. Values of ratio to peak within the range of 0.077 to 0.42 indicate a steeper receding limb of the outflow hydrograph.

Manning's roughness coefficients correspond to the common roughness of Philippine watersheds. Laoag river basin reaches' Manning's coefficients range from 0.004 to 0.034, showing that there is variety in surface roughness all over the catchment (Brunner, 2010).

Table 30.Summary of the Efficiency Test of Laoag HMS Model

RMSE	15.2
r^2	0.9195
NSE	0.92
PBIAS	-0.68
RSR	0.29

The Root Mean Square Error (RMSE) method aggregates the individual differences of these two measurements. It was computed as 15.2 m^3/s.

The Pearson correlation coefficient (r^2) assesses the strength of the linear relationship between the observations and the model. This value being close to 1 corresponds to an almost perfect match of the observed discharge and the resulting discharge from the HEC HMS model. Here, it measured 0.9195.

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 0.92.

A positive Percent Bias (PBIAS) indicates a model's propensity towards under-prediction. Negative values indicate bias towards over-prediction. Again, the optimal value is 0. In the model, the PBIAS is -0.68.

The Observation Standard Deviation Ratio, RSR, is an error index. A perfect model attains a value of 0 when the error in the units of the valuable a quantified. The model has an RSR value of 0.29.

5.7 Calculated Outflow Hydrographys and Discharge Values for Different Rainfall Return Models

5.7.1 Hydrograph Using the Rainfall Runoff Model

The summary graph (Figure 13) shows the Laoag outflow using the Laoag Rainfall Intensity-Duration-Frequency curves (RIDF) in 5 different return periods (5-year, 10-year, 25-year, 50-year, and 100-year rainfall time series) based on the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) data. The simulation results reveal significant increase in outflow magnitude as the rainfall intensity increases for a range of durations and return periods.

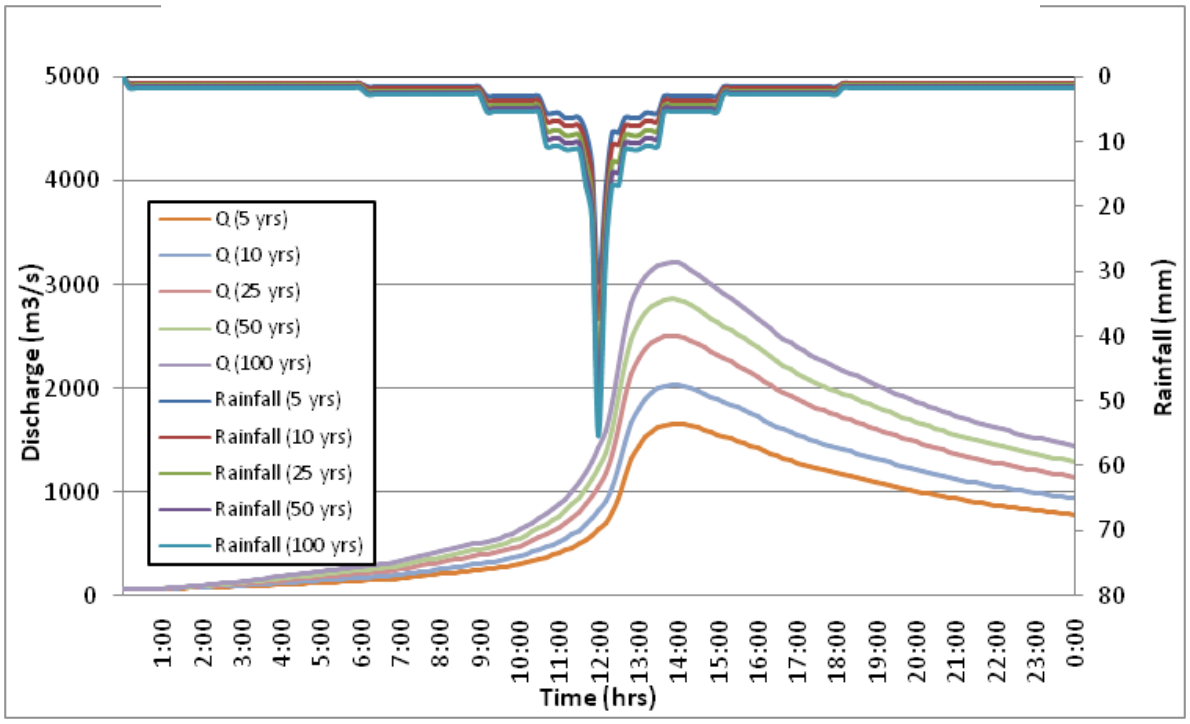

Figure 59. Outflow hydrograph at Laoag Station generated using the Laoag RIDF simulated in HEC-HMS.

A summary of the total precipitation, peak rainfall, peak outflow and time to peak of the Laoag discharge using the Laoag Rainfall Intensity-Duration-Frequency curves (RIDF) in five different return periods is shown in Table 31.

Table 31.Peak values of the Laoag HEC-HMS Model outflow using the Laoag RIDF

RIDF Period	Total Precipitation (mm)	Peak rainfall (mm)	Peak outflow (m^3/s)	Time to Peak
5-Year	331.7	31.4	1658.5	2 hours
10-Year	397.1	37.2	2030.5	2 hours
25-Year	479.8	44.5	2507	1 hour 50 minutes
50-Year	541.1	50	2861.2	1 hour 50 minutes
100-Year	602	55.3	3215.5	1 hour 50 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 real-time flood inundation extent of the river after it has been automated and uploaded on the DREAM website. For this publication, only a sample output map river was to be shown. The sample generated map of Laoag River using the calibrated HMS base flow is shown in Figure 60.

Figure 60. Sample output of Laoag RAS Model

5.9Flow Depth and Flood Hazard

The resulting hazard and flow depth maps have a 10m resolution. The 5-, 25-, and 100-year rain return scenarios of the Laoag floodplain are shown in Figures 61 to 66. The floodplain, with an area of 1407.48 sq. km., covers 16 municipalities. Table 32 shows the percentage of area affected by flooding per municipality.

Table 32.Municipalities affected in Laoag floodplain

Province	Municipality	Total Area	Area Flooded	% Flooded
Ilocos Norte	Bacarra	47.10	1.82	3.87%
Ilocos Norte	Banna	89.62	88.02	98.22%
Ilocos Norte	Batac City	134.62	3.17	2.35%
Ilocos Norte	Carasi	190.24	84.80	44.58%
Ilocos Norte	Dingras	90.65	90.65	100.00%
Ilocos Norte	Laoag City	114.36	111.04	97.10%
Ilocos Norte	Marcos	73.57	73.04	99.27%
Ilocos Norte	Nueva Era	619.00	452.32	73.07%
Ilocos Norte	Paoay Lake	3.64	3.51	96.55%
Ilocos Norte	Paoay	71.62	15.66	21.87%
Ilocos Norte	Piddig	128.57	121.36	94.40%
Ilocos Norte	Pinili	63.18	1.45	2.30%
Ilocos Norte	San Nicolas	40.23	40.14	99.79%
Ilocos Norte	Sarrat	92.25	85.01	92.15%
Ilocos Norte	Solsona	153.13	152.99	99.91%
Ilocos Norte	Vintar	497.39	55.12	11.08%

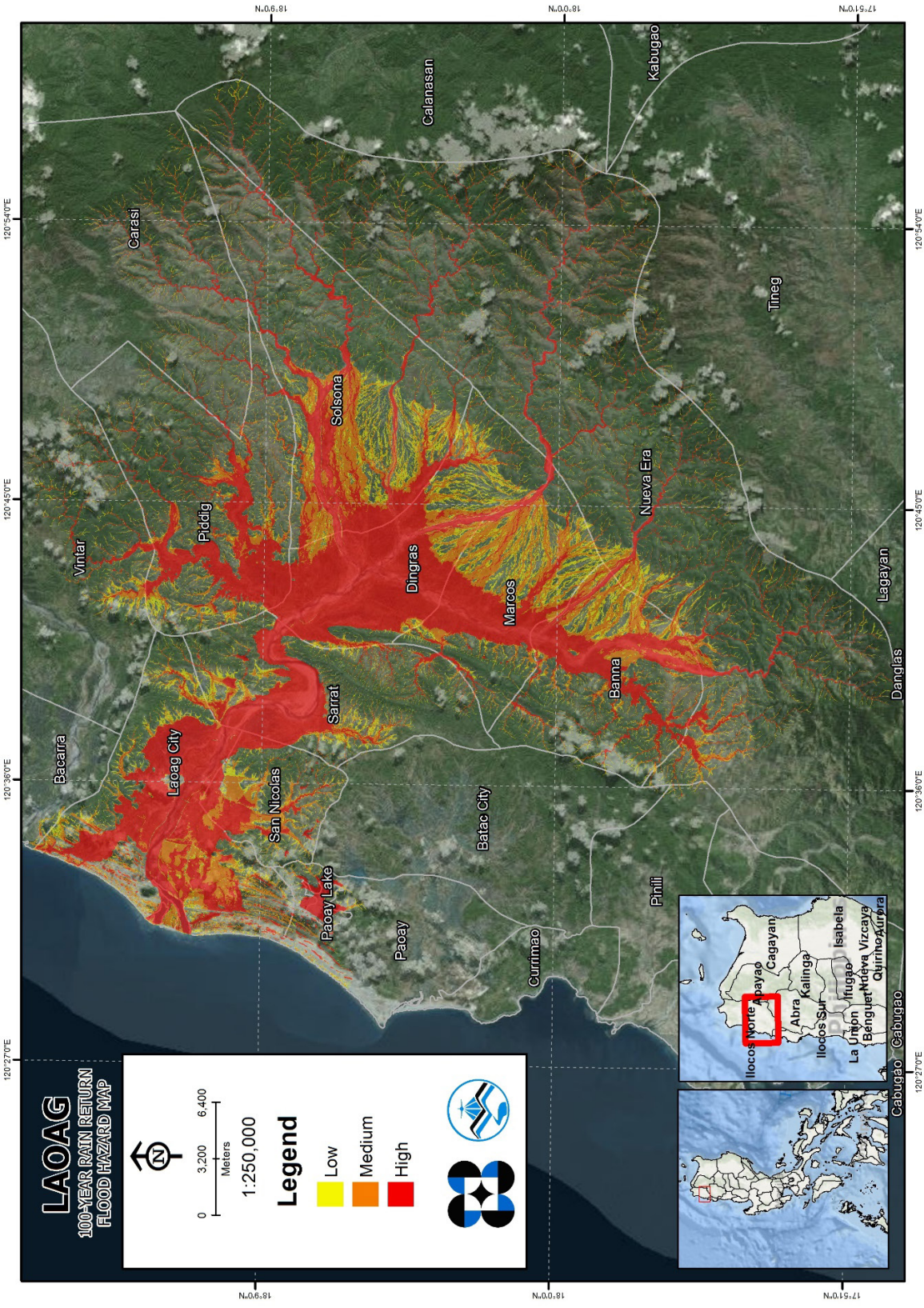

Figure 61. 100-year Flood Hazard Map for Laoag Floodplain overlaid on Google Earth imagery

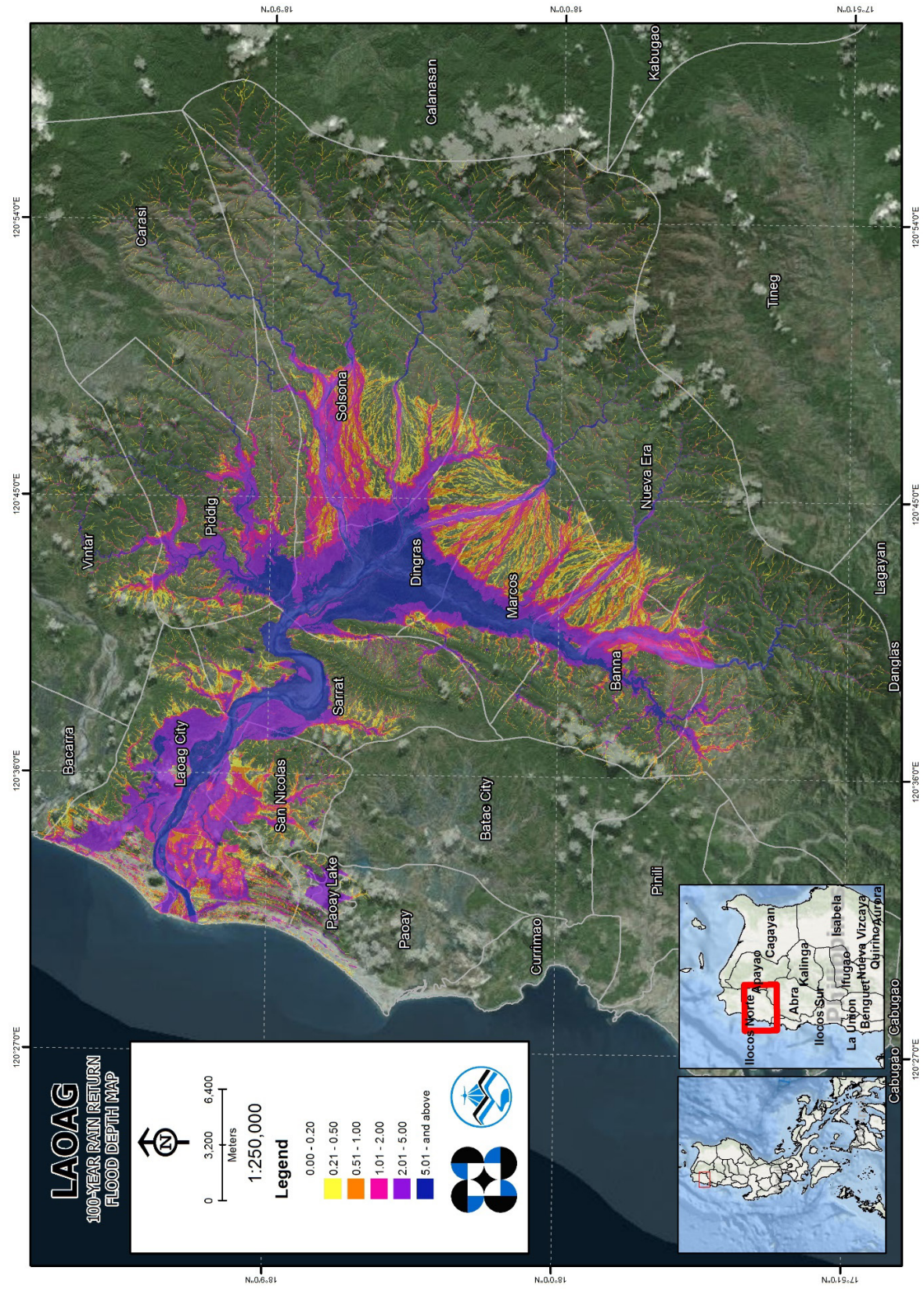

Figure 62. 100-year Flow Depth Map for Laoag Floodplain overlaid on Google Earth imagery

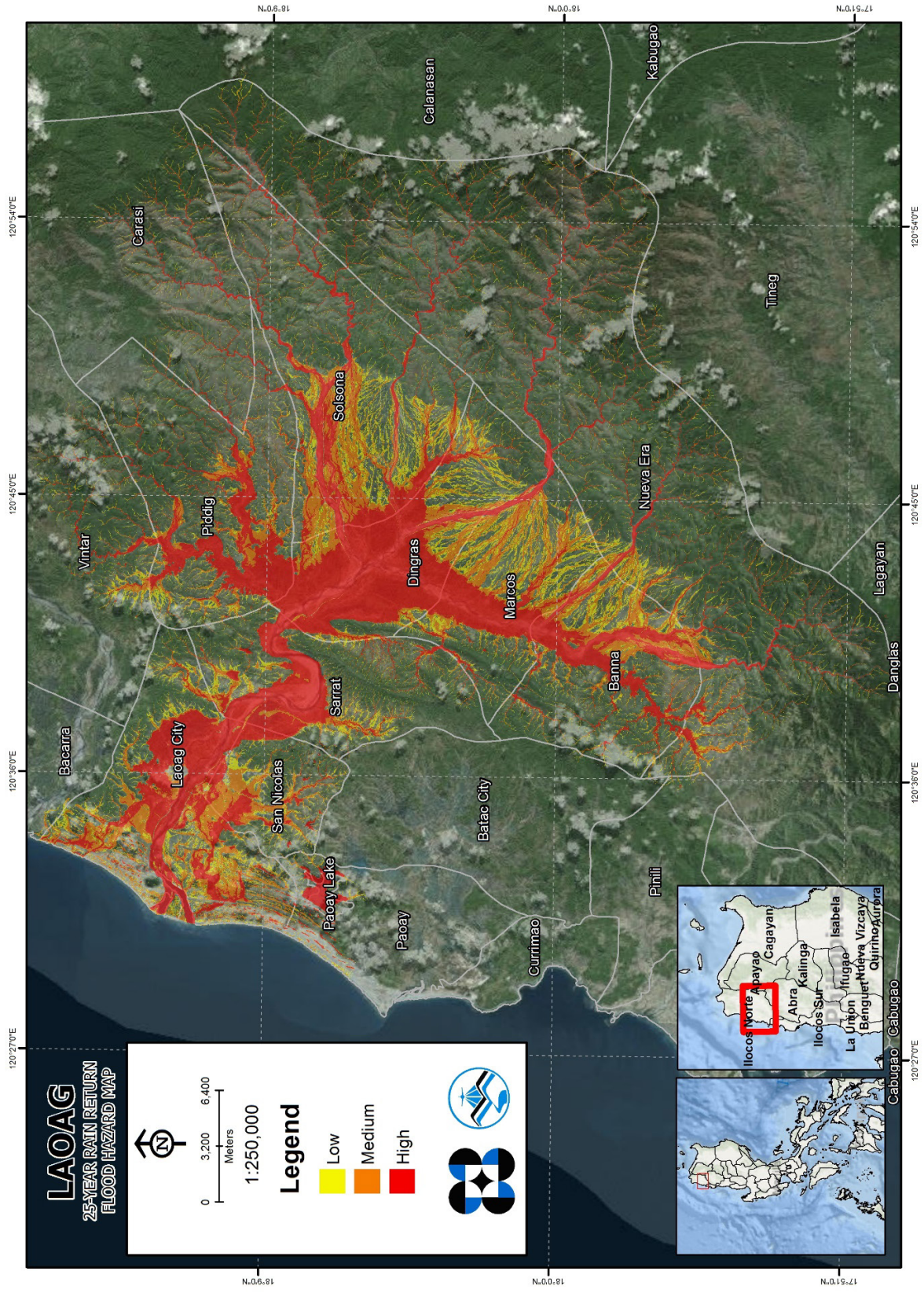

Figure 63. 25-year Flood Hazard Map for Laoag Floodplain overlaid on Google Earth imagery

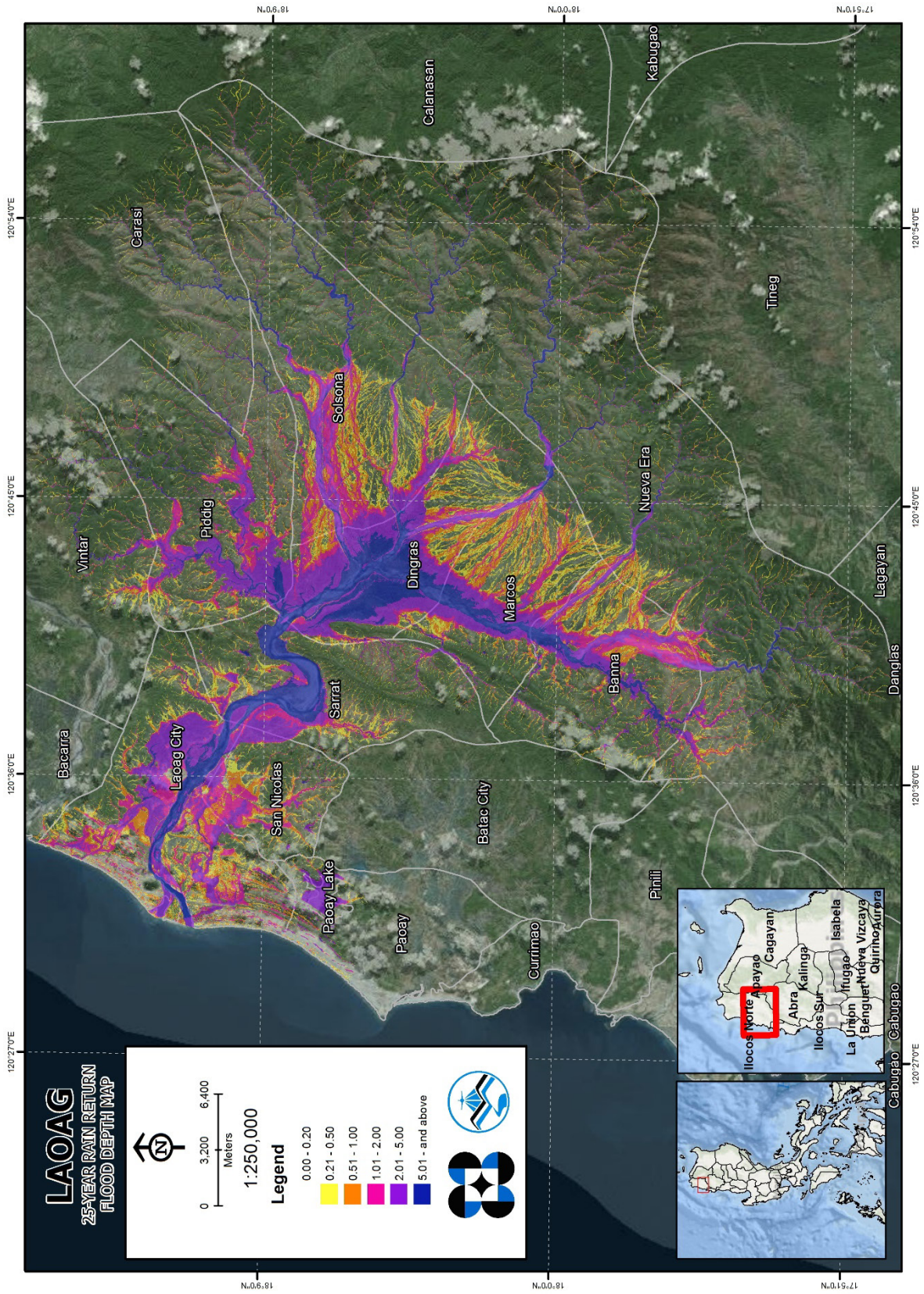

Figure 64. 25-year Flow Depth Map for Laoag Floodplain overlaid on Google Earth imagery

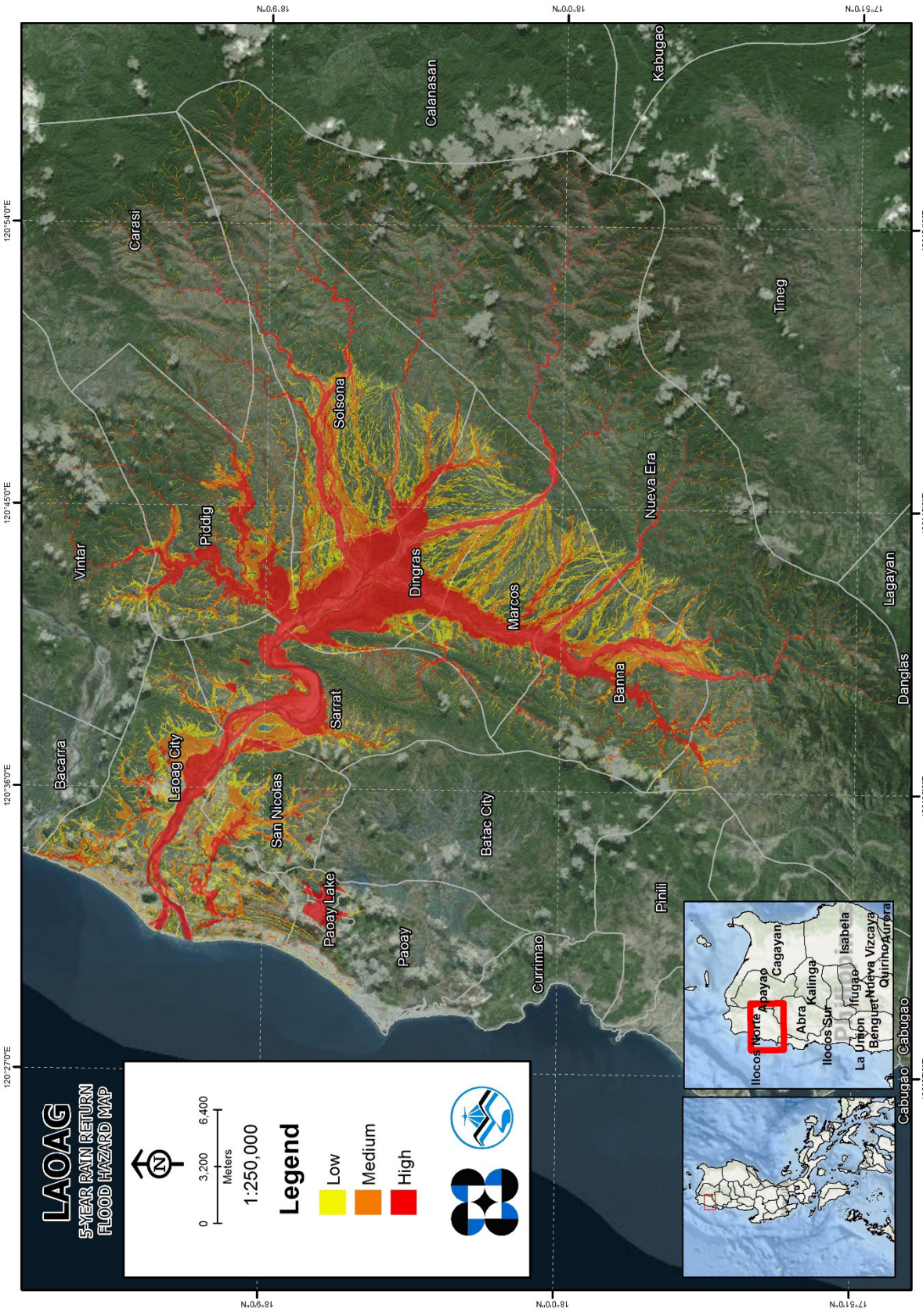

Figure 65. 5-year Flood Hazard Map for Laoag Floodplain overlaid on Google Earth imagery

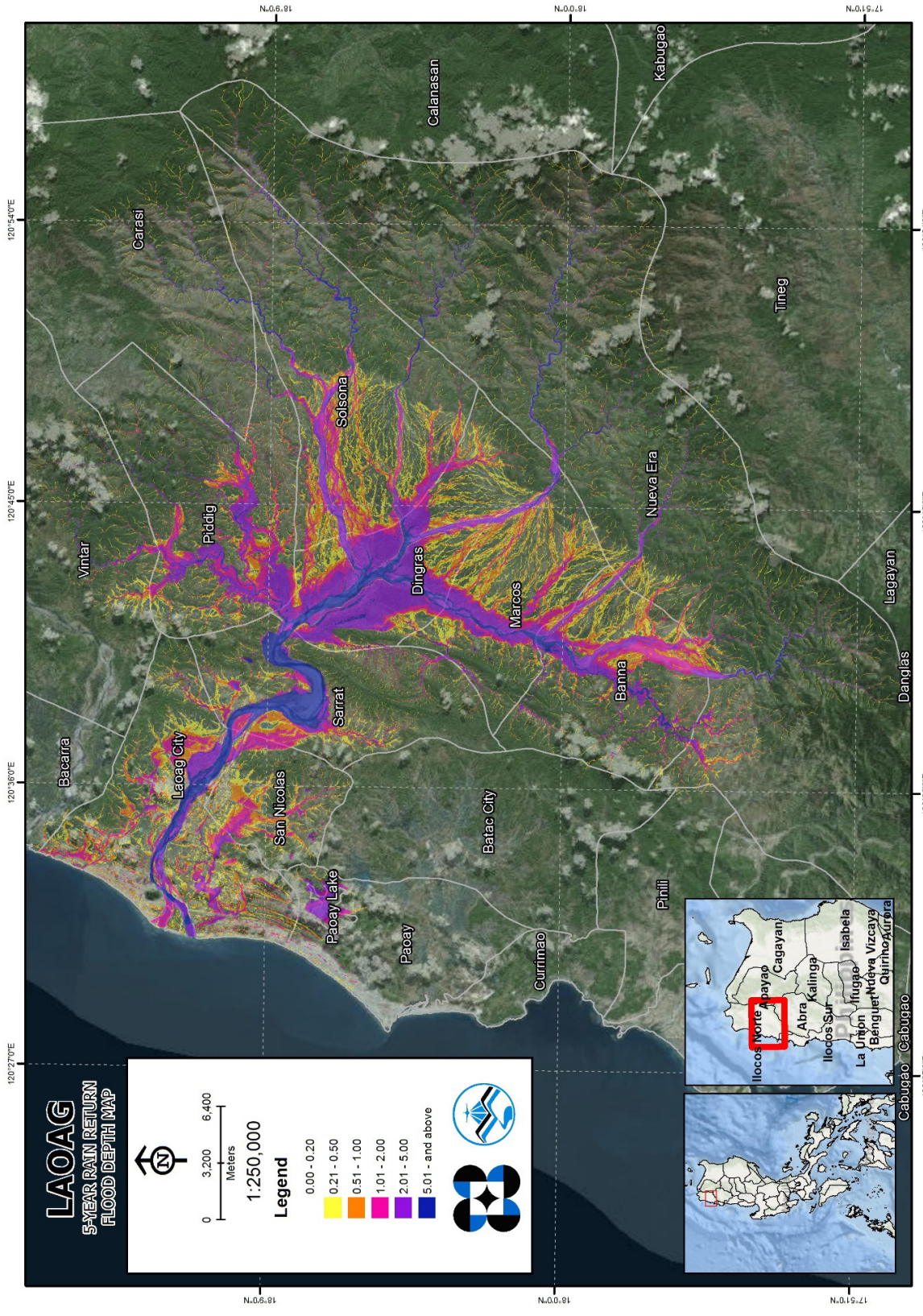

Figure 66. 5-year Flow Depth Map for Laoag Floodplain overlaid on Google Earth imagery

5.10 Inventory of Areas Exposed to Flooding of Affected Areas

Affected barangays in Laoag river basin, grouped by municipality, are listed below. For the said basin, 16 municipalities consisting of 275 barangays are expected to experience flooding when subjected to 5-yr rainfall return period.

For the 5-year return period, 3.23% of the municipality of Bacarra with an area of 47.1 sq. km. will experience flood levels of less than 0.20 meters. 0.38% of the area will experience flood levels of 0.21 to 0.50 meters while 0.19% and 0.03% of the area will experience flood depths of 0.51 to 1 meter and 1.01 to 2 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 33.Affected Areas in Bacarra, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Bacarra (in sq. km)			
	Casilian	Ganagan	Pasiocan	Sangil
0.03-0.20	0.13	1.17	0.16	0.063
0.21-0.50	0.015	0.16	0.0022	0.0035
0.51-1.00	0.0052	0.082	0.0013	0.0028
1.01-2.00	0	0.016	0.0004	0
2.01-5.00	0	0	0	0
> 5.00	0	0	0	0

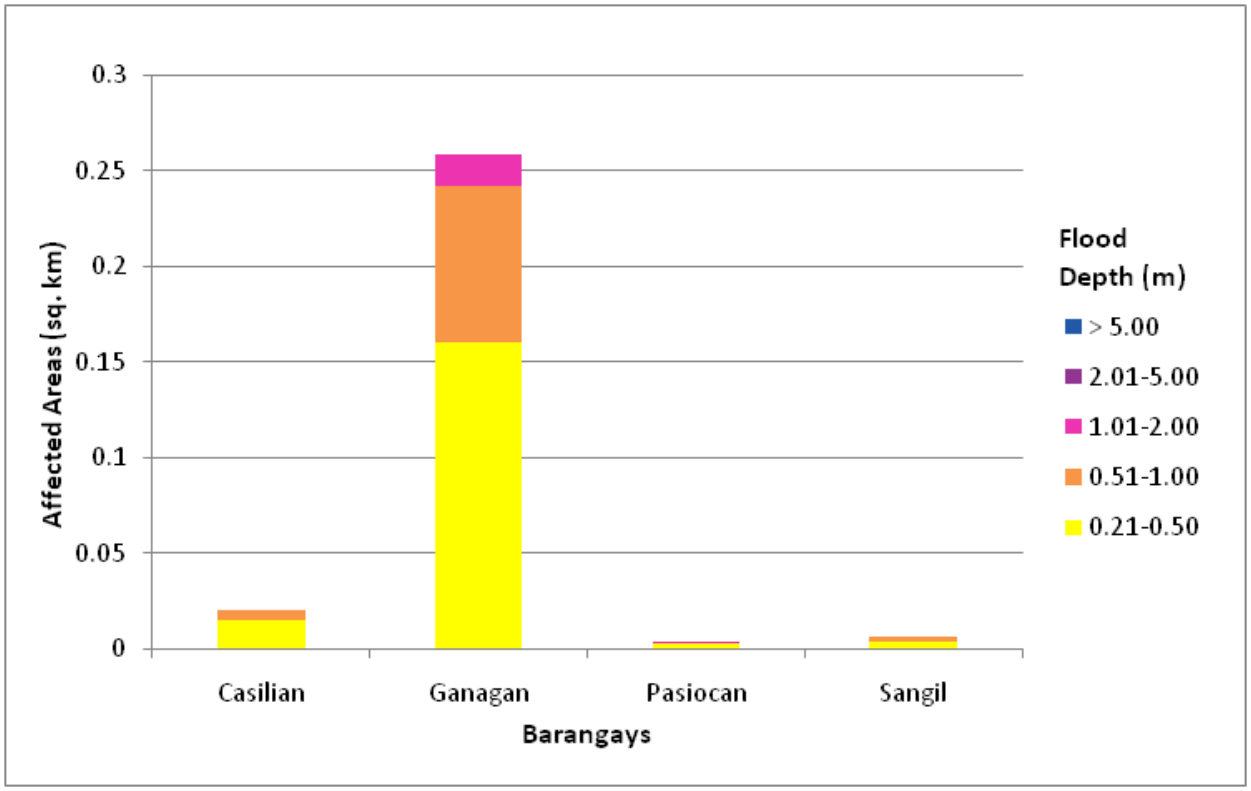

Figure 67.Affected Areas in Bacarra, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 60.47% of the municipality of Banna with an area of 89.62 sq. km. will experience flood levels of less than 0.20 meters. 9.36% of the area will experience flood levels of 0.21 to 0.50 meters while 8.80%, 9.94%, 8.01%, and 1.74% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 34.Affected Areas in Banna, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Banna (in sq. km)									
	Balioeg	Bangsar	Barba-rangay	Binacag	Bomitog	Bugasi	Caeste-banan	Caribquib	Catagtaguen	Crispina
0.03-0.20	2.32	1.8	7.04	2.4	6.35	1.22	2.23	0.19	2.99	6.2
0.21-0.50	1.33	0.14	0.33	0.16	0.35	0.72	0.96	0.066	0.82	0.57
0.51-1.00	1.82	0.097	0.25	0.2	0.15	0.4	0.42	0.094	1.2	0.51
1.01-2.00	2.62	0.076	0.19	0.24	0.1	0.32	0.15	0.17	1.25	0.41
2.01-5.00	0.83	0.12	0.11	0.29	0.049	0.39	0.072	0.52	0.81	0.42
> 5.00	0	0.029	0.0075	0.11	0.0063	0	0	0.12	0.44	0.066

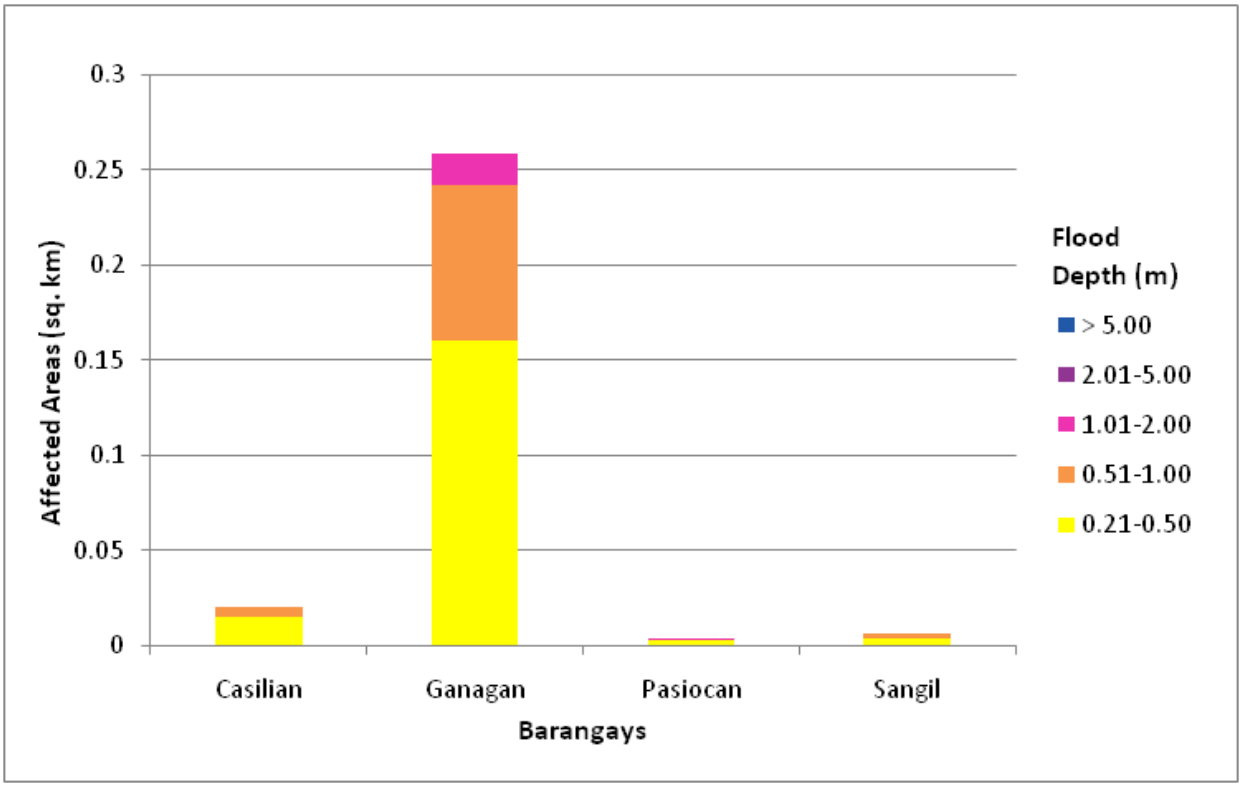

Figure 68.Affected Areas in Banna, Ilocos Norte during 5-Year Rainfall Return Period

Table 35.Affected Areas in Banna, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Banna (in sq. km)									
	Hilario	Imelda	Lorenzo	Ma-cayepy-ep	Marcos	Nagpa-tayan	Sinamar	Tabtaba-gan	Valdez	Valen-ciano
0.03-0.20	0.27	2.05	0.3	4.17	0.88	9.31	2.27	0.76	0.57	0.88
0.21-0.50	0.024	0.18	0.011	0.26	0.055	0.72	0.97	0.39	0.3	0.04
0.51-1.00	0.26	0.14	0.0076	0.35	0.027	0.45	0.85	0.37	0.28	0.015
1.01-2.00	0.46	0.16	0.0038	1.25	0.0073	0.39	0.47	0.47	0.17	0.0056
2.01-5.00	0.59	0.22	0.0055	0.35	0	0.51	0.56	1.1	0.24	0.0013
> 5.00	0.031	0.048	0.0013	0	0	0.061	0.01	0.63	0	0

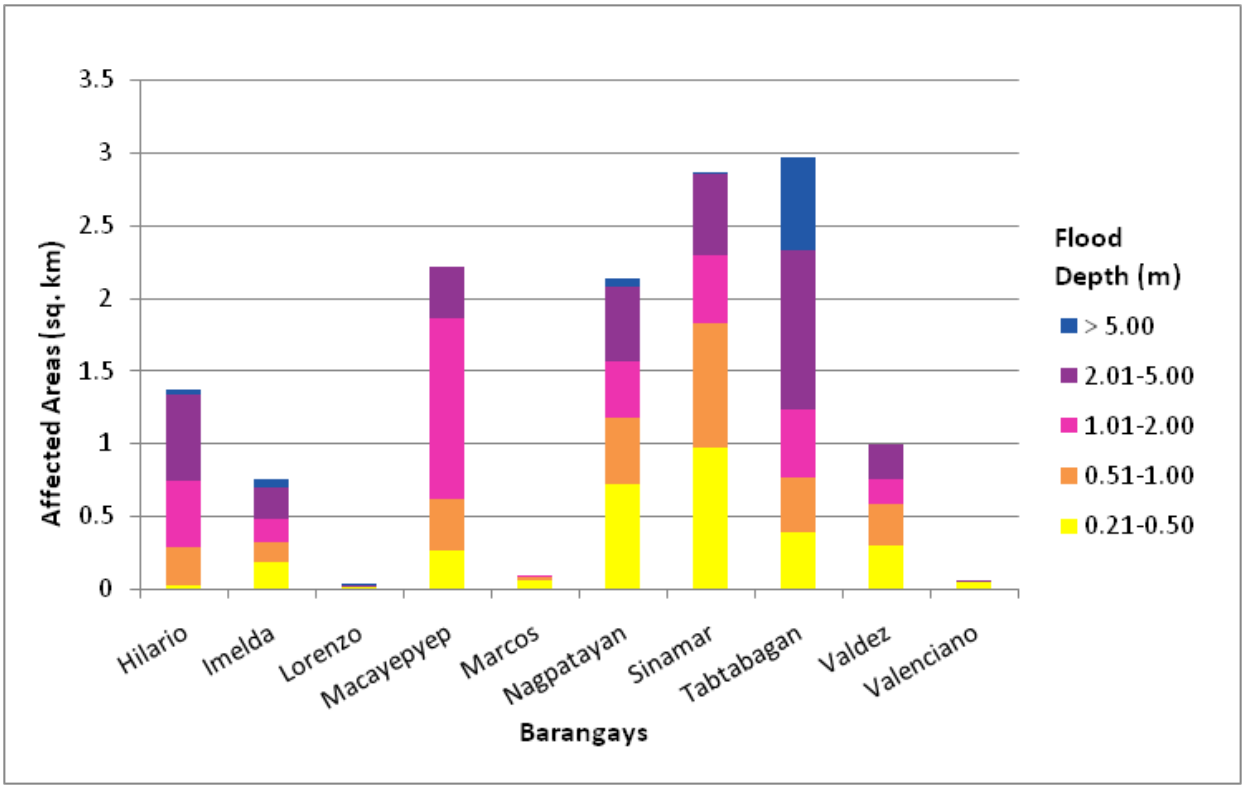

Figure 69.Affected Areas in Banna, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 2.28% of the municipality of Batac City with an area of 134.62 sq. km. 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 while 0.02% of the area will experience flood depths of 0.51 to 1 meter. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 36.Affected Areas in Batac City, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Batac City (in sq. km)						
	Baay	Bungon	Caman-dingan	Dariwd-iw	Maipalig	Nagba-calan	Sumader
0.03-0.20	0.32	0.18	0.14	0.077	1.79	0.47	0.088
0.21-0.50	0.0089	0.0047	0.0007	0.00069	0.045	0.013	0.000071
0.51-1.00	0.0018	0.0022	0.0011	0.0003	0.01	0.0062	0.00013
1.01-2.00	0.0009	0.0011	0.0004	0.0001	0.00093	0.0015	0
2.01-5.00	0.0002	0.0002	0.0013	0	0.00012	0.0008	0
> 5.00	0	0	0	0	0	0	0

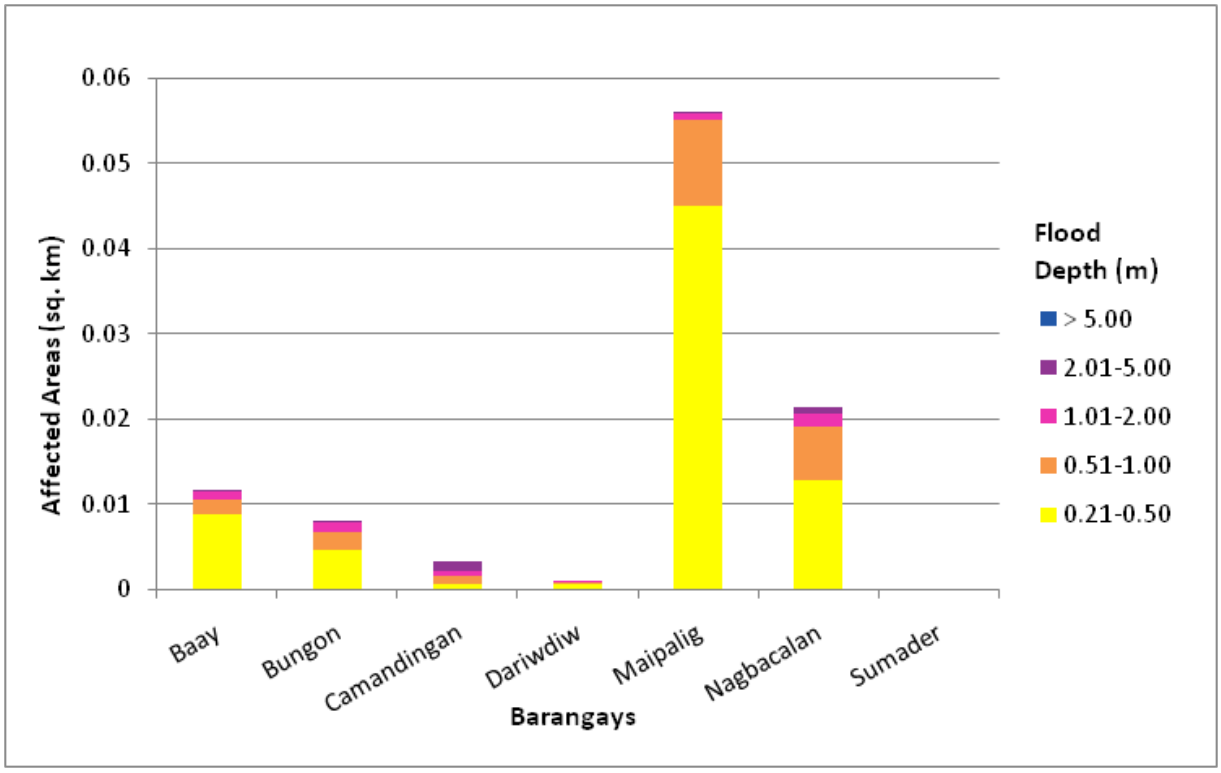

Figure 70.Affected Areas in Batac City, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 1.37% of the municipality of Carasi with an area of 190.236 sq. km. 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 while 0.04%, 0.03%, 0.01%, and 0.01% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 37.Affected Areas in Carasi, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Carasi (in sq. km)
	Virbira
0.03-0.20	2.61
0.21-0.50	0.098
0.51-1.00	0.078
1.01-2.00	0.056
2.01-5.00	0.017
> 5.00	0.017

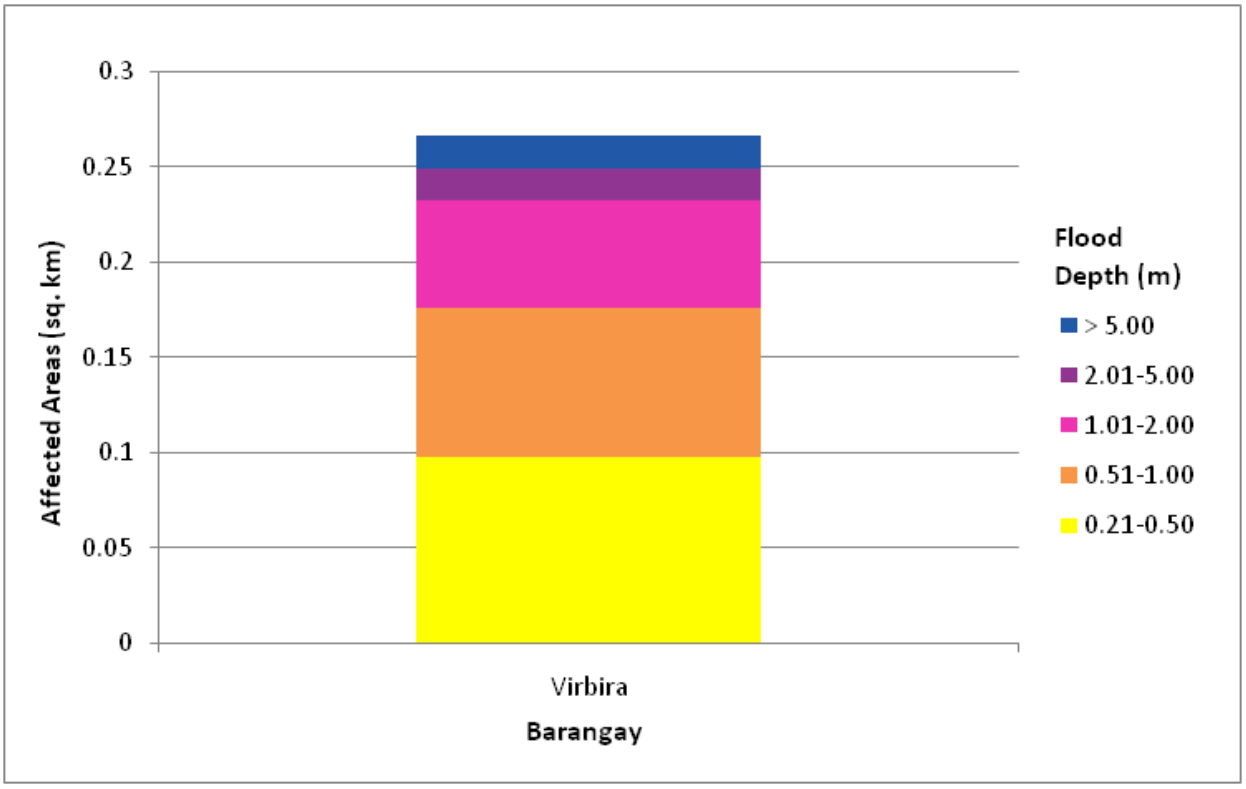

Figure 71.Affected Areas in Carasi, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 34.33% of the municipality of Dingras with an area of 90.65 sq. km. will experience flood levels of less than 0.20 meters. 11.44% of the area will experience flood levels of 0.21 to 0.50 meters while 8.84%, 11.82%, 23.80%, and 8.35% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 38.Affected Areas in Dingras, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Dingras (in sq. km)										
	Albano	Bacsil	Bagut	Bares-bes	Barong	Bungcag	Cali	Capasan	Dancel	Eliza-beth	Espiritu
0.03-0.20	0	0.9	0	3.92	0.71	0.013	1.29	0.44	0	0.49	2.18
0.21-0.50	0	0.2	0.0006	1.48	0.63	0.0021	0.82	0.15	0.00038	0.3	0.33
0.51-1.00	0.0012	0.14	0.12	0.94	0.63	0.0021	0.48	0.083	0.0029	0.34	0.27
1.01-2.00	0.0044	0.068	0.4	0.65	1.57	0.0053	0.24	0.11	0.015	0.39	0.23
2.01-5.00	0.14	0.044	0.84	2.28	1.65	0.46	0.063	0.58	0.17	0.42	0.14
> 5.00	0.23	0.0052	0.0096	0.26	0.23	0.18	0.0083	0.0043	0.19	0.0015	0.029

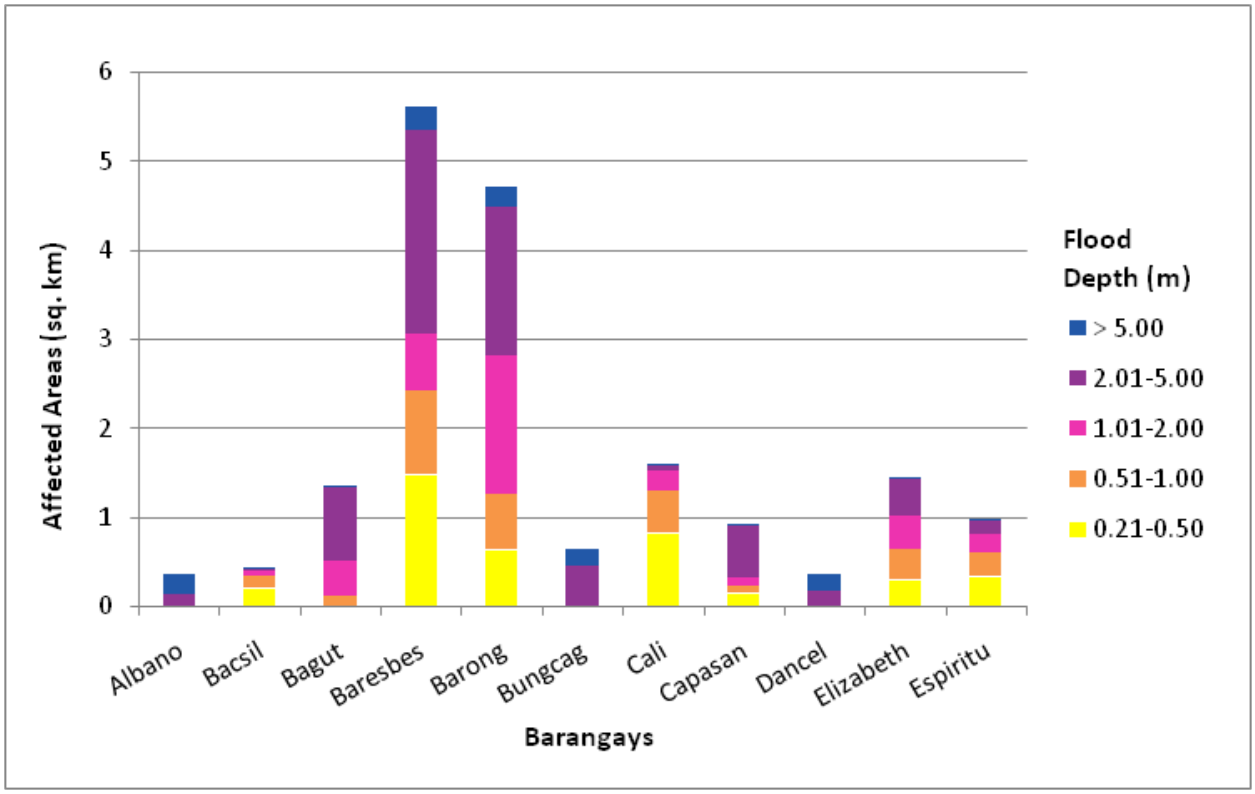

Figure 72.Affected Areas in Dingras, Ilocos Norte during 5-Year Rainfall Return Period

Table 39.Affected Areas in Dingras, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Dingras (in sq. km)									
	Foz	Guerre-ro	Lanas	Lumbad	Madam-ba	Man-daloque	Medina	Parado	Peralta	Puruga-nan
0.03-0.20	0.045	0.083	1.31	0	0	0	0.066	0.015	0.013	0.0001
0.21-0.50	0.027	0.079	0.77	0.0003	0.00088	0	0.056	0.016	0.0047	0.0025
0.51-1.00	0.047	0.095	0.56	0.0012	0.0062	0.0008	0.16	0.11	0.0072	0.0023
1.01-2.00	0.22	0.23	0.42	0.0053	0.0064	0.19	0.52	0.94	0.011	0.0029
2.01-5.00	2.67	0.3	0.92	1.57	0.25	1.4	0.29	0.44	0.71	0.22
> 5.00	0.65	0.39	0.065	1.41	0.43	0.65	0.053	0.13	0.47	0.17

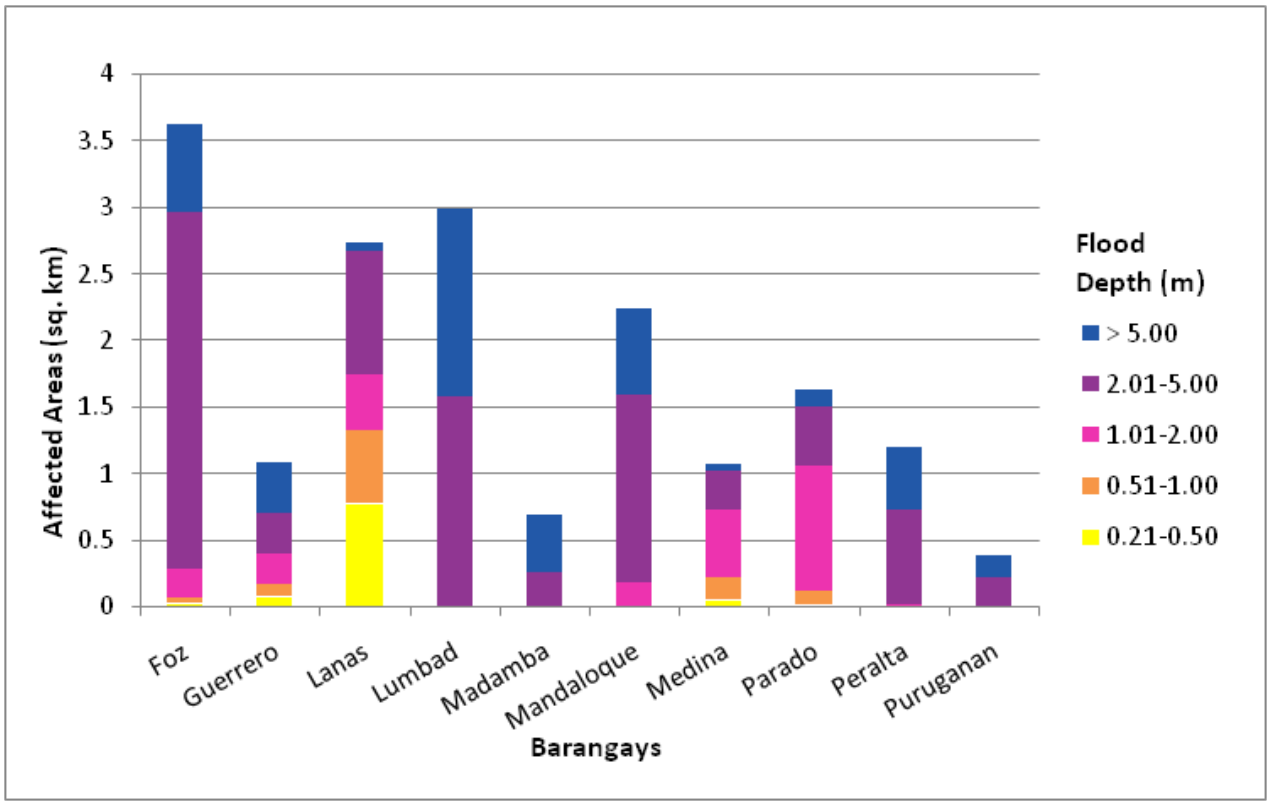

Figure 73.Affected Areas in Dingras, Ilocos Norte during 5-Year Rainfall Return Period

Table 40.Affected Areas in Dingras, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Dingras (in sq. km)									
	Root	Sagpa-tan	Sa-ludares	San Esteban	San Francis-co	San Marceli-no	San Marcos	Sulqui-ano	Suyo	Ver
0.03-0.20	0.036	0.033	0.36	0.6	12.82	4.08	0.83	0.15	0.11	0.63
0.21-0.50	0.097	0.1	0.38	0.25	2.12	0.8	0.85	0.11	0.034	0.76
0.51-1.00	0.14	0.12	0.24	0.28	1.32	0.31	0.67	0.033	0.071	0.82
1.01-2.00	0.95	0.41	0.44	0.42	0.82	0.13	0.78	0.014	0.33	0.18
2.01-5.00	0.099	1.34	0.0031	0.059	0.12	0.27	1.18	1.15	1.76	0.057
> 5.00	0.091	0.15	0	0	0	0.016	0.12	0.55	1.06	0

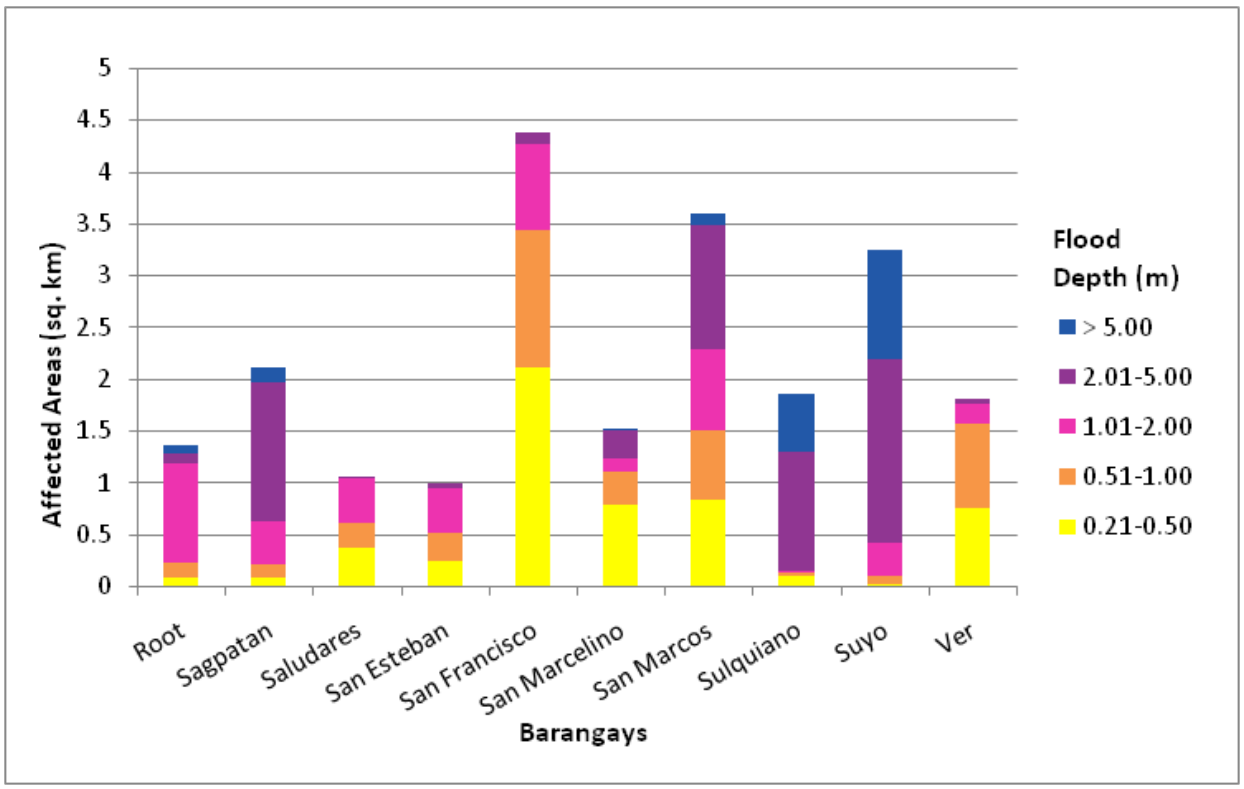

Figure 74.Affected Areas in Dingras, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 55.78% of the municipality of Laoag City with an area of 114.355 sq. km. will experience flood levels of less than 0.20 meters. 13.05% of the area will experience flood levels of 0.21 to 0.50 meters while 10.09%, 8.42%, 6.21%, and 3.61% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 41.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 1, San Lorenzo	Bgy. No. 10, San Jose	Bgy. No. 11, Santa Balbina	Bgy. No. 12, San Isidro	Bgy. No. 13, Nstra. Sra. De Visitaci	Bgy. No. 14, Santo Tomas	Bgy. No. 15, San Guillermo	Bgy. No. 16, San Jacinto	Bgy. No. 17, San Francis-co	Bgy. No. 19, Santa Marcela
0.03-0.20	0.094	0.046	0.031	0.02	0.032	0.11	0.045	0.043	0.1	0.049
0.21-0.50	0.045	0.032	0.043	0.031	0.018	0.039	0.017	0.022	0.034	0.015
0.51-1.00	0.013	0.0042	0.027	0.019	0.015	0.0047	0.00014	0.0001	0.0038	0.00035
1.01-2.00	0.0076	0.00016	0.0017	0.0094	0.002	0.0055	0.000028	0	0.0092	0.0013
2.01-5.00	0.0026	0.0018	0	0.0032	0	0.019	0	0	0.022	0.018
> 5.00	0.011	0.012	0	0	0	0.08	0	0	0.046	0.028

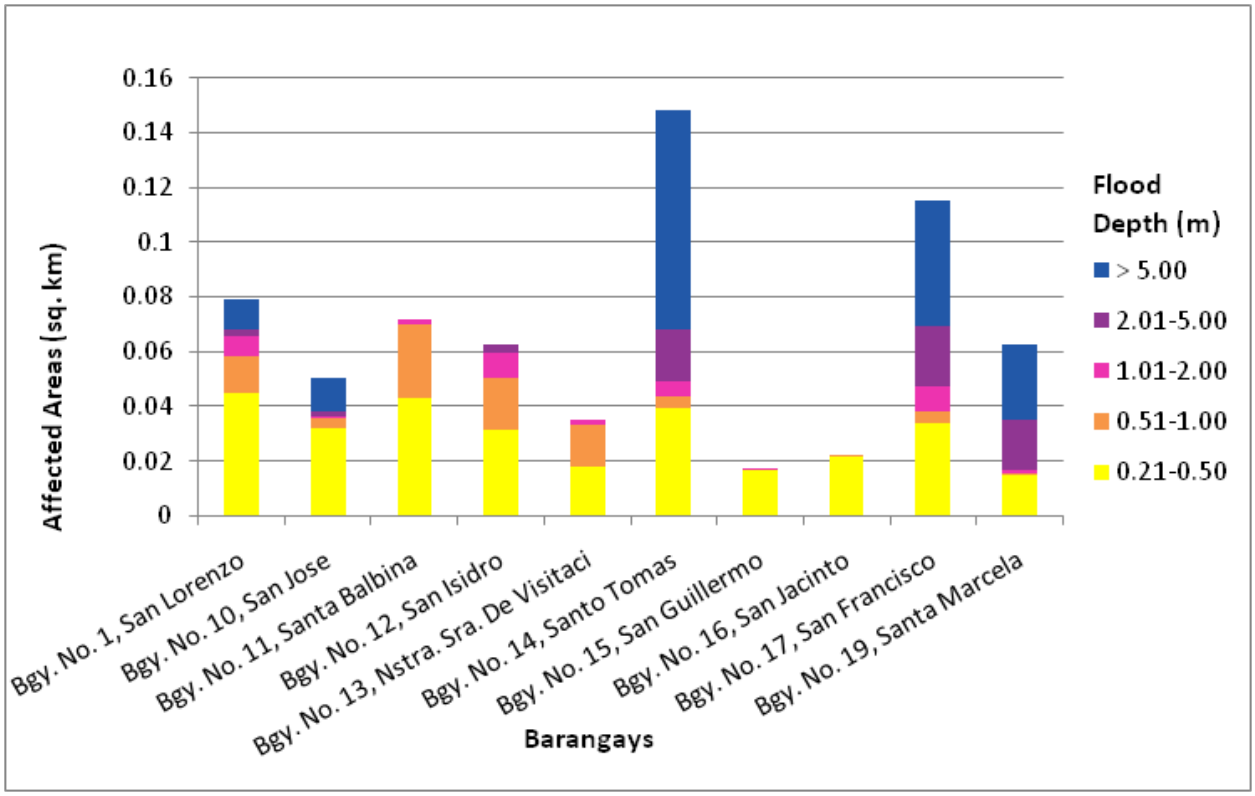

Figure 75.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Table 42.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 2, Santa Joaquina	Bgy. No. 20, San Miguel	Bgy. No. 21, San Pedro	Bgy. No. 22, San Andres	Bgy. No. 23, San Matias	Bgy. No. 24, Nstra. Sra. De Consolac	Bgy. No. 25, Santa Cayet-ana	Bgy. No. 26, San Marceli-no	Bgy. No. 27, Nstra. Sra. de Soledad	Bgy. No. 28, San Bernar-do
0.03-0.20	0.17	0.027	0.19	0.025	0.46	0.033	0.11	0.086	0.099	0.15
0.21-0.50	0.063	0.021	0.042	0.0062	0.11	0.0005	0.0053	0.0061	0.061	0.039
0.51-1.00	0.11	0.002	0.012	0.005	0.034	0.0006	0.00035	0.0026	0.0095	0.013
1.01-2.00	0.15	0.00074	0.0068	0.00062	0.0075	0.00073	0.00059	0.0043	0.0022	0.00094
2.01-5.00	0.14	0.033	0.0078	0.02	0	0.048	0.021	0.039	0.069	0.096
> 5.00	0.0032	0.045	0.0011	0.1	0	0.12	0.037	0.064	0.047	0.019

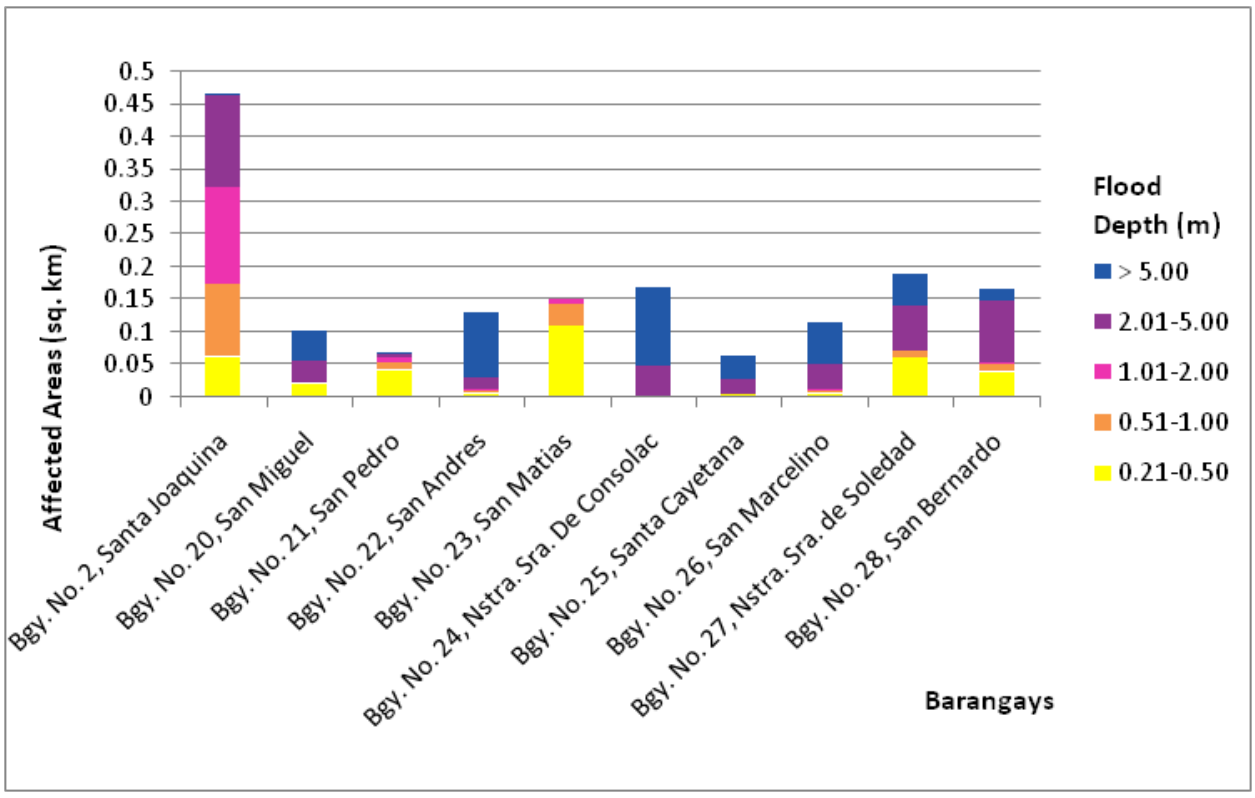

Figure 76.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Table 43.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 29, Santo Tomas	Bgy. No. 3, Nstra. Sra. Del Rosario	Bgy. No. 30-A, Suyo	Bgy. No. 30-B, Santa Maria	Bgy. No. 31, Tal-ingaan	Bgy. No. 32-A, La Paz East	Bgy. No. 32-B, La Paz West	Bgy. No. 32-C La Paz East	Bgy. No. 33-A, La Paz Proper	Bgy. No. 33-B, La Paz Proper
0.03-0.20	0.059	0.043	0.29	0.56	3.12	0.32	0.8	0.49	0.36	0.15
0.21-0.50	0.0084	0.018	0.077	0.24	0.36	0.072	0.21	0.029	0.0075	0.012
0.51-1.00	0.005	0.0075	0.016	0.4	0.42	0.047	0.18	0.041	0.0024	0.015
1.01-2.00	0.043	0.0049	0.077	0.38	0.3	0.012	0.064	0.083	0.0044	0.031
2.01-5.00	0.22	0.0092	0.12	0.26	0.072	0.0066	0.061	0.1	0.023	0.18
> 5.00	0.014	0	0.04	0.34	0.092	0.0005	0	0.1	0.018	0.043

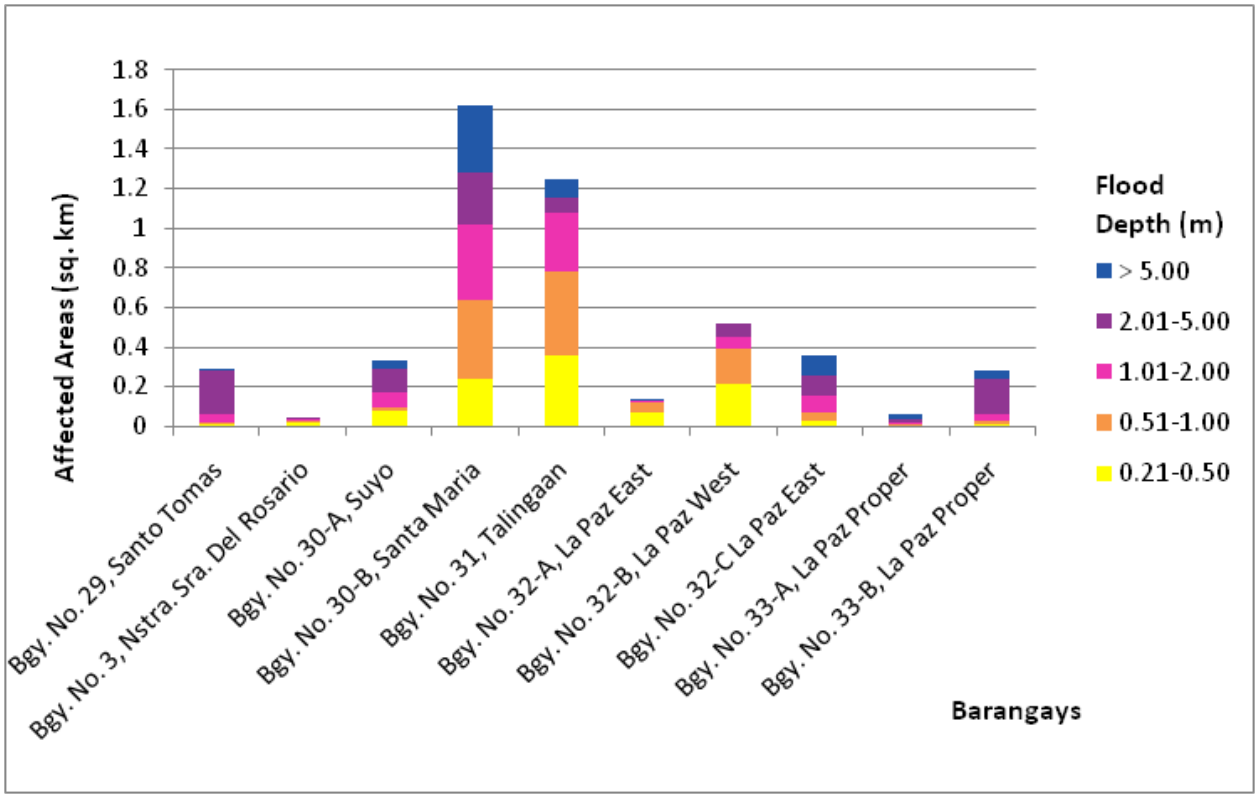

Figure 77.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Table 44.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 34-A, Gabu Norte West	Bgy. No. 34-B, Gabu Norte East	Bgy. No. 35, Gabu Sur	Bgy. No. 36, Araniw	Bgy. No. 37, Calayab	Bgy. No. 38-A, Mangato East	Bgy. No. 38-B, Mangato West	Bgy. No. 39, San-ta Rosa	Bgy. No. 4, San Guiller-mo	Bgy. No. 40, Bala-tong
0.03-0.20	0.49	0.18	0.86	1.21	4.71	0.16	0.074	1.16	0.14	2.46
0.21-0.50	0.22	0.043	0.21	0.43	0.62	0.082	0.034	0.77	0.048	0.49
0.51-1.00	0.092	0.012	0.2	0.21	0.63	0.082	0.036	0.52	0.012	0.34
1.01-2.00	0.072	0.006	0.2	0.16	0.41	0.1	0.07	0.21	0.0053	0.43
2.01-5.00	0.1	0.0042	0.16	0.15	0.054	0.063	0.23	0.26	0.011	0.13
> 5.00	0.0023	0.01	0.0017	0.00017	0	0	0	0.0001	0.00042	0.0043

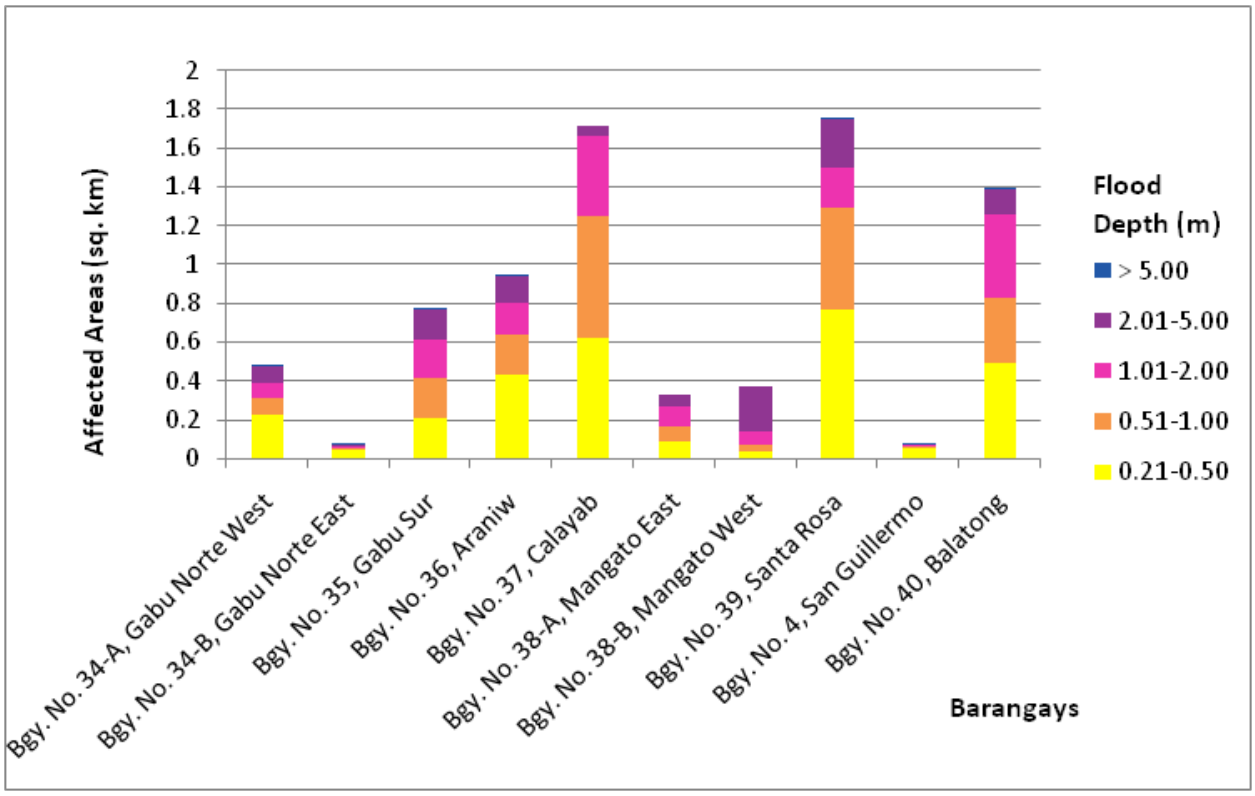

Figure 78.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Table 45.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 41, Balacad	Bgy. No. 42, Apaya	Bgy. No. 43, Cavit	Bgy. No. 44, Zam-boanga	Bgy. No. 45, Tangid	Bgy. No. 46, Nalbo	Bgy. No. 47, Bengcag	Bgy. No. 48-B, Cabun-gaan South	Bgy. No. 49-A, Daray-day	Bgy. No. 49-B, Rarabu-ran
0.03-0.20	3.45	1.41	0.23	0.62	0.71	0.28	0.78	0.51	0.42	1.02
0.21-0.50	0.62	0.48	0.044	0.22	0.25	0.077	0.22	0.18	0.24	0.3
0.51-1.00	0.53	0.56	0.048	0.11	0.12	0.073	0.19	0.1	0.19	0.11
1.01-2.00	0.32	0.62	0.078	0.19	0.071	0.24	0.15	0.16	0.23	0.028
2.01-5.00	0.052	0.64	0.04	0.18	0.21	0.15	0.32	0.086	0.023	0.0057
> 5.00	0	0	0.015	0	0.49	0.54	0.085	0	0	0

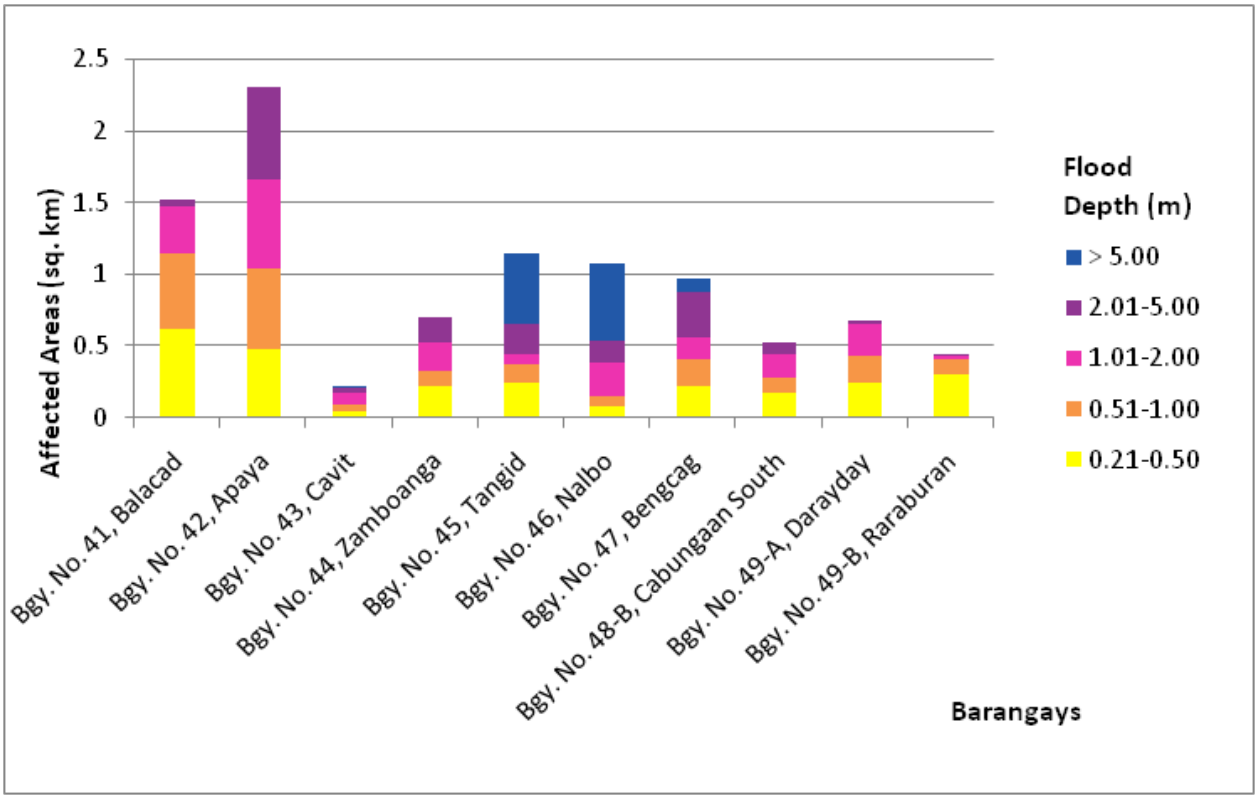

Figure 79.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Table 46.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 5, San Pedro	Bgy. No. 50, Buttong	Bgy. No. 51-A, Nangal-isan East	Bgy. No. 51-B, Nan-galisan West	Bgy. No. 52-A, San Mateo	Bgy. No. 52-B, Lataag	Bgy. No. 53, Rioeng	Bgy. No. 54-A, Lagui-Sail	Bgy. No. 54-B, Caman-gaan	Bgy. No. 55-A, Barit-Pan-dan
0.03-0.20	0.044	0.92	0.47	0.22	0.92	2.64	0.72	1.74	0.2	1.13
0.21-0.50	0.0083	0.19	0.12	0.047	0.34	1.21	0.27	0.72	0.043	0.16
0.51-1.00	0.00056	0.047	0.12	0.05	0.15	0.54	0.12	1.01	0.042	0.18
1.01-2.00	0.00031	0.021	0.08	0.051	0.27	0.12	0.38	0.5	0.36	0.18
2.01-5.00	0.0091	0.047	0.24	0.11	0.44	0.11	0.56	0.0014	0.65	0.066
> 5.00	0.036	0	0.19	0.19	0.42	0.025	0.33	0	0.44	0

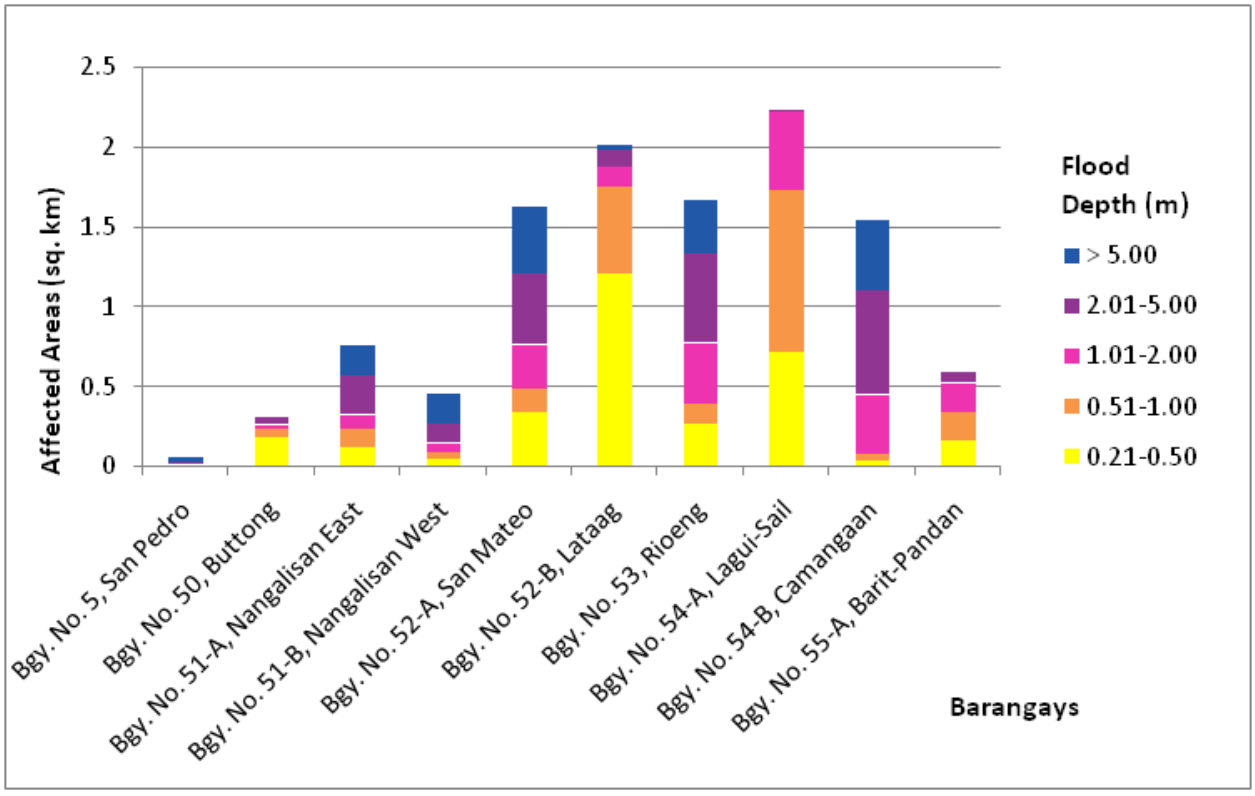

Figure 80.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Table 47.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 55-B, Salet-Bu-langon	Bgy. No. 55-C, Vira	Bgy. No. 56-A, Bacsil North	Bgy. No. 56-B, Bacsil South	Bgy. No. 57, Pila	Bgy. No. 58, Casili	Bgy. No. 59-A, Dibua South	Bgy. No. 59-B, Dibua North	Bgy. No. 6, San Agustin	Bgy. No. 60-A, Caaoa-can
0.03-0.20	4.74	1.36	4.41	4.02	1.78	1.14	0.9	1.97	0.054	0.38
0.21-0.50	0.88	0.21	0.32	0.59	0.22	0.28	0.26	0.22	0.011	0.075
0.51-1.00	0.69	0.16	0.15	0.18	0.46	0.17	0.25	0.067	0.0001	0.11
1.01-2.00	0.55	0.022	0.054	0.093	0.3	0.19	0.13	0.0046	0.0004	0.23
2.01-5.00	0.13	0	0.0074	0.072	0.016	0.07	0.0094	0	0.001	0.028
> 5.00	0	0	0	0.011	0	0	0	0	0.0032	0

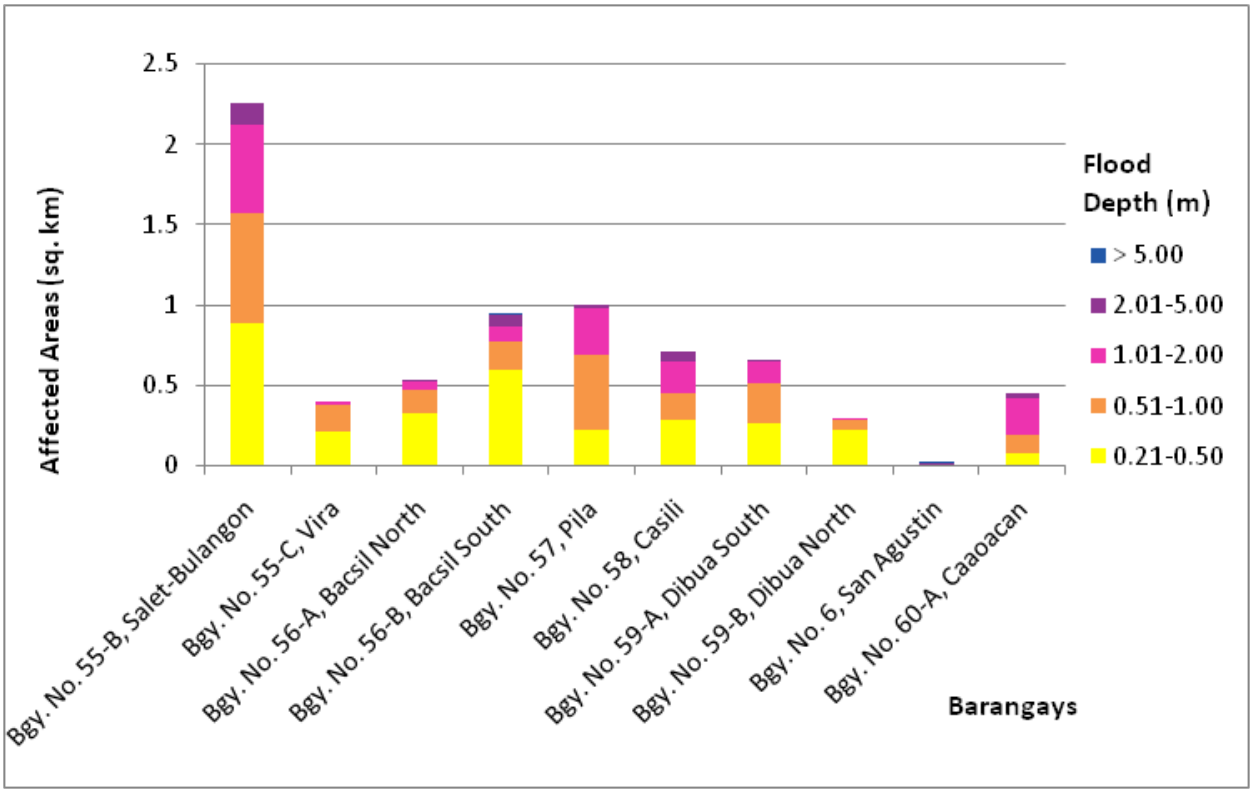

Figure 81.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Table 48.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 60-B, Madil-adig	Bgy. No. 61, Cata-ban	Bgy. No. 62-A, Navotas North	Bgy. No. 62-B, Navotas South	Bgy. No. 7-A, Nstra. Sra. De Natívid	Bgy. No. 7-B, Nstra. Sra. De Natívid	Bgy. No. 8, San Vicente	Bgy. No. 9, Santa Angela	Bry. No. 18, San Quirino	Bry. No. 48-A, Cabun-gaan North
0.03-0.20	1.79	0.56	0.35	1.74	0.046	0.031	0.035	0.054	0.052	0.38
0.21-0.50	0.54	0.3	0.1	0.38	0.013	0.013	0.013	0.022	0.009	0.077
0.51-1.00	0.37	0.46	0.13	0.4	0.00019	0	0.00033	0.0019	0.0018	0.071
1.01-2.00	0.19	0.57	0.13	0.21	0.0003	0	0.0001	0.00031	0.0048	0.016
2.01-5.00	0	0.025	0.011	0.0035	0.00081	0	0.00054	0.0011	0.032	0
> 5.00	0	0	0	0	0.006	0	0.0059	0.011	0.047	0

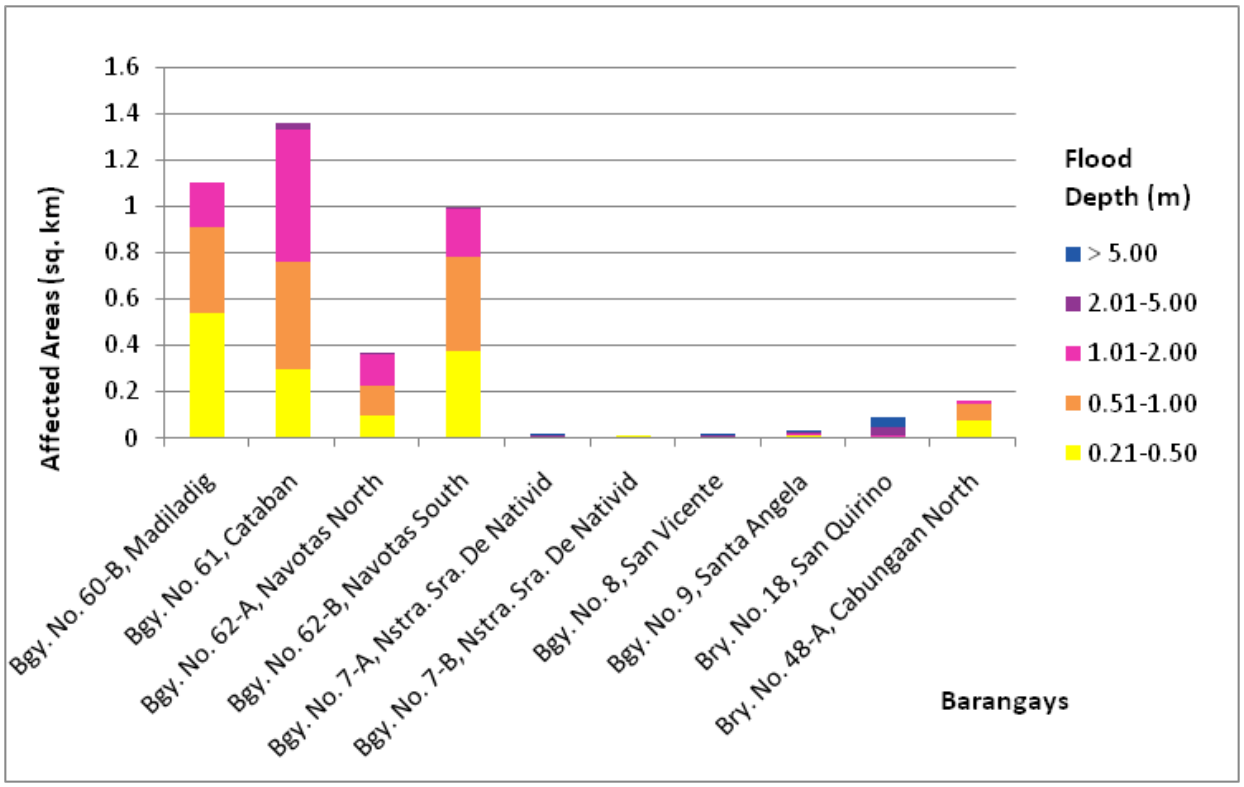

Figure 82.Affected Areas in Laoag City, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 56.99% of the municipality of Marcos with an area of 73.57 sq. km. will experience flood levels of less than 0.20 meters. 15.38% of the area will experience flood levels of 0.21 to 0.50 meters while 9.45%, 7.26%, 7.48%, and 1.40% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 49.Affected Areas in Marcos, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Marcos (in sq. km)						
	Caca-fean	Daquio-ag	Eliza-beth	Escoda	Ferdi-nand	Fortuna	Imelda
0.03-0.20	6.76	3.73	3.06	7.55	1.51	7.98	1.01
0.21-0.50	1.83	0.35	0.89	2.43	0.52	0.65	0.086
0.51-1.00	1.13	0.38	0.46	1.26	0.39	0.38	0.09
1.01-2.00	0.3	0.5	0.14	0.75	0.15	0.36	0.078
2.01-5.00	0.3	0.7	0.32	0.88	0.024	0.46	0.11
> 5.00	0.12	0.17	0.0007	0.012	0	0.14	0.02

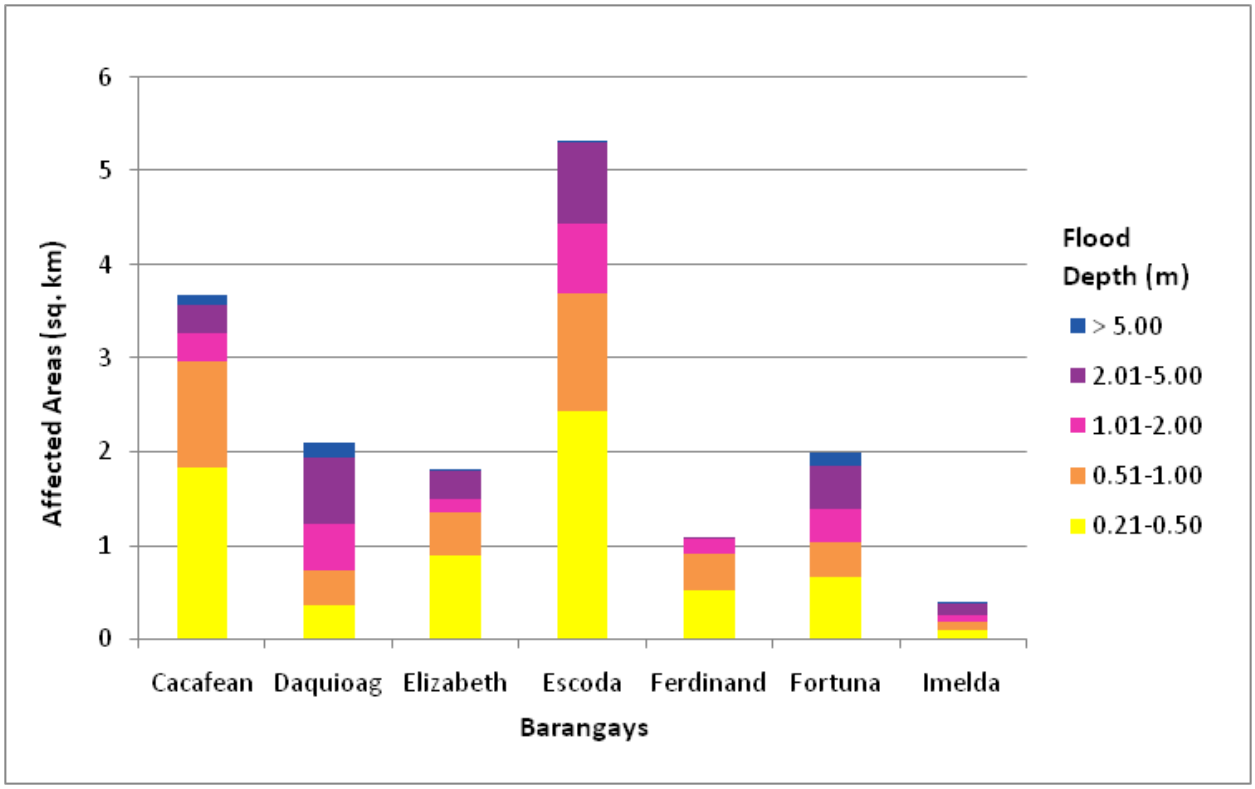

Figure 83.Affected Areas in Marcos, Ilocos Norte during 5-Year Rainfall Return Period

Table 50.Affected Areas in Marcos, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Marcos (in sq. km)					
	Lydia	Mabuti	Pacifico	Santiago	Tabuc-buc	Valdez
0.03-0.20	1.17	1.63	4.12	2.27	0.74	0.41
0.21-0.50	0.66	0.22	1.86	0.86	0.43	0.54
0.51-1.00	0.16	0.099	0.92	0.53	0.76	0.39
1.01-2.00	0.027	0.078	0.74	0.61	1.24	0.38
2.01-5.00	0.026	0.093	1.22	0.022	0.93	0.43
> 5.00	0.000095	0.055	0.17	0	0.28	0.071

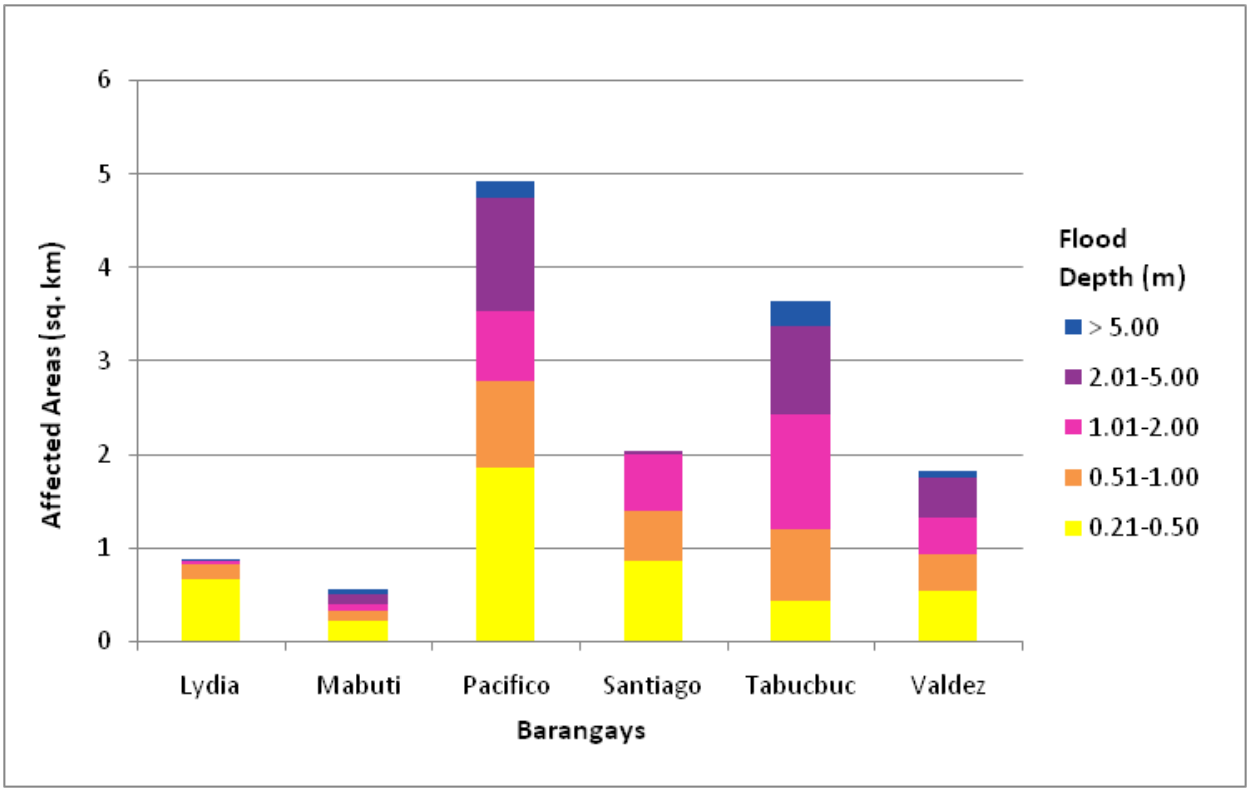

Figure 84.Affected Areas in Marcos, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 8.76% of the municipality of Nueva Era with an area of 619 sq. km. will experience flood levels of less than 0.20 meters. 0.81% of the area will experience flood levels of 0.21 to 0.50 meters while 0.55%, 0.36%, 0.28%, and 0.03% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 51.Affected Areas in Nueva Era, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Nueva Era (in sq. km)								
	Acnam	Barikir	Bugay-ong	Cabit-tauran	Caray	Garna-den	Naguil-lan	Pobla-cion	Santo Niño
0.03-0.20	0.78	0.81	5.54	10.98	10.53	5.92	4.89	2.68	12.13
0.21-0.50	0.086	0.23	0.68	1.49	0.52	0.48	0.41	0.26	0.84
0.51-1.00	0.13	0.33	0.55	0.78	0.3	0.34	0.44	0.22	0.35
1.01-2.00	0.14	0.12	0.46	0.39	0.21	0.23	0.34	0.17	0.15
2.01-5.00	0.016	0.00025	0.19	0.2	0.082	0.11	0.28	0.43	0.44
> 5.00	0	0	0.0031	0.0003	0.0019	0.0034	0.038	0.12	0.03

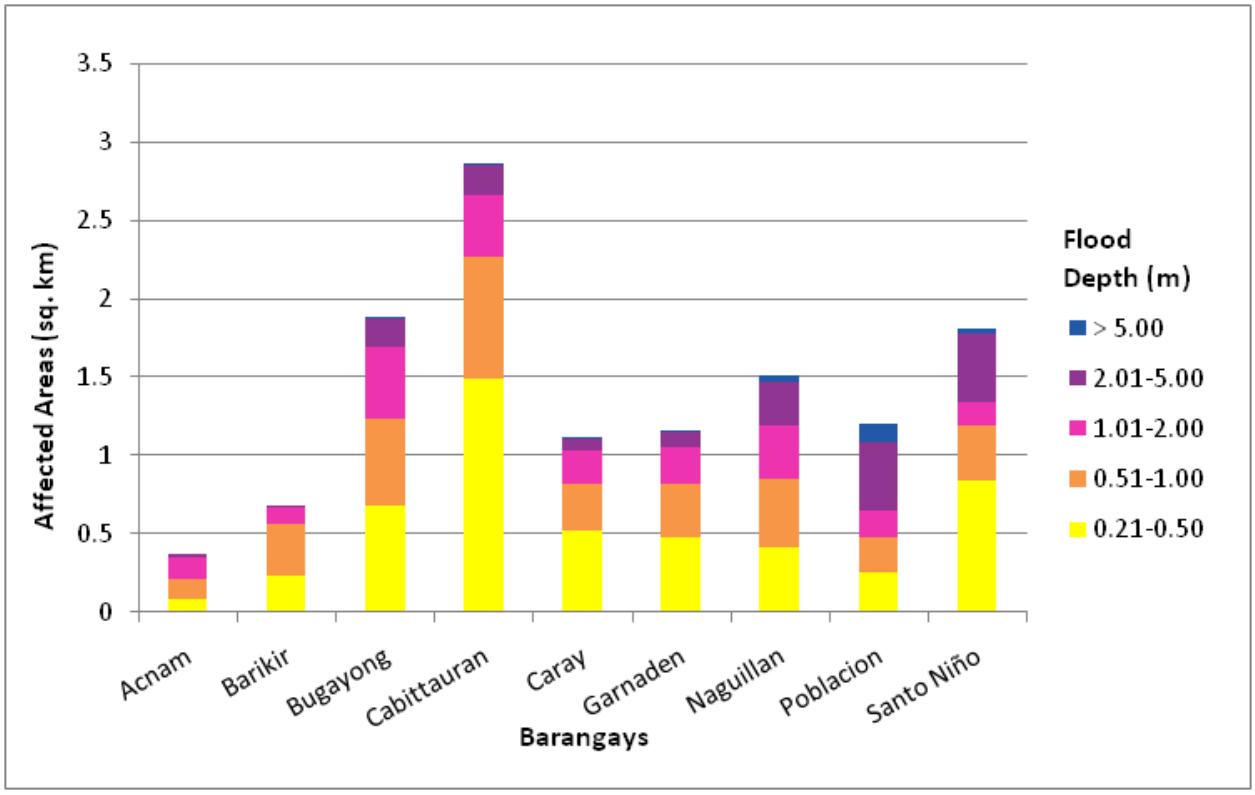

Figure 85.Affected Areas in Nueva Era, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 16.77% of the municipality of Paoay with an area of 71.616 sq. km. will experience flood levels of less than 0.20 meters. 1.09% of the area will experience flood levels of 0.21 to 0.50 meters while 0.71%, 0.44%, 0.33%, and 0.01% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 52.Affected Areas in Paoay, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Paoay (in sq. km)							
	Bacsil	Mumu-laan	Nagba-calan	Nan-guyudan	Pasil	Suba	Sungadan	Surgui
0.03-0.20	0.028	1.18	2.46	2.86	0.32	3.59	1.52	0.061
0.21-0.50	0.0001	0.13	0.12	0.16	0.014	0.24	0.12	0.0017
0.51-1.00	0	0.047	0.087	0.081	0.0012	0.26	0.033	0.00013
1.01-2.00	0	0.037	0.084	0.025	0.00058	0.17	0.000024	0
2.01-5.00	0	0.027	0.1	0.0031	0.0003	0.1	0	0
> 5.00	0	0	0.0083	0	0	0.0012	0	0

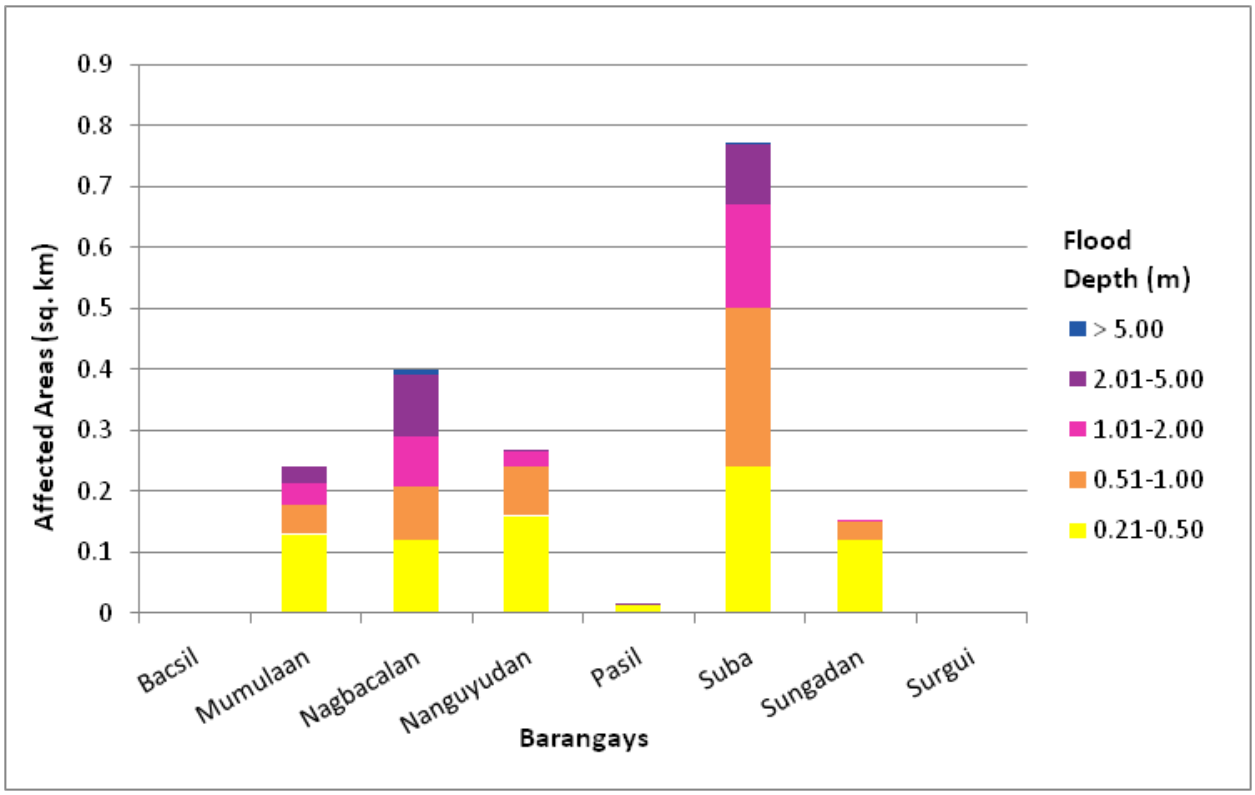

Figure 86.Affected Areas in Paoay, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 34.43% of the municipality of Paoay Lake with an area of 3.64 sq. km. will experience flood levels of less than 0.20 meters. 1.03% of the area will experience flood levels of 0.21 to 0.50 meters while 0.33%, 0.22%, and 0.11% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 53.Affected Areas in Paoay Lake, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Paoay Lake (in sq. km)
	Paoay Lake
0.03-0.20	1.25
0.21-0.50	0.037
0.51-1.00	0.012
1.01-2.00	0.008
2.01-5.00	0.0041
> 5.00	0

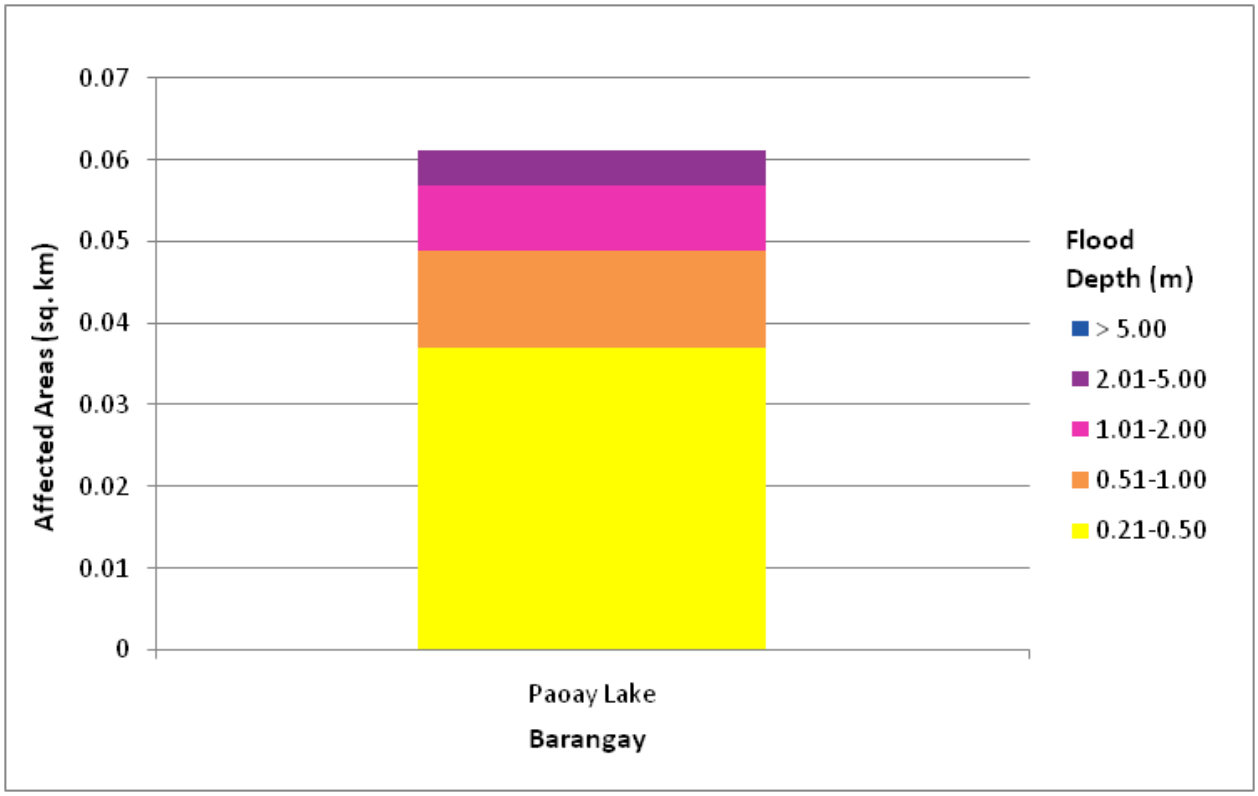

Figure 87.Affected Areas in Paoay Lake, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 43.91% of the municipality of Piddig with an area of 128.566 sq. km. will experience flood levels of less than 0.20 meters. 4.42% of the area will experience flood levels of 0.21 to 0.50 meters while 5.30%, 8.01%, 7.57%, and 0.56% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 54.Affected Areas in Piddig, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Piddig (in sq. km)											
	Ab-Abut	Abucay	Anao	Arua-Ay	Bim-manga	Boyboy	Cabaroan	Calam-beg	Callusa	Dupitac	Estancia	Gayamat
0.03-0.20	0.62	9.52	0.32	0.76	0.059	2.42	0.49	0.91	0.13	4.44	13.11	1.42
0.21-0.50	0.12	0.7	0.023	0.075	0.22	0.4	0.025	0.13	0.088	0.49	0.85	0.17
0.51-1.00	0.26	0.71	0.017	0.12	0.34	0.61	0.016	0.18	0.75	1.13	0.9	0.2
1.01-2.00	0.28	0.41	0.027	0.46	0.47	1.47	0.049	0.8	0.97	1.78	1.03	0.2
2.01-5.00	0.15	0.042	0.039	0.59	0.25	2.71	0.15	1.15	0.22	1.25	0.32	0.1
> 5.00	0	0.0001	0.02	0.002	0.011	0.088	0.06	0.094	0.016	0.029	0.026	0.0034

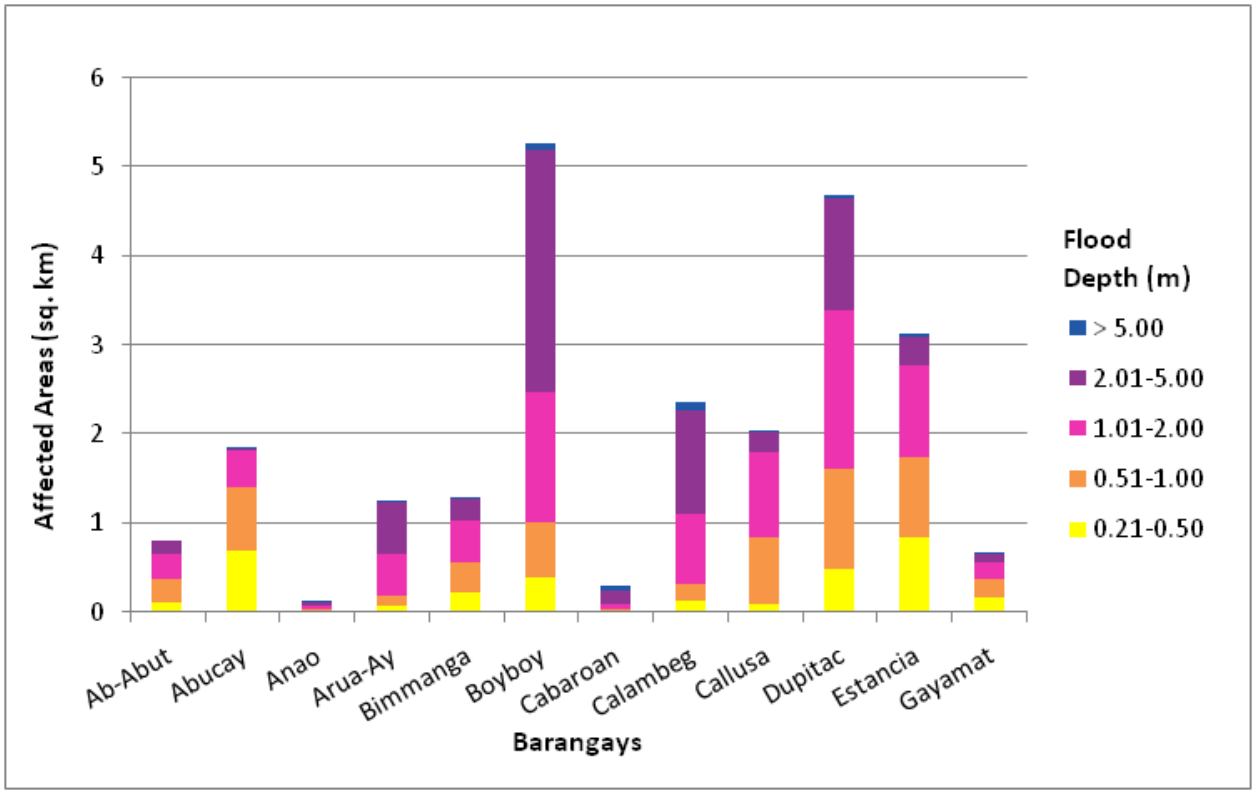

Figure 88.Affected Areas in Piddig, Ilocos Norte during 5-Year Rainfall Return Period

Table 55.Affected Areas in Piddig, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Piddig (in sq. km)										
	Lagandit	Lib-naoan	Loing	Maab-Ab-aca	Mangi-tayag	Maruaya	San Antonio	Santa Maria	Suc-suquen	Tan-gaoan	Tonoton
0.03-0.20	1.32	1.1	0.11	3.06	0.08	2.73	3.35	3.09	1.46	4.81	1.13
0.21-0.50	0.33	0.16	0.017	0.3	0.032	0.16	0.13	0.19	0.26	0.65	0.15
0.51-1.00	0.21	0.26	0.044	0.2	0.08	0.13	0.077	0.12	0.18	0.22	0.063
1.01-2.00	0.14	0.58	0.35	0.23	0.35	0.2	0.11	0.083	0.11	0.084	0.1
2.01-5.00	0.0094	0.82	0.33	0.3	0.93	0.14	0.094	0.0097	0.018	0.018	0.1
> 5.00	0	0.022	0.02	0.035	0.17	0	0.12	0	0.0006	0	0.0039

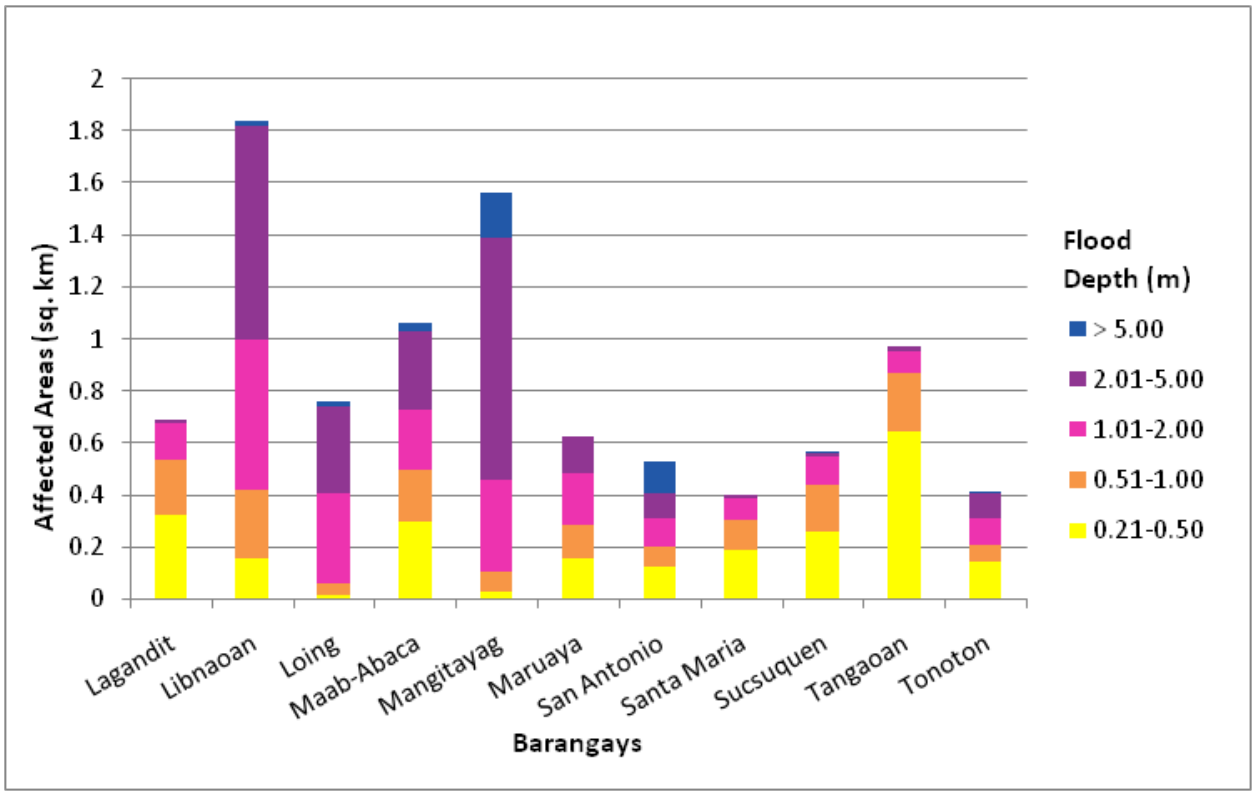

Figure 89.Affected Areas in Piddig, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 2.09% of the municipality of Pinili with an area of 63.18 sq. km. will experience flood levels of less than 0.20 meters. 0.14% of the area will experience flood levels of 0.21 to 0.50 meters while 0.05%, 0.01%, and 0.01% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 56.Affected Areas in Pinili, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Pinili (in sq. km)
	Lumbaan-Bicbica
0.03-0.20	1.32
0.21-0.50	0.091
0.51-1.00	0.028
1.01-2.00	0.0082
2.01-5.00	0.0056
> 5.00	0

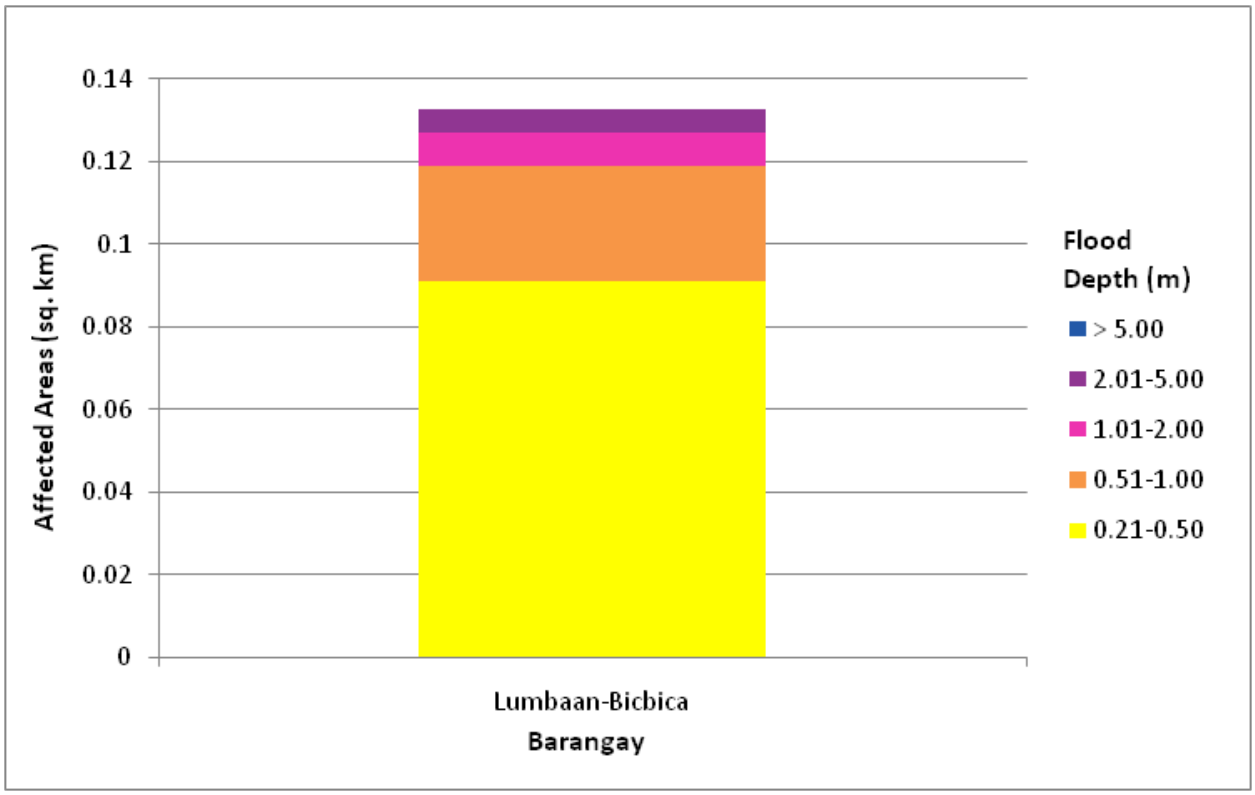

Figure 90.Affected Areas in Pinili, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 67.45% of the municipality of San Nicolas with an area of 40.225 sq. km. will experience flood levels of less than 0.20 meters. 11.43% of the area will experience flood levels of 0.21 to 0.50 meters while 10.67%, 8.10%, 2.15%, and 0.03% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 57.Affected Areas in San Nicolas, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in San Nicolas (in sq. km)											
	San Agustin	San Baltazar	San Bartolome	San Cayetano	San Eugenio	San Fernando	San Francisco	San Gregorio	San Guillermo	San Ildefonso	San Jose	San Juan Bautista
0.03-0.20	5.35	0.2	0.095	0.079	0.052	0.026	0.3	0.42	7.26	0.15	0.078	0.19
0.21-0.50	0.58	0.051	0.019	0.012	0.012	0.0097	0.049	0.17	1.09	0.043	0.018	0.036
0.51-1.00	0.5	0.024	0.015	0.025	0.0054	0.058	0.026	0.048	1.23	0.017	0	0.011
1.01-2.00	0.43	0.0069	0.0047	0	0	0	0.0098	0.012	0.24	0.017	0	0.0024
2.01-5.00	0.18	0	0	0	0	0	0	0	0.042	0	0	0
> 5.00	0.0074	0	0	0	0	0	0	0	0.0003	0	0	0

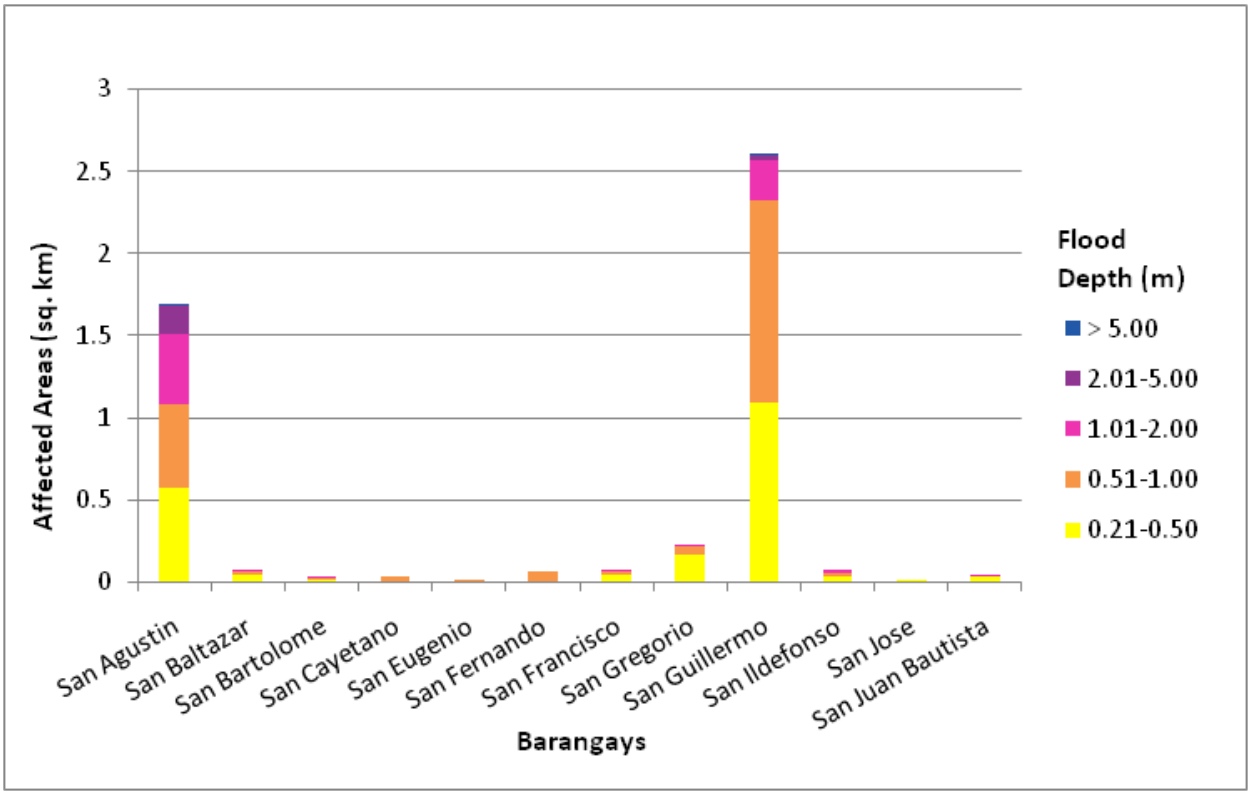

Figure 91.Affected Areas in San Nicolas, Ilocos Norte during 5-Year Rainfall Return Period

Table 58.Affected Areas in San Nicolas, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in San Nicolas (in sq. km)											
	San Lorenzo	San Lucas	San Marcos	San Miguel	San Pablo	San Paulo	San Pedro	San Rufino	San Sil-vestre	Santa Asun-cion	Santa Cecilia	Santa Monica
0.03-0.20	0.68	0.011	0.69	0.074	0.89	0.03	3.61	0.024	0.11	2.56	2.55	1.7
0.21-0.50	0.26	0.048	0.52	0.019	0.051	0.02	0.37	0.065	0.032	0.24	0.15	0.72
0.51-1.00	0.3	0.071	0.83	0.089	0.017	0.062	0.27	0.14	0.0061	0.13	0.11	0.3
1.01-2.00	0.24	0	0.97	0	0.018	0	0.16	0	0	0.036	0.6	0.51
2.01-5.00	0.046	0	0.15	0	0.012	0	0.078	0	0	0.00077	0.087	0.27
> 5.00	0	0	0.0006	0	0.0014	0	0	0	0	0	0	0.0013

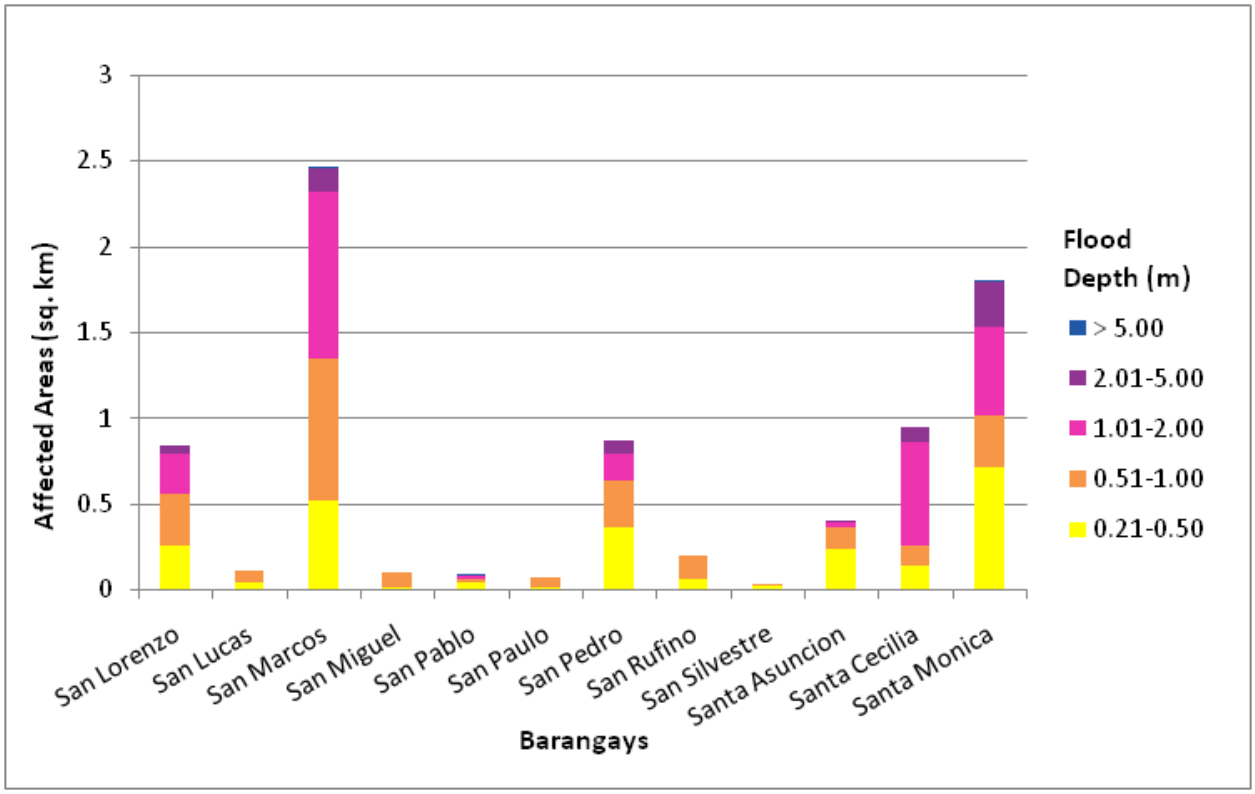

Figure 92.Affected Areas in San Nicolas, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 61.16% of the municipality of Sarrat with an area of 92.247 sq. km. will experience flood levels of less than 0.20 meters. 5.90% of the area will experience flood levels of 0.21 to 0.50 meters while 5.22%, 5.14%, 3.91%, and 10.91% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 59.Affected Areas in Sarrat, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Sarrat (in sq. km)											
	San Agustin	San Andres	San Antonio	San Ber-nabe	San Cris-tobal	San Felipe	San Francis-co	San Isidro	San Joaquin	San Jose	San Juan	San Leandro
0.03-0.20	0.17	6.17	0.23	2.06	3.38	2.44	0.29	3.53	0.21	2.09	6.83	0.3
0.21-0.50	0.029	0.44	0.3	0.32	0.14	0.21	0.12	0.16	0.027	0.36	0.48	0.012
0.51-1.00	0.0095	0.29	1.22	0.12	0.11	0.13	0.019	0.1	0.04	0.16	0.29	0.0051
1.01-2.00	0.0035	0.24	1.12	0.07	0.049	0.13	0.0023	0.08	0.031	0.13	0.29	0.0094
2.01-5.00	0.01	0.2	0.019	0.042	0.061	0.39	0	0.12	0.046	0.089	0.19	0.011
> 5.00	0.075	0.01	0.55	0.0024	0.23	0.29	0	0.4	0.4	1.19	0.0005	0.2

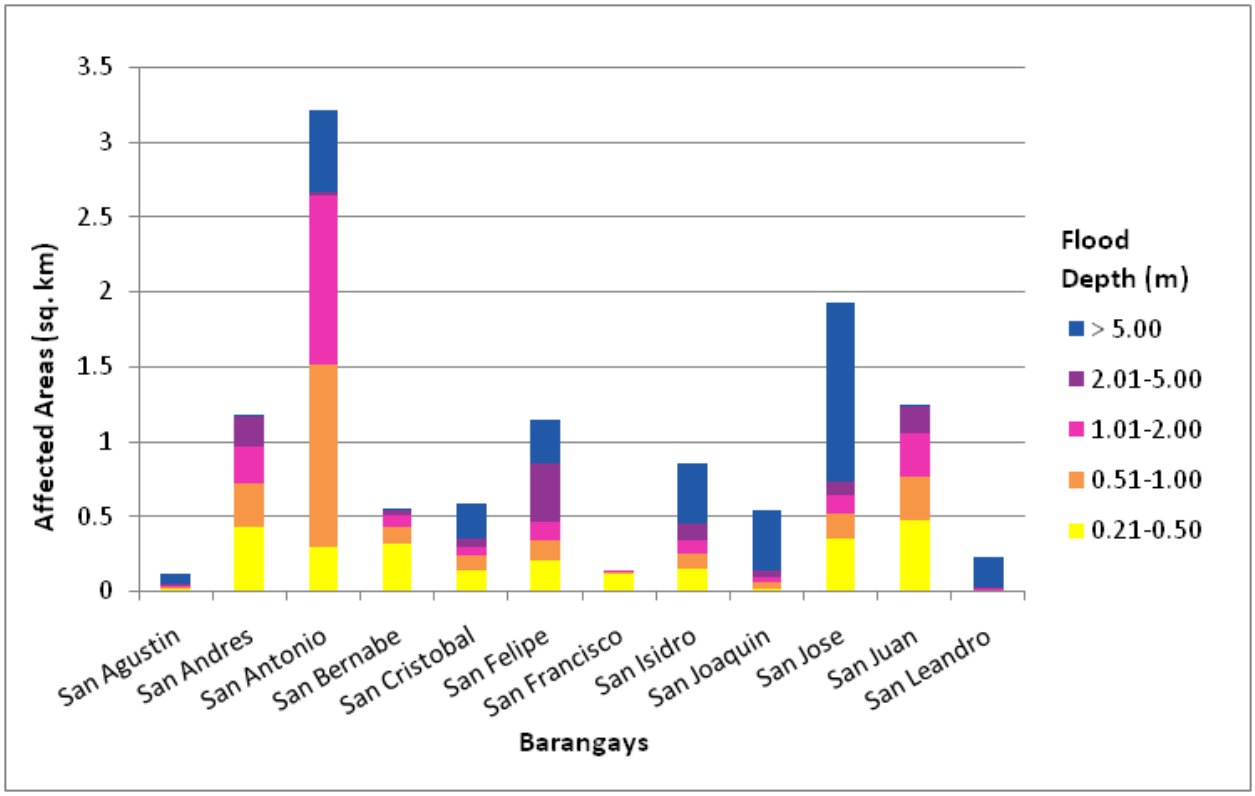

Figure 93.Affected Areas in Sarrat, Ilocos Norte during 5-Year Rainfall Return Period

Table 60.Affected Areas in Sarrat, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Sarrat (in sq. km)											
	San Lorenzo	San Manuel	San Marcos	San Nicolas	San Pedro	San Roque	San Vicente	Santa Barbara	Santa Magda-lena	Santa Rosa	Santo Santiago	Santo Tomas
0.03-0.20	0.27	0.17	3.48	0.55	8.46	1.88	0.17	0.09	6.57	2.31	4.36	0.4
0.21-0.50	0.057	0.12	0.17	0.076	0.4	0.51	0.062	0.024	0.56	0.31	0.47	0.092
0.51-1.00	0.17	0.45	0.11	0.071	0.2	0.33	0.029	0.012	0.3	0.29	0.24	0.13
1.01-2.00	0.24	0.71	0.15	0.12	0.16	0.2	0.0012	0	0.28	0.18	0.15	0.38
2.01-5.00	0.06	0.22	0.79	0.35	0.13	0.091	0.0039	0	0.2	0.053	0.1	0.43
> 5.00	0.23	0.68	2.03	0.48	0.003	0.0059	0.044	0	0.018	0.0011	0.00066	3.22

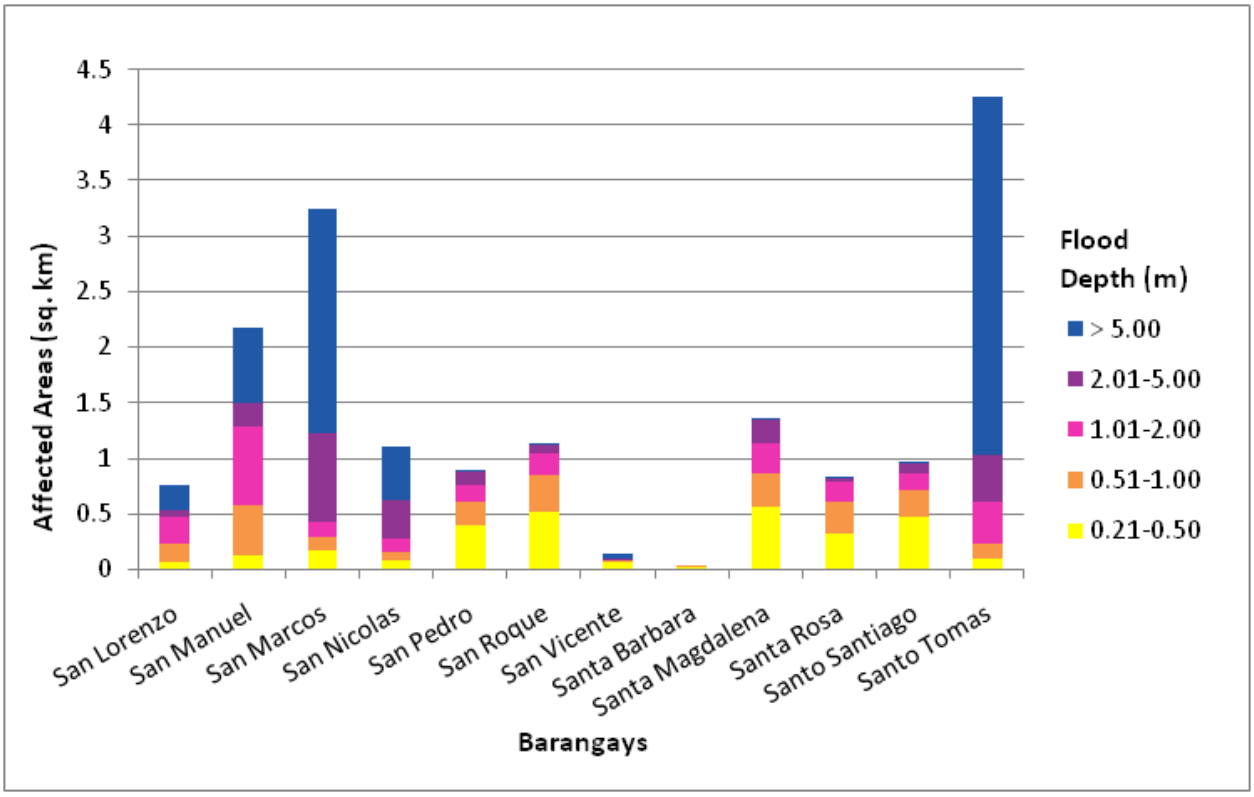

Figure 94.Affected Areas in Sarrat, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 31.17% of the municipality of Solsona with an area of 153.135 sq. km. will experience flood levels of less than 0.20 meters. 8.55% of the area will experience flood levels of 0.21 to 0.50 meters while 8.69%, 6.99%, 4.35%, and 0.24% 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. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 61.Affected Areas in Solsona, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Solsona (in sq. km)										
	Aguitap	Bagbag	Bagbago	Barcelo-na	Bubuos	Capu-rictan	Catangr-aran	Daras-das	Juan	Laureta	Lipay
0.03-0.20	0.74	0.13	0.71	0.11	2.2	0.99	1.93	0.94	2.68	1.08	4.9
0.21-0.50	0.39	0.2	0.55	0.18	0.6	0.17	0.14	0.62	1.2	0.36	0.2
0.51-1.00	0.55	0.44	0.7	0.71	0.88	0.45	0.029	0.57	0.69	0.56	0.13
1.01-2.00	0.71	0.24	1.03	0.69	0.56	0.44	0.039	0.69	0.21	0.49	0.033
2.01-5.00	0.91	0.34	1.23	0.62	0.16	0.045	0.13	0.13	0.0031	0.026	0.0003
> 5.00	0.023	0.0029	0.046	0.045	0	0	0.033	0.0059	0	0	0

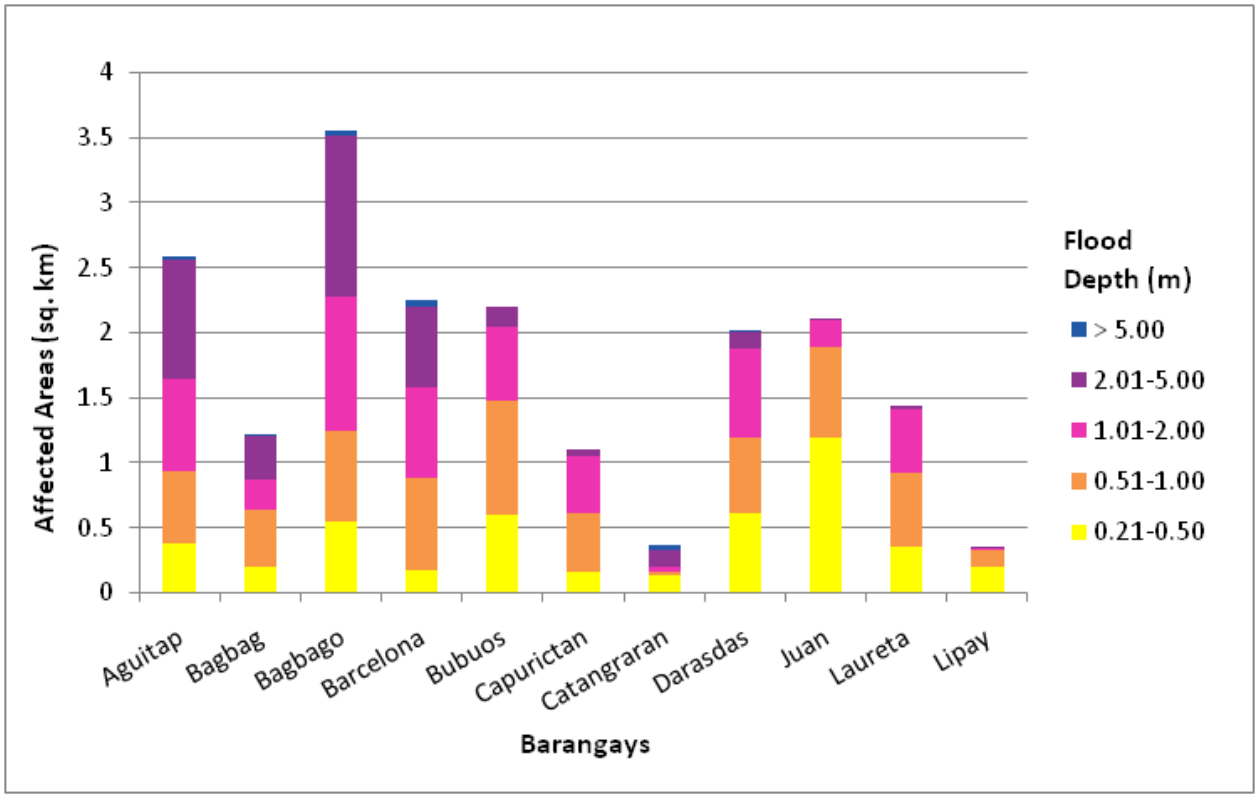

Figure 95.Affected Areas in Solsona, Ilocos Norte during 5-Year Rainfall Return Period

Table 62.Affected Areas in Solsona, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Solsona (in sq. km)										
	Maanan-teng	Manal-pac	Mari-quet	Nagpat-patan	Nalasin	Puttao	San Juan	San Julian	Santa Ana	Santiago	Talugtog
0.03-0.20	0.026	8.27	2.55	3.01	4.6	1.07	0.48	0.31	6.59	1.06	3.36
0.21-0.50	0	0.97	0.6	1.29	0.84	1.02	0.52	0.012	0.65	0.75	1.82
0.51-1.00	0	0.48	0.39	1.01	1.04	1.52	0.42	0.014	0.38	0.8	1.56
1.01-2.00	0	0.3	0.37	0.53	1.49	1.18	0.2	0.0045	0.19	0.5	0.78
2.01-5.00	0	0.33	0.091	0.11	1.3	0.28	0.37	0.0059	0.067	0.23	0.27
> 5.00	0	0.17	0	0	0.029	0	0.0051	0	0.005	0	0.01

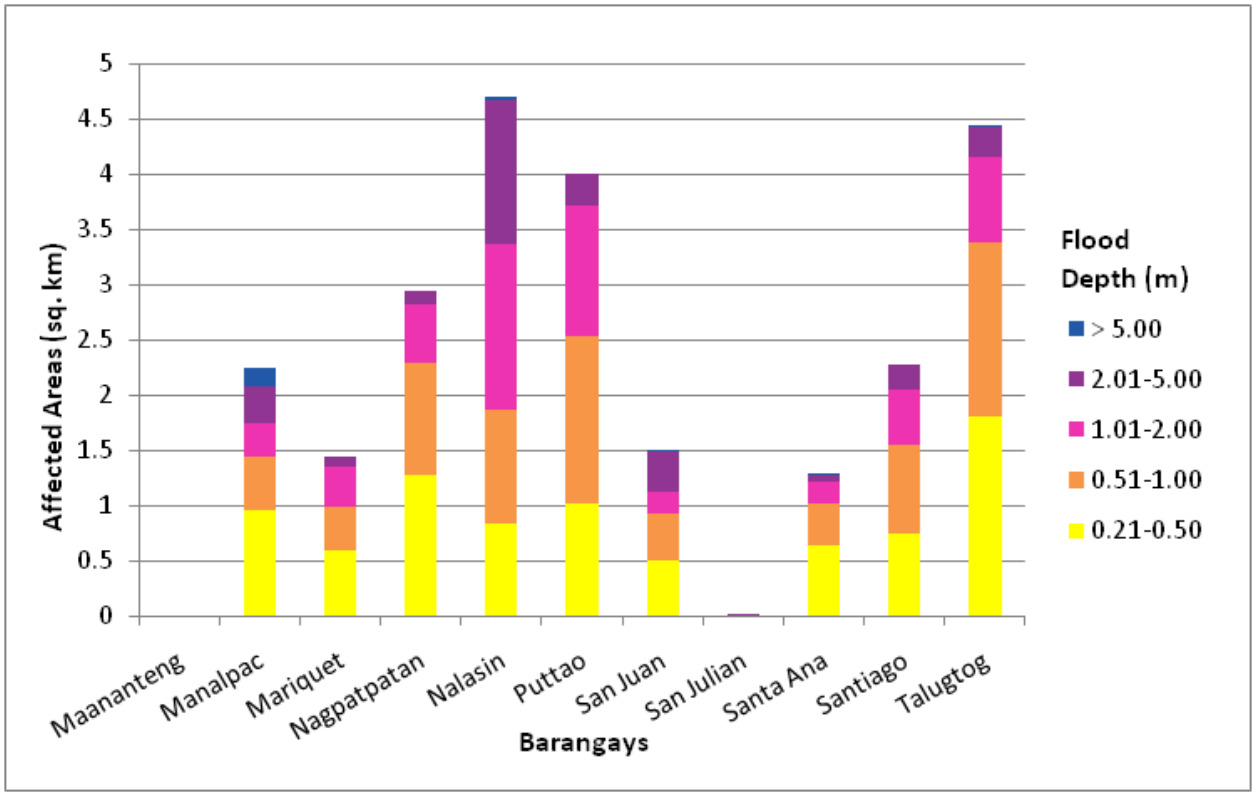

Figure 96.Affected Areas in Solsona, Ilocos Norte during 5-Year Rainfall Return Period

For the 5-year return period, 3.26% of the municipality of Vintar with an area of 497.395 sq. km. 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 while 0.16%, 0.12%, and 0.06% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 63.Affected Areas in Vintar, Ilocos Norte during 5-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Vintar (in sq. km)						
	Bulbu-lala	Ester	Lubnac	Maban-banag	Margaay	Namo-roc	Parparo-roc
0.03-0.20	1.56	5.21	0.08	6.2	0.22	1.65	1.31
0.21-0.50	0.22	0.68	0	0.23	0.0054	0.29	0.054
0.51-1.00	0.13	0.28	0	0.17	0.0011	0.18	0.015
1.01-2.00	0.033	0.21	0	0.19	0	0.15	0.0075
2.01-5.00	0.0031	0.14	0	0.11	0	0.057	0.0004
> 5.00	0	0.0098	0	0.0055	0	0.00072	0

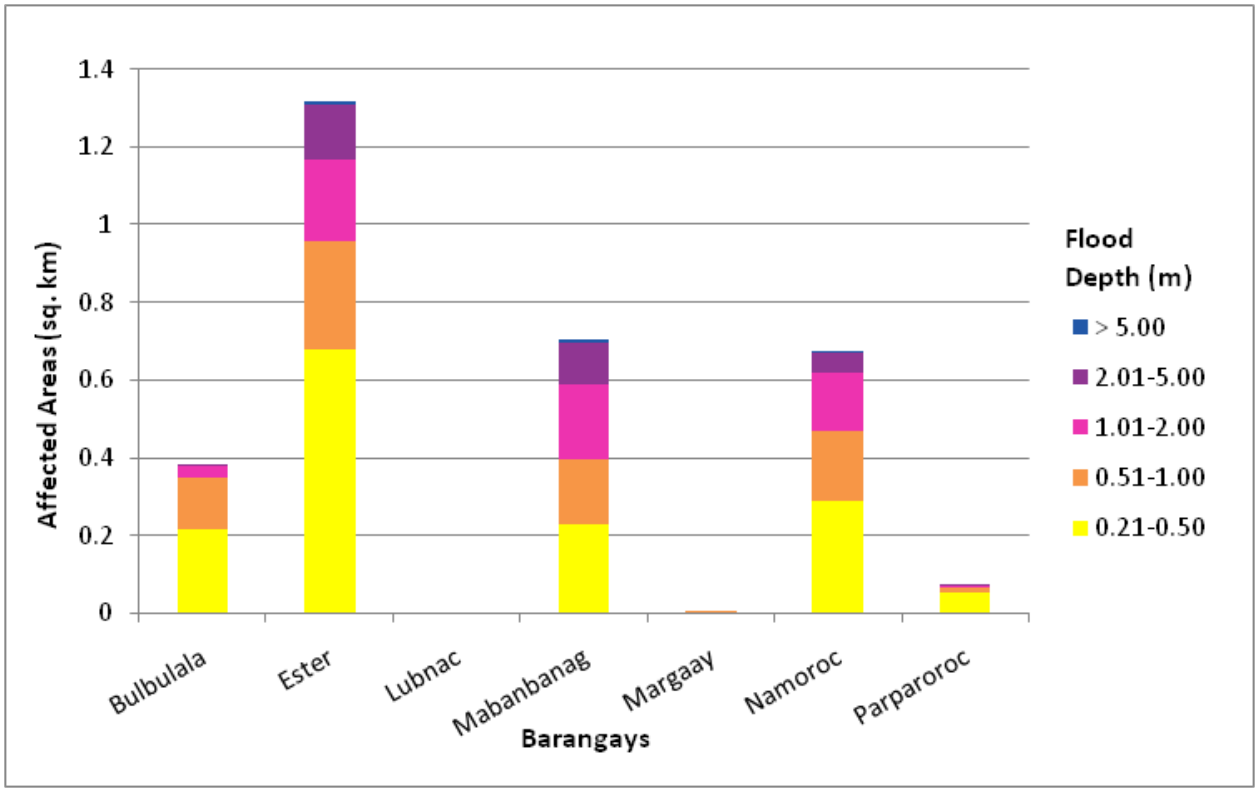

Figure 97.Affected Areas in Vintar, Ilocos Norte during 5-Year Rainfall Return Period

For the 25-year return period, 3.05% of the municipality of Bacarra with an area of 47.1 sq. km. will experience flood levels of less than 0.20 meters. 0.46% of the area will experience flood levels of 0.21 to 0.50 meters while 0.26% and 0.07% of the area will experience flood depths of 0.51 to 1 meter and 1.01 to 2 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 64.Affected Areas in Bacarra, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Bacarra (in sq. km)			
	Casilian	Ganagan	Pasiocan	Sangil
0.03-0.20	0.12	1.09	0.16	0.061
0.21-0.50	0.019	0.19	0.0033	0.0043
0.51-1.00	0.0084	0.11	0.0014	0.0041
1.01-2.00	0	0.031	0.0006	0.000063
2.01-5.00	0	0	0	0
> 5.00	0	0	0	0

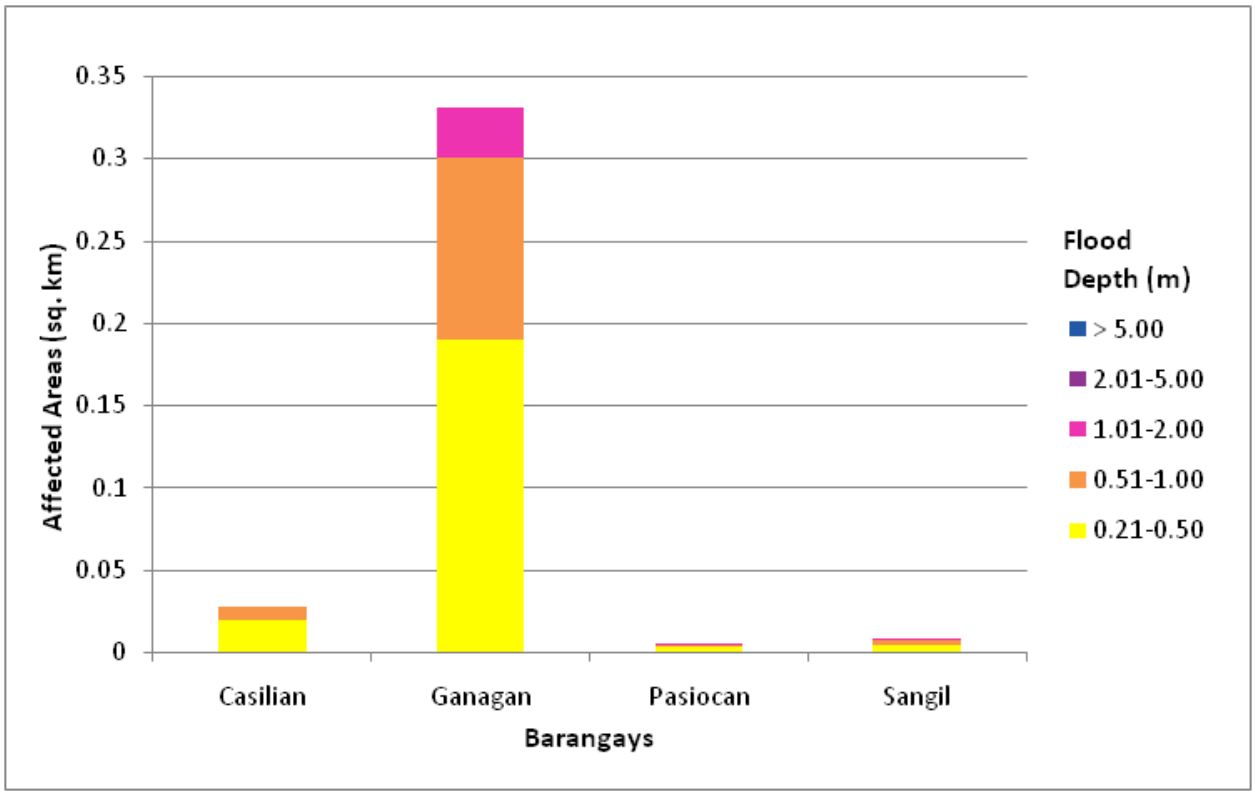

Figure 98.Affected Areas in Bacarra, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 55.22% of the municipality of Banna with an area of 89.62 sq. km. will experience flood levels of less than 0.20 meters. 8.46% of the area will experience flood levels of 0.21 to 0.50 meters while 9.48%, 11.00%, 10.89%, and 3.29% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 65.Affected Areas in Banna, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Banna (in sq. km)									
	Balioeg	Bangsar	Barba-rangay	Binacag	Bomitog	Bugasi	Caeste-banan	Caribquib	Catagtaguen	Crispina
0.03-0.20	1.87	1.68	6.89	2.28	6.2	0.85	1.53	0.12	2.58	5.93
0.21-0.50	1.01	0.13	0.36	0.12	0.41	0.57	1.1	0.043	0.42	0.55
0.51-1.00	1.58	0.1	0.27	0.17	0.19	0.67	0.84	0.06	1.21	0.57
1.01-2.00	2.69	0.099	0.23	0.29	0.13	0.49	0.23	0.14	1.44	0.44
2.01-5.00	1.77	0.19	0.17	0.35	0.069	0.47	0.12	0.34	1.17	0.57
> 5.00	0.0012	0.06	0.019	0.18	0.013	0	0	0.46	0.69	0.13

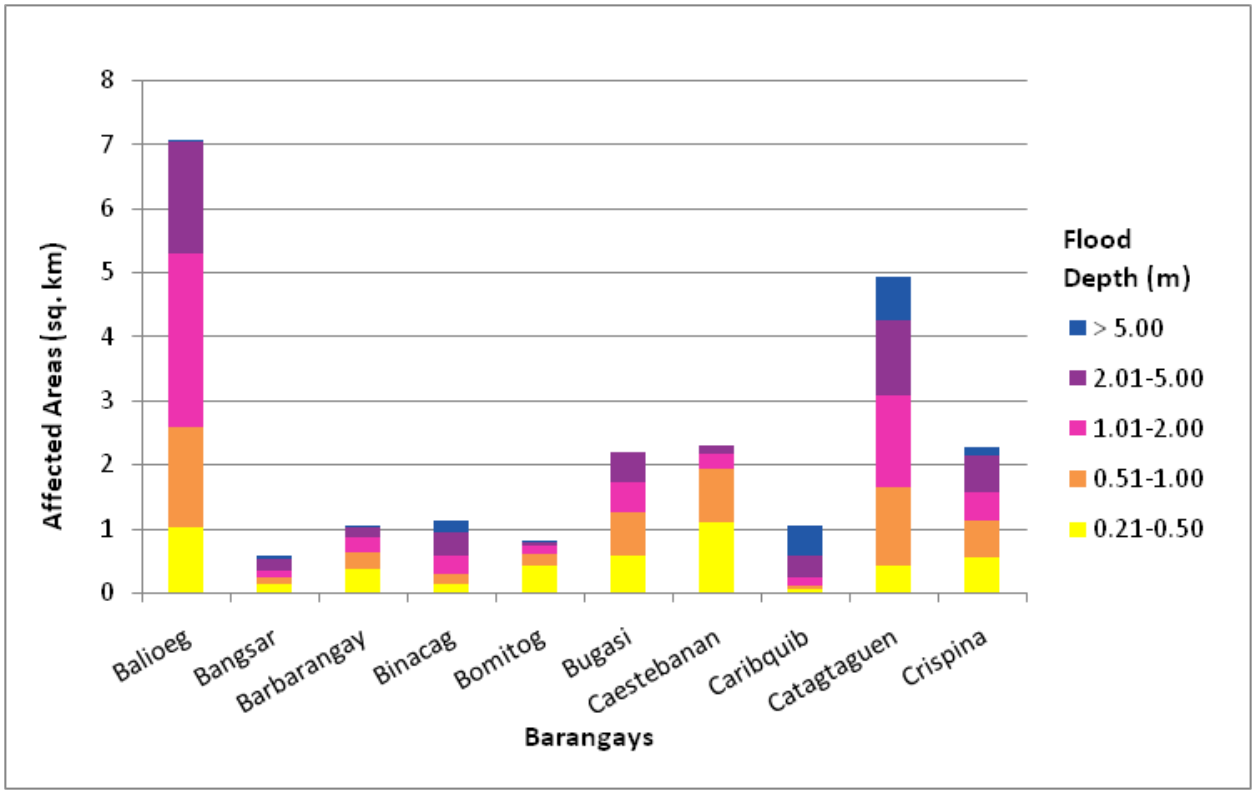

Figure 99.Affected Areas in Banna, Ilocos Norte during 25-Year Rainfall Return Period

Table 66.Affected Areas in Banna, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Banna (in sq. km)									
	Hilario	Imelda	Lorenzo	Ma-cayepy-ep	Marcos	Nagpa-tayan	Sinamar	Tabtaba-gan	Valdez	Valen-ciano
0.03-0.20	0.26	1.89	0.3	4.06	0.86	8.96	1.54	0.51	0.31	0.86
0.21-0.50	0.014	0.16	0.013	0.26	0.055	0.74	1.01	0.29	0.29	0.05
0.51-1.00	0.056	0.13	0.0079	0.29	0.036	0.58	0.99	0.34	0.4	0.02
1.01-2.00	0.4	0.2	0.006	1.07	0.013	0.4	0.86	0.48	0.25	0.0073
2.01-5.00	0.83	0.27	0.0085	0.69	0	0.63	0.7	1.1	0.31	0.0017
> 5.00	0.075	0.13	0.0022	0	0	0.14	0.041	1.01	0	0

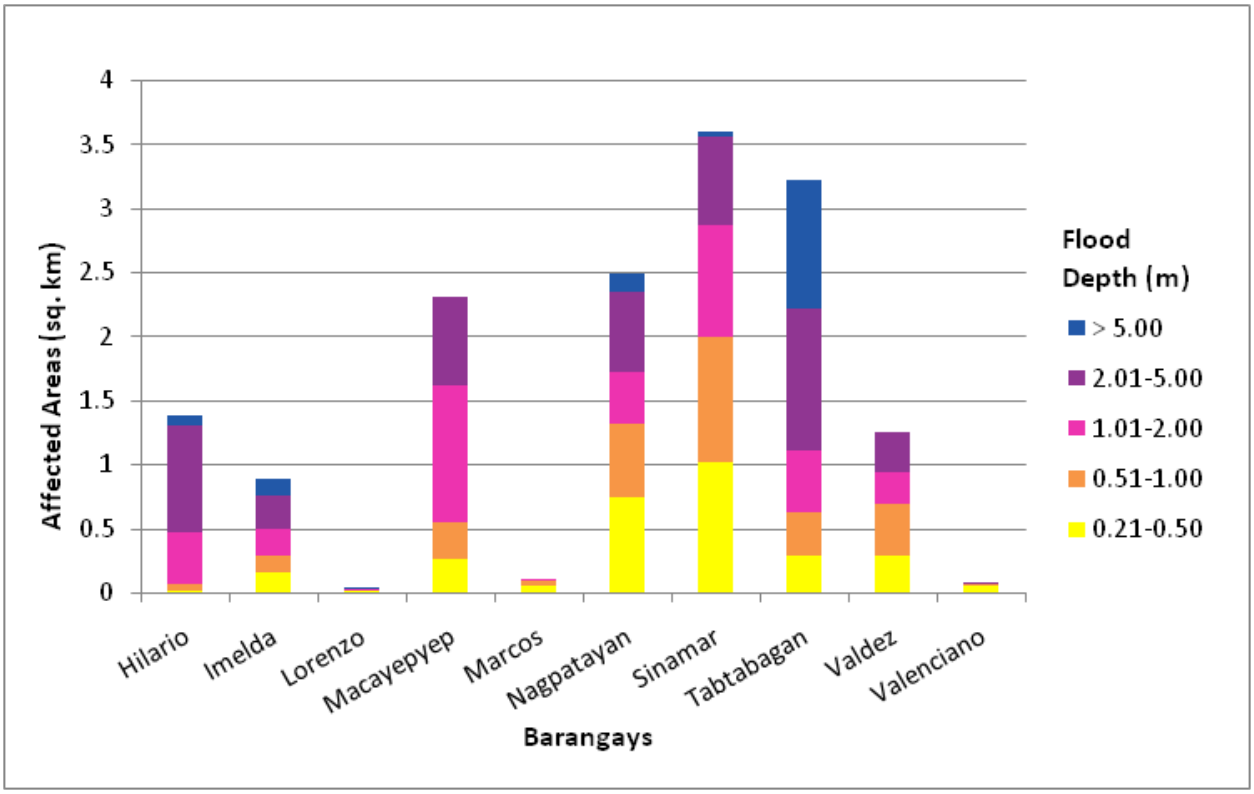

Figure 100.Affected Areas in Banna, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 2.26% of the municipality of Batac City with an area of 134.62 sq. km. will experience flood levels of less than 0.20 meters. 0.07% of the area will experience flood levels of 0.21 to 0.50 meters while 0.02% and 0.01% of the area will experience flood depths of 0.51 to 1 meter and 1.01 to 2 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 67.Affected Areas in Batac City, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Batac City (in sq. km)						
	Baay	Bungon	Caman-dingan	Dariwd-iw	Maipalig	Nagba-calan	Sumader
0.03-0.20	0.32	0.18	0.14	0.076	1.77	0.47	0.088
0.21-0.50	0.013	0.0068	0.00042	0.00082	0.055	0.013	0.00025
0.51-1.00	0.0021	0.0017	0.00071	0.0003	0.016	0.0087	0.0002
1.01-2.00	0.001	0.0019	0.0016	0.0001	0.002	0.0022	0
2.01-5.00	0.0002	0.00065	0.0016	0	0.00012	0.0009	0
> 5.00	0	0	0	0	0	0	0

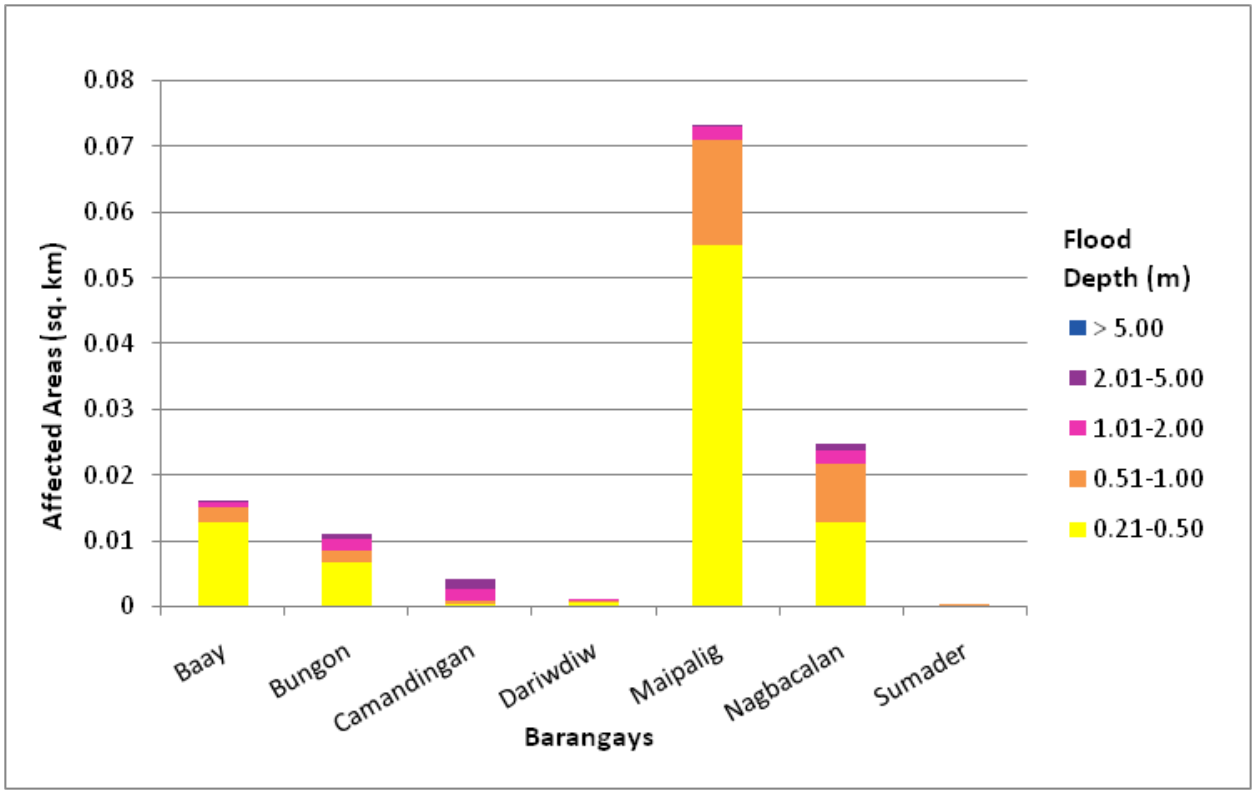

Figure 101.Affected Areas in Batac City, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 1.35% of the municipality of Carasi with an area of 190.236 sq. km. 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 while 0.04%, 0.04%, 0.01%, and 0.01% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 68.Affected Areas in Carasi, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Carasi (in sq. km)
	Virbira
0.03-0.20	2.56
0.21-0.50	0.11
0.51-1.00	0.074
1.01-2.00	0.078
2.01-5.00	0.025
> 5.00	0.027

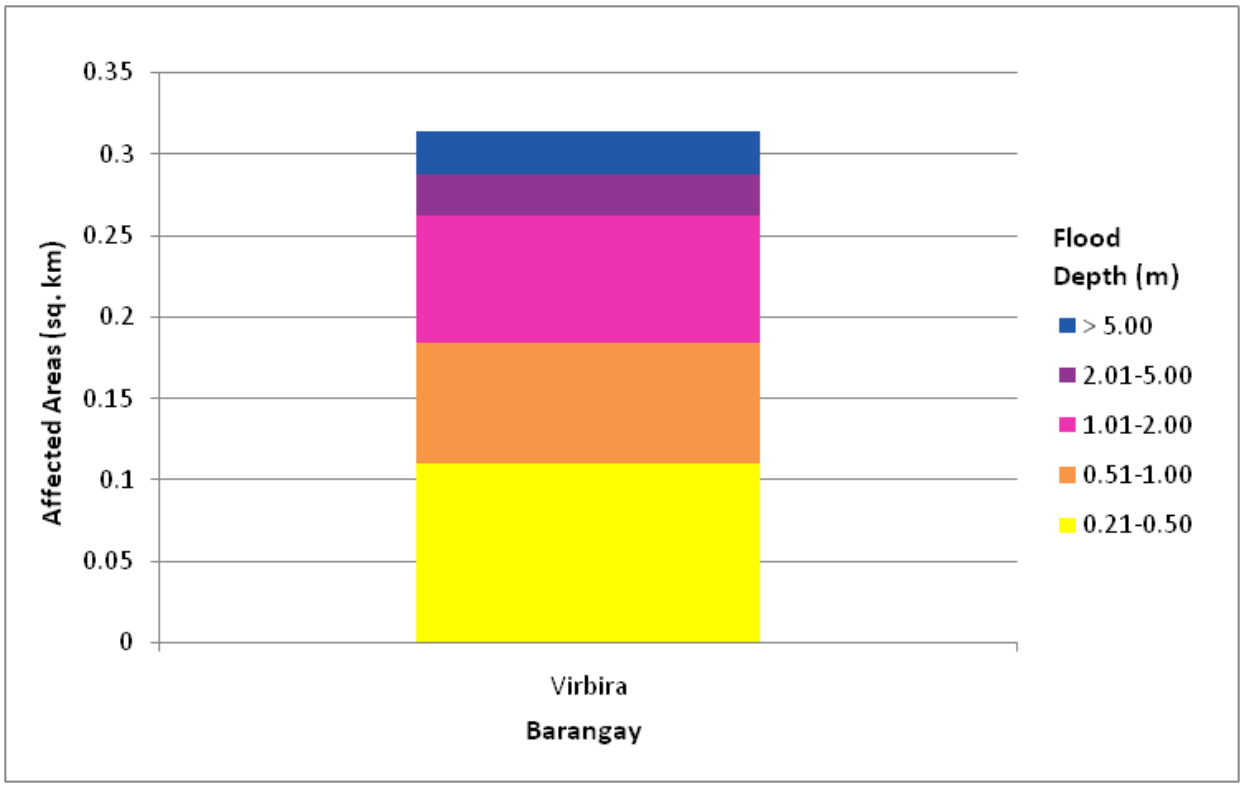

Figure 102.Affected Areas in Carasi, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 27.32% of the municipality of Dingras with an area of 90.65 sq. km. will experience flood levels of less than 0.20 meters. 9.52% of the area will experience flood levels of 0.21 to 0.50 meters while 8.78%, 9.52%, 21.53%, and 21.92% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 69.Affected Areas in Dingras, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Dingras (in sq. km)										
	Albano	Bacsil	Bagut	Bares-bes	Barong	Bungcag	Cali	Capasan	Dancel	Eliza-beth	Espiritu
0.03-0.20	0	0.8	0	2.97	0.28	0	0.9	0.36	0	0.22	2.01
0.21-0.50	0	0.15	0	1.36	0.37	0	0.71	0.14	0	0.29	0.31
0.51-1.00	0	0.19	0	1.24	0.64	0.0045	0.47	0.094	0.0011	0.36	0.36
1.01-2.00	0	0.15	0	0.9	0.87	0.009	0.58	0.059	0.0088	0.53	0.28
2.01-5.00	0.0063	0.06	0.87	2.44	2.77	0.16	0.22	0.54	0.0085	0.53	0.17
> 5.00	0.37	0.0078	0.5	0.61	0.49	0.49	0.0089	0.18	0.36	0.0031	0.045

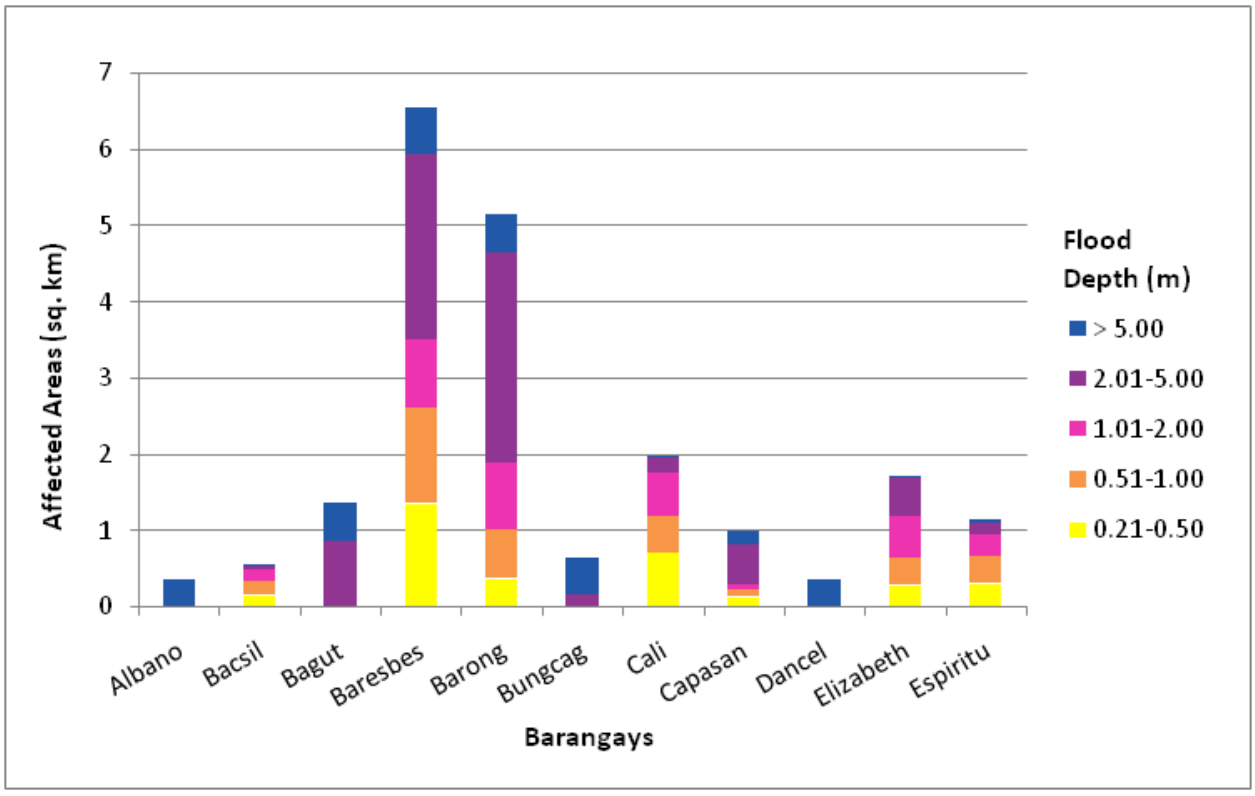

Figure 103.Affected Areas in Dingras, Ilocos Norte during 25-Year Rainfall Return Period

Table 70.Affected Areas in Dingras, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Dingras (in sq. km)									
	Foz	Guerre-ro	Lanas	Lumbad	Madam-ba	Man-daloque	Medina	Parado	Peralta	Puruga-nan
0.03-0.20	0.033	0.031	0.84	0	0	0	0.024	0.0036	0	0
0.21-0.50	0.011	0.014	0.7	0	0	0	0.0041	0.0051	0	0
0.51-1.00	0.028	0.079	0.53	0	0	0	0.037	0.019	0.0001	0
1.01-2.00	0.077	0.22	0.64	0	0	0	0.28	0.14	0.0073	0
2.01-5.00	0.57	0.17	1.11	0.043	0.016	0.5	0.69	1.24	0.23	0.0098
> 5.00	2.95	0.66	0.23	2.94	0.68	1.74	0.11	0.25	0.98	0.39

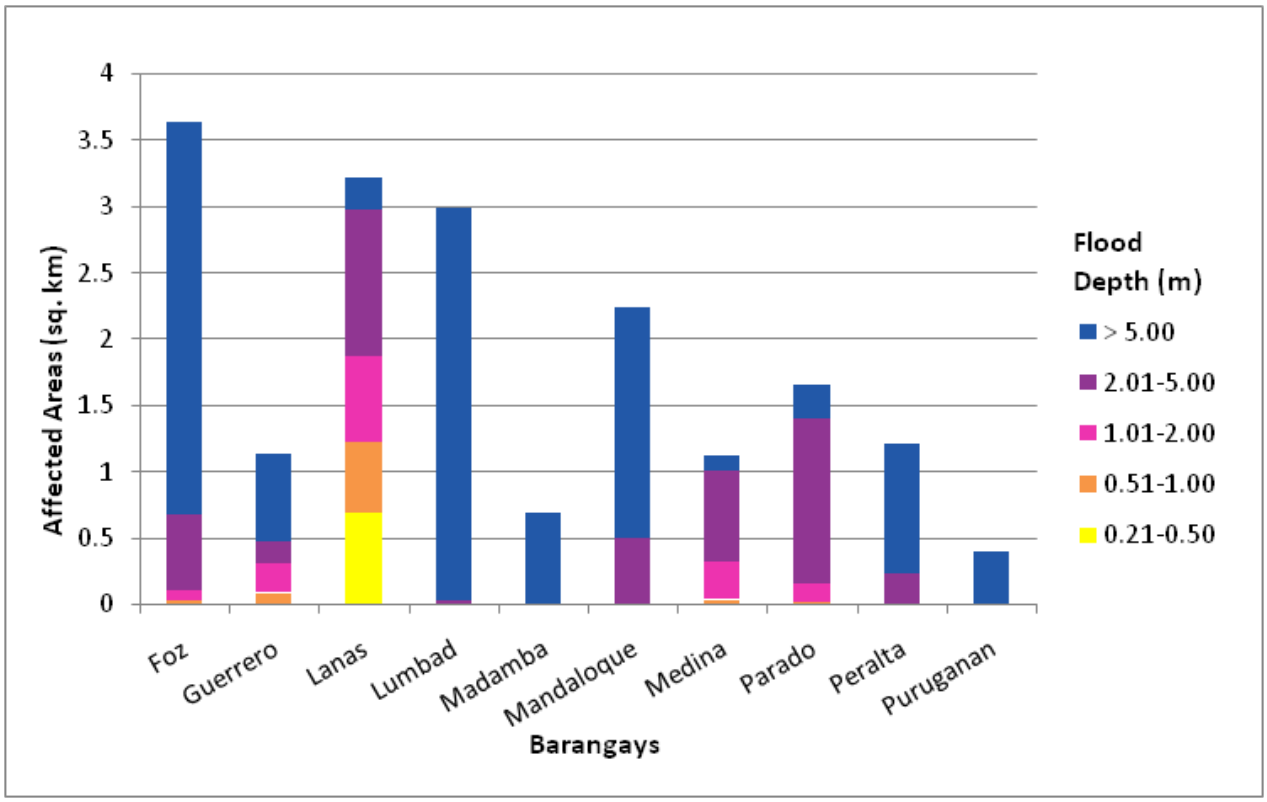

Figure 104.Affected Areas in Dingras, Ilocos Norte during 25-Year Rainfall Return Period

Table 71.Affected Areas in Dingras, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Dingras (in sq. km)									
	Root	Sagpa-tan	Sa-ludares	San Esteban	San Francis-co	San Marceli-no	San Marcos	Sulqui-ano	Suyo	Ver
0.03-0.20	0.0014	0	0.22	0.4	11.69	3.38	0.14	0.12	0.048	0.27
0.21-0.50	0.016	0	0.26	0.026	2.41	1.05	0.17	0.087	0.0082	0.53
0.51-1.00	0.15	0.0004	0.29	0.023	1.43	0.51	0.36	0.07	0.011	1.05
1.01-2.00	0.26	0.015	0.27	0.17	1.3	0.29	0.99	0.011	0.068	0.51
2.01-5.00	0.82	0.85	0.38	0.98	0.37	0.34	2.14	0.052	1.14	0.093
> 5.00	0.17	1.29	0	0.0036	0.001	0.031	0.64	1.67	2.09	0.0043

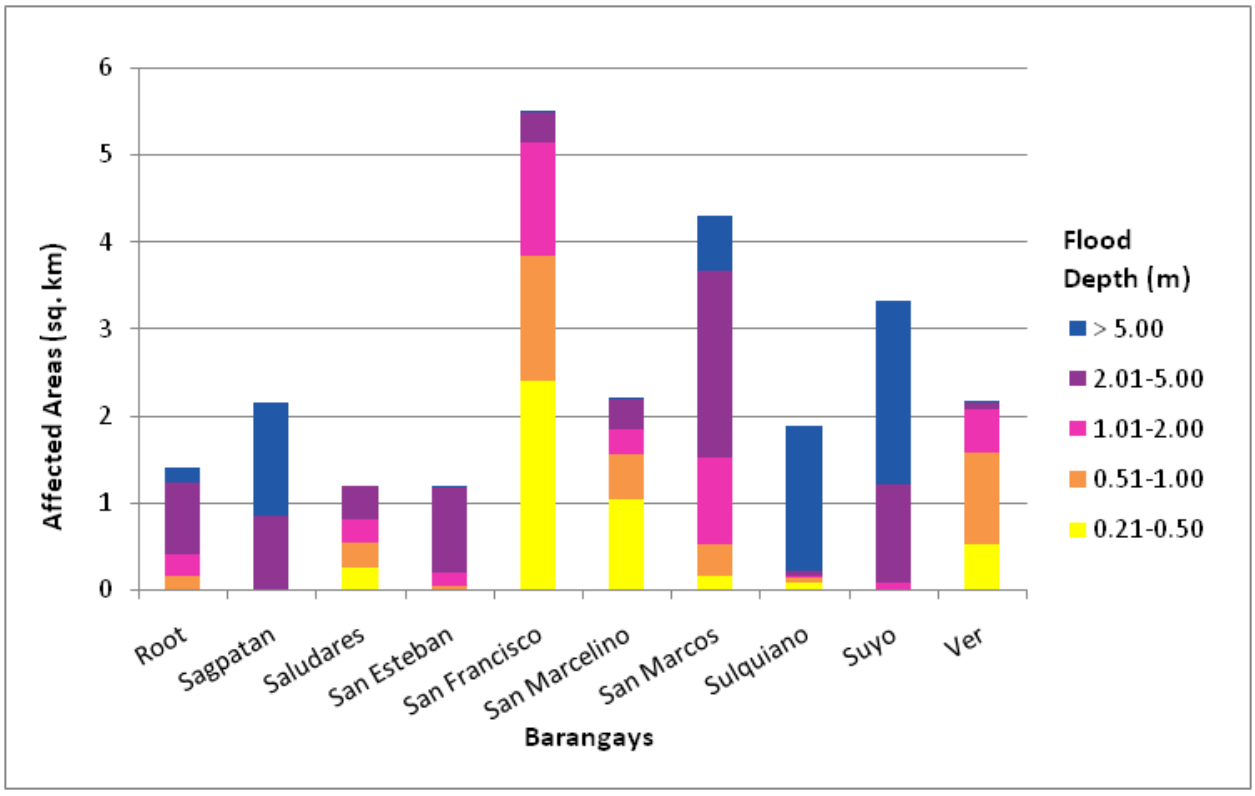

Figure 105.Affected Areas in Dingras, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 43.08% of the municipality of Laoag City with an area of 114.355 sq. km. will experience flood levels of less than 0.20 meters. 11.37% of the area will experience flood levels of 0.21 to 0.50 meters while 12.48%, 14.36%, 11.18%, and 4.70% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 72.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 1, San Lorenzo	Bgy. No. 10, San Jose	Bgy. No. 11, Santa Balbina	Bgy. No. 12, San Isidro	Bgy. No. 13, Nstra. Sra. De Visitaci	Bgy. No. 14, Santo Tomas	Bgy. No. 15, San Guillermo	Bgy. No. 16, San Jacinto	Bgy. No. 17, San Francis-co	Bgy. No. 19, Santa Marcela
0.03-0.20	0.072	0.035	0.02	0.0083	0.024	0.087	0.031	0.027	0.08	0.041
0.21-0.50	0.048	0.034	0.037	0.03	0.02	0.051	0.029	0.037	0.051	0.02
0.51-1.00	0.03	0.013	0.041	0.028	0.022	0.0083	0.0024	0.0011	0.0028	0.0028
1.01-2.00	0.008	0.0002	0.0049	0.011	0.0024	0.0057	0.000028	0	0.0053	0.00025
2.01-5.00	0.0048	0.00095	0	0.005	0	0.011	0	0	0.019	0.013
> 5.00	0.011	0.013	0	0	0	0.092	0	0	0.058	0.034

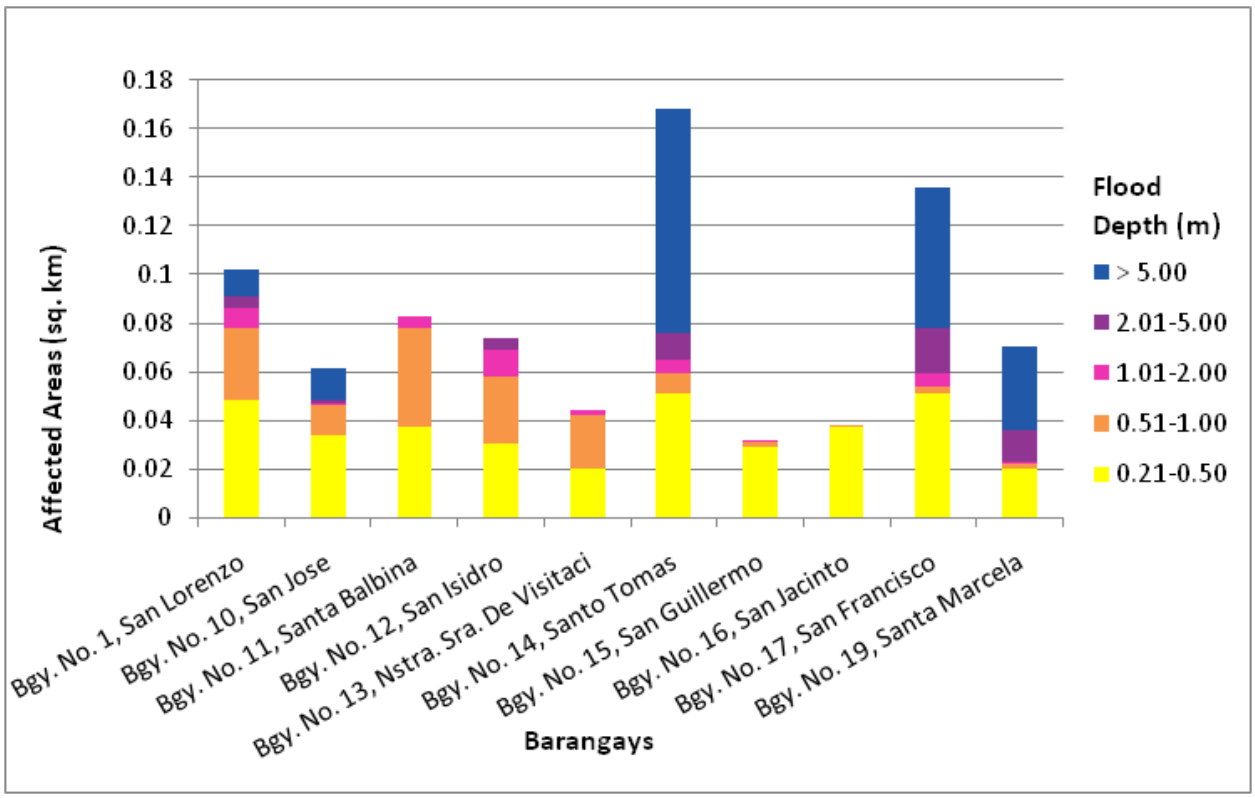

Figure 106.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Table 73.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 2, Santa Joaquina	Bgy. No. 20, San Miguel	Bgy. No. 21, San Pedro	Bgy. No. 22, San Andres	Bgy. No. 23, San Matias	Bgy. No. 24, Nstra. Sra. De Consolac	Bgy. No. 25, Santa Cayeta-na	Bgy. No. 26, San Marceli-no	Bgy. No. 27, Nstra. Sra. de Soledad	Bgy. No. 28, San Bernar-do
0.03-0.20	0.14	0.021	0.16	0.021	0.4	0.031	0.1	0.072	0.026	0.017
0.21-0.50	0.053	0.022	0.057	0.0059	0.12	0.00071	0.0099	0.016	0.06	0.06
0.51-1.00	0.11	0.0054	0.016	0.0085	0.066	0.0012	0.001	0.0041	0.08	0.12
1.01-2.00	0.17	0.00074	0.012	0.001	0.024	0.0015	0.0015	0.0029	0.0044	0.014
2.01-5.00	0.17	0.014	0.009	0.0053	0	0.015	0.011	0.028	0.034	0.049
> 5.00	0.0034	0.064	0.0016	0.12	0	0.15	0.048	0.079	0.085	0.066

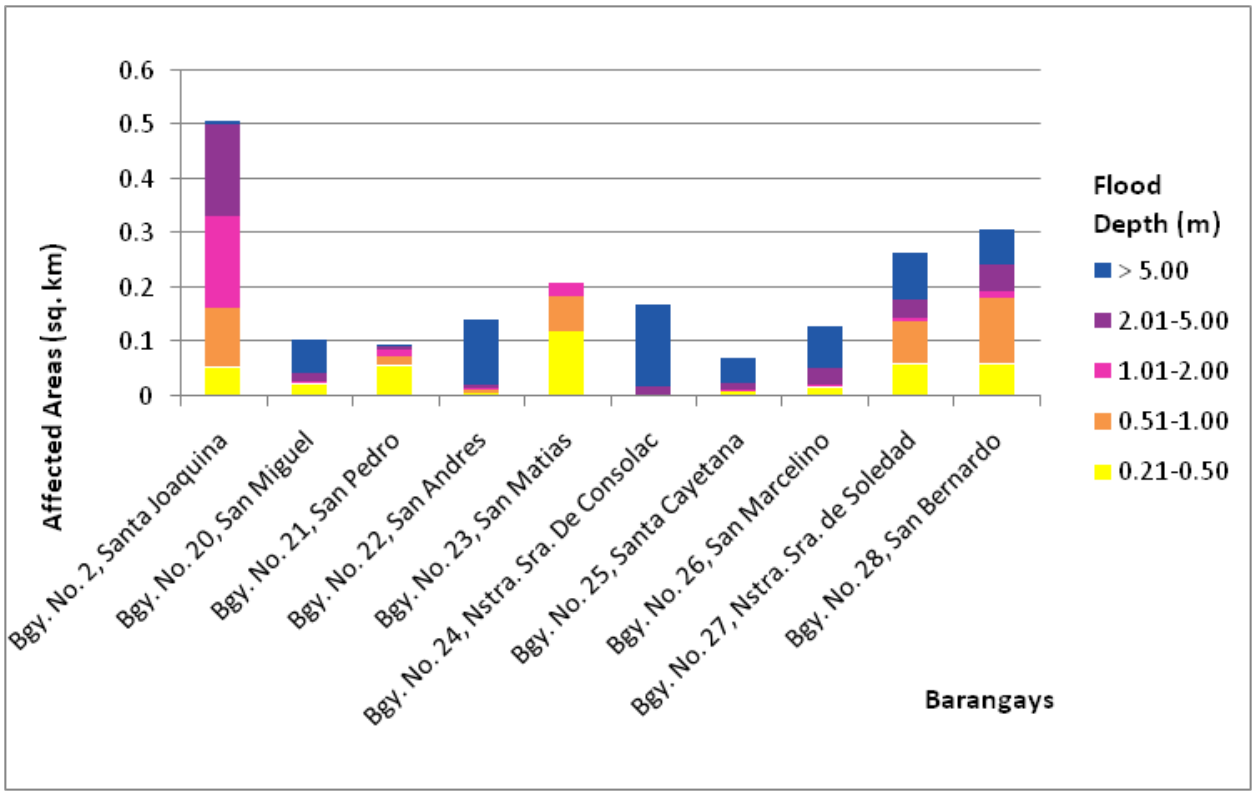

Figure 107.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Table 74.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 29, Santo Tomas	Bgy. No. 3, Nstra. Sra. Del Rosario	Bgy. No. 30-A, Suyo	Bgy. No. 30-B, Santa Maria	Bgy. No. 31, Tal-ingaan	Bgy. No. 32-A, La Paz East	Bgy. No. 32-B, La Paz West	Bgy. No. 32-C La Paz East	Bgy. No. 33-A, La Paz Proper	Bgy. No. 33-B, La Paz Proper
0.03-0.20	0.0009	0.038	0.2	0.37	2.89	0.29	0.69	0.47	0.36	0.13
0.21-0.50	0.013	0.017	0.1	0.099	0.34	0.07	0.21	0.017	0.011	0.0099
0.51-1.00	0.042	0.012	0.061	0.28	0.45	0.074	0.23	0.017	0.0029	0.015
1.01-2.00	0.017	0.0056	0.019	0.58	0.47	0.022	0.096	0.065	0.0019	0.02
2.01-5.00	0.23	0.011	0.18	0.5	0.14	0.0072	0.088	0.16	0.022	0.21
> 5.00	0.042	0	0.057	0.36	0.094	0.0011	0	0.12	0.023	0.051

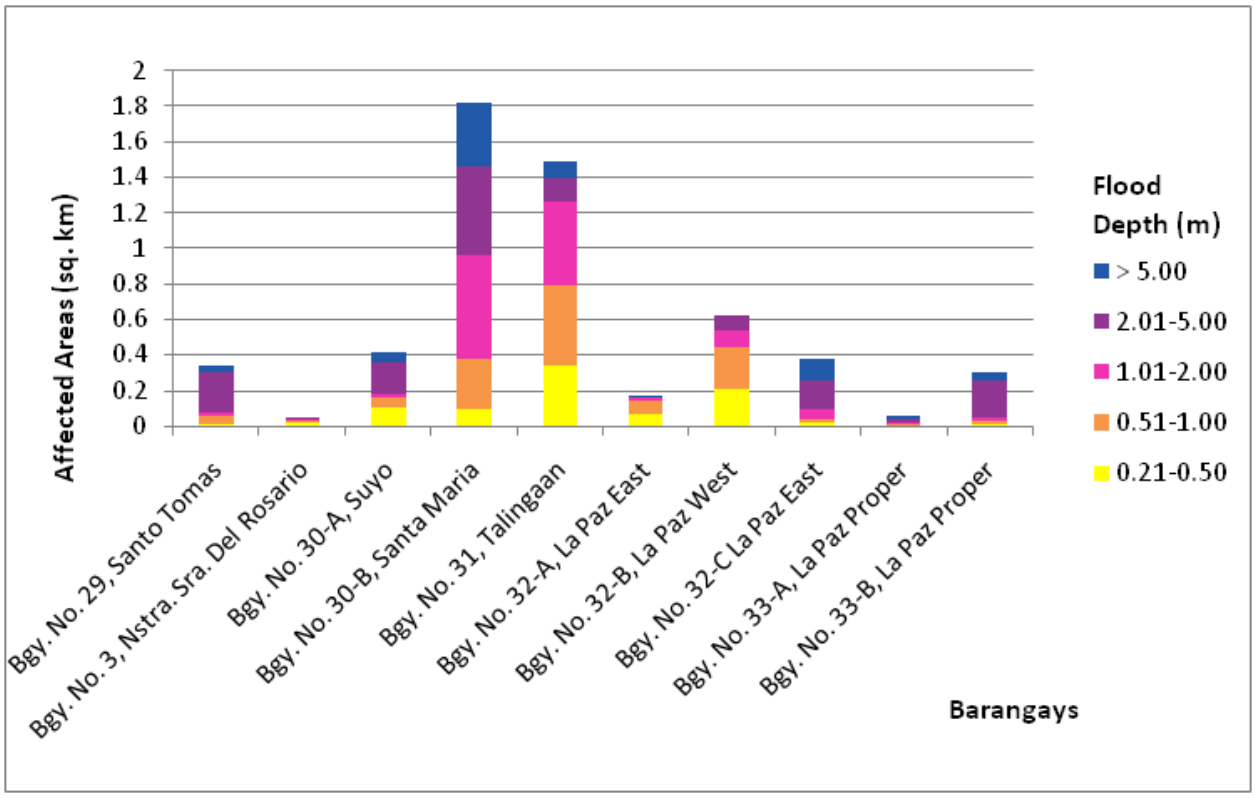

Figure 108. Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Table 75.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 34-A, Gabu Norte West	Bgy. No. 34-B, Gabu Norte East	Bgy. No. 35, Gabu Sur	Bgy. No. 36, Araniw	Bgy. No. 37, Calayab	Bgy. No. 38-A, Mangato East	Bgy. No. 38-B, Mangato West	Bgy. No. 39, San-ta Rosa	Bgy. No. 4, San Guiller-mo	Bgy. No. 40, Bala-tong
0.03-0.20	0.19	0.15	0.65	0.59	4.4	0.035	0.014	0.29	0.11	2.25
0.21-0.50	0.17	0.059	0.21	0.31	0.49	0.055	0.015	0.38	0.065	0.46
0.51-1.00	0.33	0.023	0.21	0.45	0.67	0.11	0.059	1.14	0.023	0.4
1.01-2.00	0.14	0.013	0.22	0.51	0.67	0.15	0.077	0.72	0.0057	0.44
2.01-5.00	0.14	0.0045	0.32	0.3	0.21	0.13	0.28	0.38	0.013	0.29
> 5.00	0.0073	0.011	0.01	0.00082	0.0001	0	0	0.0015	0.00063	0.0073

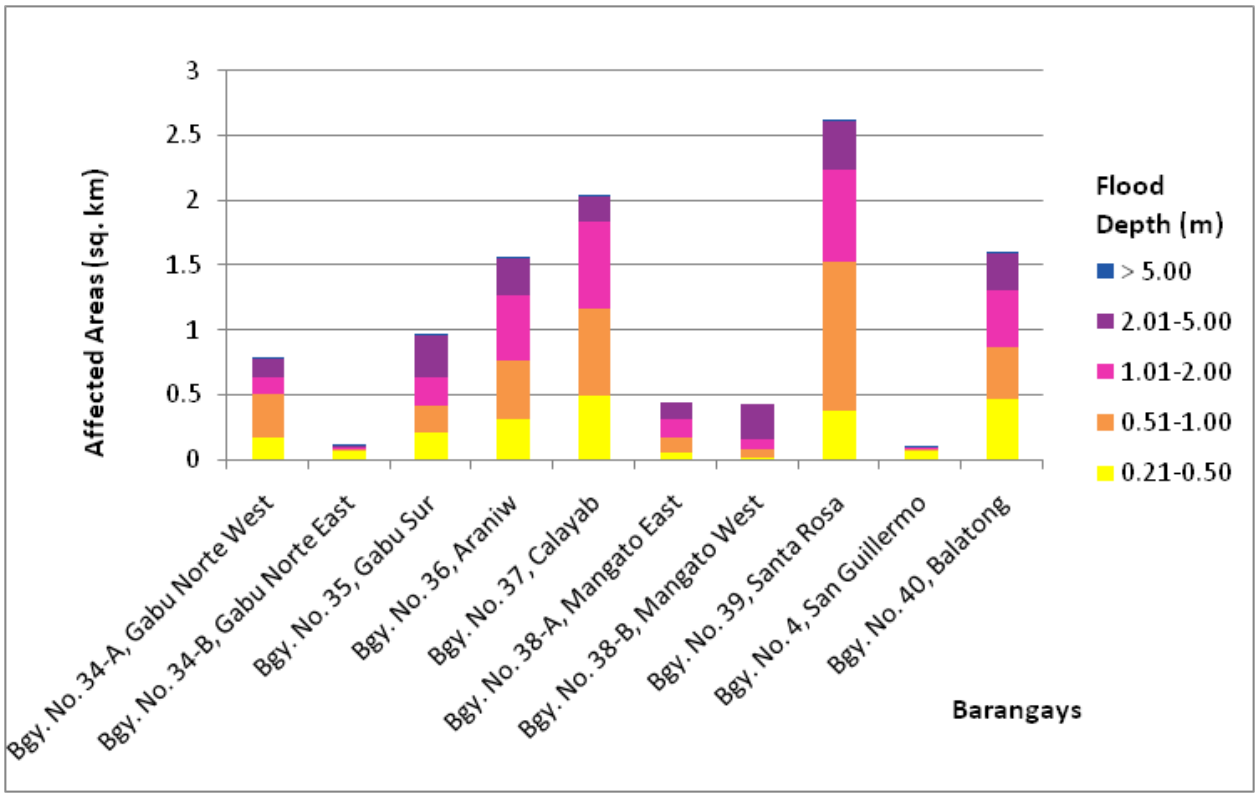

Figure 109.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Table 76.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 41, Balacad	Bgy. No. 42, Apaya	Bgy. No. 43, Cavit	Bgy. No. 44, Zam-boanga	Bgy. No. 45, Tangid	Bgy. No. 46, Nalbo	Bgy. No. 47, Bengcag	Bgy. No. 48-B, Cabun-gaan South	Bgy. No. 49-A, Daray-day	Bgy. No. 49-B, Rarabu-ran
0.03-0.20	3.12	0.92	0.016	0.07	0.09	0.014	0.0089	0.34	0.25	0.33
0.21-0.50	0.65	0.22	0.055	0.071	0.14	0.027	0.079	0.2	0.17	0.27
0.51-1.00	0.61	0.45	0.13	0.17	0.47	0.073	0.4	0.11	0.26	0.29
1.01-2.00	0.46	1.03	0.11	0.55	0.39	0.16	0.53	0.19	0.32	0.42
2.01-5.00	0.13	1.08	0.12	0.47	0.17	0.5	0.51	0.2	0.11	0.15
> 5.00	0	0	0.022	0.0001	0.59	0.58	0.21	0	0	0.0043

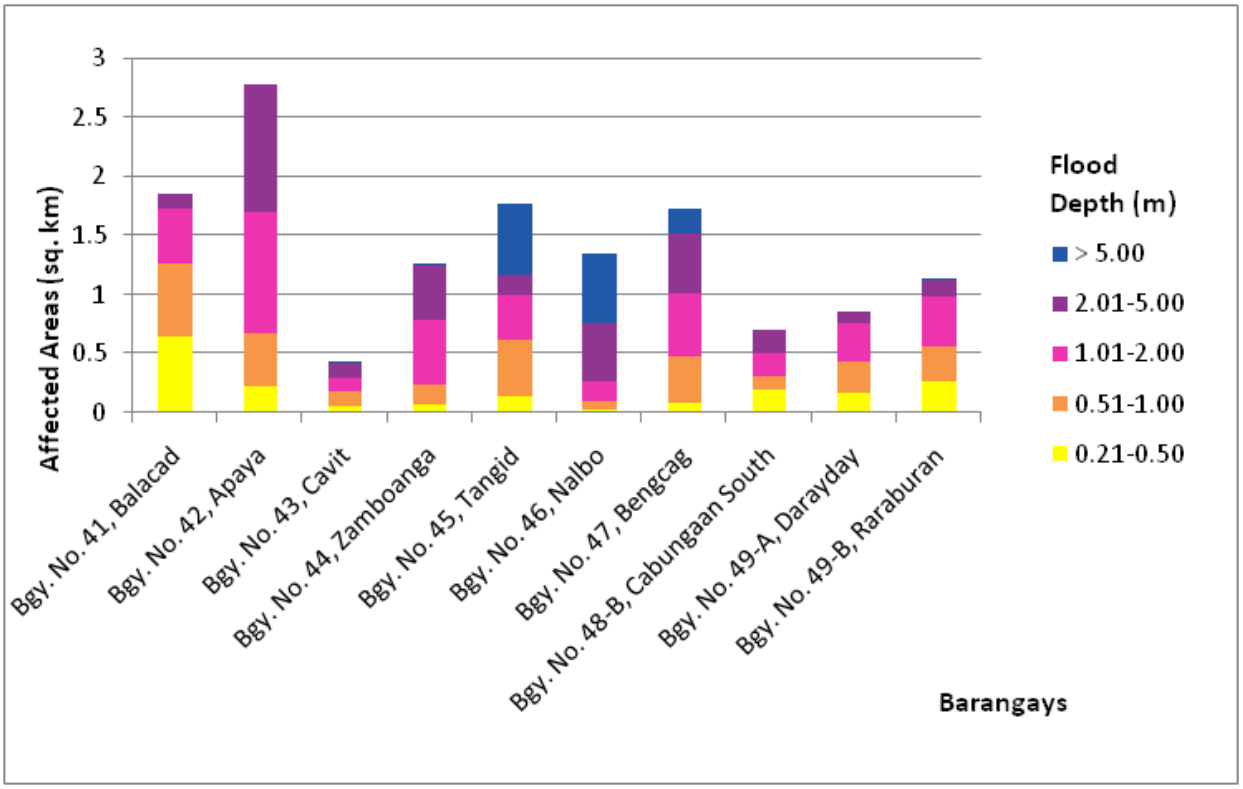

Figure 110.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Table 77.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 5, San Pedro	Bgy. No. 50, Buttong	Bgy. No. 51-A, Nangal-isan East	Bgy. No. 51-B, Nan-galisan West	Bgy. No. 52-A, San Mateo	Bgy. No. 52-B, Lataag	Bgy. No. 53, Rioeng	Bgy. No. 54-A, Lagui-Sail	Bgy. No. 54-B, Caman-gaan	Bgy. No. 55-A, Barit-Pan-dan
0.03-0.20	0.041	0.57	0.2	0.056	0.61	2.18	0.35	1.13	0.014	1.02
0.21-0.50	0.0098	0.26	0.084	0.033	0.28	1.17	0.3	0.42	0.018	0.16
0.51-1.00	0.0024	0.18	0.091	0.046	0.1	0.79	0.24	0.7	0.053	0.19
1.01-2.00	0.00031	0.11	0.18	0.14	0.24	0.35	0.16	1.7	0.051	0.25
2.01-5.00	0.0024	0.11	0.39	0.18	0.65	0.13	0.89	0.026	1.02	0.11
> 5.00	0.043	0.0093	0.26	0.22	0.66	0.032	0.44	0	0.59	0

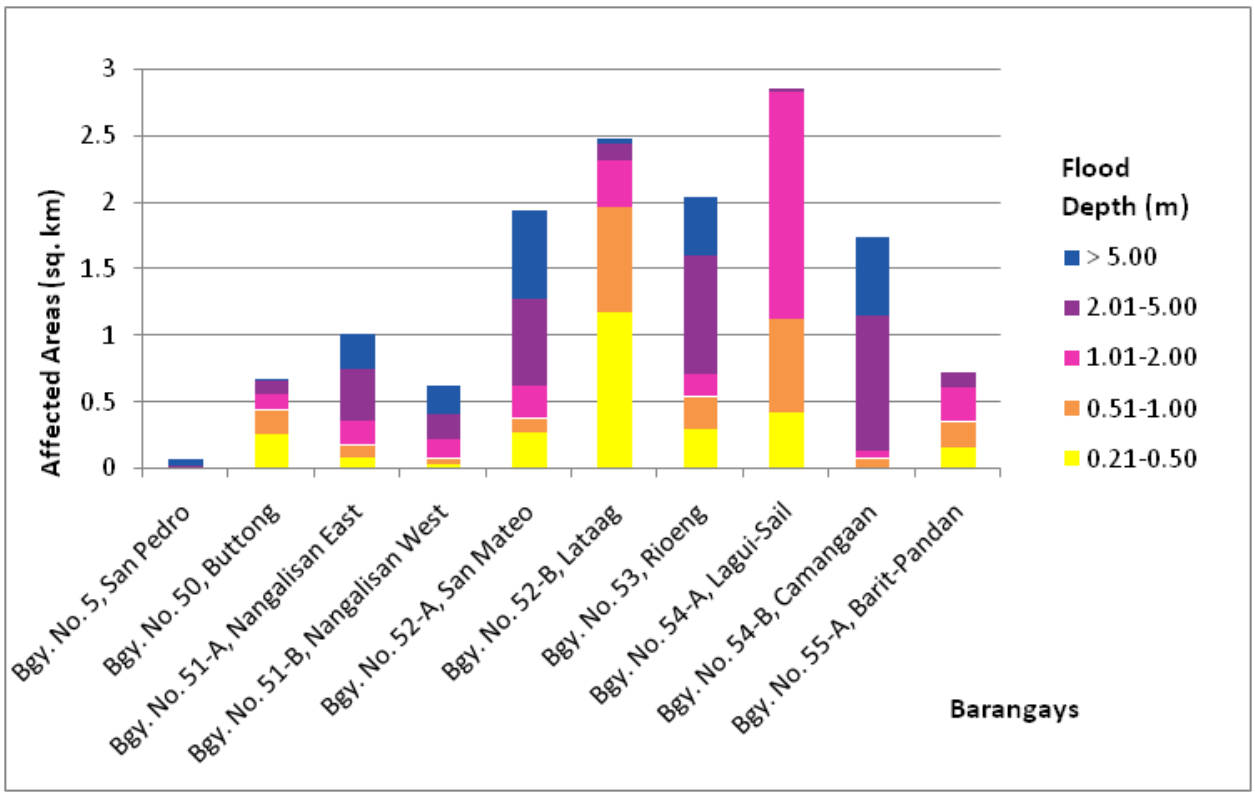

Figure 111.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Table 78.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 55-B, Salet-Bu-langon	Bgy. No. 55-C, Vira	Bgy. No. 56-A, Bacsil North	Bgy. No. 56-B, Bacsil South	Bgy. No. 57, Pila	Bgy. No. 58, Casili	Bgy. No. 59-A, Dibua South	Bgy. No. 59-B, Dibua North	Bgy. No. 6, San Agustin	Bgy. No. 60-A, Caaoa-can
0.03-0.20	4.11	1.27	4.29	3.68	1.61	0.81	0.79	1.89	0.042	0.3
0.21-0.50	0.64	0.2	0.36	0.77	0.18	0.37	0.23	0.25	0.021	0.071
0.51-1.00	0.59	0.22	0.18	0.28	0.33	0.17	0.27	0.11	0.00076	0.11
1.01-2.00	0.98	0.061	0.098	0.12	0.56	0.26	0.25	0.013	0.0001	0.22
2.01-5.00	0.69	0.0001	0.011	0.093	0.11	0.24	0.018	0	0.0011	0.12
> 5.00	0	0	0	0.013	0	0.0005	0	0	0.0035	0

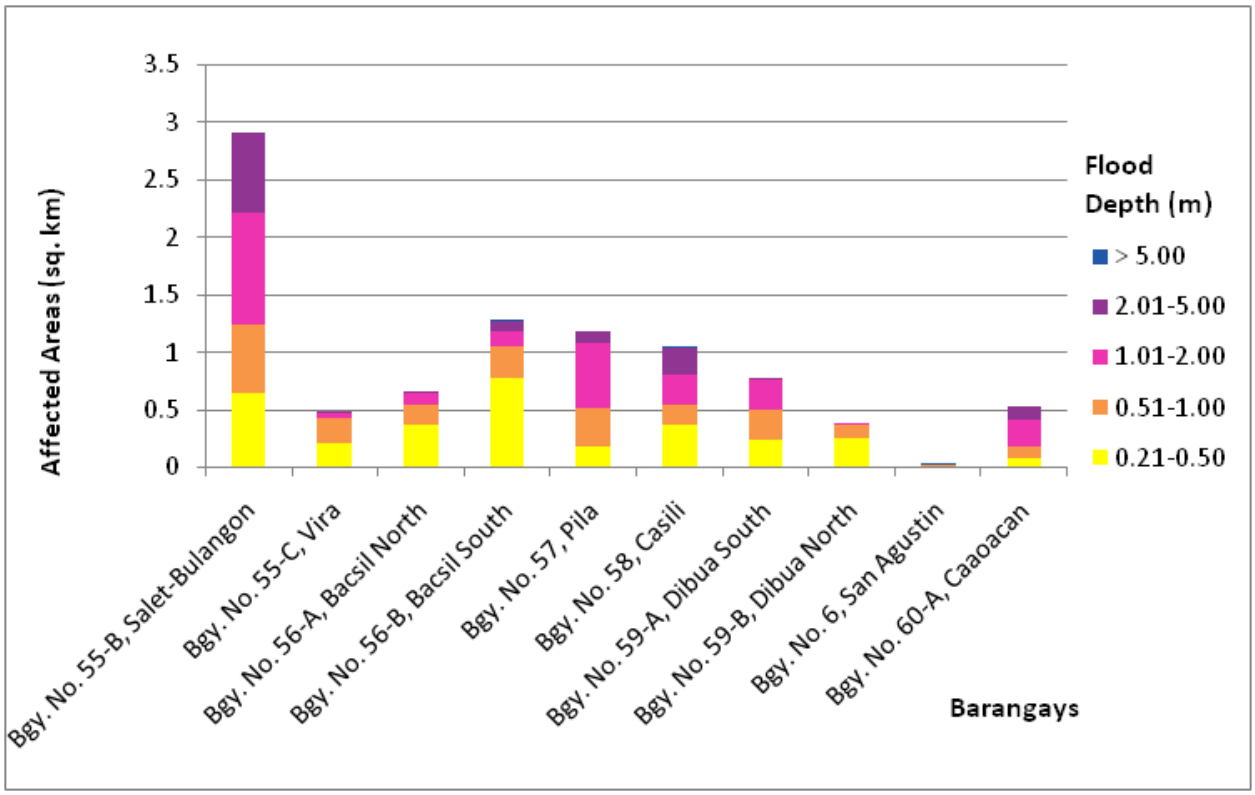

Figure 112.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Table 79.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 60-B, Madil-adig	Bgy. No. 61, Cata-ban	Bgy. No. 62-A, Navotas North	Bgy. No. 62-B, Navotas South	Bgy. No. 7-A, Nstra. Sra. De Natívid	Bgy. No. 7-B, Nstra. Sra. De Natívid	Bgy. No. 8, San Vicente	Bgy. No. 9, Santa Angela	Bry. No. 18, San Quirino	Bry. No. 48-A, Cabun-gaan North
0.03-0.20	1.49	0.3	0.24	1.38	0.038	0.016	0.025	0.041	0.045	0.045
0.21-0.50	0.62	0.15	0.082	0.36	0.021	0.027	0.021	0.03	0.014	0.085
0.51-1.00	0.42	0.31	0.14	0.45	0.00085	0.0014	0.0017	0.0068	0.00081	0.21
1.01-2.00	0.34	0.82	0.2	0.5	0.00039	0	0.00011	0.0001	0.0027	0.14
2.01-5.00	0.012	0.36	0.061	0.037	0.00076	0	0.00039	0.0011	0.027	0.057
> 5.00	0	0	0	0	0.0062	0	0.0061	0.011	0.057	0

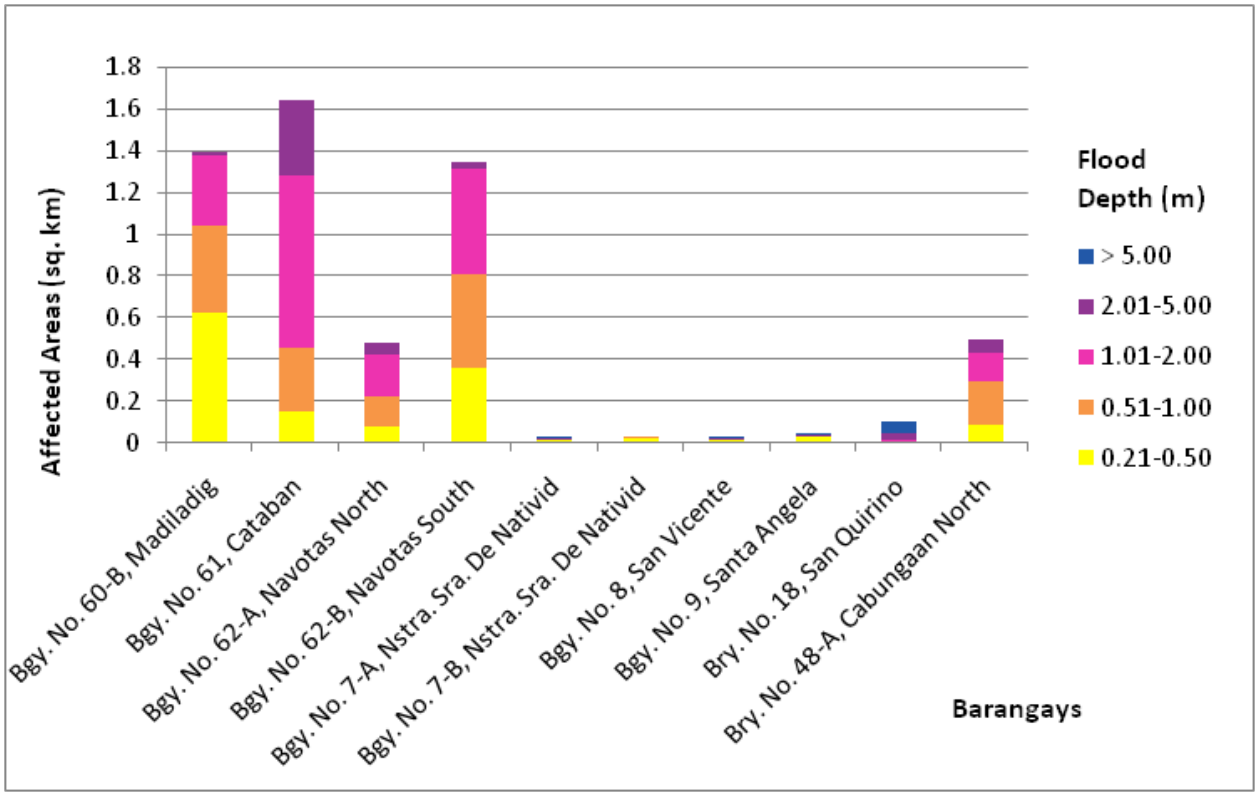

Figure 113.Affected Areas in Laoag City, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 45.79% of the municipality of Marcos with an area of 73.57 sq. km. will experience flood levels of less than 0.20 meters. 16.18% of the area will experience flood levels of 0.21 to 0.50 meters while 13.38%, 9.20%, 10.62%, and 2.81% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 80.Affected Areas in Marcos, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Marcos (in sq. km)						
	Caca-fean	Daquio-ag	Eliza-beth	Escoda	Ferdi-nand	Fortuna	Imelda
0.03-0.20	5.7	3.54	2.03	5.6	1.24	7.68	0.96
0.21-0.50	1.92	0.35	1.16	2.72	0.61	0.62	0.072
0.51-1.00	1.69	0.26	0.98	2.01	0.41	0.48	0.084
1.01-2.00	0.61	0.51	0.35	1.1	0.29	0.3	0.097
2.01-5.00	0.34	0.82	0.35	1.37	0.05	0.68	0.14
> 5.00	0.17	0.35	0.0032	0.1	0	0.19	0.036

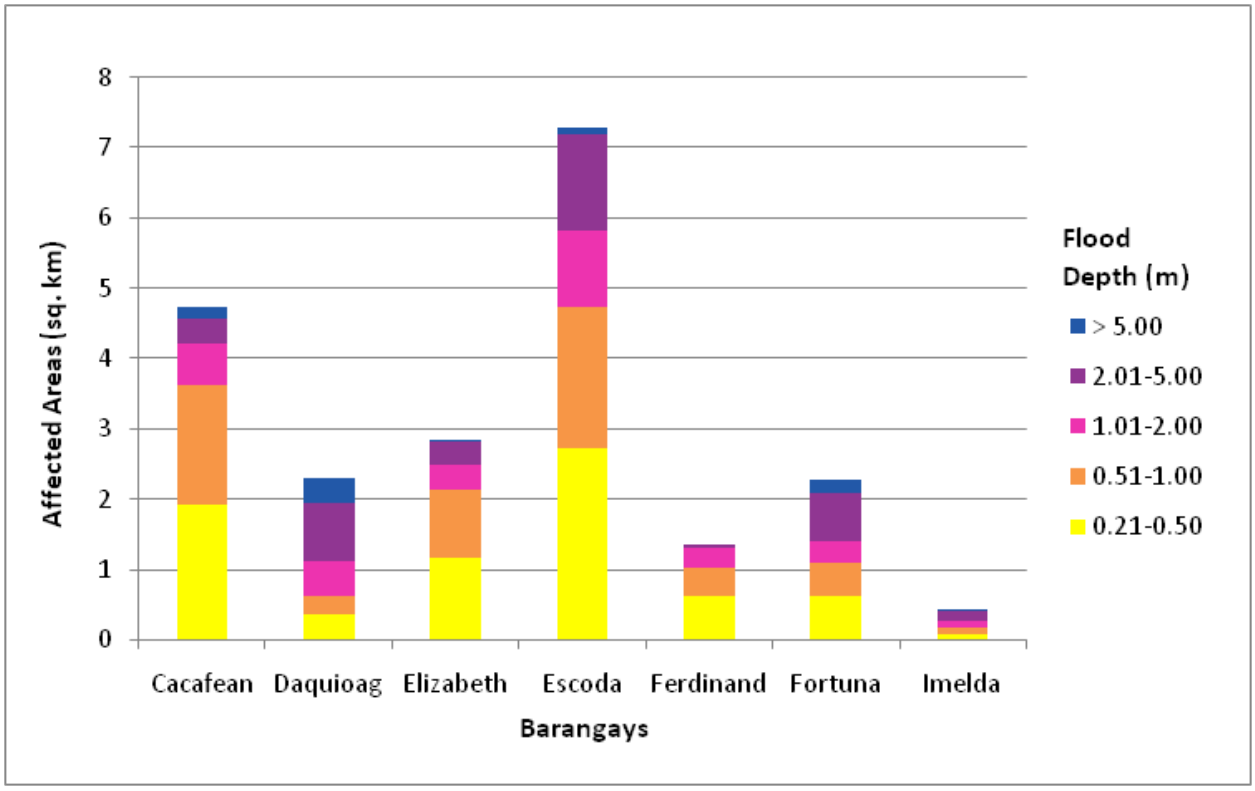

Figure 114.Affected Areas in Marcos, Ilocos Norte during 25-Year Rainfall Return Period

Table 81.Affected Areas in Marcos, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Marcos (in sq. km)					
	Lydia	Mabuti	Pacifico	Santiago	Tabuc-buc	Valdez
0.03-0.20	0.93	1.51	2.38	1.66	0.34	0.11
0.21-0.50	0.42	0.25	2.2	1.09	0.31	0.2
0.51-1.00	0.6	0.16	1.57	0.57	0.57	0.46
1.01-2.00	0.069	0.097	0.76	0.88	1.16	0.54
2.01-5.00	0.029	0.096	1.59	0.092	1.54	0.71
> 5.00	0.00013	0.064	0.52	0	0.45	0.19

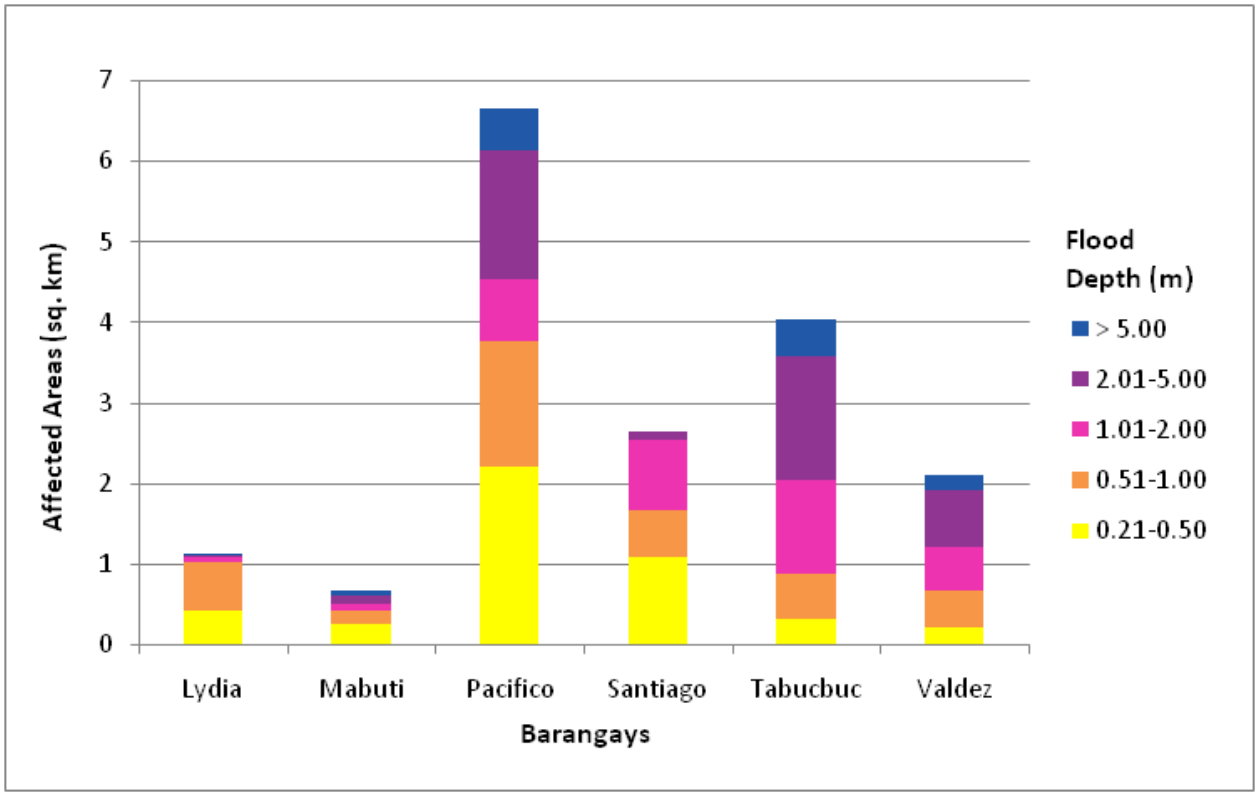

Figure 115.Affected Areas in Marcos, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 8.31% of the municipality of Nueva Era with an area of 619 sq. km. 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 while 0.69%, 0.50%, 0.37%, and 0.06% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 82.Affected Areas in Nueva Era, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Nueva Era (in sq. km)								
	Acnam	Barikir	Bugay-ong	Cabit-tauran	Caray	Garna-den	Naguil-lan	Pobla-cion	Santo Niño
0.03-0.20	0.75	0.73	5.21	10.08	10.24	5.65	4.63	2.54	11.63
0.21-0.50	0.081	0.14	0.64	1.69	0.61	0.52	0.39	0.21	1.01
0.51-1.00	0.12	0.29	0.67	1.18	0.37	0.43	0.39	0.27	0.55
1.01-2.00	0.18	0.32	0.53	0.57	0.28	0.29	0.48	0.24	0.21
2.01-5.00	0.026	0.0017	0.36	0.3	0.13	0.19	0.43	0.41	0.48
> 5.00	0	0	0.011	0.0055	0.011	0.0099	0.068	0.21	0.075

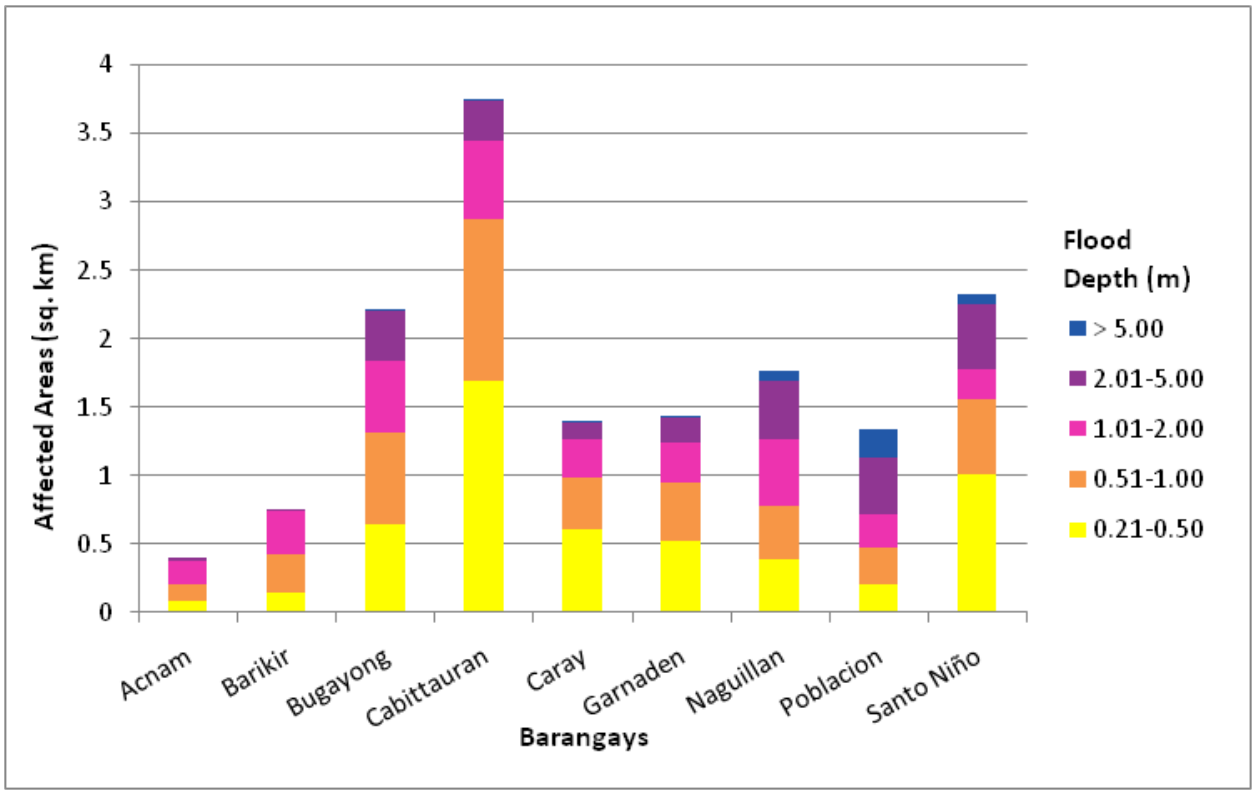

Figure 116.Affected Areas in Nueva Era, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 16.12% of the municipality of Paoay with an area of 71.616 sq. km. will experience flood levels of less than 0.20 meters. 1.25% of the area will experience flood levels of 0.21 to 0.50 meters while 0.78%, 0.56%, 0.57%, and 0.06% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 83.Affected Areas in Paoay, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Paoay (in sq. km)							
	Bacsil	Mumu-laan	Nagba-calan	Nan-guyudan	Pasil	Suba	Sun-gadan	Surgui
0.03-0.20	0.028	1.13	2.34	2.79	0.32	3.42	1.46	0.06
0.21-0.50	0.00021	0.14	0.13	0.2	0.02	0.25	0.15	0.0027
0.51-1.00	0	0.059	0.099	0.1	0.0016	0.24	0.055	0.00013
1.01-2.00	0	0.038	0.088	0.039	0.00068	0.24	0.00072	0
2.01-5.00	0	0.045	0.15	0.0047	0.0004	0.21	0	0
> 5.00	0	0.0007	0.036	0.00019	0	0.0064	0	0

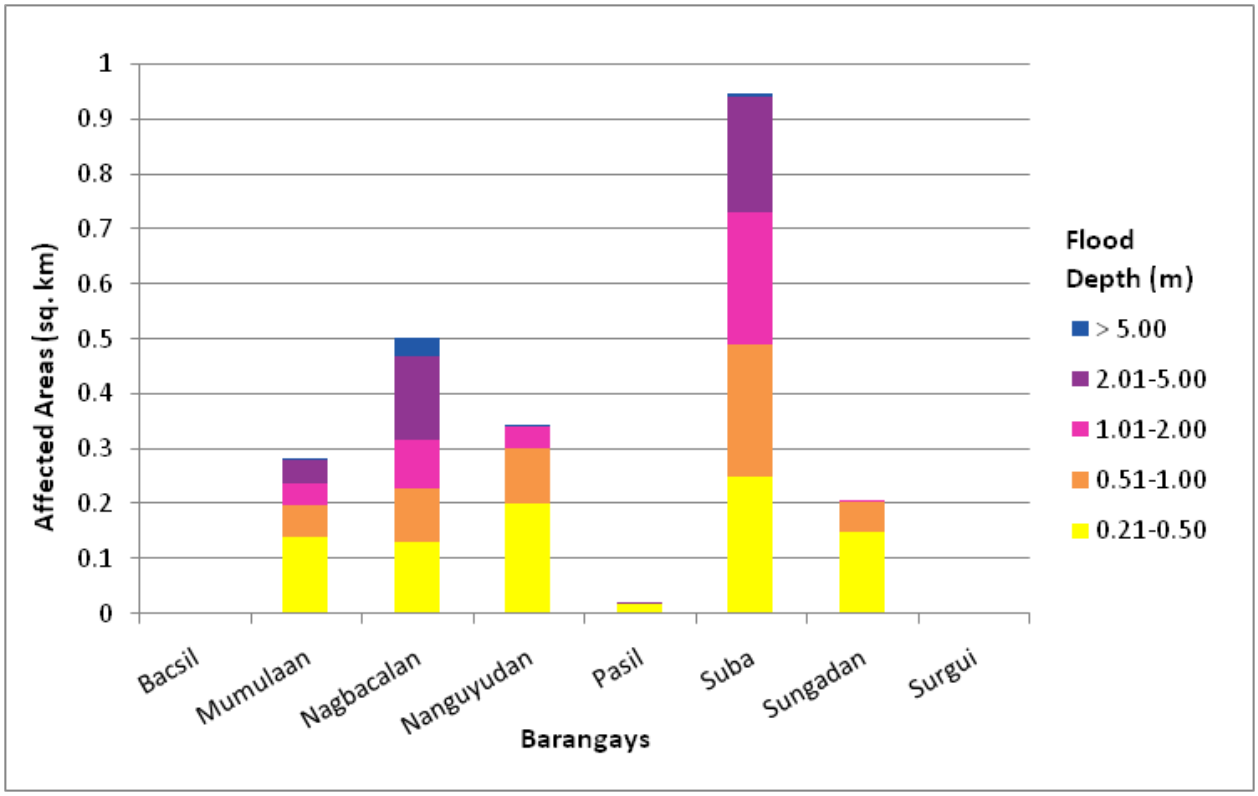

Figure 117.Affected Areas in Paoay, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 33.47% of the municipality of Paoay Lake with an area of 3.64 sq. km. will experience flood levels of less than 0.20 meters. 1.62% of the area will experience flood levels of 0.21 to 0.50 meters while 0.53%, 0.31%, 0.18%, and 0.01% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 84.Affected Areas in Paoay Lake, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Paoay Lake (in sq. km)
	Paoay Lake
0.03-0.20	1.22
0.21-0.50	0.059
0.51-1.00	0.019
1.01-2.00	0.011
2.01-5.00	0.0064
> 5.00	0.0002

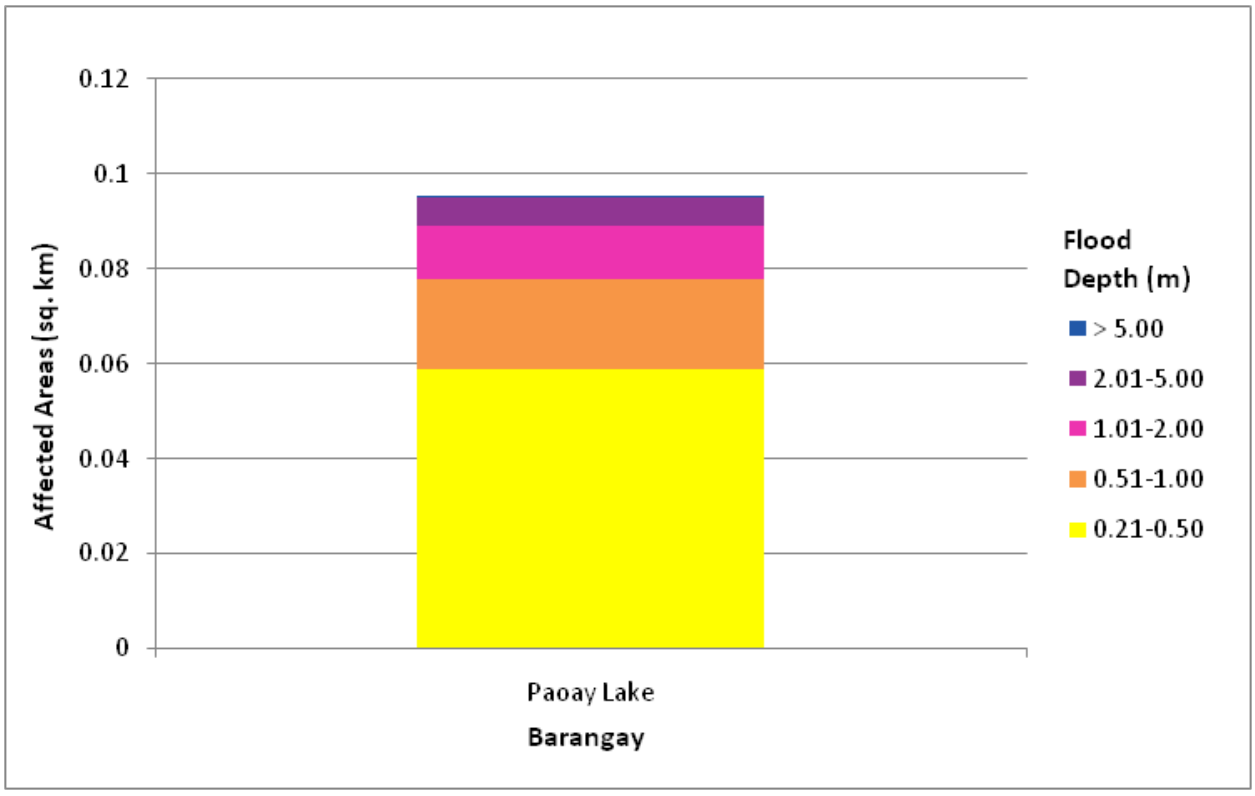

Figure 118.Affected Areas in Paoay Lake, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 41.64% of the municipality of Piddig with an area of 128.566 sq. km. will experience flood levels of less than 0.20 meters. 4.02% of the area will experience flood levels of 0.21 to 0.50 meters while 4.18%, 6.93%, 10.02%, and 2.97% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 85.Affected Areas in Piddig, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Piddig (in sq. km)											
	Ab-Abut	Abucay	Anao	Arua-Ay	Bim-manga	Boyboy	Cabaroan	Calam-beg	Callusa	Dupitac	Estancia	Gayamat
0.03-0.20	0.56	9.18	0.3	0.7	0.0036	2.11	0.48	0.84	0.085	4.12	12.75	1.36
0.21-0.50	0.077	0.71	0.028	0.052	0.054	0.27	0.028	0.096	0.025	0.39	0.78	0.14
0.51-1.00	0.19	0.72	0.017	0.1	0.19	0.42	0.014	0.11	0.24	0.7	0.78	0.18
1.01-2.00	0.34	0.66	0.025	0.15	0.19	0.88	0.021	0.48	0.97	1.75	1.36	0.26
2.01-5.00	0.25	0.12	0.043	1	0.84	1.89	0.16	1.6	0.83	2.07	0.49	0.15
> 5.00	0.0007	0.0002	0.027	0.0041	0.08	2.13	0.087	0.15	0.023	0.1	0.067	0.0049

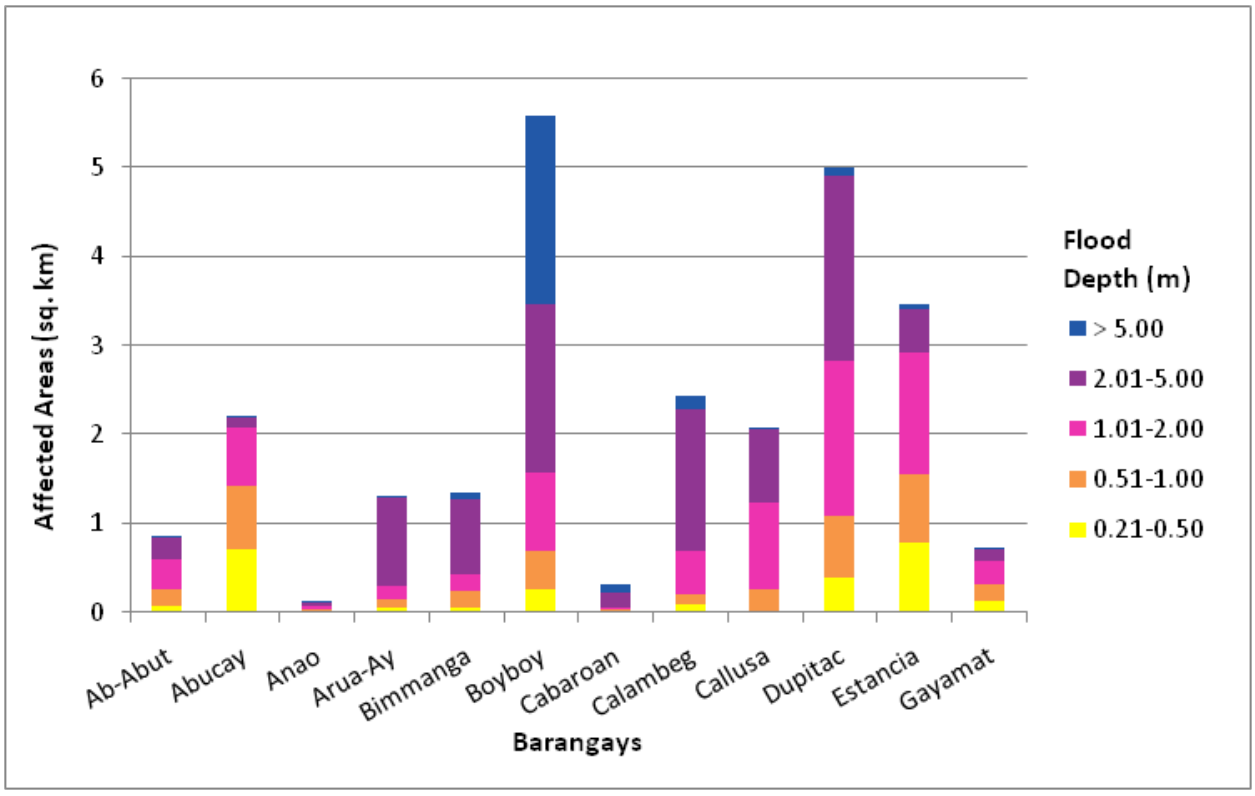

Figure 119.Affected Areas in Piddig, Ilocos Norte during 25-Year Rainfall Return Period

Table 86.Affected Areas in Piddig, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Piddig (in sq. km)										
	Lagandit	Lib-naoan	Loing	Maab-Ab-aca	Mangi-tayag	Maruaya	San Antonio	Santa Maria	Suc-suquen	Tan-gaoan	Tonoton
0.03-0.20	1.14	1	0.1	2.94	0.045	2.64	3.27	3.01	1.34	4.53	1.02
0.21-0.50	0.4	0.12	0.01	0.29	0.028	0.16	0.14	0.2	0.28	0.75	0.14
0.51-1.00	0.23	0.18	0.028	0.25	0.061	0.13	0.08	0.15	0.2	0.34	0.07
1.01-2.00	0.21	0.44	0.21	0.11	0.047	0.2	0.096	0.11	0.17	0.12	0.092
2.01-5.00	0.027	1.14	0.49	0.46	0.7	0.22	0.13	0.028	0.022	0.042	0.17
> 5.00	0	0.066	0.028	0.077	0.76	0	0.17	0	0.0025	0	0.045

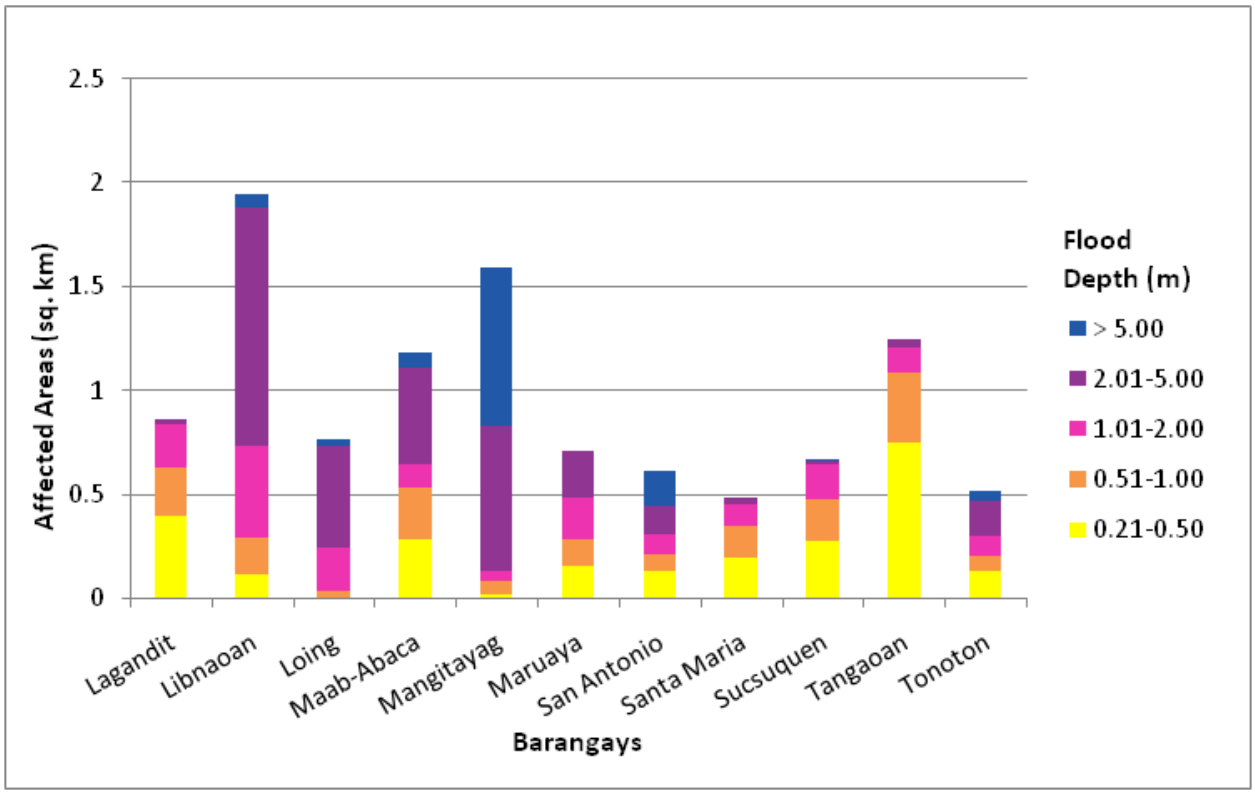

Figure 120.Affected Areas in Piddig, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 2.04% of the municipality of Pinili with an area of 63.18 sq. km. will experience flood levels of less than 0.20 meters. 0.16% of the area will experience flood levels of 0.21 to 0.50 meters while 0.07%, 0.02%, and 0.01% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 87.Affected Areas in Pinili, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Pinili (in sq. km)
	Lumbaan-Bicbica
0.03-0.20	1.29
0.21-0.50	0.1
0.51-1.00	0.046
1.01-2.00	0.011
2.01-5.00	0.0066
> 5.00	0

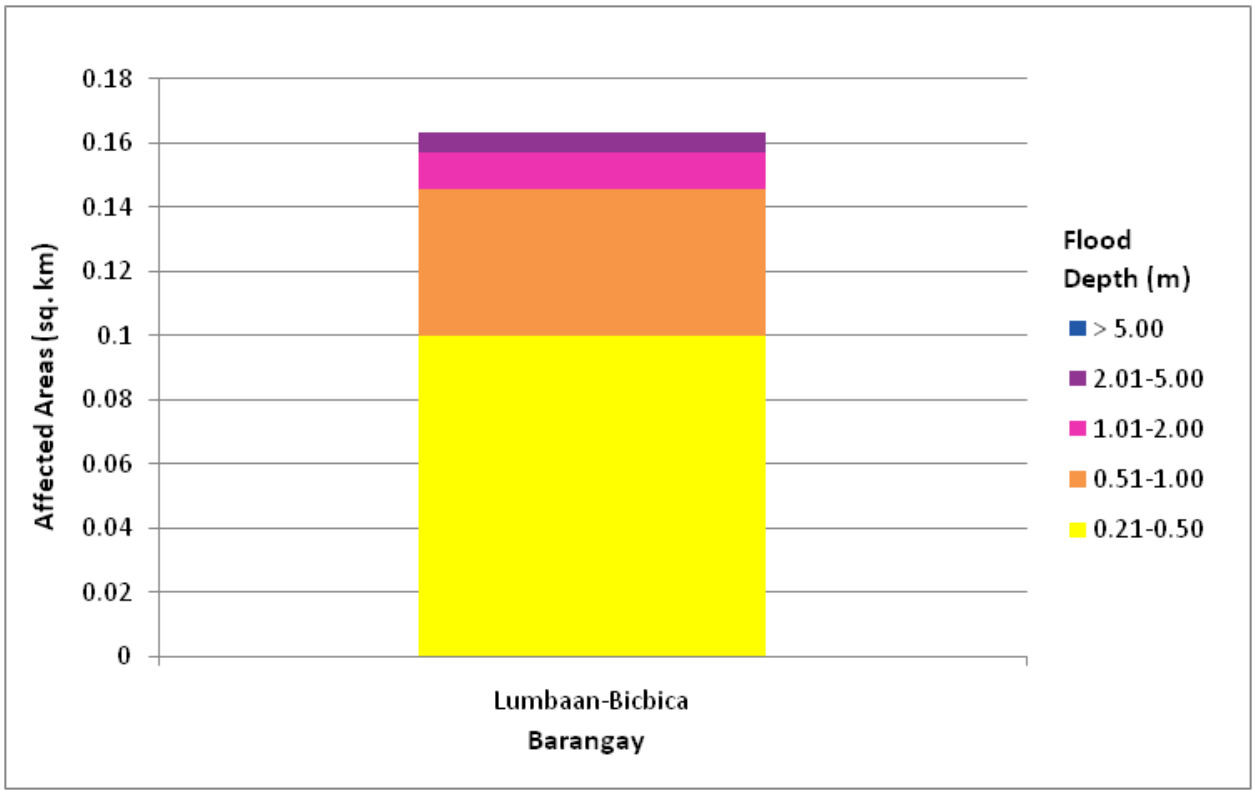

Figure 121.Affected Areas in Pinili, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 59.96% of the municipality of San Nicolas with an area of 40.225 sq. km. will experience flood levels of less than 0.20 meters. 10.60% of the area will experience flood levels of 0.21 to 0.50 meters while 12.56%, 9.67%, 6.90%, and 0.17% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 88.Affected Areas in San Nicolas, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in San Nicolas (in sq. km)											
	San Agustin	San Baltazar	San Bartolome	San Cayetano	San Eugenio	San Fernando	San Francisco	San Gregorio	San Guillermo	San Ildefonso	San Jose	San Juan Bautista
0.03-0.20	5.08	0.04	0.0053	0.069	0.021	0.022	0.084	0.12	6.93	0.054	0.018	0.024
0.21-0.50	0.56	0.076	0.0057	0.019	0.036	0.008	0.053	0.3	0.9	0.041	0.062	0.031
0.51-1.00	0.56	0.041	0.018	0.028	0.013	0.063	0.11	0.14	1.37	0.01	0.015	0.059
1.01-2.00	0.57	0.057	0.059	0.0018	0	0.0015	0.13	0.085	0.6	0.067	0.00019	0.061
2.01-5.00	0.25	0.065	0.048	0	0	0	0.011	0.011	0.053	0.056	0	0.068
> 5.00	0.035	0	0	0	0	0	0	0	0.0064	0	0	0

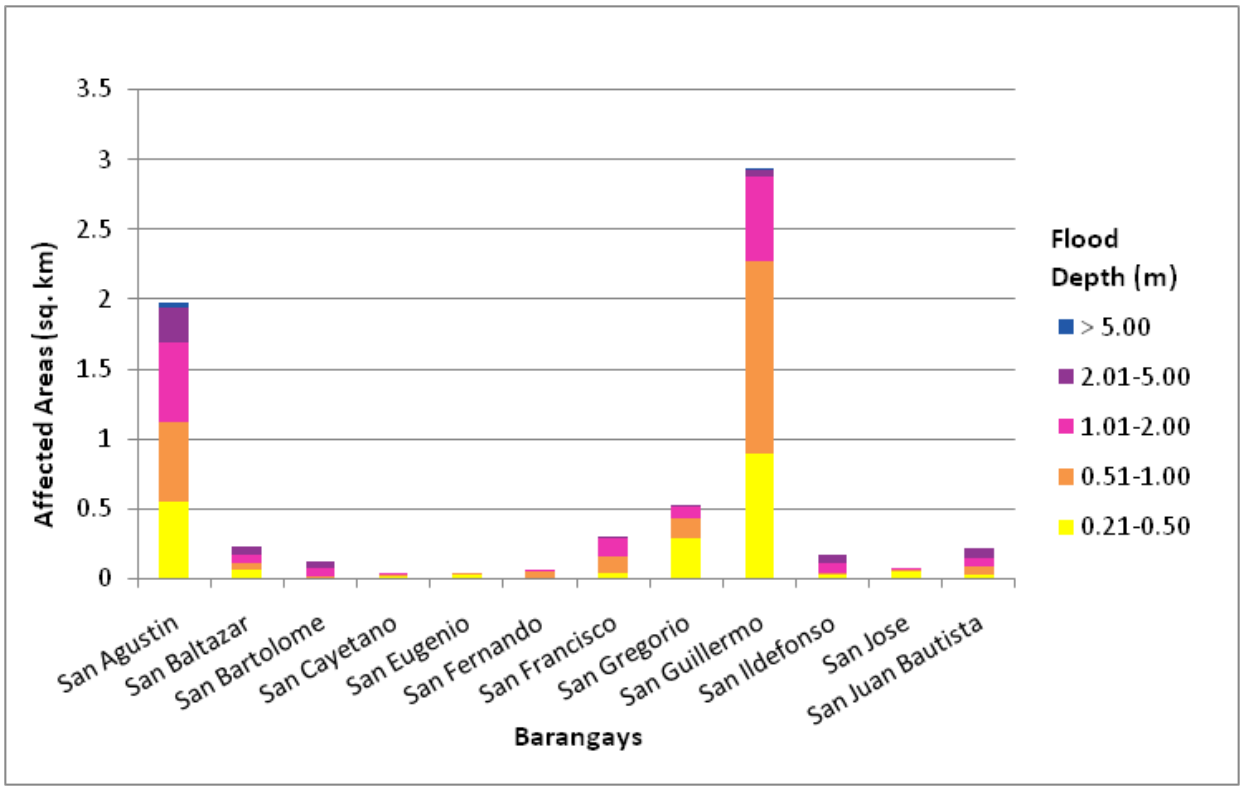

Figure 122.Affected Areas in San Nicolas, Ilocos Norte during 25-Year Rainfall Return Period

Table 89.Affected Areas in San Nicolas, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in San Nicolas (in sq. km)											
	San Lorenzo	San Lucas	San Marcos	San Miguel	San Pablo	San Paulo	San Pedro	San Rufino	San Sil-vestre	Santa Asun-cion	Santa Cecilia	Santa Monica
0.03-0.20	0.49	0.0054	0.36	0.064	0.86	0.024	3.42	0.021	0.1	2.47	2.38	1.45
0.21-0.50	0.23	0.016	0.34	0.016	0.065	0.013	0.4	0.0079	0.042	0.25	0.13	0.66
0.51-1.00	0.34	0.11	0.79	0.1	0.02	0.072	0.31	0.19	0.01	0.18	0.083	0.43
1.01-2.00	0.37	0	1.33	0.0016	0.023	0.0021	0.2	0.0001	0.0003	0.071	0.13	0.12
2.01-5.00	0.1	0	0.33	0	0.02	0	0.16	0	0	0.0052	0.77	0.84
> 5.00	0.0001	0	0.0016	0	0.0021	0	0.000007	0	0	0	0.0001	0.025

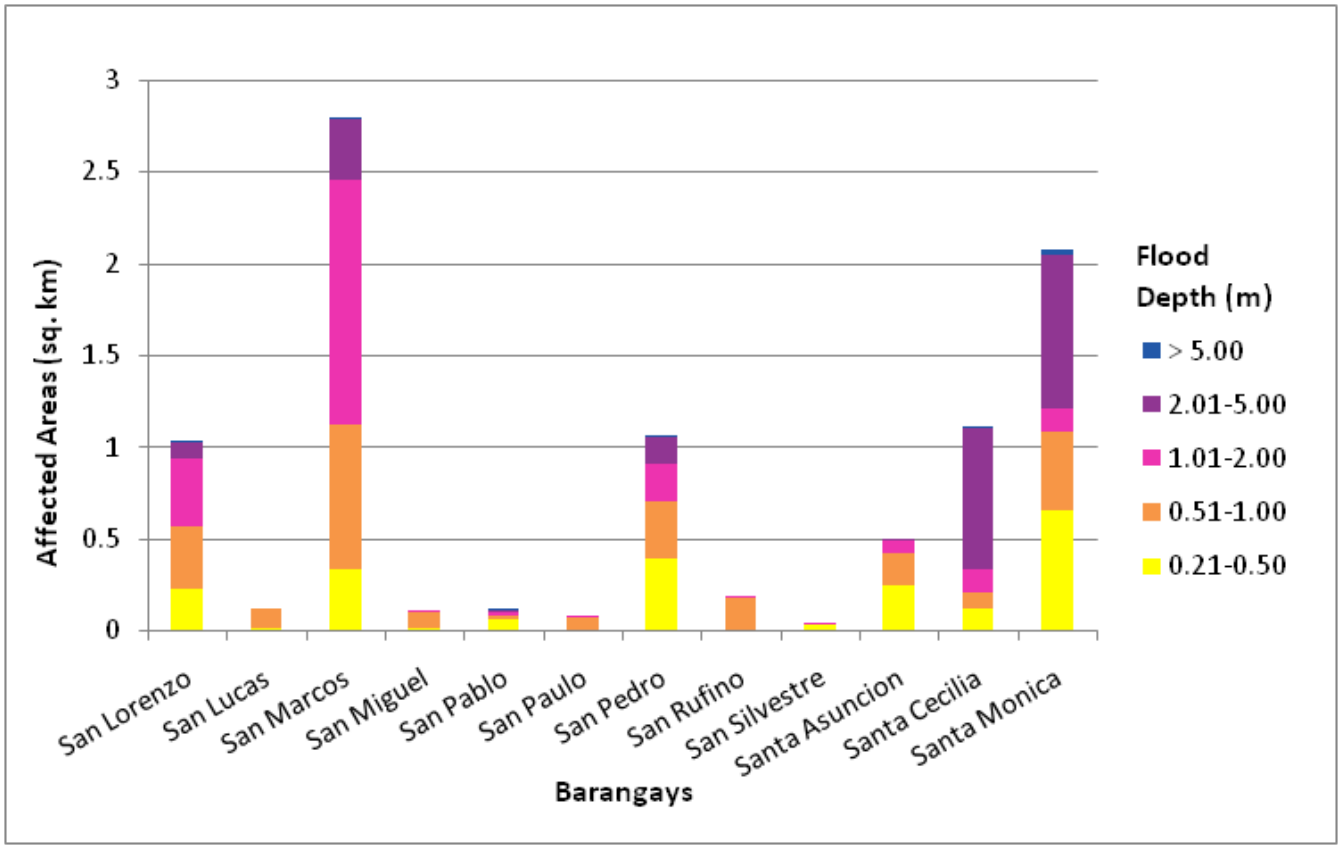

Figure 123.Affected Areas in San Nicolas, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 57.17% of the municipality of Sarrat with an area of 92.247 sq. km. will experience flood levels of less than 0.20 meters. 6.08% of the area will experience flood levels of 0.21 to 0.50 meters while 3.72%, 4.91%, 7.88%, and 12.48% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 90.Affected Areas in Sarrat, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Sarrat (in sq. km)											
	San Agustin	San Andres	San Antonio	San Ber-nabe	San Cris-tobal	San Felipe	San Francis-co	San Isidro	San Joaquin	San Jose	San Juan	San Leandro
0.03-0.20	0.14	5.94	0	1.91	3.28	2.29	0.25	3.41	0.15	1.85	6.57	0.28
0.21-0.50	0.042	0.53	0.0015	0.35	0.17	0.27	0.14	0.19	0.041	0.37	0.56	0.013
0.51-1.00	0.013	0.32	0.038	0.17	0.11	0.14	0.043	0.1	0.024	0.18	0.34	0.0073
1.01-2.00	0.01	0.27	0.95	0.12	0.073	0.16	0.0062	0.088	0.076	0.17	0.3	0.013
2.01-5.00	0.0088	0.28	1.89	0.06	0.068	0.23	0	0.12	0.038	0.2	0.3	0.024
> 5.00	0.084	0.014	0.55	0.005	0.27	0.51	0	0.48	0.43	1.24	0.0021	0.2

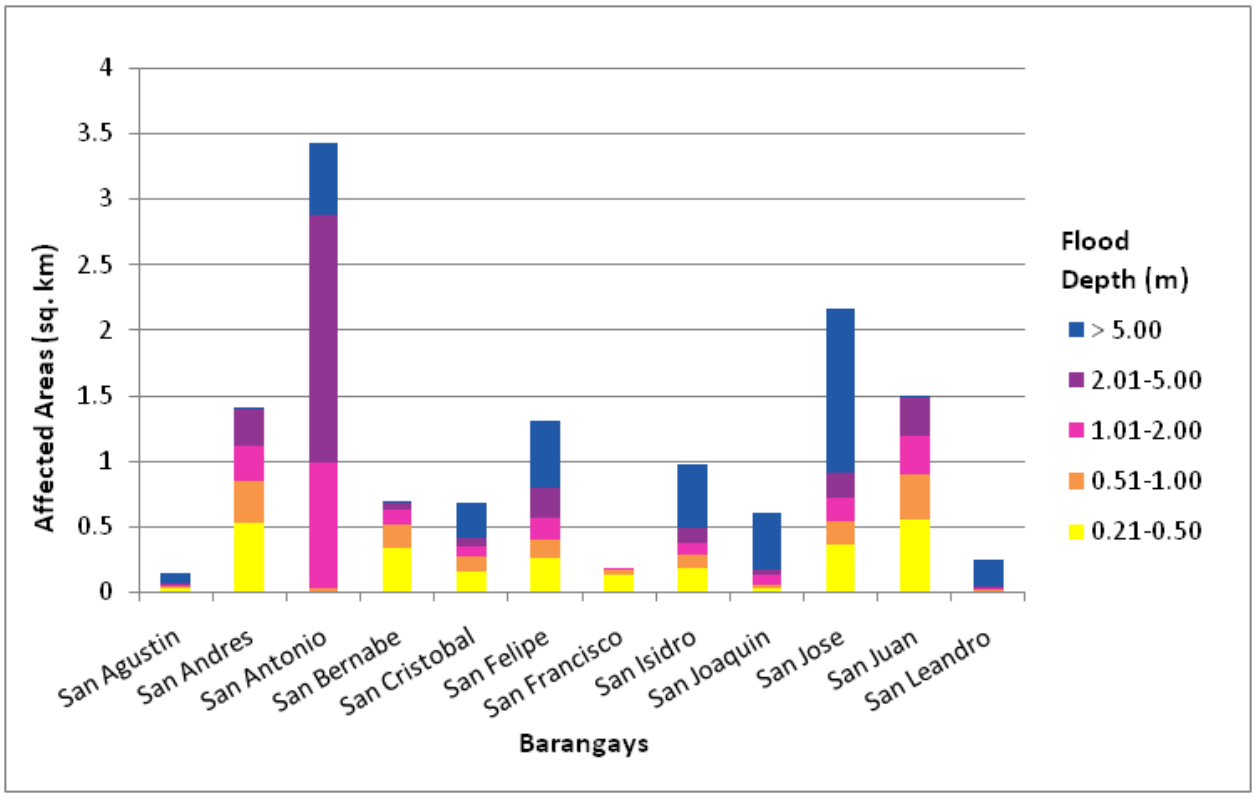

Figure 124.Affected Areas in Sarrat, Ilocos Norte during 25-Year Rainfall Return Period

Table 91.Affected Areas in Sarrat, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Sarrat (in sq. km)											
	San Lorenzo	San Manuel	San Marcos	San Nicolas	San Pedro	San Roque	San Vicente	Santa Barbara	Santa Magda-lena	Santa Rosa	Santo Santiago	Santo Tomas
0.03-0.20	0.2	0.0023	3.31	0.5	8.28	1.47	0.14	0.083	6.19	2.17	4.12	0.22
0.21-0.50	0.023	0.0011	0.18	0.061	0.47	0.55	0.063	0.023	0.72	0.29	0.54	0.0085
0.51-1.00	0.02	0.018	0.11	0.057	0.23	0.41	0.05	0.018	0.39	0.29	0.31	0.04
1.01-2.00	0.19	0.33	0.1	0.1	0.17	0.42	0.0018	0.001	0.32	0.26	0.21	0.18
2.01-5.00	0.33	1.19	0.52	0.33	0.19	0.16	0.0033	0	0.29	0.11	0.14	0.77
> 5.00	0.27	0.82	2.51	0.6	0.01	0.011	0.047	0	0.03	0.0022	0.0033	3.43

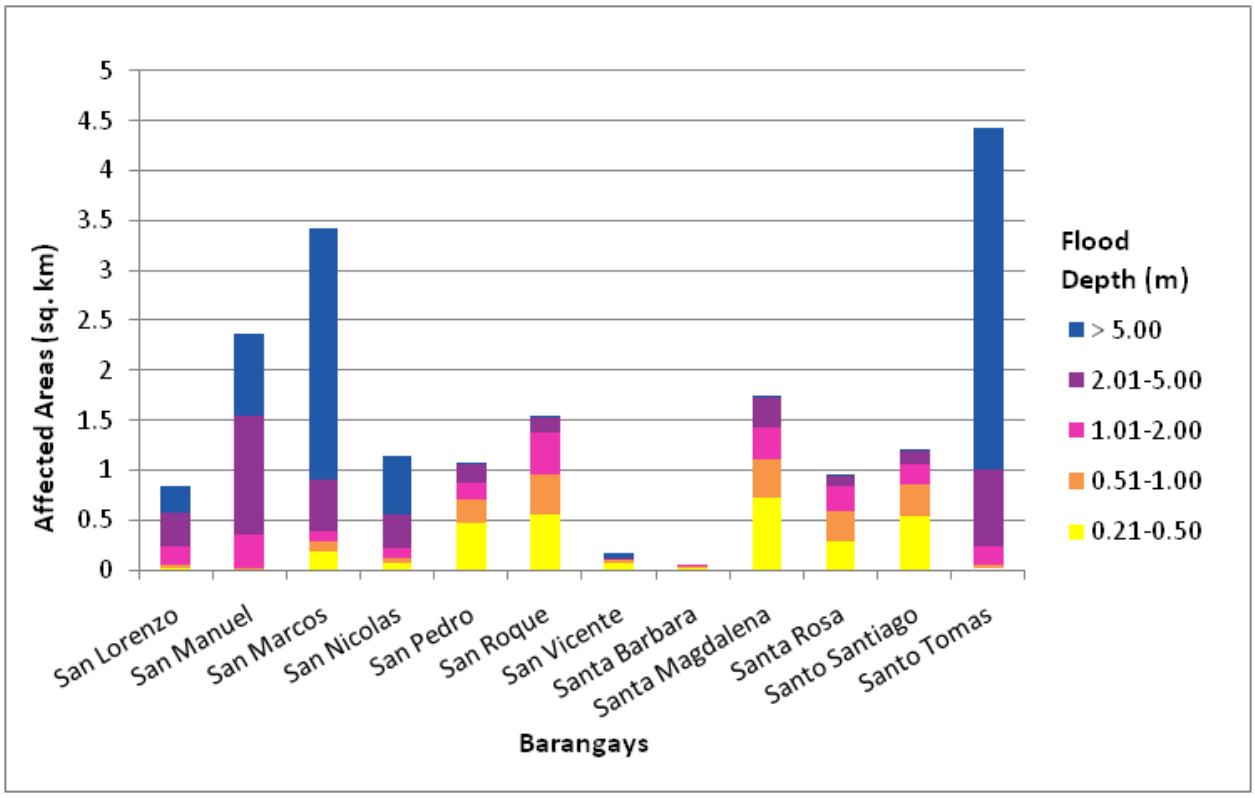

Figure 125.Affected Areas in Sarrat, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 24.35% of the municipality of Solsona with an area of 153.135 sq. km. 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 while 8.58%, 11.12%, 8.23%, and 0.66% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 92.Affected Areas in Solsona, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Solsona (in sq. km)										
	Aguitap	Bagbag	Bagbago	Barcelo-na	Bubuos	Capu-rictan	Catangr-aran	Daras-das	Juan	Laureta	Lipay
0.03-0.20	0.41	0.046	0.21	0.034	1.98	0.94	1.7	0.23	1.46	0.93	4.83
0.21-0.50	0.36	0.11	0.26	0.049	0.36	0.07	0.13	0.42	1.32	0.36	0.2
0.51-1.00	0.46	0.32	0.32	0.18	0.84	0.23	0.035	0.9	1.28	0.45	0.15
1.01-2.00	0.89	0.46	0.73	0.94	0.97	0.7	0.094	1	0.71	0.73	0.079
2.01-5.00	1.17	0.42	2.48	1.09	0.25	0.17	0.27	0.39	0.025	0.061	0.0014
> 5.00	0.035	0.0059	0.27	0.072	0.000005	0	0.086	0.011	0	0	0

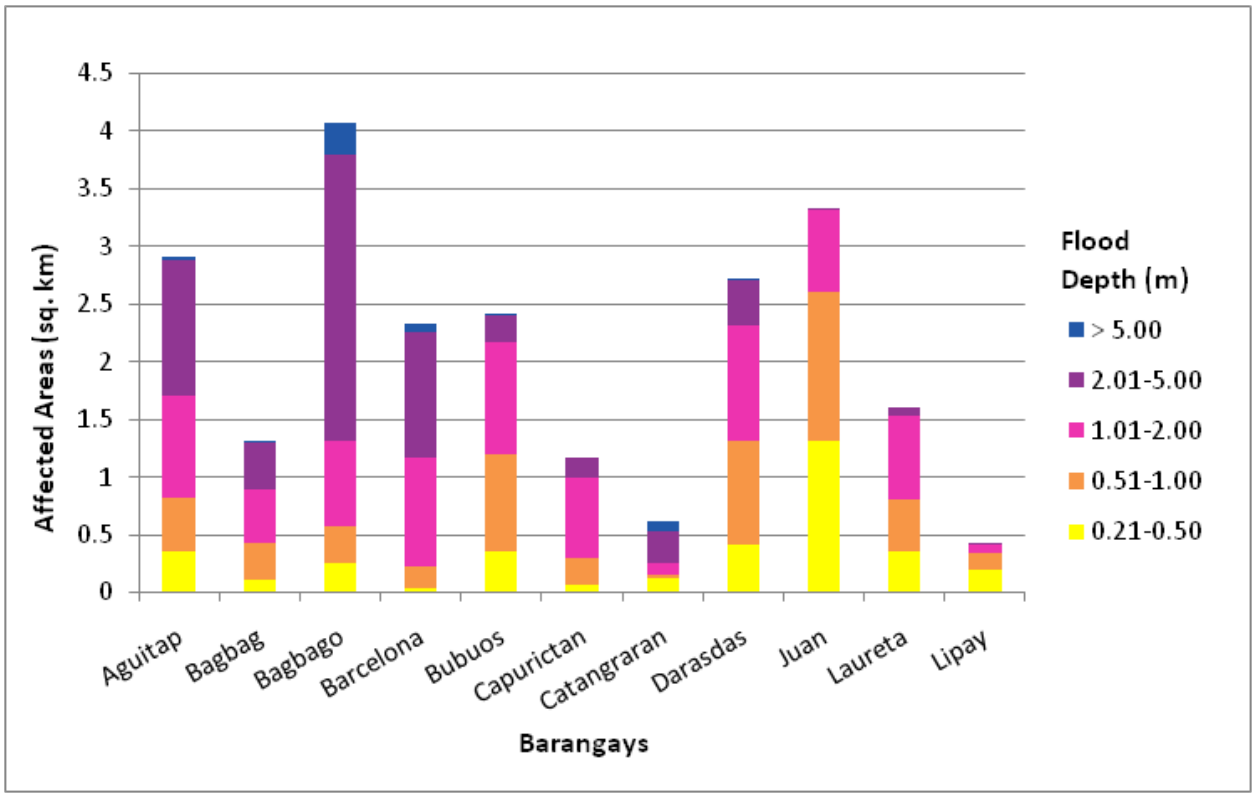

Figure 126.Affected Areas in Solsona, Ilocos Norte during 25-Year Rainfall Return Period

Table 93.Affected Areas in Solsona, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Solsona (in sq. km)										
	Maanan-teng	Manal-pac	Mari-quet	Nagpat-patan	Nalasin	Puttao	San Juan	San Julian	Santa Ana	Santiago	Talugtog
0.03-0.20	0.025	7.77	2.19	1.5	3.81	0.46	0.16	0.31	6.17	0.32	1.83
0.21-0.50	0.00023	1.01	0.74	1.35	0.89	0.19	0.32	0.0083	0.7	0.36	1.64
0.51-1.00	0	0.58	0.37	1.23	1	0.91	0.58	0.0098	0.53	0.6	2.16
1.01-2.00	0	0.48	0.56	1.38	1.73	2.34	0.24	0.013	0.29	0.93	1.76
2.01-5.00	0	0.45	0.15	0.51	1.81	1.17	0.62	0.0075	0.16	1	0.41
> 5.00	0	0.24	0	0.0001	0.062	0	0.071	0	0.017	0.12	0.018

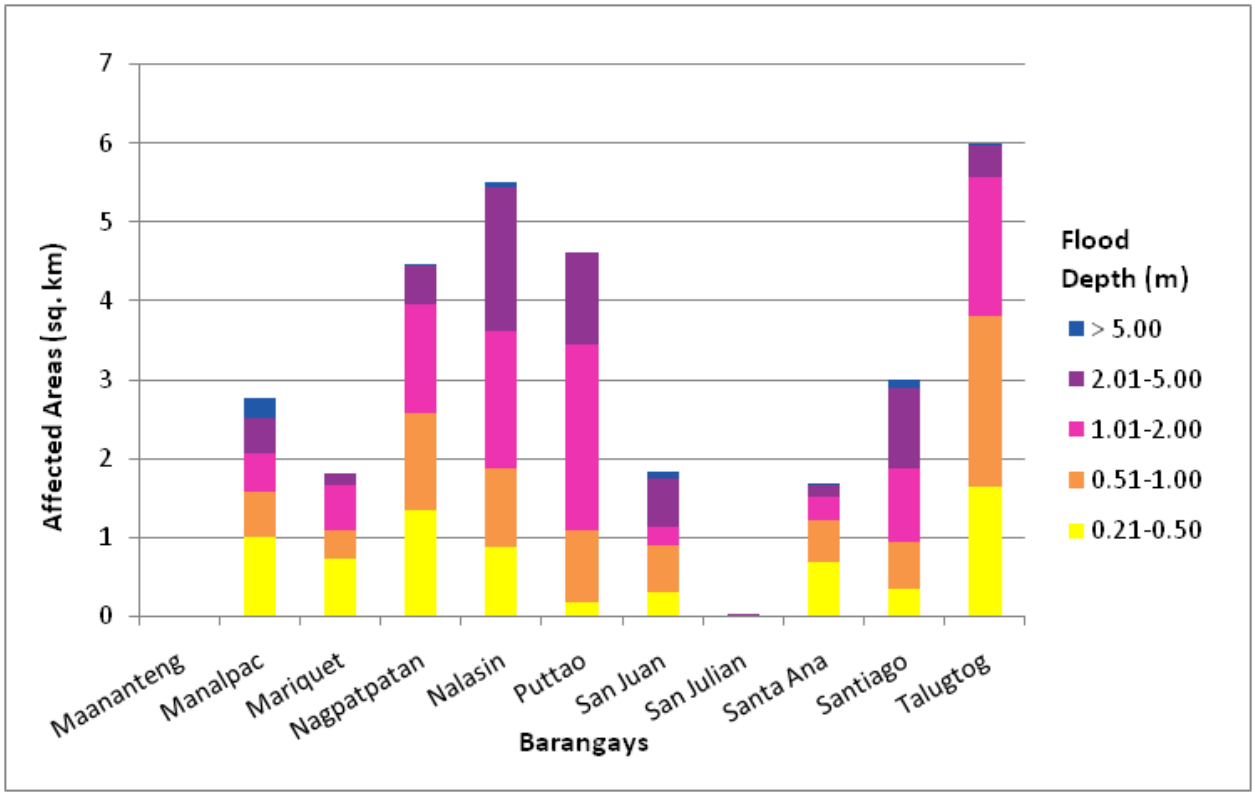

Figure 127.Affected Areas in Solsona, Ilocos Norte during 25-Year Rainfall Return Period

For the 25-year return period, 3.15% of the municipality of Vintar with an area of 497.395 sq. km. 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 while 0.19%, 0.14%, 0.10%, and 0.01% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 94.Affected Areas in Vintar, Ilocos Norte during 25-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Vintar (in sq. km)						
	Bulbu-lala	Ester	Lubnac	Maban-banag	Margaay	Namo-roc	Parparo-roc
0.03-0.20	1.5	4.95	0.08	6.1	0.21	1.56	1.29
0.21-0.50	0.2	0.71	0	0.26	0.0071	0.27	0.062
0.51-1.00	0.17	0.4	0	0.15	0.0018	0.2	0.024
1.01-2.00	0.07	0.24	0	0.21	0	0.19	0.0092
2.01-5.00	0.0058	0.22	0	0.18	0	0.095	0.00086
> 5.00	0	0.018	0	0.0095	0	0.0038	0

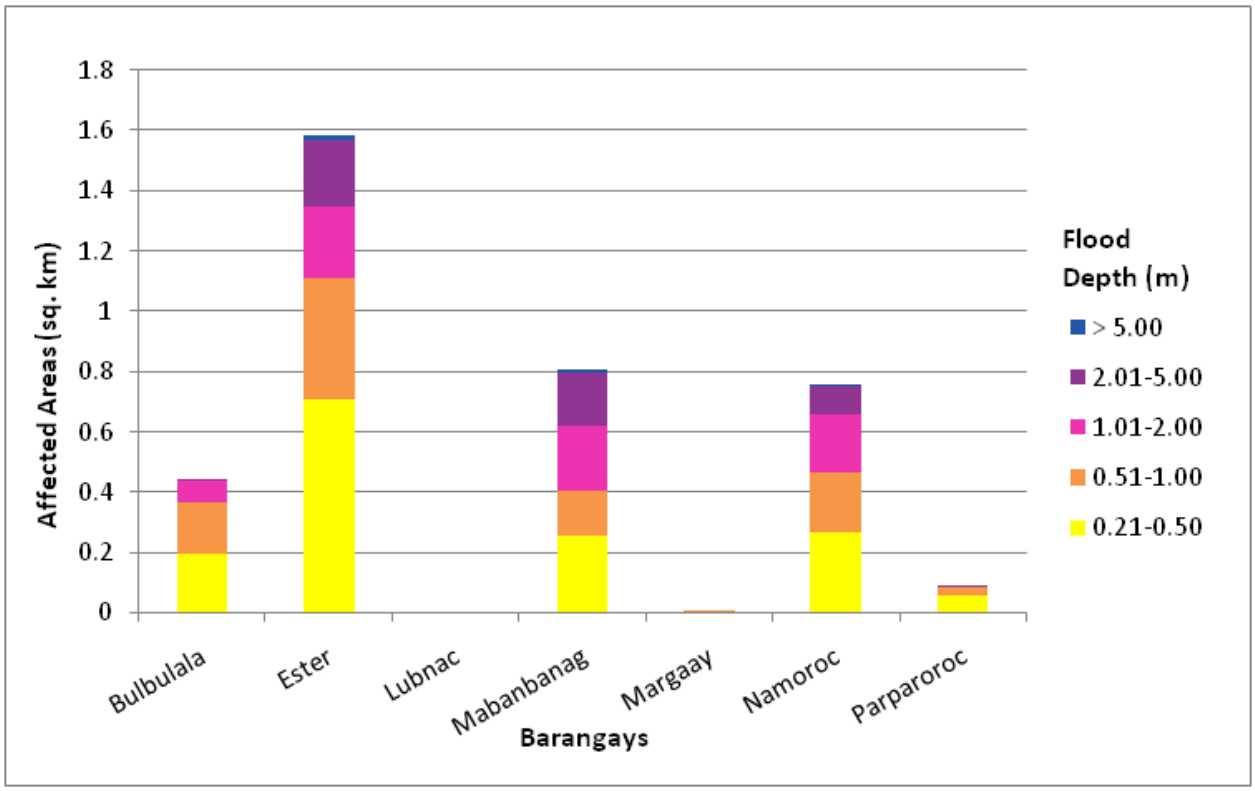

Figure 128.Affected Areas in Vintar, Ilocos Norte during 25-Year Rainfall Return Period

For the 100-year return period, 2.93% of the municipality of Bacarra with an area of 47.1 sq. km. will experience flood levels of less than 0.20 meters. 0.51% of the area will experience flood levels of 0.21 to 0.50 meters while 0.30% and 0.10% of the area will experience flood depths of 0.51 to 1 meter and 1.01 to 2 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 95.Affected Areas in Bacarra, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Bacarra (in sq. km)			
	Casilian	Ganagan	Pasiocan	Sangil
0.03-0.20	0.12	1.04	0.16	0.06
0.21-0.50	0.023	0.21	0.0038	0.0046
0.51-1.00	0.01	0.13	0.0018	0.0044
1.01-2.00	0.0001	0.044	0.00078	0.00018
2.01-5.00	0	0.0004	0	0
> 5.00	0	0	0	0

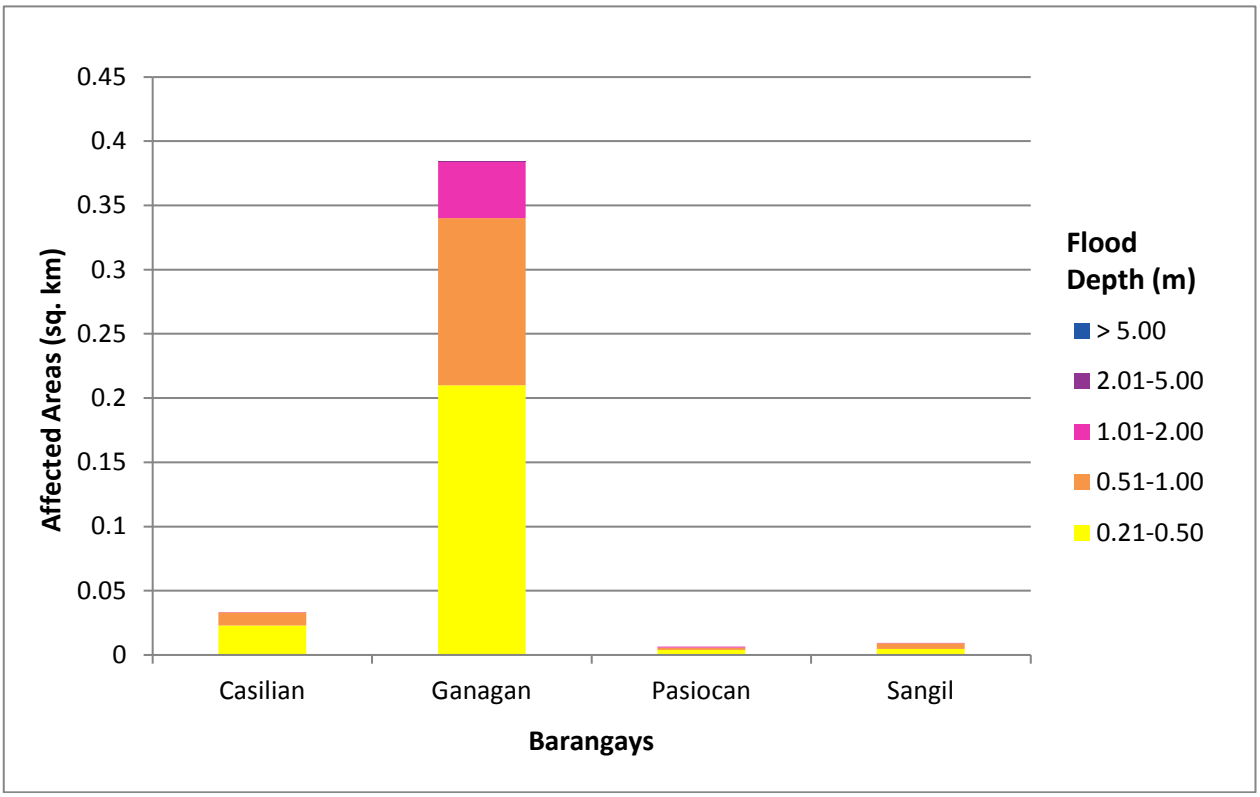

Figure 129.Affected Areas in Bacarra, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 51.26% of the municipality of Banna with an area of 89.62 sq. km. will experience flood levels of less than 0.20 meters. 7.74% of the area will experience flood levels of 0.21 to 0.50 meters while 9.31%, 11.18%, 12.82%, and 6.00% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 96.Affected Areas in Banna, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Banna (in sq. km)									
	Balioeg	Bangsar	Barba-rangay	Binacag	Bomitog	Bugasi	Caeste-banan	Carib-quib	Catag-taguen	Crispina
0.03-0.20	1.66	1.57	6.78	1.59	6.1	0.71	1.1	0.064	2.35	5.77
0.21-0.50	0.85	0.14	0.37	0.075	0.44	0.48	0.99	0.04	0.31	0.53
0.51-1.00	1.41	0.1	0.29	0.086	0.21	0.71	1.13	0.038	0.88	0.57
1.01-2.00	2.53	0.1	0.25	0.14	0.14	0.6	0.45	0.087	1.53	0.5
2.01-5.00	2.47	0.25	0.22	0.4	0.092	0.55	0.16	0.25	1.46	0.49
> 5.00	0.0048	0.093	0.028	1.11	0.018	0	0	0.67	0.96	0.33

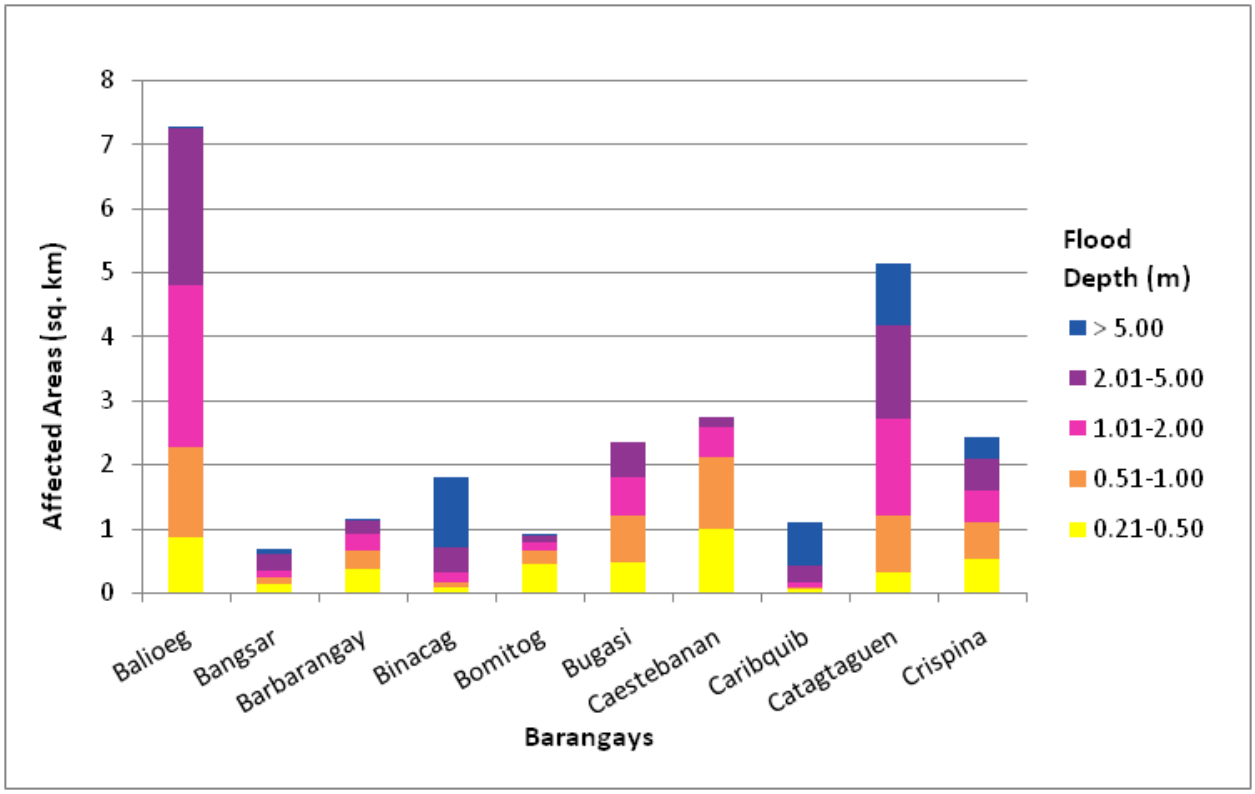

Figure 130.Affected Areas in Banna, Ilocos Norte during 100-Year Rainfall Return Period

Table 97.Affected Areas in Banna, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Banna (in sq. km)									
	Hilario	Imelda	Lorenzo	Ma-cayepy-ep	Marcos	Nagpa-tayan	Sinamar	Tabtaba-gan	Valdez	Valen-ciano
0.03-0.20	0.25	1.69	0.29	3.98	0.85	8.76	1.04	0.37	0.17	0.85
0.21-0.50	0.015	0.16	0.015	0.27	0.057	0.7	0.93	0.26	0.25	0.056
0.51-1.00	0.013	0.14	0.0086	0.27	0.04	0.68	1.09	0.24	0.42	0.023
1.01-2.00	0.24	0.17	0.0053	0.9	0.017	0.41	1.17	0.39	0.38	0.0088
2.01-5.00	0.91	0.38	0.013	0.96	0.00032	0.62	0.79	1.13	0.34	0.0017
> 5.00	0.2	0.25	0.0028	0.0001	0	0.28	0.11	1.33	0	0

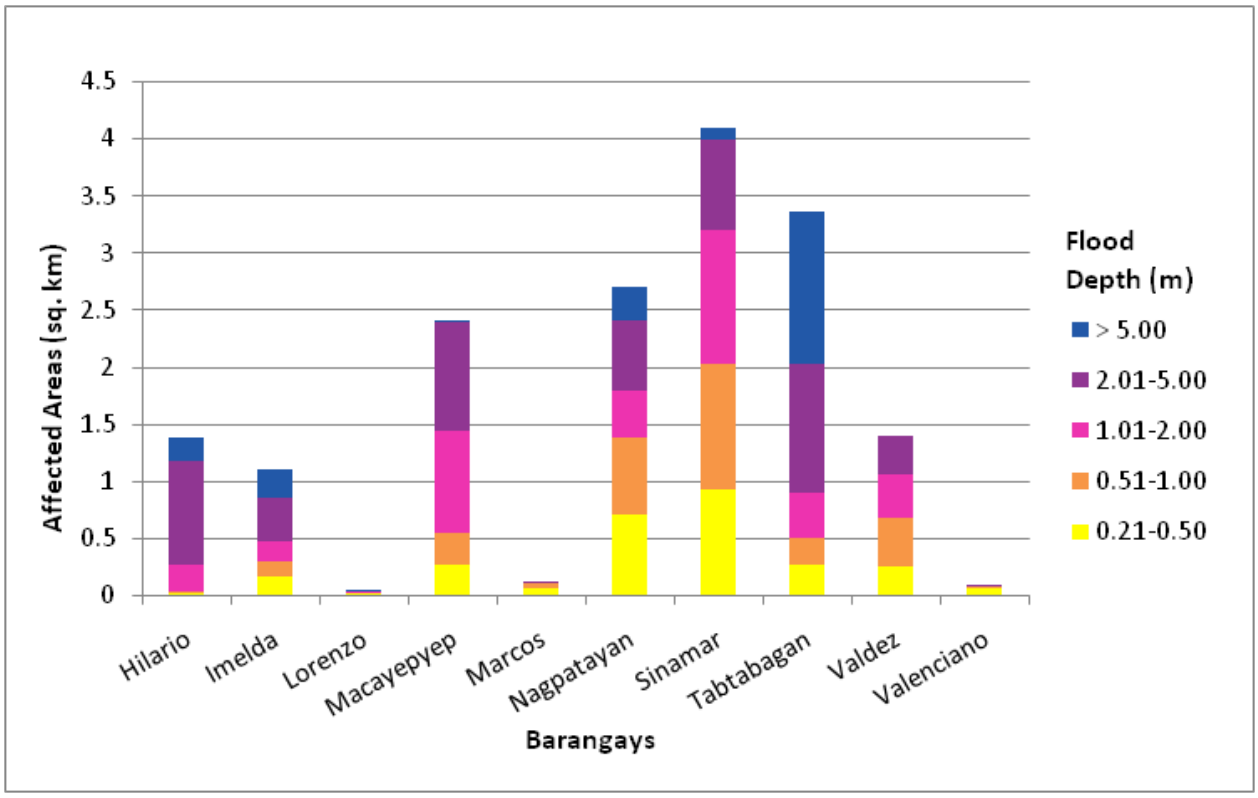

Figure 131.Affected Areas in Banna, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 2.24% of the municipality of Batac City with an area of 134.62 sq. km. will experience flood levels of less than 0.20 meters. 0.08% of the area will experience flood levels of 0.21 to 0.50 meters while 0.03% and 0.01% of the area will experience flood depths of 0.51 to 1 meter and 1.01 to 2 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 98.Affected Areas in Batac City, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Batac City (in sq. km)						
	Baay	Bungon	Caman-dingan	Dariwd-iw	Maipalig	Nagba-calan	Sumader
0.03-0.20	0.31	0.18	0.14	0.076	1.75	0.46	0.088
0.21-0.50	0.017	0.0088	0.00082	0.0012	0.065	0.016	0.00029
0.51-1.00	0.0023	0.0019	0.00058	0.0003	0.021	0.0091	0.0002
1.01-2.00	0.0011	0.0017	0.0012	0.0001	0.0025	0.0035	0
2.01-5.00	0.0002	0.001	0.0017	0	0.00012	0.0009	0
> 5.00	0	0	0.0007	0	0	0	0

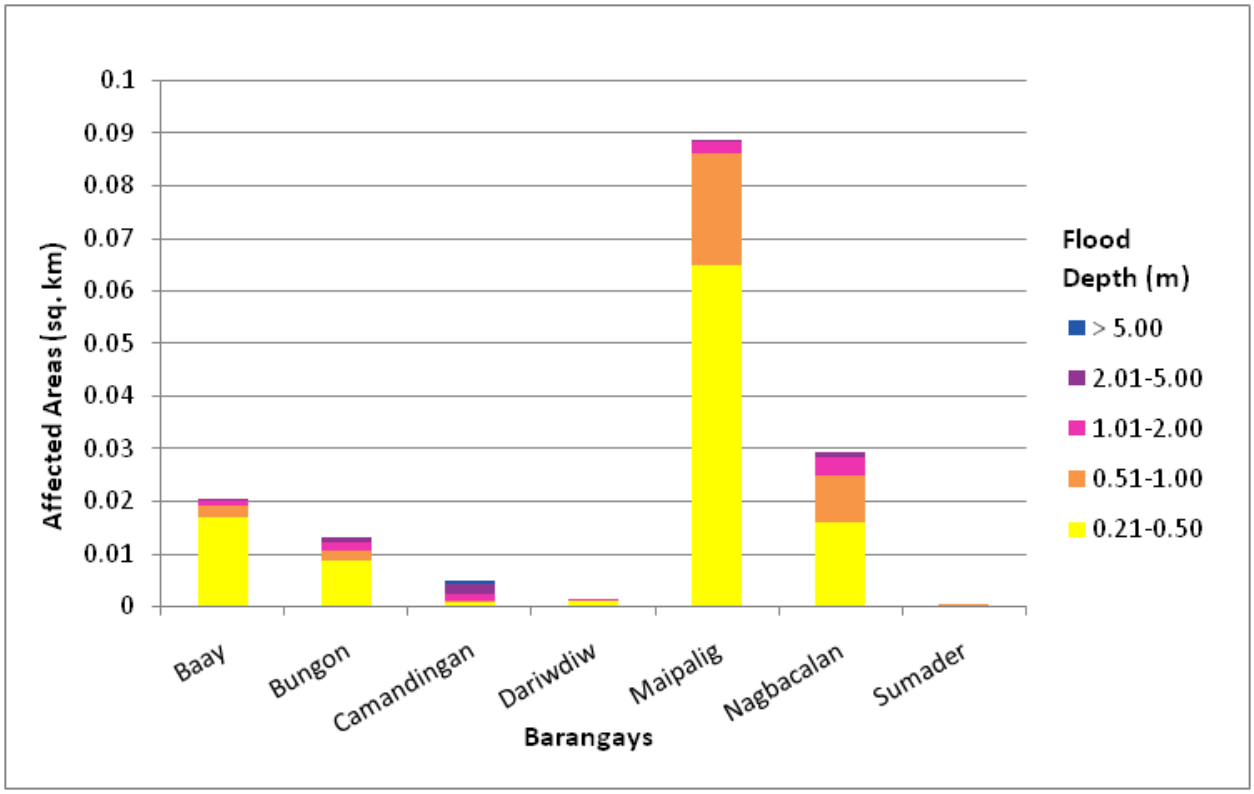

Figure 132.Affected Areas in Batac City, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 1.33% of the municipality of Carasi with an area of 190.236 sq. km. 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 while 0.04%, 0.05%, 0.02%, and 0.02% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 99.Affected Areas in Carasi, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Carasi (in sq. km)
	Virbira
0.03-0.20	2.53
0.21-0.50	0.12
0.51-1.00	0.075
1.01-2.00	0.088
2.01-5.00	0.033
> 5.00	0.032

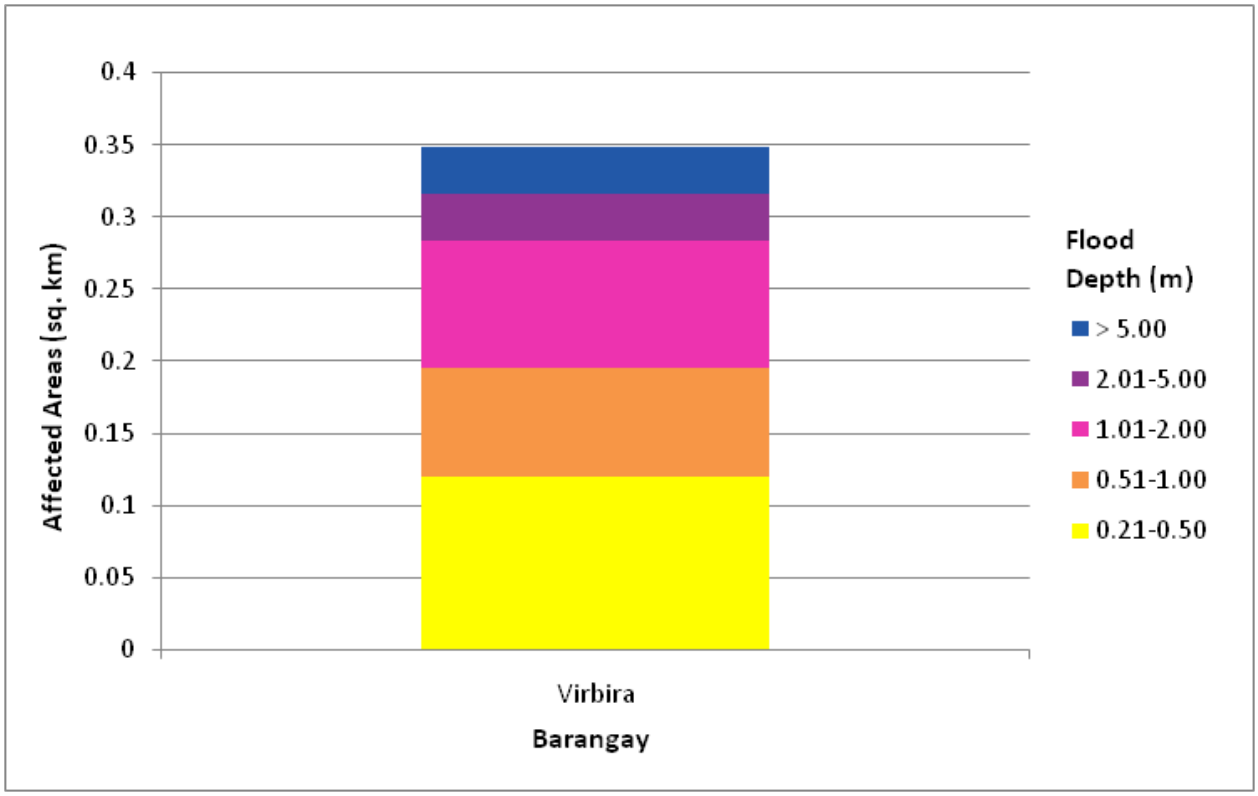

Figure 133.Affected Areas in Carasi, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 23.75% of the municipality of Dingras with an area of 90.65 sq. km. will experience flood levels of less than 0.20 meters. 8.34% of the area will experience flood levels of 0.21 to 0.50 meters while 7.97%, 8.70%, 19.35%, and 30.46% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 100.Affected Areas in Dingras, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Dingras (in sq. km)										
	Albano	Bacsil	Bagut	Bares-bes	Barong	Bungcag	Cali	Capasan	Dancel	Eliza-beth	Espiritu
0.03-0.20	0	0.56	0	2.53	0.12	0	0.64	0.26	0	0.14	1.91
0.21-0.50	0	0.022	0	1.32	0.19	0	0.63	0.083	0	0.26	0.26
0.51-1.00	0	0.018	0	1.21	0.53	0	0.43	0.063	0.0002	0.35	0.33
1.01-2.00	0	0.035	0	1.15	0.68	0.0023	0.51	0.061	0.0058	0.53	0.34
2.01-5.00	0	0.31	0.14	2.26	3.17	0.021	0.68	0.24	0.0057	0.65	0.26
> 5.00	0.37	0.42	1.23	1.05	0.73	0.64	0.0093	0.66	0.36	0.0037	0.064

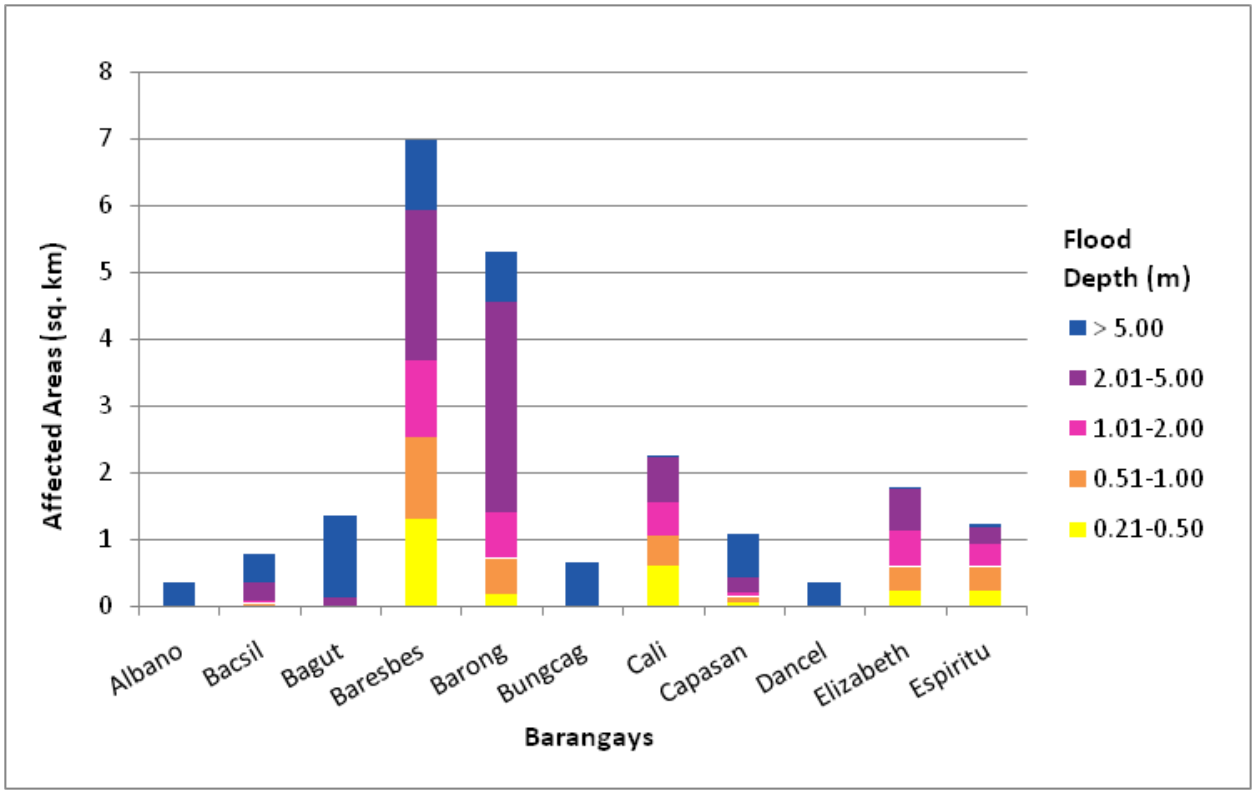

Figure 134.Affected Areas in Dingras, Ilocos Norte during 100-Year Rainfall Return Period

Table 101.Affected Areas in Dingras, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Dingras (in sq. km)									
	Foz	Guerre-ro	Lanas	Lumbad	Madam-ba	Man-daloque	Medina	Parado	Peralta	Puruga-nan
0.03-0.20	0.028	0.023	0.61	0	0	0	0.017	0	0	0
0.21-0.50	0.0082	0.0073	0.59	0	0	0	0.0036	0	0	0
0.51-1.00	0.025	0.026	0.48	0	0	0	0.0064	0	0	0
1.01-2.00	0.063	0.19	0.53	0	0	0	0.12	0.0002	0	0
2.01-5.00	0.39	0.26	1.03	0.000099	0.00088	0	0.84	1.27	0.026	0.0037
> 5.00	3.15	0.67	0.8	2.99	0.69	2.24	0.16	0.38	1.18	0.4

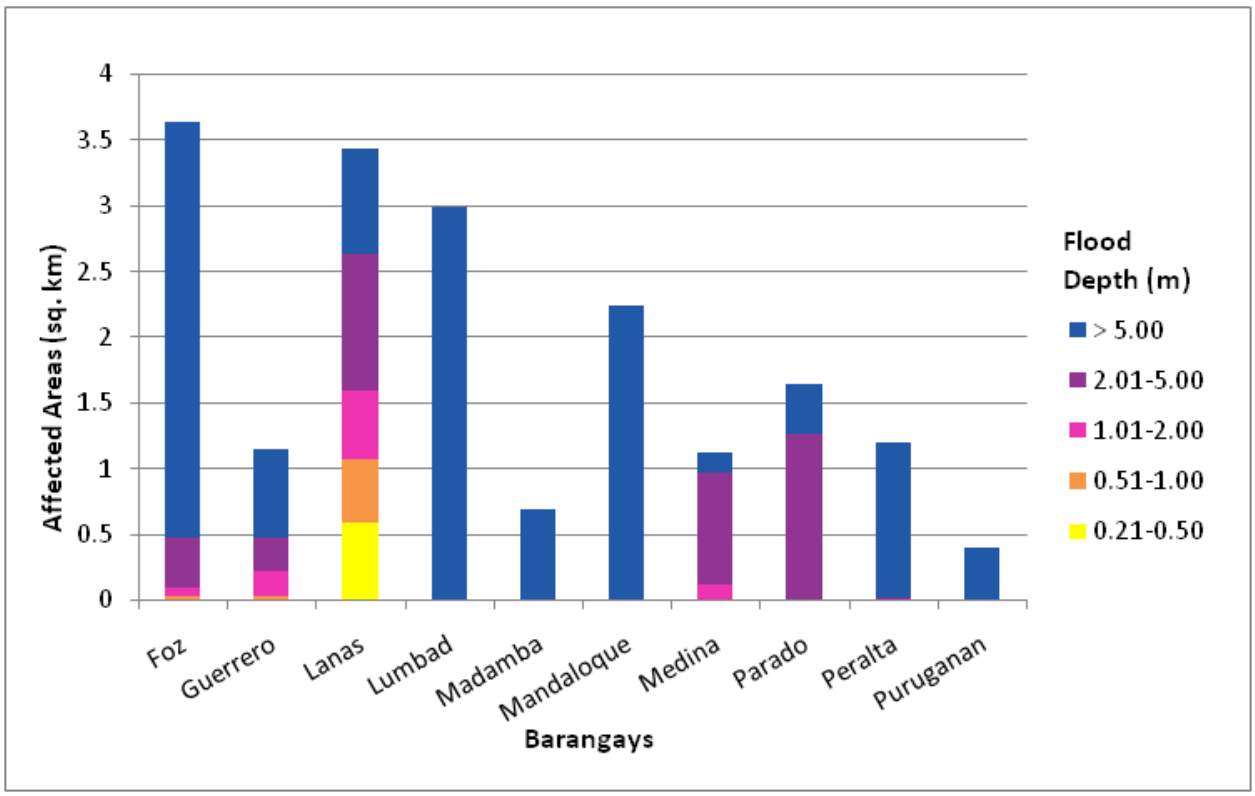

Figure 135.Affected Areas in Dingras, Ilocos Norte during 100-Year Rainfall Return Period

Table 102.Affected Areas in Dingras, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Dingras (in sq. km)									
	Root	Sagpa-tan	Sa-ludares	San Esteban	San Francis-co	San Marceli-no	San Marcos	Sulqui-ano	Suyo	Ver
0.03-0.20	0.0001	0	0.1	0.35	11	2.91	0.00013	0.11	0.036	0.17
0.21-0.50	0.0014	0	0.16	0.022	2.55	1.02	0.0017	0.064	0.0031	0.35
0.51-1.00	0.044	0	0.26	0.012	1.56	0.76	0.024	0.081	0.0037	1.01
1.01-2.00	0.25	0	0.32	0.027	1.44	0.45	0.32	0.025	0.019	0.82
2.01-5.00	0.96	0.19	0.58	0.49	0.64	0.4	2.06	0.019	0.55	0.11
> 5.00	0.17	1.98	0	0.7	0.0019	0.056	2.03	1.71	2.76	0.0085

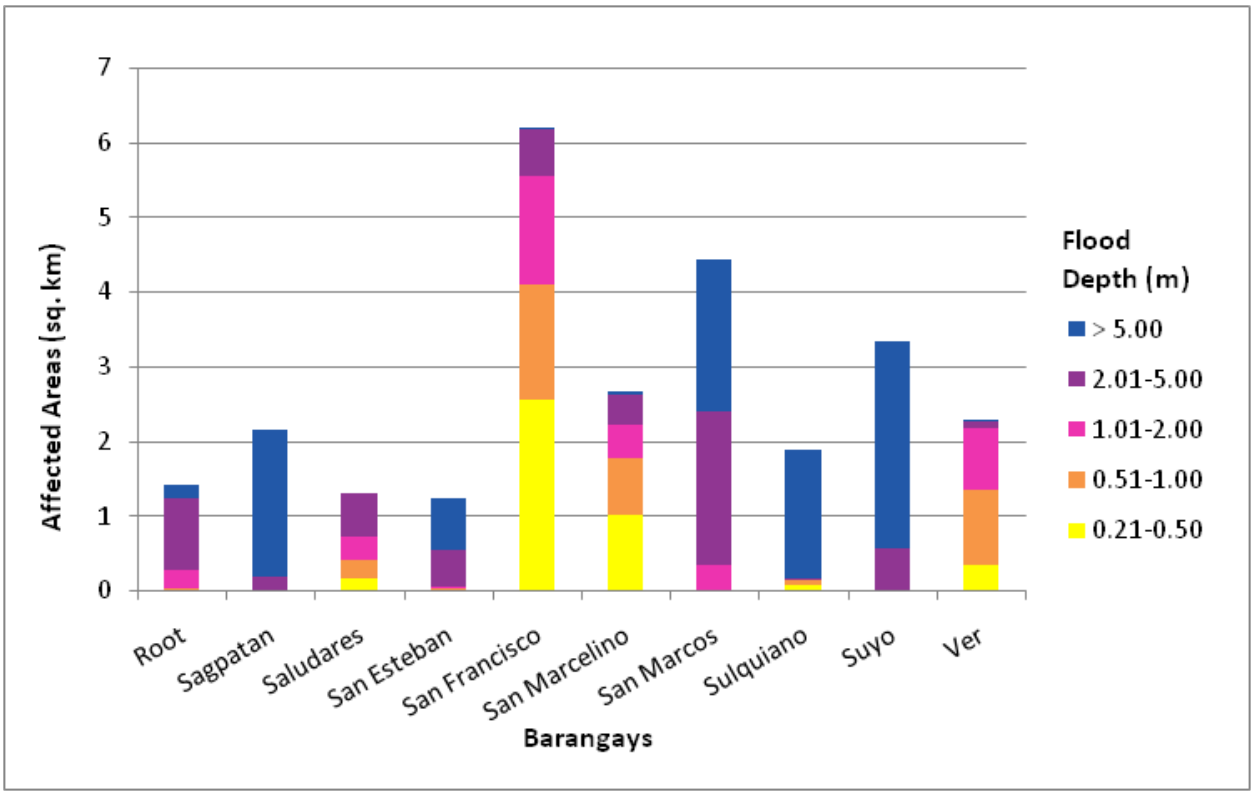

Figure 136.Affected Areas in Dingras, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 37.49% of the municipality of Laoag City with an area of 114.355 sq. km. will experience flood levels of less than 0.20 meters. 9.87% of the area will experience flood levels of 0.21 to 0.50 meters while 11.22%, 16.83%, 15.54%, and 5.05% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 103.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 1, San Lorenzo	Bgy. No. 10, San Jose	Bgy. No. 11, Santa Balbina	Bgy. No. 12, San Isidro	Bgy. No. 13, Nstra. Sra. De Visitaci	Bgy. No. 14, Santo Tomas	Bgy. No. 15, San Guiller-mo	Bgy. No. 16, San Jacinto	Bgy. No. 17, San Francis-co	Bgy. No. 19, Santa Marcela
0.03-0.20	0.052	0.024	0.013	0	0.014	0.076	0.016	0.021	0.07	0.037
0.21-0.50	0.051	0.017	0.016	0.0028	0.013	0.033	0.026	0.024	0.049	0.023
0.51-1.00	0.045	0.039	0.044	0.041	0.022	0.034	0.02	0.021	0.016	0.0041
1.01-2.00	0.012	0.0027	0.029	0.029	0.017	0.0078	0.00093	0	0.0049	0.00025
2.01-5.00	0.0048	0.00085	0	0.0087	0.0016	0.011	0	0	0.018	0.013
> 5.00	0.011	0.013	0	0	0	0.093	0	0	0.059	0.034

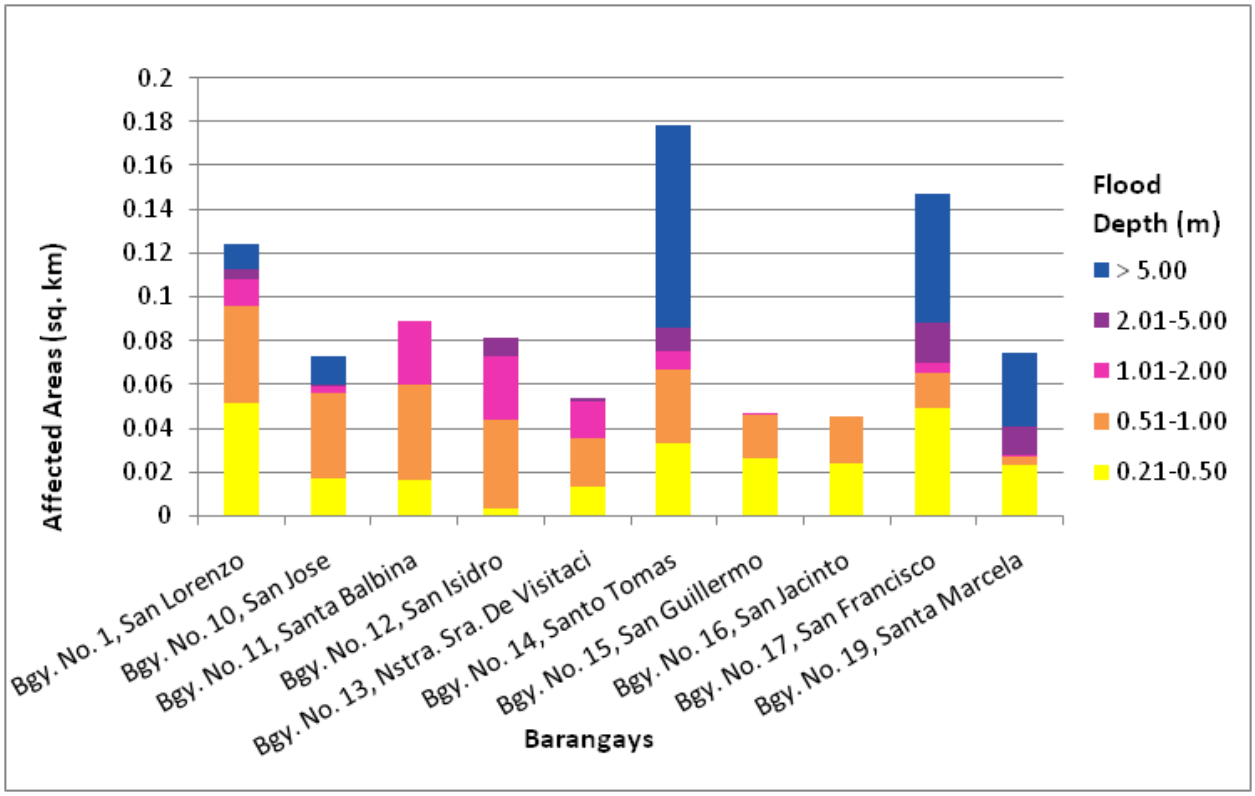

Figure 137.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Table 104.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 2, Santa Joaquina	Bgy. No. 20, San Miguel	Bgy. No. 21, San Pedro	Bgy. No. 22, San Andres	Bgy. No. 23, San Matias	Bgy. No. 24, Nstra. Sra. De Consolac	Bgy. No. 25, Santa Cayet-ana	Bgy. No. 26, San Marceli-no	Bgy. No. 27, Nstra. Sra. de Soledad	Bgy. No. 28, San Bernar-do
0.03-0.20	0.093	0.018	0.11	0.02	0.36	0.031	0.095	0.068	0.02	0.01
0.21-0.50	0.045	0.023	0.08	0.0058	0.12	0.00061	0.014	0.017	0.047	0.044
0.51-1.00	0.076	0.0083	0.038	0.0095	0.069	0.0014	0.001	0.0051	0.097	0.13
1.01-2.00	0.21	0.00064	0.023	0.0013	0.054	0.0014	0.0017	0.0036	0.0059	0.023
2.01-5.00	0.22	0.013	0.012	0.0041	0	0.0099	0.0094	0.027	0.03	0.044
> 5.00	0.0034	0.065	0.0016	0.12	0	0.16	0.049	0.081	0.088	0.072

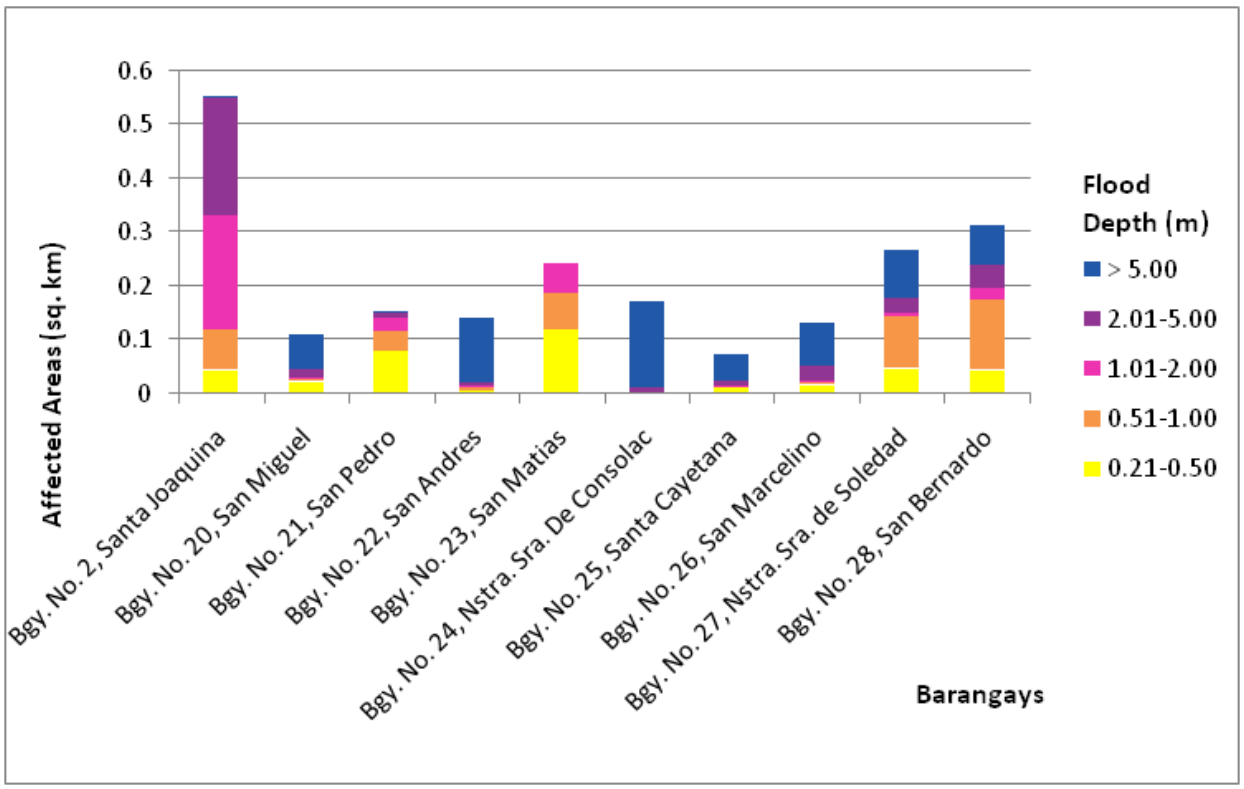

Figure 138.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Table 105.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 29, Santo Tomas	Bgy. No. 3, Nstra. Sra. Del Rosario	Bgy. No. 30-A, Suyo	Bgy. No. 30-B, Santa Maria	Bgy. No. 31, Tal-ingaan	Bgy. No. 32-A, La Paz East	Bgy. No. 32-B, La Paz West	Bgy. No. 32-C La Paz East	Bgy. No. 33-A, La Paz Proper	Bgy. No. 33-B, La Paz Proper
0.03-0.20	0.0007	0.028	0.16	0.3	2.76	0.26	0.63	0.46	0.36	0.13
0.21-0.50	0.0076	0.018	0.11	0.13	0.32	0.066	0.21	0.021	0.013	0.01
0.51-1.00	0.043	0.012	0.076	0.26	0.43	0.089	0.26	0.014	0.0035	0.015
1.01-2.00	0.02	0.012	0.026	0.6	0.56	0.035	0.12	0.049	0.0015	0.02
2.01-5.00	0.23	0.013	0.18	0.53	0.21	0.0074	0.1	0.17	0.015	0.2
> 5.00	0.046	0	0.06	0.36	0.096	0.0018	0	0.12	0.031	0.061

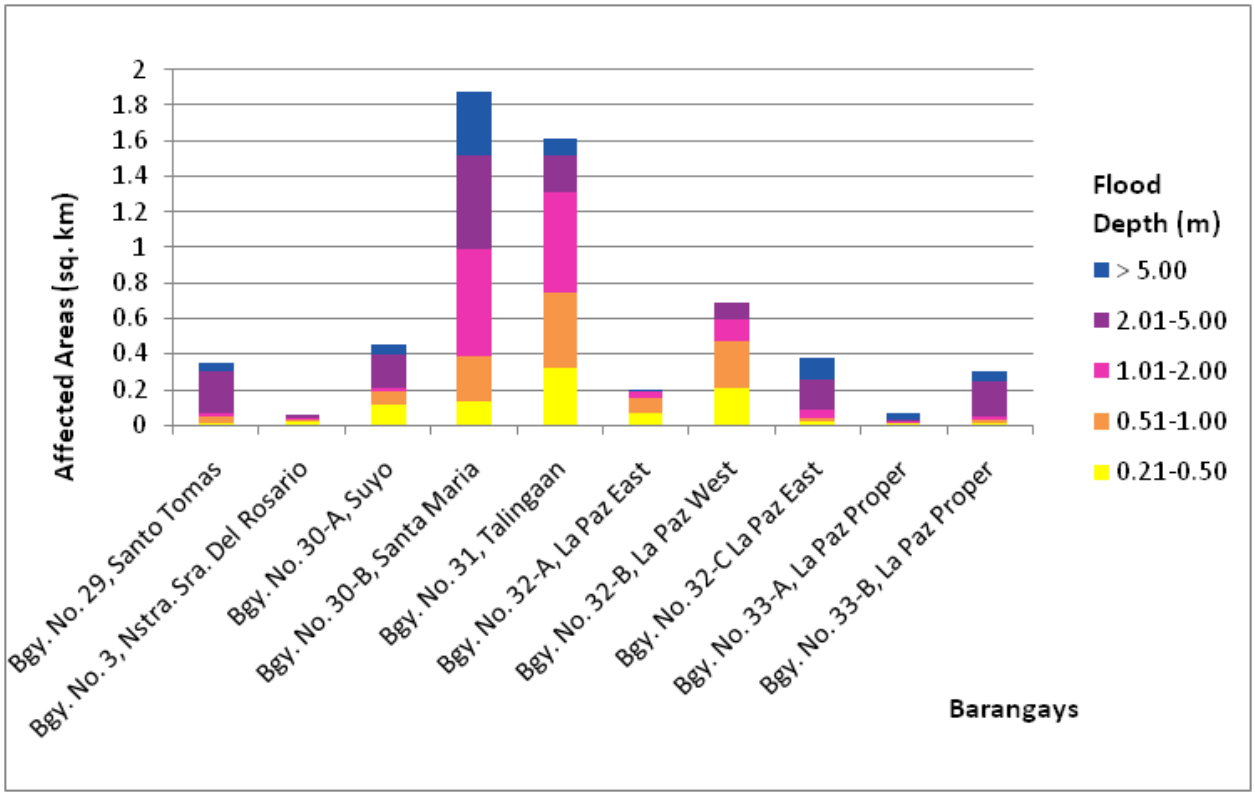

Figure 139.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Table 106.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 34-A, Gabu Norte West	Bgy. No. 34-B, Gabu Norte East	Bgy. No. 35, Gabu Sur	Bgy. No. 36, Araniw	Bgy. No. 37, Calayab	Bgy. No. 38-A, Mangato East	Bgy. No. 38-B, Mangato West	Bgy. No. 39, San-ta Rosa	Bgy. No. 4, San Guiller-mo	Bgy. No. 40, Bala-tong
0.03-0.20	0.093	0.076	0.52	0.26	3.22	0.0001	0	0.17	0.068	2.1
0.21-0.50	0.061	0.073	0.2	0.17	0.38	0.022	0.0045	0.059	0.076	0.45
0.51-1.00	0.23	0.062	0.24	0.4	0.58	0.079	0.026	0.15	0.043	0.37
1.01-2.00	0.42	0.025	0.22	0.76	0.6	0.19	0.11	1.65	0.015	0.55
2.01-5.00	0.17	0.009	0.42	0.56	0.3	0.19	0.31	0.87	0.015	0.36
> 5.00	0.0082	0.011	0.022	0.0058	0.0002	0.000042	0.002	0.0091	0.00063	0.013

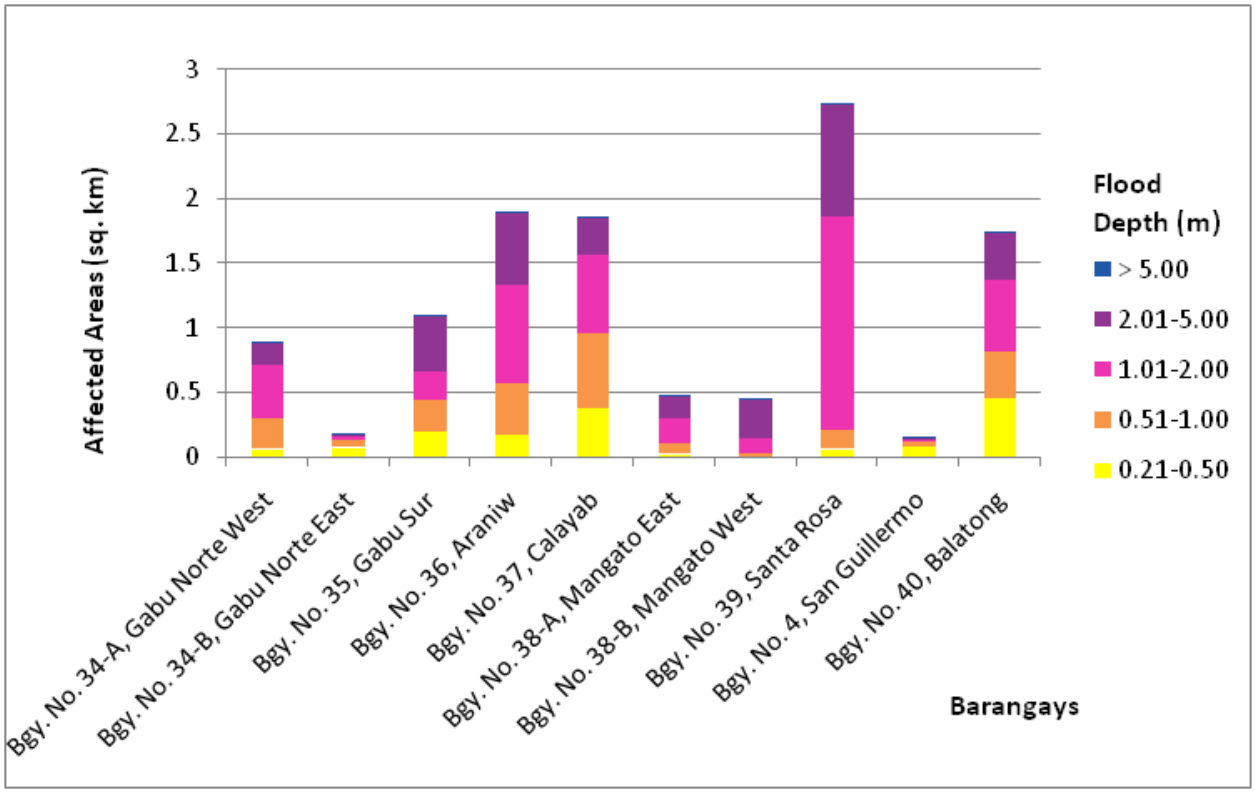

Figure 140.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Table 107.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 41, Balacad	Bgy. No. 42, Apaya	Bgy. No. 43, Cavit	Bgy. No. 44, Zam-boanga	Bgy. No. 45, Tangid	Bgy. No. 46, Nalbo	Bgy. No. 47, Beng-cag	Bgy. No. 48-B, Cabun-gaan South	Bgy. No. 49-A, Daray-day	Bgy. No. 49-B, Rarabu-ran
0.03-0.20	2.92	0.82	0.0001	0.011	0.058	0.0087	0.000003	0.19	0.16	0.23
0.21-0.50	0.66	0.16	0.0039	0.027	0.092	0.025	0.0055	0.2	0.14	0.27
0.51-1.00	0.64	0.22	0.063	0.11	0.42	0.064	0.22	0.16	0.22	0.3
1.01-2.00	0.55	0.67	0.2	0.41	0.51	0.16	0.61	0.18	0.38	0.47
2.01-5.00	0.2	1.83	0.16	0.76	0.16	0.52	0.65	0.31	0.2	0.19
> 5.00	0	0.00098	0.023	0.012	0.6	0.59	0.25	0.0004	0	0.0047

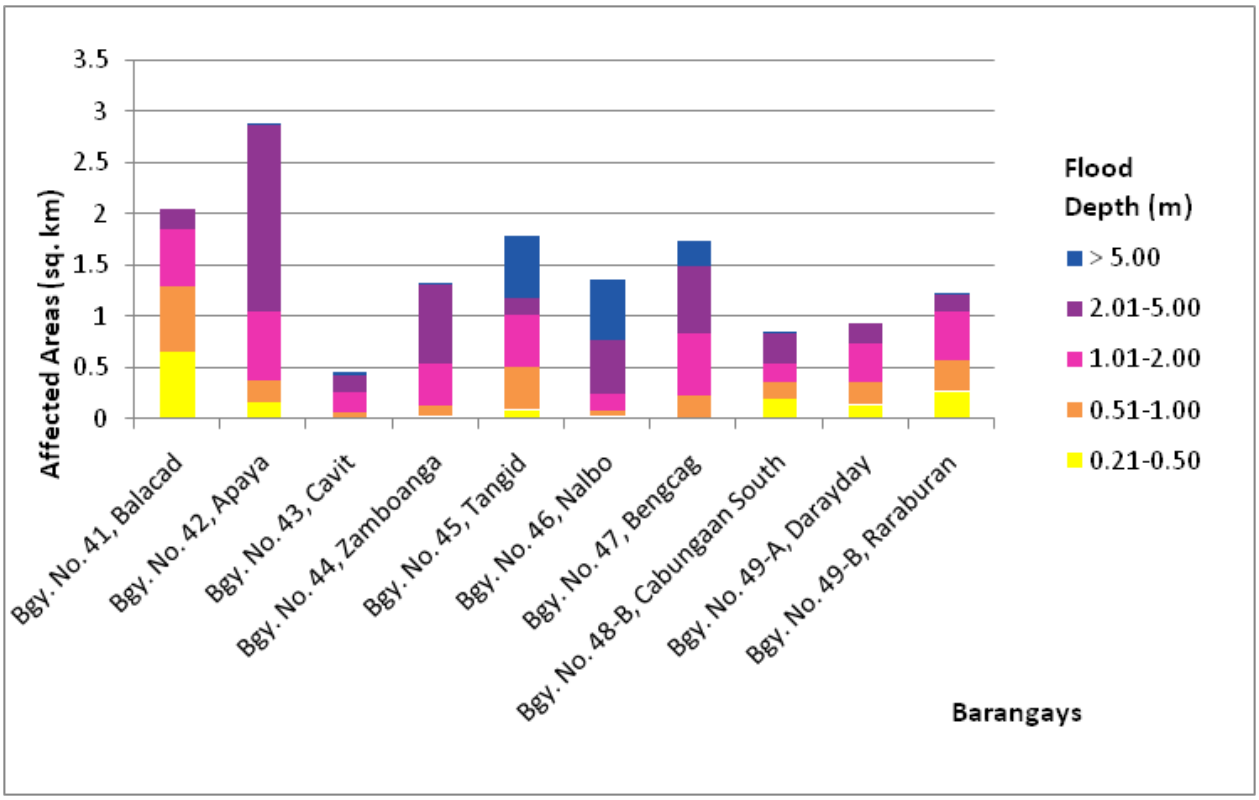

Figure 141.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Table 108.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 5, San Pedro	Bgy. No. 50, Buttong	Bgy. No. 51-A, Nangal-isan East	Bgy. No. 51-B, Nan-galisan West	Bgy. No. 52-A, San Mateo	Bgy. No. 52-B, Lataag	Bgy. No. 53, Rioeng	Bgy. No. 54-A, Lagui-Sail	Bgy. No. 54-B, Caman-gaan	Bgy. No. 55-A, Barit-Pan-dan
0.03-0.20	0.039	0.41	0.18	0.042	0.52	1.99	0.27	1	0.011	0.94
0.21-0.50	0.011	0.31	0.086	0.031	0.27	1	0.28	0.38	0.013	0.11
0.51-1.00	0.0035	0.26	0.094	0.047	0.16	0.76	0.29	0.49	0.053	0.17
1.01-2.00	0.00031	0.14	0.18	0.12	0.078	0.72	0.16	1.74	0.048	0.31
2.01-5.00	0.0022	0.11	0.4	0.21	0.73	0.14	0.9	0.38	1	0.19
> 5.00	0.043	0.013	0.27	0.22	0.8	0.037	0.48	0	0.62	0

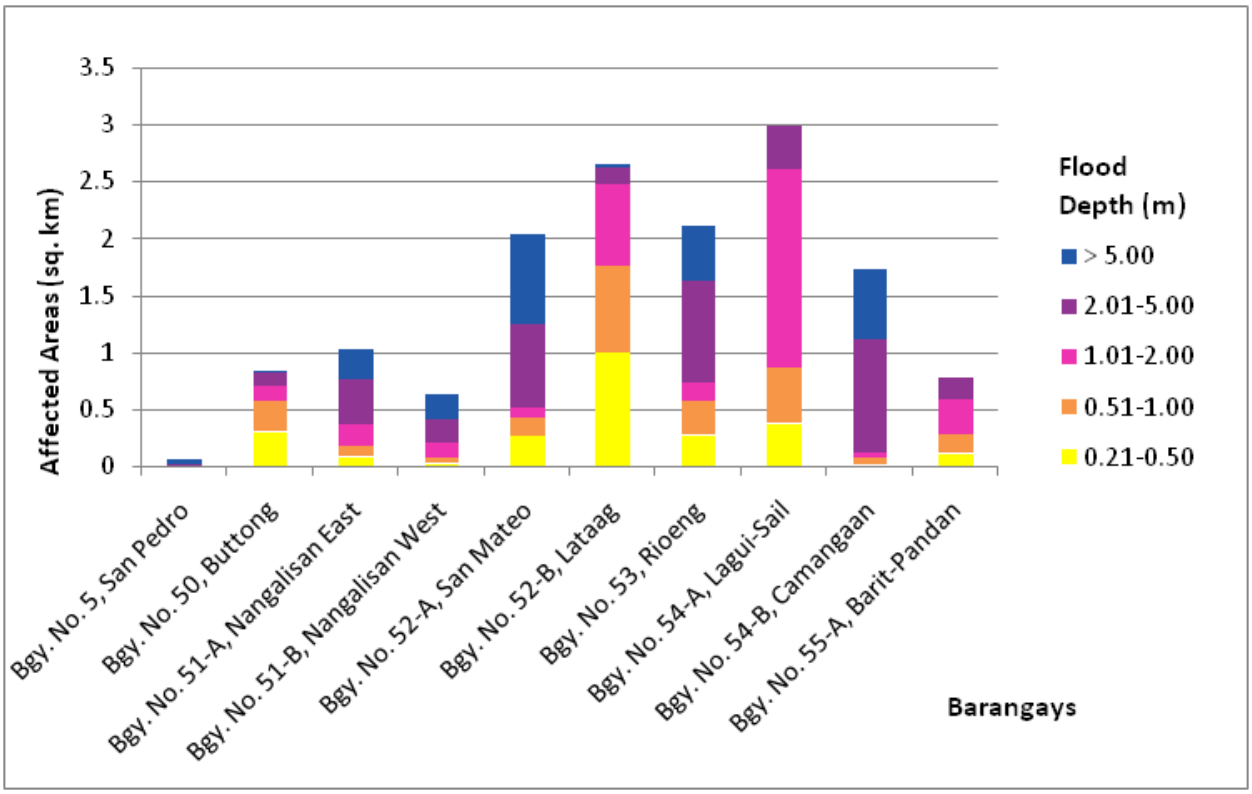

Figure 142.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Table 109.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 55-B, Salet-Bu-langon	Bgy. No. 55-C, Vira	Bgy. No. 56-A, Bacsil North	Bgy. No. 56-B, Bacsil South	Bgy. No. 57, Pila	Bgy. No. 58, Casili	Bgy. No. 59-A, Dibua South	Bgy. No. 59-B, Dibua North	Bgy. No. 6, San Agustin	Bgy. No. 60-A, Caaoa-can
0.03-0.20	3.85	1.21	4.2	3.43	1.49	0.33	0.7	1.84	0.03	0.27
0.21-0.50	0.62	0.19	0.39	0.87	0.16	0.25	0.21	0.26	0.027	0.067
0.51-1.00	0.55	0.22	0.2	0.37	0.18	0.53	0.25	0.14	0.0065	0.11
1.01-2.00	0.86	0.13	0.13	0.17	0.67	0.33	0.35	0.022	0.0003	0.21
2.01-5.00	1.12	0.0056	0.019	0.11	0.3	0.42	0.051	0.0001	0.0011	0.17
> 5.00	0.0001	0	0	0.014	0	0.0051	0	0	0.0035	0

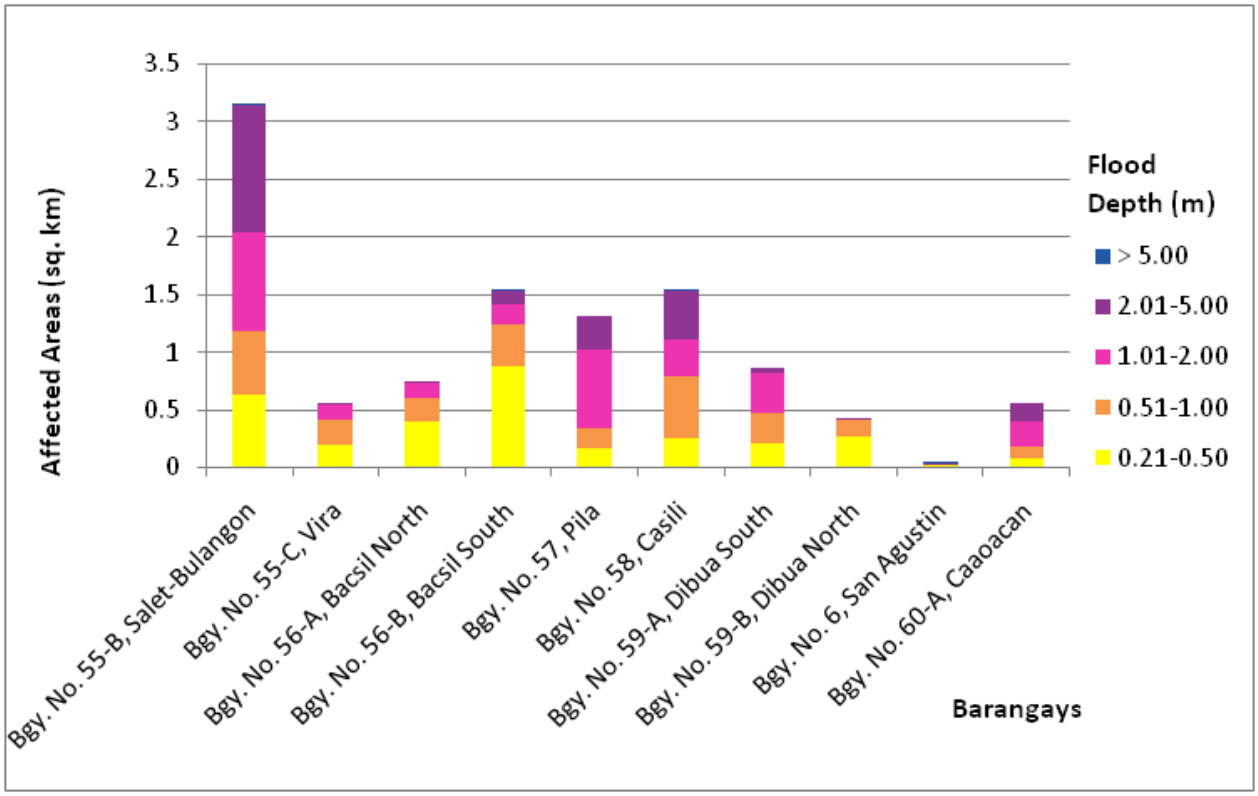

Figure 143.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Table 110.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Laoag City (in sq. km)									
	Bgy. No. 60-B, Madil-adig	Bgy. No. 61, Cata-ban	Bgy. No. 62-A, Navotas North	Bgy. No. 62-B, Navotas South	Bgy. No. 7-A, Nstra. Sra. De Natívid	Bgy. No. 7-B, Nstra. Sra. De Natívid	Bgy. No. 8, San Vicente	Bgy. No. 9, Santa Angela	Bry. No. 18, San Quirino	Bry. No. 48-A, Cabun-gaan North
0.03-0.20	1.32	0.25	0.16	1.12	0.029	0.002	0.018	0.028	0.042	0.019
0.21-0.50	0.63	0.064	0.063	0.22	0.026	0.015	0.012	0.02	0.017	0.046
0.51-1.00	0.51	0.17	0.1	0.4	0.0049	0.028	0.018	0.028	0.00093	0.19
1.01-2.00	0.4	0.77	0.24	0.72	0.00039	0	0.00011	0.0014	0.0025	0.2
2.01-5.00	0.03	0.67	0.16	0.27	0.00086	0	0.00039	0.0011	0.026	0.09
> 5.00	0	0	0	0	0.0062	0	0.0061	0.011	0.058	0

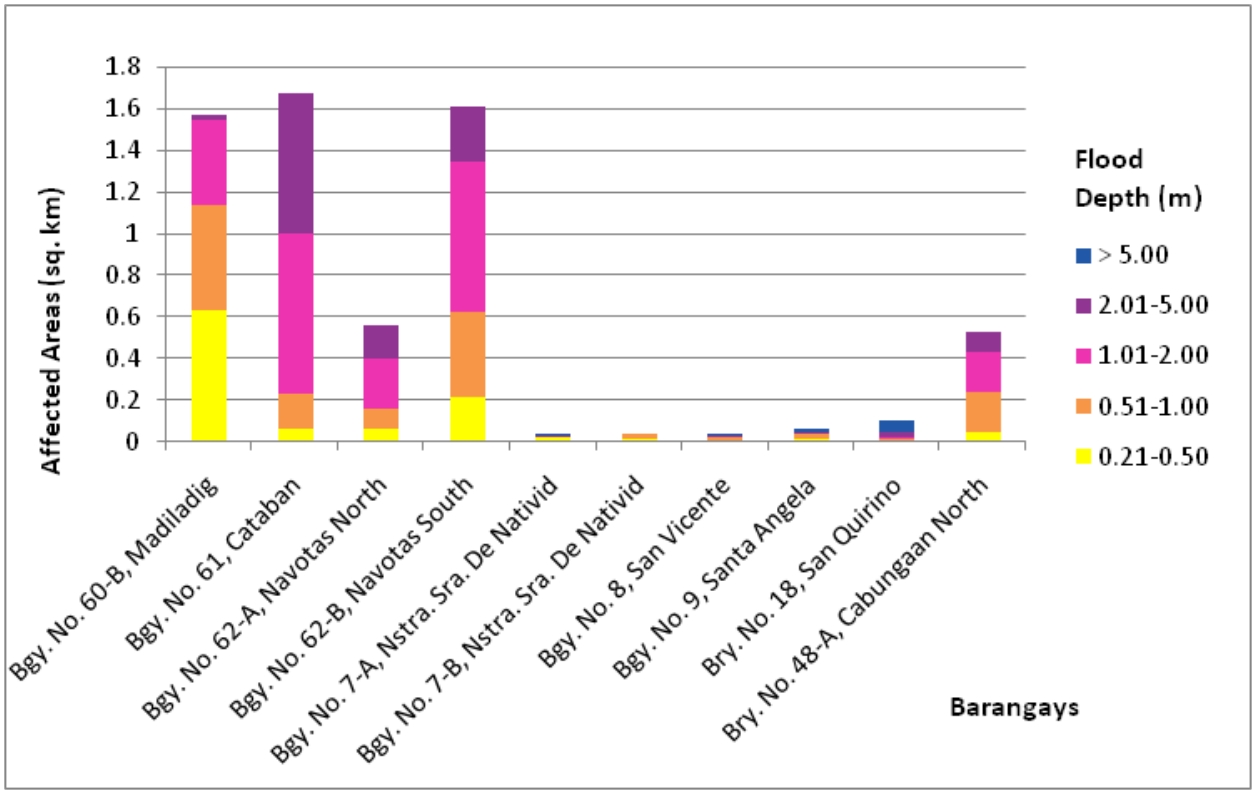

Figure 144.Affected Areas in Laoag City, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 38.63% of the municipality of Marcos with an area of 73.57 sq. km. will experience flood levels of less than 0.20 meters. 14.88% of the area will experience flood levels of 0.21 to 0.50 meters while 16.59%, 11.05%, 12.14%, and 4.68% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 111.Affected Areas in Marcos, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Marcos (in sq. km)						
	Caca-fean	Daquio-ag	Eliza-beth	Escoda	Ferdi-nand	Fortuna	Imelda
0.03-0.20	4.85	3.36	1.36	4.16	0.94	7.49	0.94
0.21-0.50	1.99	0.39	1.05	2.5	0.73	0.62	0.068
0.51-1.00	2.01	0.28	1.43	2.6	0.48	0.52	0.078
1.01-2.00	1.01	0.25	0.65	1.66	0.36	0.33	0.11
2.01-5.00	0.37	1.01	0.38	1.62	0.08	0.71	0.14
> 5.00	0.21	0.54	0.005	0.36	0	0.29	0.058

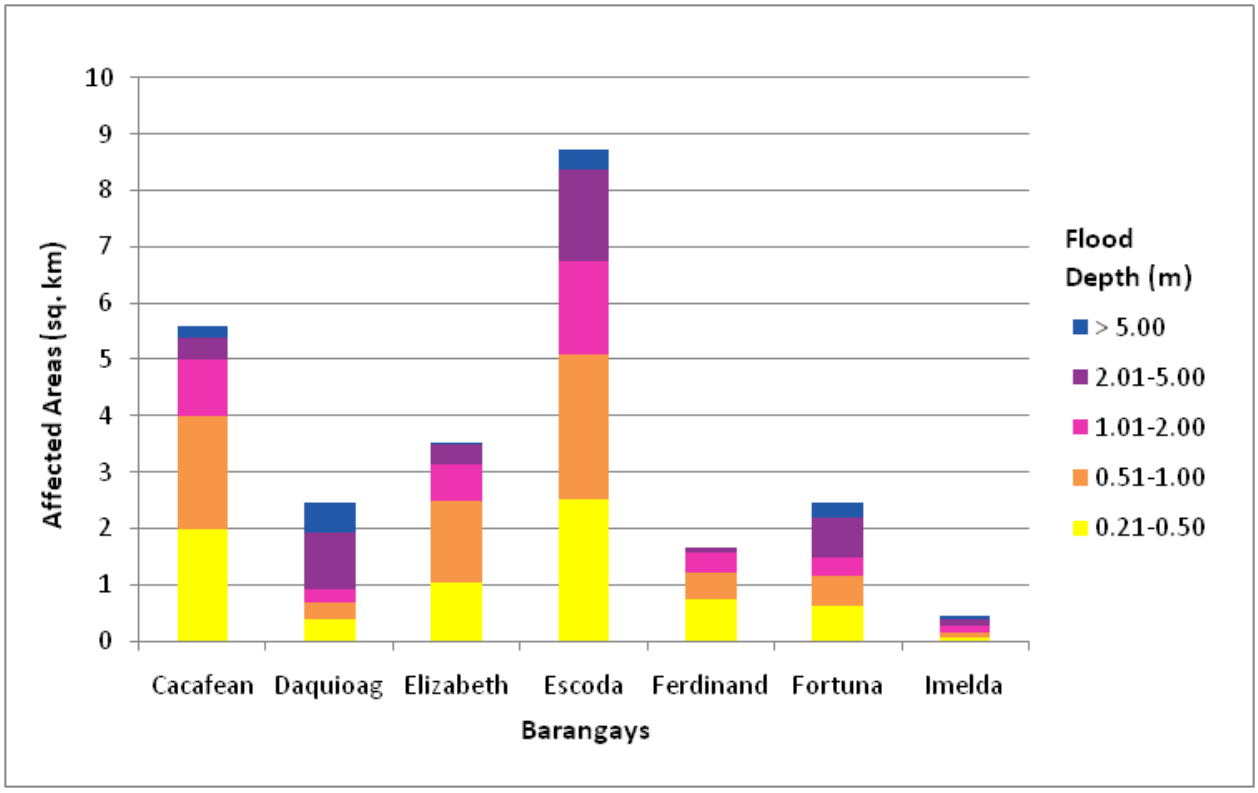

Figure 145.Affected Areas in Marcos, Ilocos Norte during 100-Year Rainfall Return Period

Table 112.Affected Areas in Marcos, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Marcos (in sq. km)					
	Lydia	Mabuti	Pacifico	Santiago	Tabucbuc	Valdez
0.03-0.20	0.83	1.44	1.55	1.28	0.17	0.059
0.21-0.50	0.29	0.26	1.7	1.06	0.21	0.09
0.51-1.00	0.74	0.18	2.34	0.82	0.45	0.28
1.01-2.00	0.14	0.12	1.05	0.93	1.1	0.42
2.01-5.00	0.049	0.1	1.53	0.21	1.79	0.93
> 5.00	0.00013	0.069	0.84	0	0.65	0.43

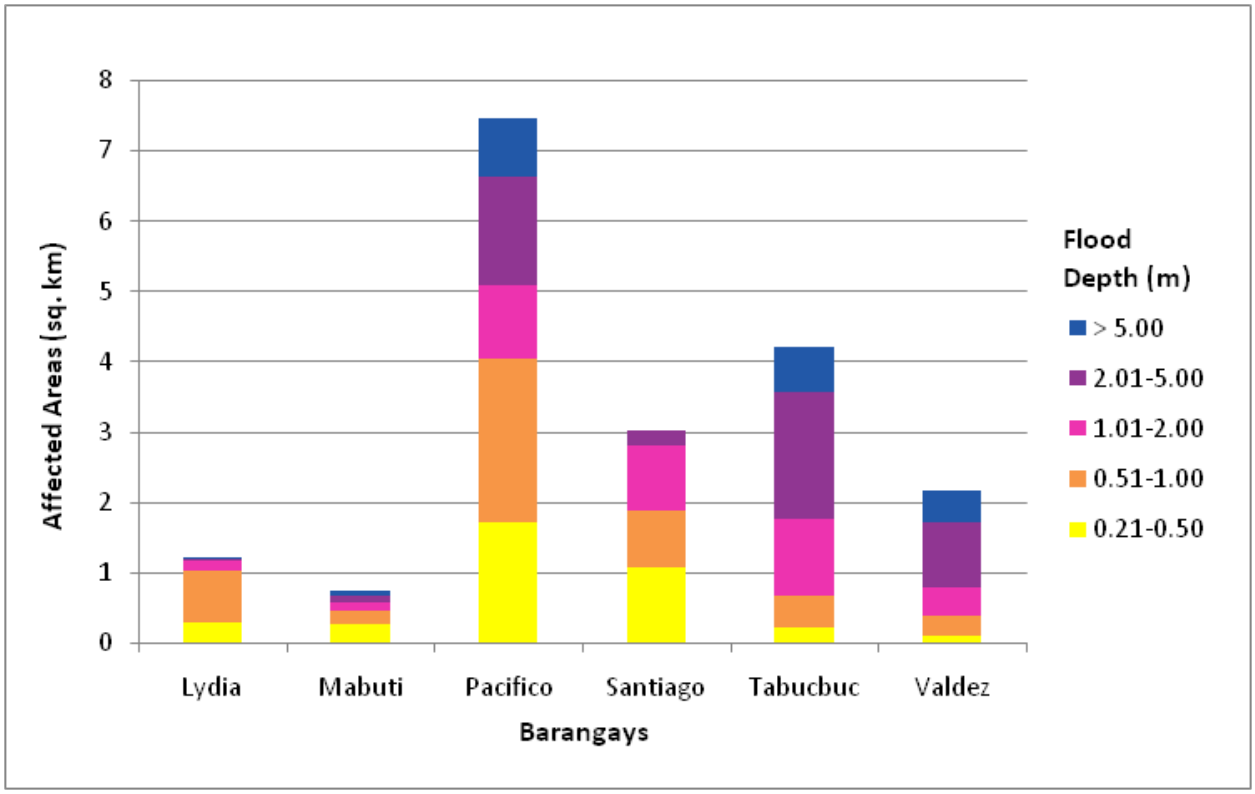

Figure 146.Affected Areas in Marcos, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 7.96% of the municipality of Nueva Era with an area of 619 sq. km. 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 while 0.77%, 0.63%, 0.47%, and 0.11% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 113.Affected Areas in Nueva Era, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Nueva Era (in sq. km)								
	Acnam	Barikir	Bugay-ong	Cabit-tauran	Caray	Garna-den	Naguil-lan	Pobla-cion	Santo Niño
0.03-0.20	0.73	0.69	4.92	9.51	10.05	5.39	4.41	2.47	11.12
0.21-0.50	0.078	0.12	0.6	1.64	0.68	0.49	0.39	0.19	1.1
0.51-1.00	0.12	0.24	0.68	1.43	0.41	0.47	0.38	0.23	0.82
1.01-2.00	0.19	0.43	0.56	0.85	0.31	0.4	0.51	0.33	0.31
2.01-5.00	0.034	0.014	0.61	0.38	0.16	0.27	0.61	0.41	0.4
> 5.00	0	0	0.055	0.011	0.017	0.066	0.09	0.26	0.2

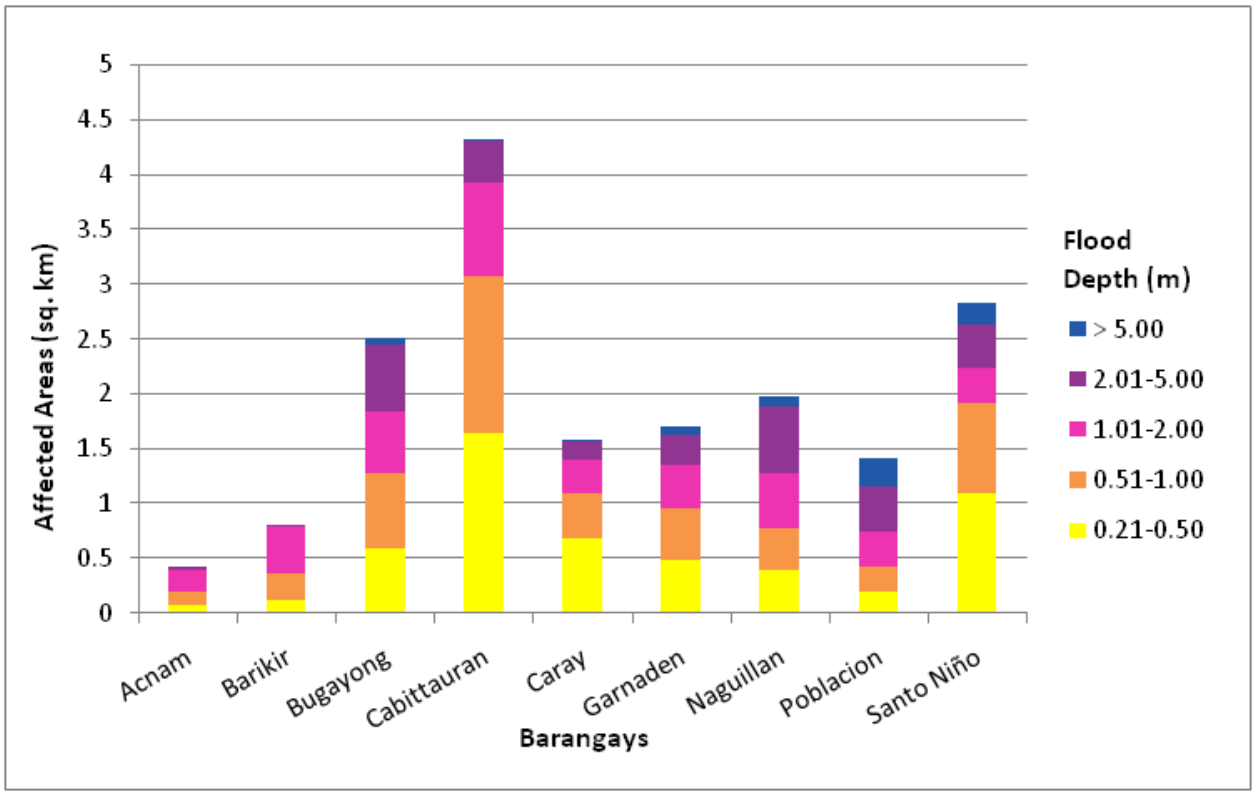

Figure 147.Affected Areas in Nueva Era, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 12.22% of the municipality of Paoay with an area of 71.616 sq. km. will experience flood levels of less than 0.20 meters. 1.06% of the area will experience flood levels of 0.21 to 0.50 meters while 0.76%, 0.59%, 0.48%, and 0.08% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 114.Affected Areas in Paoay, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Paoay (in sq. km)							
	Bacsil	Mumu-laan	Nagba-calan	Nan-guyudan	Pasil	Suba	Sun-gadan	Surgui
0.03-0.20	0.0059	0.28	1.26	2.89	0.31	2.34	1.59	0.059
0.21-0.50	0.0002	0.011	0.05	0.27	0.026	0.16	0.25	0.0037
0.51-1.00	0	0.0094	0.039	0.16	0.0027	0.18	0.16	0.00013
1.01-2.00	0	0.011	0.054	0.11	0.00068	0.22	0.021	0
2.01-5.00	0	0.019	0.12	0.0054	0.0005	0.19	0	0
> 5.00	0	0.0022	0.039	0.00019	0	0.013	0	0

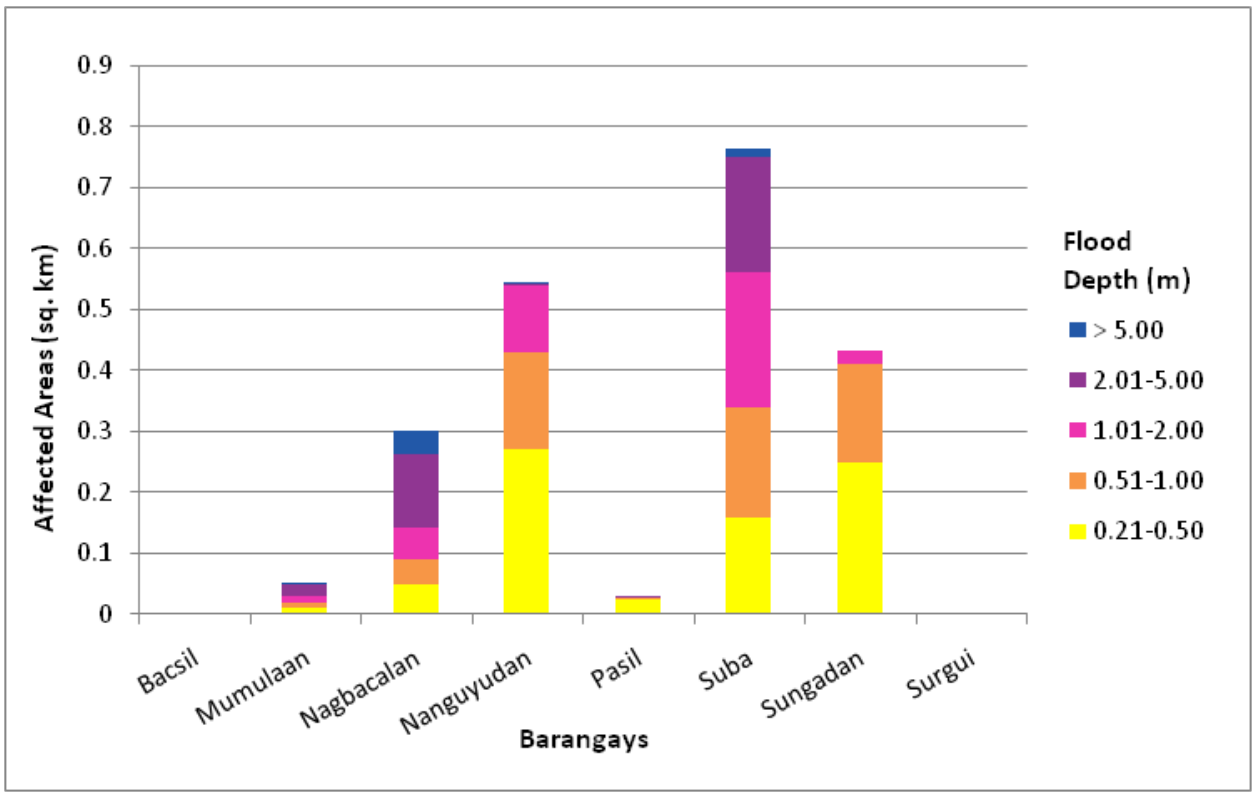

Figure 148.Affected Areas in Paoay, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 38.23% of the municipality of Paoay Lake with an area of 3.64 sq. km. will experience flood levels of less than 0.20 meters. 2.95% of the area will experience flood levels of 0.21 to 0.50 meters while 0.71%, 0.50%, 0.25%, and 0.02% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 115.Affected Areas in Paoay Lake, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Paoay Lake (in sq. km)
	Paoay Lake
0.03-0.20	1.39
0.21-0.50	0.11
0.51-1.00	0.026
1.01-2.00	0.018
2.01-5.00	0.0091
> 5.00	0.00056

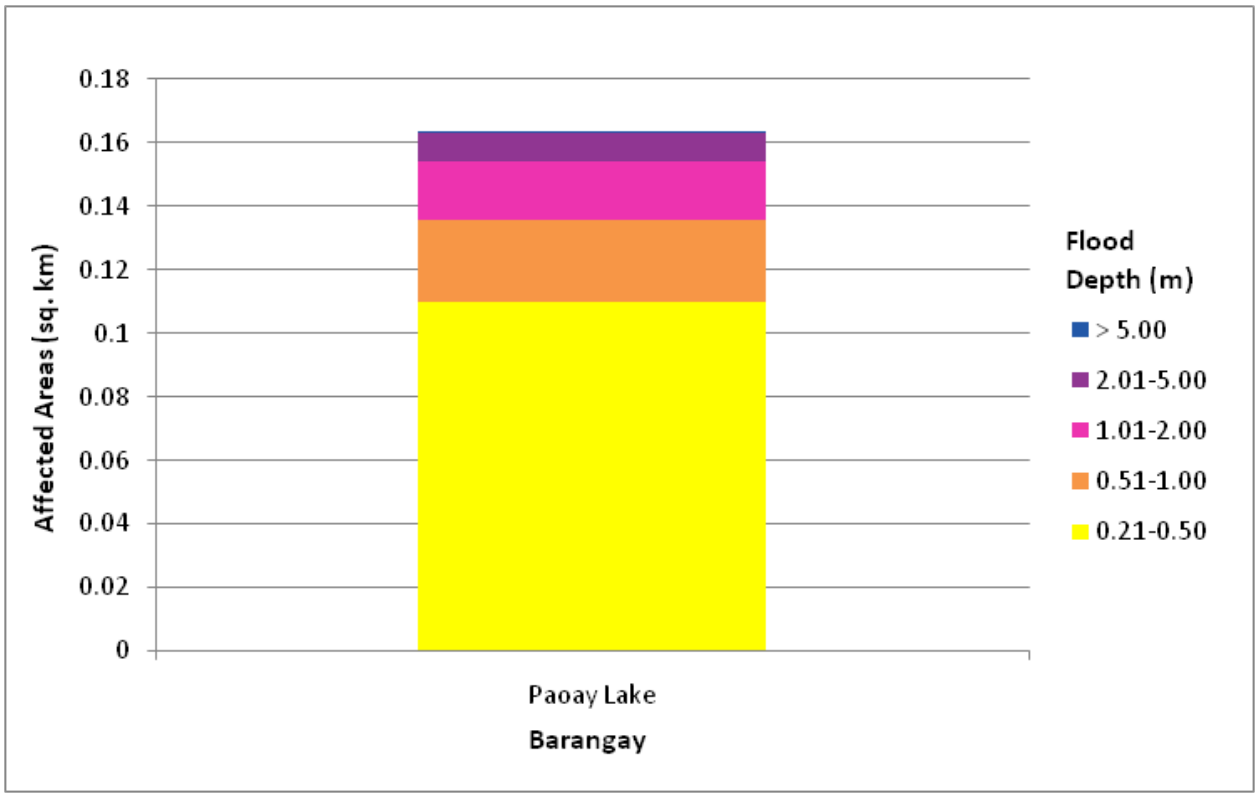

Figure 149.Affected Areas in Paoay Lake, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 38.25% of the municipality of Piddig with an area of 128.566 sq. km. will experience flood levels of less than 0.20 meters. 3.30% of the area will experience flood levels of 0.21 to 0.50 meters while 2.79%, 4.56%, 8.18%, and 12.68% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 116.Affected Areas in Piddig, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Piddig (in sq. km)											
	Ab-Abut	Abucay	Anao	Arua-Ay	Bim-manga	Boyboy	Cabaroan	Calam-beg	Callusa	Dupitac	Estancia	Gayamat
0.03-0.20	0.17	8.56	0.12	0.42	0	1.33	0.37	0.78	0.059	3.91	12.56	1.1
0.21-0.50	0.011	0.53	0.0069	0.017	0	0.093	0.02	0.086	0.0039	0.34	0.75	0.058
0.51-1.00	0.016	0.45	0.011	0.023	0	0.11	0.013	0.075	0.016	0.52	0.74	0.048
1.01-2.00	0.038	0.47	0.02	0.038	0	0.27	0.023	0.25	0.36	1.41	1.37	0.069
2.01-5.00	0.14	0.46	0.069	0.16	0.23	0.91	0.053	1.25	0.93	2.54	0.72	0.43
> 5.00	1.05	0.92	0.22	1.35	1.12	4.99	0.31	0.82	0.8	0.41	0.092	0.4

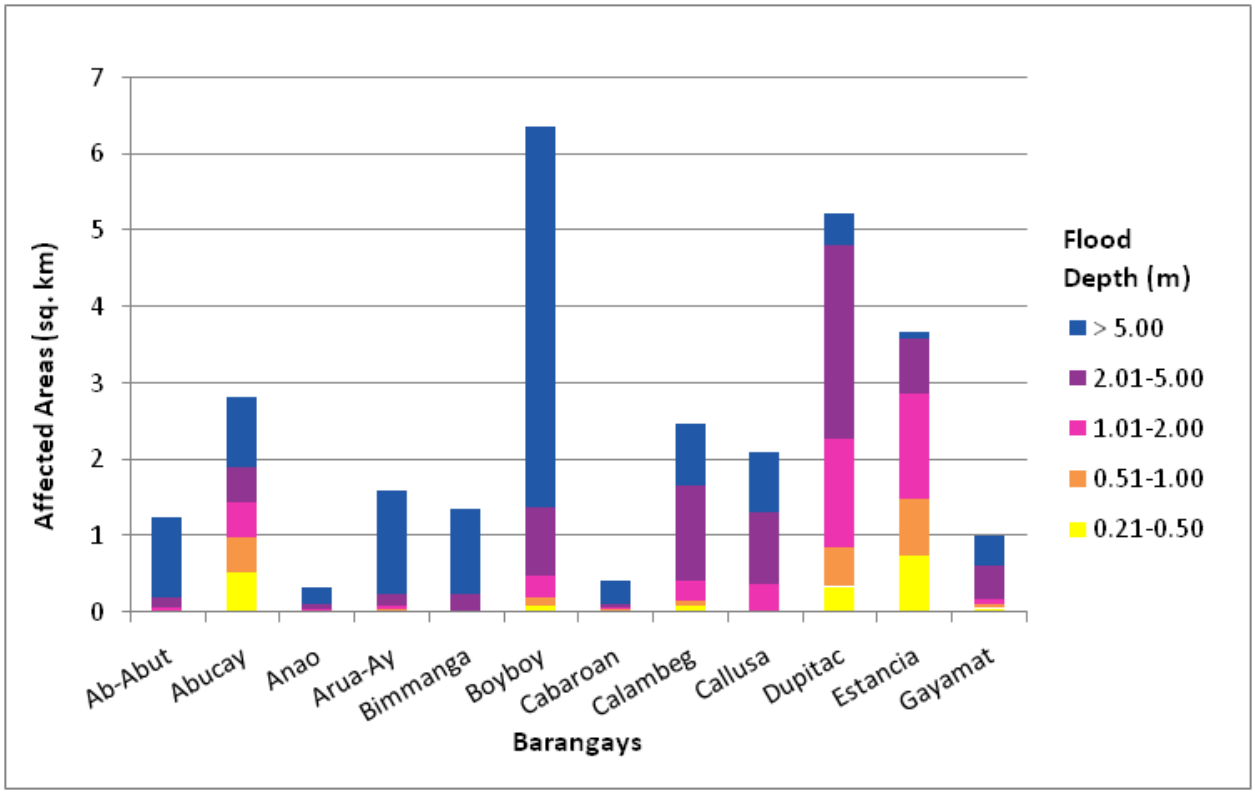

Figure 150.Affected Areas in Piddig, Ilocos Norte during 100-Year Rainfall Return Period

Table 117.Affected Areas in Piddig, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Piddig (in sq. km)										
	Lagandit	Lib-naoan	Loing	Maab-Ab-aca	Mangi-tayag	Maruaya	San Antonio	Santa Maria	Suc-suquen	Tan-gaoan	Tonoton
0.03-0.20	1.05	0.93	0.018	2.73	0.018	2.58	3.22	2.95	1.12	4.25	0.93
0.21-0.50	0.4	0.11	0.0009	0.26	0.0009	0.15	0.14	0.21	0.22	0.71	0.13
0.51-1.00	0.24	0.15	0.0016	0.21	0.002	0.13	0.086	0.16	0.17	0.36	0.064
1.01-2.00	0.27	0.3	0.003	0.15	0.0038	0.2	0.091	0.12	0.15	0.18	0.063
2.01-5.00	0.058	1.33	0.013	0.18	0.028	0.21	0.15	0.051	0.19	0.25	0.15
> 5.00	0	0.13	0.84	0.6	1.58	0.091	0.19	0	0.17	0.024	0.2

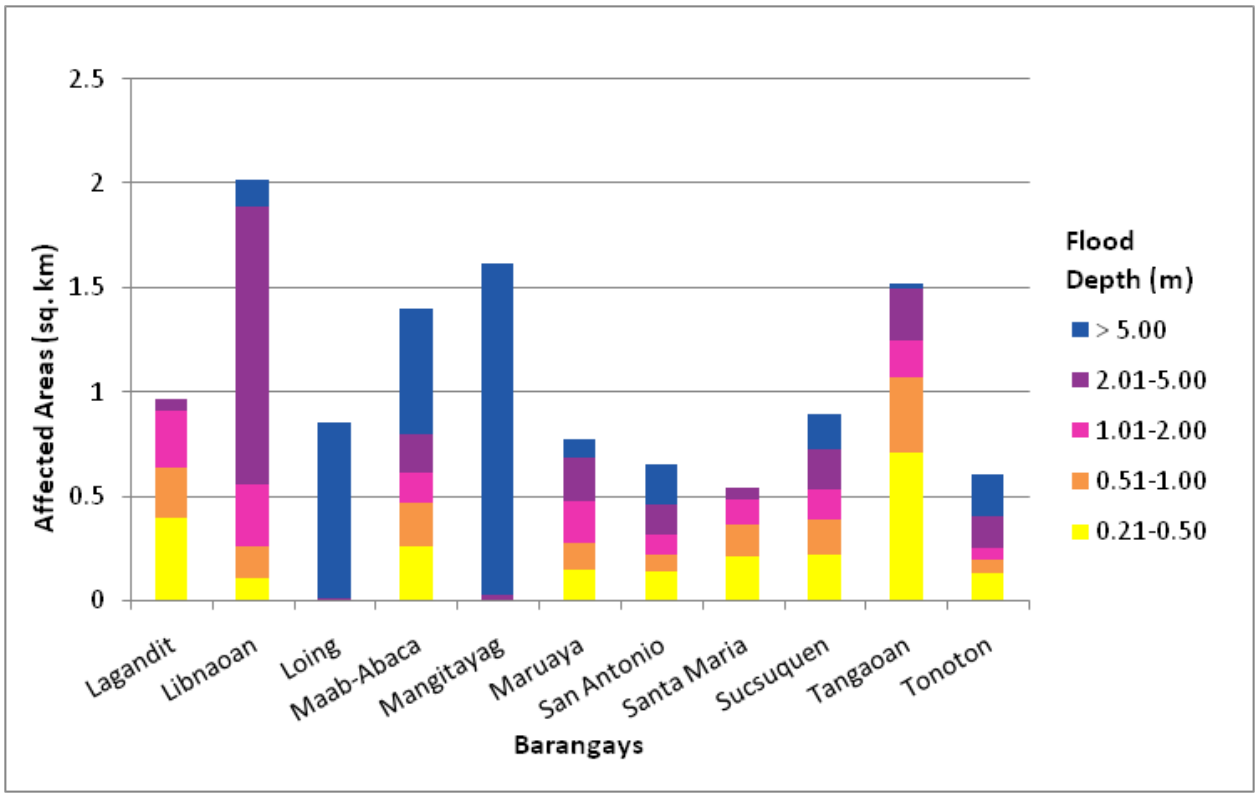

Figure 151.Affected Areas in Piddig, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 2.00% of the municipality of Pinili with an area of 63.18 sq. km. will experience flood levels of less than 0.20 meters. 0.17% of the area will experience flood levels of 0.21 to 0.50 meters while 0.09%, 0.02%, and 0.01% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, and 2.01 to 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 118.Affected Areas in Pinili, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangay in Pinili (in sq. km)
	Lumbaan-Bicbica
0.03-0.20	1.27
0.21-0.50	0.11
0.51-1.00	0.056
1.01-2.00	0.014
2.01-5.00	0.0087
> 5.00	0

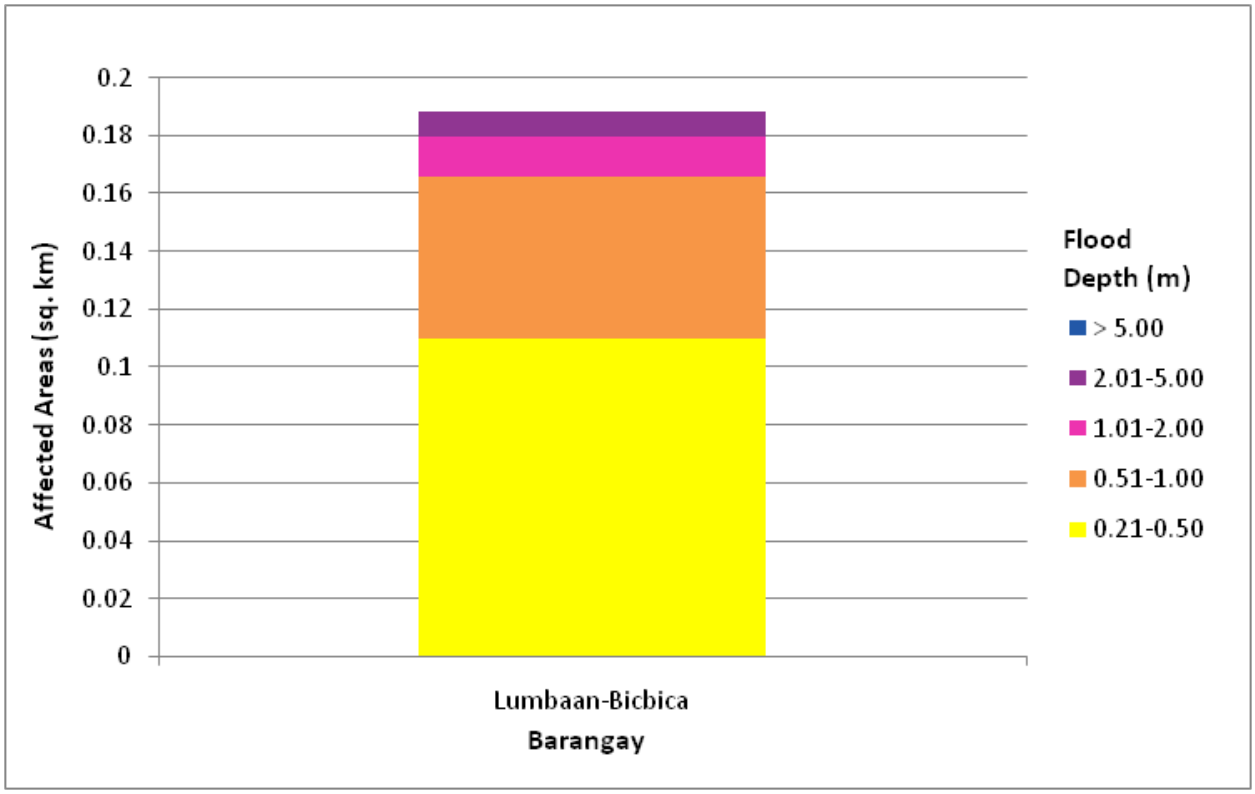

Figure 152.Affected Areas in Pinili, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 57.49% of the municipality of San Nicolas with an area of 40.225 sq. km. will experience flood levels of less than 0.20 meters. 9.53% of the area will experience flood levels of 0.21 to 0.50 meters while 12.76%, 10.90%, 8.27%, and 0.93% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 119.Affected Areas in San Nicolas, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in San Nicolas (in sq. km)											
	San Agustin	San Balt-azar	San Bar-tolome	San Cay-etano	San Eugenio	San Fer-nando	San Francis-co	San Gre-gorio	San Guiller-mo	San Ilde-fonso	San Jose	San Juan Bautista
0.03-0.20	4.92	0.032	0.0051	0.063	0.012	0.02	0.075	0.066	6.75	0.047	0.011	0.023
0.21-0.50	0.54	0.071	0.0051	0.019	0.023	0.0075	0.048	0.27	0.85	0.043	0.06	0.022
0.51-1.00	0.59	0.053	0.016	0.024	0.034	0.046	0.11	0.21	1.33	0.013	0.024	0.062
1.01-2.00	0.62	0.051	0.06	0.011	0	0.021	0.14	0.088	0.86	0.062	0.00019	0.057
2.01-5.00	0.34	0.072	0.051	0	0	0	0.015	0.016	0.067	0.062	0	0.08
> 5.00	0.044	0	0	0	0	0	0	0	0.014	0	0	0

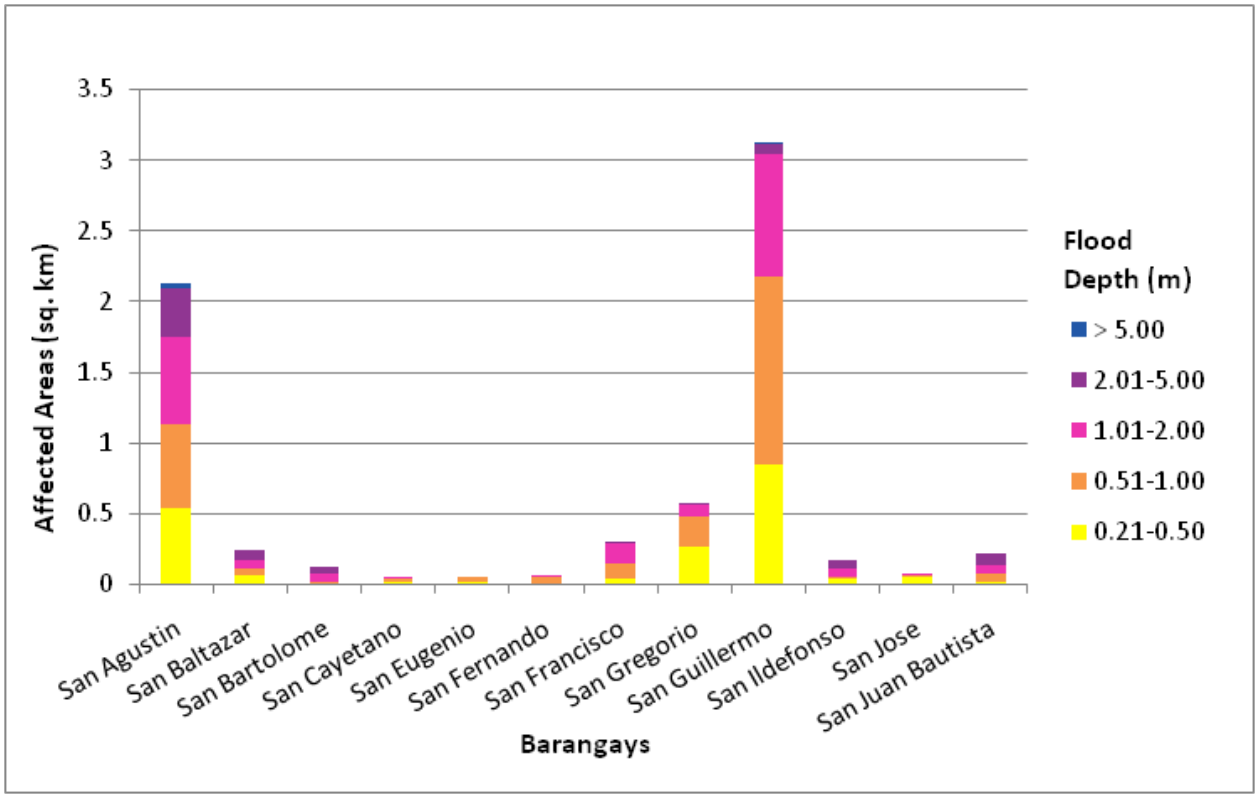

Figure 153.Affected Areas in San Nicolas, Ilocos Norte during 100-Year Rainfall Return Period

Table 120.Affected Areas in San Nicolas, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in San Nicolas (in sq. km)											
	San Lorenzo	San Lucas	San Marcos	San Miguel	San Pablo	San Paulo	San Pedro	San Rufino	San Sil-vestre	Santa Asun-cion	Santa Cecilia	Santa Monica
0.03-0.20	0.4	0.0015	0.29	0.057	0.84	0.022	3.31	0.019	0.089	2.41	2.32	1.35
0.21-0.50	0.18	0.01	0.18	0.018	0.07	0.014	0.39	0.0068	0.05	0.25	0.12	0.58
0.51-1.00	0.32	0.1	0.69	0.08	0.025	0.064	0.33	0.18	0.014	0.18	0.072	0.56
1.01-2.00	0.44	0.019	1.32	0.028	0.023	0.012	0.26	0.014	0.00049	0.12	0.1	0.071
2.01-5.00	0.19	0	0.67	0	0.026	0	0.2	0	0	0.016	0.67	0.85
> 5.00	0.0005	0	0.0028	0	0.0026	0	0.00011	0	0	0	0.21	0.1

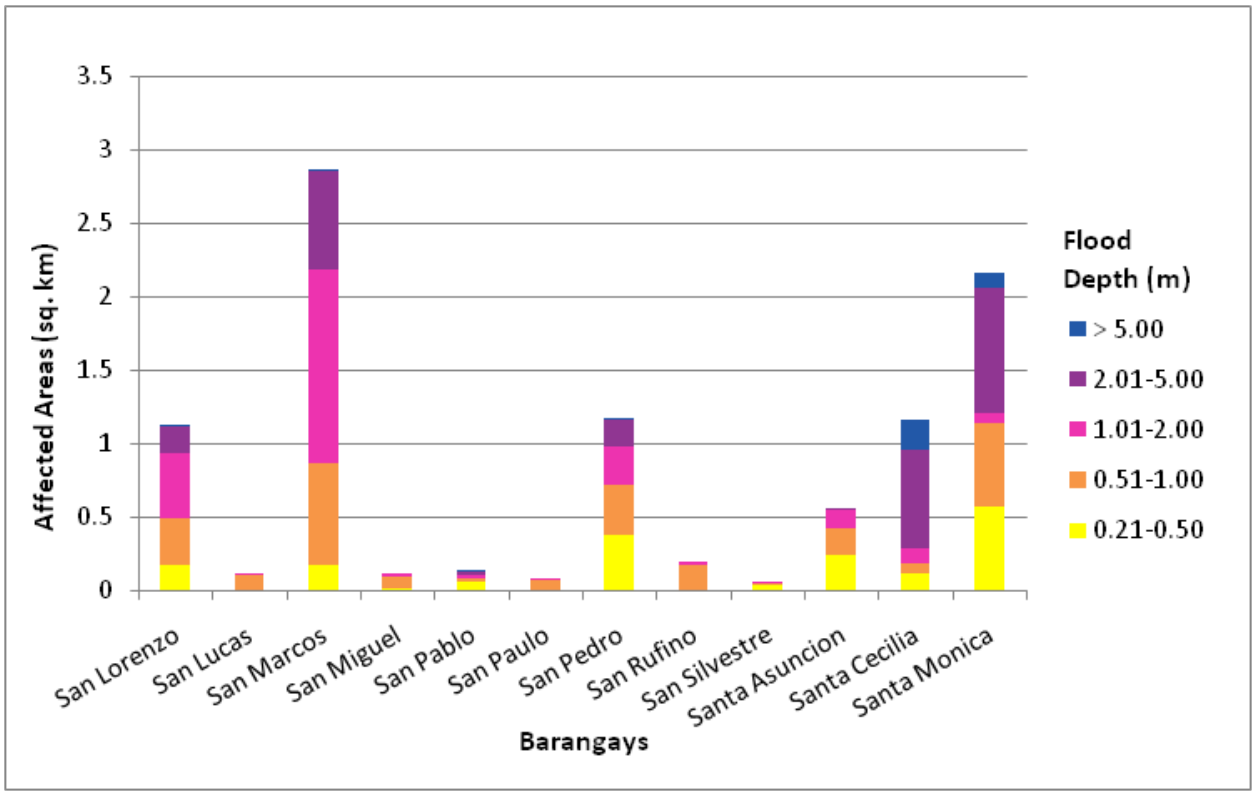

Figure 154.Affected Areas in San Nicolas, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 53.75% of the municipality of Sarrat with an area of 92.247 sq. km. will experience flood levels of less than 0.20 meters. 6.14% of the area will experience flood levels of 0.21 to 0.50 meters while 3.99%, 3.61%, 9.65%, and 15.11% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 121.Affected Areas in Sarrat, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Sarrat (in sq. km)											
	San Agustin	San Andres	San Antonio	San Ber-nabe	San Cris-tobal	San Felipe	San Francis-co	San Isidro	San Joaquin	San Jose	San Juan	San Leandro
0.03-0.20	0.069	5.77	0	1.82	3.19	1.87	0.19	3.29	0.078	1.56	6.34	0.23
0.21-0.50	0.037	0.61	0	0.34	0.19	0.25	0.12	0.21	0.041	0.34	0.61	0.018
0.51-1.00	0.038	0.32	0	0.2	0.1	0.15	0.12	0.12	0.053	0.24	0.41	0.026
1.01-2.00	0.046	0.31	0.018	0.16	0.092	0.16	0.014	0.098	0.088	0.2	0.33	0.019
2.01-5.00	0.02	0.32	2.57	0.089	0.083	0.3	0.00059	0.16	0.061	0.31	0.38	0.034
> 5.00	0.086	0.015	0.84	0.006	0.31	0.87	0	0.52	0.44	1.37	0.0049	0.21

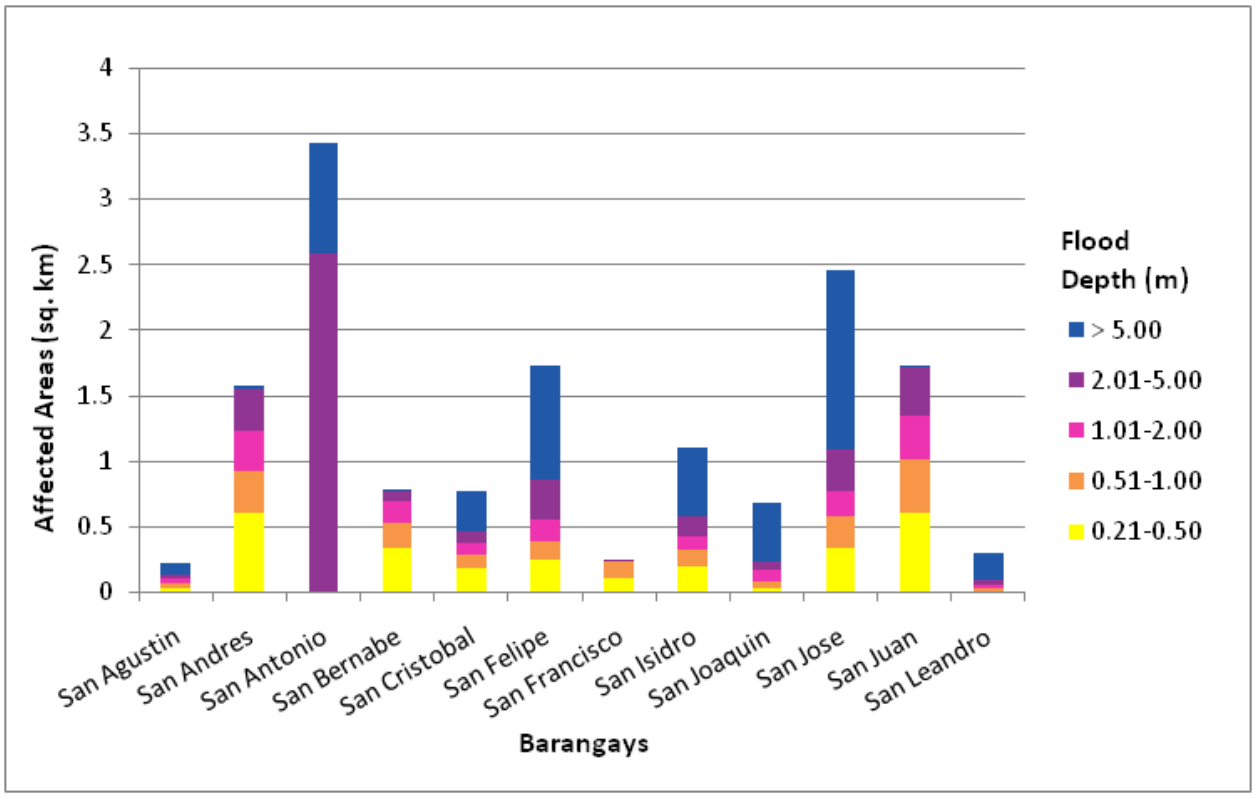

Figure 155.Affected Areas in Sarrat, Ilocos Norte during 100-Year Rainfall Return Period

Table 122.Affected Areas in Sarrat, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Sarrat (in sq. km)											
	San Lorenzo	San Manuel	San Marcos	San Nicolas	San Pedro	San Roque	San Vicente	Santa Barbara	Santa Magdalena	Santa Rosa	Santo Santiago	Santo Tomas
0.03-0.20	0.16	0	3.19	0.45	8.13	1.25	0.12	0.068	5.89	1.89	3.88	0.17
0.21-0.50	0.01	0.00011	0.19	0.036	0.52	0.54	0.024	0.016	0.79	0.18	0.57	0.0061
0.51-1.00	0.011	0.00095	0.11	0.018	0.26	0.45	0.059	0.013	0.5	0.13	0.35	0.011
1.01-2.00	0.029	0.0047	0.11	0.062	0.19	0.53	0.049	0.029	0.35	0.15	0.27	0.022
2.01-5.00	0.53	1.39	0.35	0.29	0.23	0.24	0.0061	0.000063	0.37	0.39	0.24	0.53
> 5.00	0.31	0.96	2.79	0.79	0.021	0.016	0.047	0	0.04	0.39	0.011	3.9

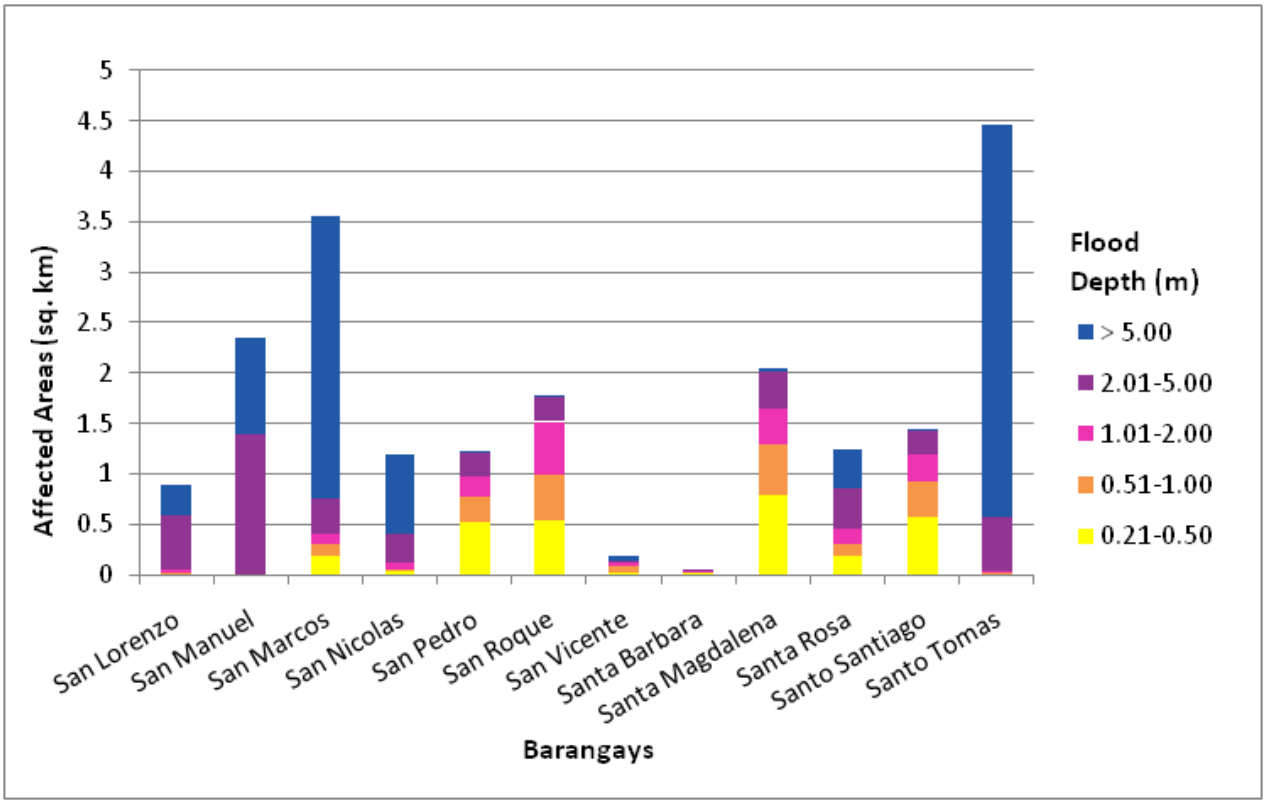

Figure 156.Affected Areas in Sarrat, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 22.00% of the municipality of Solsona with an area of 153.135 sq. km. will experience flood levels of less than 0.20 meters. 5.86% of the area will experience flood levels of 0.21 to 0.50 meters while 7.88%, 12.43%, 10.09%, and 1.77% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 123.Affected Areas in Solsona, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Solsona (in sq. km)										
	Agui-tap	Bagbag	Bagba-go	Bar-celo-na	Bubuos	Capu-rictan	Catan-graran	Daras-das	Juan	Lau-reta	Lipay
0.03-0.20	0.28	0.025	0.072	0.016	1.87	0.88	1.65	0.054	1.07	0.83	4.78
0.21-0.50	0.3	0.057	0.092	0.032	0.3	0.053	0.14	0.22	0.85	0.4	0.21
0.51-1.00	0.42	0.25	0.19	0.089	0.56	0.1	0.049	0.74	1.45	0.41	0.15
1.01-2.00	0.91	0.55	0.64	0.59	1.29	0.67	0.064	1.25	1.32	0.78	0.11
2.01-5.00	1.36	0.47	2.32	1.43	0.37	0.36	0.3	0.67	0.1	0.096	0.015
> 5.00	0.055	0.0092	0.97	0.21	0.00013	0.03	0.1	0.014	0	0	0

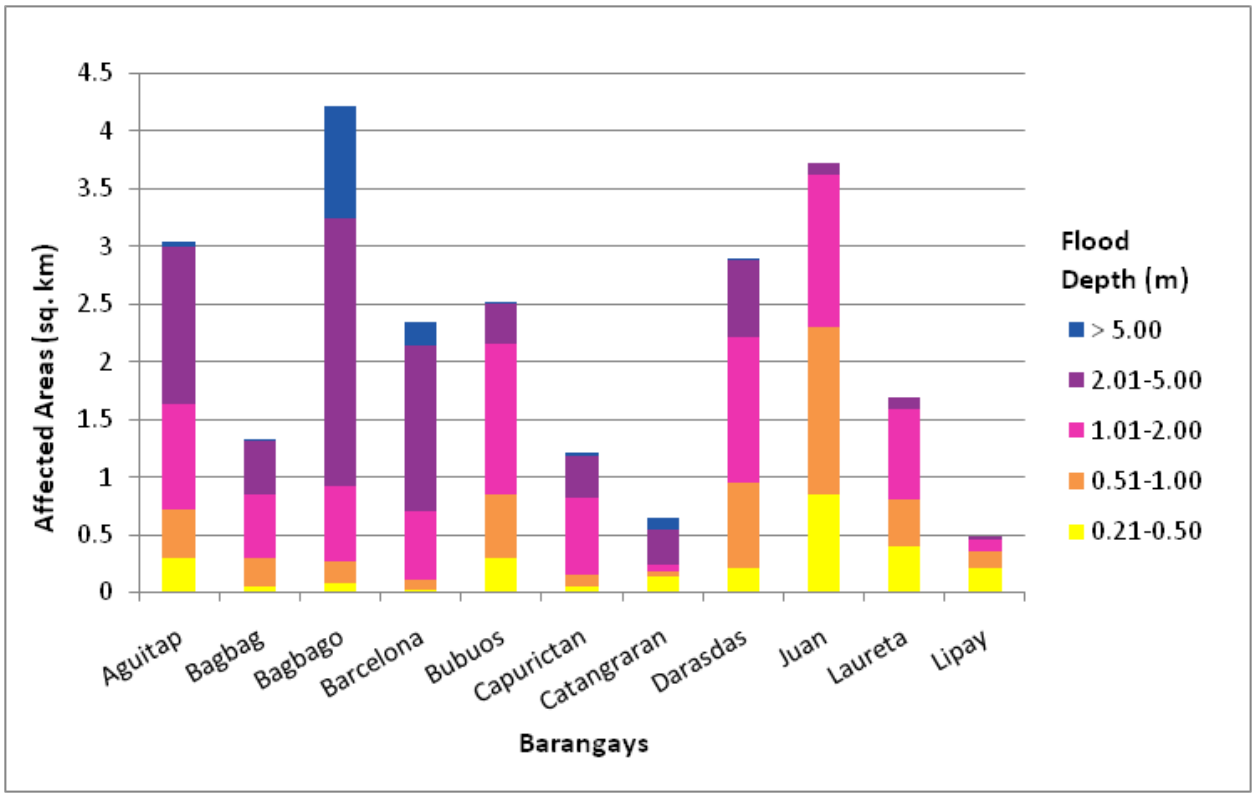

Figure 157.Affected Areas in Solsona, Ilocos Norte during 100-Year Rainfall Return Period

Table 124.Affected Areas in Solsona, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Solsona (in sq. km)										
	Maa-nan-teng	Manal-pac	Mari-quet	Nag-patpa-tan	Nala-sin	Puttao	San Juan	San Julian	Santa Ana	San-ti-ago	Ta-lug-tog
0.03-0.20	0.025	7.5	1.98	1	3.5	0.34	0.044	0.3	5.99	0.061	1.42
0.21-0.50	0.00053	1.01	0.82	1.35	0.78	0.18	0.15	0.0098	0.7	0.17	1.13
0.51-1.00	0	0.57	0.44	1.37	0.96	0.64	0.55	0.0044	0.59	0.35	2.18
1.01-2.00	0	0.58	0.6	1.53	1.8	2.25	0.41	0.017	0.36	0.9	2.41
2.01-5.00	0	0.57	0.16	0.72	2.18	1.67	0.55	0.01	0.21	1.26	0.64
> 5.00	0	0.29	0	0.0004	0.093	0.0061	0.29	0	0.025	0.59	0.024

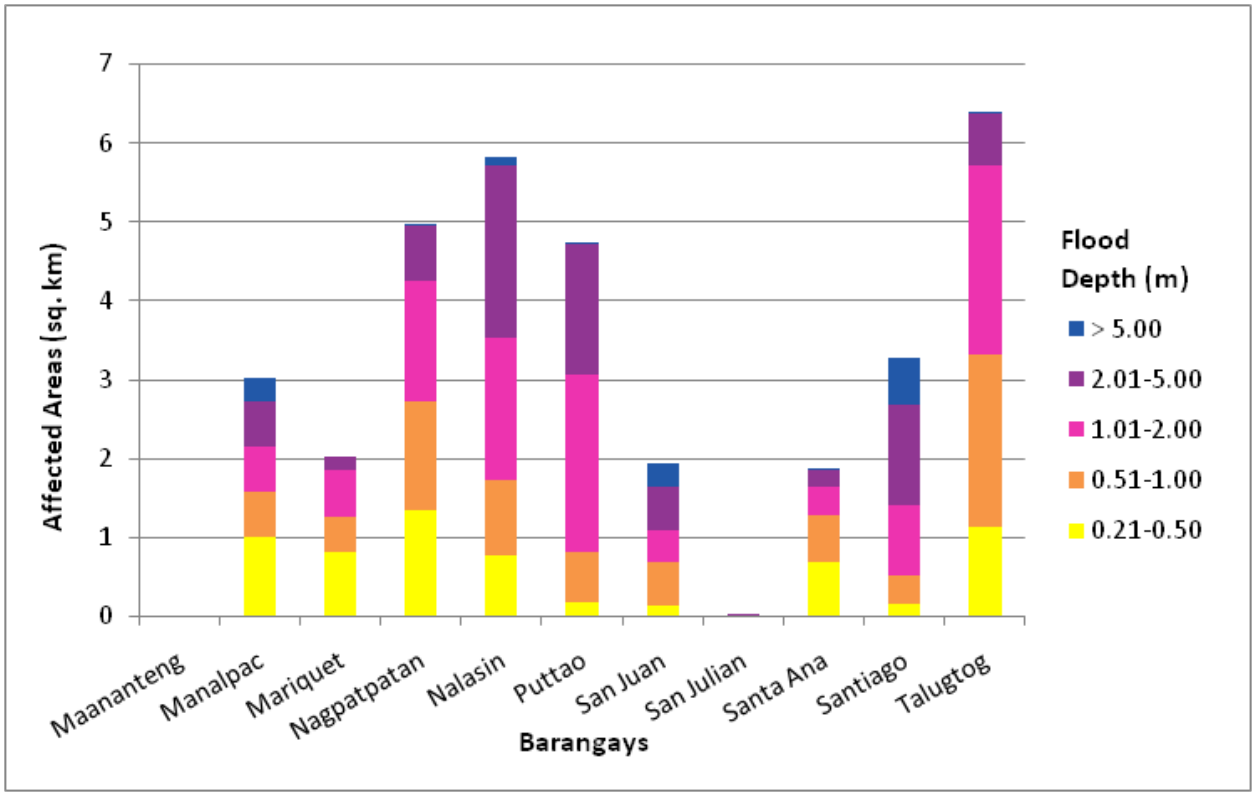

Figure 158.Affected Areas in Solsona, Ilocos Norte during 100-Year Rainfall Return Period

For the 100-year return period, 3.09% of the municipality of Vintar with an area of 497.395 sq. km. will experience flood levels of less than 0.20 meters. 0.31% of the area will experience flood levels of 0.21 to 0.50 meters while 0.20%, 0.17%, 0.13%, and 0.01% of the area will experience flood depths of 0.51 to 1 meter, 1.01 to 2 meters, 2.01 to 5 meters, and more than 5 meters, respectively. Listed in the table are the affected areas in square kilometers by flood depth per barangay.

Table 125.Affected Areas in Vintar, Ilocos Norte during 100-Year Rainfall Return Period

Affected area (sq. km.) By flood depth (in m.)	Area of affected barangays in Vintar (in sq. km)						
	Bulbulala	Ester	Lubnac	Mabanbanag	Margaay	Namoroc	Parparoroc
0.03-0.20	1.45	4.8	0.08	6.03	0.21	1.5	1.27
0.21-0.50	0.2	0.73	0.00012	0.28	0.0085	0.24	0.067
0.51-1.00	0.17	0.44	0	0.15	0.0024	0.22	0.03
1.01-2.00	0.12	0.29	0	0.2	0	0.21	0.011
2.01-5.00	0.0093	0.26	0	0.23	0	0.14	0.0021
> 5.00	0	0.021	0	0.013	0	0.0051	0

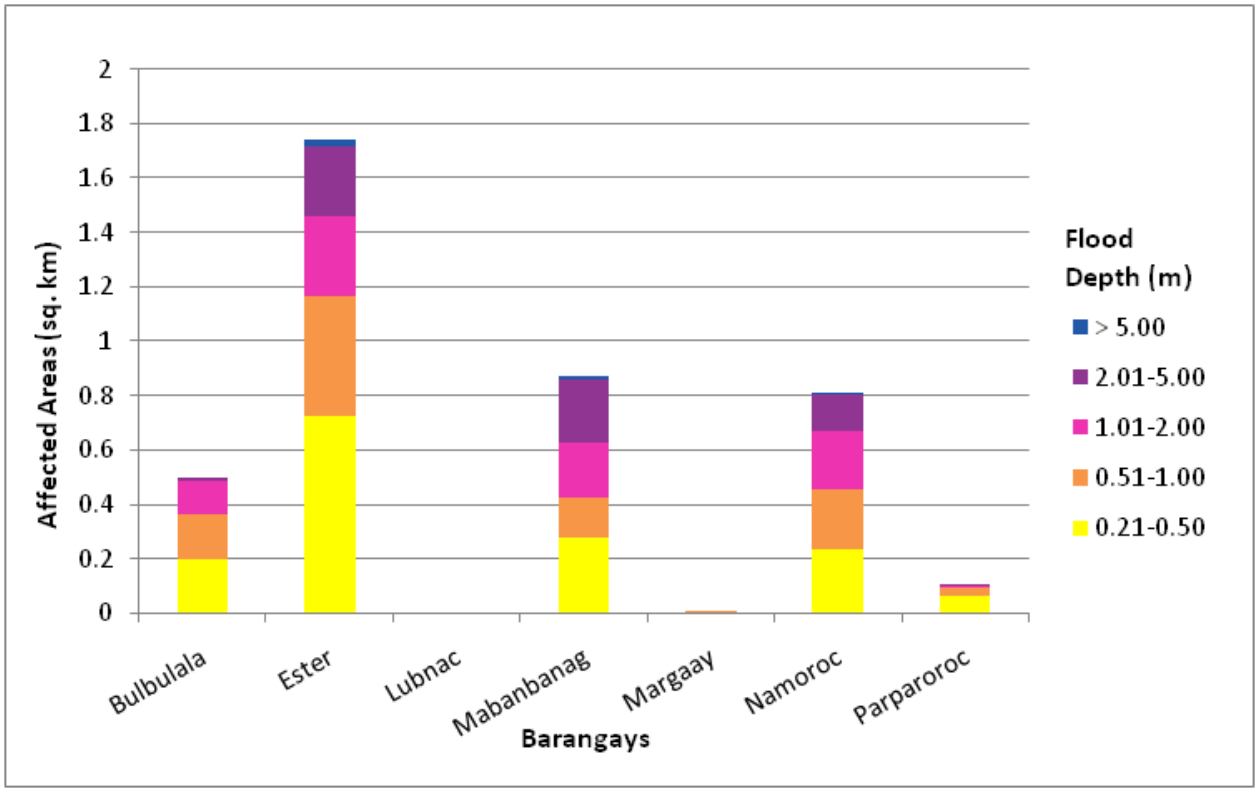

Figure 159.Affected Areas in Vintar, Ilocos Norte during 100-Year Rainfall Return Period

Among the barangays in the municipality of Bacarra in Ilocos Norte, Ganagan is projected to have the highest percentage of area that will experience flood levels at 3.02%. Meanwhile, Pasiocan posted the second highest percentage of area that may be affected by flood depths at 0.35%.

Among the barangays in the municipality of Banna in Ilocos Norte, Nagpatayan is projected to have the highest percentage of area that will experience flood levels at 12.77%. Meanwhile, Balioeg posted the second highest percentage of area that may be affected by flood depths at 9.95%.

Among the barangays in the municipality of Batac City in Ilocos Norte, Maipalig is projected to have the highest percentage of area that will experience flood levels at 1.37%. Meanwhile, Nagbacalan posted the second highest percentage of area that may be affected by flood depths at 0.37%.

Brgy. Virbira is the only barangay affected in the municipality of Carasi in Ilocos Norte. The barangay is projected to experience flood in 1.51% of the municipality.

Among the barangays in the municipality of Dingras in Ilocos Norte, San Francisco is projected to have the highest percentage of area that will experience flood levels at 18.97%. Meanwhile, Baresbes posted the second highest percentage of area that may be affected by flood depths at 10.51%.

Among the barangays in the municipality of Laoag City in Ilocos Norte, Bgy. No. 55-B, Salet-Bulangon is projected to have the highest percentage of area that will experience flood levels at 6.12%. Meanwhile, Bgy. No. 37, Calayab posted the second highest percentage of area that may be affected by flood depths at 5.63%.

Among the barangays in the municipality of Marcos in Ilocos Norte, Escoda is projected to have the highest percentage of area that will experience flood levels at 17.52%. Meanwhile, Cacafean posted the second highest percentage of area that may be affected by flood depths at 14.17%.

Among the barangays in the municipality of Nueva Era in Ilocos Norte, Santo Niño is projected to have the highest percentage of area that will experience flood levels at 2.25%. Meanwhile, Cabittauran posted the second highest percentage of area that may be affected by flood depths at 2.23%.

Among the barangays in the municipality of Paoay in Ilocos Norte, Suba is projected to have the highest percentage of area that will experience flood levels at 6.08%. Meanwhile, Nanguyudan posted the second highest percentage of area that may be affected by flood depths at 4.38%.

Brgy. Paoay Lake is the only barangay affected in the municipality of Paoay Lake in Ilocos Norte. The barangay is projected to experience flood in 36.13% of the municipality.

Among the barangays in the municipality of Piddig in Ilocos Norte, Estancia is projected to have the highest percentage of area that will experience flood levels at 12.63%. Meanwhile, Abucay posted the second highest percentage of area that may be affected by flood depths at 8.86%.

Brgy. Lumbaan-Bicbica is the only barangay affected in the municipality of Pinili in Ilocos Norte. The barangay is projected to experience flood in 2.30% of the municipality.

Among the barangays in the municipality of San Nicolas in Ilocos Norte, San Guillermo is projected to have the highest percentage of area that will experience flood levels at 24.49%. Meanwhile, San Agustin posted the second highest percentage of area that may be affected by flood depths at 17.54%.

Among the barangays in the municipality of Sarrat in Ilocos Norte, San Pedro is projected to have the highest percentage of area that will experience flood levels at 10.13%. Meanwhile, San Juan posted the second highest percentage of area that may be affected by flood depths at 8.75%.

Among the barangays in the municipality of Solsona in Ilocos Norte, Manalpac is projected to have the highest percentage of area that will experience flood levels at 6.87%. Meanwhile, Nalasin posted the second highest percentage of area that may be affected by flood depths at 6.08%.

Among the barangays in the municipality of Vintar in Ilocos Norte, Mabanbanag is projected to have the highest percentage of area that will experience flood levels at 1.39%. Meanwhile, Ester posted the second highest percentage of area that may be affected by flood depths at 1.31%.

Moreover, the generated flood hazard maps for the Laoag Floodplain were used to assess the vulnerability of the educational and medical institutions in the floodplain. Using the flood depth units of PAGASA for hazard maps - "Low", "Medium", and "High" - the affected institutions were given their individual assessment for each Flood Hazard Scenario (5 yr, 25 yr, and 100 yr).

Table 126.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	82.83	75.16	62.70
Medium	107.54	117.52	107.25
High	122.48	179.65	238.11
TOTAL	**312.85**	**372.33**	**408.06**

Of the 231 identified educational institutions in the Laoag floodplain, two schools were assessed to be highly prone to flooding as they are exposed to the High level flooding for all three rainfall scenarios. These are the Sarrat National High School in Brgy. San Nicolas and Solsona National High School in Brgy Bagbag. Six other institutions were found to be also susceptible to flooding, experiencing Medium level flooding in the 5-year return period, and High level flooding in the 25- and 100-year rainfall scenarios. See Appendix 12 for a detailed enumeration of schools in the Laoag floodplain.

34 medical institutions were identified in the Laoag floodplain. Barabar Mothering Center was found to be prone to flooding, having Medium level flooding in the 5-year rain return period and High level flooding the other two rainfall scenarios. See Appendix 13 for a detailed enumeration of hospitals and clinics in the Laoag floodplain.

5.11 Flood Validation

In order to check and validate the extent of flooding in different river systems, validation survey work was done. Field personnel gathered secondary data regarding flood occurrence in the area within the major river system in the Philippines.

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

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

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

The flood validation survey was conducted in December 2016. The flood validation consists of 489 points randomly selected all over the Laoag flood plain. It has an RMSE value of 1.34.

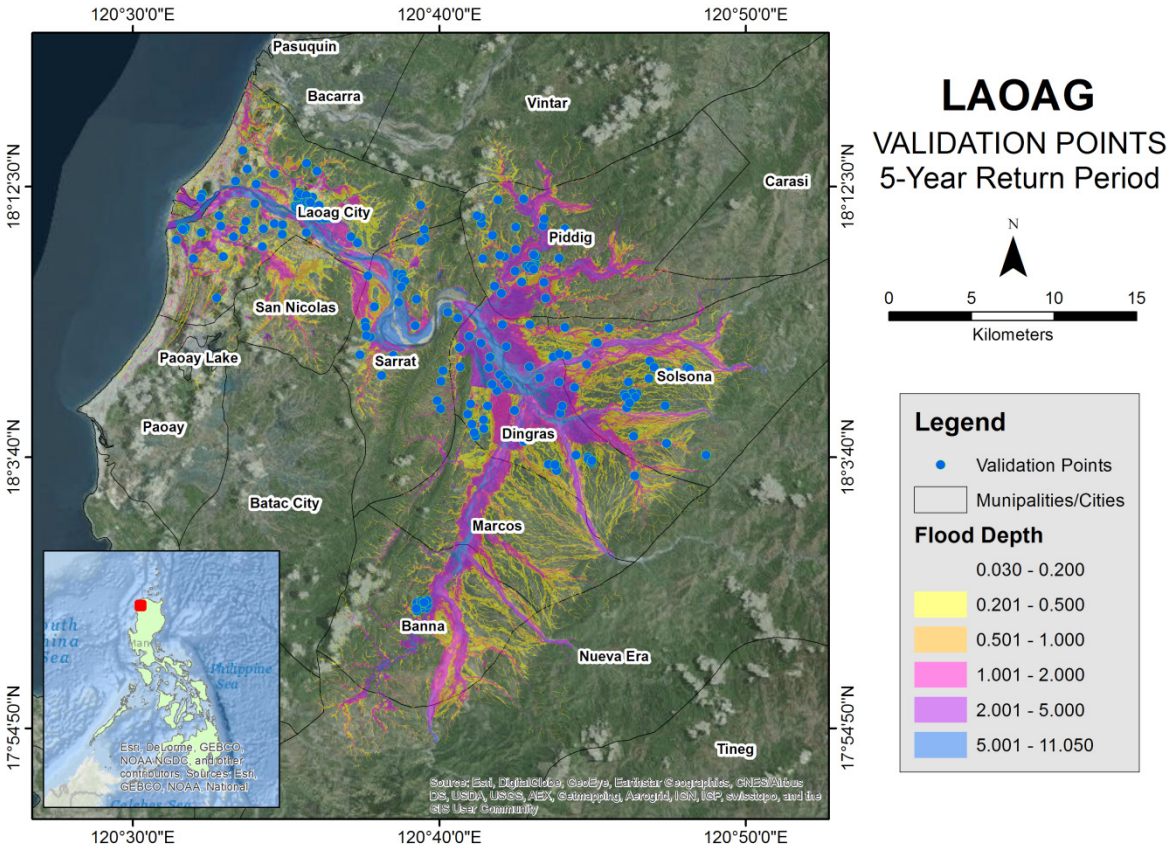

Figure 160. Flood Validation Points for Laoag River Basin

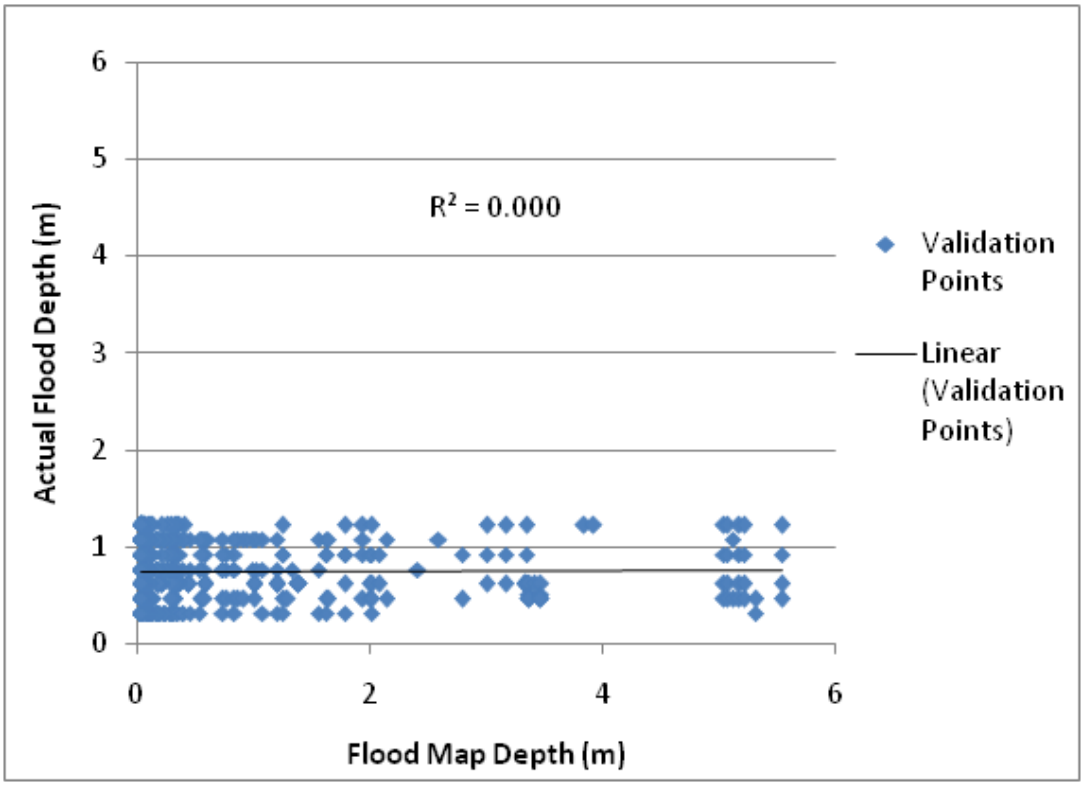

Figure 161.Flood Map Depth vs Actual Flood Depth for Laoag

Table 127.Actual Flood Depth vs Simulated Flood Depth in laoag

LAOAG 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	0	0	0	0	0	0	0
	0.21-0.50	81	18	11	13	8	8	139
	0.51-1.00	98	40	16	27	21	10	212
	1.01-2.00	78	23	12	11	8	6	138
	2.01-5.00	0	0	0	0	0	0	0
	> 5.00	0	0	0	0	0	0	0
	Total	257	81	39	51	37	24	489

The overall accuracy generated by the flood model is estimated at 9.20%, with 45 points correctly matching the actual flood depths. In addition, there were 179 points estimated one level above and below the correct flood depths while there were 161 points and 104 points estimated two levels above and below, and three or more levels above and below the correct flood depth. A total of 112 points were overestimated while a total of 332 points were underestimated in the modelled flood depths of Laoag.

Table 128.Summary of Accuracy Assessment in Laoag

	No. of Points	%
Correct	45	**9.20**
Overestimated	112	22.90
Underestimated	332	67.89
Total	489	100

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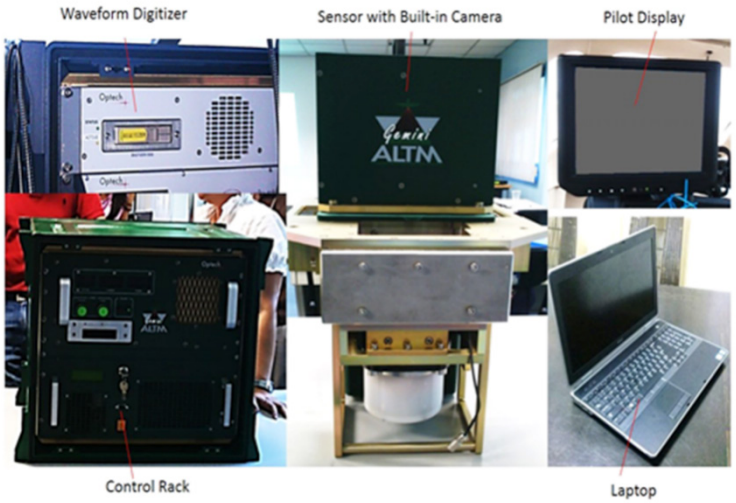
Sarmiento C., Paringit E.C., et al. 2014. *DREAM Data Acquisition Component Manual*. Quezon City, Philippines: UP Training Center for Applied Geodesy and Photogrammetry.

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

ANNEXES

ANNEX 1. Technical Specifications of the LiDAR Sensors Used in the Malaking Ilog Floodplain Survey

Table A-1.1 Technical Specifications of the LiDAR Sensors used in the Malaking Ilog Floodplain Survey



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

Table 2. NAMRIA Certification of Reference Points used in the LiDAR Survey

ILN-11

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

February 19, 2014

CERTIFICATION

To whom it may concern:

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

Province: **ILOCOS NORTE**
Station Name: **ILN-11**
Order: **2nd**

Island: **LUZON**
Municipality: **BATAC**
Barangay: **POBLACION**

PRS92 Coordinates

Latitude: **18° 3' 26.86785"** Longitude: **120° 33' 49.91547"** Ellipsoidal Hgt: **42.96000 m.**

WGS84 Coordinates

Latitude: **18° 3' 20.64552"** Longitude: **120° 33' 54.52048"** Ellipsoidal Hgt: **74.87400 m.**

PTM Coordinates

Northing: **1997176.225 m.** Easting: **453827.436 m.** Zone: **3**

UTM Coordinates

Northing: **1,998,122.81** Easting: **242,121.13** Zone: **51**

Location Description

ILN-11
Is situated on the rooftop of Batac Municipal Bldg. It is located near the E end corner of the upper rooftop, about 15 m. E of a small antenna tower. It is about 1.9 m. and 2.8 m. perpendicular distance from the N and E edge of the rooftop, respectively. Mark is the head of a 3" copper nail centered and embedded on top of a 22 cm. x 22 cm. cement putty set flushed on the cemented rooftop, with inscriptions "ILN-11, 2004, NAMRIA".

Requesting Party: **UP DREAM**
Pupose: **Reference**
OR Number: **8795394 A**
T.N.: **2014-352**

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

9902192014140833

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

ILN-16

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

February 26, 2014

CERTIFICATION

To whom it may concern:

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

Province: **ILOCOS NORTE**
Station Name: **ILN-16**
Order: **2nd**

Island: **LUZON**
Municipality: **BACARRA**
Barangay: **POBLACION**

PRS92 Coordinates

Latitude: **18° 15' 10.11635"** Longitude: **120° 36' 24.06955"** Ellipsoidal Hgt: **22.50000 m.**

WGS84 Coordinates

Latitude: **18° 15' 3.85580"** Longitude: **120° 36' 28.65812"** Ellipsoidal Hgt: **53.87800 m.**

PTM Coordinates

Northing: **2018785.646 m.** Easting: **458407.057 m.** Zone: **3**

UTM Coordinates

Northing: **2,019,690.45** Easting: **246,937.75** Zone: **51**

Location Description

ILN-16
From the Bacarra Municipal Hall Bldg., proceed to Bacarra Central Elem. School about 50 m. SW. Station is situated near the SW corner of the boundary lot of the school. It is 4 m. and 4.75 m. perpendicular distance from its W and S wall fence, respectively. Mark is the head of a 3" copper nail ceneterd and embedded on top of a 25 cm. x 25 cm. concrete monument set 5 cm. protruding above the ground surface, with inscriptions "ILN-16, 2004, NAMRIA".

Requesting Party: **UP DREAM**
Pupose: **Reference**
OR Number: **8795440 A**
T.N.: **2014-392**

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

9902262014143419

CIP/4701/12/09/814

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ILN-17

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

March 25, 2014

CERTIFICATION

To whom it may concern:

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

Province: **ILOCOS NORTE**
Station Name: **ILN-17**
Order: **2nd**

Island: **LUZON**
Municipality: **PASUQUIN**
Barangay: **POBLACION**

PRS92 Coordinates

Latitude: **18° 20' 6.62958"** Longitude: **120° 37' 1.30945"** Ellipsoidal Hgt: **16.73900 m.**

WGS84 Coordinates

Latitude: **18° 20' 0.35240"** Longitude: **120° 37' 5.89113"** Ellipsoidal Hgt: **47.87100 m.**

PTM Coordinates

Northing: **2027898.996 m.** Easting: **459520.118 m.** Zone: **3**

UTM Coordinates

Northing: **2,028,794.85** Easting: **248,151.17** Zone: **51**

Location Description

ILN-17
From Laoag City, travel N for about 17 km. up to Pasuquin Mun. Hall. Station is located about 70 m. S of the mun. hall, about 40 Km. W of the church main entrance, about 30 m. SW of Rizal monument, about 14 m. SW of a kiosk and about 9 m. E of the SE corner of Pasuquin Elem. School. It is on the SW corner of the concrete fence of the kiosk area located between the Rizal monument and the playground and 1.7 m. S of the 7th lightpost from the N. Mark is a 3 in. copper nail centered on a 27 cm. x 27 cm. concrete block and flushed with the ground surface, with inscriptions "ILN-17 2004 NAMRIA".

Requesting Party: **UP DREAM**
Pupose: **Reference**
OR Number: **8795829 A**
T.N.: **2014-648**

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

9903252014114317

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ISO 9001: 2008 CERTIFIED FOR MAPPING AND GEOSPATIAL INFORMATION MANAGEMENT

ILN-3234

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

February 19, 2014

CERTIFICATION

To whom it may concern:

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

Province: **ILOCOS NORTE**
Station Name: **ILN-3234**
Order: **4th**

Island: **LUZON**
Municipality: **BATAC**
Barangay: **QUILING SUR**

PRS92 Coordinates

Latitude: **18° 3' 41.82025"** Longitude: **120° 32' 50.31072"** Ellipsoidal Hgt: **22.63200 m.**

WGS84 Coordinates

Latitude: **18° 3' 35.59528"** Longitude: **120° 32' 54.91553"** Ellipsoidal Hgt: **54.49200 m.**

PTM Coordinates

Northing: **1997640.111 m.** Easting: **452075.694 m.** Zone: **3**

UTM Coordinates

Northing: **1,998,605.86** Easting: **240,373.73** Zone: **51**

Location Description

ILN-3234
Is located at Brgy. Quiling, Mun. of Batac, inside the Mariano Marcos Memorial State University. It is situated about 50 m. S of the admin. bldg. and 10 m. NW of the Mariano Marcos monument. Mark is the head of a 4 in. copper nail centered and embedded on a 20 cm. x 20 cm. concrete monument, with inscriptions "ILN-3234 2007 NAMRIA".

Requesting Party: **UP DREAM**
Pupose: **Reference**
OR Number: **8795394 A**
T.N.: **2014-351**

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

9902192014140752

CIP/4701/12/09/814

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www.namria.gov.ph

ILN-3302

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

March 04, 2014

CERTIFICATION

To whom it may concern:

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

Province: **ILOCOS NORTE**
Station Name: **ILN-3302**
Order: **4th**

Island: **LUZON**
Municipality: **VINTAR**
Barangay: **SAN NICOLAS (POB.)**

PRS92 Coordinates

Latitude:	**18° 13' 22.82114"**	Longitude:	**120° 38' 50.91391"**	Ellipsoidal Hgt:	**37.53500 m.**

WGS84 Coordinates

Latitude:	**18° 13' 16.56953"**	Longitude:	**120° 38' 55.50479"**	Ellipsoidal Hgt:	**69.10800 m.**

PTM Coordinates

Northing:	**2015478.316 m.**	Easting:	**462714.303 m.**	Zone:	**3**

UTM Coordinates

Northing:	**2,016,334.86**	Easting:	**251,210.34**	Zone:	**51**

Location Description

ILN-3302
From Laoag City Proper, travel N for about 6 km. and turn right before reaching the bridge at Km. Post No. 493. Then continue traveling for another 5 km. to reach Brgy. San Nicolas, Mun. of Vintar. Station is located along the brgy. road, 400 m. SE of the new public market. It is also about 4 m. from the prov'l. road centerline and about 300 m. SE of station ILN-15 (BBM No. 8). Mark is the head of a 4 in. copper nail centered and embedded on a 20 cm. x 20 cm. concrete monument, with inscriptions "ILN-3302 2007 NAMRIA".

Requesting Party:	**UP-DREAM**
Pupose:	**Reference**
OR Number:	**8795470 A**
T.N.:	**2014-437**

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

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

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CIP/4701/12/09/814

ANNEX 3. BASELINE PROCESSING REPORTS OF REFERENCE POINTS USED

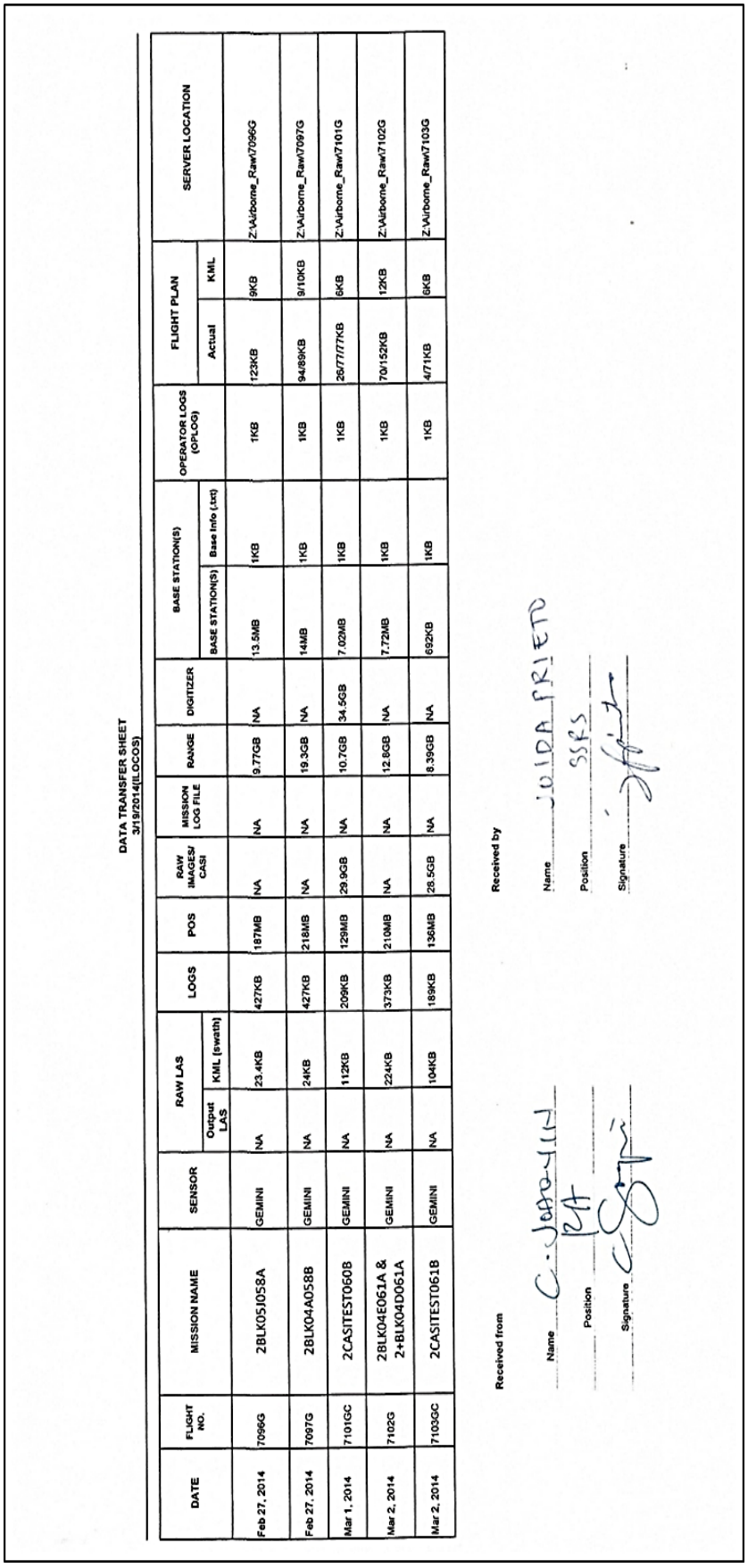
Annex 4. The LiDAR Survey Team Composition

Table A-4.1. The 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 S. 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)	ENGR. LOVELYN ASUNCION	UP TCAGP
	Supervising Science Research Specialist (Supervising SRS)	LOVELY GRACIA ACUNA	UP TCAGP
FIELD TEAM			
LiDAR Operation	Senior Science Research Specialist (SSRS)	AUBREY PAGADOR	UP-TCAGP
	RA	MA. VERLINA TONGA	UP-TCAGP
	RA	MARY CATHERINE ELIZABETH BALIGUAS	UP-TCAGP
Ground Survey, Data Download and Transfer	RA	ENGR. IRO NIEL ROXAS	UP-TCAGP
LiDAR Operation	Airborne Security	DIOSCORO SOBERANO	PILIPPINE AIR FORCE (PAF)
	Pilot	CAPT. RAUL CZ SAMAR	ASIAN AEROSPACE CORPORATION (AAC)
		CAPT. CESAR SHERWIN ALFONSO III	AAC

Annex 5. Data Transfer Sheet for the Laoag Floodplain

Table A-5.1. Data Transfer Sheet for the Laoag Floodplain



DATA TRANSFER SHEET
3/13/2014(ILOCOS)

DATE	FLIGHT NO.	MISSION NAME	SENSOR	RAW LAS		LOGS	POS	RAW IMAGES/ CASI	MISSION LOG FILE	RANGE	DIGITIZER	BASE STATION(S)		OPERATOR LOGS (OPLOG)	FLIGHT PLAN		SERVER LOCATION
				Output LAS	KML (swath)							BASE STATION(S)	Base Info (.txt)		Actual	KML	
Feb 27, 2014	7096G	2BLK05J058A	GEMINI	NA	23.4KB	427KB	187MB	NA	NA	9.77GB	NA	13.5MB	1KB	1KB	123KB	9KB	Z:\Airborne_Raw\7096G
Feb 27, 2014	7097G	2BLK04A058B	GEMINI	NA	24KB	427KB	218MB	NA	NA	19.3GB	NA	14MB	1KB	1KB	94/89KB	9/10KB	Z:\Airborne_Raw\7097G
Mar 1, 2014	7101GC	2CASITEST060B	GEMINI	NA	112KB	209KB	129MB	29.9GB	NA	10.7GB	34.5GB	7.02MB	1KB	1KB	26/77/77KB	6KB	Z:\Airborne_Raw\7101G
Mar 2, 2014	7102G	2BLK04E061A & 2+BLK04D061A	GEMINI	NA	224KB	373KB	210MB	NA	NA	12.8GB	NA	7.72MB	1KB	1KB	70/152KB	12KB	Z:\Airborne_Raw\7102G
Mar 2, 2014	7103GC	2CASITEST061B	GEMINI	NA	104KB	189KB	136MB	28.5GB	NA	8.39GB	NA	692KB	1KB	1KB	4/71KB	6KB	Z:\Airborne_Raw\7103G

Received from

Name C. Jaranilla

Position PAT

Signature

Received by

Name JOIDA FRIETO

Position SSRS

Signature

DATA TRANSFER SHEET ILOCOS
4/25/2014(~~Albay-sorsogon~~)

DATE	FLIGHT NO.	MISSION NAME	SENSOR	RAW LAS		LOGS	POS	RAW IMAGES/ CASI	MISSION LOG FILE	RANGE	DIGITIZER	BASE STATION(S)		OPERATOR LOGS (OPLOG)	FLIGHT PLAN		SERVER LOCATION
				Output LAS	KML (swath)							BASE STATION(S)	Base Info (.txt)		Actual	KML	
2/21/2014	7085G	2BLK05G052A	GEMINI	NA	180	330	158	N/A	N/A	13.9	N/A	11.6	200	639	44.8	6.91	Z:\Airborne_Raw\7085G
2/22/2014	7086G	2BLK05H053A	GEMINI	NA	81	522	227	N/A	N/A	27.5	N/A	12.9	179	327	408	8.7	Z:\Airborne_Raw\7086G
2/22/2014	7087G	2BLK05GS+F053B	GEMINI	NA	98.3	601	247	N/A	N/A	26.2	N/A	12.3	179	586	366	12.2	Z:\Airborne_Raw\7087G
2/23/2014	7088G	2BLK05FS+E054A	GEMINI	NA	77.2	467	211	N/A	N/A	21.2	N/A	11.2	163	749	201	12.1	Z:\Airborne_Raw\7088G
2/23/2014	7089G	2BLK05I054B	GEMINI	NA	191	349	199	N/A	N/A	15	N/A	10.7	163	372	263	9.53	Z:\Airborne_Raw\7089GG

Received from

Name CHRIS JUATONGCO
Position RA
Signature

Received by

Name JOIDA F. PRIETO
Position SSRS
Signature
04/25/14

DATA TRANSFER SHEET
Ilocos

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	
na	7090G	na	GEMIN	NA	na	na	na	na	na	8.11	na	na	1KB	1KB	na	na	Z:\DAC\RAW DATA
na	7091G	na	GEMIN	NA	na	na	na	na	na	15.8	na	na	1KB	1KB	na	na	Z:\DAC\RAW DATA
25-Feb-14	7092G	2BLK05DS+K056A	GEMIN	NA	41	336	199	na	na	11.8	na	13	1KB	1KB	5/7	1	Z:\DAC\RAW DATA
25-Feb-14	7093G	2BLK05C&A056B	GEMIN	NA	29	374	197	na	na	13	na	13.3	1KB	1KB	2/4	6/5	Z:\DAC\RAW DATA
26-Feb-14	7094G	2BLK05B+05AS+04F057A	GEMIN	NA	31	474	231	na	na	15.1	na	11.4	1KB	1KB	6/3/2/5	1	Z:\DAC\RAW DATA
	7095G		GEMIN	NA	15	242	143	na	na	7.76	na	11.5	1KB	1KB	6	12	Z:\DAC\RAW DATA

Received from

Name
Position
Signature

Received by

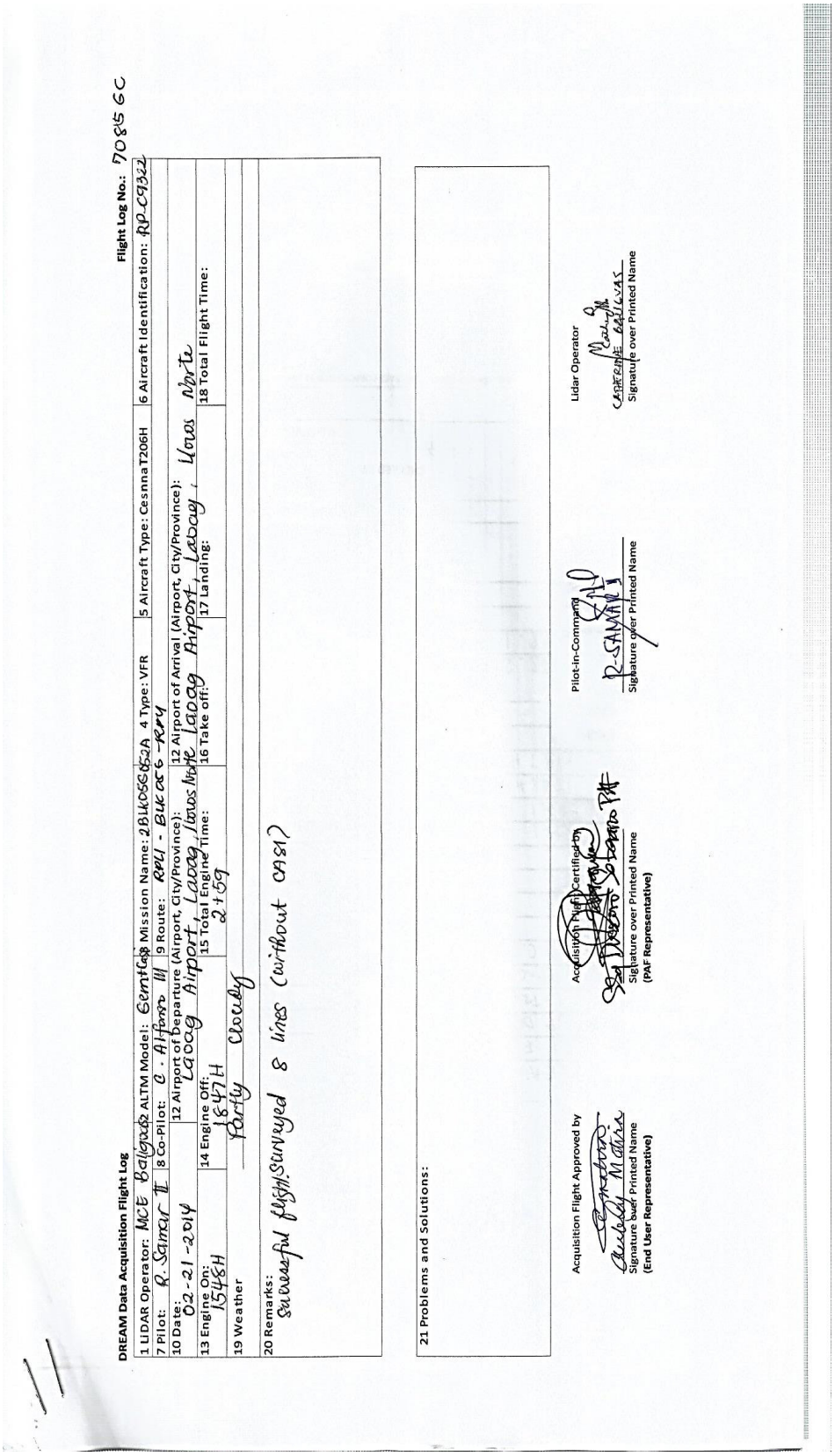
Name
Position
Signature 7/28/15

15-21

ANNEX 6. Flight Logs for the Flight Missions

Table A-6.1. Flight Logs for the Flight Missions

1. Flight Log for 2BLK05G052A Mission



DREAM Data Acquisition Flight Log

Flight Log No.: 7085 CC

1 LiDAR Operator: MCE Balgoa	2 ALTM Model: Gemini	3 Mission Name: 2BLK05G052A	4 Type: VFR	5 Aircraft Type: Cessna T206H	6 Aircraft Identification: RP-C9322
7 Pilot: R. Samar II	8 Co-Pilot: C. Alfaro III	9 Route: RMJ - Bulacan - RMJ			
10 Date: 02-21-2019	11 Airport of Departure (Airport, City/Province): Laoag Airport, Laoag, Ilocos Norte		12 Airport of Arrival (Airport, City/Province): Laoag Airport, Laoag, Ilocos Norte		
13 Engine On: 1548H	14 Engine Off: 1847H	15 Total Engine Time: 2.59	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: Partly Cloudy					

20 Remarks: Successful flight. Surveyed 8 lines (without CAS1)

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
R-SAMAR II
Signature over Printed Name

Lidar Operator
CARLENE BALGOA
Signature over Printed Name

2. Flight Log for 2BLK05H053A Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 7086 ec

1 LIDAR Operator: MVE Tonog	2 ALTM Model: Gemini	3 Mission Name: 2BLK05H053A	4 Type: VFR
5 Aircraft Type: Cessna T206H	6 Aircraft Identification: RP-C9322		
7 Pilot: R. Samar II	8 Co-Pilot: C. Alfonso III	9 Route: RPU ~ Bikolso ~ RPU	
10 Date: 02-22-2014	11 Airport of Departure (Airport, City/Province): Laoag Int'l Airport, Laoag City, Ilocos Norte	12 Airport of Arrival (Airport, City/Province): Laoag Int'l Airport, Laoag City, Ilocos Norte	
13 Engine On: 0918 H	14 Engine Off: 1311 H	15 Total Engine Time: 3+53	16 Take off:
17 Landing	18 Total Flight Time:		
19 Weather: windy			

20 Remarks: successful flight; mission accomplished (without GPS)

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

R-SAMAR II

Signature over Printed Name

Lidar Operator

Ma. Verna C. Perez

Signature over Printed Name

3. Flight Log for 2BLK05GS053B & 2BLK05F053B Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 20876C

1 LiDAR Operator: MCE Baliguas	2 ALTM Model: Gemini	3 Mission Name: 2BLK05GSF053B	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: RP-C9322
7 Pilot: R. Samar II	8 Co-Pilot: C. Alfonso III	9 Route: RPLV-BLK 05G-RPLV			
10 Date: 02-22-2014	12 Airport of Departure (Airport, City/Province): Laoag Int'l Airport, Laoag City, Ilocos Norte		12 Airport of Arrival (Airport, City/Province): Laoag Int'l Airport, Laoag City, Ilocos Norte		
13 Engine On: 1416H	14 Engine Off: 1833H	15 Total Engine Time: 4+17	16 Take-off:	17 Landing:	18 Total Flight Time:
19 Weather: windy					
20 Remarks: successful flight, computed area of BLK05G and surveyed 8 lines of BLK05F (without CASI)					
21 Problems and Solutions:					

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Aubrey Matira	SSg Dioscoro Soterano PAF	R. Samar II	Catherine Baliguas
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

4. Flight Log for 2BLKFS054A & 2BLKE054A Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 7088GC

1 LiDAR Operator: MCE Baliguas	2 ALTM Model: Gemini	3 Mission Name: 2BLK05FSE054A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-C9322
7 Pilot: R. Samar II	8 Co-Pilot: C. Alfonso III	9 Route: RPLI - BLKFS - RPLI			
10 Date: 02-23-2014	12 Airport of Departure (Airport, City/Province): Laoag Int'l Airport, Laoag City, Ilocos Norte		12 Airport of Arrival (Airport, City/Province): Laoag Int'l Airport, Laoag City, Ilocos Norte		
13 Engine On: 0920H	14 Engine Off: 1301H	15 Total Engine Time: 3+41	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: windy					
20 Remarks: successful flight; completed area of BLK05F and surveyed 7 lines of BLK05E (without CASI).					

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Aubrey Matira	Sgt Dioscoro Zozobrado PAF	R. Samar II	Catherine Baliguas
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

5. Flight Log for 2BLK05I054B Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 70896C

1 LiDAR Operator: MVE Tonga	2 ALTM Model: Gemini	3 Mission Name: 2BLK05I054B	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: RP-C9322
7 Pilot: R. Samar II	8 Co-Pilot: C. Alfonso III	9 Route: RPLI - BLK05I - RPLI			
10 Date: 02-23-2014	12 Airport of Departure (Airport, City/Province): Laoag Int'l Airport, Laoag City, Ilocos Norte		12 Airport of Arrival (Airport, City/Province): Laoag Int'l Airport, Laoag City, Ilocos Norte		
13 Engine On: 1420H	14 Engine Off: 1749H	15 Total Engine Time: 3+29	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: Windy					

20 Remarks:

Successful flight; surveyed 11 lines (w/o CASI)

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Antero Matira	SSgt Dioscoro Sabajano PAF	R. Samar II	MVE Tonga
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

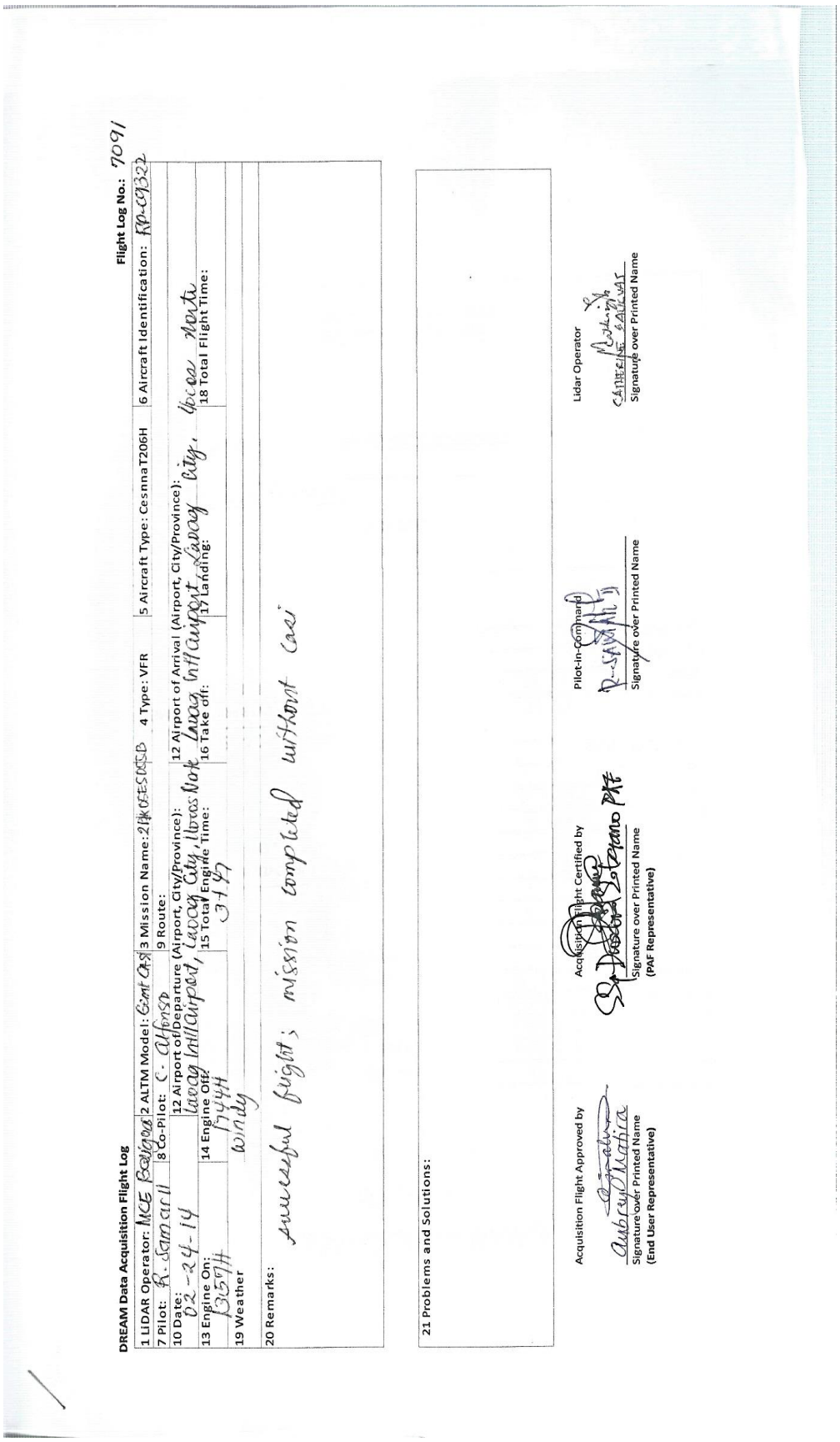
DREAM Data Acquisition Flight Log — **Flight Log No.:** 7090

1 LiDAR Operator: MVE Team	2 ALTM Model: Gemini	3 Mission Name: 2BLK05L055A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-C9322
7 Pilot: R. Samar II	8 Co-Pilot: C Alfonso III	9 Route:			
10 Date: 02-24-2014	12 Airport of Departure (Airport, City/Province): Laoag Int'l Airport, Laoag City, Ilocos Norte		12 Airport of Arrival (Airport, City/Province): Laoag Int'l Airport, Laoag City, Ilocos Norte		
13 Engine On: 0851H	14 Engine Off: 1144H	15 Total Engine Time: 2.53	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: windy					
20 Remarks: Successful flight's mission completed without CASI					

21 Problems and Solutions:

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

7. Flight Log for 2BLK05ES055B & 2BLK05D055B Mission



DREAM Data Acquisition Flight Log

Flight Log No.: 7091

1 LiDAR Operator: MCE Baligod	2 ALTM Model: Gemini	3 Mission Name: 2BLK05ES055B	4 Type: VFR
5 Aircraft Type: Cessna T206H	6 Aircraft Identification: RP-C9332		
7 Pilot: R. Samaniego	8 Co-Pilot: C. Alfonso	9 Route:	
10 Date: 02-24-14	12 Airport of Departure (Airport, City/Province): Laoag Int'l Airport, Laoag City, Ilocos Nor	12 Airport of Arrival (Airport, City/Province): Laoag Int'l Airport, Laoag City, Ilocos Norte	
13 Engine On: 1359H	14 Engine Off: 1744	15 Total Engine Time: 3+45	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: windy			

20 Remarks: successful flight; mission completed without case

21 Problems and Solutions:

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

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

Pilot-in-Command
Signature over Printed Name

Lidar Operator
Signature over Printed Name

8. Flight Log for 2BLK05DS056A & 2BLK05K056A Mission

DREAM Data Acquisition Flight Log 	Flight Log No.: 7092

1 LiDAR Operator: MCE BALIGUAS	2 ALTM Model: GEM + CASI	3 Mission Name: 2BLK05DS056A & 2BLK05K056A	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: 9322
7 Pilot: R. SAMAR III	8 Co-Pilot: C. ALFONSO III	9 Route:			
10 Date: 02-25-2014	12 Airport of Departure (Airport, City/Province): Laoag Int'l Airport, Laoag City, Ilocos Norte		12 Airport of Arrival (Airport, City/Province): Laoag Int'l Airport		
13 Engine On: 0941H	14 Engine Off: 1322H	15 Total Engine Time: 3+41	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather	partly cloudy				
20 Remarks: Mission completed (without casi)					

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Aubrey Matira	Sg Dearo Santarano PAF	R. SAMAR III	CATHERINE BALIGUAS
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

9. Flight Log for for 2BLK05C&A056B Mission

DREAM Data Acquisition Flight Log 2BLK05C056B R **Flight Log No.:** 7093

1 LiDAR Operator: MVE TONGA	2 ALTM Model: Gem + CASI	3 Mission Name: 2BLK05A056B	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: 9322
7 Pilot: R SAMAR II	8 Co-Pilot: C. ALFONSO III	9 Route:			
10 Date: 02-25-2014	12 Airport of Departure (Airport, City/Province): Laoag Int'l Airport, Laoag City, Ilocos Norte		12 Airport of Arrival (Airport, City/Province): Laoag Int'l Airport		
13 Engine On: 1457H	14 Engine Off: 1820H	15 Total Engine Time: 3+23	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: Partly cloudy					
20 Remarks: Mission completed (without casi)					

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Aubrey Matira	SSg Dosoro [illegible] PAF	R. SAMAR II	M. Tonga
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

10. Flight Log for 2BLK05B057A & 2BLK05AS05B & 2BLK04F057A Mission

DREAM Data Acquisition Flight Log — **Flight Log No.:** 7094

1 LiDAR Operator: MVE Tiwig	2 ALTM Model: Gem 4 CASI	3 Mission Name: 2BLK05B057A, 2BLK05AS05A, 2BLK04F057A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: 9322
7 Pilot: R. Samar II	8 Co-Pilot: C. Alfonso III	9 Route:			
10 Date: 02-26-2014	12 Airport of Departure (Airport, City/Province): RPLI		12 Airport of Arrival (Airport, City/Province): RPLI		
13 Engine On: 0850H	14 Engine Off: 1249H	15 Total Engine Time: 3159	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: Windy					

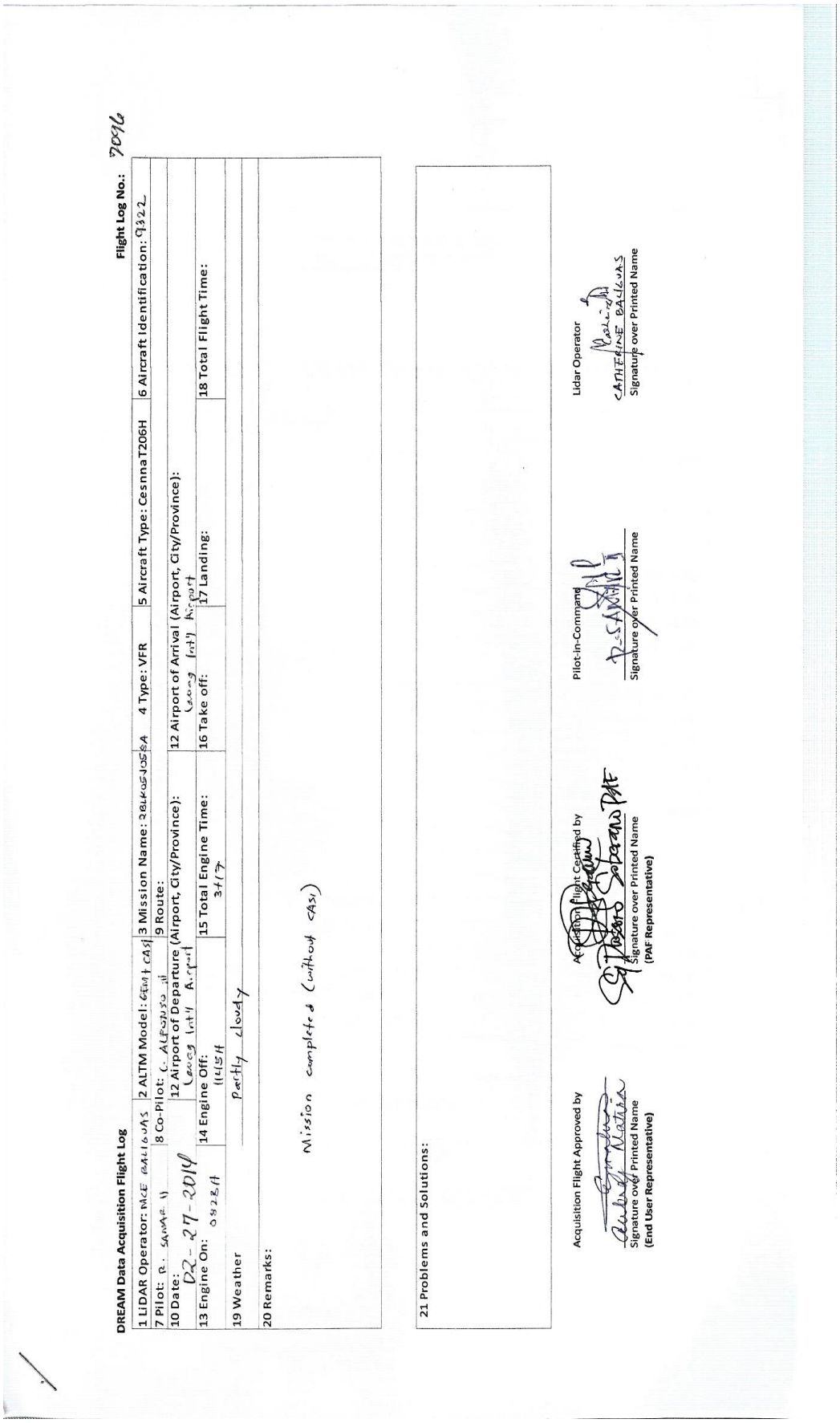
20 Remarks:

Blocks of 05A & 05B completed and surveyed 4 lines of BLK 04F (without CASI)

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Aubrey Matira	SSg Doscar Stagano PAF	R. Samar II	
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

11. Flight Log for 2BLK05J058A Mission



DREAM Data Acquisition Flight Log

Flight Log No.: 7096

1 LiDAR Operator: MCE BALLOMAS	2 ALTM Model: Gemini (ASI)	3 Mission Name: 2BLK05J058A	4 Type: VFR	5 Aircraft Type: CessnaT206H	6 Aircraft Identification: 9322
7 Pilot: R. SAMANIEGO	8 Co-Pilot: C. ALEGADO JR	9 Route:			
10 Date: 02-27-2014	11 Airport of Departure (Airport, City/Province): Laoag Int'l Airport		12 Airport of Arrival (Airport, City/Province): Laoag Int'l Airport		
13 Engine On: 0922H	14 Engine Off: 1145H	15 Total Engine Time: 3+17	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather	Partly cloudy				
20 Remarks:	Mission complete (without CASI)				
21 Problems and Solutions:					

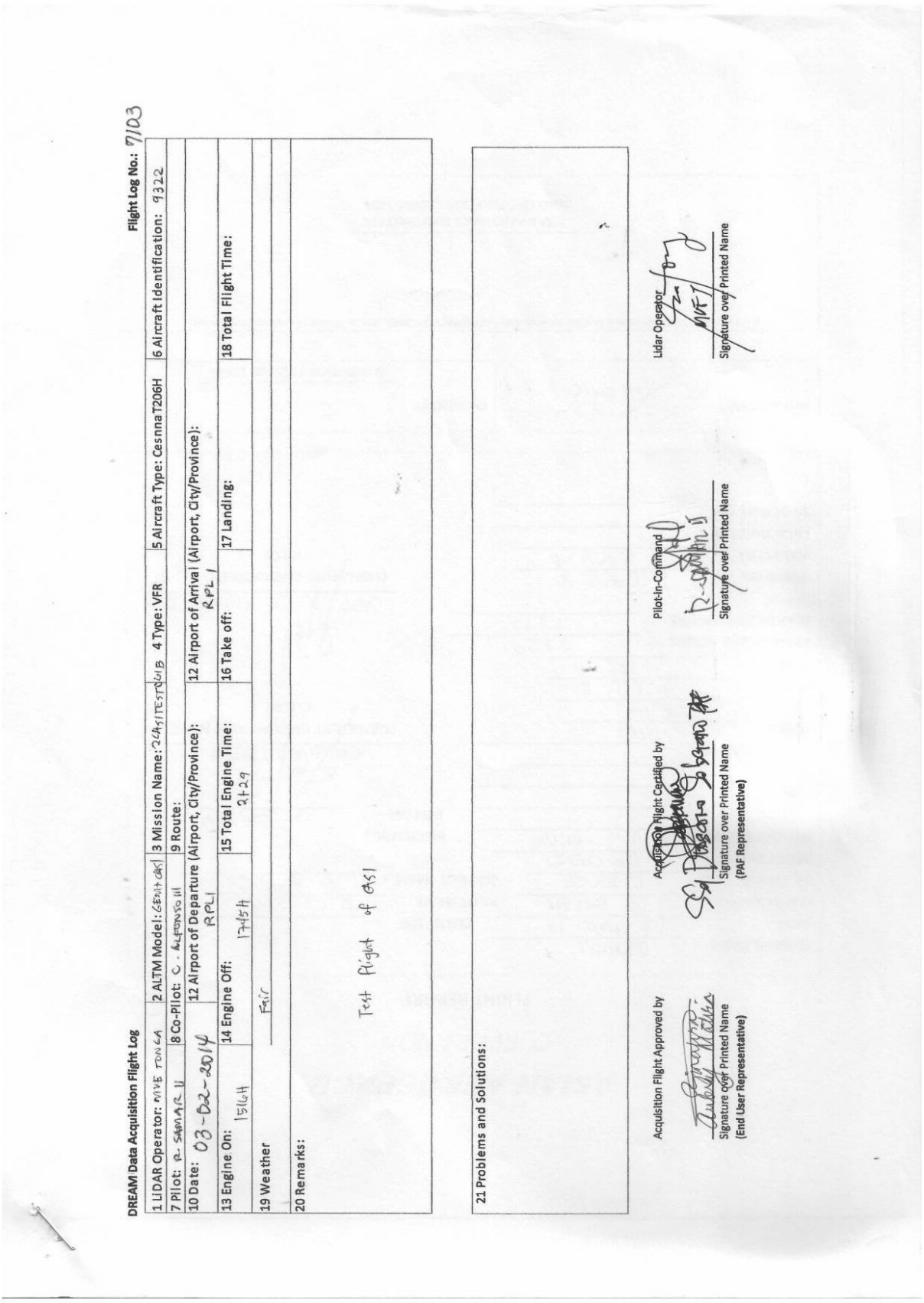
Acquisition Flight Approved by
Signature over Printed Name
(End User Representative)

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

Pilot-in-Command
Signature over Printed Name

Lidar Operator
CATHERINE BALLOMAS
Signature over Printed Name

12. Flight Log for 2CASITEST061B Mission



DREAM Data Acquisition Flight Log

Flight Log No.: 7103

1 LiDAR Operator: NIKE RONGA	2 ALTM Model: GEMINI ORS	3 Mission Name: 2CASITEST061B	4 Type: VFR	5 Aircraft Type: Cessna T206H	6 Aircraft Identification: 9322
7 Pilot: R. SAMAR II	8 Co-Pilot: C. ALFONSO III	9 Route:		
10 Date: 03-02-2014	11 Airport of Departure (Airport, City/Province): RPLI		12 Airport of Arrival (Airport, City/Province): RPLI	
13 Engine On: 1514H	14 Engine Off: 1745H	15 Total Engine Time: 2+29	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: Fair					
20 Remarks: Test Flight of CASI					
21 Problems and Solutions:					

Acquisition Flight Approved by

Signature over Printed Name
(End User Representative)

Acquisition Flight Certified by

Signature over Printed Name
(PAF Representative)

Pilot-In-Command

Signature over Printed Name

Lidar Operator

Signature over Printed Name

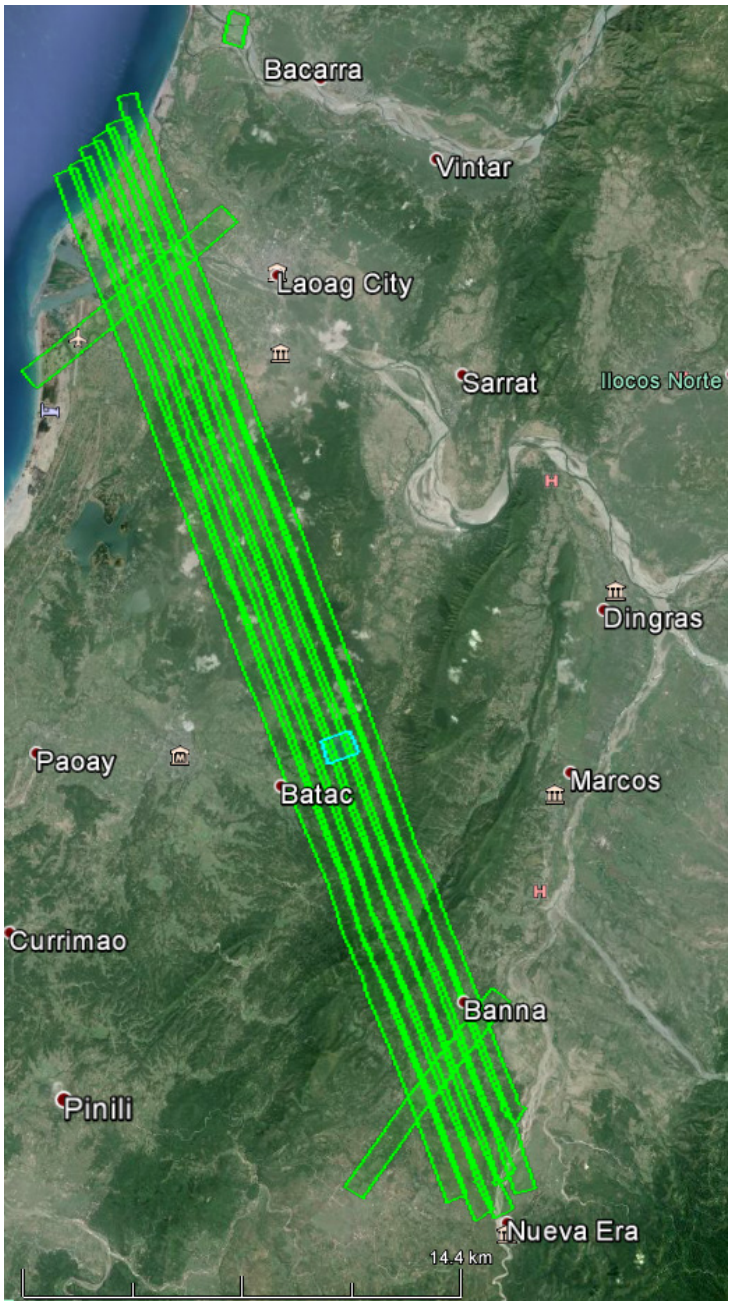
Annex 7. Flight Status Reports

Table A-7.1. Flight Status Reports

FLIGHT STATUS REPORT ILOCOS NORTE, ILOCOS SUR and ABRA (FEBRUARY 18 – MARCH 14, 2014)					
FLIGHT NO	**AREA**	**MISSION**	**OPERATOR**	**D A T E FLOWN**	**REMARKS**
7085	BLK05	2BLK05G052A	MCE BALIGUAS	21 FEB 14	Surveyed 8 line (without CASI)
7086	BLK05	2BLK05H053A	MVE TONGA	22 FEB 14	Mission completed (without CASI)
7087	BLK05	2BLK05GS053B & 2BLK05F053B	MCE BALIGUAS	22 FEB 14	Completed area of BLK05G and surveyed 8 lines at BLK05F (without CASI)
7088	BLK05	2BLKFS054A & 2BLKE054A	MCE BALIGUAS	23 FEB 14	Completed area of BLK05F and surveyed 7 lines at BLK05E (without CASI)
7089	BLK05	2BLK05I054B	MVE TONGA	23 FEB 14	Surveyed 11 lines (without CASI)
7090	BLK05	2BLK05L055A	MVE TONGA	24 FEB 14	Mission completed (without CASI)
7091	BLK05	2BLK05ES055B & 2BLK05D055B	MCE BALIGUAS	24 FEB 14	Mission completed (without CASI)
7092	BLK05	2BLK05DS056A & 2BLK05K056A	MCE BALIGUAS	25 FEB 14	Mission completed (without CASI)
7093	BLK05	2BLK05C056B & 2BLK05A056B	MVE TONGA	25 FEB 14	Mission completed (without CASI)
7094	BLK05 and BLK04	2BLK05B057A & 2BLK05AS057A & 2BLK04F057A	MVE TONGA	26 FEB 14	Blocks 05A and 05 B completed and surveyed 9 lines of BLK04F (without CASI)
7095	BLK04	2BLK04C057B	MCE BALIGUAS	26 FEB 14	Mission completed (without CASI)
7096	BLK05	2BLK05J058A	MCE BALIGUAS	27 FEB 14	Mission completed (without CASI)
7103	BLK05	2CASITEST061B	MVE TONGA	02 MAR 14	Test Flight of CASI

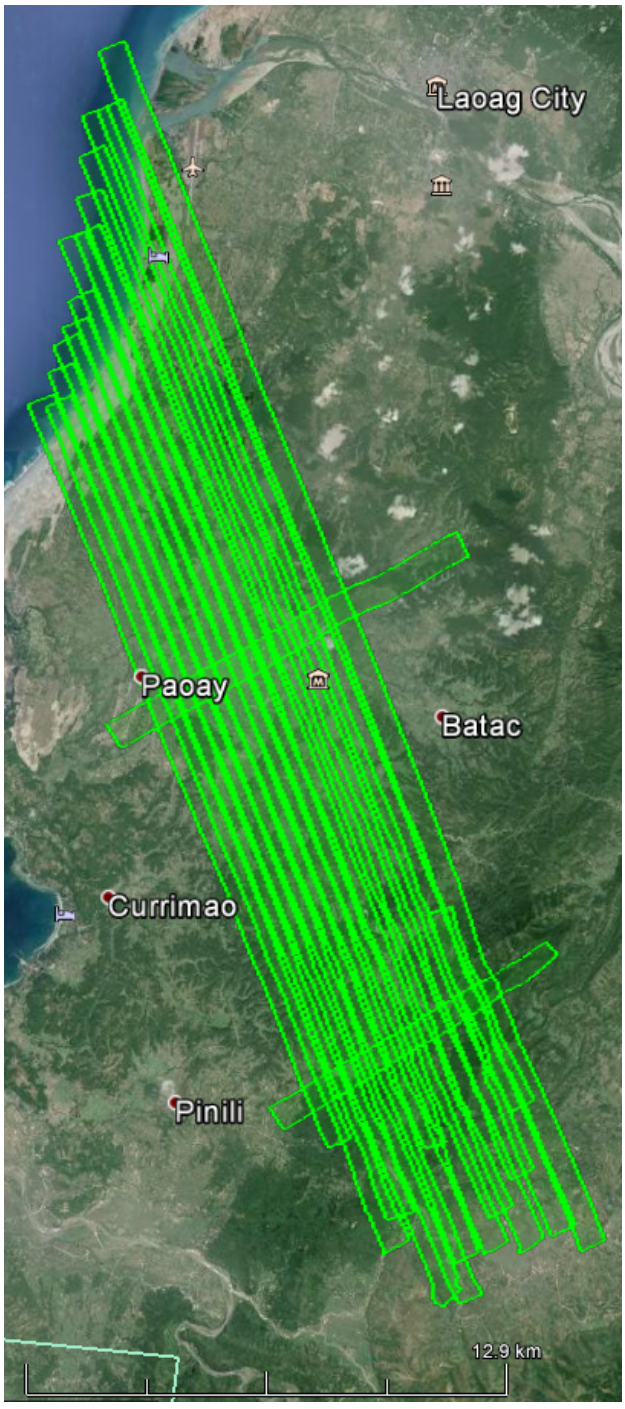
1. Swath Coverage for Mission 2BLK05G052A

Flight No. : 7085 G
Area: BLK05
Mission Name: 2BLK05G052A
Parameters: Altitude: 1000m ; Scan Frequency: 40Hz ; Scan angle: 20^{0}; Overlap: 25%



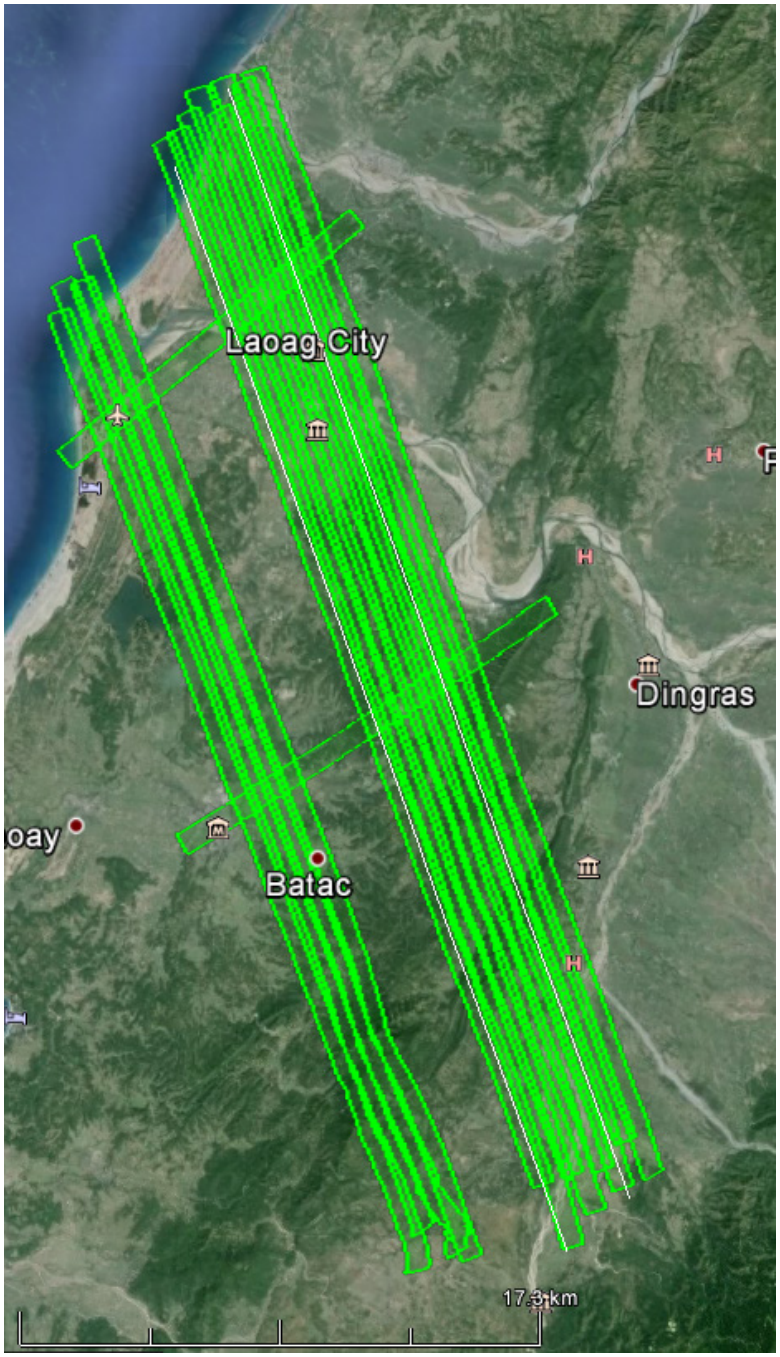
2. Swath Coverage for Mission 2BLK05H053A

Flight No. : 7086 G
Area: BLK05
Mission Name: 2BLK05H053A
Parameters: Altitude: 1000m; Scan Frequency: 50Hz; Scan angle: 20; Overlap: 45%



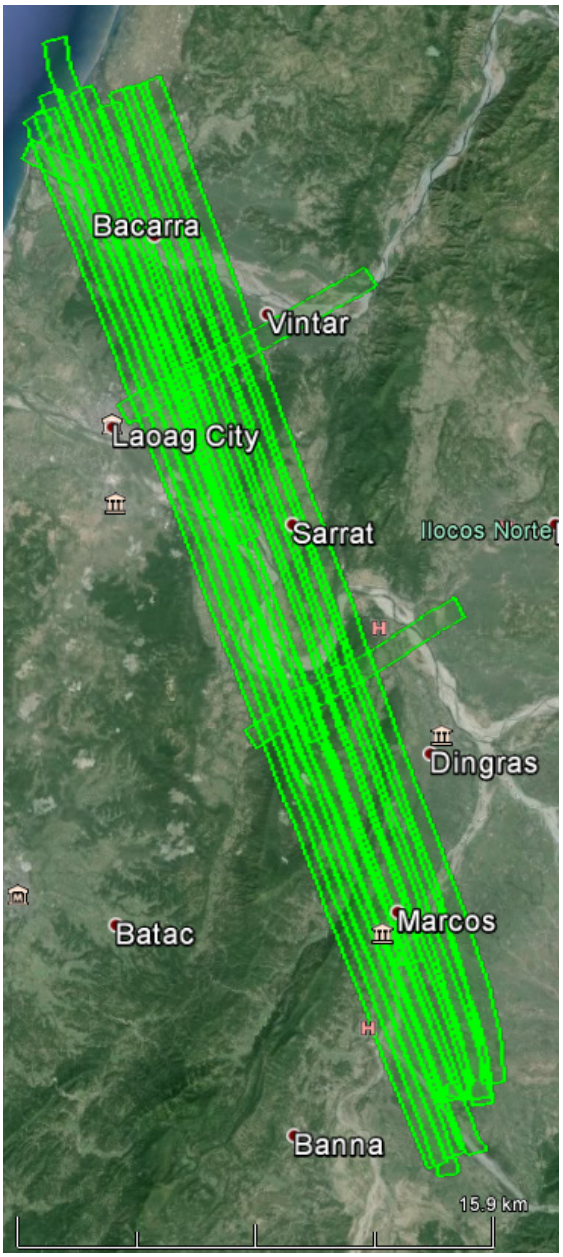
3. Swath Coverage for Mission 2BLK05GS053B & 2BLK05F053B

Flight No. : 7087 G
Area: BLK05
Mission Name: 2BLK05GS053B & 2BLK05F053B
Parameters: Altitude: 1000m; Scan Frequency: 50Hz; Scan angle: 20^{0}; Overlap: 30%



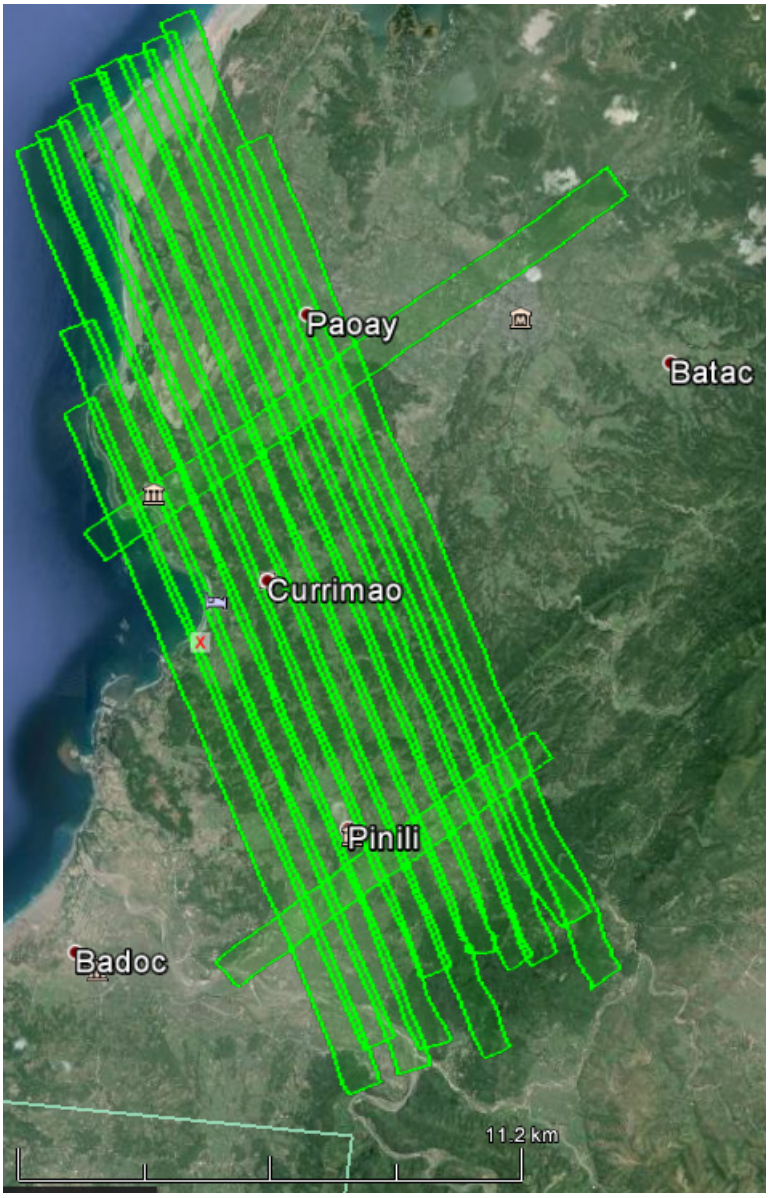
4. Swath Coverage for Mission 2BLK05FS053B & 2BLK05E054A

Flight No. : 7088 G
Area: BLK05
Mission Name: 2BLK05FS053B & 2BLK05E054A
Parameters: Altitude: 1000m; Scan Frequency: 50Hz; Scan angle: 20^{0}; Overlap: 25%



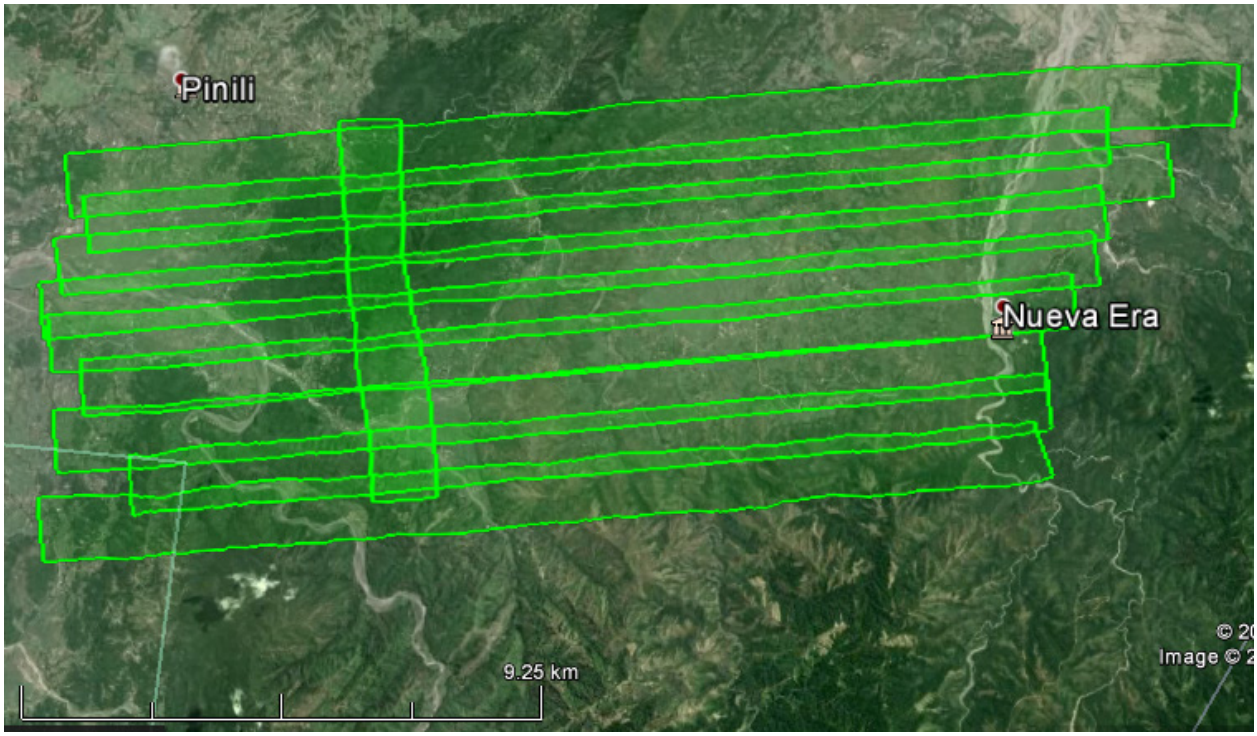
5. Swath Coverage for Mission 2BLK05I054B

Flight No. : 7089 G
Area: BLK05
Mission Name: 2BLK05I054B
Parameters: Altitude: 1000m; Scan Frequency: 50Hz; Scan angle: 20^{0}; Overlap: 45%



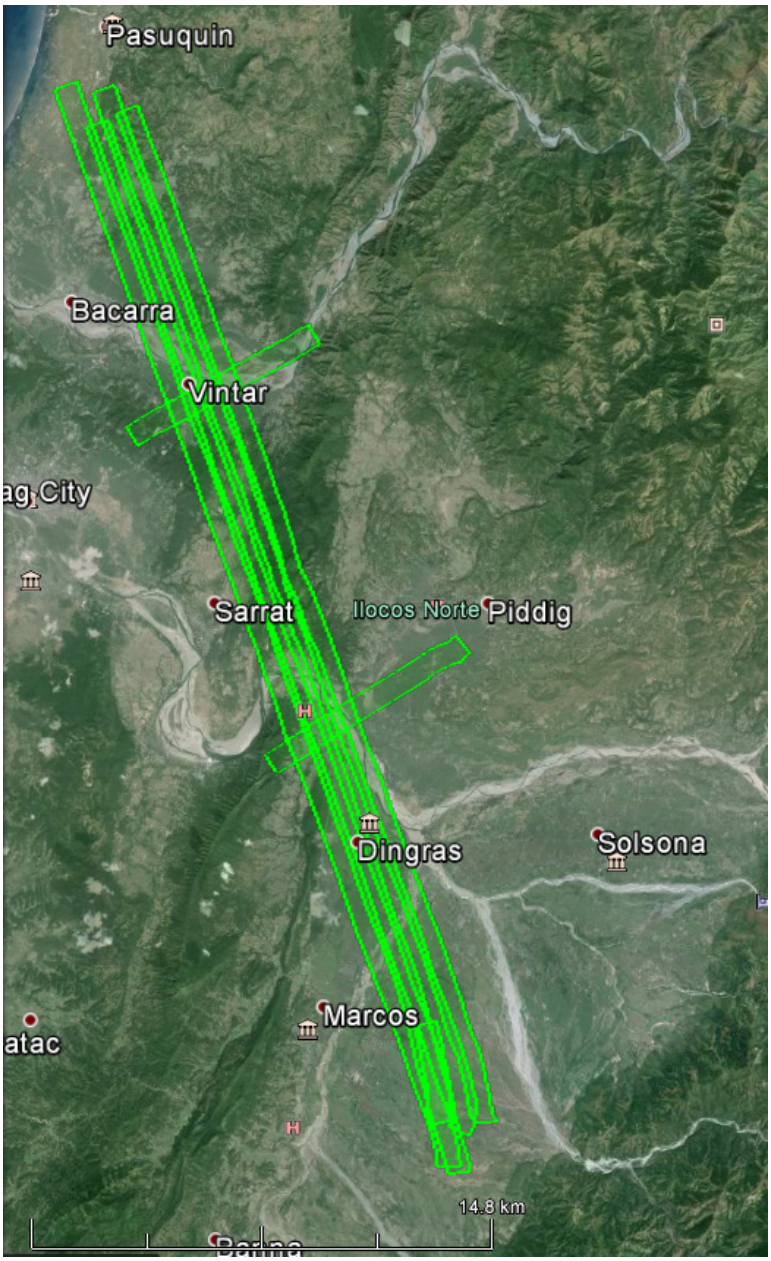
6. Swath Coverage for Mission 2BLK05L055A

Flight No. : 7090 G
Area: BLK05
Mission Name: 2BLK05L055A
Parameters: Altitude: 1350m; Scan Frequency: 50Hz; Scan angle: 20$^{\theta}$; Overlap: 30%

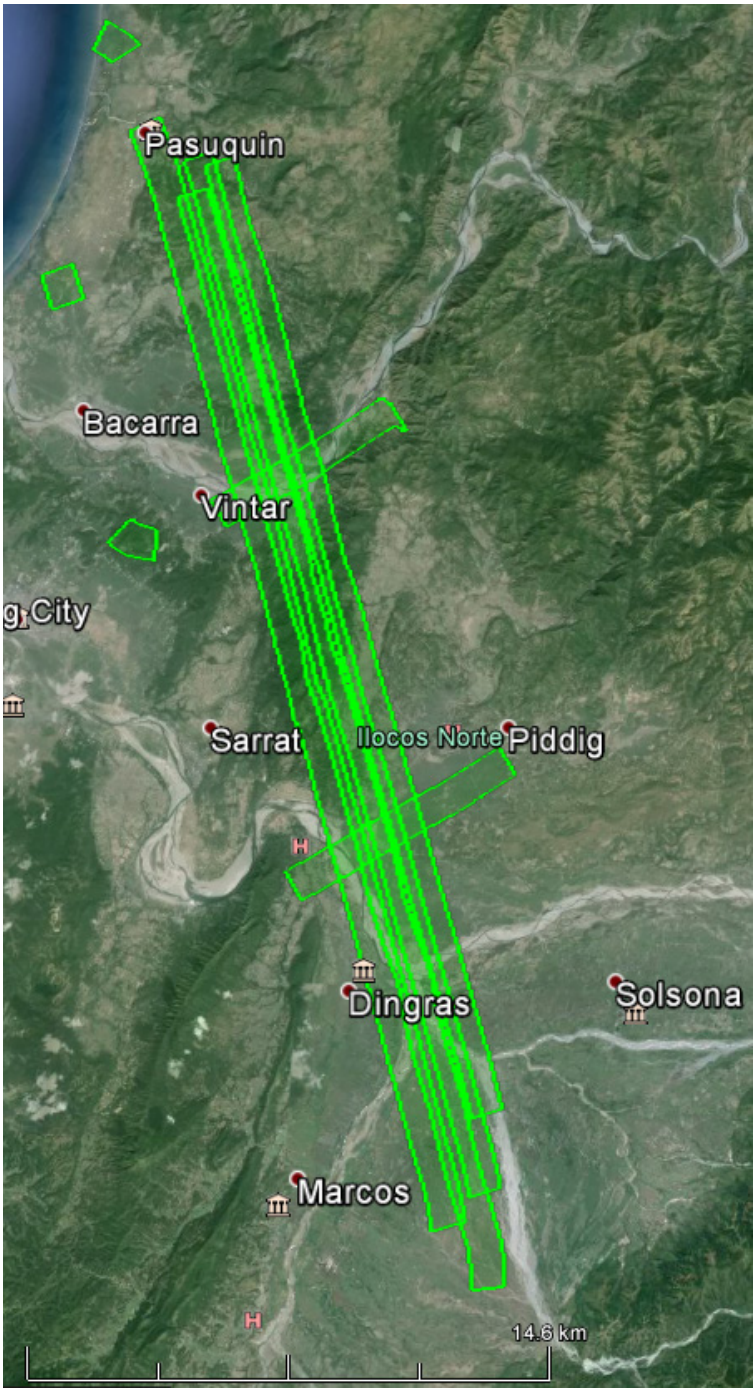


7. Swath Coverage for Mission 2BLK05ES055B & 2BLK05D055B

Flight No. : 7091 G
Area: BLK05
Mission Name: 2BLK05ES055B & 2BLK05D055B
2BLK05ES055B
Parameters: Altitude: 1000m; Scan Frequency: 50Hz; Scan angle: 20^{0}; Overlap: 25%

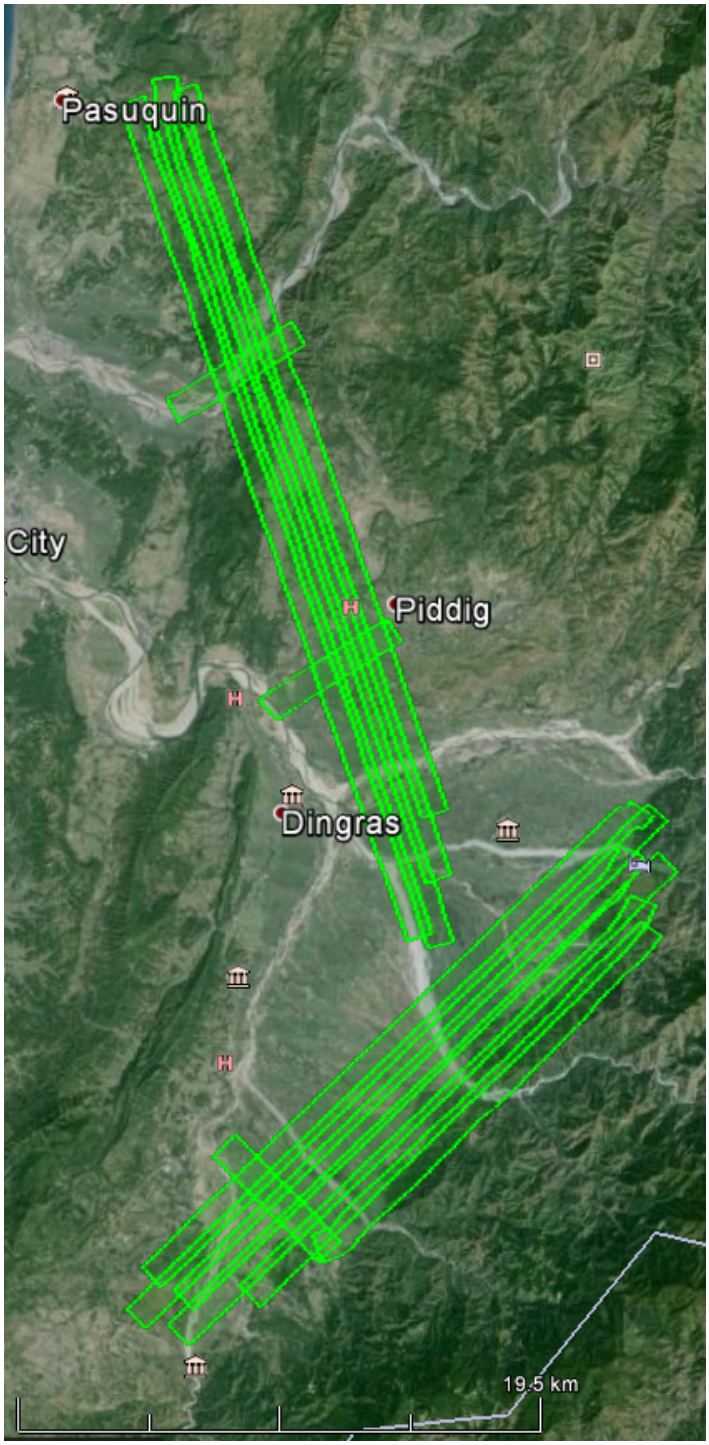


2BLK05D055B
Parameters: Altitude: 1400m; Scan Frequency: 50Hz; Scan angle: 20^{0}; Overlap: 30%



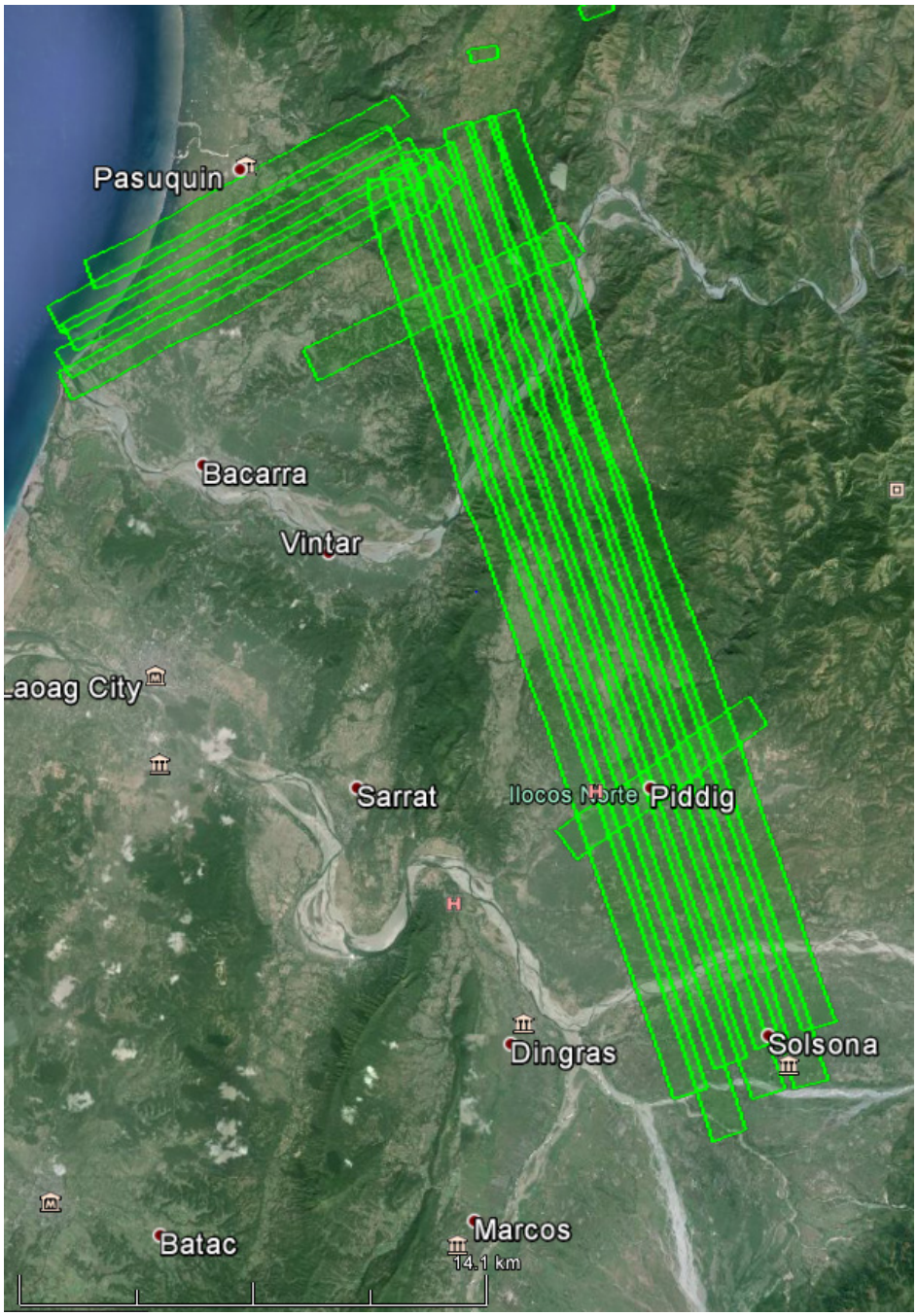
8. Swath Coverage for Mission 2BLK05DS056A & 2BLK05K056a

Flight No. : 7092 G
Area: BLK05
Mission Name: 2BLK05DS056A & 2BLK05K056a
Parameters:Altitude: 1500m to 1400m to 1300m; Scan Frequency: 50Hz; Scan angle: 20^{0}; Overlap: 30%



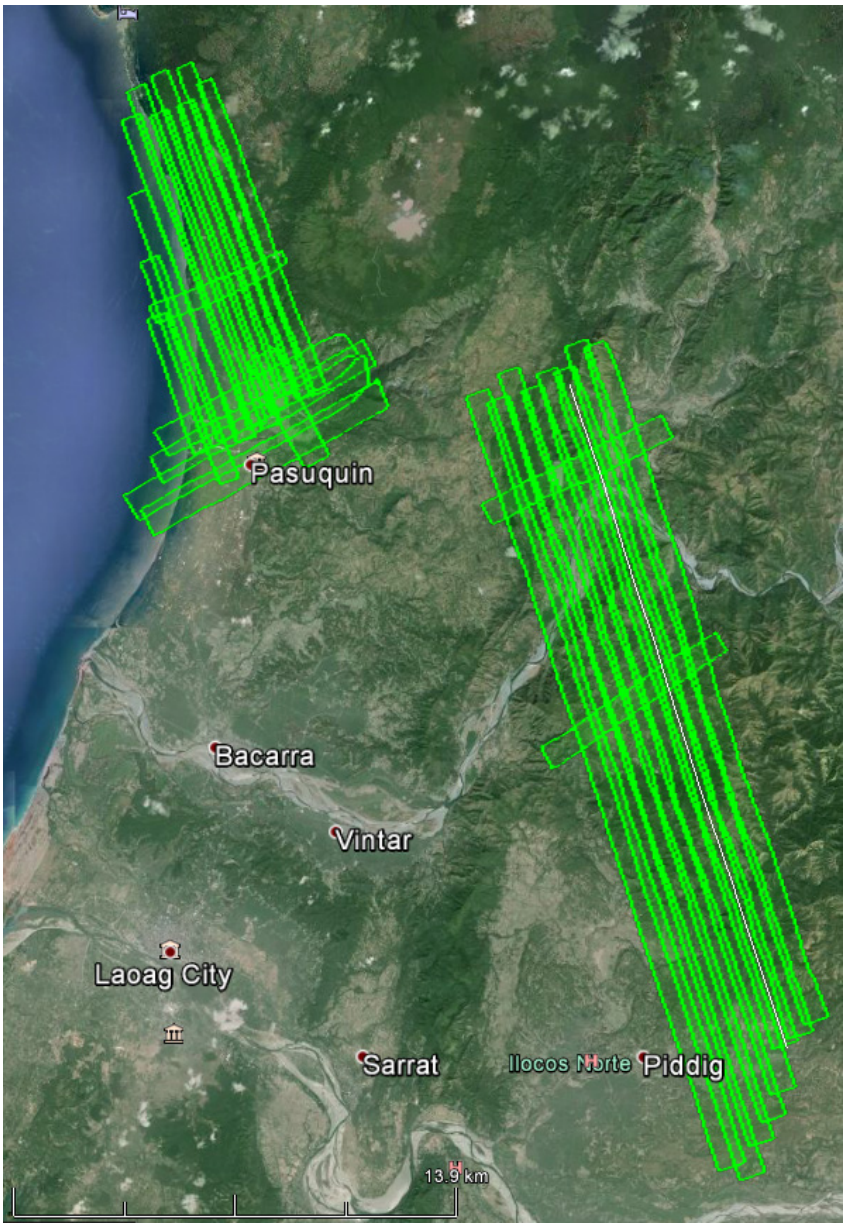
9. Swath Coverage for Mission 2BLK05C056B & 2BLK05A056B

Flight No. : 7093 G
Area: BLK05
Mission Name: 2BLK05C056B & 2BLK05A056B
Parameters: 2BLK05C056B
Altitude: 1400m; Scan Frequency: 50Hz; Scan angle: 20^{0}; Overlap: 30%
2BLK05A056B
Altitude: 1200m; Scan Frequency: 50Hz; Scan angle: 20^{0}; Overlap: 25%



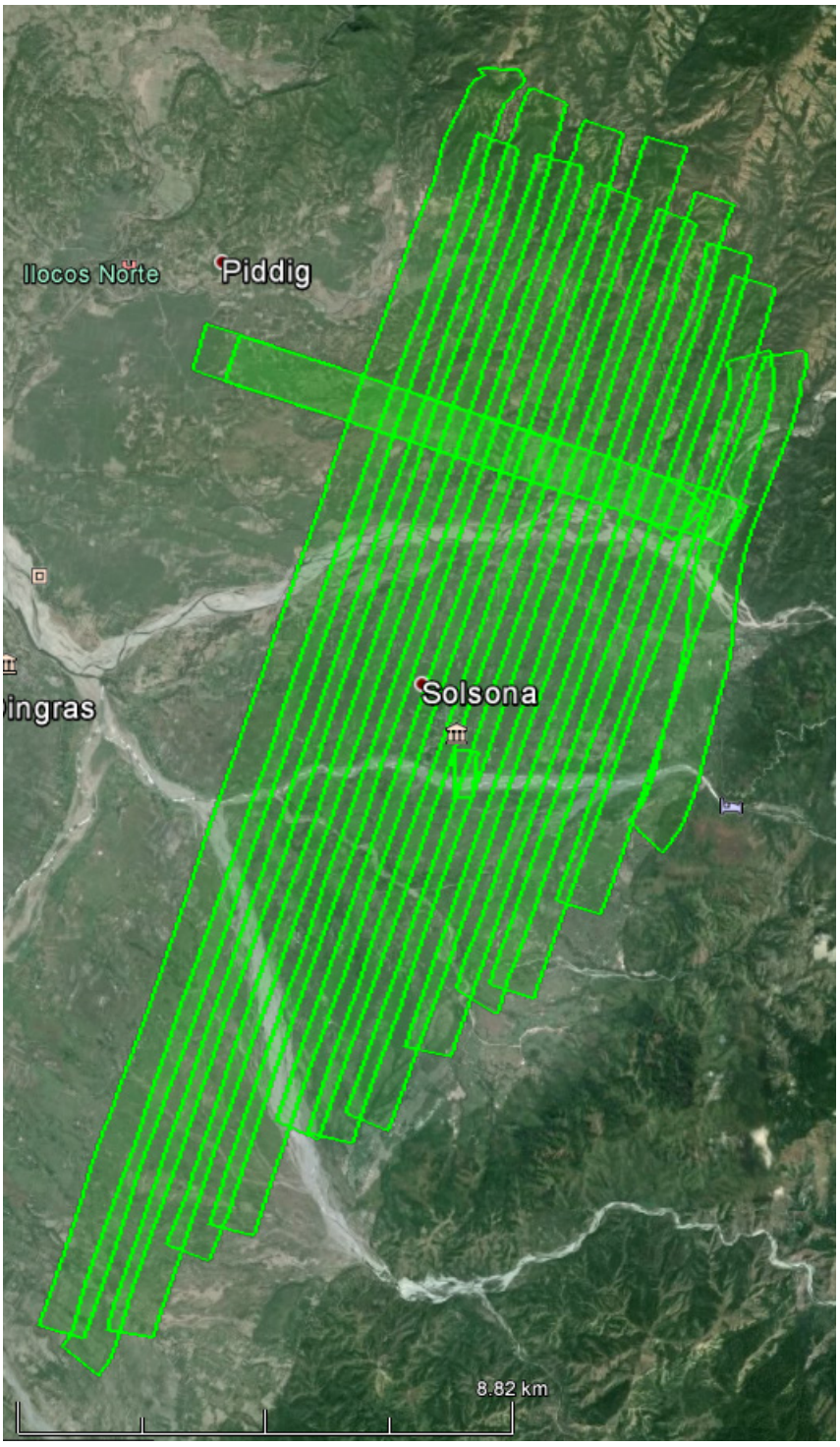
10. Swath Coverage for Mission 2BLK05B057A & 2BLK05AS057A & 2BLK04F057A

Flight No. : 7094 G
Area: BLK05 & BLK04
Mission Name: 2BLK05B057A & 2BLK05AS057A & 2BLK04F057A
Parameters: 2BLK05B057A
Altitude: 1500m; Scan Frequency: 50Hz; Scan angle: 15^{0}; Overlap: 30%
2BLK05AS057A
Altitude: 1200m; Scan Frequency: 50Hz; Scan angle: 20^{0}; Overlap: 25%
2BLK04F057A
Altitude: 1100m; Scan Frequency: 50Hz; Scan angle: 15^{0}; Overlap: 25%



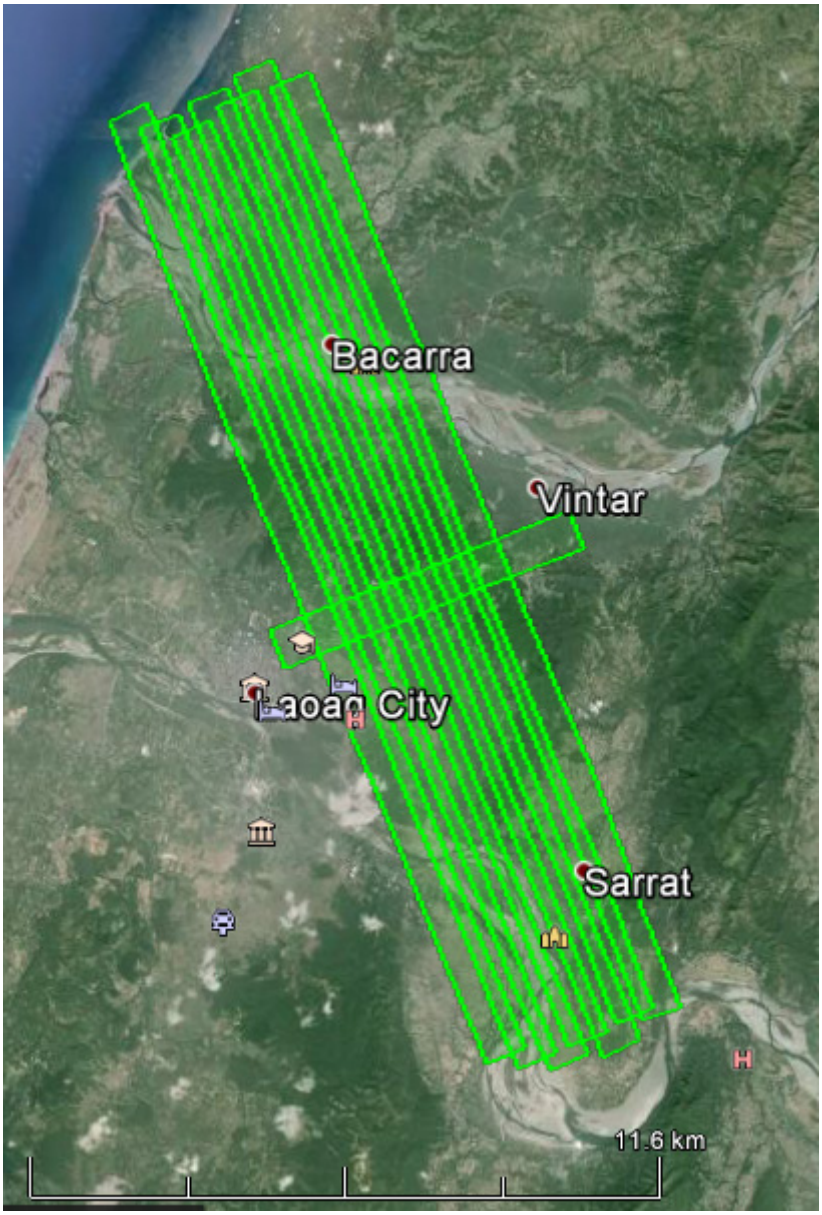
11. Swath Coverage for Mission 2BLK05J058A

Flight No. : 7096 G
Area: BLK05
Mission Name: 2BLK05J058A
Parameters: Altitude: 1500m; Scan Frequency: 50Hz; Scan angle: 15^{0}; Overlap: 30%



12. Swath Coverage for Mission 2BLK05J058A

Flight No. : 7103 G
Area: BLK05
Mission Name: 2CASITEST061B
Parameters: Altitude: 1000m; Scan Frequency: 50Hz; Scan angle: 20^{0}; Overlap: 30%



Annex 8. Mission Summary Reports

Table A-8.1. Mission Summary Reports

Flight Area	**Ilocos**
Mission Name	**Blk5A**
Inclusive Flights	7093G / 7094G
Range data size	13.0 GB / 15.1 GB
Base data size	13.3 MB
POS	197 MB / 231 MB
Image	N/A
Transfer date	March 3, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	No
Processing Mode (<=1)	Yes
Smoothed Performance Metrics (in cm)	
RMSE for North Position (<4.0 cm)	3.4
RMSE for East Position (<4.0 cm)	3.2
RMSE for Down Position (<8.0 cm)	3.9
Boresight correction stdev (<0.001deg)	0.000177
IMU attitude correction stdev (<0.001deg)	0.001821
GPS position stdev (<0.01m)	0.0029
Minimum % overlap (>25)	31.94%
Ave point cloud density per sq.m. (>2.0)	1.78
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	248
Maximum Height	502.99 m
Minimum Height	39.12 m
Classification (# of points)	
Ground	72,403,808
Low vegetation	49,318,800
Medium vegetation	62,219,702
High vegetation	98,593,809
Building	1,272,957
Orthophoto	No
Processed by	Engr. Angelo Carlo Bongat, Engr. Kenneth Solidum, Engr. Melanie Hingpit, Ryan James Nicholai Dizon

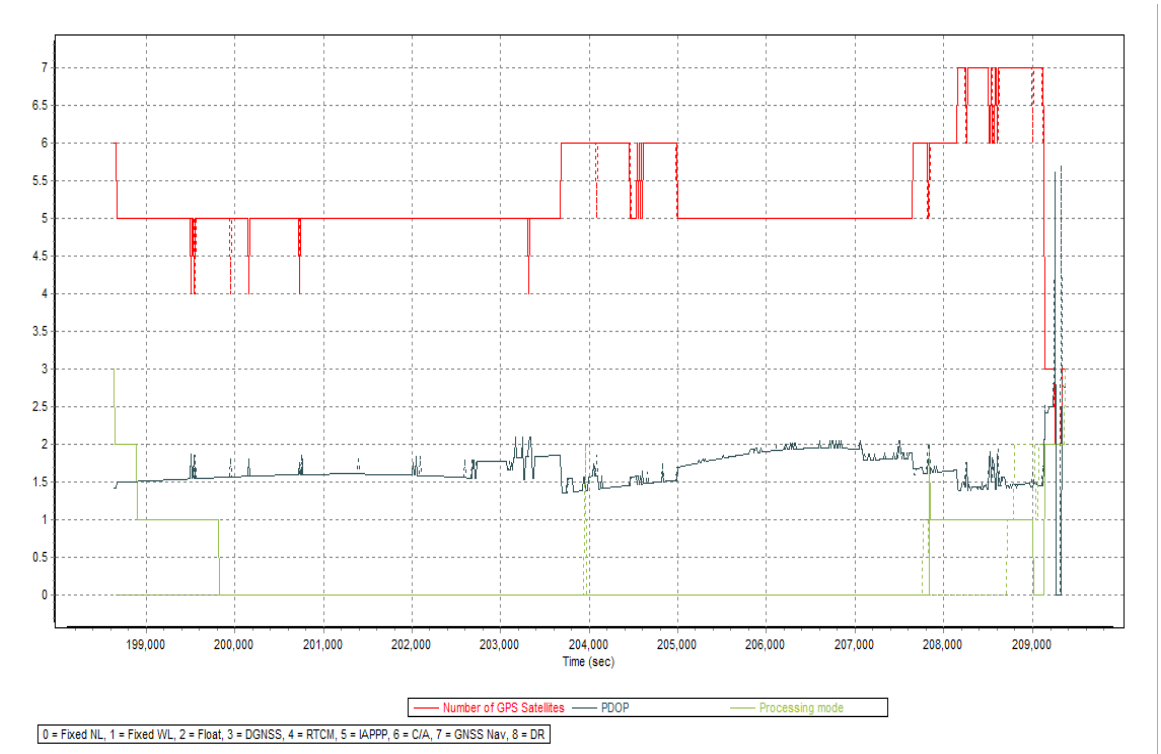


Figure 1.1.1 Solution Status

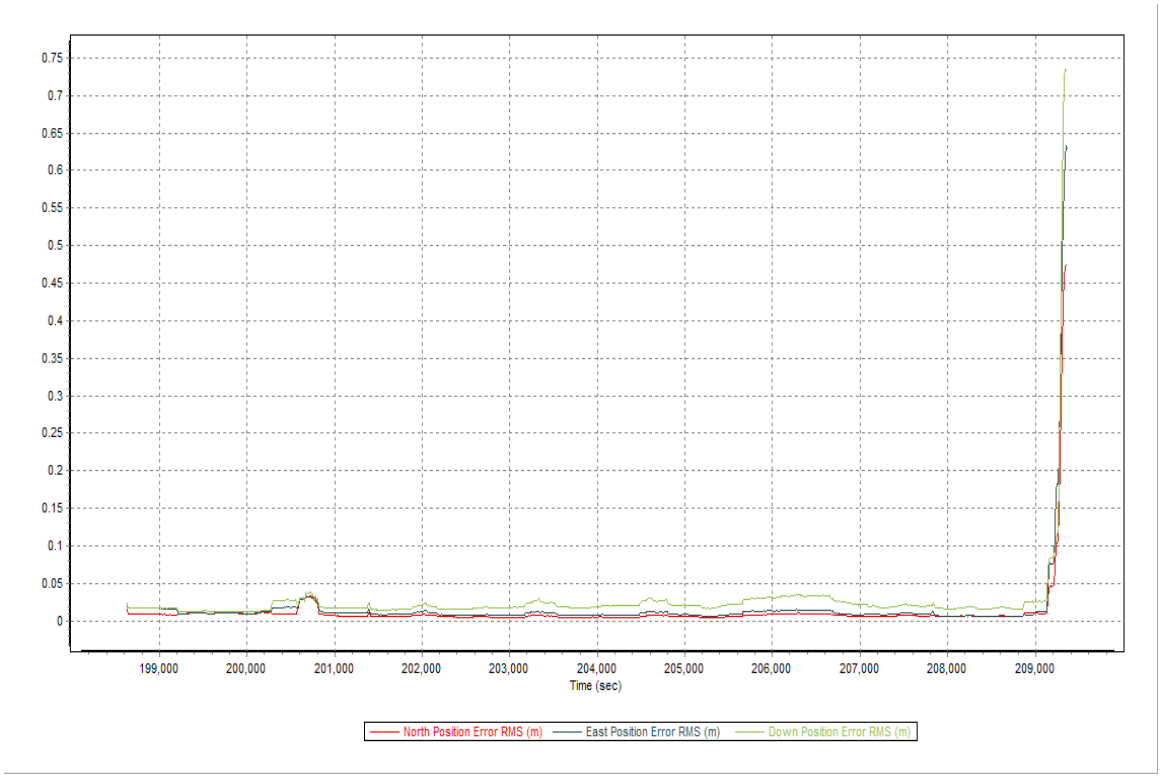


Figure 1.1.2Smoothed Performance Metric Parameters

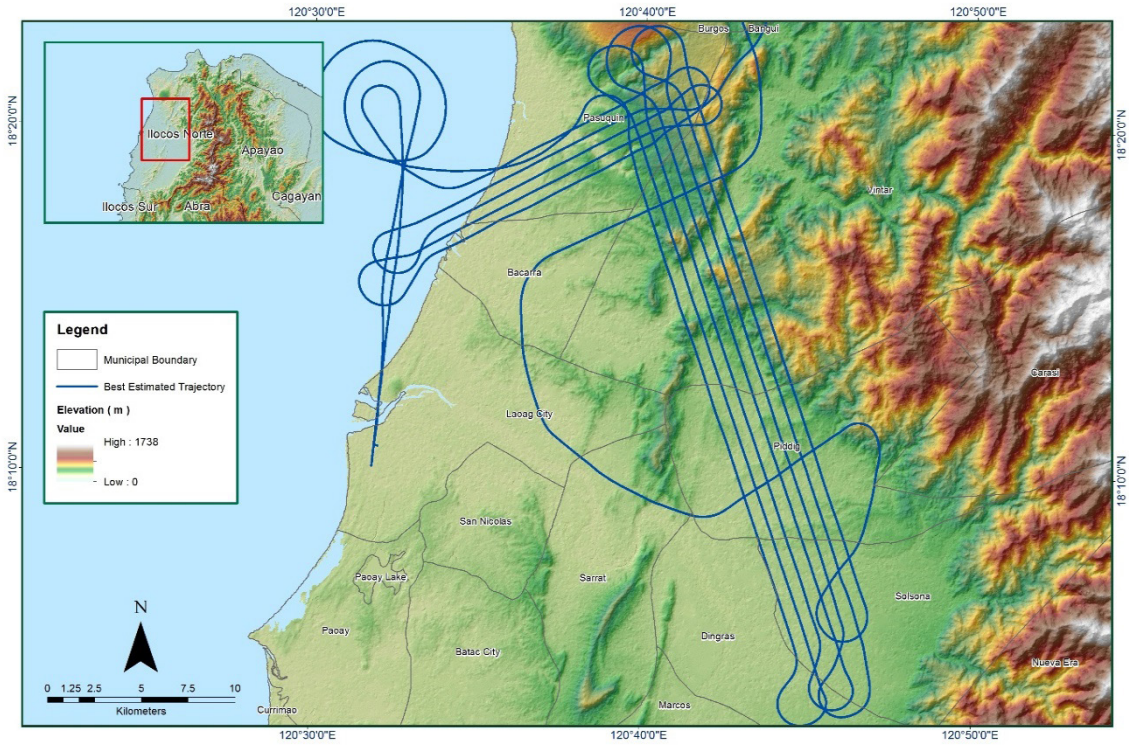


Figure 1.1.3 Best Estimated Trajectory

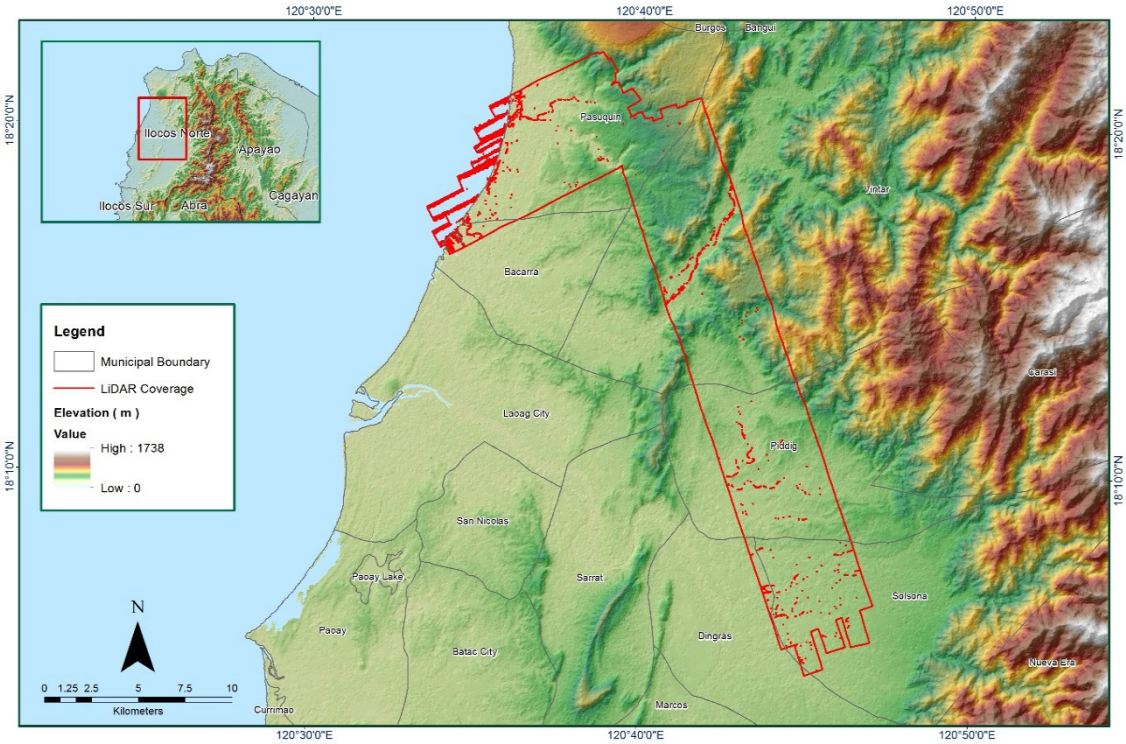


Figure 1.1.4Coverage of LiDAR data

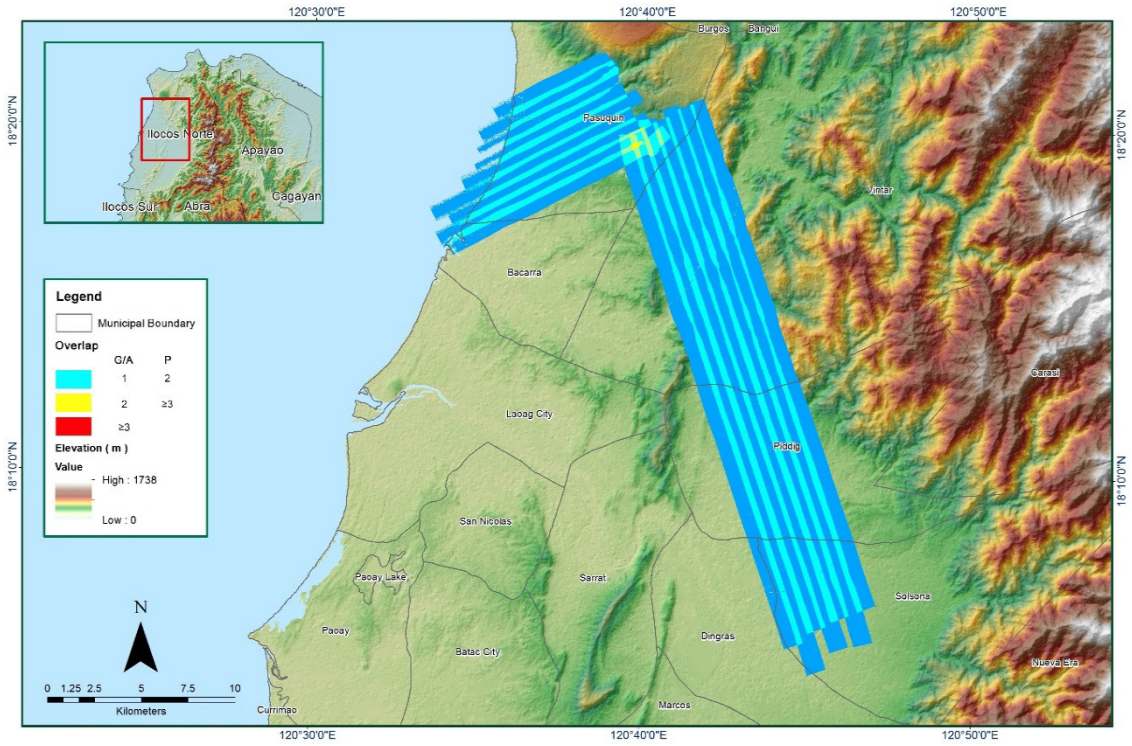


Figure 1.1.5 Image of data overlap

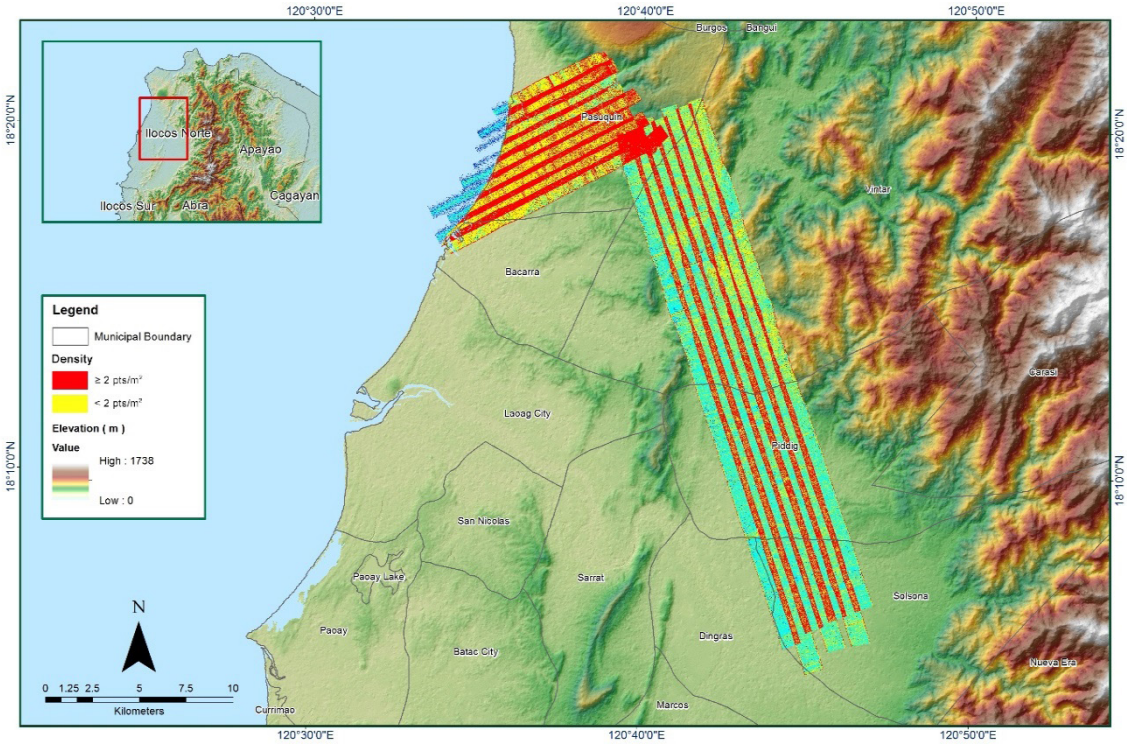


Figure 1.1.6 Density map of merged LiDAR data

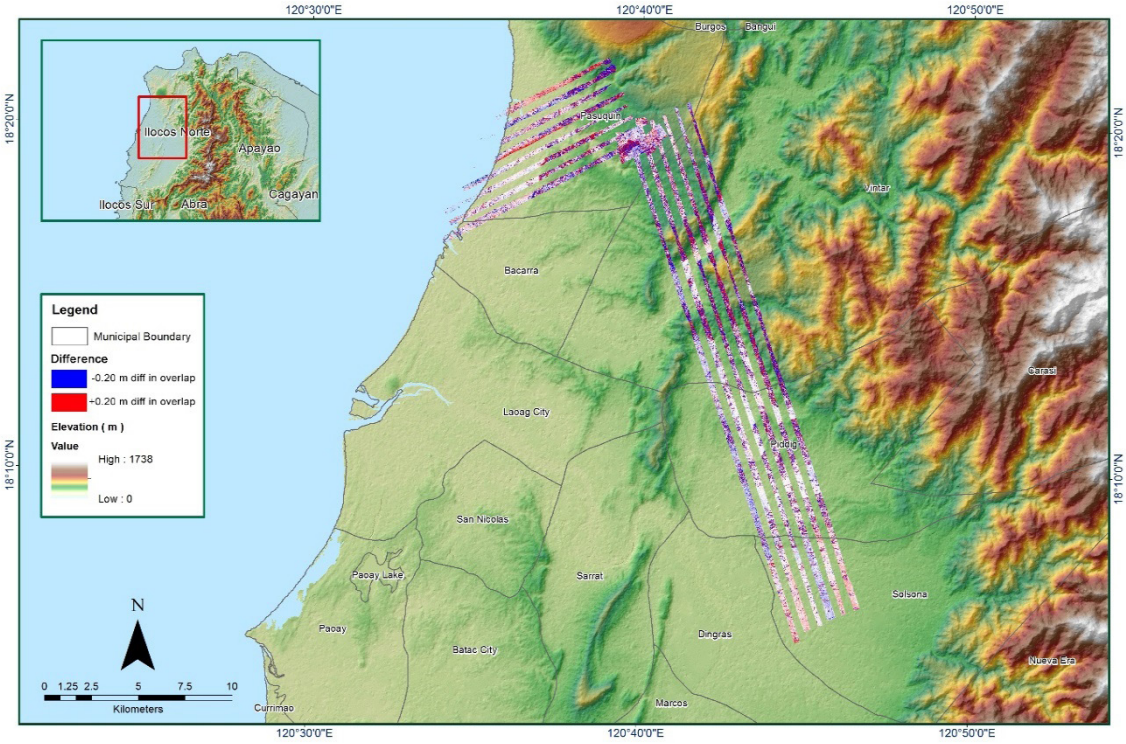


Figure 1.1.7 Elevation difference between flight lines

Flight Area	Ilocos
Mission Name	**Blk5B**
Inclusive Flights	7094G
Range data size	15.1 GB
Base data size	11.4 MB
POS	231 MB
Image	N/A
Transfer date	March 3, 2014
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)	5.4
RMSE for East Position (<4.0 cm)	2.0
RMSE for Down Position (<8.0 cm)	9.4
Boresight correction stdev (<0.001deg)	0.000309
IMU attitude correction stdev (<0.001deg)	0.000682
GPS position stdev (<0.01m)	0.0029
Minimum % overlap (>25)	23.14%
Ave point cloud density per sq.m. (>2.0)	2.37
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	152
Maximum Height	629.52 m
Minimum Height	75.34 m
Classification (# of points)	
Ground	38,645,276
Low vegetation	14,305,851
Medium vegetation	22,951,466
High vegetation	44,471,526
Building	83,933,604
Orthophoto	No
Processed by	Engr. Angelo Carlo Bongat, Engr. Christy Lubiano, Engr. Gladys Mae Apat

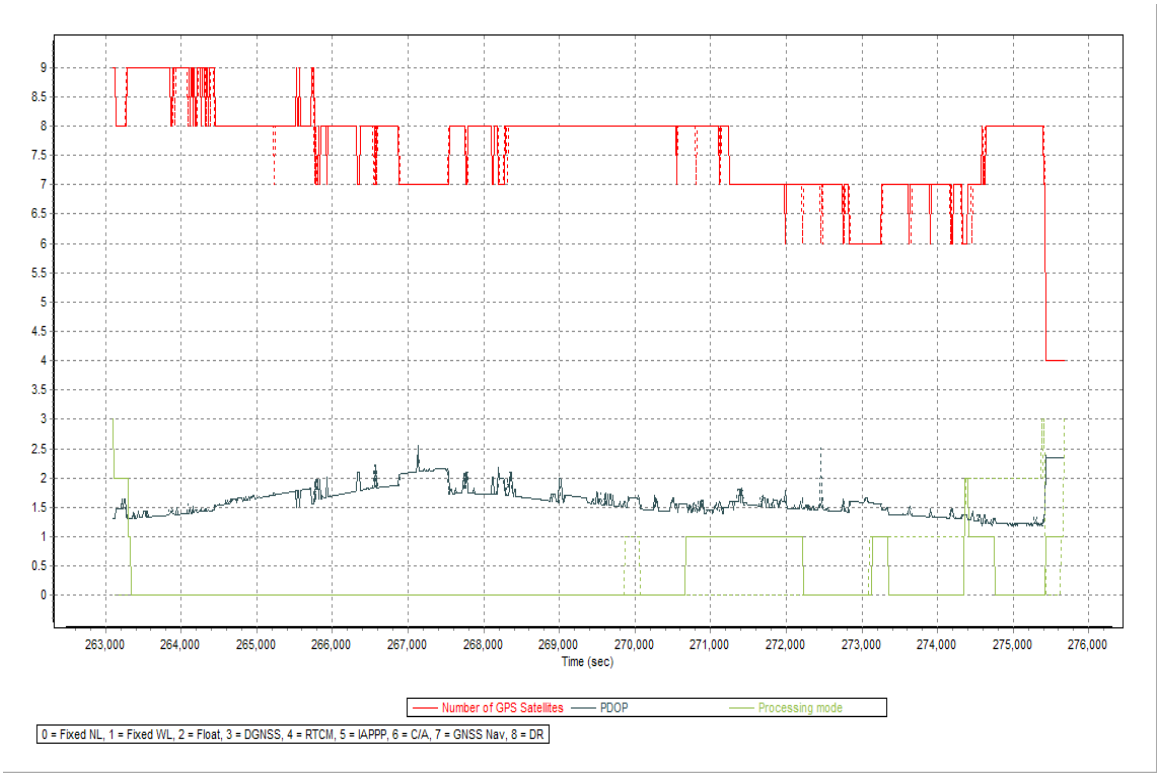


Figure 1.2.1 Solution Status

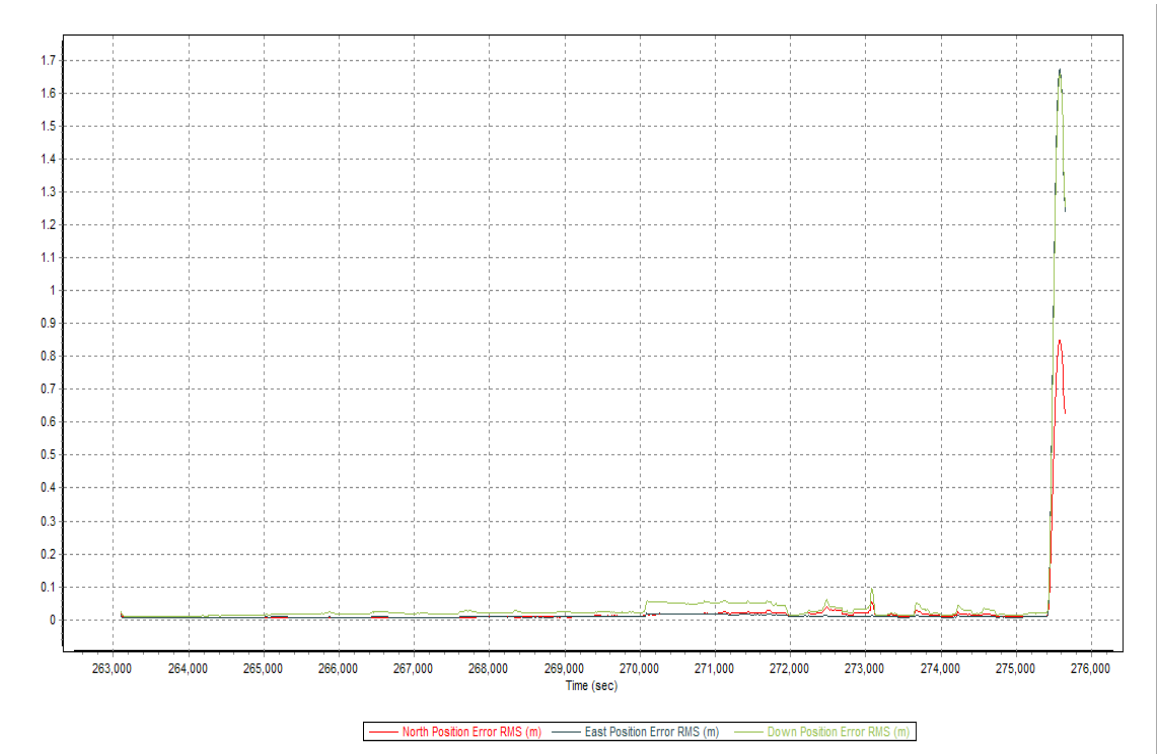


Figure 1.2.2 Smoothed Performance Metric Parameters

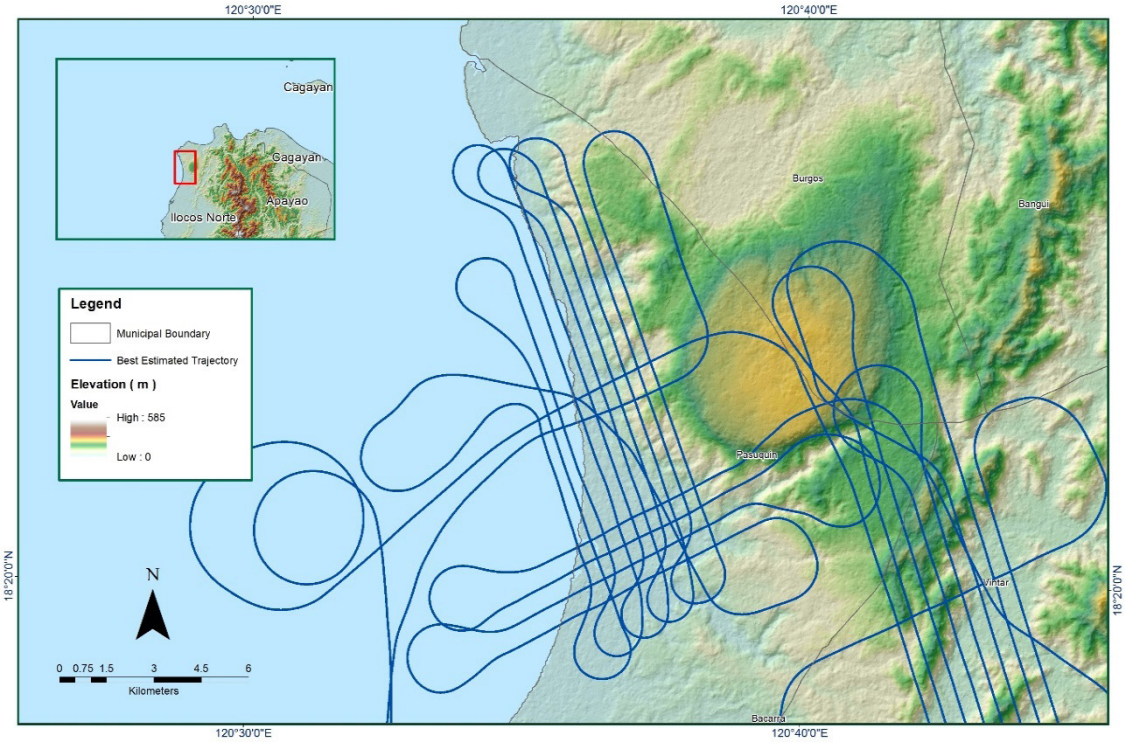


Figure 1.2.3 Best Estimated Trajectory

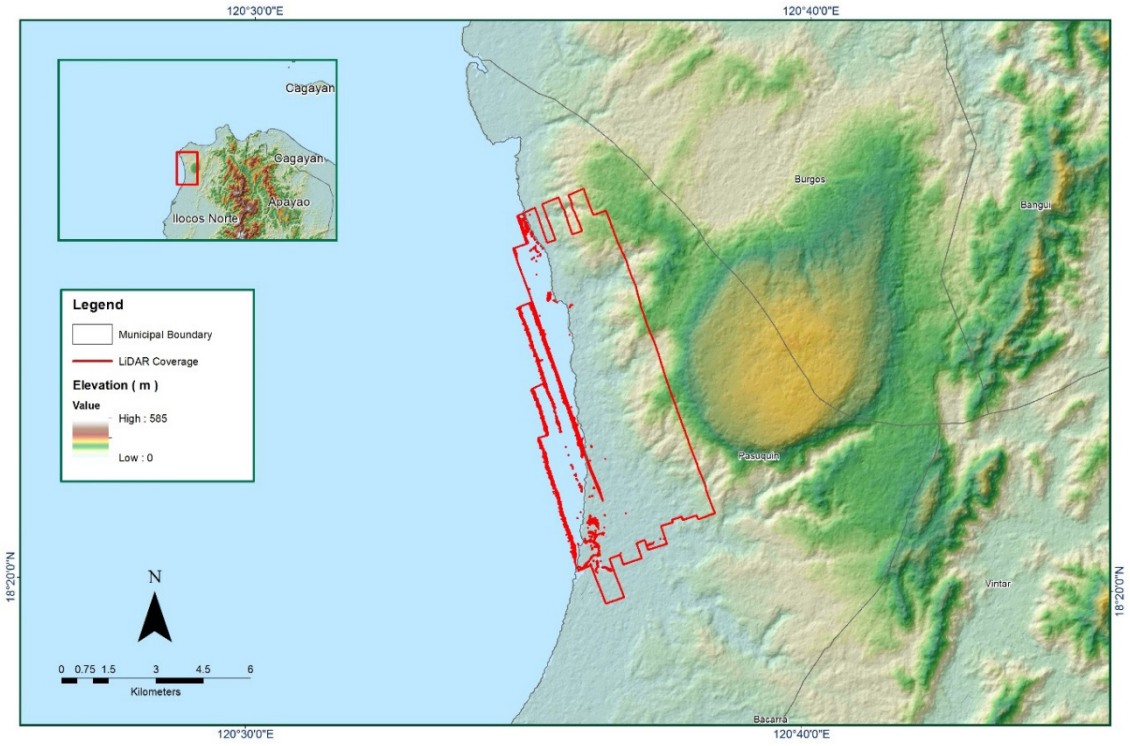


Figure 1.2.4Coverage of LiDAR data

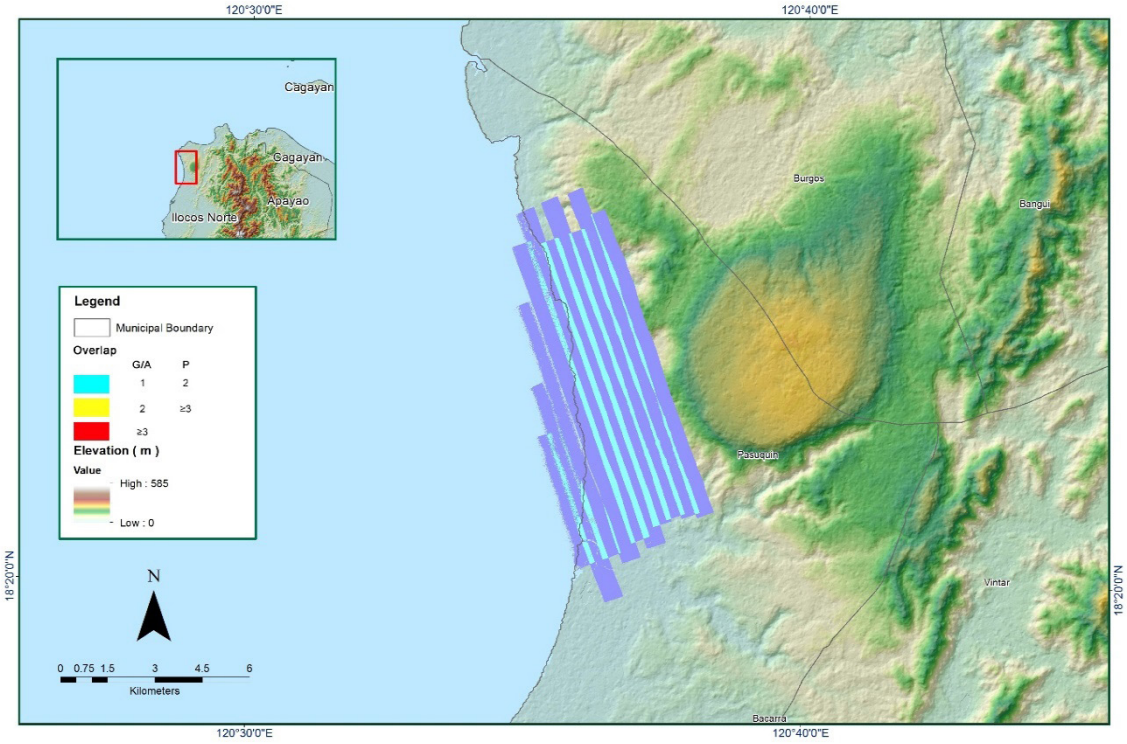


Figure 1.2.5 Image of data overlap

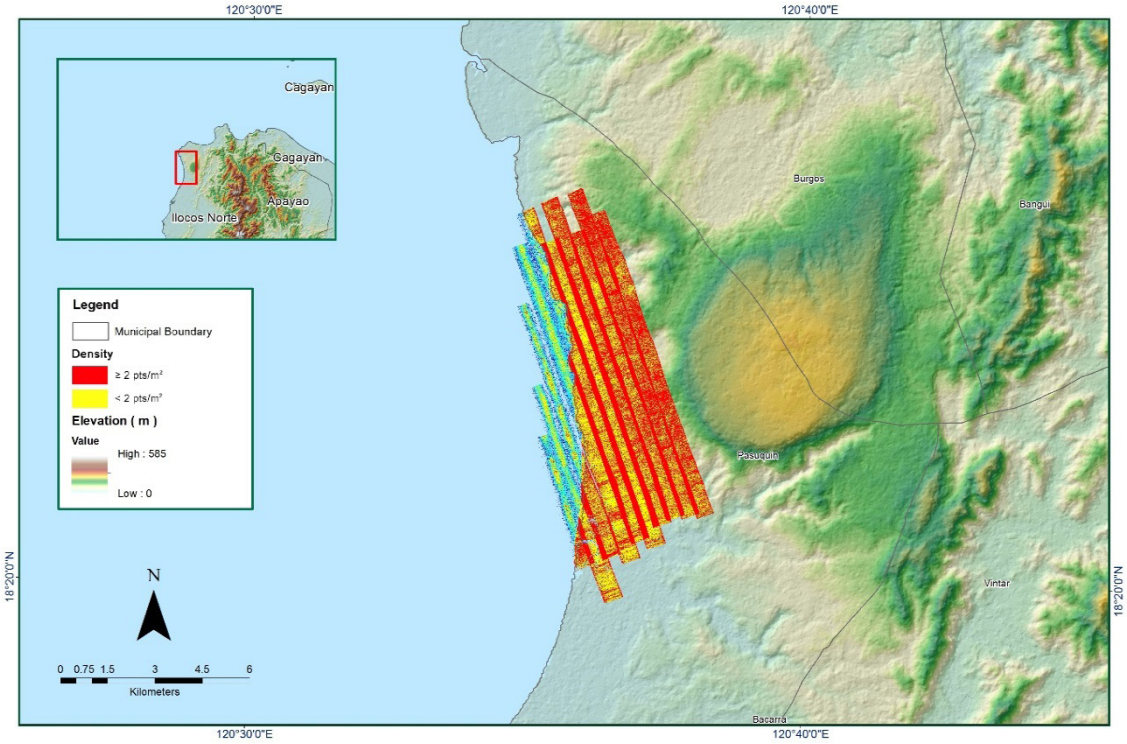


Figure 1.2.6 Density map of merged LiDAR data

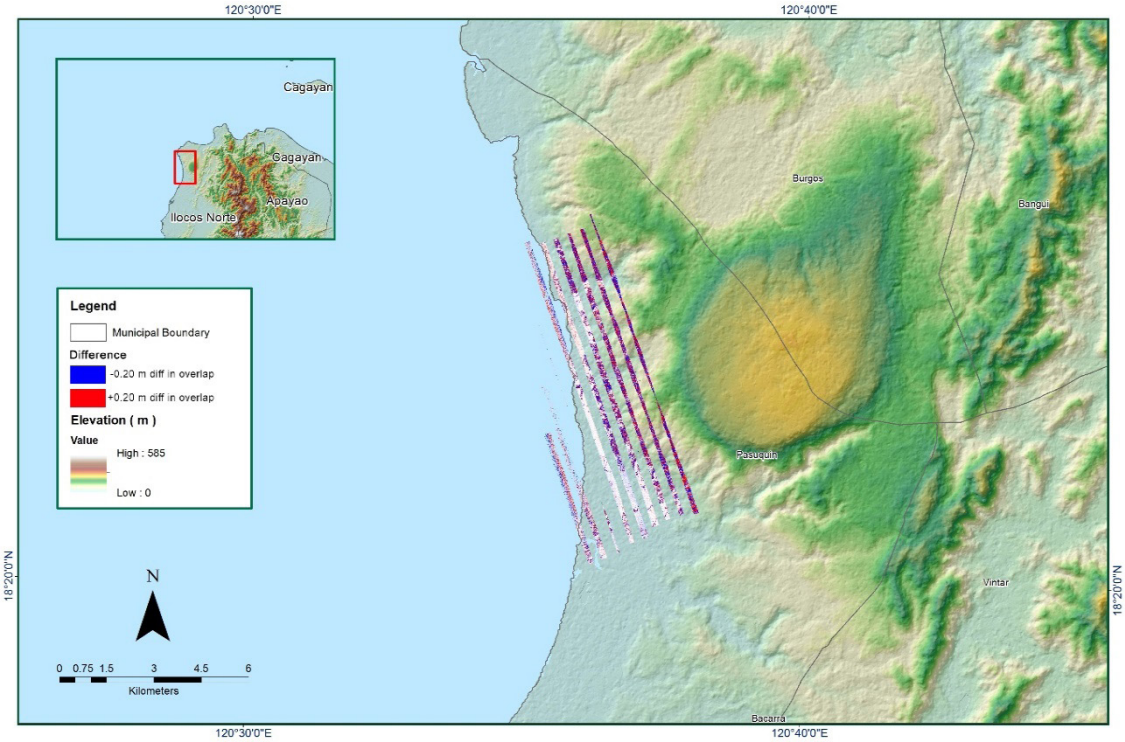


Figure 1.2.7 Elevation difference between flight lines

Flight Area	Ilocos
Mission Name	**Blk5C**
Inclusive Flights	7093G
Range data size	13.0 GB
Base data size	13.3 MB
POS	197 MB
Image	N/A
Transfer date	March 3, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	No
Processing Mode (<=1)	Yes
Smoothed Performance Metrics(in cm)	
RMSE for North Position (<4.0 cm)	3.4
RMSE for East Position (<4.0 cm)	3.2
RMSE for Down Position (<8.0 cm)	3.9
Boresight correction stdev (<0.001deg)	0.000177
IMU attitude correction stdev (<0.001deg)	0.001821
GPS position stdev (<0.01m)	0.0029
Minimum % overlap (>25)	31.94%
Ave point cloud density per sq.m. (>2.0)	1.78
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	204
Maximum Height	503.01 m
Minimum Height	61.68 m
Classification (# of points)	
Ground	36,640,456
Low vegetation	38,807,563
Medium vegetation	38,435,176
High vegetation	76,650,235
Building	1,181,514
Orthophoto	No
Processed by	Engr. Carlyn Ann Ibañez. Celina Rosete, Engr. Elainne Lopez

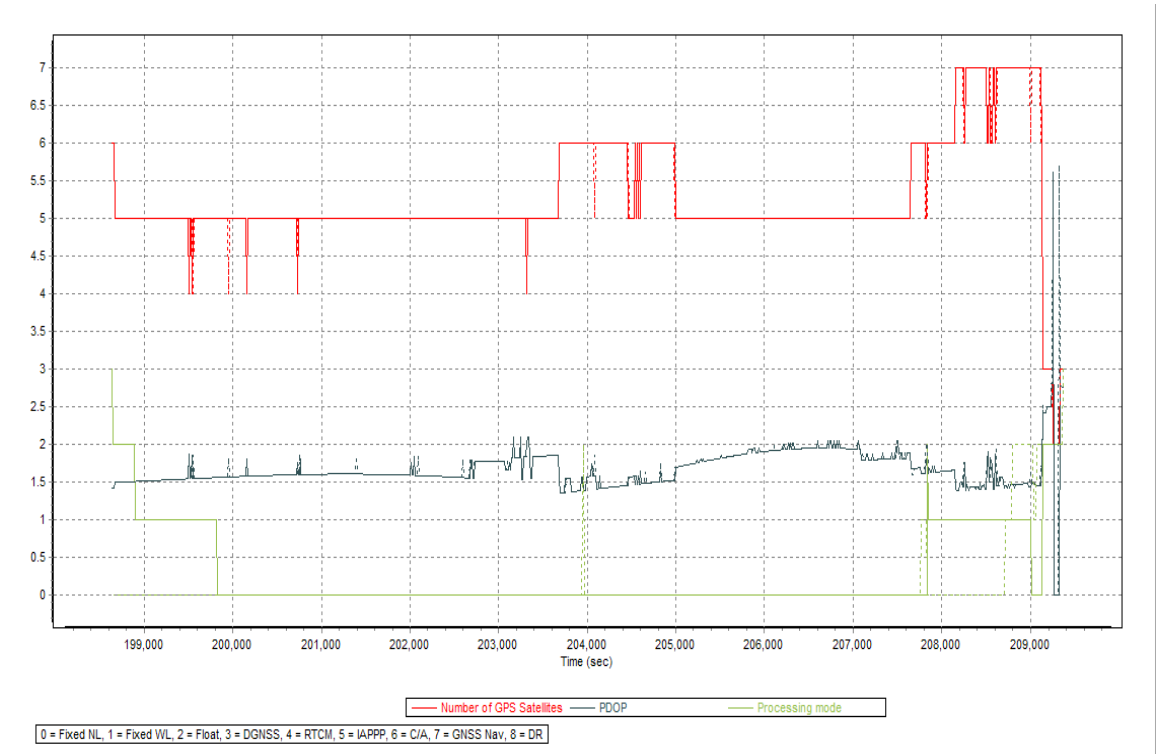


Figure 1.3.1. Solution Status

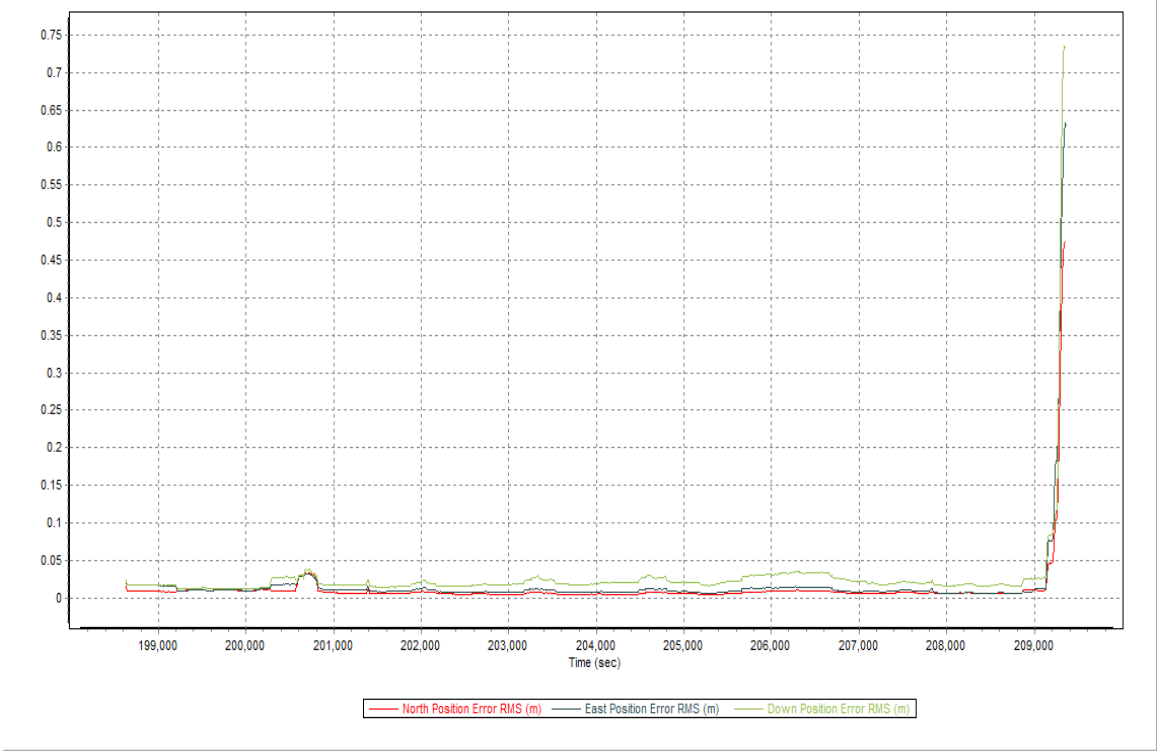


Figure 1.3.2. Smoothed Performance Metric Parameter

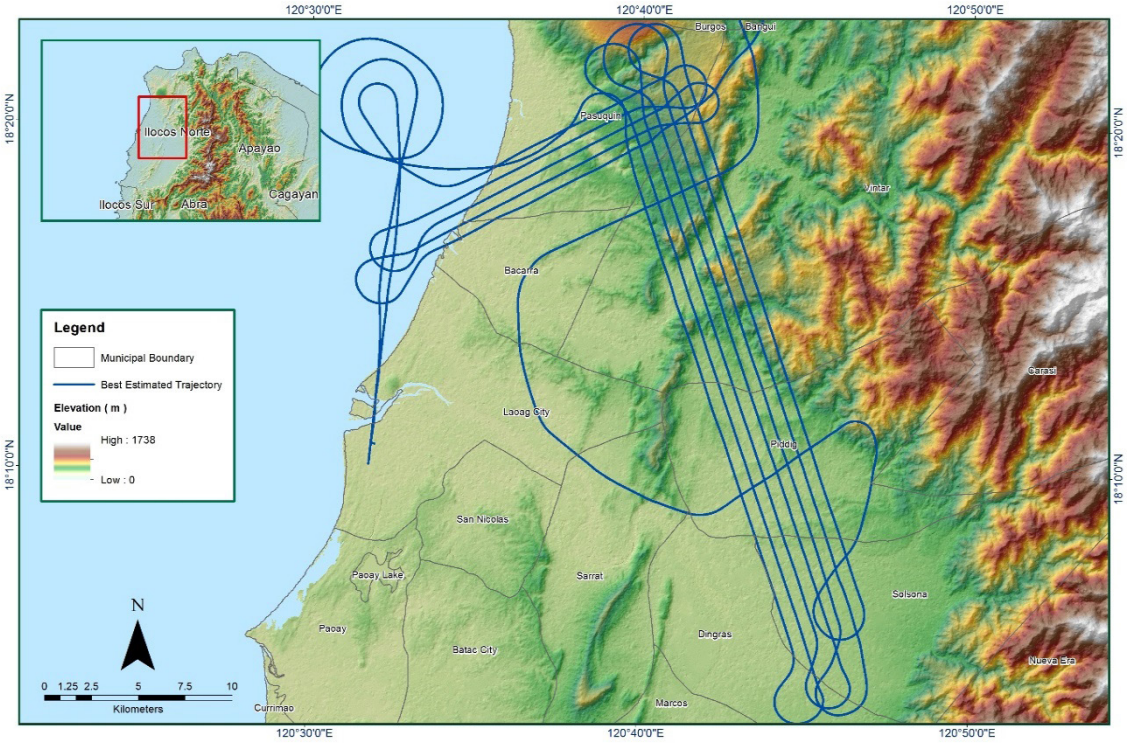


Figure 1.3.3. Best Estimated Trajectory

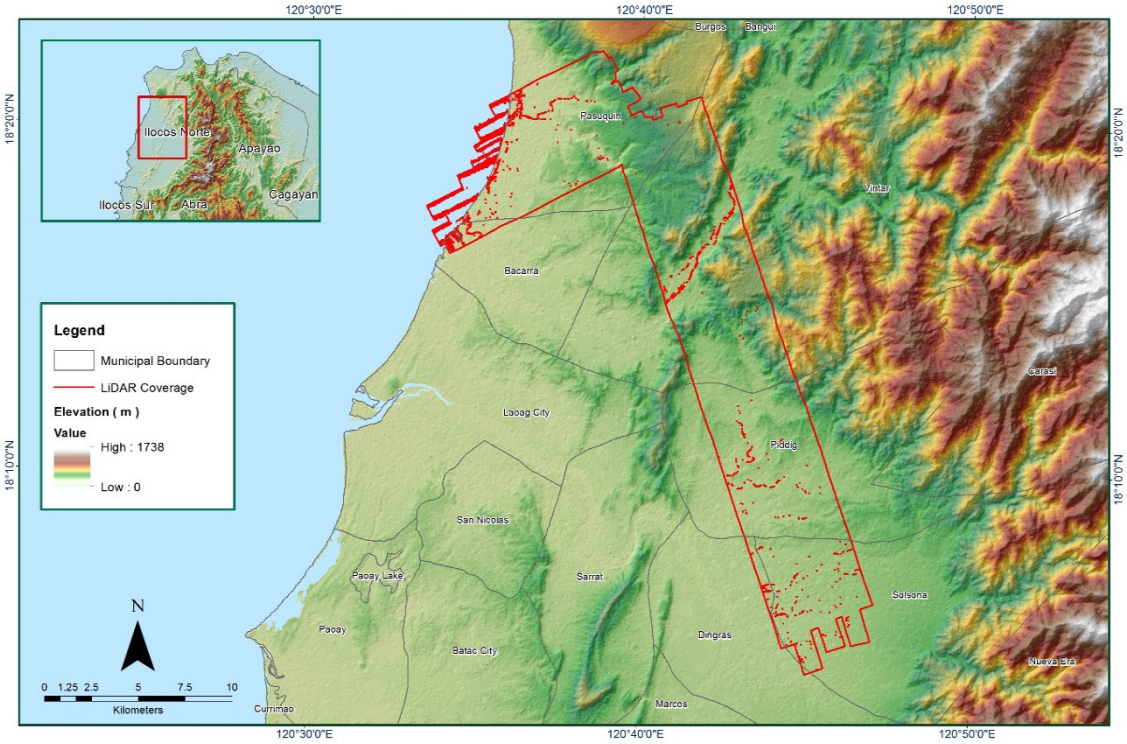


Figure 1.3.4. Coverage of LiDAR data

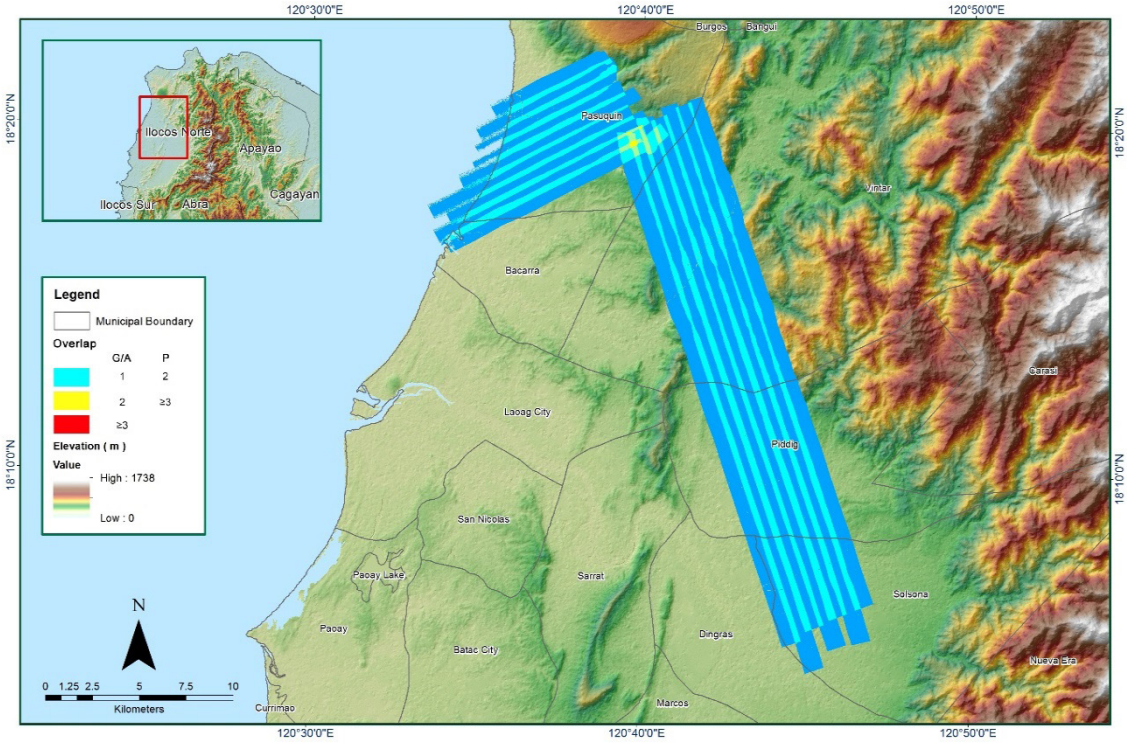


Figure 1.3.5. Image of data overlap

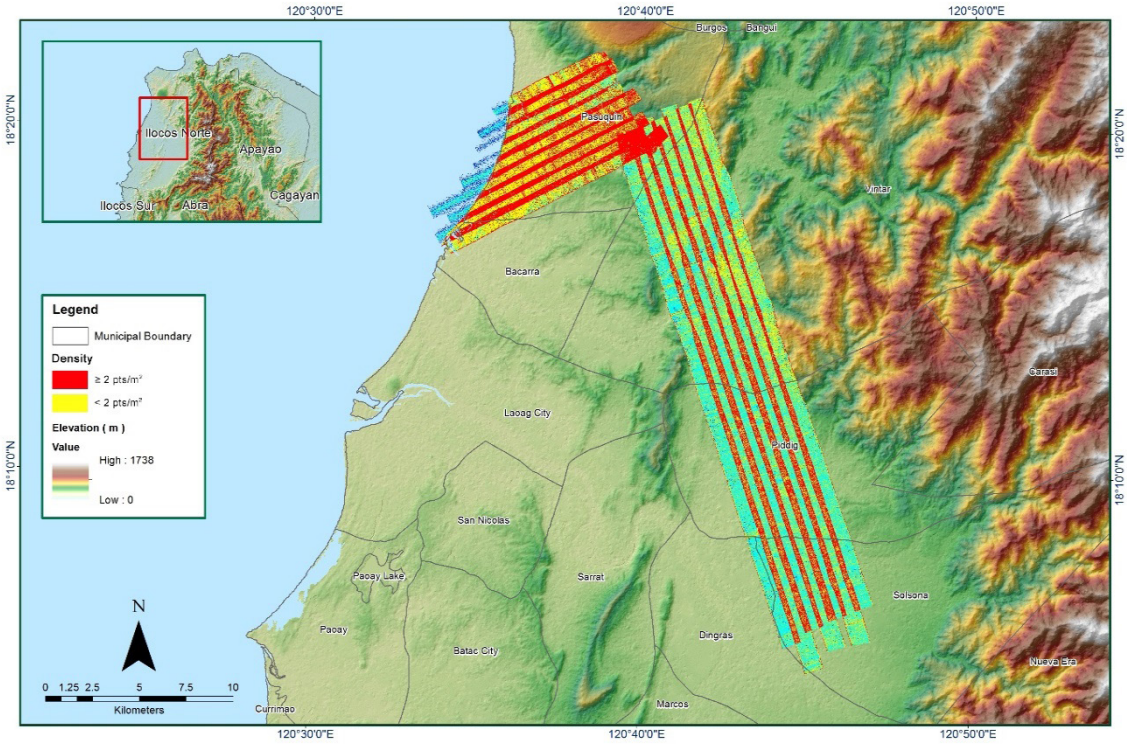


Figure 1.3.6. Density map of merged LiDAR data

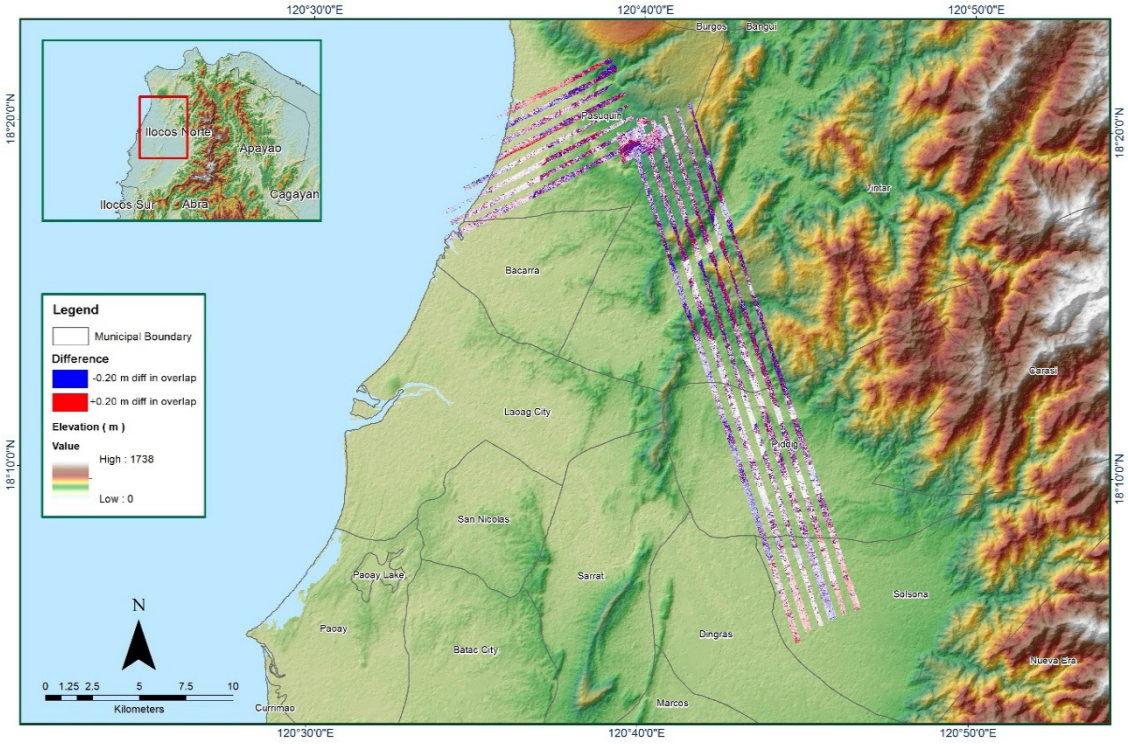


Figure 1.3.7. Elevation difference between flight lines

Flight Area	Ilocos
Mission Name	**Blk5D**
Inclusive Flights	7092G
Range data size	11.8 GB
Base data size	13 MB
POS	199 MB
Image	N/A
Transfer date	March 3, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	No
Processing Mode (<=1)	Yes
Smoothed Performance Metrics(in cm)	
RMSE for North Position (<4.0 cm)	2.6
RMSE for East Position (<4.0 cm)	2.5
RMSE for Down Position (<8.0 cm)	3.3
Boresight correction stdev (<0.001deg)	0.000314
IMU attitude correction stdev (<0.001deg)	0.000547
GPS position stdev (<0.01m)	0.0104
Minimum % overlap (>25)	68.68%
Ave point cloud density per sq.m. (>2.0)	1.62
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	136
Maximum Height	453.01 m
Minimum Height	47.27 m
Classification (# of points)	
Ground	43,938,236
Low vegetation	24,884,917
Medium vegetation	19,773,139
High vegetation	41,805,680
Building	978,440
Orthophoto	No
Processed by	Engr. Irish Cortez, Engr. Christy Lubiano, AilynBiñas

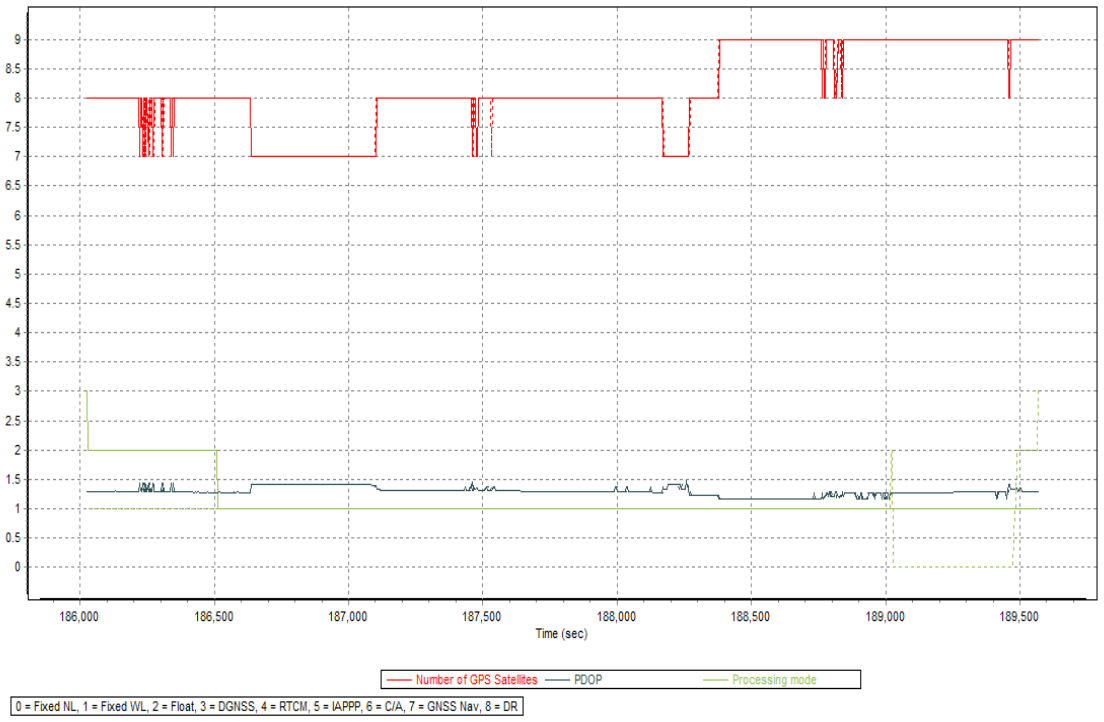


Figure 1.4.1. Solution Status

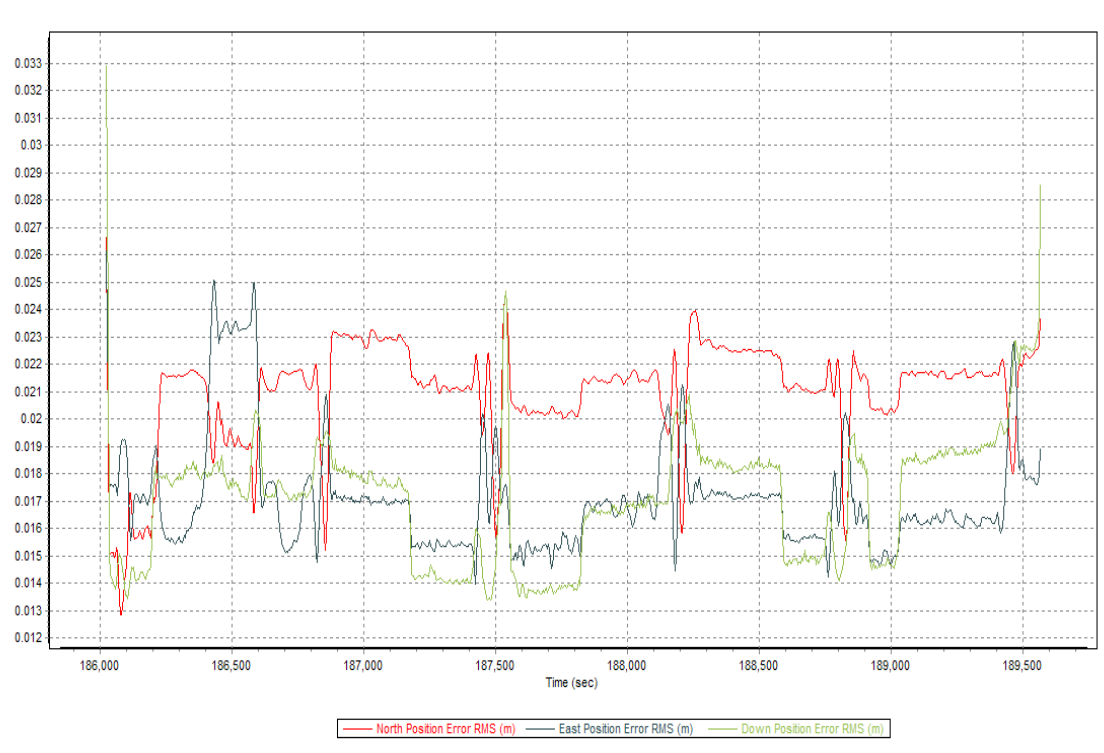


Figure 1.4.2. Smoothed Performance Metric Parameters

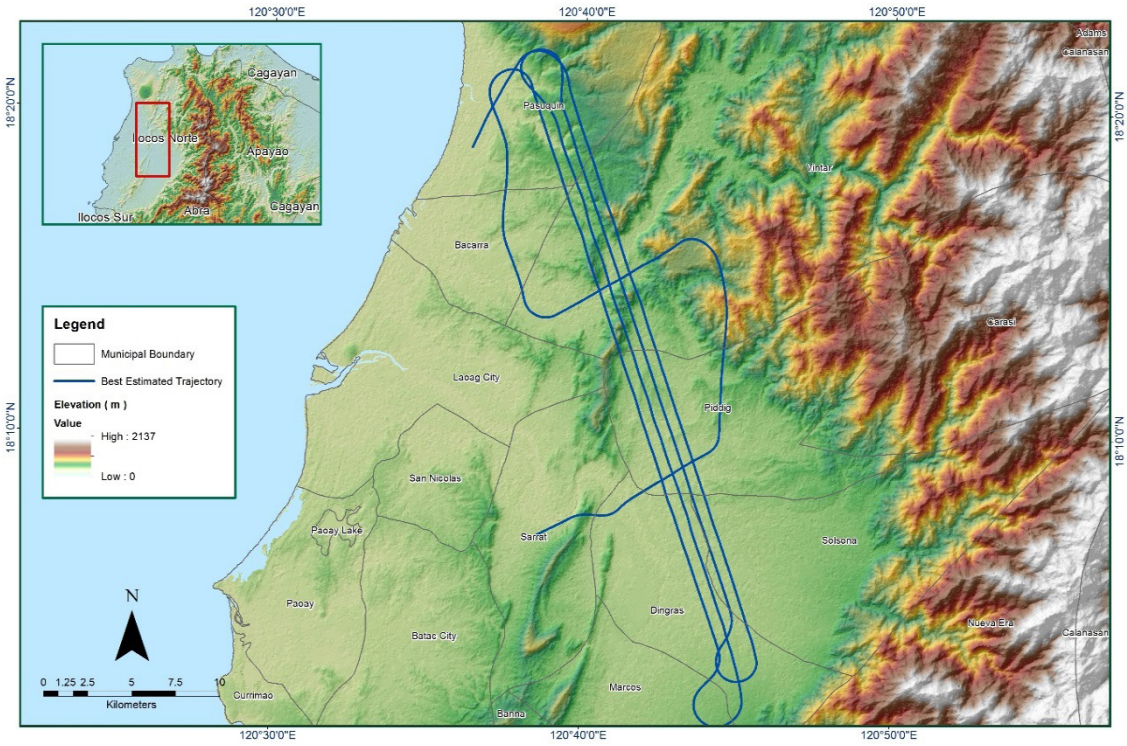


Figure 1.4.3. Best Estimated Trajectory

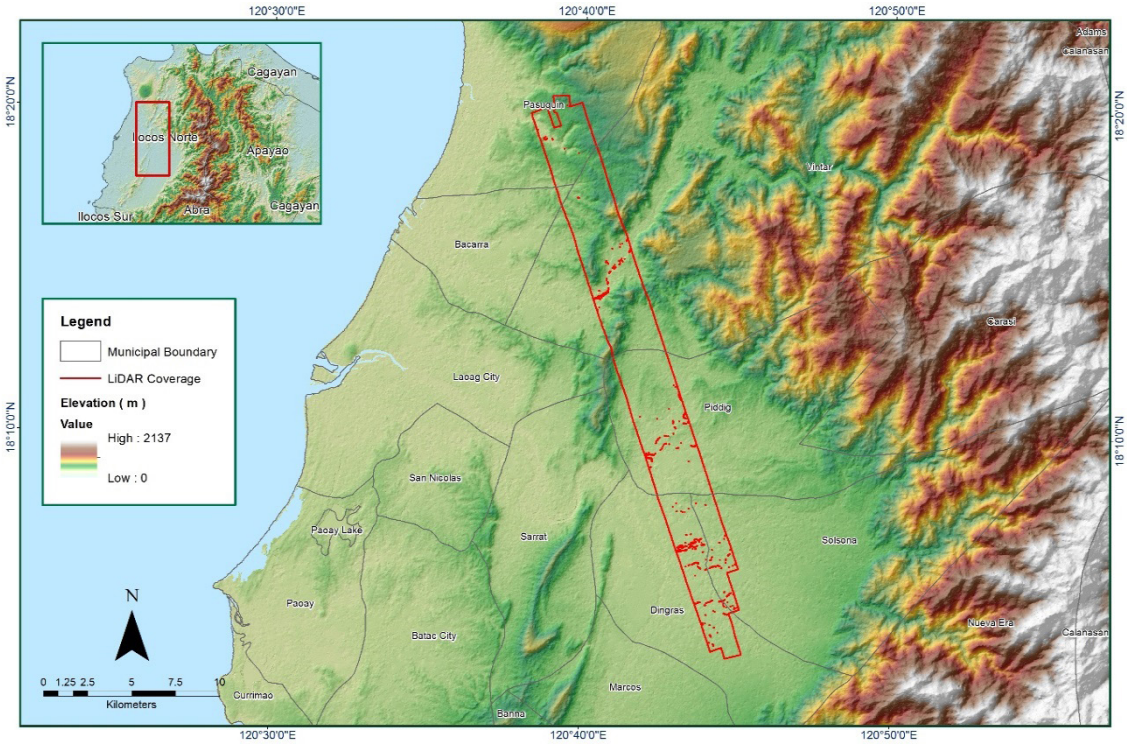


Figure 1.4.4. Coverage of LiDAR data

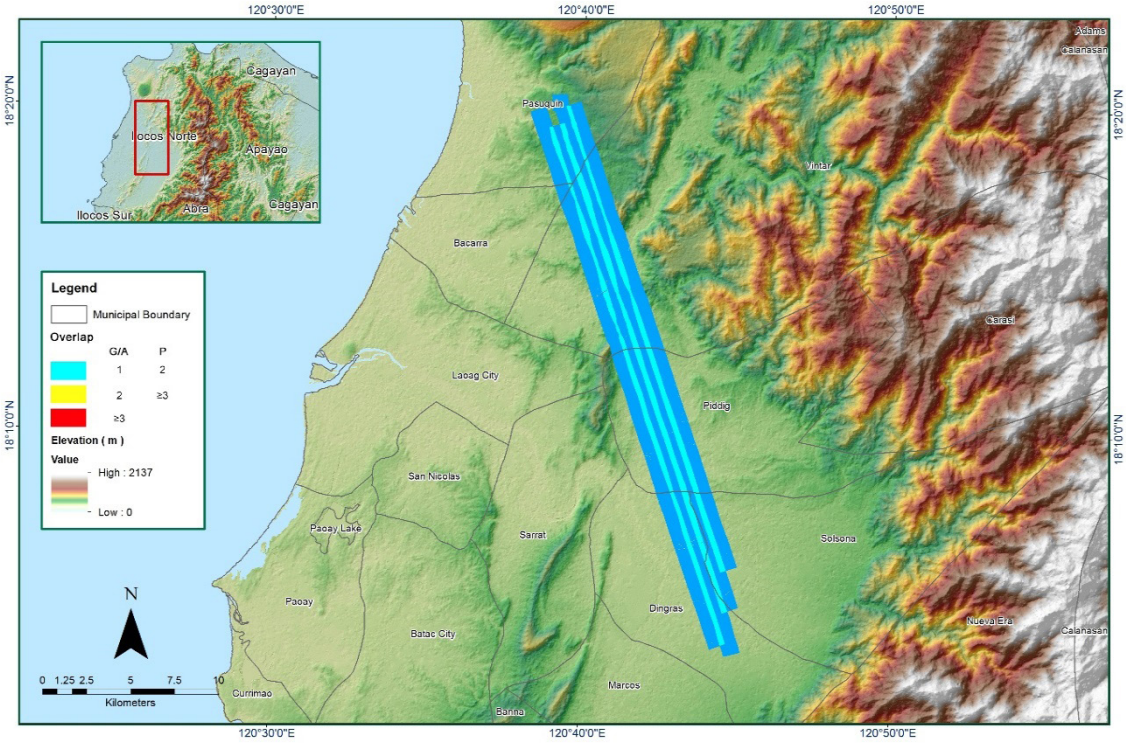


Figure 1.4.5. Image of data overlap

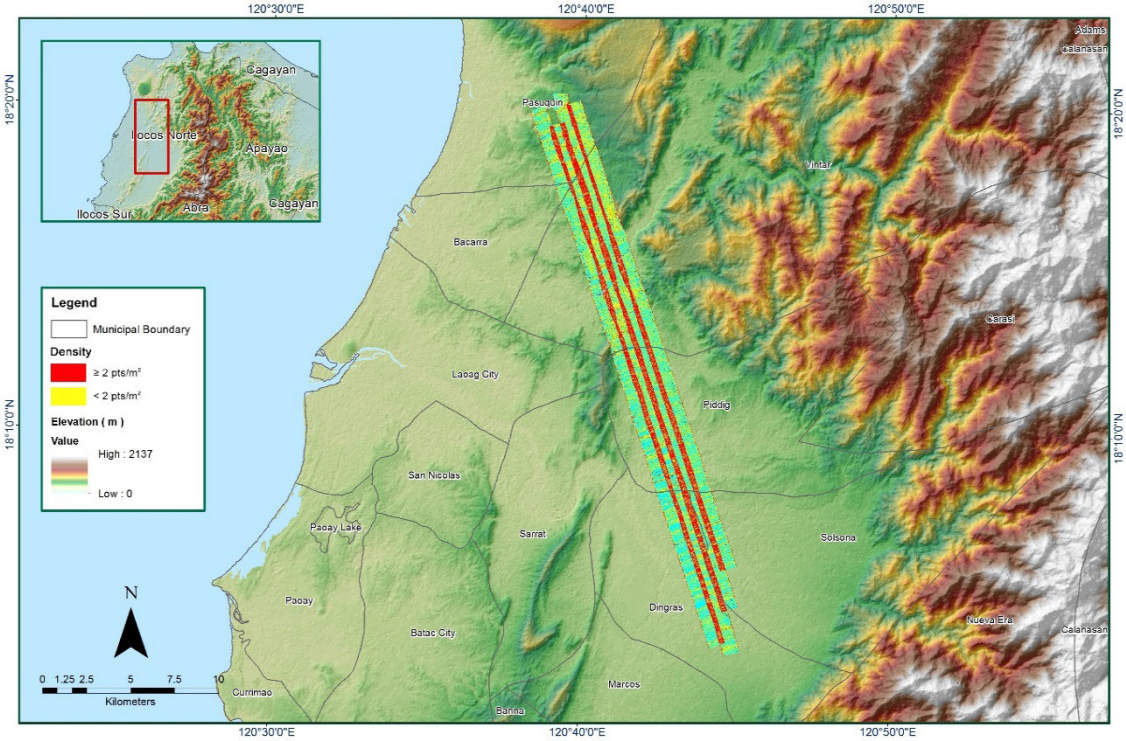


Figure 1.4.6. Density map of merged LiDAR data

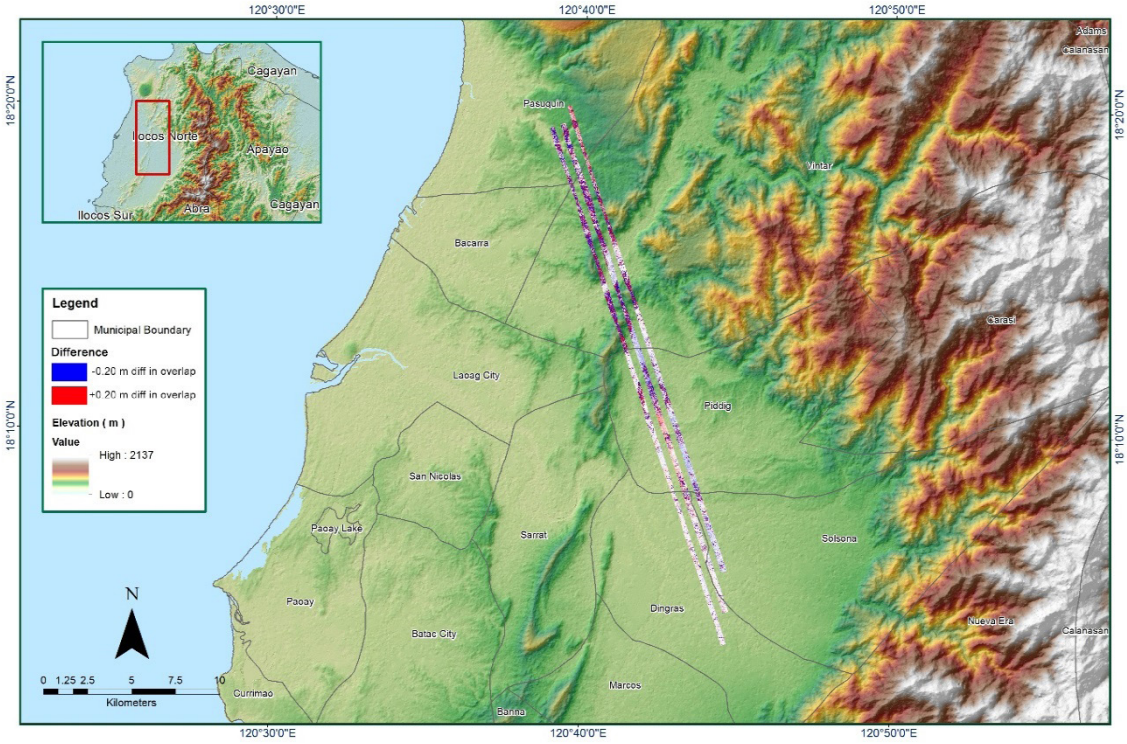


Figure 1.4.7. Elevation difference between flight lines

Flight Area	Ilocos
Mission Name	**5DsEs**
Inclusive Flights	7091G
Range data size	15.8
Base data size	N/A
POS	N/A
Image	N/A
Transfer date	March 3, 2014
Solution Status	
Number of Satellites (>6)	N/A
PDOP (<3)	N/A
Baseline Length (<30km)	N/A
Processing Mode (<=1)	N/A
Smoothed Performance Metrics(in cm)	
RMSE for North Position (<4.0 cm)	N/A
RMSE for East Position (<4.0 cm)	N/A
RMSE for Down Position (<8.0 cm)	N/A
Boresight correction stdev (<0.001deg)	N/A
IMU attitude correction stdev (<0.001deg)	N/A
GPS position stdev (<0.01m)	N/A
Minimum % overlap (>25)	98.51
Ave point cloud density per sq.m. (>2.0)	5.09
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	196
Maximum Height	387.52 m
Minimum Height	42.55 m
Classification (# of points)	
Ground	91289416
Low vegetation	164468879
Medium vegetation	211773161
High vegetation	198073691
Building	11618600
Orthophoto	No
Processed by	Engr. Irish Cortez, Engr. Edgardo Gubatanga Jr., AilynBiñas

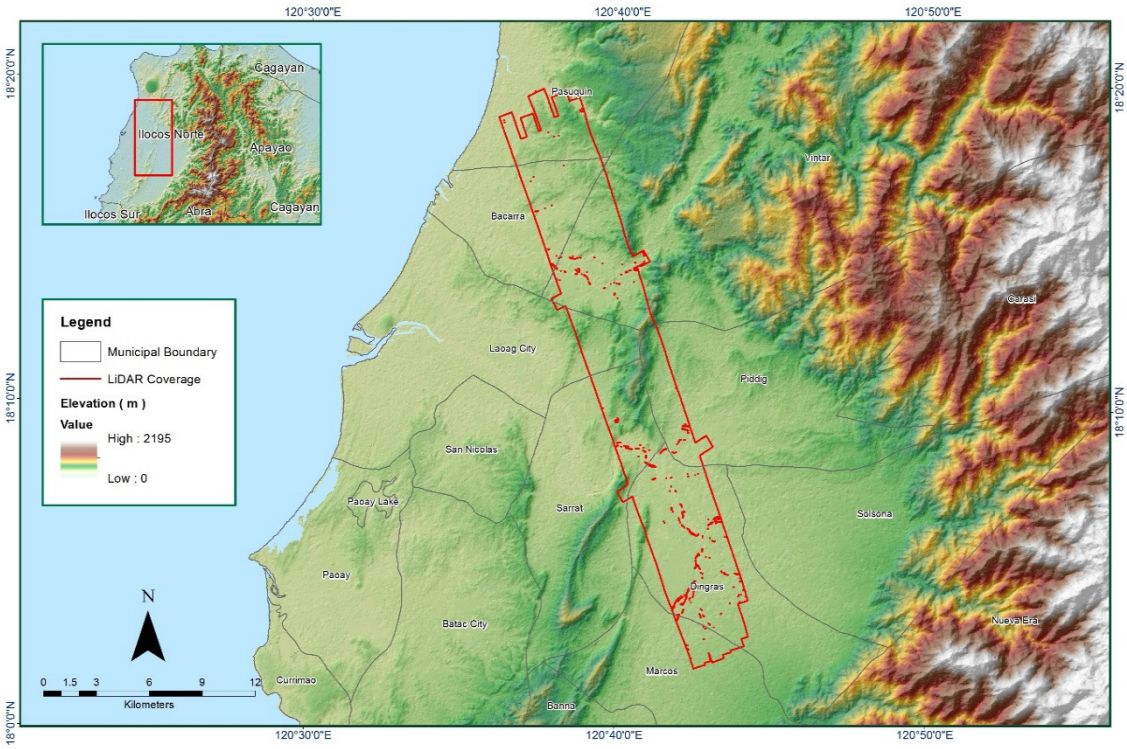


Figure 1.5.1. Coverage of LiDAR data

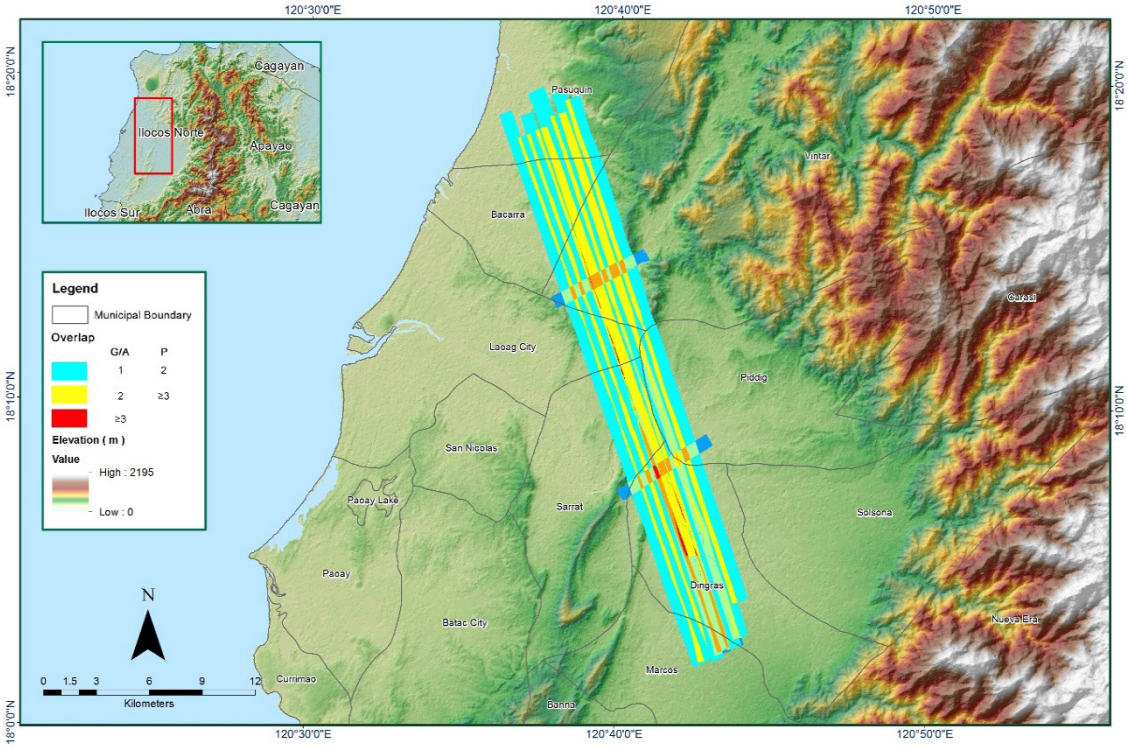


Figure 1.5.2. Image of data overlap

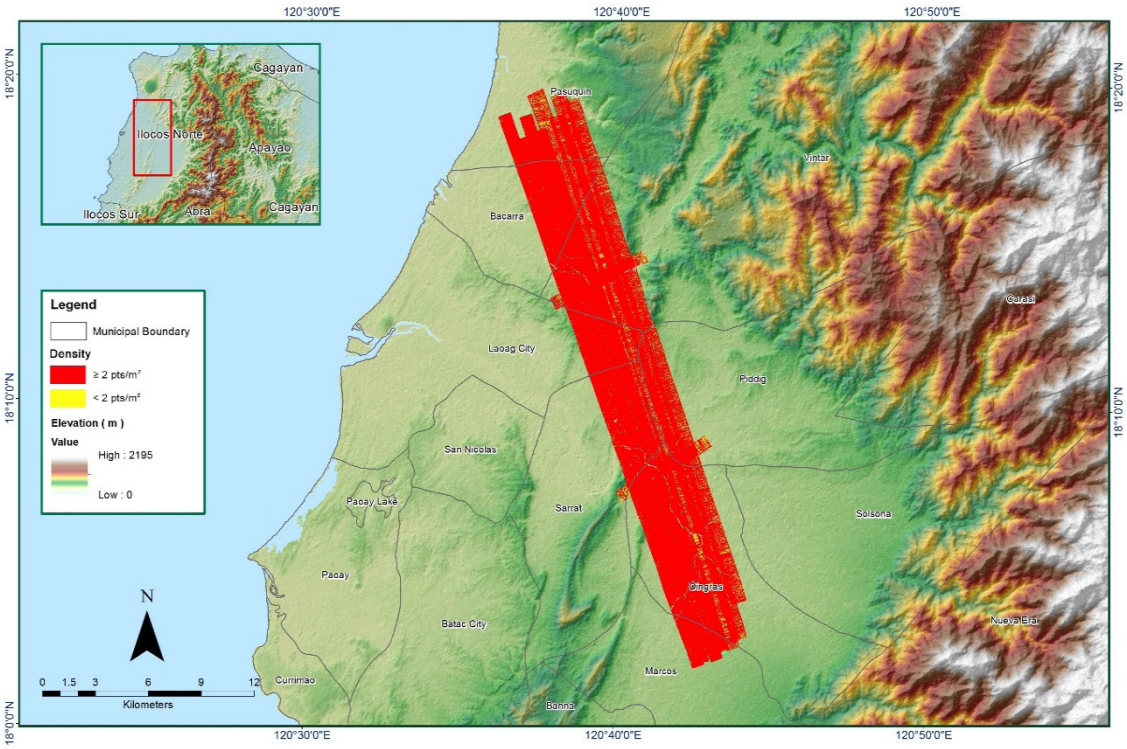


Figure 1.5.3. Density map of merged LiDAR data

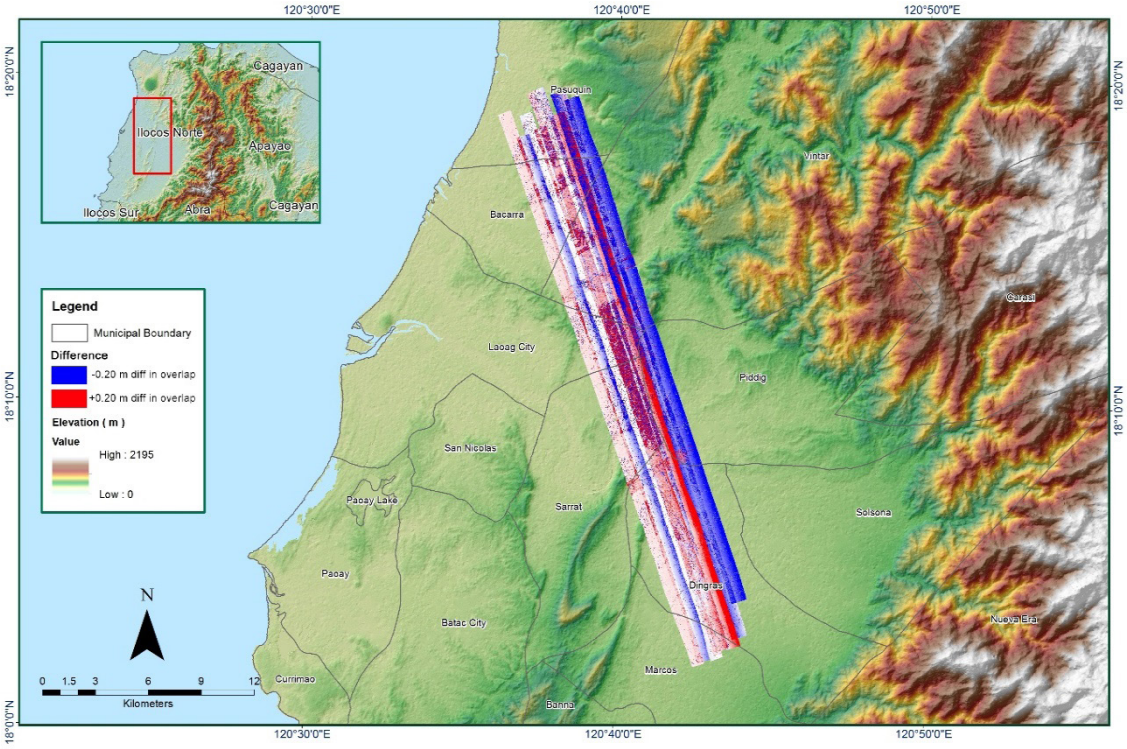


Figure 1.5.4. Elevation difference between flight lines

Flight Area	Ilocos
Mission Name	**Blk5EF**
Inclusive Flights	7088G
Range data size	21.2 GB
Base data size	11.2 MB
POS	211 MB
Image	N/A
Transfer date	March 3, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	No
Processing Mode (<=1)	No
Smoothed Performance Metrics(in cm)	
RMSE for North Position (<4.0 cm)	1.3
RMSE for East Position (<4.0 cm)	1.4
RMSE for Down Position (<8.0 cm)	2.9
Boresight correction stdev (<0.001deg)	0.000312
IMU attitude correction stdev (<0.001deg)	0.0001893
GPS position stdev (<0.01m)	0.0093
Minimum % overlap (>25)	50.57%
Ave point cloud density per sq.m. (>2.0)	3.56
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	222
Maximum Height	349.30 m
Minimum Height	39.75 m
Classification (# of points)	
Ground	129,214,820
Low vegetation	316,462,897
Medium vegetation	240953904
High vegetation	257358666
Building	24520904
Orthophoto	No
Processed by	Engr. Irish Cortez, Celina Rosete, Engr. RoaShalemar Redo

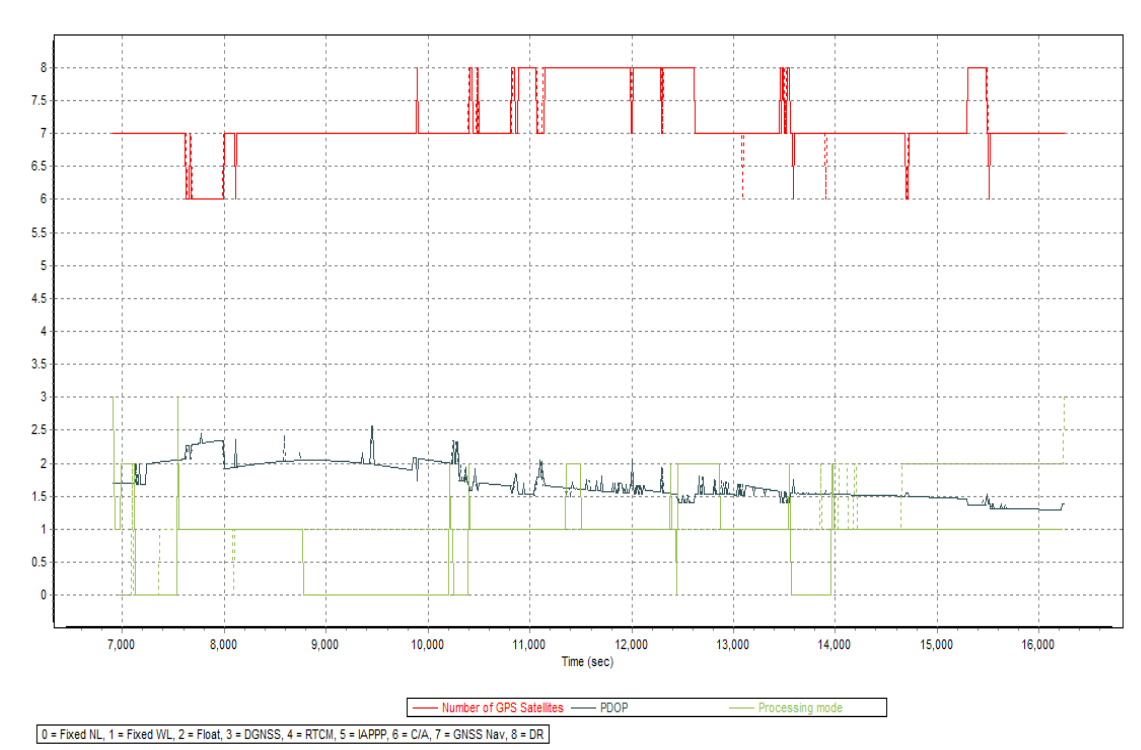


Figure 1.6.1. Solution Status

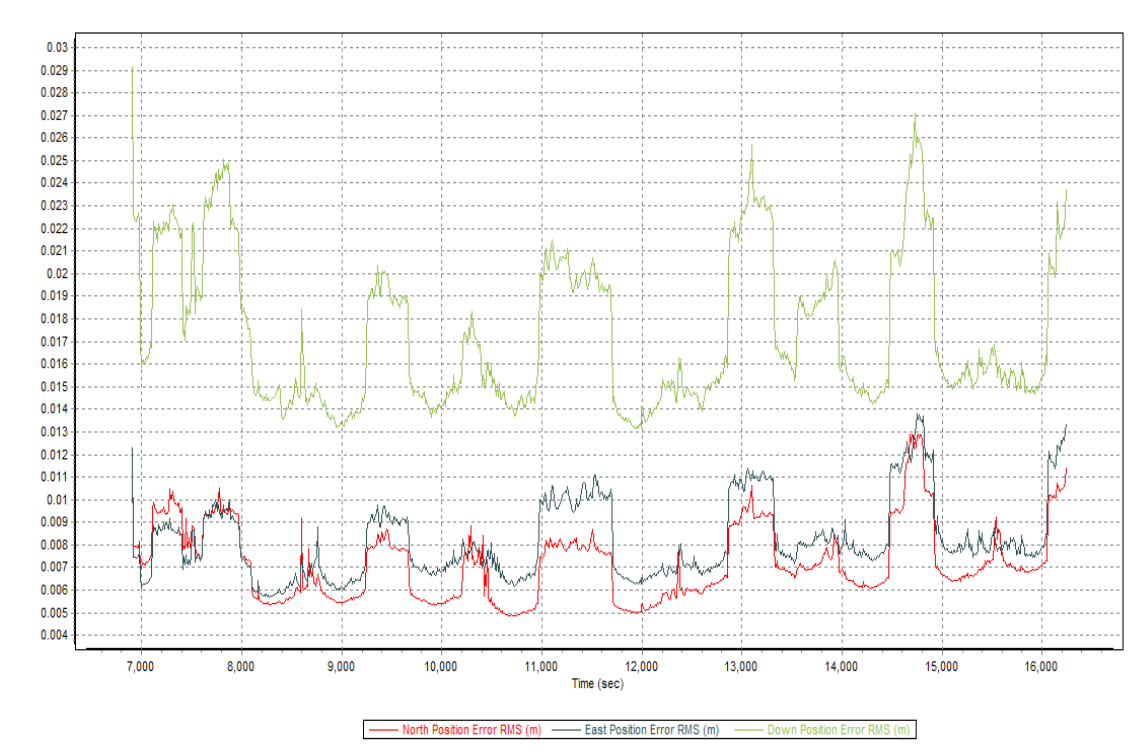


Figure 1.6.2. Smoothed Performance Metric Parameters

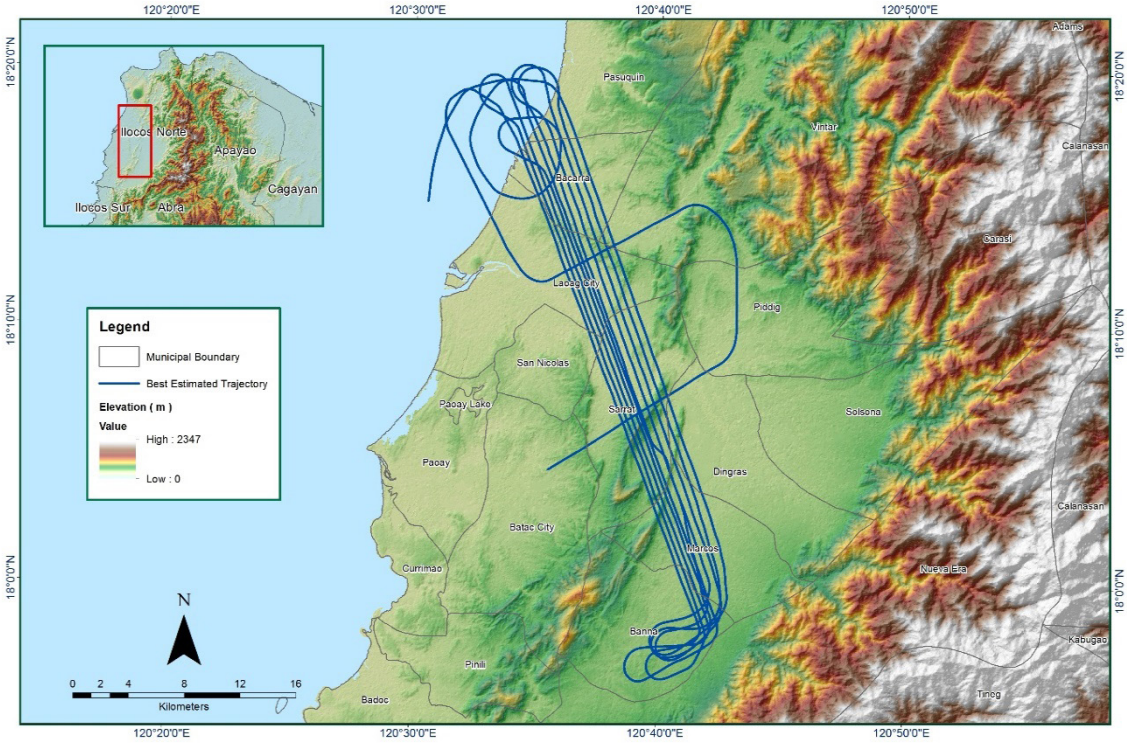


Figure 1.6.3. Best Estimated Trajectory

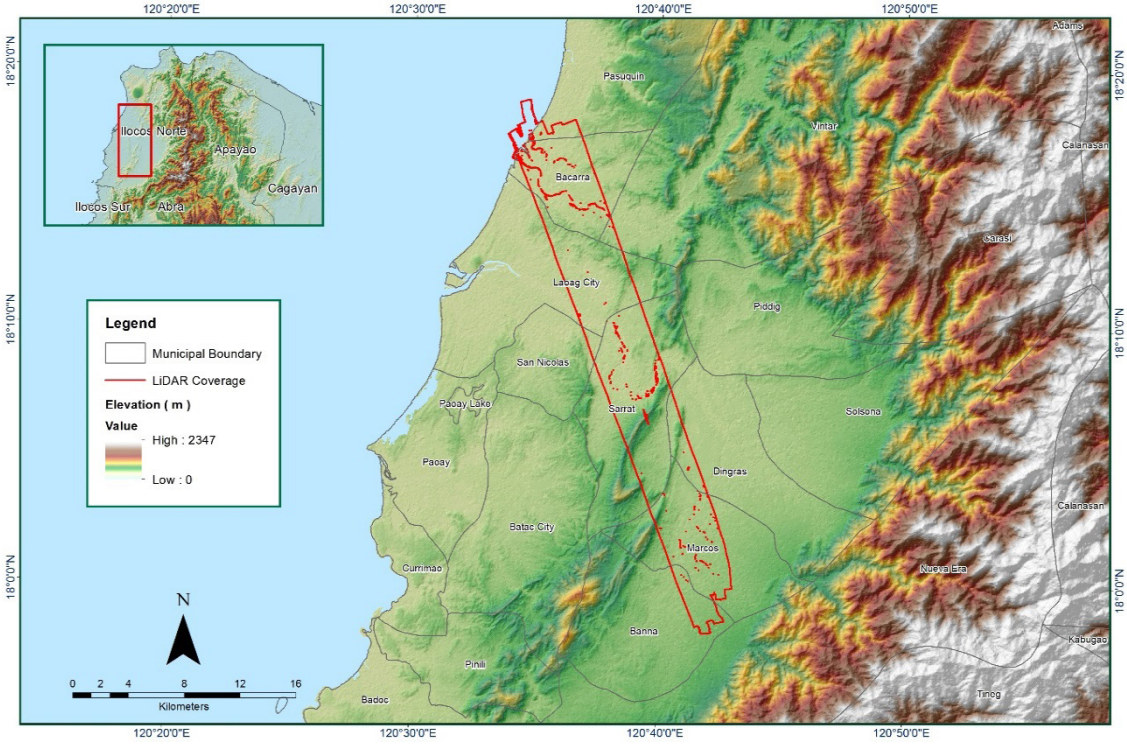


Figure 1.6.4. Coverage of LiDAR data

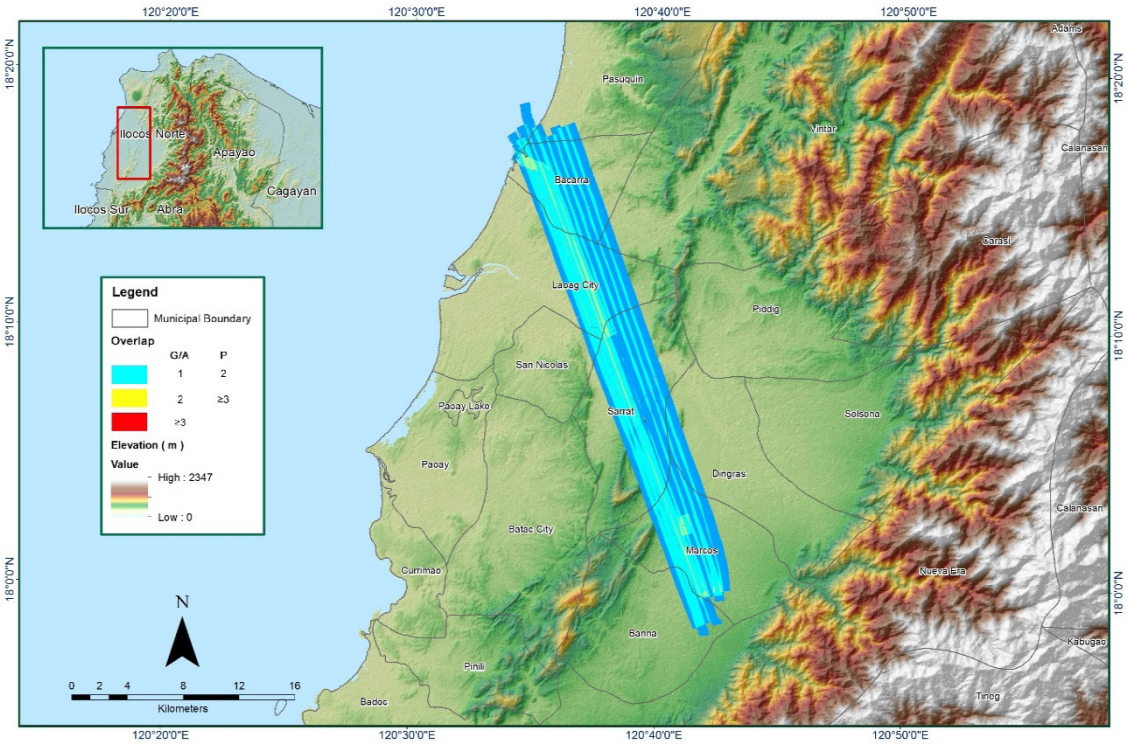


Figure 1.6.5. Image of data overlap

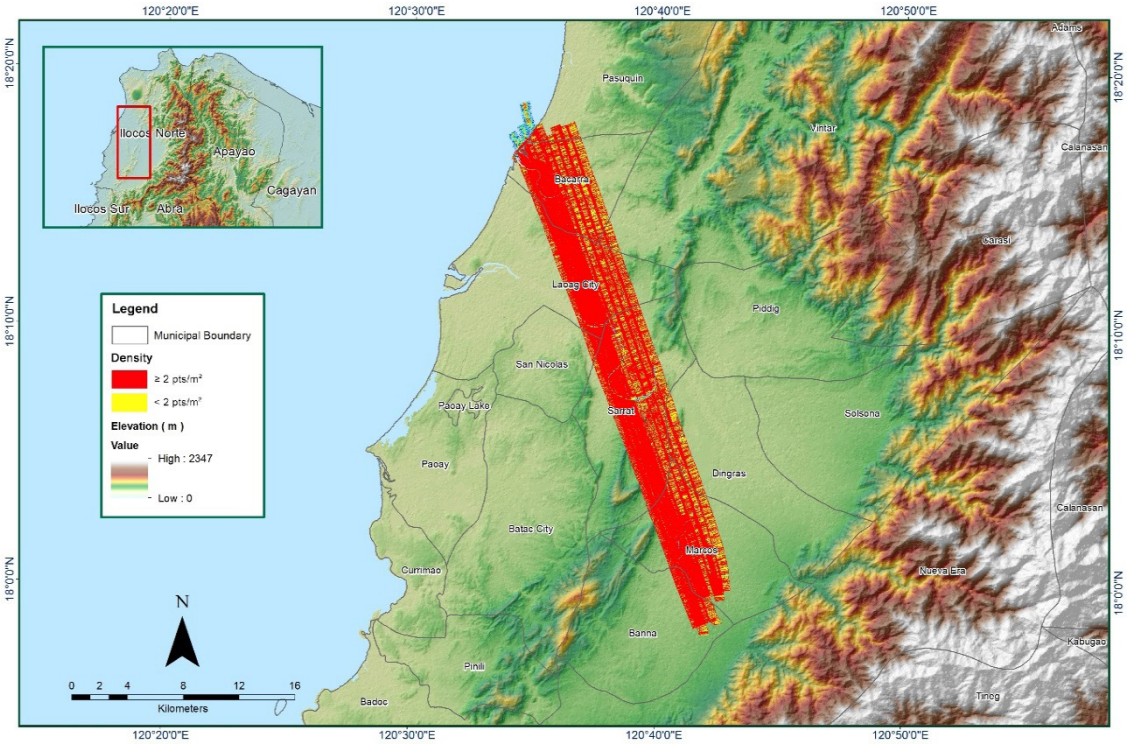


Figure 1.6.6. Density map of merged LiDAR data

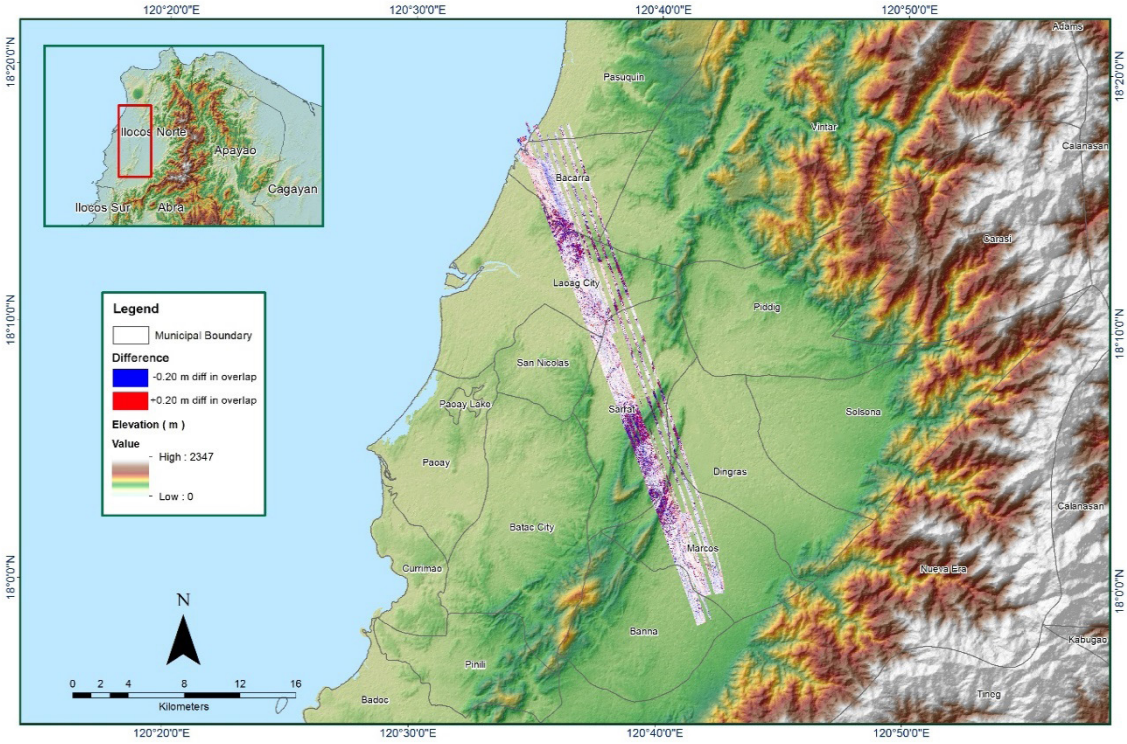


Figure 1.6.7. Elevation difference between flight lines

Flight Area	Ilocos
Mission Name	**Blk5EF additional**
Inclusive Flights	7087G
Range data size	26.2 GB
Base data size	12.3 MB
POS	247 MB
Image	N/A
Transfer date	March 3, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	No
Processing Mode (<=1)	No
Smoothed Performance Metrics(in cm)	
RMSE for North Position (<4.0 cm)	4.6
RMSE for East Position (<4.0 cm)	7.7
RMSE for Down Position (<8.0 cm)	8.4
Boresight correction stdev (<0.001deg)	0.000353
IMU attitude correction stdev (<0.001deg)	0.001157
GPS position stdev (<0.01m)	0.0031
Minimum % overlap (>25)	32.82%
Ave point cloud density per sq.m. (>2.0)	3.09
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	222
Maximum Height	466.06 m
Minimum Height	39.20 m
Classification (# of points)	
Ground	83,228,672
Low vegetation	90,581,648
Medium vegetation	104,895,186
High vegetation	167,061,020
Building	8,465,630
Orthophoto	No
Processed by	Victoria Rejuso, AljonRieAraneta, Engr. Ma. AilynOlanda

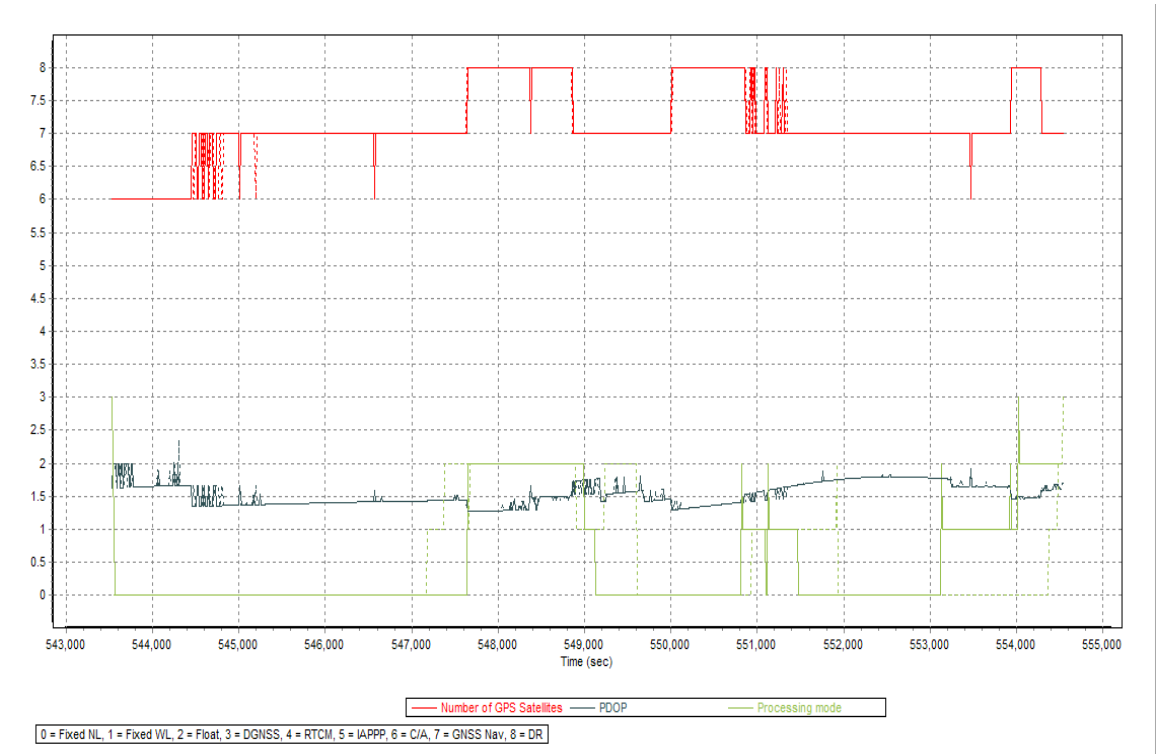


Figure 1.7.1. Solution Status

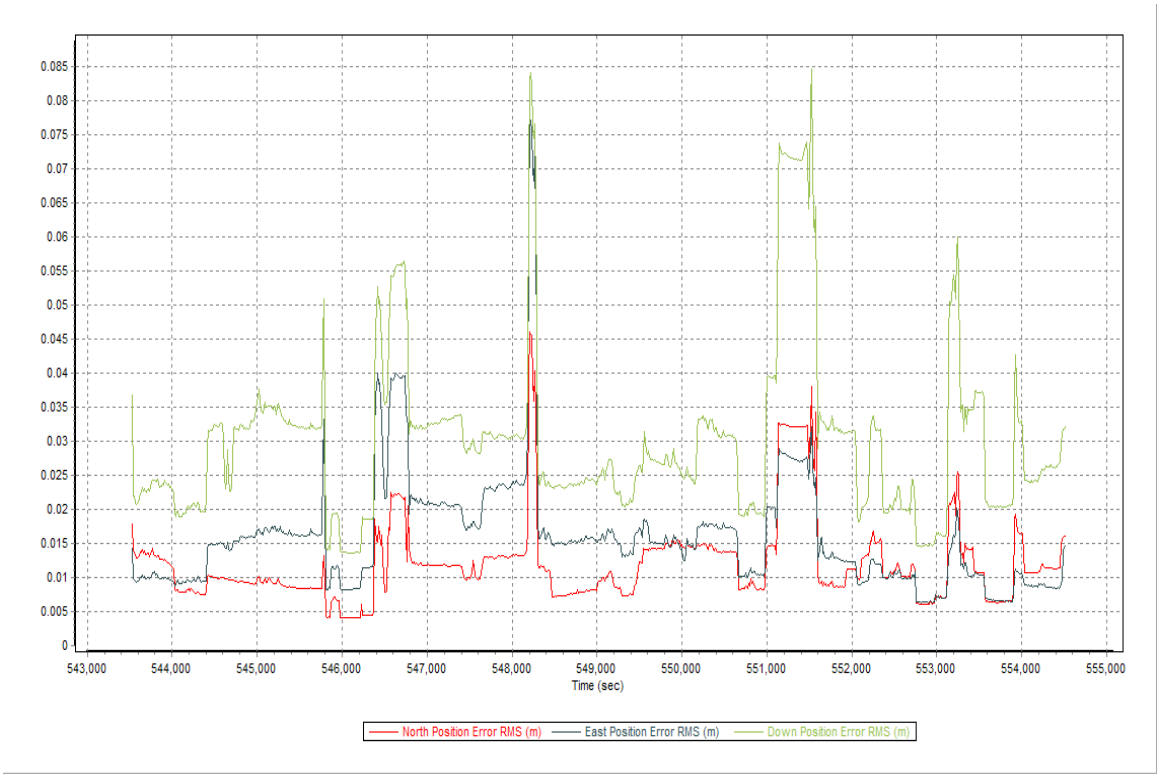


Figure 1.7.2. Smoothed Performance Metric Parameters

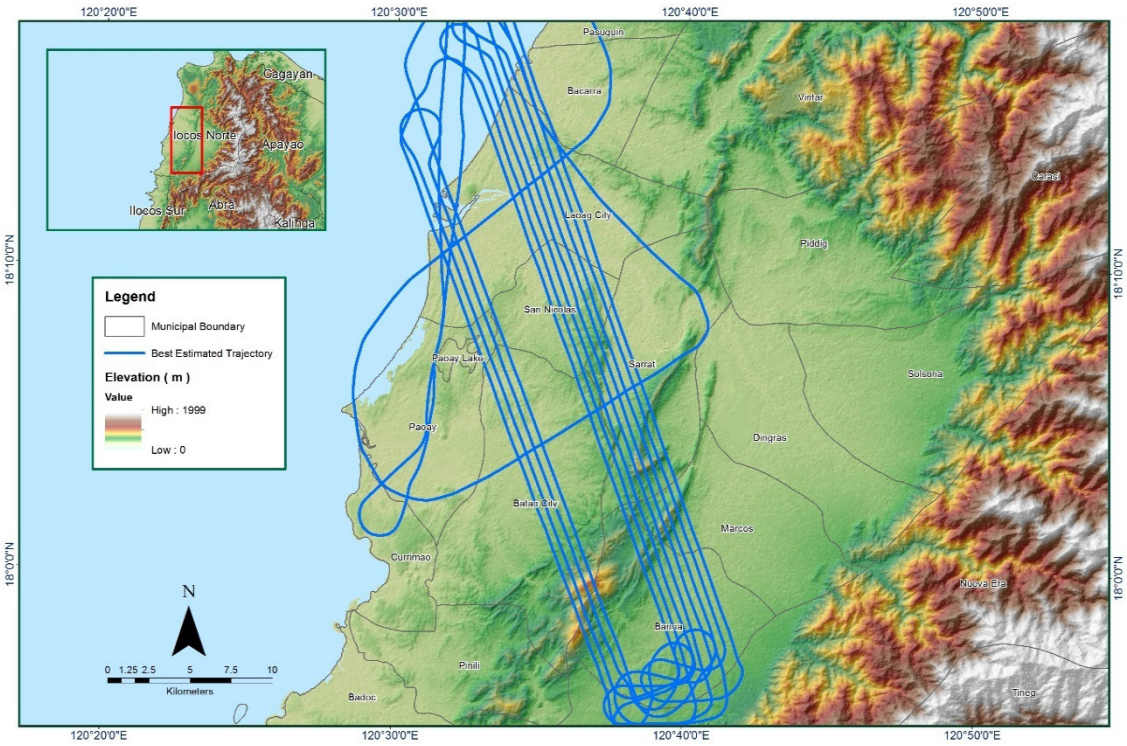


Figure 1.7.3. Best Estimated Trajectory

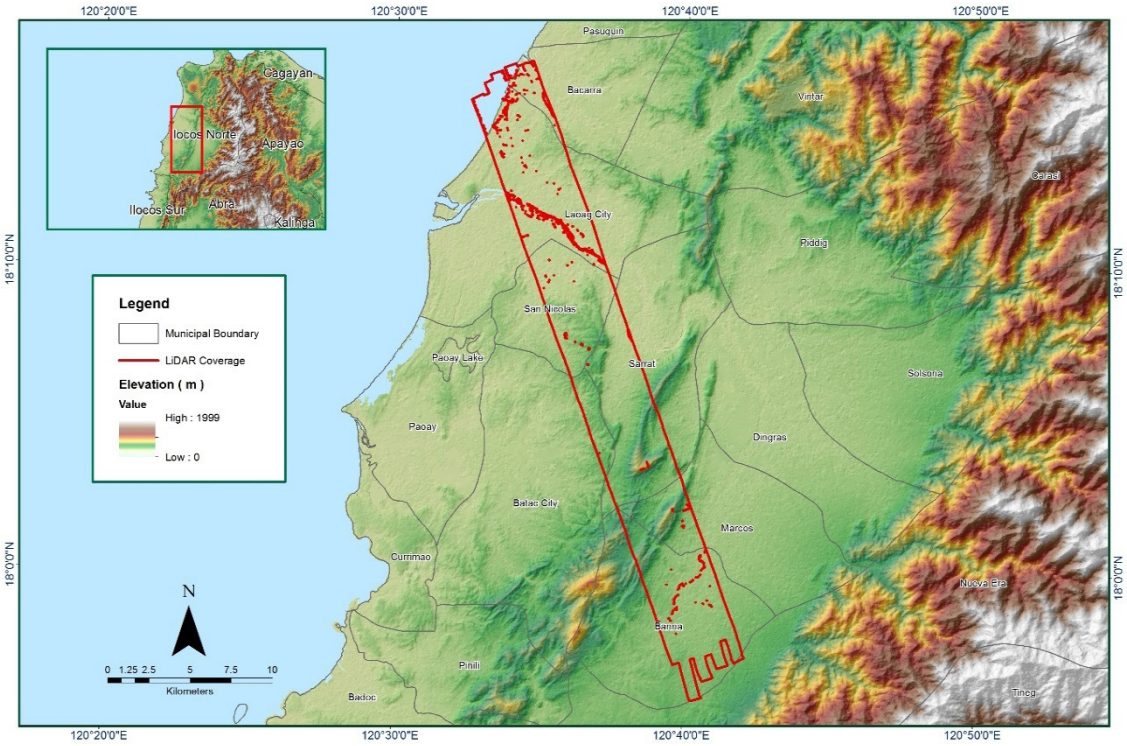


Figure 1.7.4. Coverage of LiDAR data

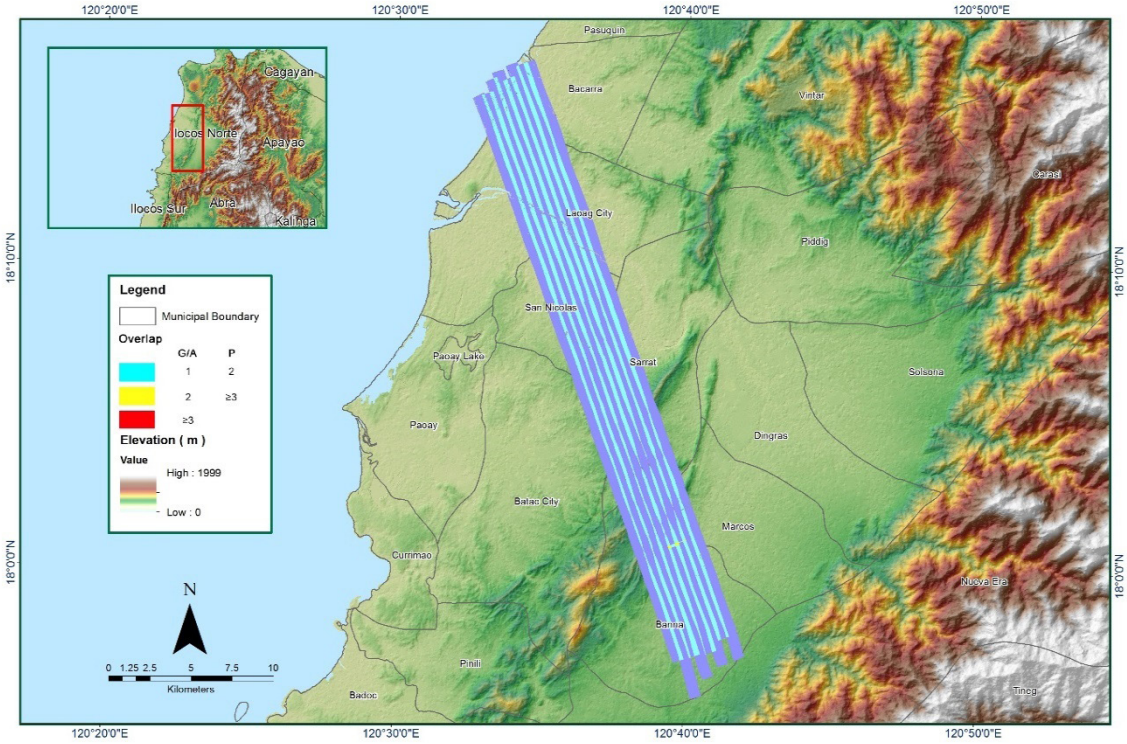


Figure 1.7.5. Image of data overlap

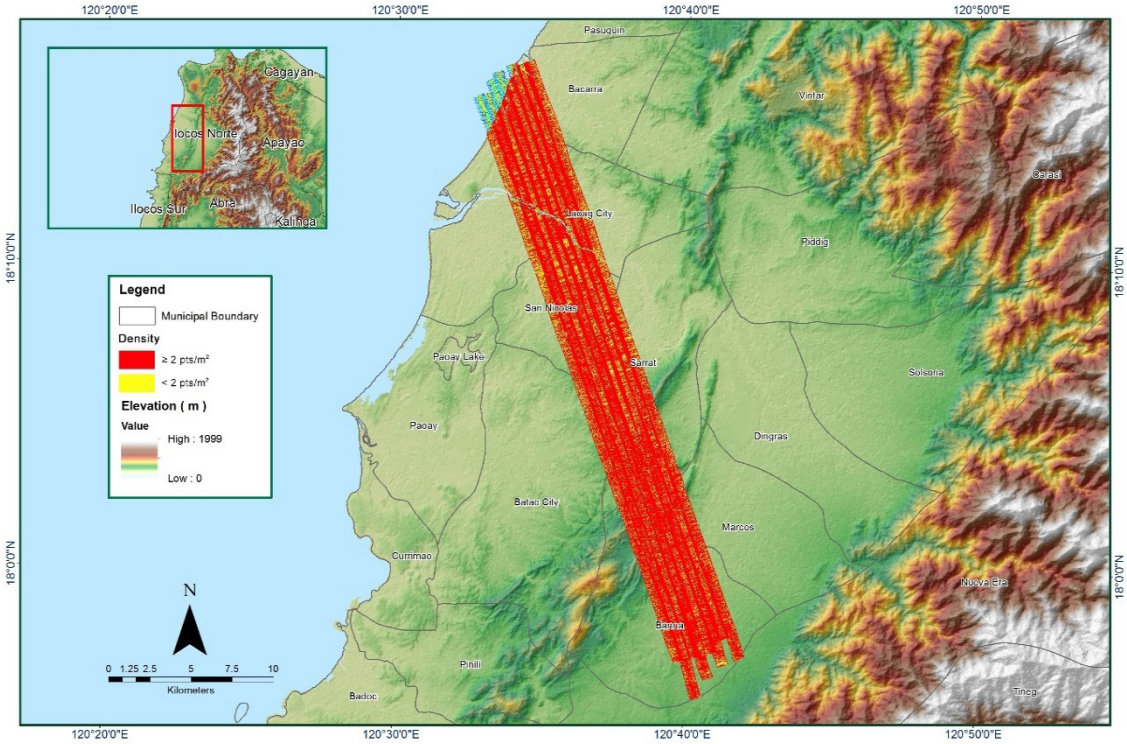


Figure 1.7.6. Density map of merged LiDAR data

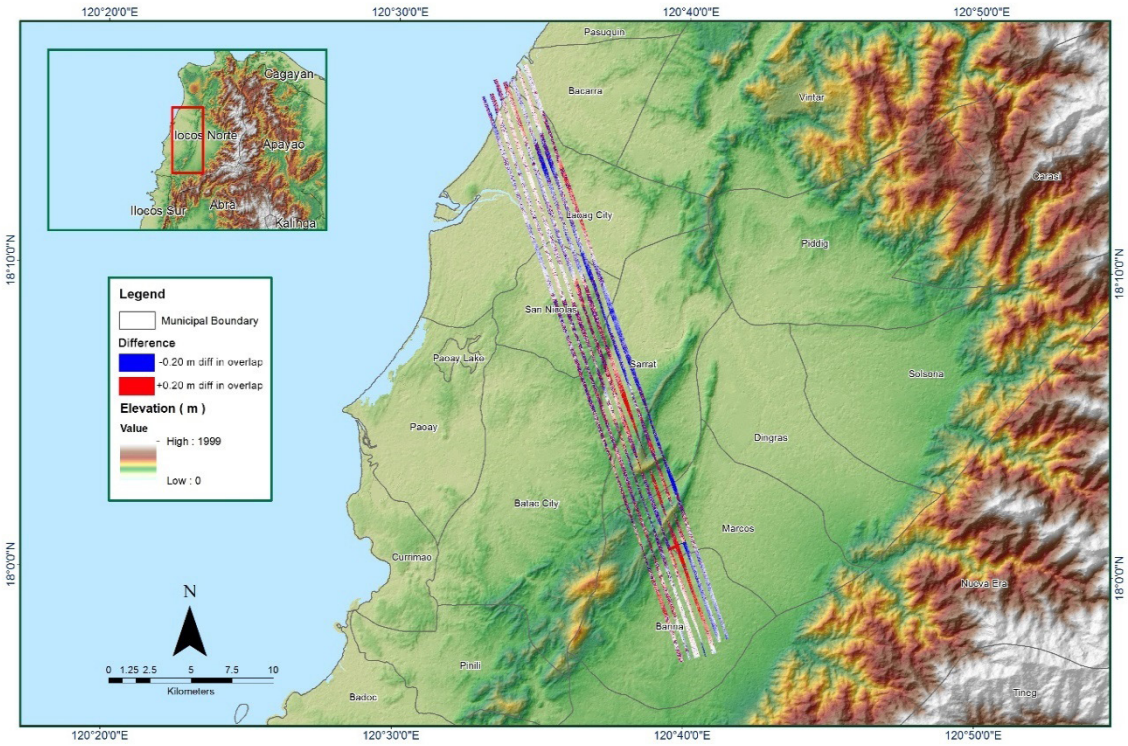


Figure 1.7.7. Elevation difference between flight lines

Flight Area	Ilocos
Mission Name	**Blk5E_supplement**
Inclusive Flights	7103GC
Range data size	8.39 GB
Base data size	692 KB
POS	136 MB
Image	N/A
Transfer date	March 3, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	No
Baseline Length (<30km)	No
Processing Mode (<=1)	No
Smoothed Performance Metrics(in cm)	
RMSE for North Position (<4.0 cm)	6.1
RMSE for East Position (<4.0 cm)	5.4
RMSE for Down Position (<8.0 cm)	1.1
Boresight correction stdev (<0.001deg)	0.000312
IMU attitude correction stdev (<0.001deg)	0.001893
GPS position stdev (<0.01m)	0.0093
Minimum % overlap (>25)	37.72%
Ave point cloud density per sq.m. (>2.0)	3.05
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	103
Maximum Height	180.33 m
Minimum Height	39.57 m
Classification (# of points)	
Ground	45,668,783
Low vegetation	55,842,716
Medium vegetation	48,568,491
High vegetation	46,041,084
Building	4,125,980
Orthophoto	No
Processed by	Engr. Angelo Carlo Bongat, Engr. Christy Lubiano, Engr. Gladys Mae Apat

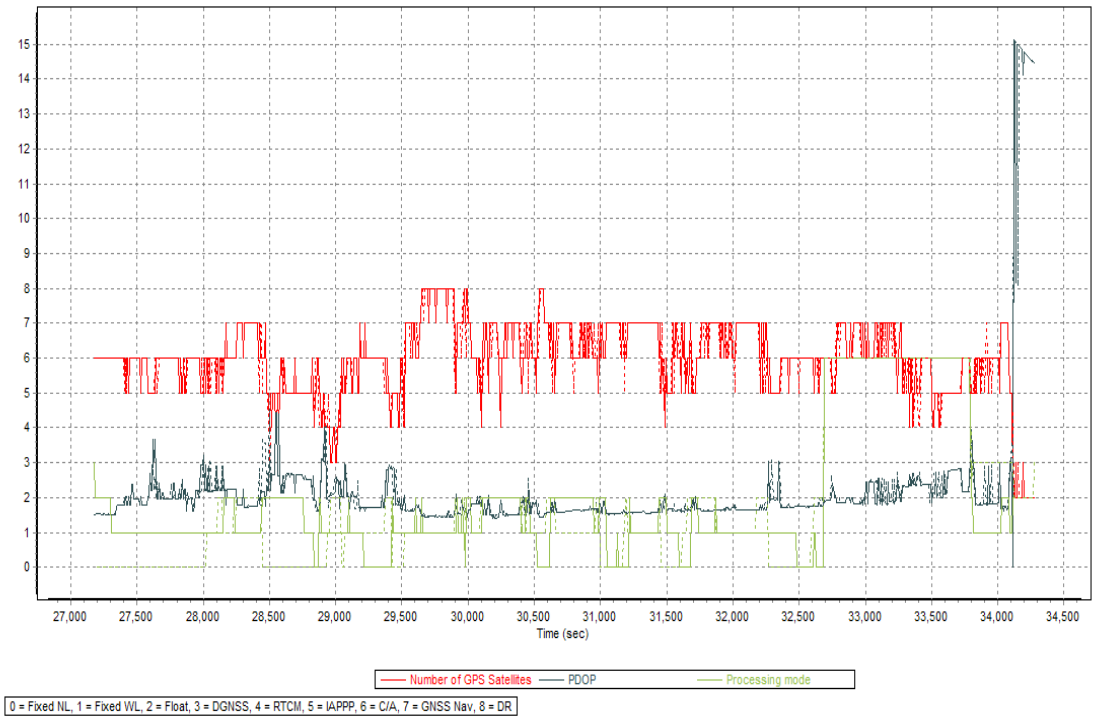


***Figure** 1.8.1. Solution Status*

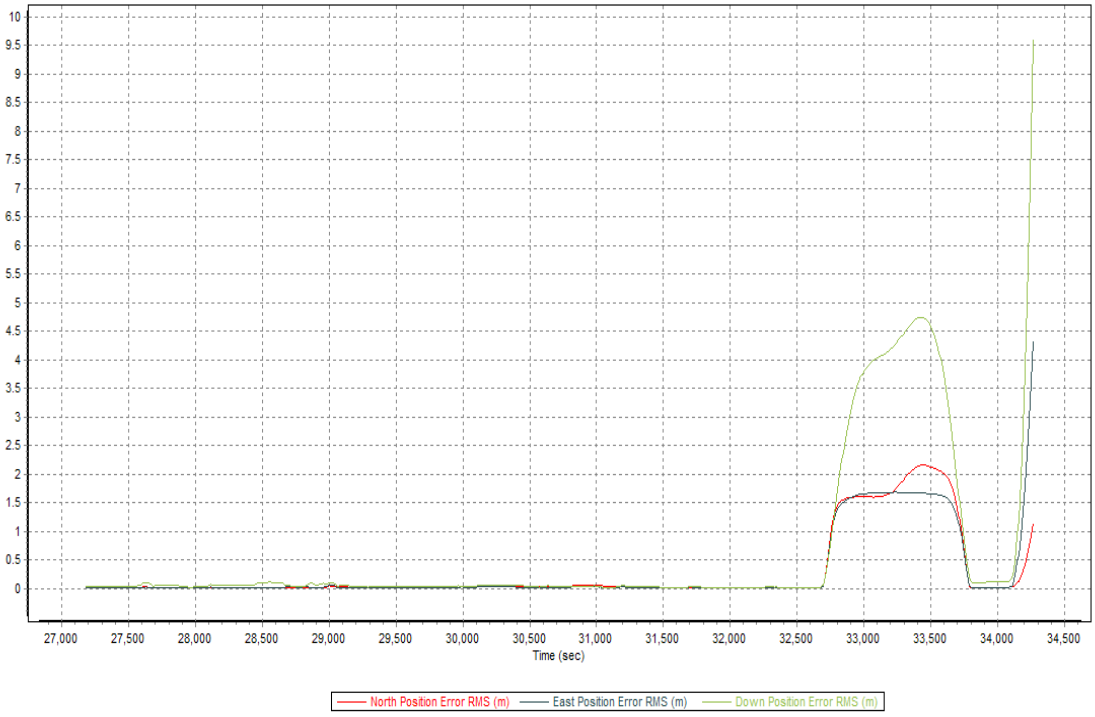


Figure 1.8.2. Smoothed Performance Metric Parameters

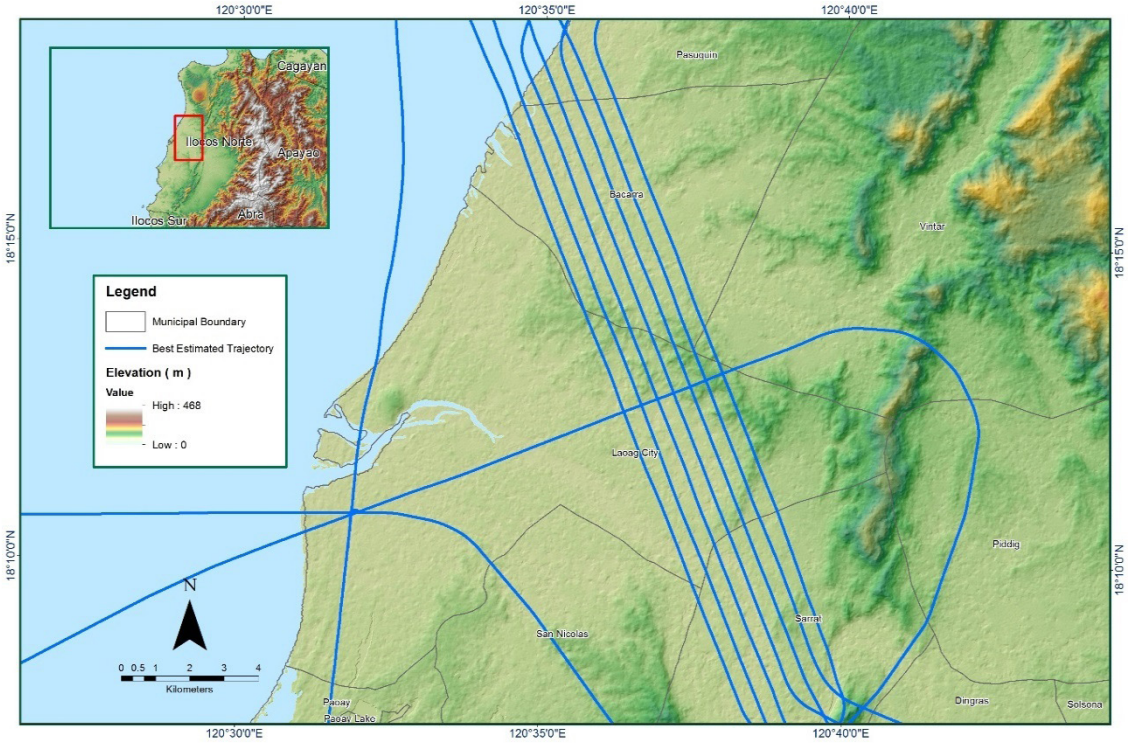


Figure 1.8.3. Best Estimated Trajectory

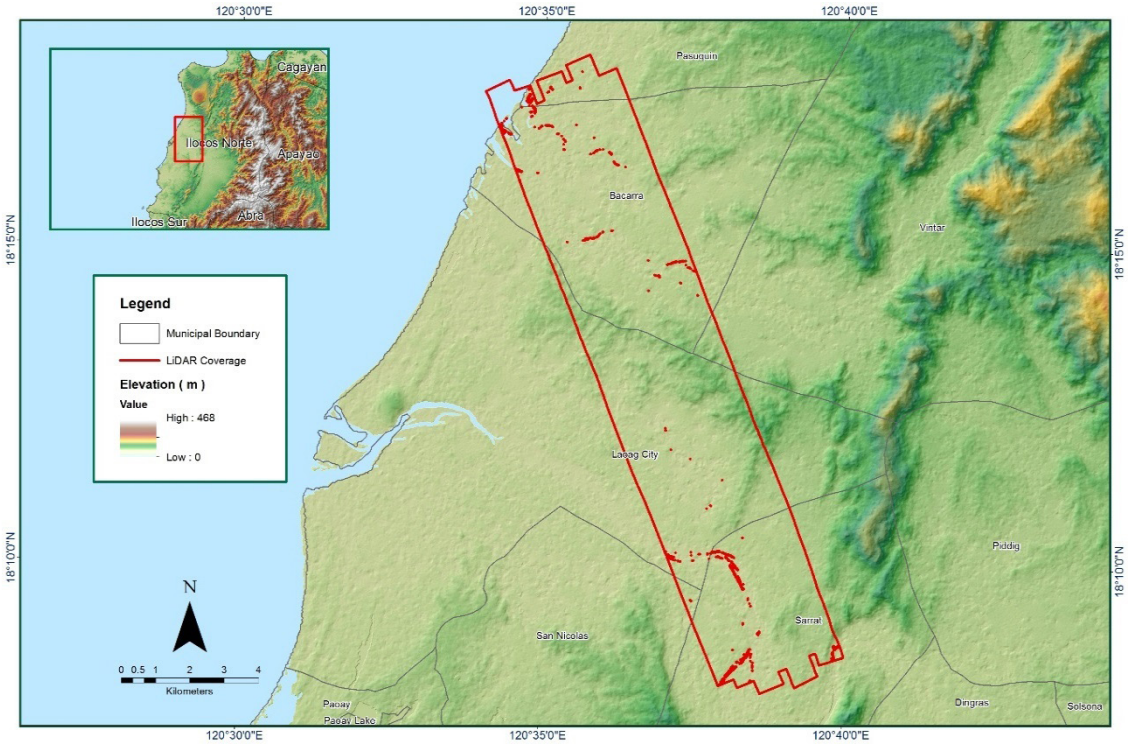


Figure 1.8.4. Coverage of LiDAR data

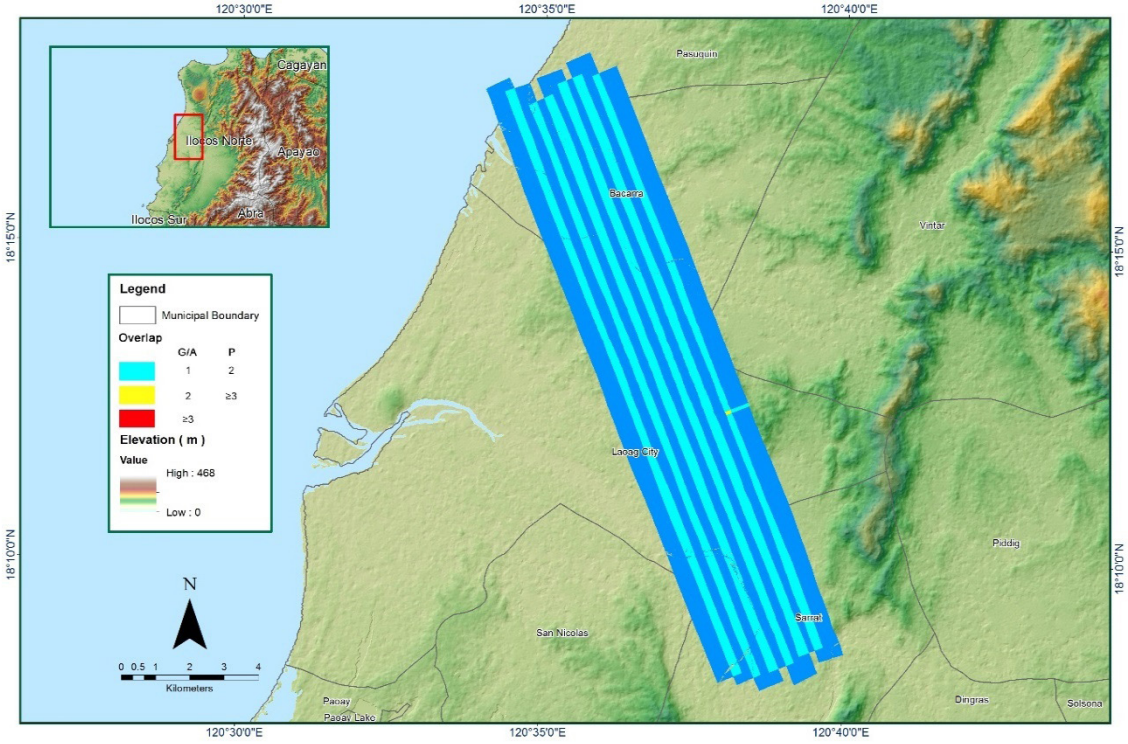


Figure 1.8.5. Image of data overlap

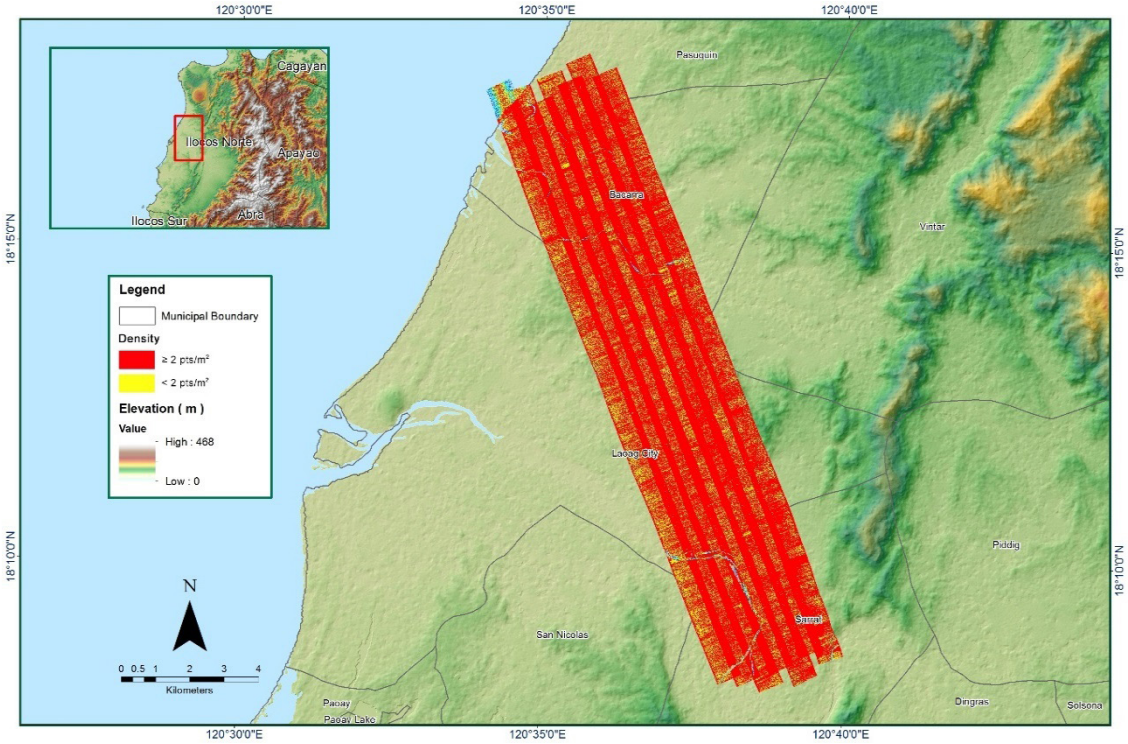


Figure 1.8.6. Density map of merged LiDAR data

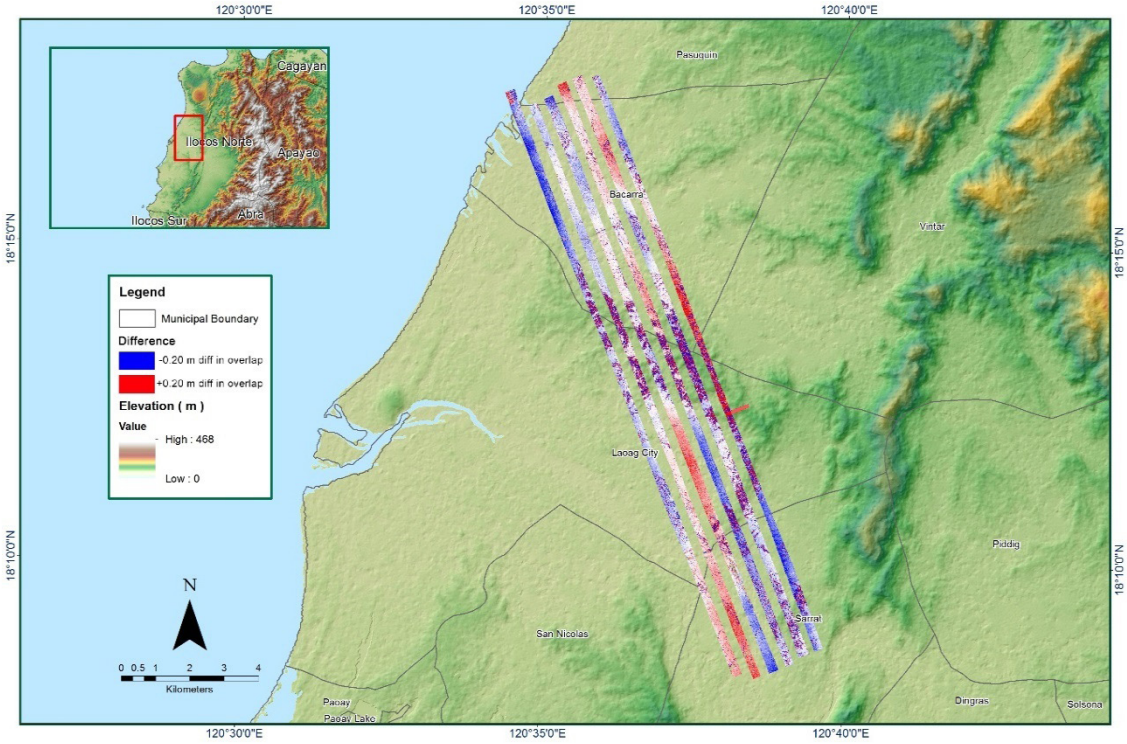


Figure 1.8.7. Elevation difference between flight lines

Flight Area	Ilocos
Mission Name	**Blk05FG_additional**
Inclusive Flights	7087G
Range data size	26.2GB
Base data size	12.3 MB
POS	247MB
Image	N/A
Transfer date	April 25, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	No
Processing Mode (<=1)	No
Smoothed Performance Metrics(in cm)	
RMSE for North Position (<4.0 cm)	2.9
RMSE for East Position (<4.0 cm)	5.2
RMSE for Down Position (<8.0 cm)	9.6
Boresight correction stdev (<0.001deg)	0.000323
IMU attitude correction stdev (<0.001deg)	0.000528
GPS position stdev (<0.01m)	0.0111
Minimum % overlap (>25)	21.67%
Ave point cloud density per sq.m. (>2.0)	2.87
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	131
Maximum Height	39.50 m
Minimum Height	589.13 m
Classification (# of points)	
Ground	35,485,459
Low vegetation	36,495,875
Medium vegetation	46,829,856
High vegetation	80,548,539
Building	2,331,876
Orthophoto	No
Processed by	Victoria Rejuso, Engr. Antonio Chua Jr., Engr. Melissa Fernandez

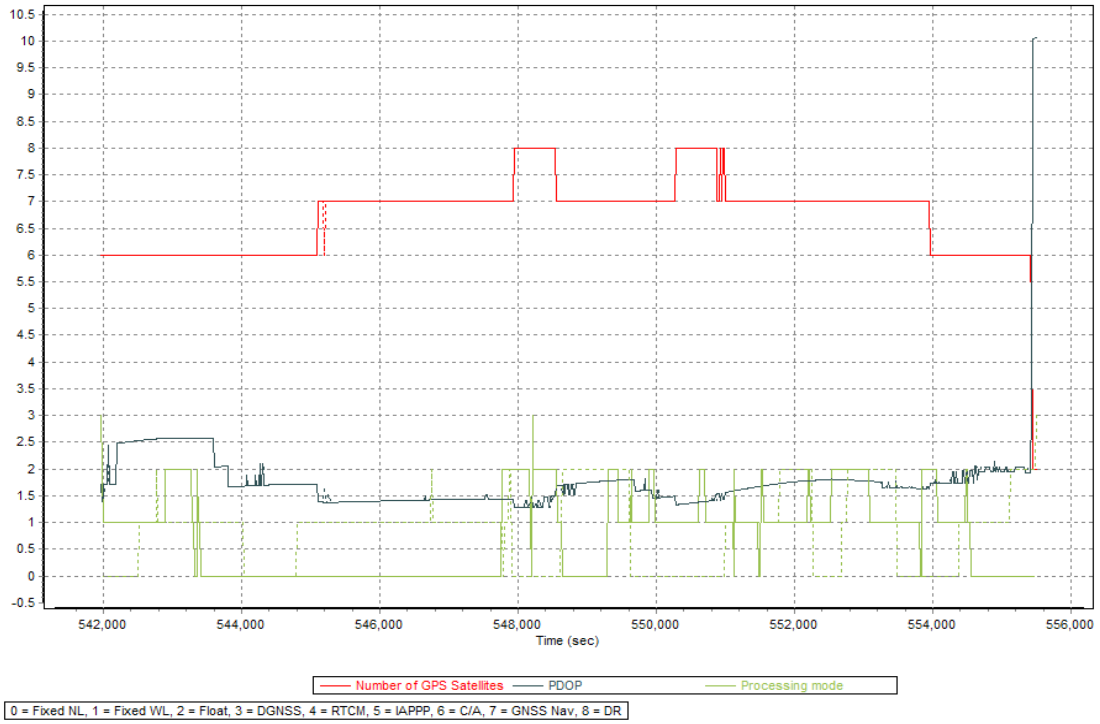


Figure 1.9.1. Solution Status

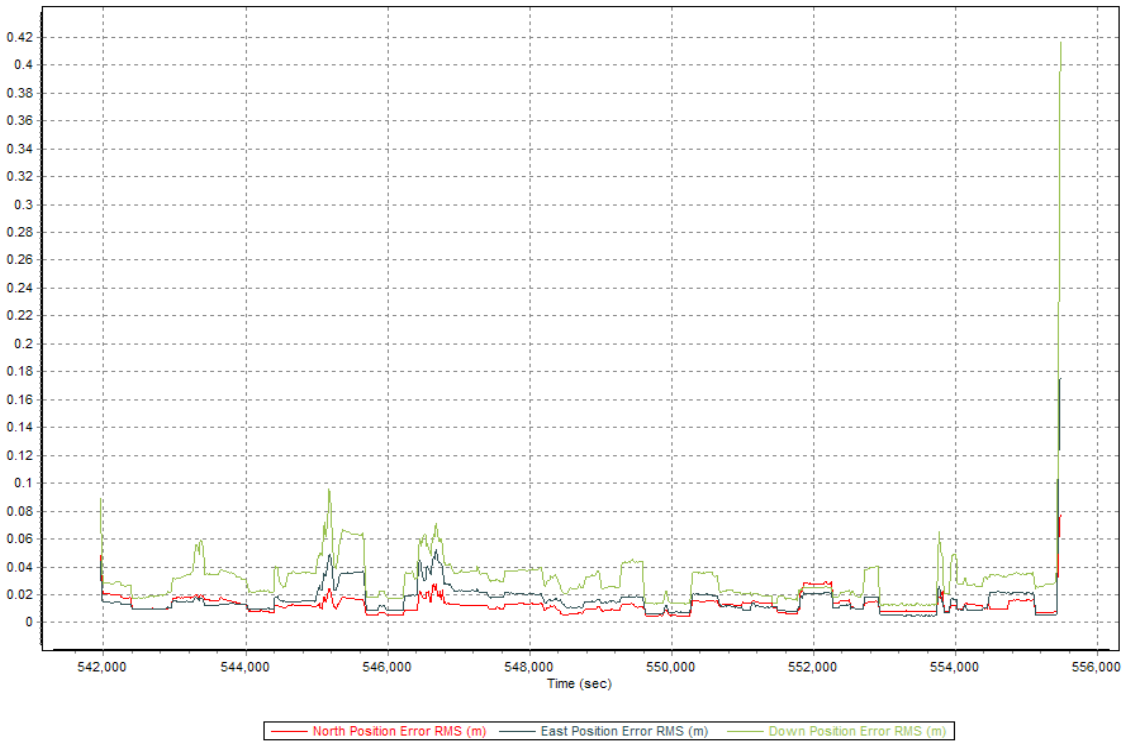


Figure 1.9.2. Smoothed Performance Metric Parameters

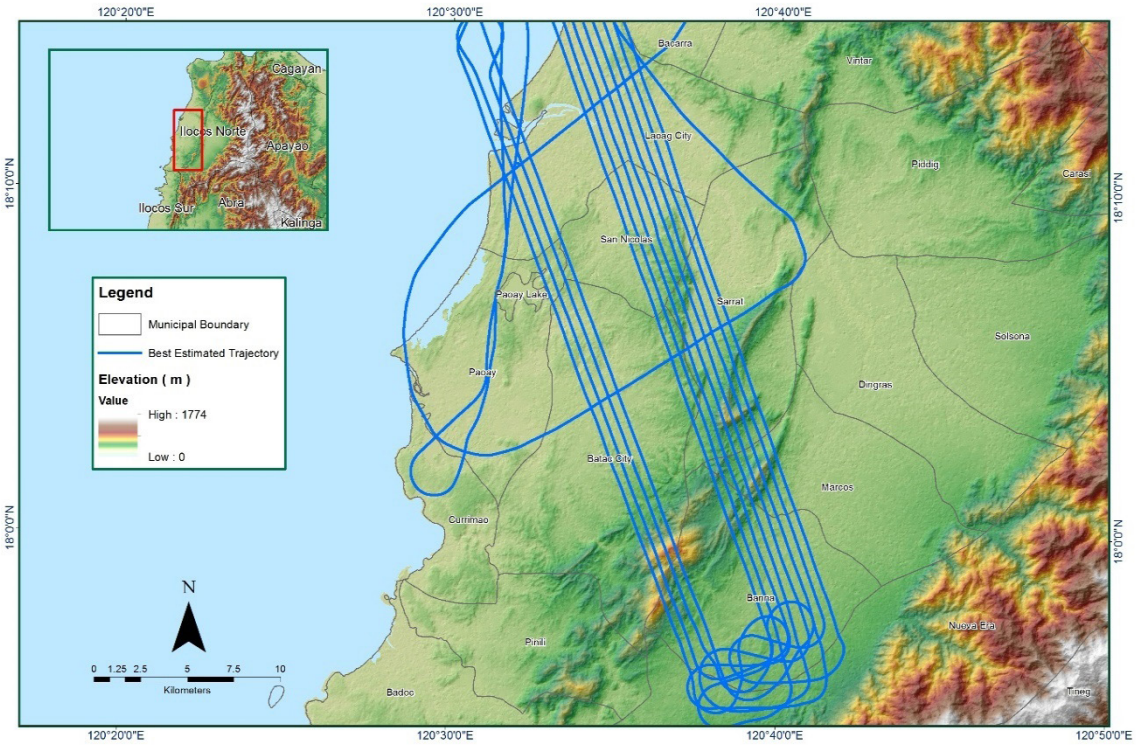


Figure 1.9.3. Best Estimated Trajectory

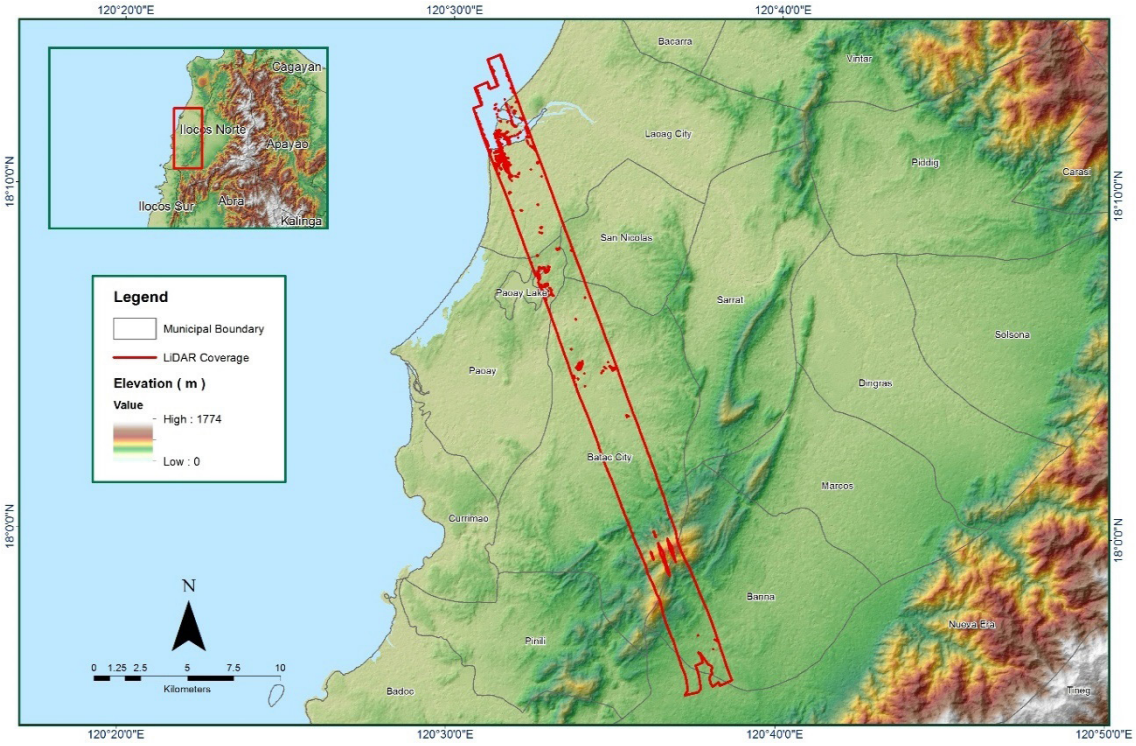


Figure 1.9.4. Coverage of LiDAR data

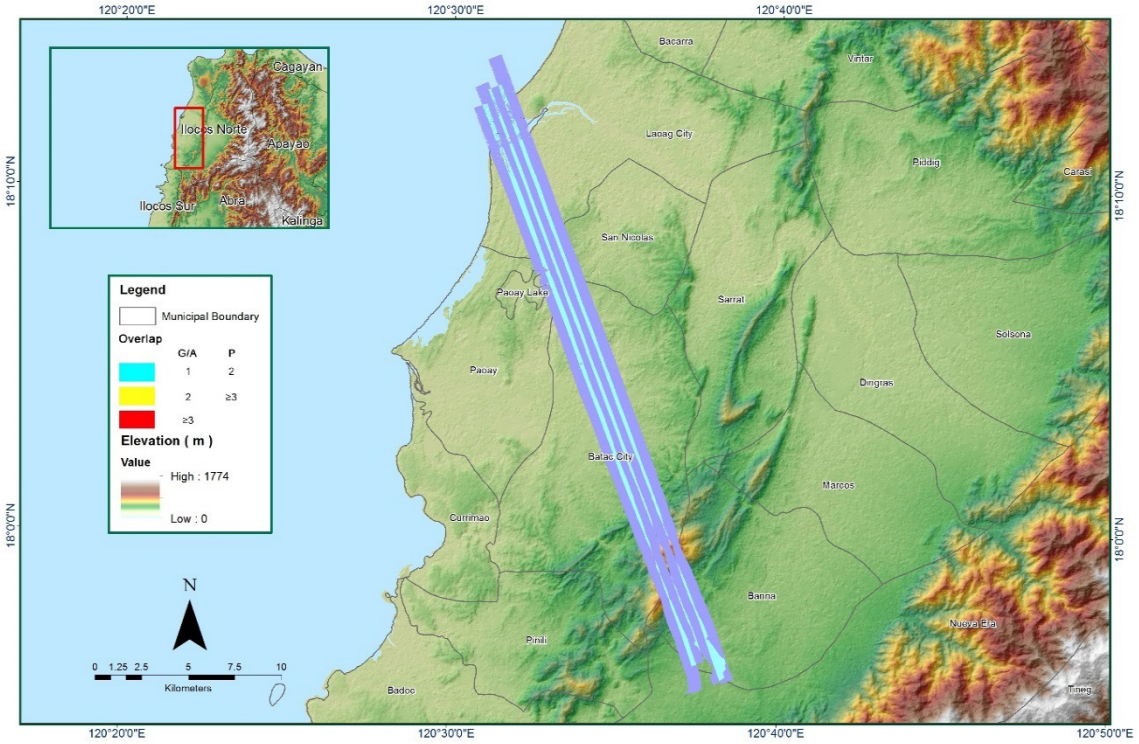


Figure 1.9.5. Image of data overlap

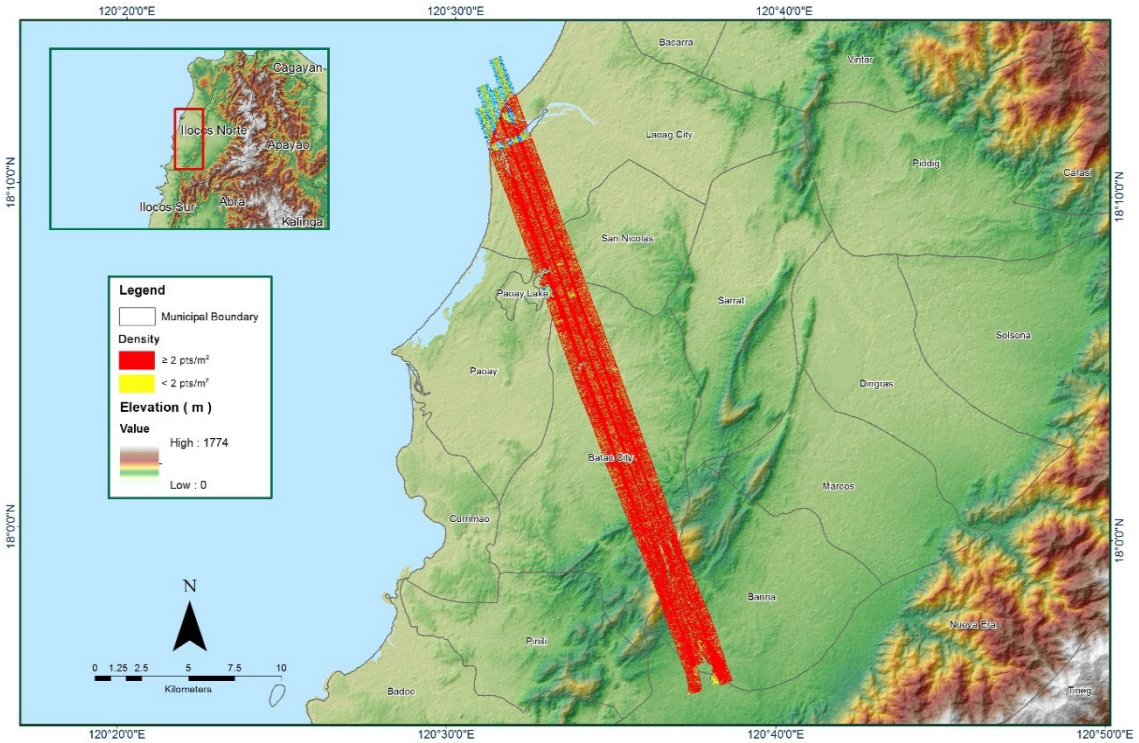


Figure 1.9.6. Density map of merged LiDAR data

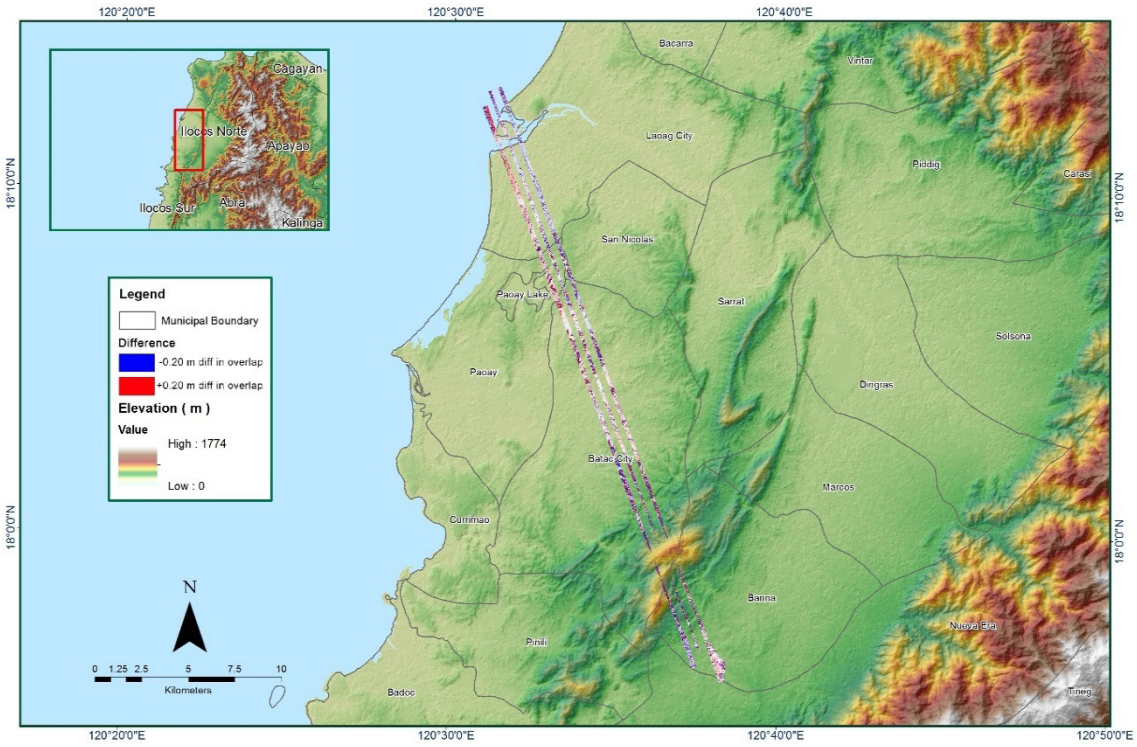


Figure 1.9.7. Elevation difference between flight lines

Flight Area	Ilocos
Mission Name	**Blk05_G**
Inclusive Flights	7085G
Range data size	13.9 GB
Base data size	11.6 MB
POS	158 MB
Image	N/A
Transfer date	April 25, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	Yes
Processing Mode (<=1)	No
Smoothed Performance Metrics(in cm)	
RMSE for North Position (<4.0 cm)	3.1
RMSE for East Position (<4.0 cm)	3.7
RMSE for Down Position (<8.0 cm)	9.2
Boresight correction stdev (<0.001deg)	0.000673
IMU attitude correction stdev (<0.001deg)	0.000756
GPS position stdev (<0.01m)	0.0112
Minimum % overlap (>25)	84.28%
Ave point cloud density per sq.m. (>2.0)	5.65
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	176
Maximum Height	537.85 m
Minimum Height	38.95 m
Classification (# of points)	
Ground	62,450,922
Low vegetation	62,751,467
Medium vegetation	74,301,334
High vegetation	133,270,609
Building	3,941,158
Orthophoto	No
Processed by	Victoria Rejuso, Engr. Antonio Chua Jr., Engr. Jeffrey Delica

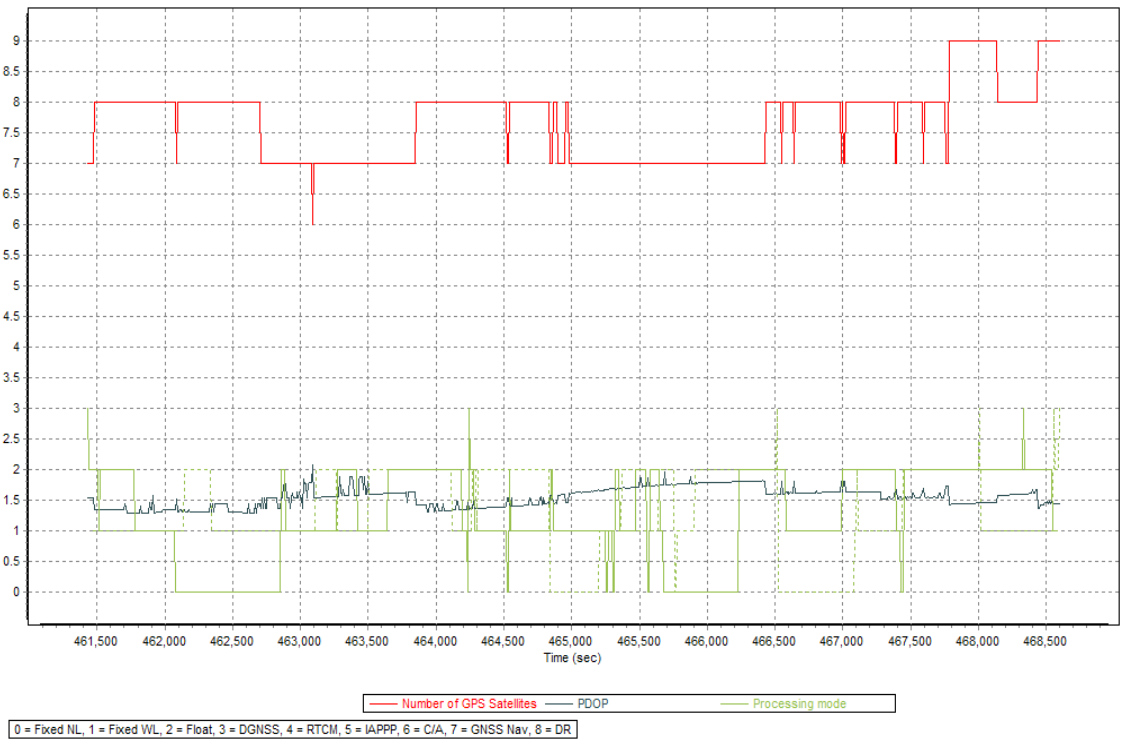


Figure 1.10.1. Solution Status

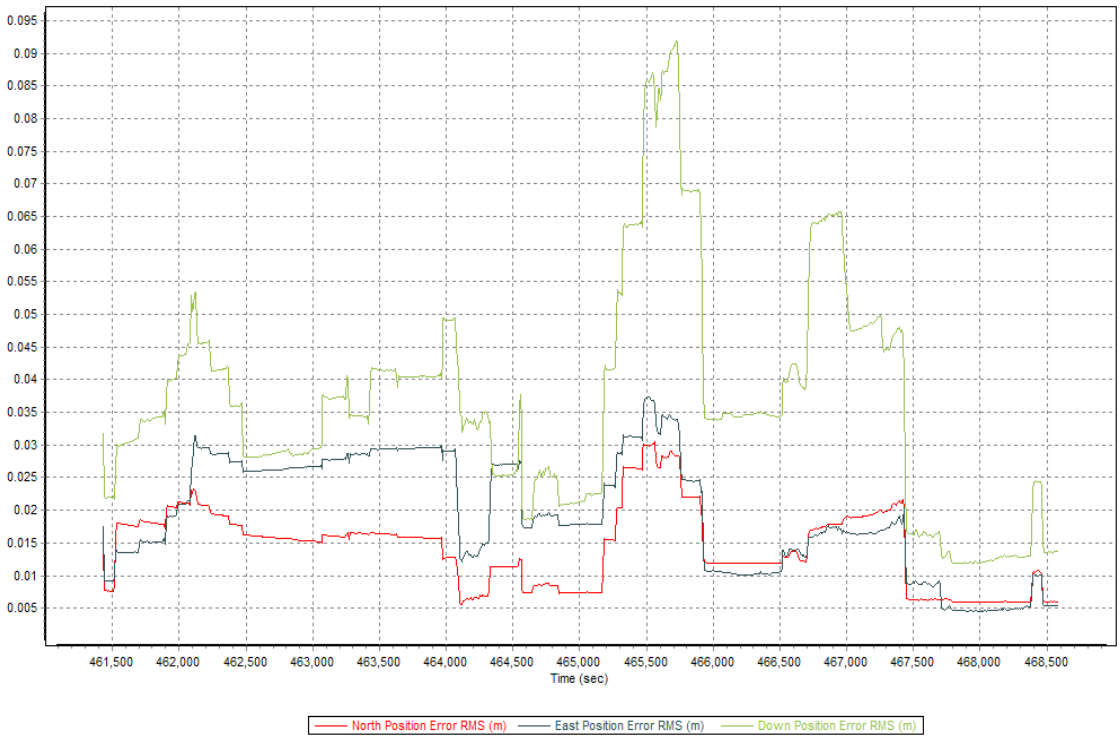


Figure 1.10.2. Smoothed Performance Metric Parameters

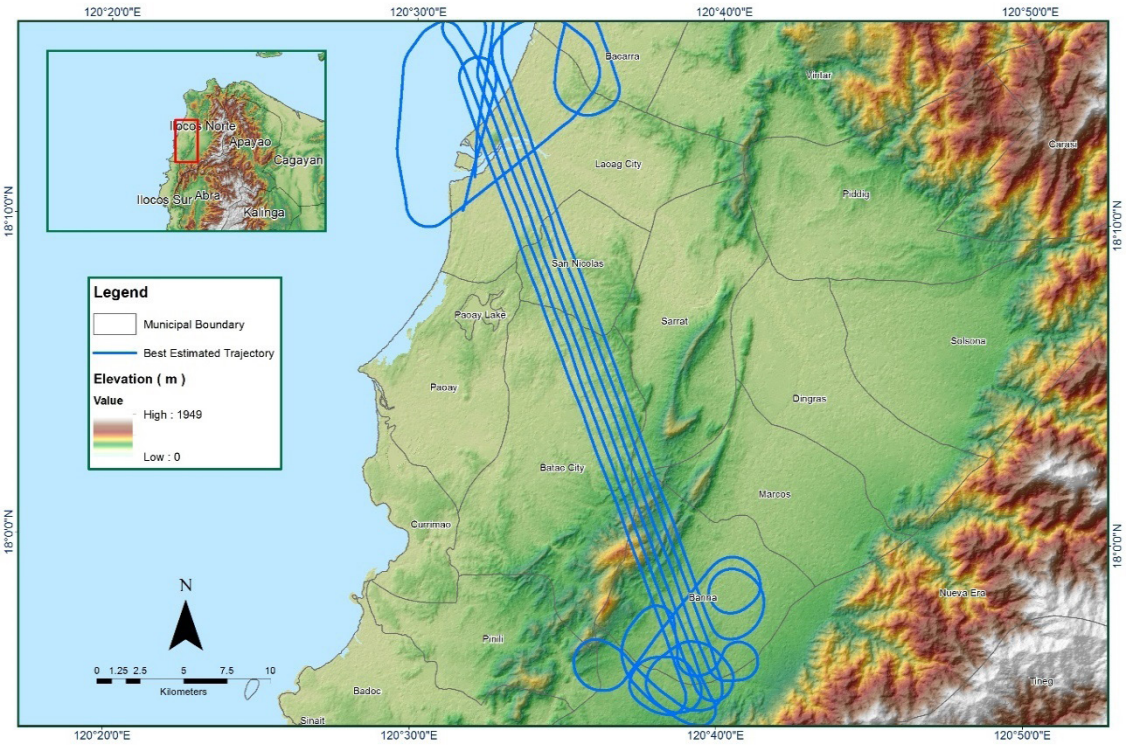


Figure 1.10.3. Best Estimated Trajectory

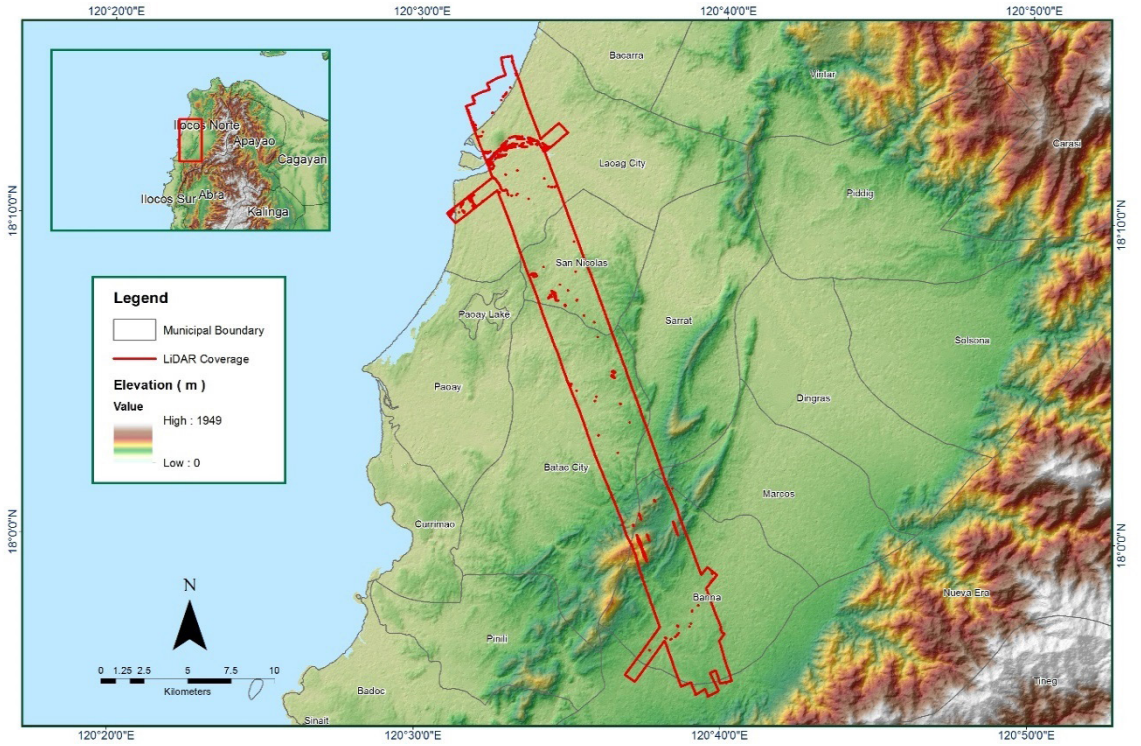


Figure 1.10.4. Coverage of LiDAR data

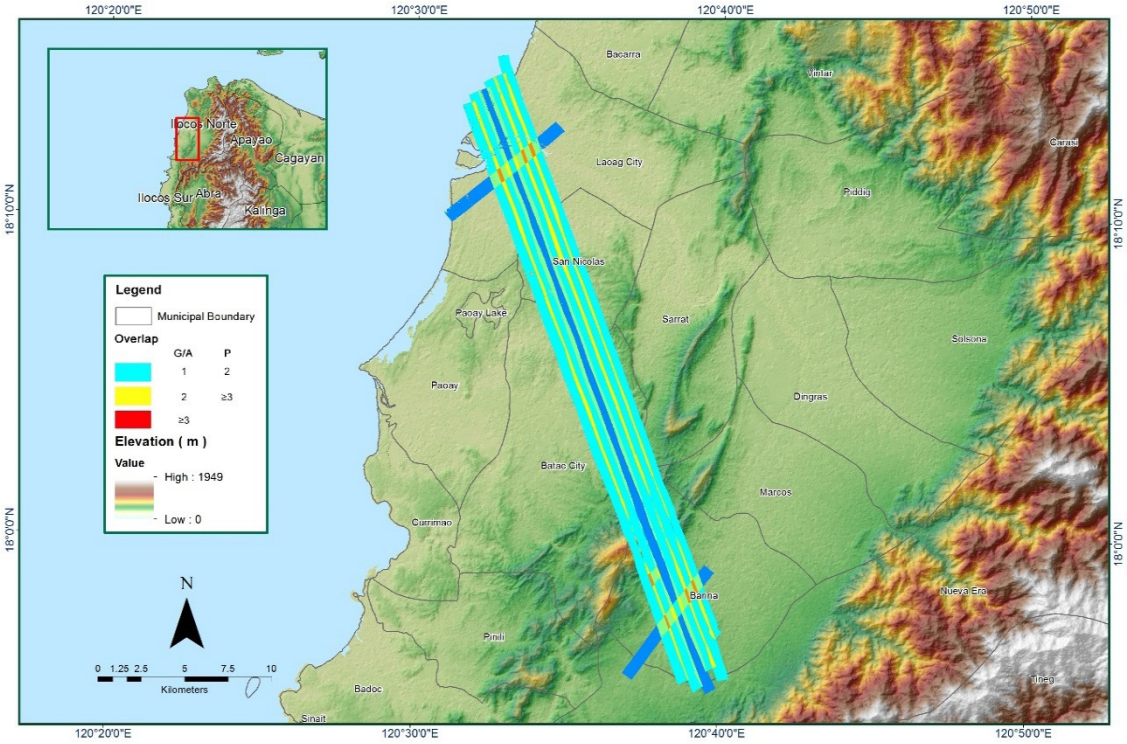


Figure 1.10.5. Image of data overlap

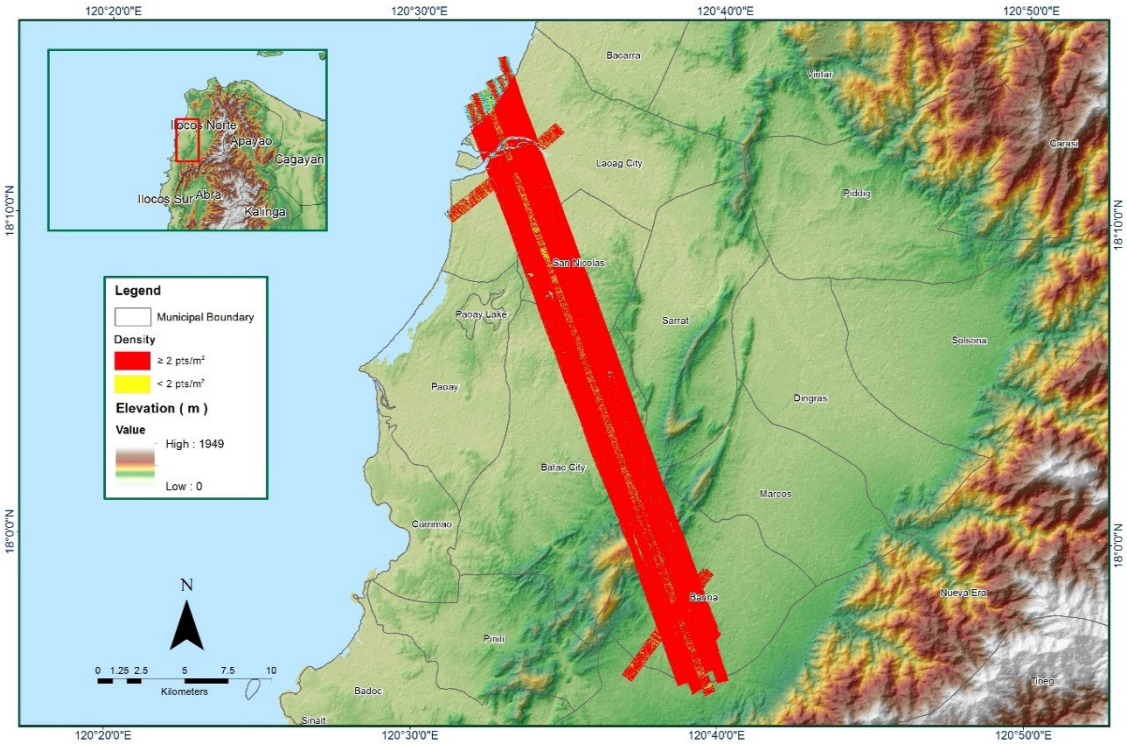


Figure 1.10.6. Density map of merged LiDAR data

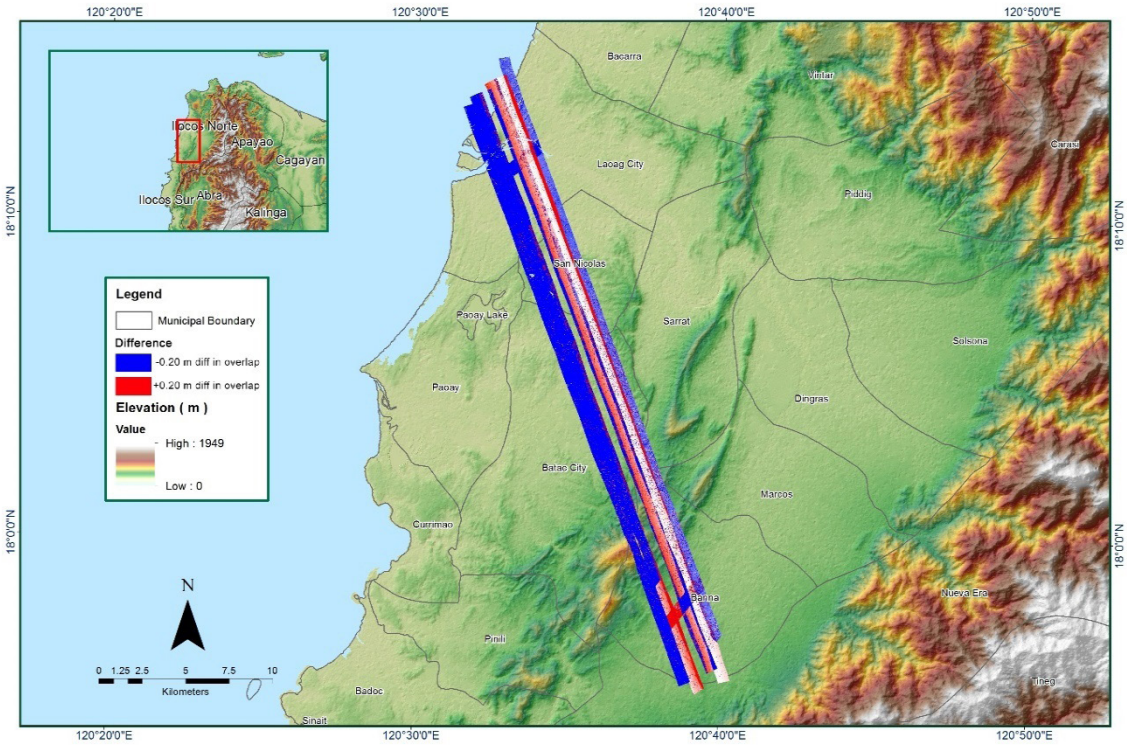


Figure 1.10.7. Elevation difference between flight lines

Flight Area	Ilocos
Mission Name	**Blk05_H**
Inclusive Flights	7086G
Range data size	27.5GB
Base data size	12.9 MB
POS	227MB
Image	N/A
Transfer date	April 25, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	Yes
Processing Mode (<=1)	No
Smoothed Performance Metrics(in cm)	
RMSE for North Position (<4.0 cm)	2.3
RMSE for East Position (<4.0 cm)	1.7
RMSE for Down Position (<8.0 cm)	4.6
Boresight correction stdev (<0.001deg)	0.000303
IMU attitude correction stdev (<0.001deg)	0.002460
GPS position stdev (<0.01m)	0.0085
Minimum % overlap (>25)	50.03%
Ave point cloud density per sq.m. (>2.0)	4.34
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	225
Maximum Height	588.11 m
Minimum Height	38.82 m
Classification (# of points)	
Ground	60,695,013
Low vegetation	81,084,657
Medium vegetation	267,249,514
High vegetation	270,673,899
Building	3,887,059
Orthophoto	No
Processed by	Engr. Jennifer Saguran, Engr. Charmaine Cruz, Ryan James Nicholai Dizon

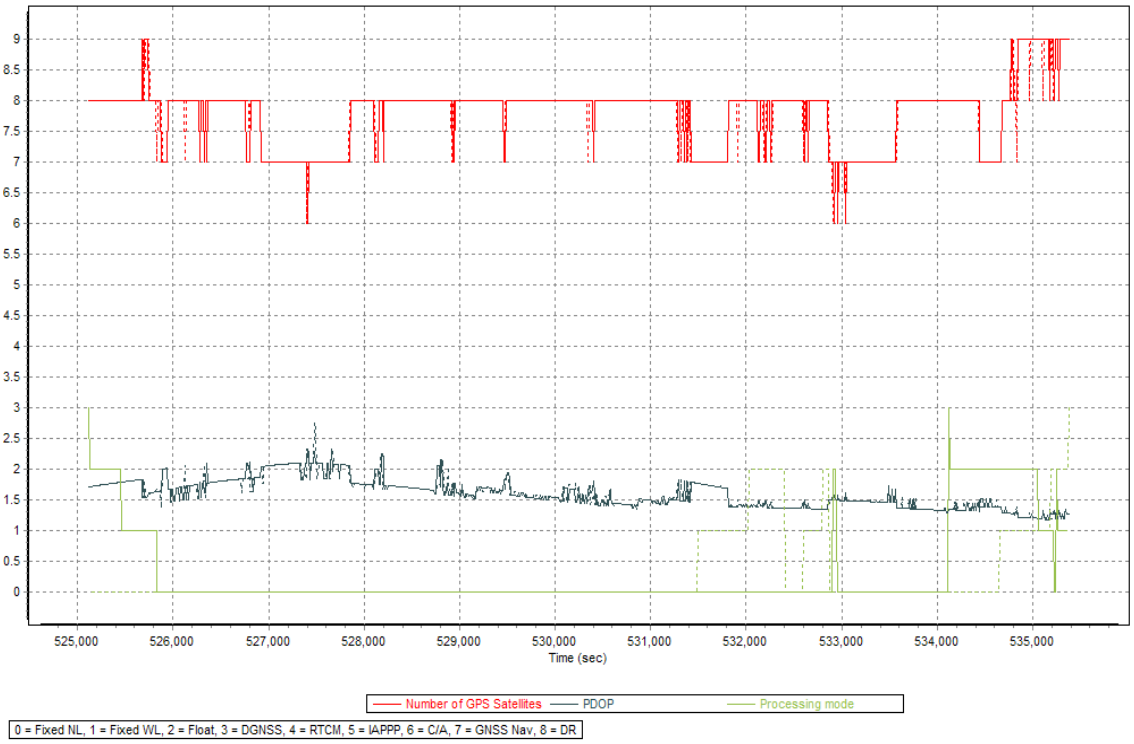


Figure 1.11.1. Solution Status

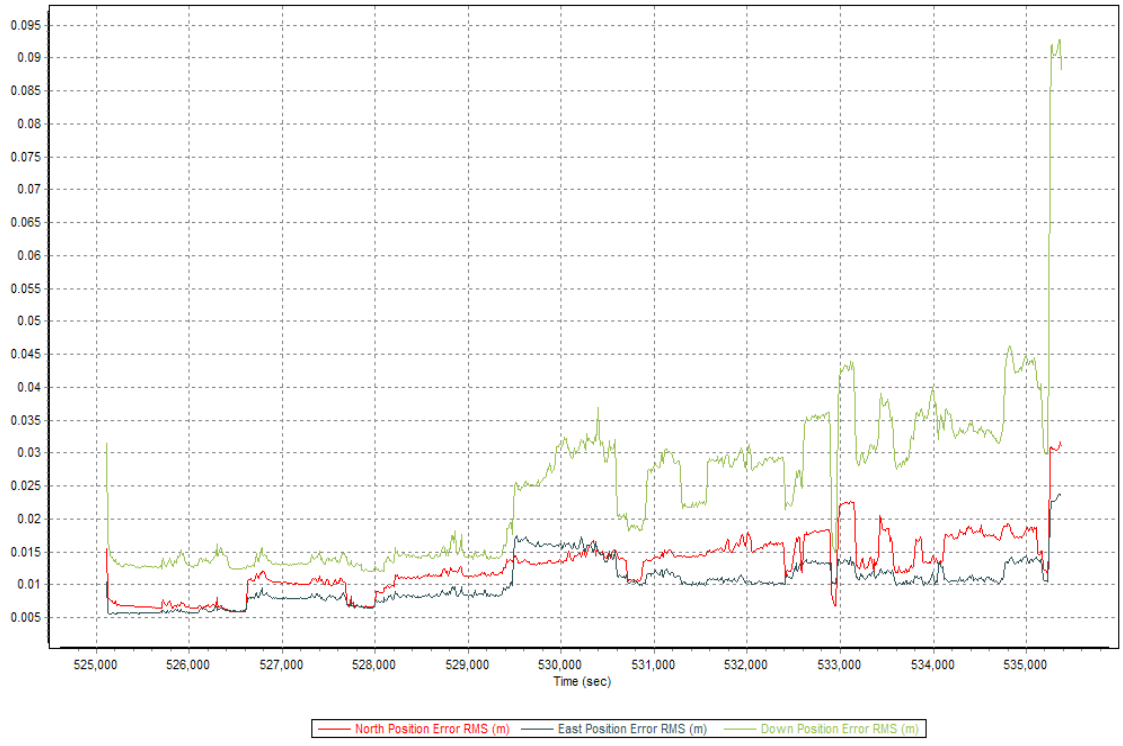


Figure 1.11.2. Smoothed Performance Metric Parameters

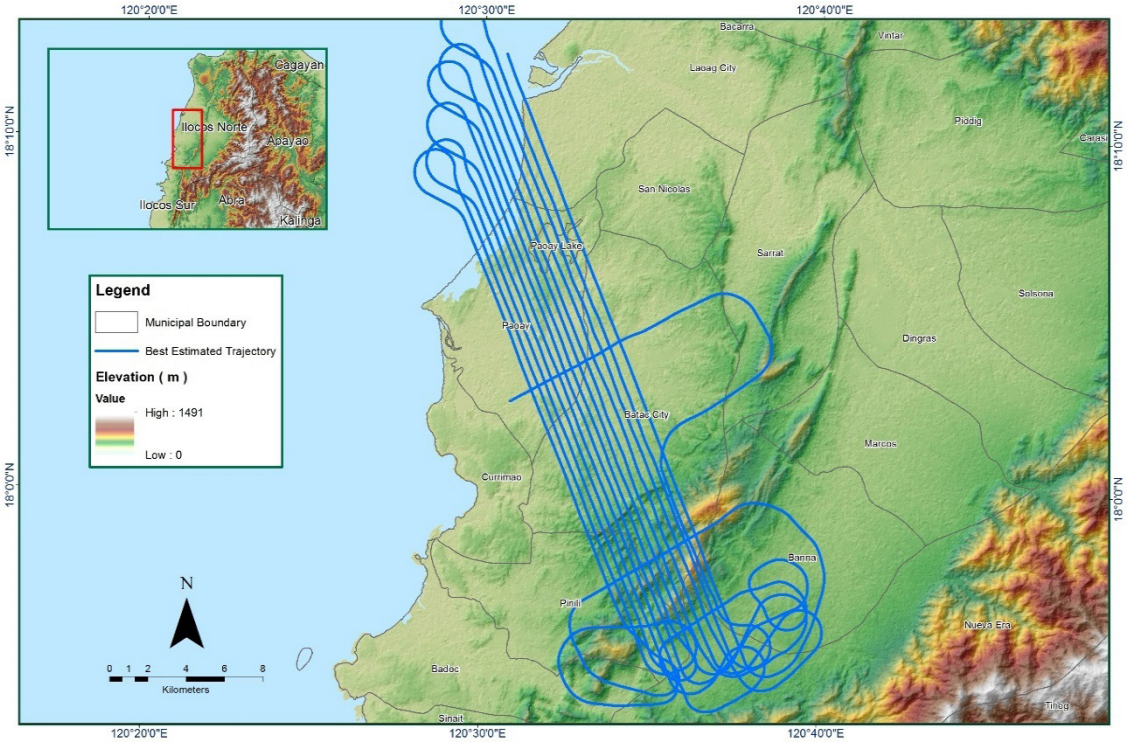


Figure 1.11.3. Best Estimated Trajectory

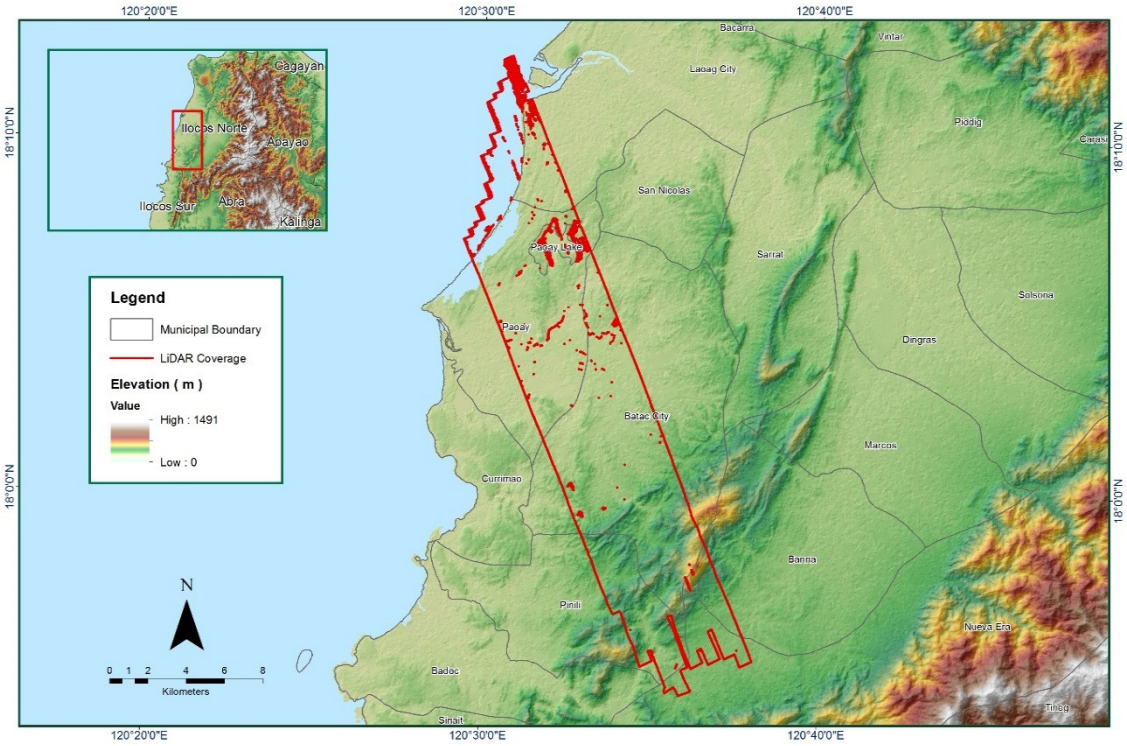


Figure 1.11.4. Coverage of LiDAR data

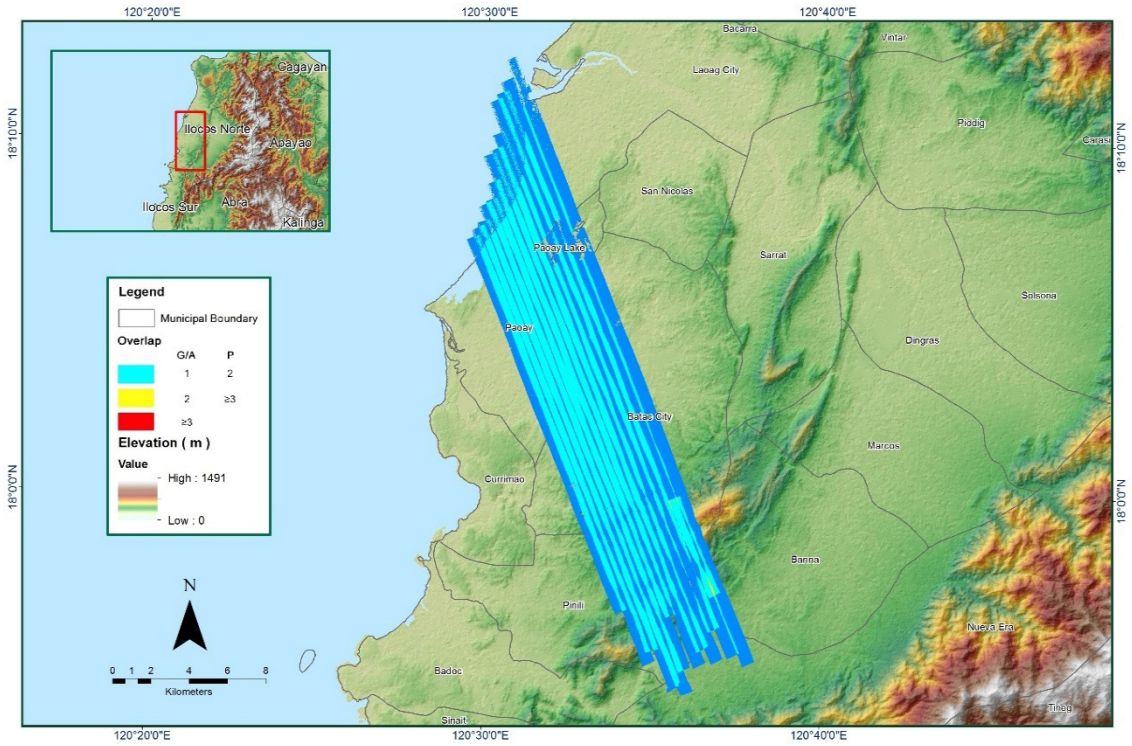


Figure 1.11.5. Image of data overlap

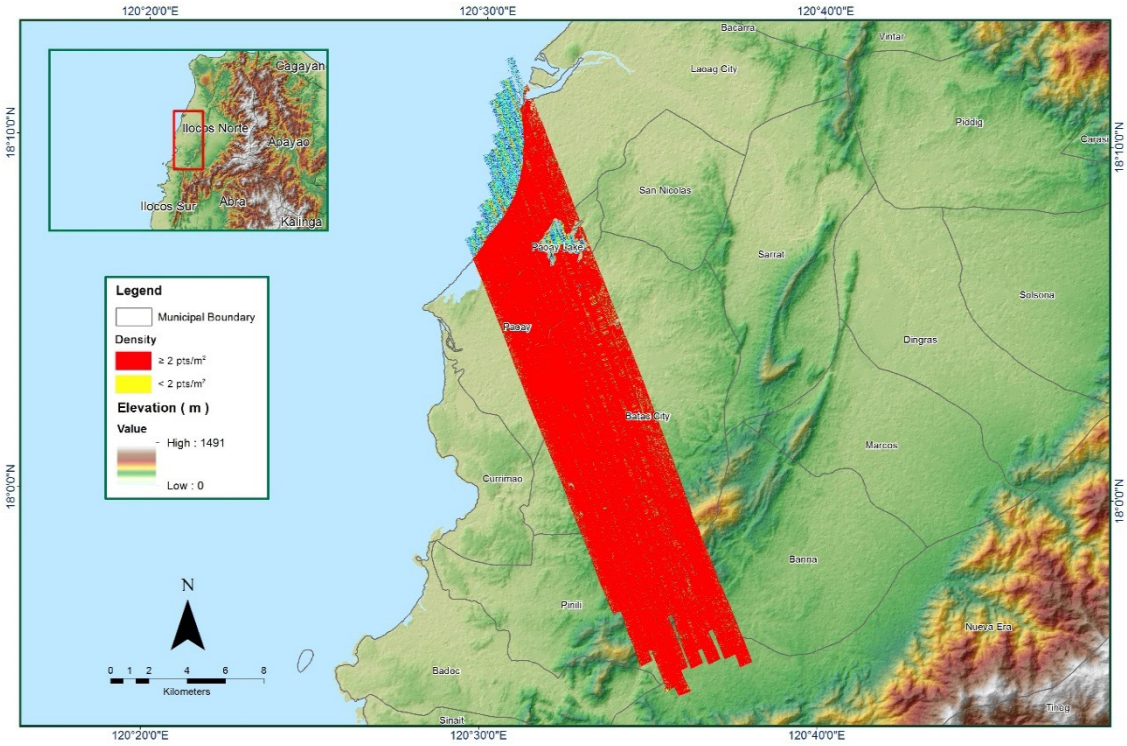


Figure 1.11.6. Density map of merged LiDAR data

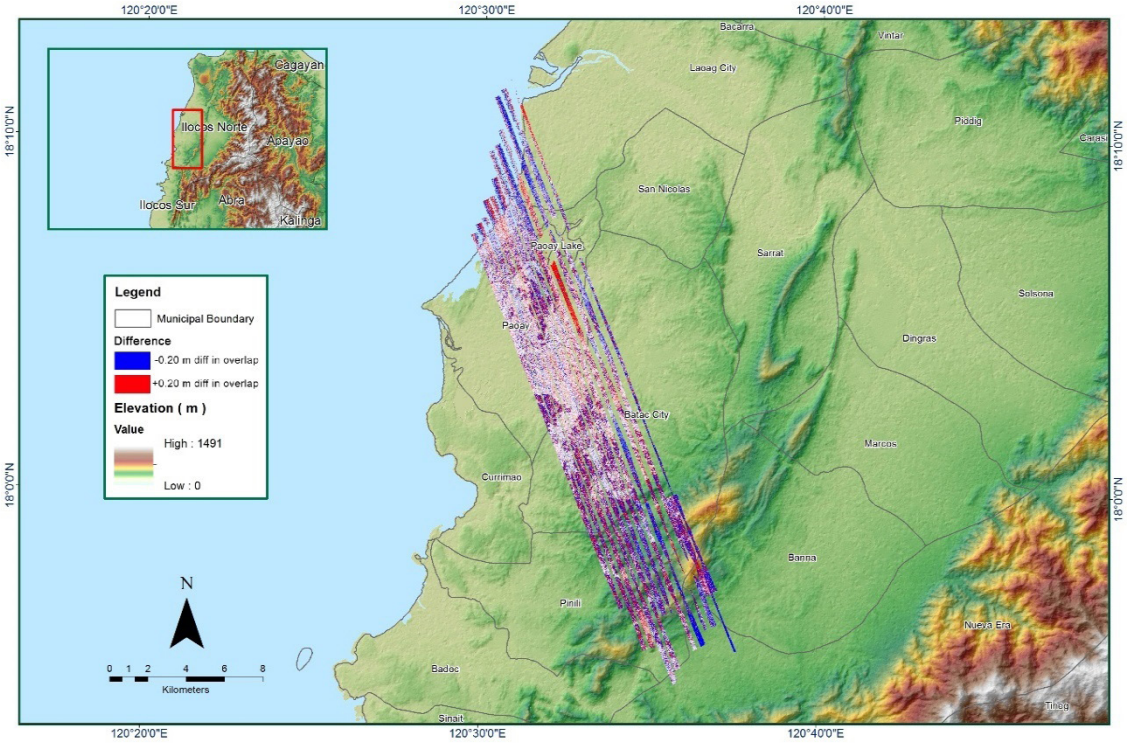


Figure 1.11.7. Elevation difference between flight lines

Flight Area	Ilocos
Mission Name	**Blk05_I**
Inclusive Flights	7089G
Range data size	15GB
Base data size	10.7 MB
POS	199MB
Image	N/A
Transfer date	April 25, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	No
Processing Mode (<=1)	No
Smoothed Performance Metrics(in cm)	
RMSE for North Position (<4.0 cm)	2.4
RMSE for East Position (<4.0 cm)	3.8
RMSE for Down Position (<8.0 cm)	6.3
Boresight correction stdev (<0.001deg)	0.000236
IMU attitude correction stdev (<0.001deg)	0.000595
GPS position stdev (<0.01m)	0.0076
Minimum % overlap (>25)	23.97%
Ave point cloud density per sq.m. (>2.0)	2.75
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	176
Maximum Height	430.63 m
Minimum Height	39.72 m
Classification (# of points)	
Ground	59,718,110
Low vegetation	61,744,910
Medium vegetation	74,943,525
High vegetation	130,099,811
Building	3,324,729
Orthophoto	No
Processed by	Victoria Rejuso, Engr. Melanie Hingpit, Ryan James Nicholai Dizon

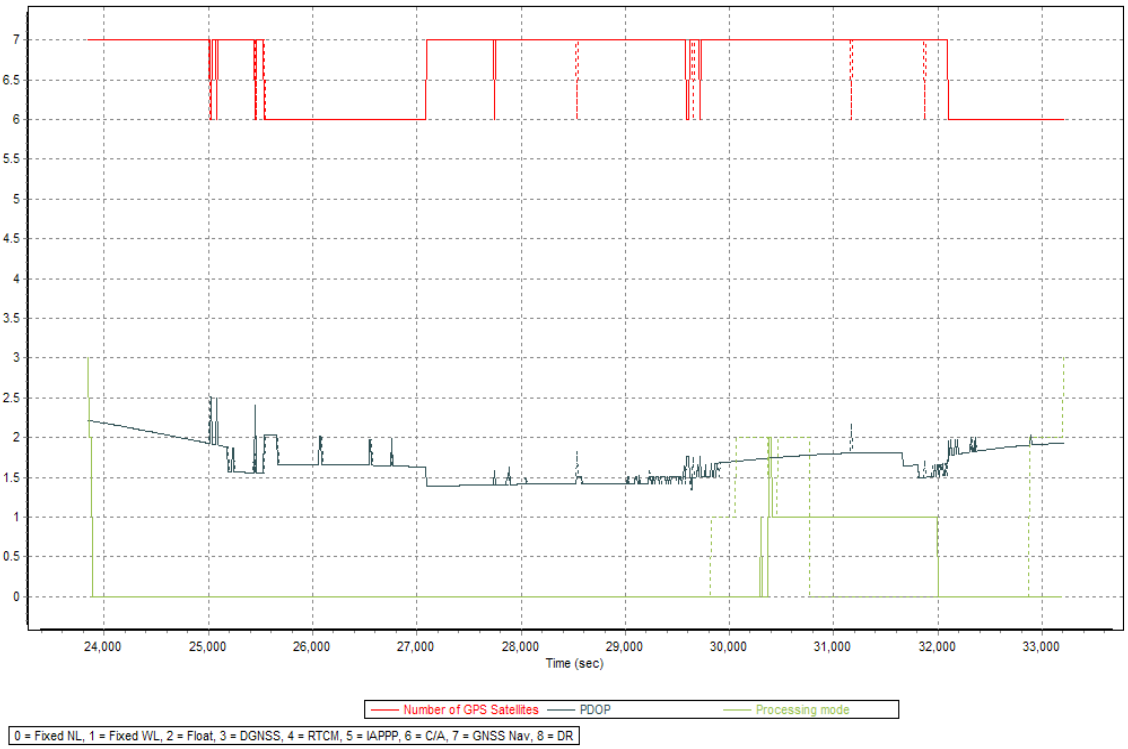


Figure 1.12.1. Solution Status

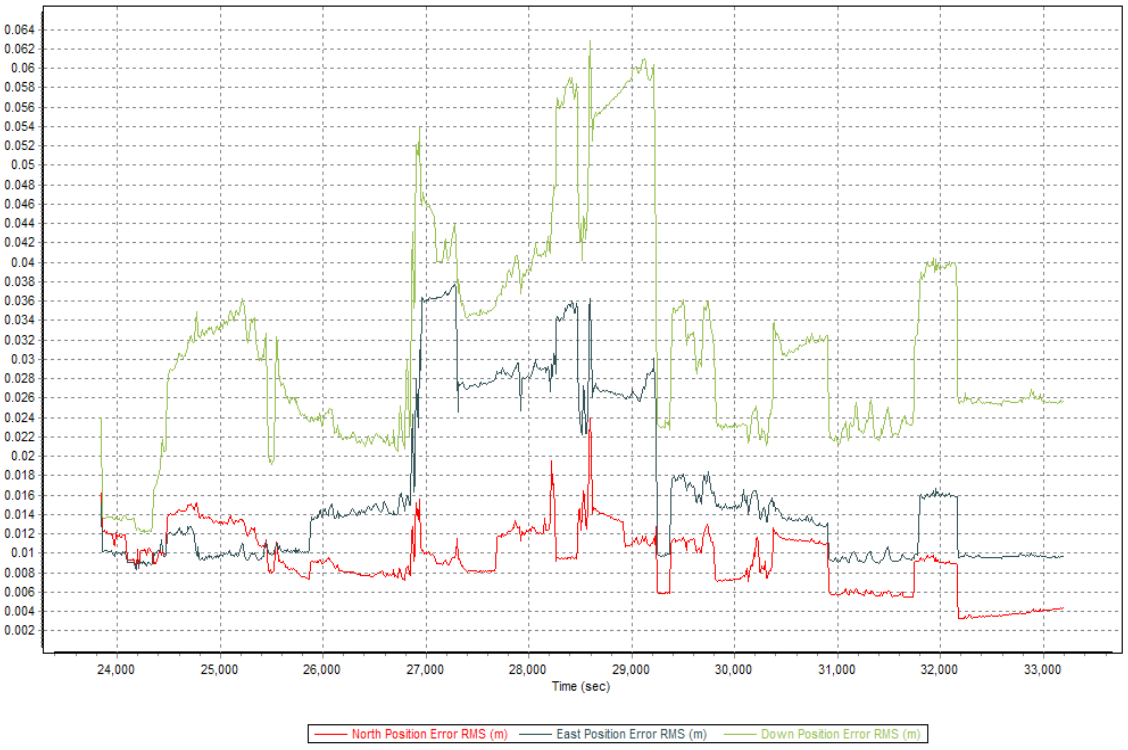


Figure 1.12.2. Smoothed Performance Metric Parameters

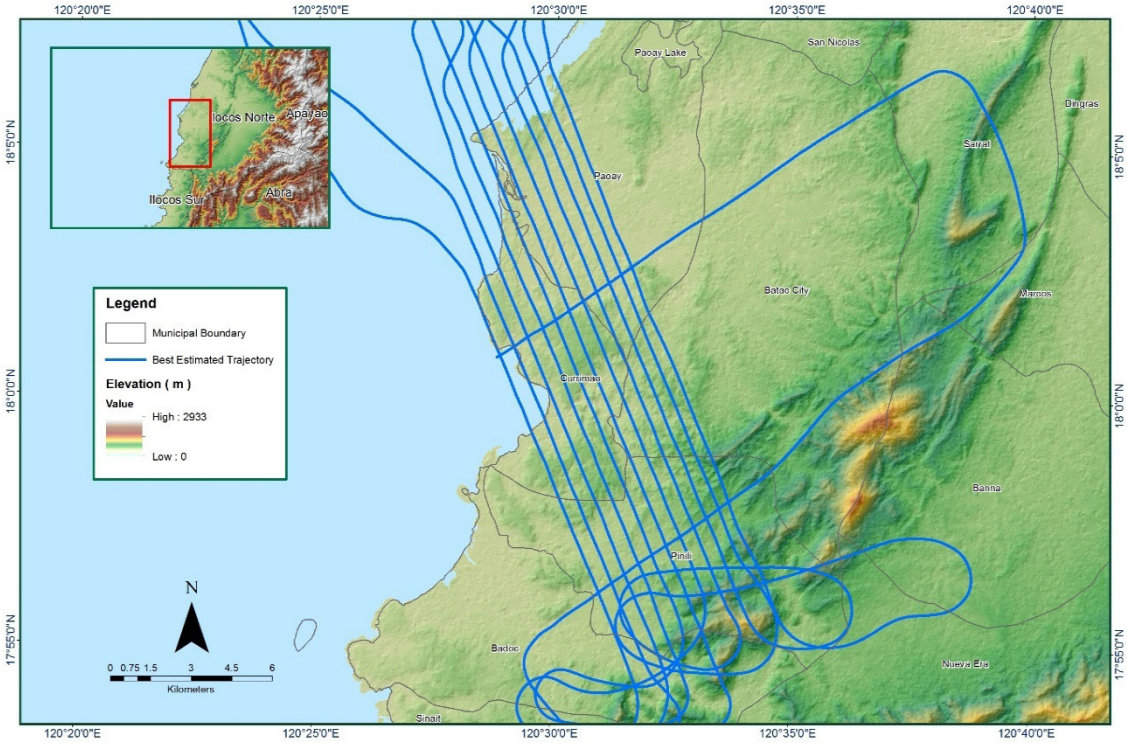


Figure 1.12.3. Best Estimated Trajectory

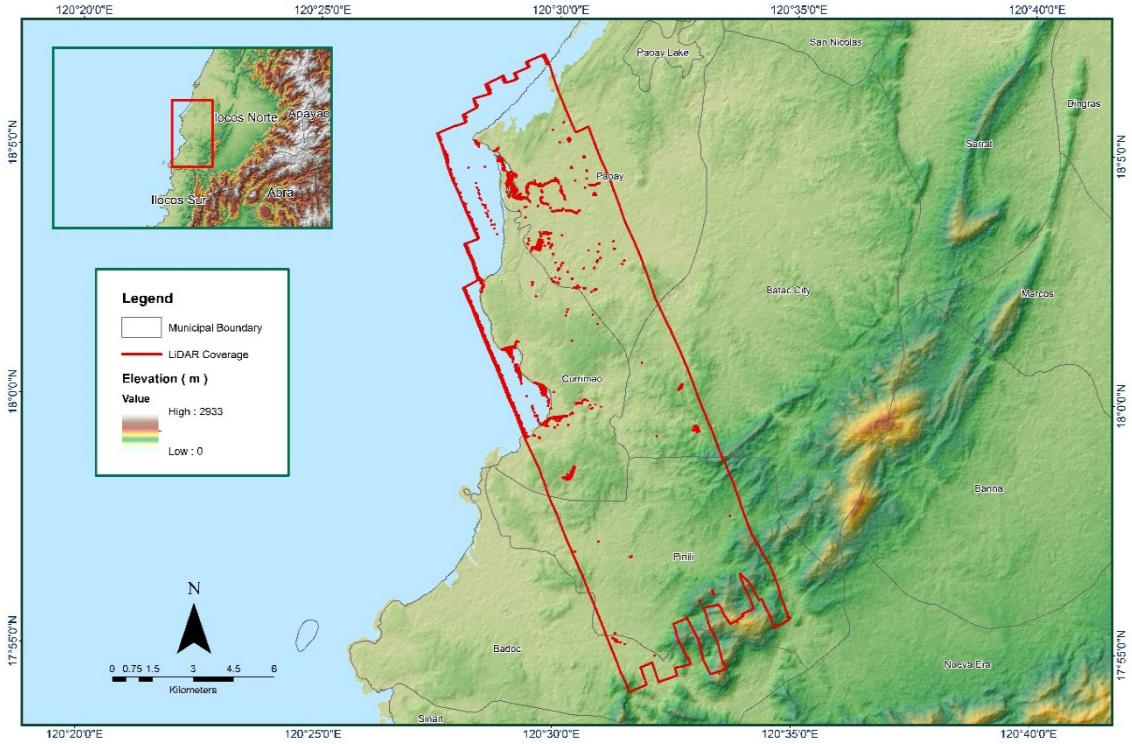


Figure 1.12.4. Coverage of LiDAR data

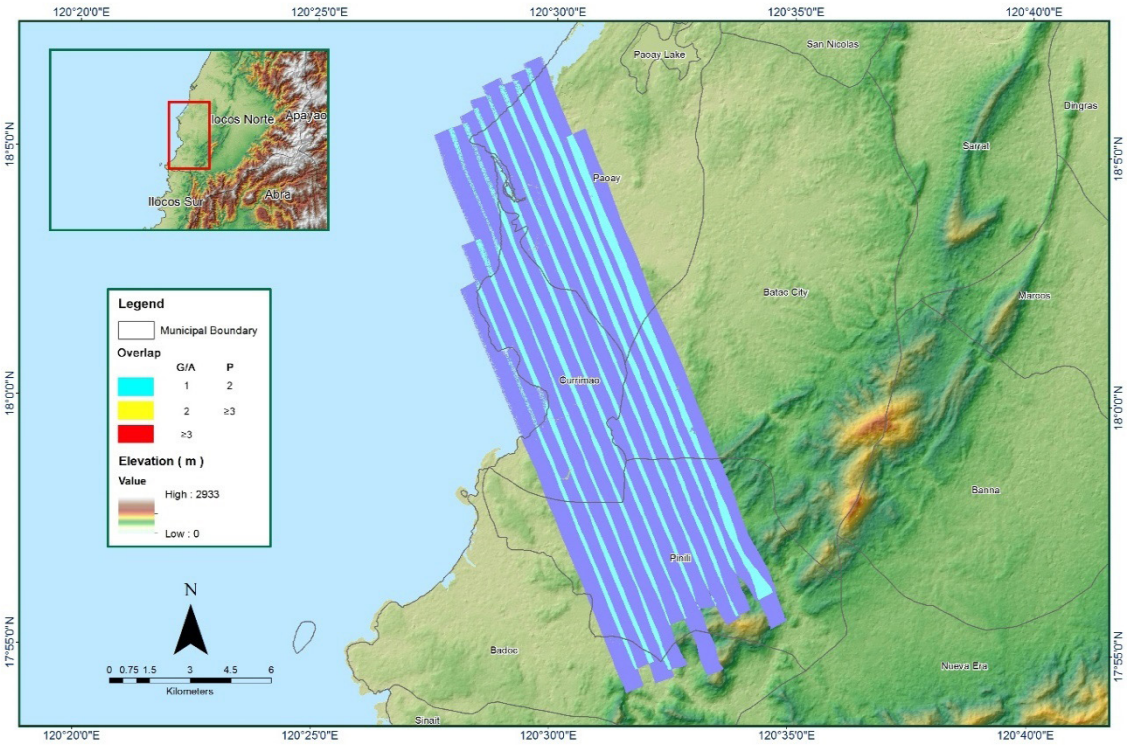


Figure 1.12.5. Image of data overlap

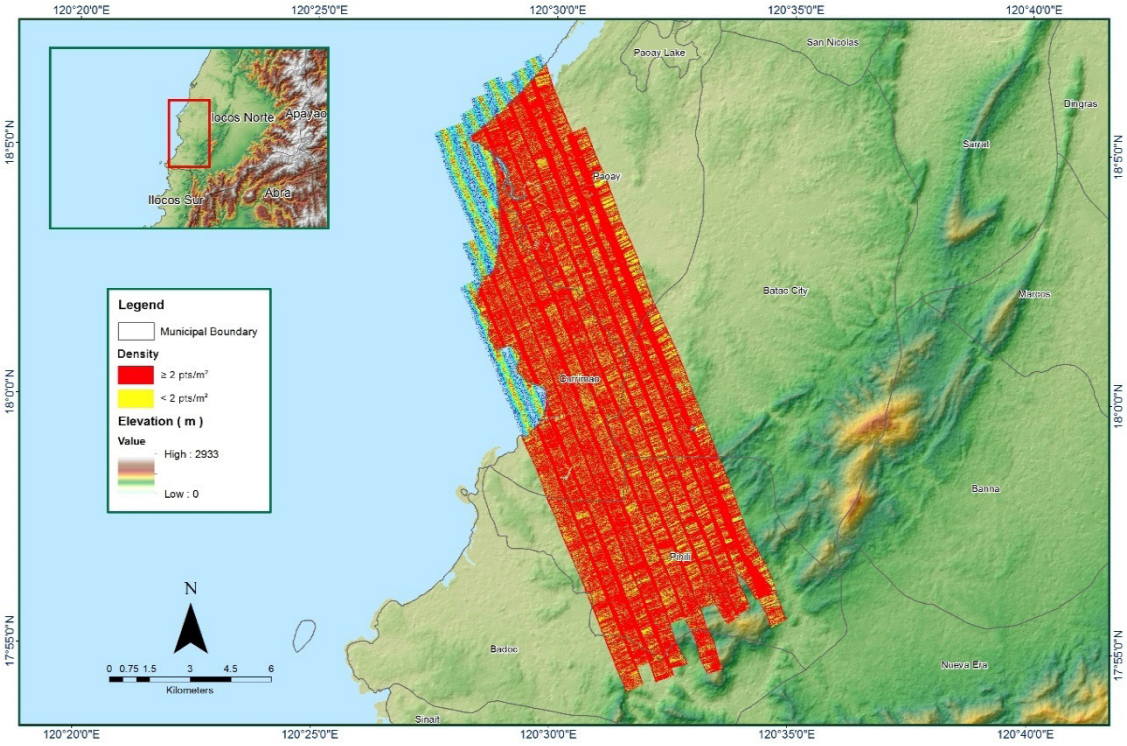


Figure 1.12.6. Density map of merged LiDAR data

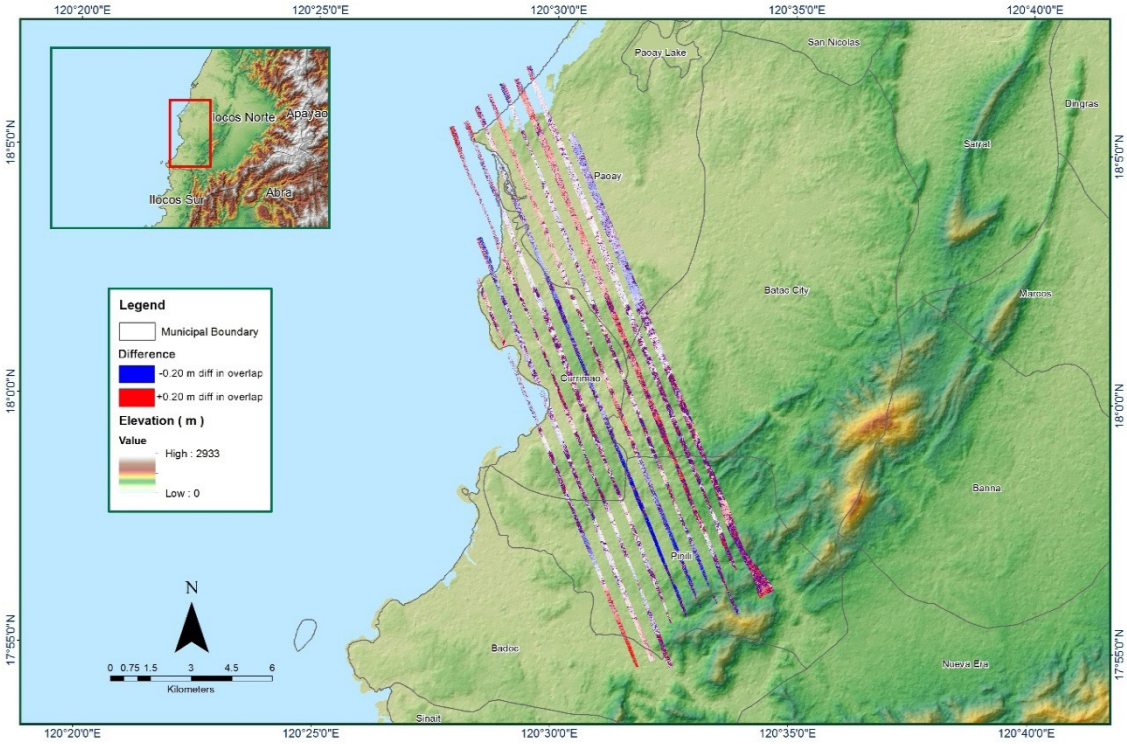


Figure 1.12.7. Elevation difference between flight lines

Flight Area	Ilocos
Mission Name	**Blk05_J**
Inclusive Flights	7096G
Range data size	9.77GB
Base data size	13.5 MB
POS	187MB
Image	N/A
Transfer date	April 22, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	No
Processing Mode (<=1)	No
Smoothed Performance Metrics(in cm)	
RMSE for North Position (<4.0 cm)	1.5
RMSE for East Position (<4.0 cm)	1.4
RMSE for Down Position (<8.0 cm)	3.2
Boresight correction stdev (<0.001deg)	0.000199
IMU attitude correction stdev (<0.001deg)	0.000345
GPS position stdev (<0.01m)	0.0079
Minimum % overlap (>25)	38.52%
Ave point cloud density per sq.m. (>2.0)	1.99
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	175
Maximum Height	565.73 m
Minimum Height	68.84 m
Classification (# of points)	
Ground	84,318,601
Low vegetation	65,281,234
Medium vegetation	41,998,017
High vegetation	41,281,186
Building	1,431,762
Orthophoto	No
Processed by	Engr. Carlyn Ann Ibañez, Celina Rosete, Engr. Gladys Mae Apat

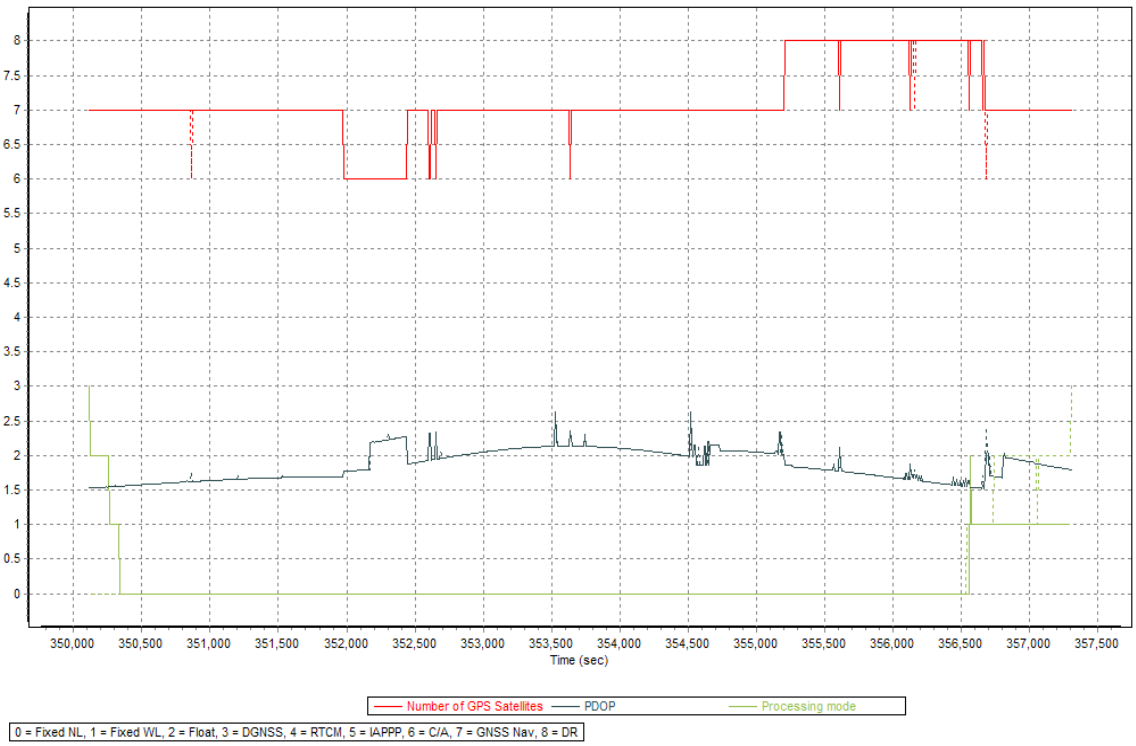


Figure 1.13.1. Solution Status

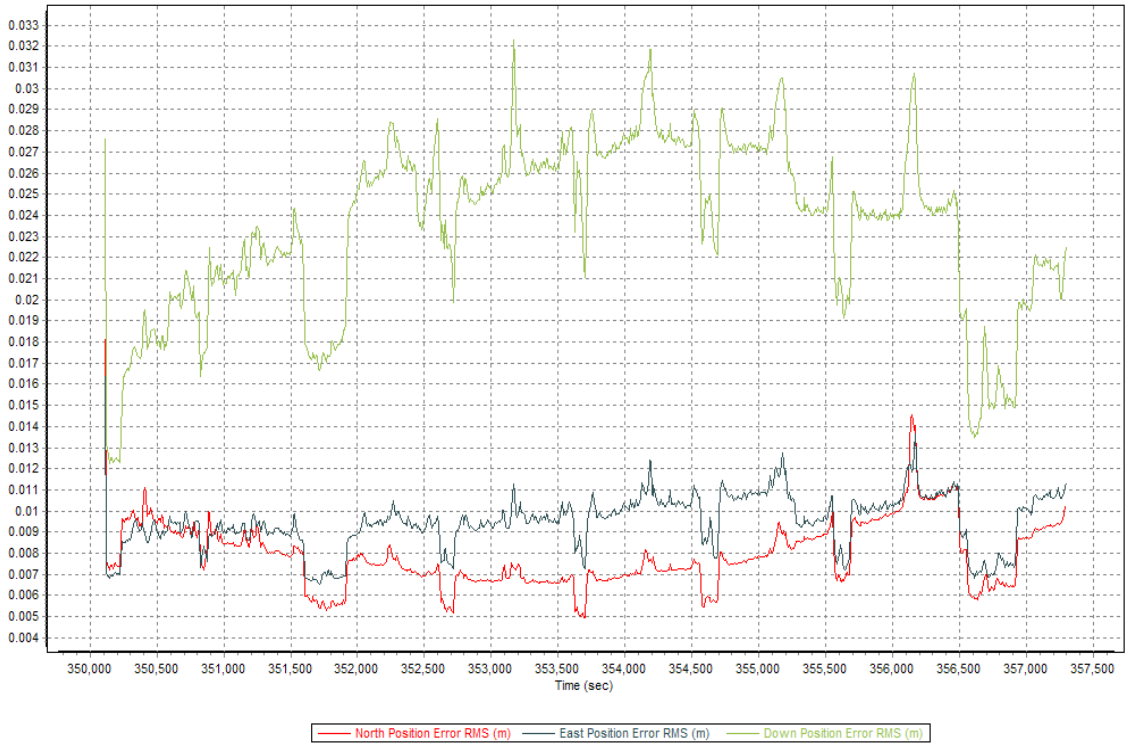


Figure 1.13.2. Smoothed Performance Metric Parameters

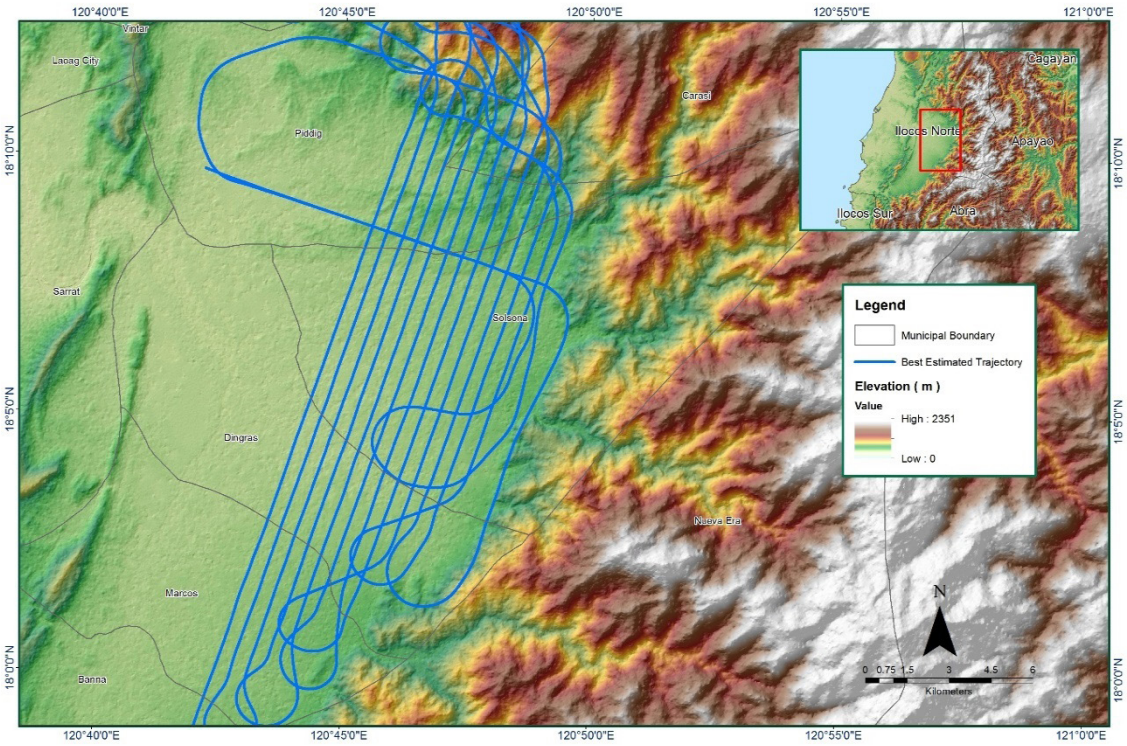


Figure 1.13.3. Best Estimated Trajectory

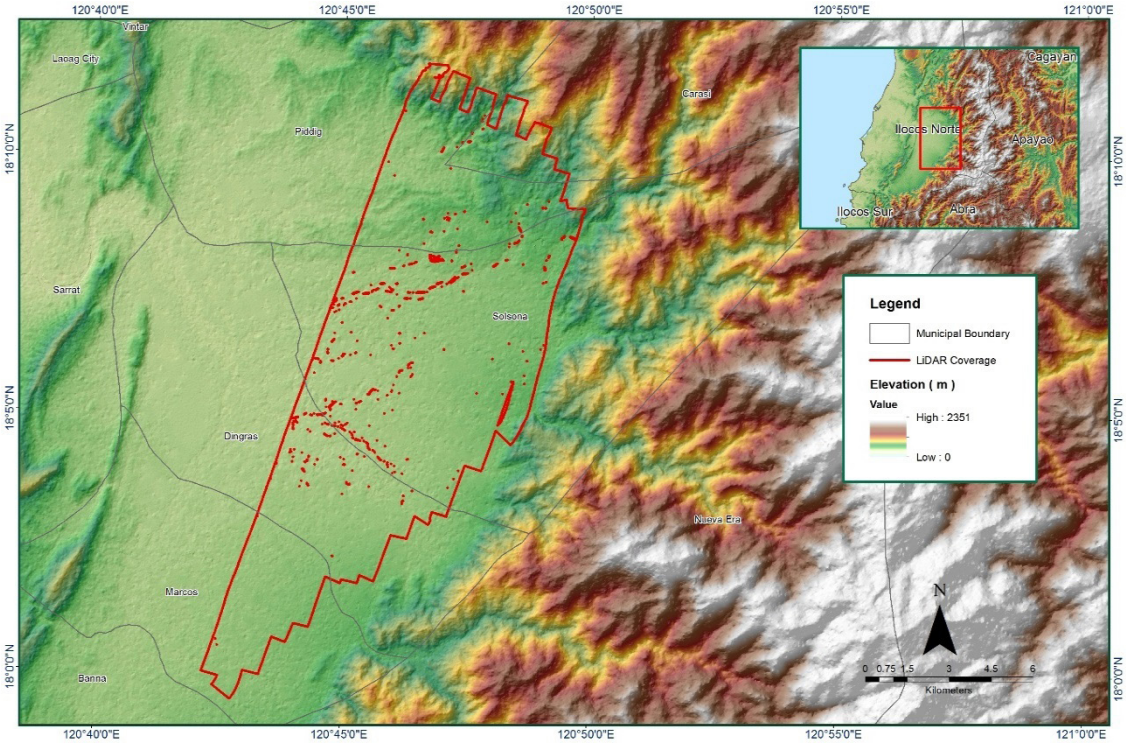


Figure 1.13.4. Coverage of LiDAR data

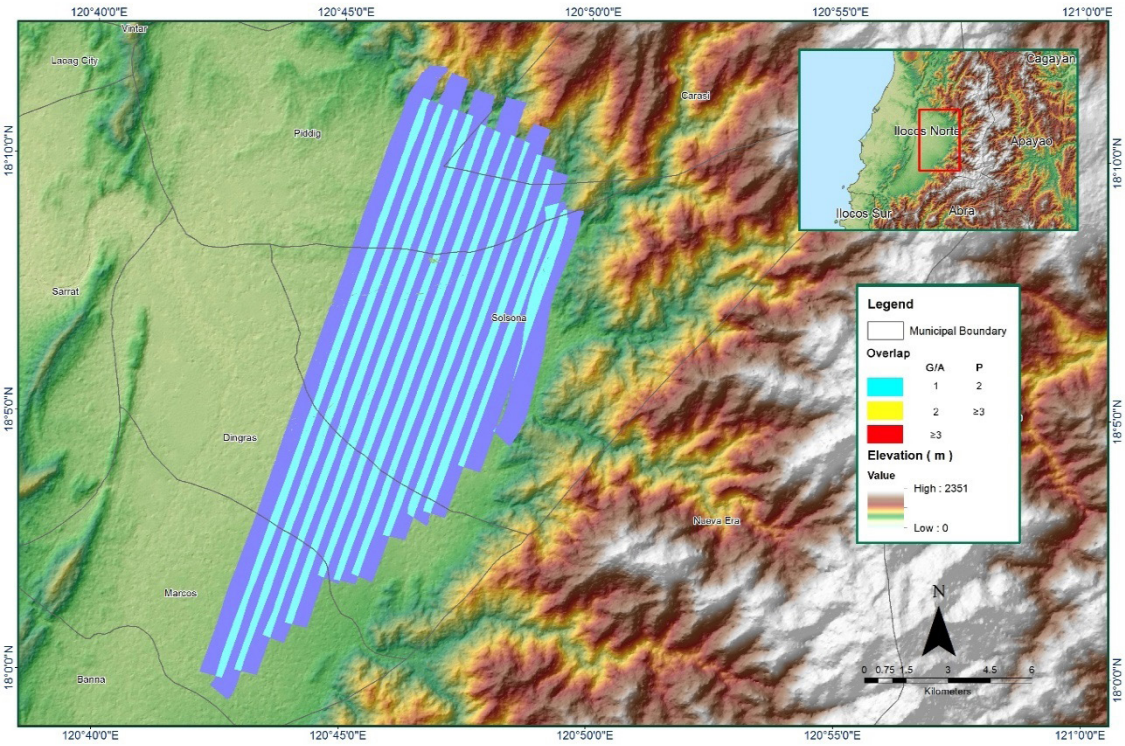


Figure 1.13.5. Image of data overlap

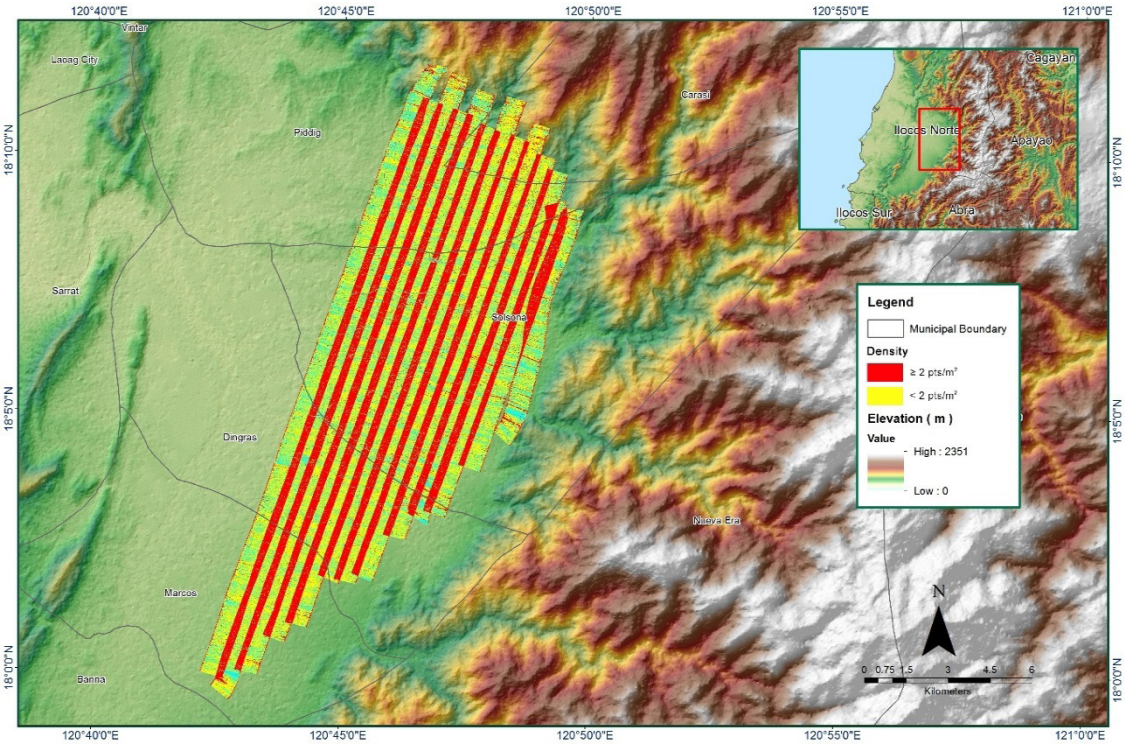


Figure 1.13.6. Density map of merged LiDAR data

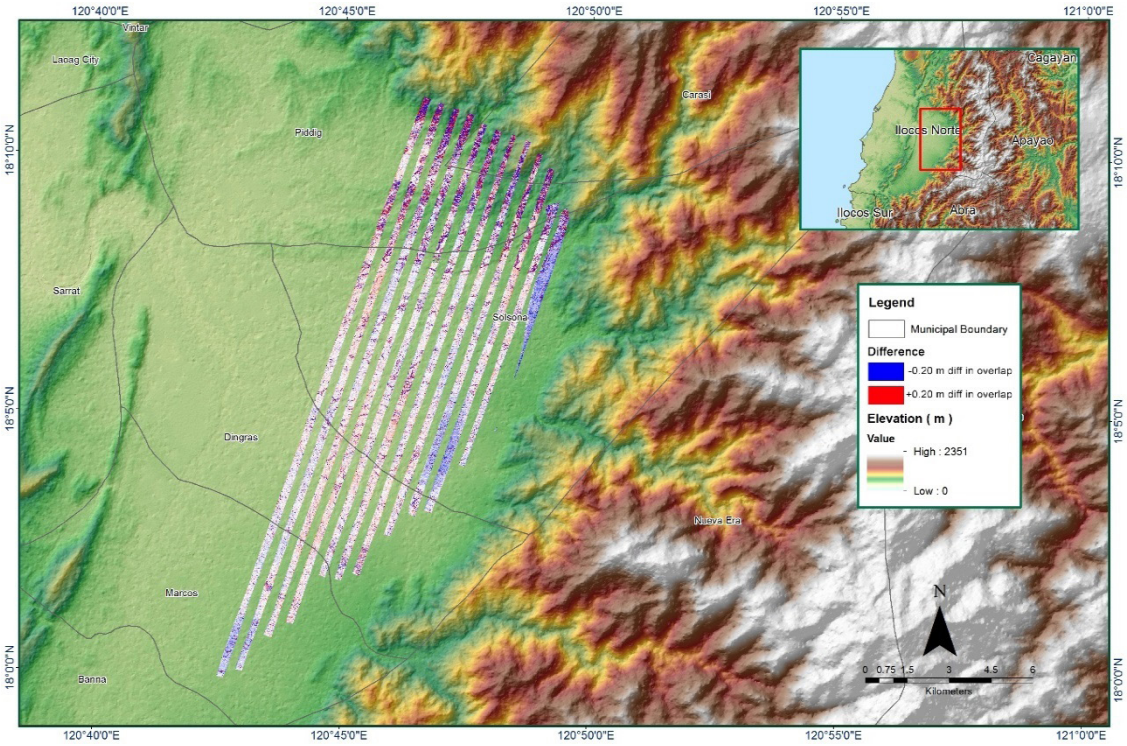


Figure 1.13.7. Elevation difference between flight lines

Flight Area	Ilocos
Mission Name	**Blk05_K**
Inclusive Flights	7092G
Range data size	11.8 GB
Base data size	13 MB
POS	199 MB
Image	N/A
Transfer date	March 3, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	Yes
Processing Mode (<=1)	No
Smoothed Performance Metrics(in cm)	
RMSE for North Position (<4.0 cm)	2.6
RMSE for East Position (<4.0 cm)	2.6
RMSE for Down Position (<8.0 cm)	2.7
Boresight correction stdev (<0.001deg)	0.000340
IMU attitude correction stdev (<0.001deg)	0.000572
GPS position stdev (<0.01m)	0.0099
Minimum % overlap (>25)	29.24%
Ave point cloud density per sq.m. (>2.0)	1.49
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	153
Maximum Height	544.7m
Minimum Height	85.18m
Classification (# of points)	
Ground	52,381,844
Low vegetation	28,468,833
Medium vegetation	28,259,008
High vegetation	37,286,356
Building	814,199
Orthophoto	No
Processed by	Engr. Irish Cortez, Celina Rosete, Engr. Gladys Mae Apat

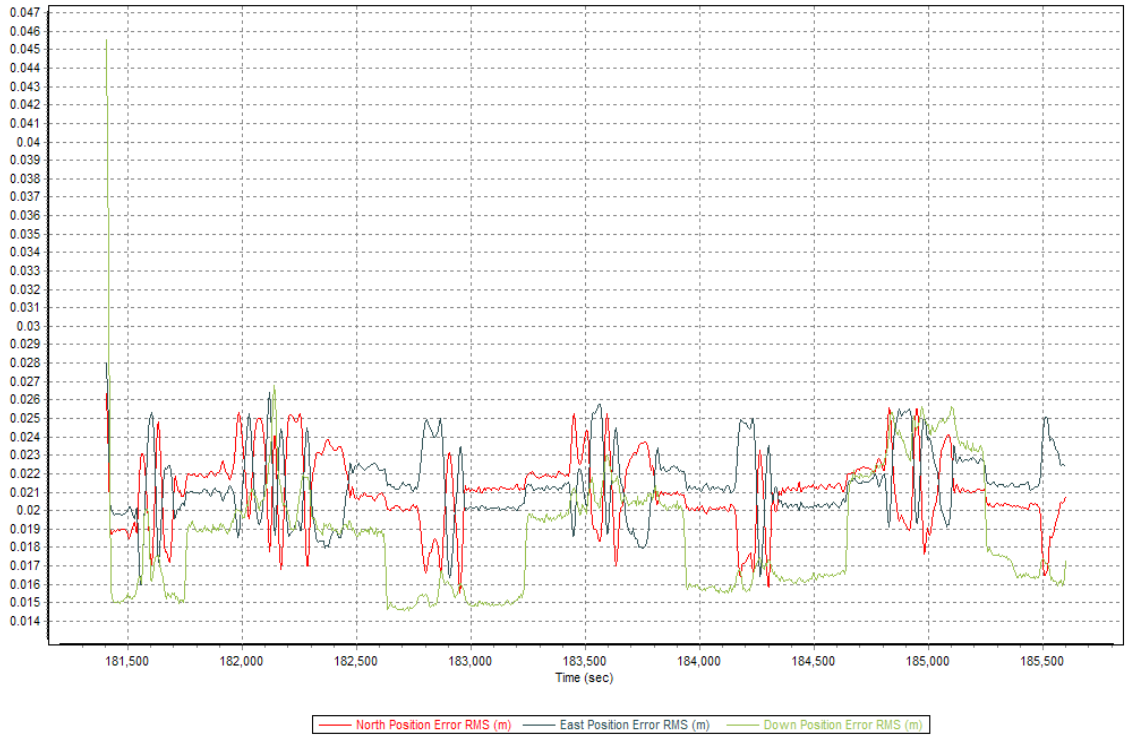


Figure 1.14.1. Solution Status

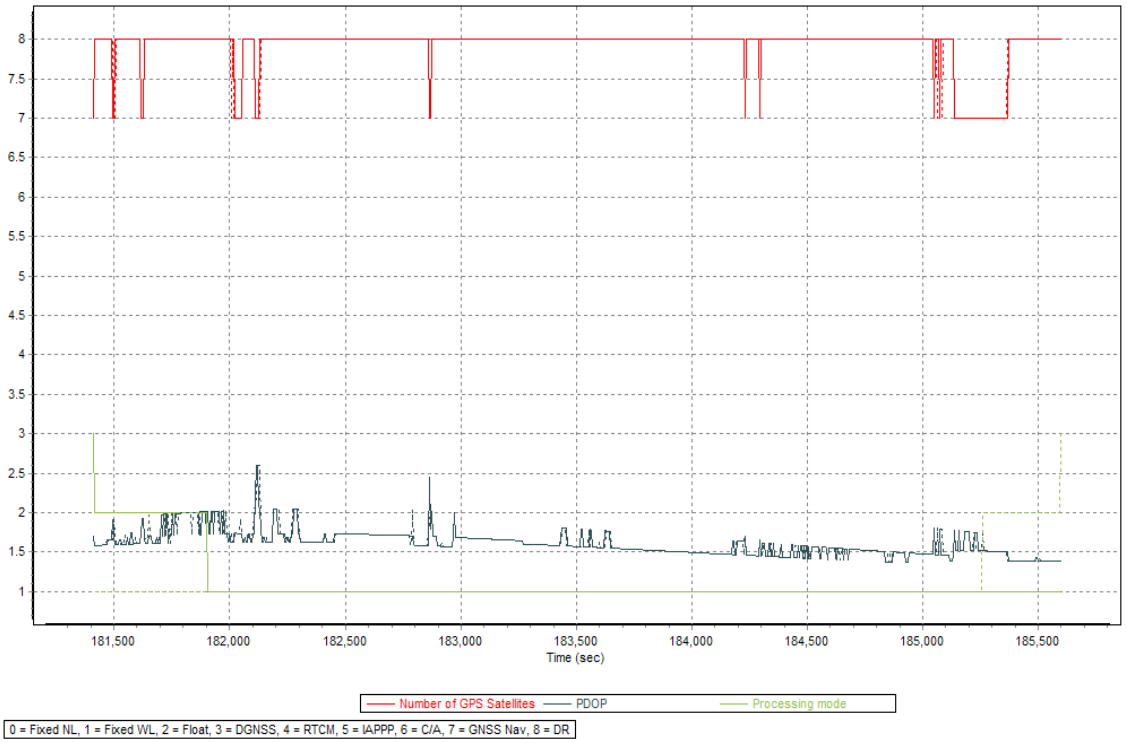


Figure 1.14.2. Smoothed Performance Metric Parameters

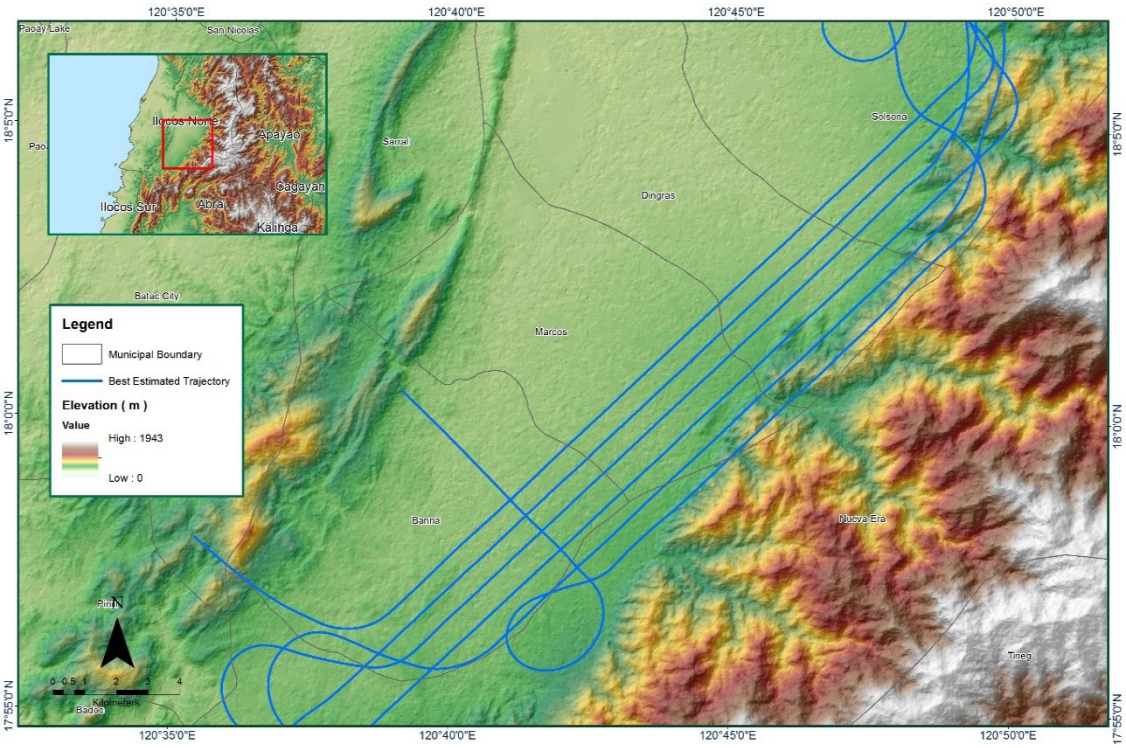


Figure 1.14.3. Best Estimated Trajectory

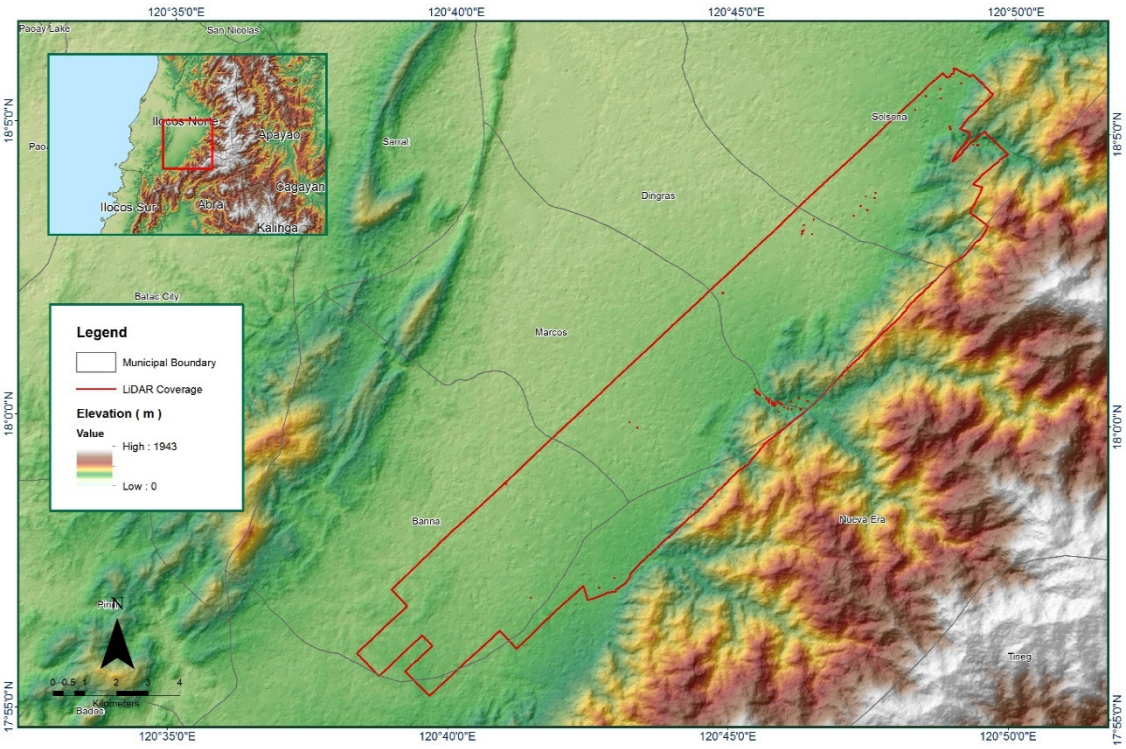


Figure 1.14.4. Coverage of LiDAR data

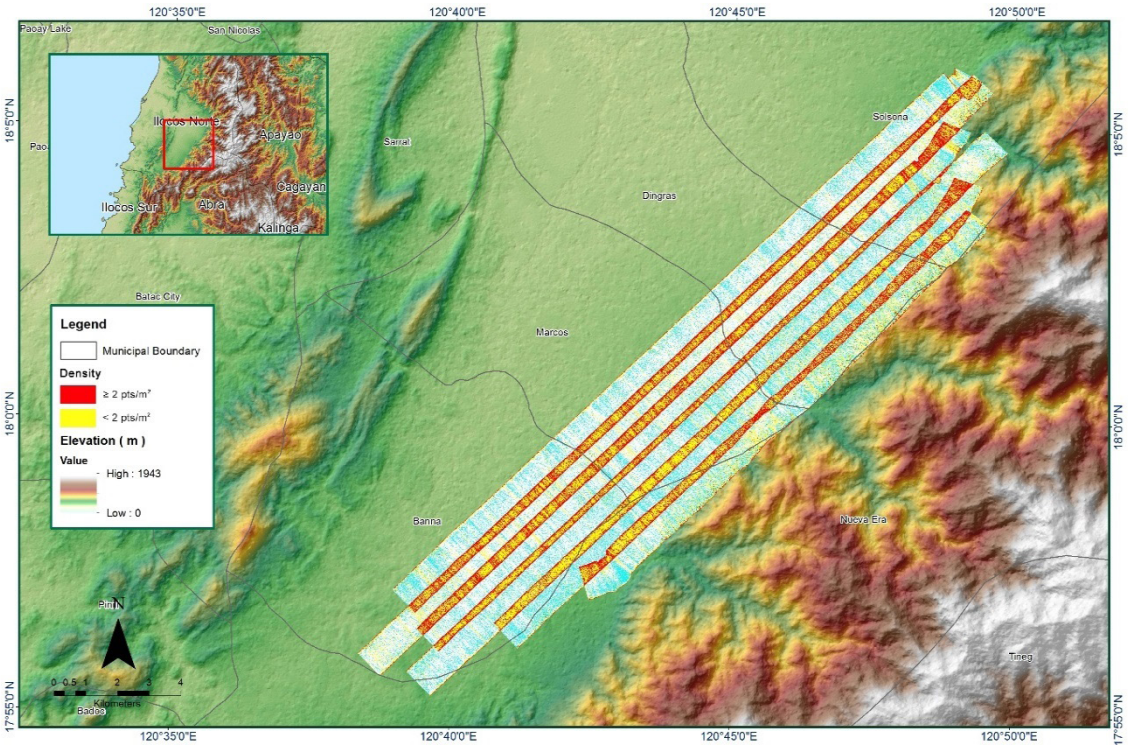


Figure 1.14.5. Image of data overlap

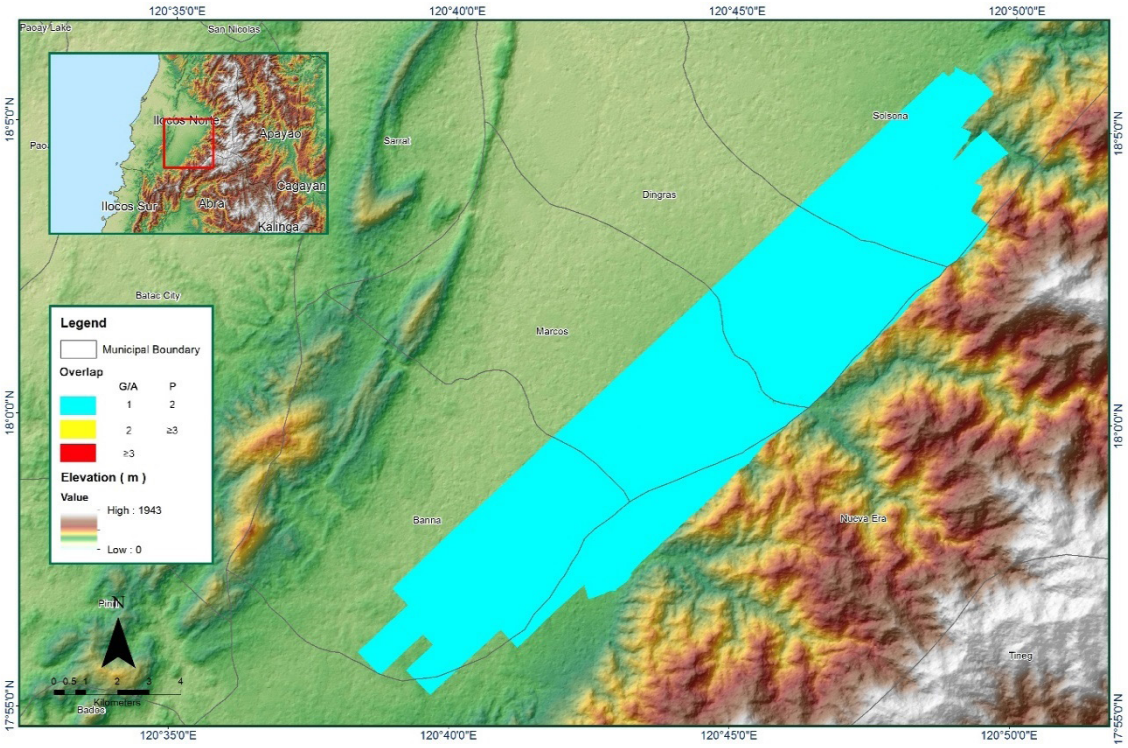


Figure 1.14.6. Density map of merged LiDAR data

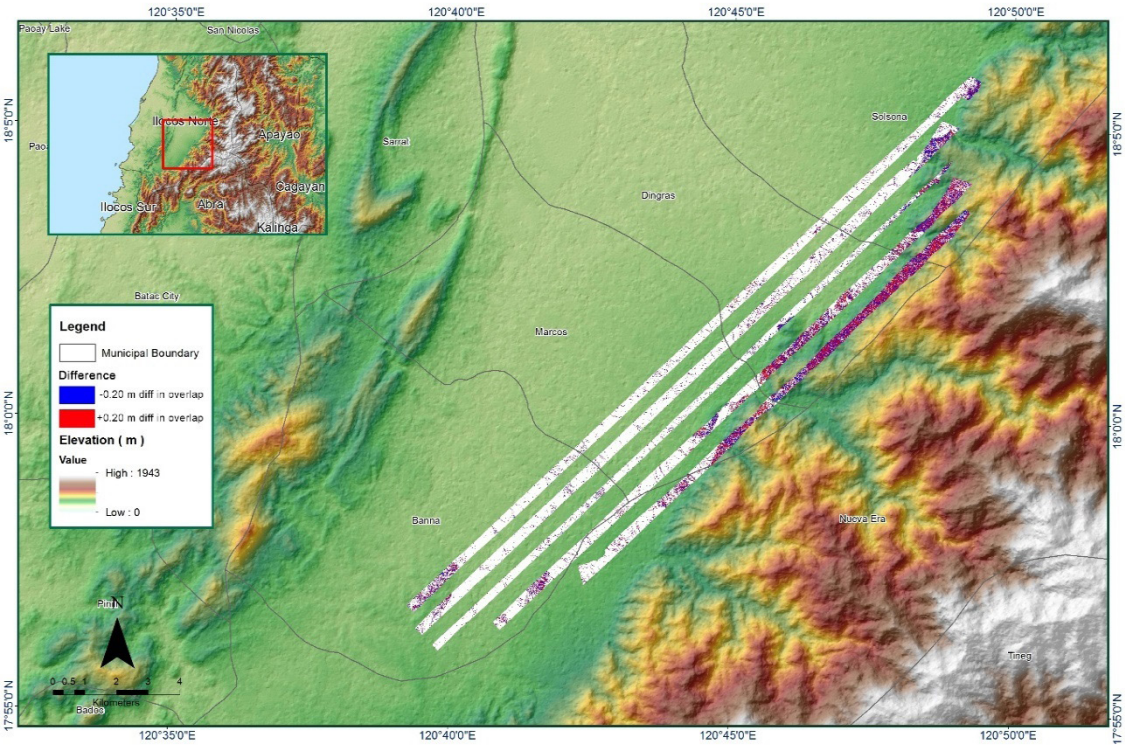


Figure 1.14.7. Elevation difference between flight lines

Flight Area	Ilocos
Mission Name	**Blk05_L**
Inclusive Flights	7090G
Range data size	8.11 GB
Base data size	N/A
POS	N/A
Image	N/A
Transfer date	March 3, 2014
Solution Status	
Number of Satellites (>6)	Yes
PDOP (<3)	Yes
Baseline Length (<30km)	No
Processing Mode (<=1)	No
Smoothed Performance Metrics(in cm)	
RMSE for North Position (<4.0 cm)	1.9
RMSE for East Position (<4.0 cm)	2.6
RMSE for Down Position (<8.0 cm)	5.1
Boresight correction stdev (<0.001deg)	0.000438
IMU attitude correction stdev (<0.001deg)	0.000782
GPS position stdev (<0.01m)	0.0096
Minimum % overlap (>25)	25.13%
Ave point cloud density per sq.m. (>2.0)	1.48
Elevation difference between strips (<0.20m)	Yes
Number of 1km x 1km blocks	166
Maximum Height	492.49m
Minimum Height	53.15m
Classification (# of points)	
Ground	46,609,803
Low vegetation	30,744,580
Medium vegetation	40,736,552
High vegetation	57,958,014
Building	478,482
Orthophoto	No
Processed by	Engr. Jennifer Saguran, Engr. Harmond Santos, Engr. Gladys Mae Apat

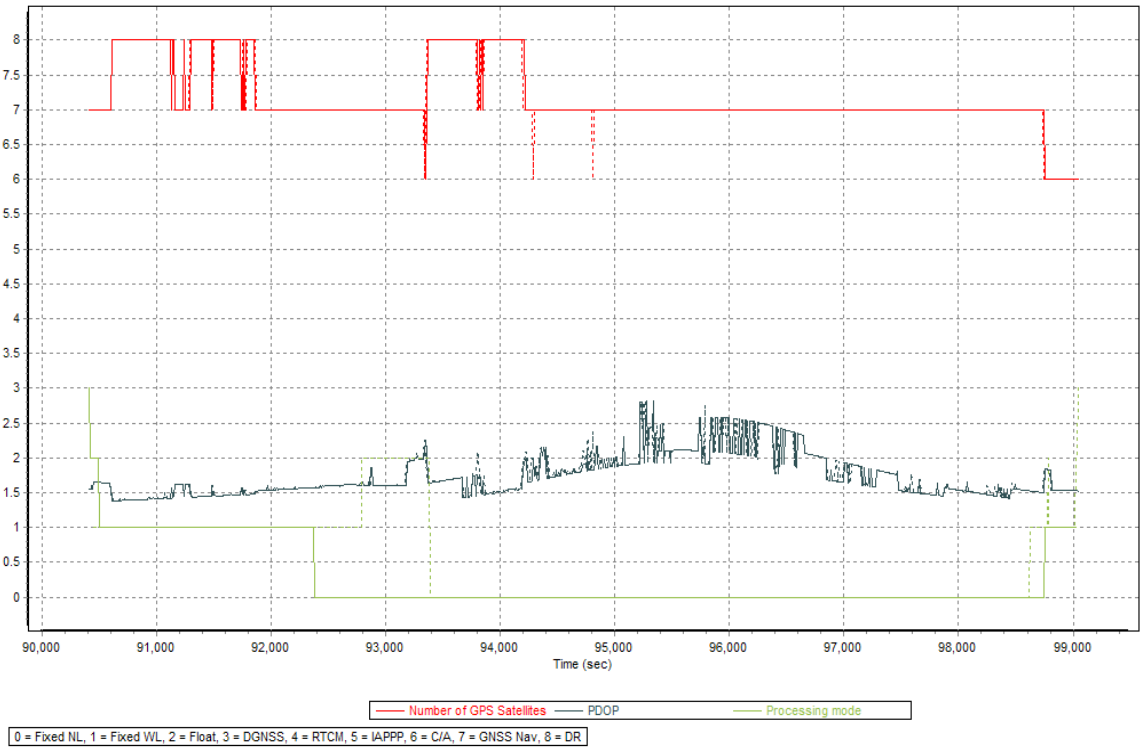


Figure 1.15.1. Solution Status

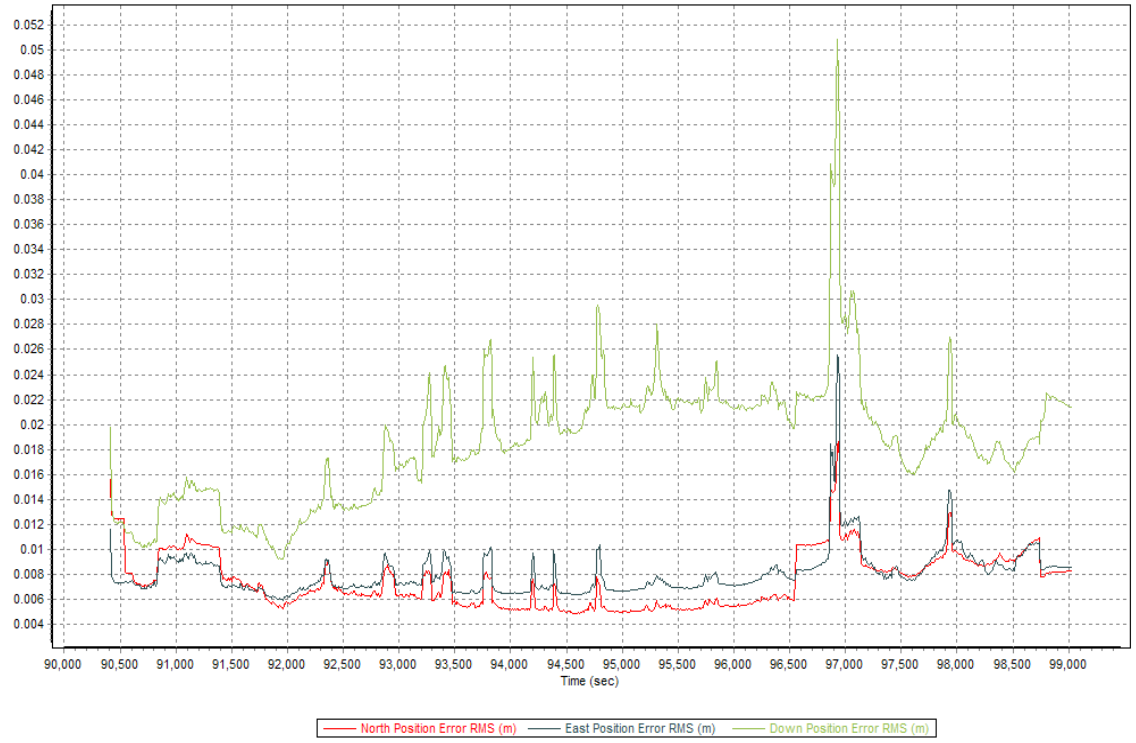


Figure 1.15.2. Smoothed Performance Metric Parameters

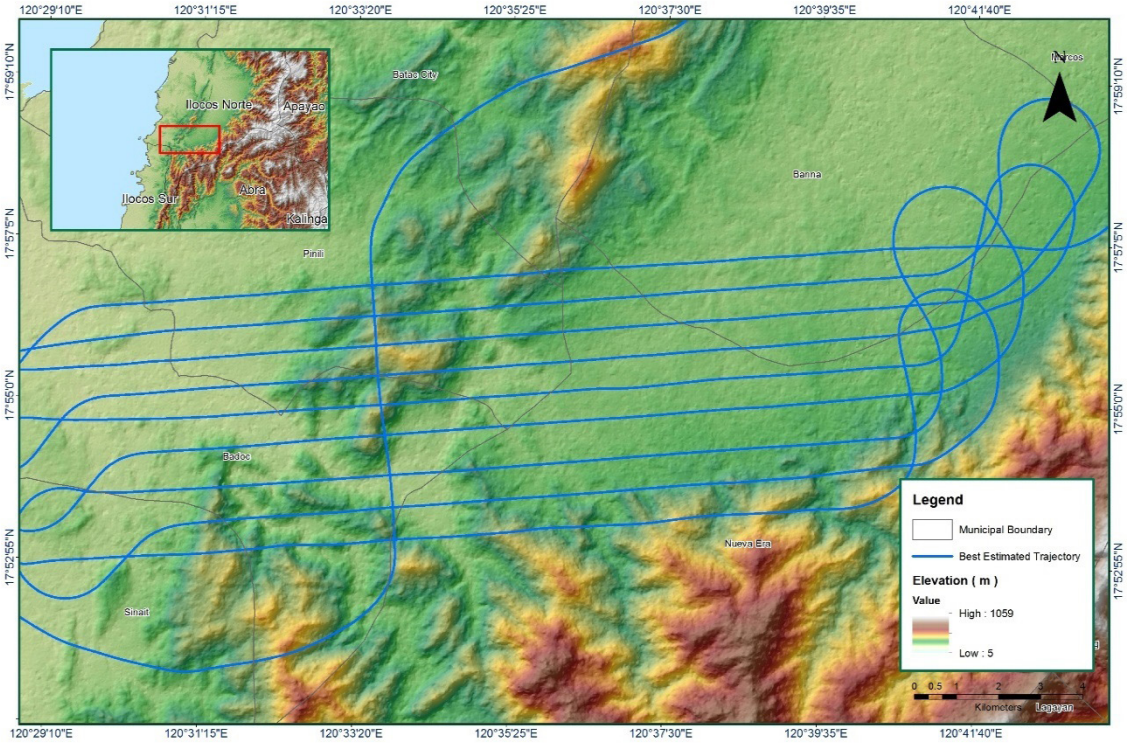


Figure 1.15.3. Best Estimated Trajectory

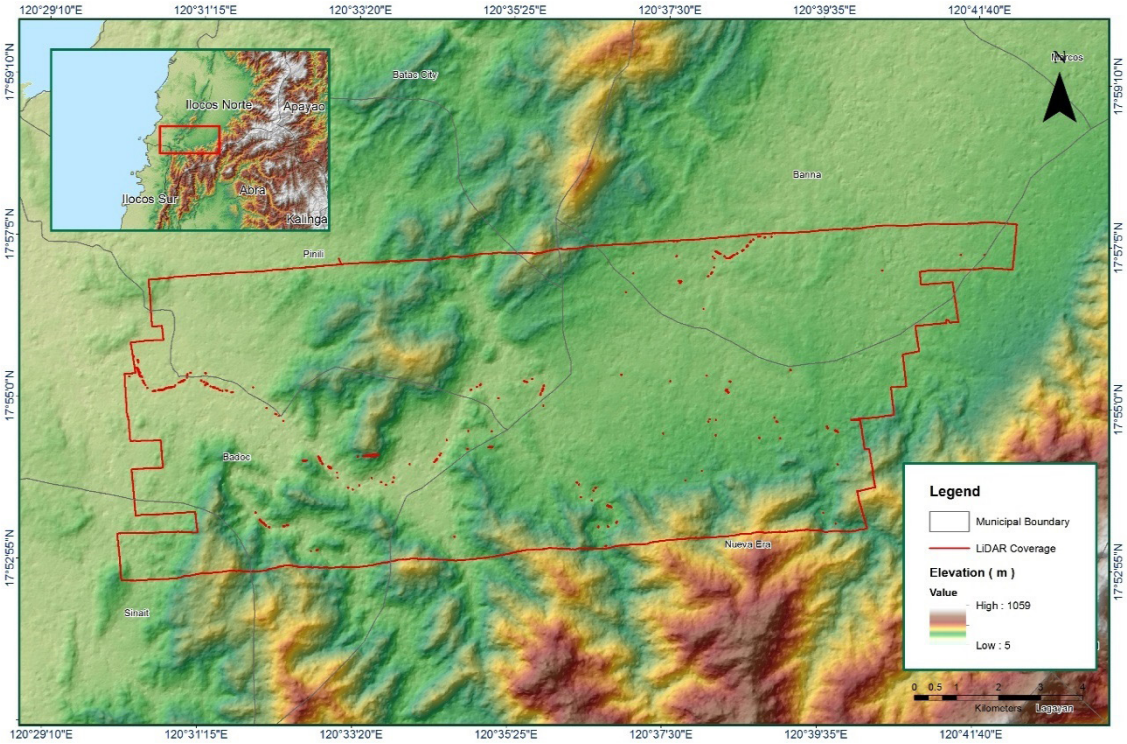


Figure 1.15.4. Coverage of LiDAR data

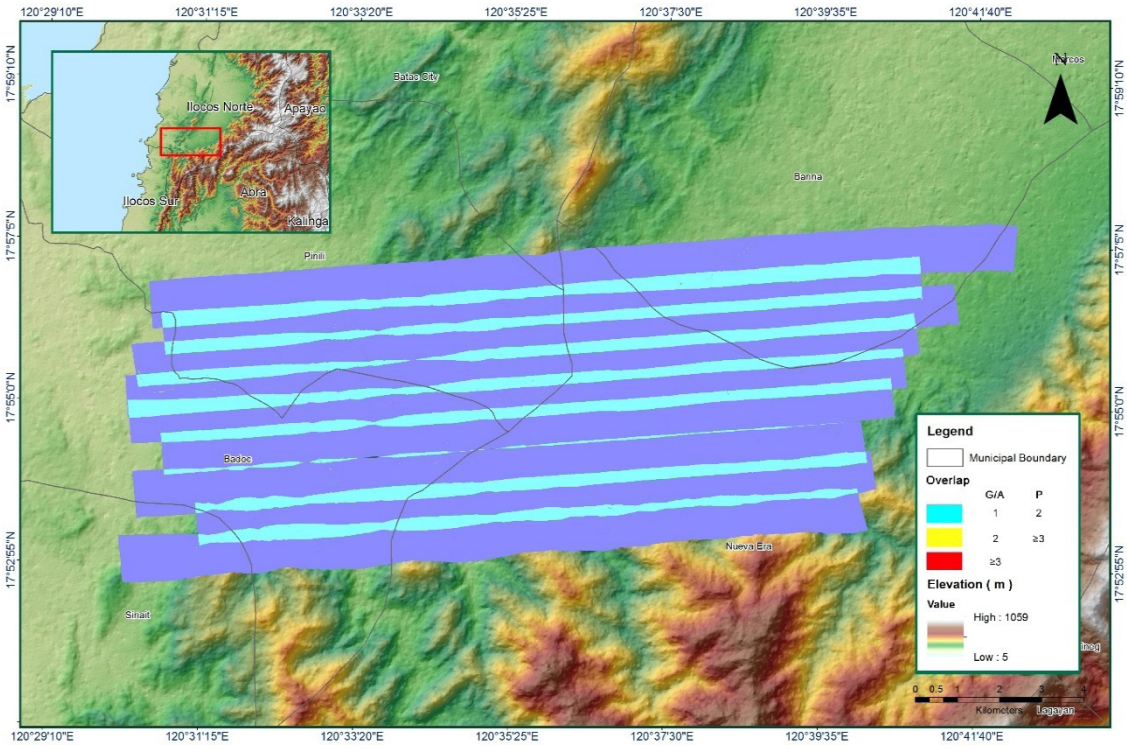


Figure 1.15.5. Image of data overlap

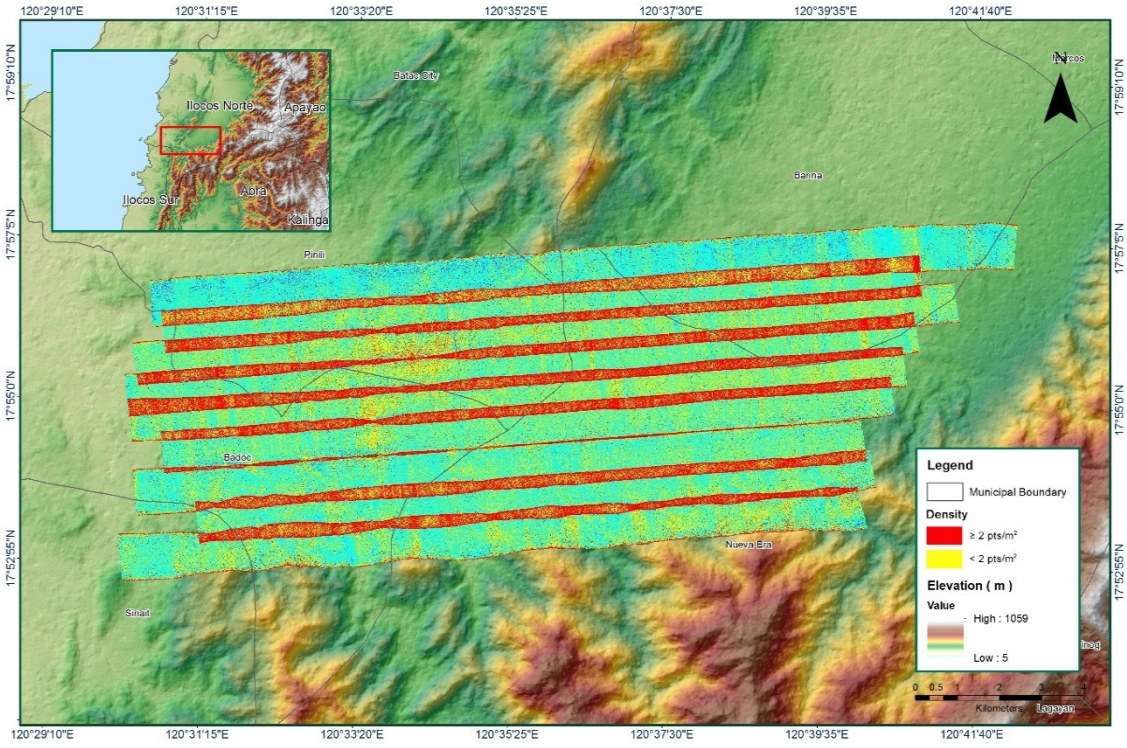


Figure 1.15.6. Density map of merged LiDAR data

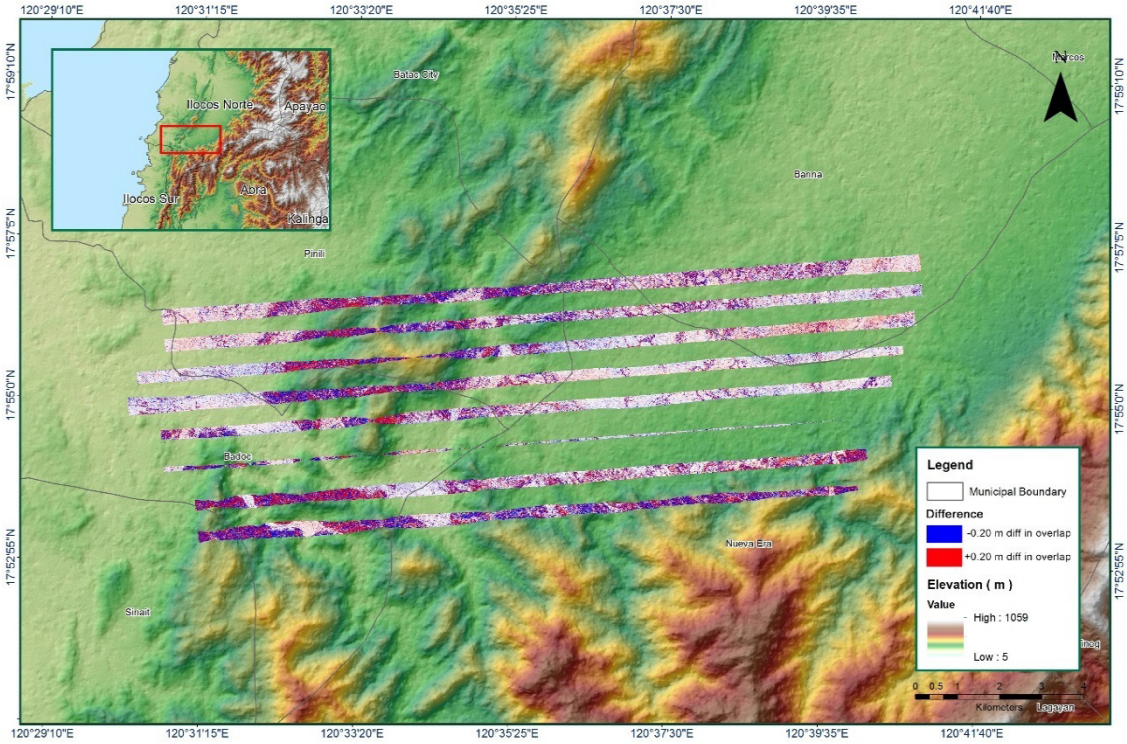


Figure 1.15.7. Elevation difference between flight lines

Annex 9. Laoag Model Basin Parameters

Table 9. Laoag Model Basin Parameters

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (cms)	Recession Constant	Threshold Type	Ratio to Peak
W1000	2.6136	82.933	0	0.18586	2.12324	Discharge	0.087308518	0.5	Ratio to Peak	0.3
W1010	4.2126	75.092	0	0.33035	3.77384	Discharge	1.307698204	0.5	Ratio to Peak	0.3
W1020	2.7788	82.048	0	0.26804	3.06215	Discharge	1.079273686	0.5	Ratio to Peak	0.3
W1030	3.9763	76.156	0	0.040494	0.462609	Discharge	0.015767356	0.5	Ratio to Peak	0.3
W1040	3.5076	78.358	0	0.44266	5.05694	Discharge	0.413939039	0.5	Ratio to Peak	0.3
W1050	2.3335	84.478	0	0.41003	4.68412	Discharge	0.608421475	0.5	Ratio to Peak	0.3
W1060	2.5326	83.374	0	0.22725	2.59602	Discharge	2.674312659	0.5	Ratio to Peak	0.3
W1070	3.2217	79.765	0	0.24944	2.8496187	Discharge	1.212561138	0.5	Ratio to Peak	0.3
W1080	3.0684	80.541	0	0.23491	2.68366	Discharge	1.010011256	0.5	Ratio to Peak	0.3
W1090	2.3669	84.291	0	0.40712	4.65094	Discharge	1.255507888	0.5	Ratio to Peak	0.3
W1100	4.0007	76.045	0	0.24596	2.80987	Discharge	1.127476221	0.5	Ratio to Peak	0.3
W1110	3.0696	80.535	0	0.45218	5.16572	Discharge	1.795934936	0.5	Ratio to Peak	0.3
W1120	2.2515	84.941	0	0.31165	3.56034	Discharge	2.555248906	0.5	Ratio to Peak	0.3
W1130	2.3985	84.115	0	0.44923	5.13205	Discharge	3.355616808	0.5	Ratio to Peak	0.3
W1140	4.3399	74.531	0	1.0211	11.6648	Discharge	4.219329786	0.5	Ratio to Peak	0.3
W1150	2.186	85.315	0	0.18205	2.07977	Discharge	0.240920791	0.5	Ratio to Peak	0.3

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (cms)	Recession Constant	Threshold Type	Ratio to Peak
W1160	3.4964	78.413	0	0.15942	1.82126	Discharge	0.834346738	0.5	Ratio to Peak	0.3
W1170	3.5593	78.109	0	0.2474	2.82632	Discharge	1.134183779	0.5	Ratio to Peak	0.3
W1180	1.5697	89	0	0.087845	1.00352	Discharge	0.019938906	0.5	Ratio to Peak	0.3
W1190	1.7756	87.734	0	0.26423	3.01854	Discharge	0.09728716	0.5	Ratio to Peak	0.3
W1200	2.7189	82.367	0	0.18644	2.12989	Discharge	0.115829424	0.5	Ratio to Peak	0.3
W1210	2.3573	84.345	0	0.3543	4.04747	Discharge	0.960209933	0.5	Ratio to Peak	0.3
W1220	3.0271	80.752	0	0.6171	7.0497	Discharge	1.639952048	0.5	Ratio to Peak	0.3
W1230	2.8342	81.755	0	0.61382	7.0126	Discharge	3.539017989	0.5	Ratio to Peak	0.3
W1240	1.7261	88.035	0	0.15018	1.7157	Discharge	0.040373988	0.5	Ratio to Peak	0.3
W1250	2.661	82.677	0	0.45456	5.19288	Discharge	3.809158006	0.5	Ratio to Peak	0.3
W1260	2.5621	83.213	0	0.16967	1.9383	Discharge	0.659509178	0.5	Ratio to Peak	0.3
W1270	3.2886	79.431	0	0.22819	2.6068	Discharge	0.745292416	0.5	Ratio to Peak	0.3
W1280	1.5966	88.832	0	0.82771	9.4556	Discharge	0.555716606	0.5	Ratio to Peak	0.3
W1300	6.5623	65.932	0	1.3647	15.5904	Discharge	3.100729594	0.5	Ratio to Peak	0.3
W1310	3.7692	77.114	0	0.79325	9.0622	Discharge	1.772375787	0.5	Ratio to Peak	0.3
W1320	2.3828	84.202	0	0.37919	4.33188	Discharge	2.501092265	0.5	Ratio to Peak	0.3
W1330	3.0628	80.57	0	0.11121	1.2705	Discharge	0.332198713	0.5	Ratio to Peak	0.3
W1340	3.5847	77.987	0	0.47615	5.43956	Discharge	0.83903284	0.5	Ratio to Peak	0.3

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (cms)	Recession Constant	Threshold Type	Ratio to Peak
W1350	2.2609	84.888	0	0.85165	9.7293	Discharge	1.573740178	0.5	Ratio to Peak	0.3
W1360	4.7283	72.87	0	0.96158	10.9851	Discharge	3.043209985	0.5	Ratio to Peak	0.3
W1370	4.3728	74.388	0	0.06628	0.75719	Discharge	0.011761198	0.5	Ratio to Peak	0.3
W1380	6.5988	71.197	0	0.79115	20.732	Discharge	6.1485	0.75987	Ratio to Peak	0.19301
W1400	2.3457	66	0	0.16429	6.3969	Discharge	0.14849	0.76475	Ratio to Peak	0.42354
W1410	1.2769	89.1	0	0.15605	20.819	Discharge	1.3029	1	Ratio to Peak	0.19303
W1420	2.3993	99	0	0.12283	1.0758	Discharge	0.0429953	0.51073	Ratio to Peak	0.28377
W1430	1.8101	99	0	0.16561	1.2171	Discharge	0.0773797	0.51067	Ratio to Peak	0.28375
W1440	2.7406	49.052	0	0.75587	19.669	Discharge	1.2496	1	Ratio to Peak	0.42354
W1450	1.5729	99	0	0.8148	13.989	Discharge	2.0579	1	Ratio to Peak	0.42354
W1460	1.4126	70.824	0	1.7013	5.9166	Discharge	1.9792	1	Ratio to Peak	0.42354
W1470	0.57347	84.206	0	0.23602	14.285	Discharge	1.8145	0.76436	Ratio to Peak	0.27671
W1480	0.47773	81.183	0	0.46061	12.174	Discharge	4.544	1	Ratio to Peak	0.28236
W1490	4.4267	81.835	0	0.26882	5.7095	Discharge	2.9817	0.49263	Ratio to Peak	0.28812
W1500	3.1658	80.046	0	0.26445	3.02113	Discharge	1.498211235	0.5	Ratio to Peak	0.3
W1510	8.4957	73.983	0	0.22284	3.7268	Discharge	2.2699	0.76265	Ratio to Peak	0.12805
W1520	2.4435	83.865	0	0.2315	2.64467	Discharge	1.736246856	0.5	Ratio to Peak	0.3
W1530	6.7413	76.006	0	0.1311	1.7675	Discharge	1.1824	0.2242	Ratio to Peak	0.42354

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (cms)	Recession Constant	Threshold Type	Ratio to Peak
W1540	5.1348	77.661	0	0.30961	1.063	Discharge	1.0101	0.43398	Ratio to Peak	0.42354
W1550	2.1017	99	0	0.25244	0.82935	Discharge	0.0984597	0.7418	Ratio to Peak	0.076887
W1560	0.55376	76.857	0	0.51699	9.0753	Discharge	1.5458	1	Ratio to Peak	0.18824
W1570	1.5559	99	0	0.13881	0.91379	Discharge	1.3192	0.43522	Ratio to Peak	0.18824
W1580	6.8801	47.859	0	0.20407	4.5524	Discharge	4.4289	1	Ratio to Peak	0.18824
W1590	1.9484	99	0	0.14429	1.5435	Discharge	0.35389	0.21448	Ratio to Peak	0.19208
W1600	1.2206	76.289	0	0.21341	7.1732	Discharge	1.1086	1	Ratio to Peak	0.19698
W1610	2.2476	99	0	0.021381	0.55218	Discharge	0.0032468	0.45196	Ratio to Peak	0.27671
W1620	2.0927	99	0	0.16654	1.6116	Discharge	0.12963	0.45196	Ratio to Peak	0.28236
W1630	1.2644	99	0	0.2129	12.618	Discharge	3.062	0.84787	Ratio to Peak	0.2895
W1640	1.173	99	0	0.19293	7.5617	Discharge	1.3818	0.32966	Ratio to Peak	0.19697
W1650	2.5735	44.808	0	0.1566	1.723	Discharge	2.2233	1	Ratio to Peak	0.28812
W1660	1.2945	99	0	0.11698	0.52386	Discharge	0.0282621	0.45196	Ratio to Peak	0.19303
W1670	0.95895	99	0	0.14267	0.70987	Discharge	0.47698	0.30746	Ratio to Peak	0.28812
W1680	0.63433	85.553	0	0.20663	12.46	Discharge	1.7229	1	Ratio to Peak	0.13333
W1690	2.4103	86.741	0	0.18097	3.0902	Discharge	2.4863	0.21449	Ratio to Peak	0.18824
W1700	1.1644	87.176	0	0.14216	12.147	Discharge	1.2737	0.81975	Ratio to Peak	0.088889
W1710	1.4934	89.1	0	0.14547	8.5288	Discharge	1.6835	0.56692	Ratio to Peak	0.28375

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (cms)	Recession Constant	Threshold Type	Ratio to Peak
W1720	1.9571	77.596	0	1.4011	16.028	Discharge	2.6956	0.82905	Ratio to Peak	0.19208
W1730	2.347	56.803	0	0.99975	11.423	Discharge	3.3689	0.75574	Ratio to Peak	0.19208
W1740	1.4883	89.836	0	0.1423	1.5612	Discharge	1.6829	0.45196	Ratio to Peak	0.28812
W1750	5.9797	87.354	0	0.14471	3.4503	Discharge	1.9467	0.70589	Ratio to Peak	0.19208
W1760	1.4478	99	0	0.076415	0.25719	Discharge	0.0809042	0.45196	Ratio to Peak	0.27671
W1770	2.5681	80.416	0	0.0166667	1.9376	Discharge	1.1676	0.30746	Ratio to Peak	0.18824
W1780	1.4774	99	0	0.025955	0.19372	Discharge	0.0082714	0.45196	Ratio to Peak	0.27671
W1790	1.4774	99	0	0.028481	0.12754	Discharge	0.011177	0.45196	Ratio to Peak	0.27671
W1800	1.3753	88.439	0	0.115	4.5598	Discharge	0.93874	0.31496	Ratio to Peak	0.2008
W1810	1.6659	83.939	0	0.57517	4.9118	Discharge	3.7953	0.82638	Ratio to Peak	0.19278
W1820	1.2666	79.393	0	0.14828	4.3708	Discharge	4.4845	0.99402	Ratio to Peak	0.28895
W1840	3.0018	80.883	0	0.58158	6.64398	Discharge	0.513339539	0.5	Ratio to Peak	0.3
W1850	3.6722	77.57	0	0.64302	7.3458	Discharge	4.018103039	0.5	Ratio to Peak	0.3
W1890	3.5973	77.927	0	0.77075	8.8053	Discharge	0.608164198	0.5	Ratio to Peak	0.3
W1900	2.4457	99	0	0.099131	0.67904	Discharge	0.0708583	0.45196	Ratio to Peak	0.27671
W920	3.6602	77.628	0	1.5485	17.690227	Discharge	4.214919337	0.5	Ratio to Peak	0.3
W930	3.8447	76.762	0	0.36362	4.15401	Discharge	1.753815146	0.5	Ratio to Peak	0.3
W940	2.1443	85.555	0	0.23784	2.71712	Discharge	1.32081929	0.5	Ratio to Peak	0.3

Basin Number	SCS Curve Number Loss			Clark Unit Hydrograph Transform		Recession Baseflow				
	Initial Abstraction (mm)	Curve Number	Impervious (%)	Time of Concentration (HR)	Storage Coefficient (HR)	Initial Type	Initial Discharge (cms)	Recession Constant	Threshold Type	Ratio to Peak
W950	1.9622	86.617	0	0.41438	4.73389	Discharge	0.958684653	0.5	Ratio to Peak	0.3
W960	1.1067	91.984	0	0.29371	3.35538	Discharge	0.203781132	0.5	Ratio to Peak	0.3
W970	2.9251	81.279	0	0.26882	3.07097	Discharge	1.633373128	0.5	Ratio to Peak	0.3
W980	4.7866	72.627	0	0.40539	4.631199	Discharge	0.130273645	0.5	Ratio to Peak	0.3
W990	2.6413	82.783	0	1.0243	11.7012	Discharge	2.302713932	0.5	Ratio to Peak	0.3

Annex 10. Laoag Model Reach Parameters

Table 10-A.1. Laoag Model Reach Parameters

Reach Number	Muskingum Cunge Channel Routing						
	Time Step Method	Length (m)	Slope	Manning's n	Shape	Width	Side Slope
R100	Automatic Fixed Interval	2493.5	0.000553	0.01	Trapezoid	99.8	1
R130	Automatic Fixed Interval	8157	0.000349	0.01	Trapezoid	31.7	1
R160	Automatic Fixed Interval	412.13	0.002835	0.01	Trapezoid	82	1
R190	Automatic Fixed Interval	7011.4	0.001624	0.01	Trapezoid	138	1
R1910	Automatic Fixed Interval	293.85	0.000968	0.006665	Trapezoid	417	1
R200	Automatic Fixed Interval	5391.6	0.002043	0.01	Trapezoid	85	1
R210	Automatic Fixed Interval	2813.2	0.003275	0.01	Trapezoid	263	1
R240	Automatic Fixed Interval	712.55	0.001945	0.01	Trapezoid	78.5	1
R260	Automatic Fixed Interval	3661.2	0.000772	0.01	Trapezoid	591	1
R280	Automatic Fixed Interval	676.98	0.001336	0.01	Trapezoid	497	1
R290	Automatic Fixed Interval	2592.1	0.001239	0.01	Trapezoid	151	1
R30	Automatic Fixed Interval	867.11	0.004264	0.01	Trapezoid	404	1
R300	Automatic Fixed Interval	1010.8	0.00088	0.01	Trapezoid	617	1
R320	Automatic Fixed Interval	2059.4	0.000877	0.01	Trapezoid	129	1
R340	Automatic Fixed Interval	2462.5	0.000784	0.01	Trapezoid	466	1
R350	Automatic Fixed Interval	3368.5	0.00099	0.01	Trapezoid	19	1

Reach Number	Muskingum Cunge Channel Routing						
	Time Step Method	Length (m)	Slope	Manning's n	Shape	Width	Side Slope
R370	Automatic Fixed Interval	8478.1	0.000951	0.01	Trapezoid	835	1
R380	Automatic Fixed Interval	1741.7	0.003071	0.01	Trapezoid	22.8	1
R390	Automatic Fixed Interval	5760.3	0.002624	0.01	Trapezoid	422	1
R40	Automatic Fixed Interval	396.84	0.0001	0.01	Trapezoid	188	1
R400	Automatic Fixed Interval	5433.1	0.000821	0.01	Trapezoid	655	1
R410	Automatic Fixed Interval	203.14	0.002701	0.01	Trapezoid	161	1
R450	Automatic Fixed Interval	879.12	0.000374	0.01	Trapezoid	441	1
R480	Automatic Fixed Interval	885.27	0.002185	0.021802	Trapezoid	168	1
R490	Automatic Fixed Interval	519.71	0.000911	0.0098	Trapezoid	93.6	1
R50	Automatic Fixed Interval	11234	9.09E-05	0.01	Trapezoid	239	1
R500	Automatic Fixed Interval	3093.6	0.00143	0.009	Trapezoid	308	1
R510	Automatic Fixed Interval	2353.5	0.001348	0.00586	Trapezoid	353	1
R530	Automatic Fixed Interval	3530.6	0.002702	0.016905	Trapezoid	125	1
R570	Automatic Fixed Interval	9252.8	0.002218	0.01	Trapezoid	33	1
R600	Automatic Fixed Interval	3457.8	0.00466	0.007472	Trapezoid	98.4	1
R610	Automatic Fixed Interval	5631.4	0.00122	0.008481	Trapezoid	341	1
R640	Automatic Fixed Interval	1632.7	0.001407	0.011453	Trapezoid	171	1
R660	Automatic Fixed Interval	1848.9	0.001371	0.006505	Trapezoid	275	1

Reach Number	Muskingum Cunge Channel Routing						
	Time Step Method	Length (m)	Slope	Manning's n	Shape	Width	Side Slope
R680	Automatic Fixed Interval	1412.7	0.001837	0.006313	Trapezoid	167	1
R690	Automatic Fixed Interval	113.14	0.001371	0.013365	Trapezoid	197	1
R70	Automatic Fixed Interval	365.56	0.00671	0.01	Trapezoid	13	1
R710	Automatic Fixed Interval	648.7	0.00353	0.00446	Trapezoid	145	1
R730	Automatic Fixed Interval	601.84	0.000465	0.022228	Trapezoid	120	1
R770	Automatic Fixed Interval	2975.6	0.001932	0.0039	Trapezoid	297	1
R780	Automatic Fixed Interval	3290.2	0.003074	0.033895	Trapezoid	274	1
R790	Automatic Fixed Interval	3899.6	0.000639	0.011253	Trapezoid	40.7	1
R840	Automatic Fixed Interval	4412.4	0.001318	0.0115	Trapezoid	47.6	1
R850	Automatic Fixed Interval	788.41	0.000346	0.014888	Trapezoid	31.4	1
R870	Automatic Fixed Interval	239.71	0.001571	0.027128	Trapezoid	33.2	1
R880	Automatic Fixed Interval	251.42	0.001813	0.013355	Trapezoid	24.3	1
R90	Automatic Fixed Interval	1130.5	0.002721	0.01	Trapezoid	53.4	1

ANNEX 11. LAOAG FIELD VALIDATION POINTS

Table A-11.1. Laoag Field Validation Points

Point Number	Validation Coordinates		Model Var (m)	Validation points (m)	Error (m)	Event/Date	Rain Return/ Scenario
	Lat	Long					
1	17.97907	120.659557	0.030	0.457	0.209	Ineng/ August 20-23, 2015	5- Year
2	17.98116	120.660323	0.030	0.305	0.093	Ineng/ August 20-23, 2015	5- Year
3	18.11573	120.728587	0.180	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
4	18.06142	120.747518	0.200	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
5	18.11742	120.731939	0.440	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
6	18.10606	120.699475	3.920	1.219	1.486	Mario/ September 18-22, 2014	5- Year
7	18.12135	120.703088	3.170	1.219	1.486	Mario/ September 18-22, 2014	5- Year
8	18.08658	120.707487	0.030	1.219	1.486	Mario/ September 18-22, 2014	5- Year
9	18.05398	120.730442	0.330	1.219	1.486	Mario/ September 18-22, 2014	5- Year
10	18.05727	120.726059	0.050	1.219	1.486	Mario/ September 18-22, 2014	5- Year
11	18.12325	120.689454	5.540	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
12	18.0571	120.729591	0.070	1.219	1.486	Mario/ September 18-22, 2014	5- Year
13	17.98208	120.654425	0.030	0.305	0.093	Ineng/ August 20-23, 2015	5- Year
14	18.11555	120.694168	5.170	1.219	1.486	Mario/ September 18-22, 2014	5- Year
15	18.11026	120.7156	3.350	1.219	1.486	Mario/ September 18-22, 2014	5- Year
16	18.08896	120.692849	0.270	1.219	1.486	Mario/ September 18-22, 2014	5- Year
17	18.14001	120.671358	0.270	0.914	0.836	Mario/ September 18-22, 2014	5- Year
18	18.07682	120.690906	0.350	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
19	18.08153	120.69072	0.070	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
20	18.12087	120.677589	2.000	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
21	18.1009	120.703835	5.040	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
22	18.09012	120.683632	2.080	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
23	18.0852	120.732322	3.470	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
24	17.97904	120.656636	0.090	0.305	0.093	Ineng/ August 20-23, 2015	5- Year
25	18.13328	120.715936	0.350	0.305	0.093	Ineng/ August 20-23, 2015	5- Year
26	18.08905	120.73336	3.370	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
27	18.10074	120.695352	5.210	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
28	18.05832	120.74938	0.050	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
29	18.0594	120.749765	0.040	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
30	18.11009	120.783522	0.210	0.610	0.372	Ineng/ August 20-23, 2015	5- Year
31	18.06003	120.747641	0.090	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
32	18.10443	120.721166	1.010	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
33	18.10208	120.731731	3.330	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
34	18.10393	120.7807	0.370	0.610	0.372	Ineng/ August 20-23, 2015	5- Year
35	18.06244	120.740875	0.590	0.610	0.372	Ineng/ August 20-23, 2015	5- Year
36	18.09538	120.767322	0.030	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
37	18.09396	120.768203	1.200	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
38	18.09079	120.770042	1.390	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
39	18.11573	120.728587	0.180	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
40	18.11742	120.731939	0.440	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
41	18.06244	120.740875	0.590	0.610	0.372	Ineng/ August 20-23, 2015	5- Year
42	18.12135	120.703088	3.170	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
43	18.08658	120.707487	0.030	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
44	18.07268	120.686341	0.060	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
45	18.07449	120.685708	0.120	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year

46	18.07682	120.690906	0.350	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
47	18.11555	120.694168	5.170	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
48	18.11026	120.7156	3.350	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
49	18.13328	120.715936	0.350	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
50	18.11009	120.783522	0.210	0.610	0.372	Ineng/ August 20-23, 2015	5- Year
51	18.0512	120.772756	1.790	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
52	18.10992	120.693492	3.410	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
53	18.13676	120.676769	0.030	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
54	18.20968	120.567078	0.300	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
55	18.16327	120.71798	0.030	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
56	18.1269	120.68278	2.010	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
57	18.08153	120.69072	0.070	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
58	18.17119	120.718033	0.030	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
59	18.05398	120.730442	0.330	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
60	18.10393	120.7807	0.370	0.610	0.372	Ineng/ August 20-23, 2015	5- Year
61	18.05727	120.726059	0.050	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
62	18.0571	120.729591	0.070	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
63	18.10329	120.702074	5.070	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
64	18.1103	120.678035	0.040	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
65	18.13333	120.700909	3.000	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
66	18.11009	120.783522	0.210	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
67	18.10393	120.7807	0.370	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
68	18.12087	120.677589	2.000	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
69	18.06244	120.740875	0.590	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
70	18.07501	120.722902	0.560	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
71	18.12325	120.689454	5.540	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
72	18.13457	120.626284	1.630	0.305	0.093	Egay/ July 4-8, 2015	5- Year
73	18.1996	120.596577	0.080	0.305	0.093	Egay/ July 4-8, 2015	5- Year
74	18.0512	120.772756	1.790	1.219	1.486	Igme/ July 24-28, 2008	5- Year
75	18.19727	120.594187	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
76	18.19281	120.595974	0.200	1.067	1.138	Igme/ July 24-28, 2008	5- Year
77	18.19587	120.596773	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
78	18.20419	120.591135	0.240	1.067	1.138	Igme/ July 24-28, 2008	5- Year
79	18.1009	120.703835	5.040	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
80	18.1956	120.598644	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
81	18.1981	120.601237	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
82	18.19427	120.600312	0.120	1.067	1.138	Igme/ July 24-28, 2008	5- Year
83	18.19096	120.6016	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
84	18.19382	120.604205	0.160	1.067	1.138	Igme/ July 24-28, 2008	5- Year
85	18.0512	120.772756	1.790	0.305	0.093	Egay/ July 4-8, 2015	5- Year
86	18.19103	120.604362	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
87	18.19097	120.607021	0.540	1.067	1.138	Igme/ July 24-28, 2008	5- Year
88	18.20968	120.567078	0.300	1.219	1.486	Igme/ July 24-28, 2008	5- Year
89	18.16327	120.71798	0.030	1.219	1.486	Igme/ July 24-28, 2008	5- Year
90	18.09012	120.683632	2.080	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
91	18.1269	120.68278	2.010	1.219	1.486	Igme/ July 24-28, 2008	5- Year
92	18.17119	120.718033	0.030	1.219	1.486	Igme/ July 24-28, 2008	5- Year
93	18.20163	120.589859	0.460	1.067	1.138	Igme/ July 24-28, 2008	5- Year
94	18.21142	120.555829	0.840	1.067	1.138	Igme/ July 24-28, 2008	5- Year
95	18.19281	120.595974	0.200	0.305	0.093	Egay/ July 4-8, 2015	5- Year

96	18.21786	120.562282	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
97	18.2042	120.537835	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
98	18.21786	120.562282	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
99	18.20225	120.536962	0.400	1.067	1.138	Igme/ July 24-28, 2008	5- Year
100	18.20225	120.536962	0.400	1.067	1.138	Igme/ July 24-28, 2008	5- Year
101	18.0852	120.732322	3.470	0.508	0.258	Pepeng/ October 2-5, 2009	5- Year
102	18.18457	120.528021	0.230	1.067	1.138	Igme/ July 24-28, 2008	5- Year
103	18.18602	120.528645	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
104	18.17934	120.523864	1.560	1.067	1.138	Igme/ July 24-28, 2008	5- Year
105	18.18332	120.537148	0.160	1.067	1.138	Igme/ July 24-28, 2008	5- Year
106	18.18561	120.526633	0.250	1.067	1.138	Igme/ July 24-28, 2008	5- Year
107	18.20265	120.597755	0.180	0.305	0.093	Egay/ July 4-8, 2015	5- Year
108	18.18105	120.554836	0.990	1.067	1.138	Igme/ July 24-28, 2008	5- Year
109	18.18692	120.547834	0.040	1.067	1.138	Igme/ July 24-28, 2008	5- Year
110	18.17036	120.54925	0.320	1.067	1.138	Igme/ July 24-28, 2008	5- Year
111	18.14785	120.545686	1.080	1.067	1.138	Igme/ July 24-28, 2008	5- Year
112	17.98335	120.660031	0.050	0.305	0.093	Ineng/ August 20-23, 2015	5- Year
113	18.08905	120.73336	3.370	0.508	0.258	Pepeng/ October 2-5, 2009	5- Year
114	18.16908	120.532865	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
115	18.18501	120.527142	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
116	18.19256	120.546938	0.300	1.067	1.138	Igme/ July 24-28, 2008	5- Year
117	18.19911	120.566348	0.280	1.067	1.138	Igme/ July 24-28, 2008	5- Year
118	18.18816	120.577005	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
119	18.18958	120.561538	0.300	1.067	1.138	Igme/ July 24-28, 2008	5- Year
120	18.19587	120.596773	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
121	18.18487	120.560278	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
122	18.17568	120.570436	1.200	1.067	1.138	Igme/ July 24-28, 2008	5- Year
123	18.18241	120.581291	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
124	18.10074	120.695352	5.210	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
125	18.18537	120.570961	0.050	1.067	1.138	Igme/ July 24-28, 2008	5- Year
126	18.18335	120.594288	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
127	18.18759	120.581401	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
128	18.17777	120.622253	0.160	1.067	1.138	Igme/ July 24-28, 2008	5- Year
129	18.18107	120.618657	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
130	18.19201	120.610857	0.060	1.067	1.138	Igme/ July 24-28, 2008	5- Year
131	18.21673	120.60012	0.040	1.067	1.138	Igme/ July 24-28, 2008	5- Year
132	18.20419	120.591135	0.240	0.305	0.093	Egay/ July 4-8, 2015	5- Year
133	18.22113	120.594621	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
134	18.18496	120.658407	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
135	18.05832	120.74938	0.050	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
136	18.19834	120.656477	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
137	18.21532	120.577068	0.190	1.067	1.138	Igme/ July 24-28, 2008	5- Year
138	18.1956	120.598644	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
139	18.22797	120.559742	0.740	1.067	1.138	Igme/ July 24-28, 2008	5- Year
140	18.13457	120.626284	1.630	0.914	0.836	Mario/ September 18-22, 2014	5- Year
141	18.13202	120.626611	1.250	0.914	0.836	Mario/ September 18-22, 2014	5- Year
142	18.20265	120.597755	0.180	0.762	0.581	Mario/ September 18-22, 2014	5- Year
143	18.19103	120.604362	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
144	18.1999	120.596119	0.040	0.762	0.581	Mario/ September 18-22, 2014	5- Year
145	18.20419	120.591135	0.240	0.762	0.581	Mario/ September 18-22, 2014	5- Year

146	18.0594	120.749765	0.040	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
147	18.19793	120.588143	0.110	0.762	0.581	Mario/ September 18-22, 2014	5- Year
148	18.19696	120.588572	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
149	18.1981	120.601237	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
150	18.19815	120.589963	0.120	0.762	0.581	Mario/ September 18-22, 2014	5- Year
151	18.19809	120.591339	0.120	0.762	0.581	Mario/ September 18-22, 2014	5- Year
152	18.1995	120.593253	0.350	0.762	0.581	Mario/ September 18-22, 2014	5- Year
153	18.20359	120.594303	0.310	0.762	0.581	Mario/ September 18-22, 2014	5- Year
154	18.19968	120.594538	0.110	0.762	0.581	Mario/ September 18-22, 2014	5- Year
155	18.1996	120.596577	0.080	0.762	0.581	Mario/ September 18-22, 2014	5- Year
156	18.19427	120.600312	0.120	0.305	0.093	Egay/ July 4-8, 2015	5- Year
157	18.06979	120.712748	1.940	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
158	18.19727	120.594187	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
159	18.19281	120.595974	0.200	0.762	0.581	Mario/ September 18-22, 2014	5- Year
160	18.19587	120.596773	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
161	18.1956	120.598644	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
162	18.1981	120.601237	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
163	18.19427	120.600312	0.120	0.762	0.581	Mario/ September 18-22, 2014	5- Year
164	18.19096	120.6016	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
165	18.19382	120.604205	0.160	0.762	0.581	Mario/ September 18-22, 2014	5- Year
166	18.19096	120.6016	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
167	18.19103	120.604362	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
168	18.10443	120.721166	1.010	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
169	18.19097	120.607021	0.540	0.762	0.581	Mario/ September 18-22, 2014	5- Year
170	18.20968	120.567078	0.300	0.914	0.836	Mario/ September 18-22, 2014	5- Year
171	18.20163	120.589859	0.460	0.762	0.581	Mario/ September 18-22, 2014	5- Year
172	18.21142	120.555829	0.840	0.762	0.581	Mario/ September 18-22, 2014	5- Year
173	18.13202	120.626611	1.250	0.305	0.093	Egay/ July 4-8, 2015	5- Year
174	18.19382	120.604205	0.160	0.305	0.093	Egay/ July 4-8, 2015	5- Year
175	18.21786	120.562282	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
176	18.2042	120.537835	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
177	18.21786	120.562282	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
178	18.20225	120.536962	0.400	0.762	0.581	Mario/ September 18-22, 2014	5- Year
179	18.10208	120.731731	3.330	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
180	18.18457	120.528021	0.230	0.762	0.581	Mario/ September 18-22, 2014	5- Year
181	18.18602	120.528645	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
182	18.17934	120.523864	1.560	0.762	0.581	Mario/ September 18-22, 2014	5- Year
183	18.18332	120.537148	0.160	0.762	0.581	Mario/ September 18-22, 2014	5- Year
184	18.18561	120.526633	0.250	0.762	0.581	Mario/ September 18-22, 2014	5- Year
185	18.19103	120.604362	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
186	18.18105	120.554836	0.990	0.762	0.581	Mario/ September 18-22, 2014	5- Year
187	18.18692	120.547834	0.040	0.762	0.581	Mario/ September 18-22, 2014	5- Year
188	18.17036	120.54925	0.320	0.762	0.581	Mario/ September 18-22, 2014	5- Year
189	18.14785	120.545686	1.080	0.762	0.581	Mario/ September 18-22, 2014	5- Year
190	18.09538	120.767322	0.030	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
191	18.16908	120.532865	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
192	18.18501	120.527142	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
193	18.19256	120.546938	0.300	0.762	0.581	Mario/ September 18-22, 2014	5- Year
194	18.19911	120.566348	0.280	0.762	0.581	Mario/ September 18-22, 2014	5- Year
195	18.18816	120.577005	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year

196	18.18958	120.561538	0.300	0.762	0.581	Mario/ September 18-22, 2014	5- Year
197	18.19097	120.607021	0.540	0.305	0.093	Egay/ July 4-8, 2015	5- Year
198	18.18487	120.560278	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
199	18.17568	120.570436	1.200	0.762	0.581	Mario/ September 18-22, 2014	5- Year
200	18.18241	120.581291	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
201	18.09396	120.768203	1.200	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
202	18.18537	120.570961	0.050	0.762	0.581	Mario/ September 18-22, 2014	5- Year
203	18.18335	120.594288	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
204	18.18759	120.581401	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
205	18.17777	120.622253	0.160	0.762	0.581	Mario/ September 18-22, 2014	5- Year
206	18.18107	120.618657	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
207	18.19201	120.610857	0.060	0.762	0.581	Mario/ September 18-22, 2014	5- Year
208	18.21673	120.60012	0.040	0.762	0.581	Mario/ September 18-22, 2014	5- Year
209	18.19513	120.592163	0.060	0.305	0.093	Egay/ July 4-8, 2015	5- Year
210	18.22113	120.594621	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
211	18.18496	120.658407	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
212	18.09079	120.770042	1.390	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
213	18.19834	120.656477	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
214	18.21532	120.577068	0.190	0.762	0.581	Mario/ September 18-22, 2014	5- Year
215	18.13268	120.653507	0.130	0.305	0.093	Egay/ July 4-8, 2015	5- Year
216	18.22797	120.559742	0.740	0.762	0.581	Mario/ September 18-22, 2014	5- Year
217	18.20536	120.58945	0.180	0.305	0.093	Egay/ July 4-8, 2015	5- Year
218	18.20968	120.567078	0.300	0.305	0.093	Egay/ July 4-8, 2015	5- Year
219	18.16327	120.71798	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
220	18.1269	120.68278	2.010	0.305	0.093	Egay/ July 4-8, 2015	5- Year
221	18.17119	120.718033	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
222	18.1454	120.644623	5.310	0.305	0.093	Egay/ July 4-8, 2015	5- Year
223	17.98298	120.656755	0.030	0.305	0.093	Ineng/ August 20-23, 2015	5- Year
224	18.11573	120.728587	0.180	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
225	18.20163	120.589859	0.460	0.305	0.093	Egay/ July 4-8, 2015	5- Year
226	18.21142	120.555829	0.840	0.305	0.093	Egay/ July 4-8, 2015	5- Year
227	18.21786	120.562282	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
228	18.2042	120.537835	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
229	18.20225	120.536962	0.400	0.305	0.093	Egay/ July 4-8, 2015	5- Year
230	18.20225	120.536962	0.400	0.305	0.093	Egay/ July 4-8, 2015	5- Year
231	18.18457	120.528021	0.230	0.305	0.093	Egay/ July 4-8, 2015	5- Year
232	18.18602	120.528645	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
233	18.17934	120.523864	1.560	0.305	0.093	Egay/ July 4-8, 2015	5- Year
234	18.1995	120.593253	0.350	0.305	0.093	Egay/ July 4-8, 2015	5- Year
235	18.11742	120.731939	0.440	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
236	18.18332	120.537148	0.160	0.305	0.093	Egay/ July 4-8, 2015	5- Year
237	18.18561	120.526633	0.250	0.305	0.093	Egay/ July 4-8, 2015	5- Year
238	18.18692	120.547834	0.040	0.305	0.093	Egay/ July 4-8, 2015	5- Year
239	18.17036	120.54925	0.320	0.305	0.093	Egay/ July 4-8, 2015	5- Year
240	18.1999	120.596119	0.040	0.305	0.093	Egay/ July 4-8, 2015	5- Year
241	18.14785	120.545686	1.080	0.305	0.093	Egay/ July 4-8, 2015	5- Year
242	18.16908	120.532865	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
243	18.18501	120.527142	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
244	18.19256	120.546938	0.300	0.305	0.093	Egay/ July 4-8, 2015	5- Year
245	18.20359	120.594303	0.310	0.305	0.093	Egay/ July 4-8, 2015	5- Year

246	18.12135	120.703088	3.170	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
247	18.19911	120.566348	0.280	0.305	0.093	Egay/ July 4-8, 2015	5- Year
248	18.18816	120.577005	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
249	18.18487	120.560278	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
250	18.17568	120.570436	1.200	0.305	0.093	Egay/ July 4-8, 2015	5- Year
251	18.18241	120.581291	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
252	18.20419	120.591135	0.240	0.305	0.093	Egay/ July 4-8, 2015	5- Year
253	18.18537	120.570961	0.050	0.305	0.093	Egay/ July 4-8, 2015	5- Year
254	18.18335	120.594288	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
255	18.18759	120.581401	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
256	18.17777	120.622253	0.160	0.305	0.093	Egay/ July 4-8, 2015	5- Year
257	18.08658	120.707487	0.030	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
258	18.19968	120.594538	0.110	0.305	0.093	Egay/ July 4-8, 2015	5- Year
259	18.18107	120.618657	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
260	18.19201	120.610857	0.060	0.305	0.093	Egay/ July 4-8, 2015	5- Year
261	18.21673	120.60012	0.040	0.305	0.093	Egay/ July 4-8, 2015	5- Year
262	18.22113	120.594621	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
263	18.18496	120.658407	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
264	18.19834	120.656477	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
265	18.21532	120.577068	0.190	0.305	0.093	Egay/ July 4-8, 2015	5- Year
266	18.19793	120.588143	0.110	0.305	0.093	Egay/ July 4-8, 2015	5- Year
267	18.19513	120.592163	0.060	0.305	0.093	Egay/ July 4-8, 2015	5- Year
268	18.07268	120.686341	0.060	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
269	18.22797	120.559742	0.740	0.305	0.093	Egay/ July 4-8, 2015	5- Year
270	18.19696	120.588572	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
271	18.19696	120.588572	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
272	18.19815	120.589963	0.120	0.305	0.093	Egay/ July 4-8, 2015	5- Year
273	18.19727	120.594187	0.030	0.305	0.093	Egay/ July 4-8, 2015	5- Year
274	18.13268	120.653507	0.130	0.305	0.093	Egay/ July 4-8, 2015	5- Year
275	18.18958	120.561538	0.300	0.305	0.093	Egay/ July 4-8, 2015	5- Year
276	18.13457	120.626284	1.630	1.067	1.138	Igme/ July 24-28, 2008	5- Year
277	18.13202	120.626611	1.250	1.219	1.486	Igme/ July 24-28, 2008	5- Year
278	18.20265	120.597755	0.180	1.067	1.138	Igme/ July 24-28, 2008	5- Year
279	18.07449	120.685708	0.120	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
280	18.19103	120.604362	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
281	18.1999	120.596119	0.040	1.067	1.138	Igme/ July 24-28, 2008	5- Year
282	18.20419	120.591135	0.240	1.067	1.138	Igme/ July 24-28, 2008	5- Year
283	18.19793	120.588143	0.110	1.067	1.138	Igme/ July 24-28, 2008	5- Year
284	18.19696	120.588572	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
285	18.19696	120.588572	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
286	18.1999	120.596119	0.040	0.305	0.093	Egay/ July 4-8, 2015	5- Year
287	18.19815	120.589963	0.120	1.067	1.138	Igme/ July 24-28, 2008	5- Year
288	18.19809	120.591339	0.120	1.067	1.138	Igme/ July 24-28, 2008	5- Year
289	18.1995	120.593253	0.350	1.067	1.138	Igme/ July 24-28, 2008	5- Year
290	18.11555	120.694168	5.170	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
291	18.20359	120.594303	0.310	1.067	1.138	Igme/ July 24-28, 2008	5- Year
292	18.19968	120.594538	0.110	1.067	1.138	Igme/ July 24-28, 2008	5- Year
293	18.19513	120.592163	0.060	1.219	1.486	Igme/ July 24-28, 2008	5- Year
294	18.13268	120.653507	0.130	1.219	1.486	Igme/ July 24-28, 2008	5- Year
295	18.1999	120.596119	0.040	1.067	1.138	Igme/ July 24-28, 2008	5- Year

296	18.1996	120.596577	0.080	1.067	1.138	Igme/ July 24-28, 2008	5- Year
297	18.09911	120.740171	0.580	0.762	0.581	Mario/ September 18-22, 2014	5- Year
298	18.07909	120.684303	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
299	18.16626	120.718612	0.030	0.305	0.093	Ineng/ August 20-23, 2015	5- Year
300	18.16515	120.714156	0.030	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
301	18.11026	120.7156	3.350	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
302	18.18843	120.689526	0.030	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
303	18.16476	120.718356	0.070	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
304	18.20104	120.698587	0.070	1.067	1.138	Igme/ July 24-28, 2008	5- Year
305	18.20167	120.712569	2.140	1.067	1.138	Igme/ July 24-28, 2008	5- Year
306	18.16244	120.707784	1.640	1.067	1.138	Igme/ July 24-28, 2008	5- Year
307	18.18633	120.708208	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
308	18.15026	120.700334	5.110	1.067	1.138	Igme/ July 24-28, 2008	5- Year
309	18.18545	120.734917	0.870	1.067	1.138	Igme/ July 24-28, 2008	5- Year
310	18.16406	120.715401	0.090	0.305	0.093	Ineng/ August 20-23, 2015	5- Year
311	18.20104	120.698587	0.090	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
312	18.08465	120.682185	0.060	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
313	18.18186	120.695492	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
314	18.19161	120.689384	0.120	1.067	1.138	Igme/ July 24-28, 2008	5- Year
315	18.1542	120.696715	0.290	1.067	1.138	Igme/ July 24-28, 2008	5- Year
316	18.17108	120.699376	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
317	18.16521	120.716718	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
318	18.17421	120.70825	1.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
319	18.15637	120.711504	0.610	1.067	1.138	Igme/ July 24-28, 2008	5- Year
320	18.14776	120.724438	2.590	1.067	1.138	Igme/ July 24-28, 2008	5- Year
321	18.1705	120.719167	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
322	18.20167	120.712569	2.140	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
323	18.0512	120.772756	1.790	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
324	18.18691	120.723053	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
325	18.15633	120.723527	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
326	18.16939	120.731822	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
327	18.17421	120.70825	1.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
328	18.20104	120.698587	0.070	0.762	0.581	Mario/ September 18-22, 2014	5- Year
329	18.15633	120.723527	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
330	18.18633	120.708208	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
331	18.16908	120.69025	0.270	0.762	0.581	Mario/ September 18-22, 2014	5- Year
332	18.19245	120.687204	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
333	18.16939	120.731822	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
334	17.98072	120.656782	0.030	0.305	0.093	Ineng/ August 20-23, 2015	5- Year
335	18.14001	120.671358	0.030	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
336	18.16244	120.707784	1.640	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
337	18.17022	120.70215	2.410	0.762	0.581	Mario/ September 18-22, 2014	5- Year
338	18.17108	120.699376	0.030	0.762	0.581	Mario/ September 18-22, 2014	5- Year
339	18.19079	120.723753	1.330	0.762	0.581	Mario/ September 18-22, 2014	5- Year
340	18.18633	120.708208	0.030	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
341	18.15026	120.700334	5.110	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
342	18.18545	120.734917	0.870	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
343	18.15973	120.627741	0.840	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
344	18.15369	120.645912	0.730	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
345	18.13457	120.626284	1.630	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year

346	18.20968	120.567078	0.300	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
347	18.13202	120.626611	1.250	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
348	18.1454	120.644623	5.310	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
349	18.16073	120.646489	0.140	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
350	18.16084	120.643684	0.040	0.914	0.836	Karen/ August 18-21, 2008	5- Year
351	18.18022	120.658969	0.040	0.914	0.836	Karen/ August 18-21, 2008	5- Year
352	18.14303	120.631401	0.770	0.914	0.836	Karen/ August 18-21, 2008	5- Year
353	18.10567	120.635199	0.060	0.914	0.836	Karen/ August 18-21, 2008	5- Year
354	18.15843	120.646396	0.320	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
355	18.11396	120.638955	0.030	0.914	0.836	Karen/ August 18-21, 2008	5- Year
356	18.0512	120.772756	1.790	0.914	0.836	Karen/ August 18-21, 2008	5- Year
357	18.16327	120.71798	0.030	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
358	18.1165	120.641608	0.090	0.914	0.836	Karen/ August 18-21, 2008	5- Year
359	18.15843	120.646396	0.320	0.914	0.836	Karen/ August 18-21, 2008	5- Year
360	18.14715	120.654357	0.030	0.914	0.836	Karen/ August 18-21, 2008	5- Year
361	18.0876	120.667354	0.030	0.914	0.836	Karen/ August 18-21, 2008	5- Year
362	18.15369	120.645912	0.730	0.914	0.836	Karen/ August 18-21, 2008	5- Year
363	18.13457	120.626284	1.630	0.914	0.836	Karen/ August 18-21, 2008	5- Year
364	18.13202	120.626611	1.250	0.914	0.836	Karen/ August 18-21, 2008	5- Year
365	18.15973	120.627741	0.840	0.914	0.836	Karen/ August 18-21, 2008	5- Year
366	18.14001	120.671358	0.030	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
367	18.12653	120.629069	2.790	0.914	0.836	Karen/ August 18-21, 2008	5- Year
368	18.1269	120.68278	2.010	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
369	18.12735	120.627067	0.030	0.914	0.836	Karen/ August 18-21, 2008	5- Year
370	18.17858	120.656642	0.120	0.914	0.836	Karen/ August 18-21, 2008	5- Year
371	18.15701	120.647932	0.320	0.914	0.836	Karen/ August 18-21, 2008	5- Year
372	18.16073	120.646489	0.140	0.914	0.836	Karen/ August 18-21, 2008	5- Year
373	18.09209	120.665404	0.030	0.914	0.836	Karen/ August 18-21, 2008	5- Year
374	18.11684	120.623491	0.090	0.914	0.836	Karen/ August 18-21, 2008	5- Year
375	18.10241	120.667606	0.030	0.914	0.836	Karen/ August 18-21, 2008	5- Year
376	18.19513	120.592163	0.060	0.914	0.836	Karen/ August 18-21, 2008	5- Year
377	18.13268	120.653507	0.130	0.914	0.836	Karen/ August 18-21, 2008	5- Year
378	18.15843	120.646396	0.320	0.762	0.581	Mario/ September 18-22, 2014	5- Year
379	18.17119	120.718033	0.030	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
380	18.15701	120.647932	0.320	0.762	0.581	Mario/ September 18-22, 2014	5- Year
381	18.15369	120.645912	0.730	0.762	0.581	Mario/ September 18-22, 2014	5- Year
382	18.15973	120.627741	0.840	0.762	0.581	Mario/ September 18-22, 2014	5- Year
383	18.14303	120.631401	0.770	0.762	0.581	Mario/ September 18-22, 2014	5- Year
384	18.19513	120.592163	0.060	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
385	18.13268	120.653507	0.130	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
386	18.12653	120.629069	2.790	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
387	18.12735	120.627067	0.030	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
388	18.14303	120.631401	0.770	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
389	18.12343	120.75152	0.560	0.457	0.209	Ineng/ August 20-23, 2015	5- Year
390	18.05398	120.730442	0.330	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
391	18.11353	120.781039	0.040	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
392	18.10203	120.769479	0.100	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
393	18.09544	120.770064	0.110	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
394	18.08924	120.789477	0.040	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
395	18.06876	120.790118	1.010	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year

396	18.09576	120.774081	1.290	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
397	18.11647	120.736199	0.550	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
398	18.06236	120.811762	0.040	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
399	18.09911	120.740171	0.580	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
400	18.06236	120.811762	0.040	0.305	0.093	Ineng/ August 20-23, 2015	5- Year
401	18.05727	120.726059	0.050	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
402	18.11001	120.801147	0.120	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
403	18.10766	120.791406	0.030	1.067	1.138	Igme/ July 24-28, 2008	5- Year
404	18.12344	120.752544	0.940	1.067	1.138	Igme/ July 24-28, 2008	5- Year
405	18.09283	120.770408	0.040	1.067	1.138	Igme/ July 24-28, 2008	5- Year
406	18.11171	120.746686	0.920	1.067	1.138	Igme/ July 24-28, 2008	5- Year
407	18.13124	120.75892	0.330	1.067	1.138	Igme/ July 24-28, 2008	5- Year
408	18.06236	120.811762	0.040	0.610	0.372	Ineng/ August 20-23, 2015	5- Year
409	18.1319	120.734865	1.940	1.067	1.138	Igme/ July 24-28, 2008	5- Year
410	18.11353	120.781039	0.040	1.067	1.138	Igme/ July 24-28, 2008	5- Year
411	18.10203	120.769479	0.100	1.067	1.138	Igme/ July 24-28, 2008	5- Year
412	18.0571	120.729591	0.070	0.914	0.836	Pepeng/ October 2-5, 2009	5- Year
413	18.08814	120.768609	0.590	1.067	1.138	Igme/ July 24-28, 2008	5- Year
414	18.08924	120.789477	0.040	1.067	1.138	Igme/ July 24-28, 2008	5- Year
415	18.06876	120.790118	1.010	1.067	1.138	Igme/ July 24-28, 2008	5- Year
416	18.07263	120.772291	0.410	1.067	1.138	Igme/ July 24-28, 2008	5- Year
417	18.11647	120.736199	0.550	1.067	1.138	Igme/ July 24-28, 2008	5- Year
418	18.06236	120.811762	0.040	1.067	1.138	Igme/ July 24-28, 2008	5- Year
419	18.10766	120.791406	0.030	0.457	0.209	Pepeng/ October 2-5, 2009	5- Year
420	18.09911	120.740171	0.580	1.067	1.138	Igme/ July 24-28, 2008	5- Year
421	18.10929	120.802632	0.550	1.067	1.138	Igme/ July 24-28, 2008	5- Year
422	18.10766	120.791406	0.030	1.219	1.486	Mario/ September 18-22, 2014	5- Year
423	18.20968	120.567078	0.300	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
424	18.09608	120.771531	0.030	1.219	1.486	Mario/ September 18-22, 2014	5- Year
425	18.11353	120.781039	0.040	1.219	1.486	Mario/ September 18-22, 2014	5- Year
426	18.10203	120.769479	0.100	1.219	1.486	Mario/ September 18-22, 2014	5- Year
427	18.08924	120.789477	0.040	1.219	1.486	Mario/ September 18-22, 2014	5- Year
428	18.07263	120.772291	0.410	1.219	1.486	Mario/ September 18-22, 2014	5- Year
429	18.06236	120.811762	0.040	1.219	1.486	Mario/ September 18-22, 2014	5- Year
430	18.09376	120.773222	0.030	0.457	0.209	Pepeng/ October 2-5, 2009	5- Year
431	18.11171	120.746686	0.920	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
432	18.13124	120.75892	0.330	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
433	18.1319	120.734865	1.940	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
434	18.16327	120.71798	0.030	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
435	17.98185	120.657039	0.190	0.305	0.093	Ineng/ August 20-23, 2015	5- Year
436	18.1269	120.68278	2.010	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
437	18.17119	120.718033	0.030	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
438	18.12087	120.677589	2.000	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
439	18.13328	120.715936	0.350	0.610	0.372	Ineng/ August 20-23, 2015	5- Year
440	18.10329	120.702074	5.070	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
441	18.1009	120.703835	5.040	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
442	18.10443	120.721166	1.010	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
443	18.13328	120.715936	0.350	0.610	0.372	Ineng/ August 20-23, 2015	5- Year
444	18.10208	120.731731	3.330	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
445	18.09538	120.767322	0.030	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year

446	17.97754	120.654539	0.030	0.457	0.209	Ineng/ August 20-23, 2015	5- Year
447	18.09396	120.768203	1.200	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
448	18.09079	120.770042	1.390	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
449	18.11573	120.728587	0.180	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
450	18.13328	120.715936	0.350	0.610	0.372	Ineng/ August 20-23, 2015	5- Year
451	18.11742	120.731939	0.440	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
452	18.0852	120.732322	3.470	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
453	18.08905	120.73336	3.370	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
454	18.10329	120.702074	5.070	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
455	18.12325	120.689454	5.540	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
456	18.11555	120.694168	5.170	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
457	17.98335	120.660031	0.050	0.457	0.209	Ineng/ August 20-23, 2015	5- Year
458	18.10074	120.695352	5.210	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
459	18.10329	120.702074	5.070	1.219	1.486	Mario/ September 18-22, 2014	5- Year
460	18.10825	120.668743	0.100	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
461	18.13333	120.700909	3.000	1.219	1.486	Mario/ September 18-22, 2014	5- Year
462	18.07268	120.686341	0.060	1.219	1.486	Mario/ September 18-22, 2014	5- Year
463	18.07449	120.685708	0.120	1.219	1.486	Mario/ September 18-22, 2014	5- Year
464	18.11009	120.783522	0.210	1.219	1.486	Mario/ September 18-22, 2014	5- Year
465	18.10393	120.7807	0.370	1.219	1.486	Mario/ September 18-22, 2014	5- Year
466	18.12325	120.689454	5.540	1.219	1.486	Mario/ September 18-22, 2014	5- Year
467	18.07682	120.690906	0.350	1.219	1.486	Mario/ September 18-22, 2014	5- Year
468	17.97889	120.654155	0.050	0.457	0.209	Ineng/ August 20-23, 2015	5- Year
469	18.08153	120.69072	0.070	1.219	1.486	Mario/ September 18-22, 2014	5- Year
470	18.13333	120.700909	3.000	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
471	18.1009	120.703835	5.040	1.219	1.486	Mario/ September 18-22, 2014	5- Year
472	18.0852	120.732322	3.470	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
473	18.08905	120.73336	3.370	0.457	0.209	Labuyo/ September 19-23, 2005	5- Year
474	18.11009	120.783522	0.210	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
475	18.14001	120.671358	0.030	1.219	1.486	Mario/ September 18-22, 2014	5- Year
476	18.17119	120.718033	0.030	1.219	1.486	Mario/ September 18-22, 2014	5- Year
477	18.10393	120.7807	0.370	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
478	18.09728	120.697896	3.840	1.219	1.486	Mario/ September 18-22, 2014	5- Year
479	17.98223	120.658431	0.030	0.305	0.093	Ineng/ August 20-23, 2015	5- Year
480	18.10074	120.695352	5.210	1.219	1.486	Mario/ September 18-22, 2014	5- Year
481	18.05832	120.74938	0.050	1.219	1.486	Mario/ September 18-22, 2014	5- Year
482	18.0594	120.749765	0.040	1.219	1.486	Mario/ September 18-22, 2014	5- Year
483	18.06979	120.712748	1.940	1.219	1.486	Mario/ September 18-22, 2014	5- Year
484	18.10443	120.721166	1.010	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
485	18.06244	120.740875	0.590	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
486	18.10208	120.731731	3.330	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
487	18.09538	120.767322	0.030	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
488	18.09396	120.768203	1.200	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year
489	18.09079	120.770042	1.390	0.610	0.372	Pepeng/ October 2-5, 2009	5- Year

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ANNEX 12. Educational Institutions Affected by Flooding in Laoag Floopdplain

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

Ilocos Norte				
Banna				
Building Name	**Barangay**	**Rainfall Scenario**		
		5-year	**25-year**	**100-year**
BANGSAR ES	Bangsar			
BARBARANGAY ES	Barbarangay			
BININGAN ES	Barbarangay			
BUGASI ES	Bugasi			
CARIBQUIB DAY CARE CENTER	Caribquib			
CARIBQUIB NHS	Caribquib			
CATAGTAGUEN ES	Catagtaguen			
CATAGTAGUEN NHS	Catagtaguen			
CARIBQUIB ES	Crispina			
BANNA NATIONAL HIGH SCHOOL	Hilario			
BANNA NATIONAL HIGH SCHOOL	Lorenzo			
BANNA CES	Marcos			
NAGPATAYAN ES	Nagpatayan			
TABTABAGAN ES	Tabtabagan	Medium	High	High
BANNA ACADEMY	Valenciano			
BANNA CES	Valenciano			
Batac City				
Building Name	**Barangay**	**Rainfall Scenario**		
		5-year	**25-year**	**100-year**
NANGUYUDAN ES	Baay			
Dingras				
Building Name	**Barangay**	**Rainfall Scenario**		
		5-year	**25-year**	**100-year**
BACSIL ES	Bacsil			High
BARESBES ES	Baresbes			
BARONG ES	Barong	Low	Low	Medium
DINGRAS NHS/LT. EDGAR FOZ MEM. NHS (BARONG CAMPUS)	Barong		Medium	High
ELIZABETH ES	Barong			
SALUDARES-CALI ES	Cali			
CAPASAN ES	Capasan			
DINGRAS CENTRAL ES	Guerrero	Low	Medium	High
BARONG ES	Lanas			Medium
DINGRAS NHS/LT. EDGAR FOZ MEM. NHS (BARONG CAMPUS)	Lanas		Low	High
DINGRAS FAITH ACADEMY INC.	Madamba	High	High	High
MARIANO MARCOS STATE UNIVERSITY, DINGRAS	Madamba	High	High	High

MANDALOQUE ES	Mandaloque	High	High	High
MEDINA PARADO ES	Parado	High	High	High
PERALTA ES	Peralta	High	High	High
SAGPATAN ES	Sagpatan	High	High	High
BAGUT ES	San Esteban			High
FRANCISCO ES	San Francisco			Low
MABINO ES	San Francisco			
SAN MARCELINO ES	San Francisco			
SAN MARCELINO NATIONAL HIGH SCHOOL	San Francisco		Low	Low
SAN ESTEBAN ES	San Marcos	Medium	Medium	High
DINGRAS NHS/LT. EDGAR FOZ MEM. NHS	Suyo	Medium	High	High
SUYO ES	Suyo	Medium	High	High
SUYO NATIONAL HIGH SCHOOL	Suyo	Medium	High	High
SUYO NATIONAL HIGH SCHOOL	Suyo	Medium	High	High
PACIFICO ES	Ver		Low	Medium
Laoag City				
Building Name	**Barangay**	**Rainfall Scenario**		
		5-year	**25-year**	**100-year**
STA. MARIA ELEMENTARY SCHOOL	Bgy. No. 1, San Lorenzo	Low	Low	High
PCF (PONTIFICIO COLLEGIO FILIPPINO)	Bgy. No. 10, San Jose			
SHAMROCK ES	Bgy. No. 10, San Jose		Low	Medium
UCCP LAOAG CITY	Bgy. No. 10, San Jose			Low
ILOCOS NORTE COLLEGE OF ARTS & TRADES	Bgy. No. 12, San Isidro		Low	High
MMSU COLLEGE OF INDUSTRIAL TECHNOLOGY	Bgy. No. 12, San Isidro	Low	Low	High
SHAMROCK ES	Bgy. No. 12, San Isidro	Low	Low	High
THE LIVING GATES OF PRAISE CHURCH, INC.	Bgy. No. 13, Nstra. Sra. De Visitaci	Low	Medium	High
DATA CENTER COLLEGE OF THE PHILIPPINES - LAOAG CITY	Bgy. No. 14, Santo Tomas			
HOLY SPIRIT ACADEMY OF LAOAG	Bgy. No. 14, Santo Tomas	Low	Low	Low
PCF (PONTIFICIO COLLEGIO FILIPPINO)	Bgy. No. 14, Santo Tomas			
LAOAG CES	Bgy. No. 15, San Guillermo			
DIVINE WORD COLLEGE OF LAOAG	Bgy. No. 16, San Jacinto		Low	Medium
LAOAG CES	Bgy. No. 16, San Jacinto			
HOLY SPIRIT ACADEMY OF LAOAG	Bgy. No. 17, San Francisco			
LAOAG CES	Bgy. No. 17, San Francisco			Low

AMA COMPUTER UNIVERSITY - LAOAG CITY	Bgy. No. 19, Santa Marcela	Low	Low	Low
STI-LAOAG CITY	Bgy. No. 19, Santa Marcela	Low	Medium	Medium
STA. MARIA ELEMENTARY SCHOOL	Bgy. No. 2, Santa Joaquina		Low	High
CENTER OF THE ARTS AND THE ACADEME	Bgy. No. 20, San Miguel			
ILOCOS NORTE ADVENTIST SCHOOL	Bgy. No. 20, San Miguel			
R. B. ABLAN ES	Bgy. No. 20, San Miguel	Low	Low	Low
A. P. SANTOS ES (SPED CENTER)	Bgy. No. 21, San Pedro	Low	Low	High
ILOCOS NORTE COLLEGE OF ARTS & TRADES	Bgy. No. 21, San Pedro	Low	Low	High
ILOCOS NORTE NATIONAL HIGH SCHOOL COMPOUND	Bgy. No. 21, San Pedro	Low	Low	High
ILOCOS NORTE NHS	Bgy. No. 21, San Pedro		Low	Medium
MARIANO MARCOS STATE UNIVERSITY	Bgy. No. 21, San Pedro			
MMSU COLLEGE OF INDUSTRIAL TECHNOLOGY	Bgy. No. 21, San Pedro		Low	Medium
MMSU LAOAG LIBRARY BUILDING	Bgy. No. 21, San Pedro			Low
NORTHERN CHRISTIAN COLLEGE	Bgy. No. 21, San Pedro			Medium
NORTHERN CHRISTIAN COLLEGE AUDITORIUM	Bgy. No. 21, San Pedro			Medium
INTERNATIONAL SCHOOL OF THE ARTS, THE LANGUAGES AND THE ACADEME	Bgy. No. 22, San Andres	Low	Medium	Medium
CATERPILLAR LEARNING CENTER!	Bgy. No. 23, San Matias			
GABALDON ES	Bgy. No. 23, San Matias			Medium
GABALDON ES	Bgy. No. 25, Santa Cayetana			Medium
GABALDON ES	Bgy. No. 26, San Marcelino		Low	Medium
GABALDON ES	Bgy. No. 27, Nstra. Sra. de Soledad		Low	Medium
PLARIDEL ES	Bgy. No. 28, San Bernardo		Medium	Medium
ST. JOSEPH HIGH SCHOOL - LAOAG CITY	Bgy. No. 28, San Bernardo		Medium	Medium
PLARIDEL ES	Bgy. No. 29, Santo Tomas		Medium	Medium
SUYO ES	Bgy. No. 30-A, Suyo			High
STO. NINO PRIMARY SCHOOL	Bgy. No. 31, Talingaan			
ILOCOS NORTE REGIONAL SCHOOL OF FISHERIES	Bgy. No. 32-B, La Paz West			
E. F. SIAZON MEM. ES	Bgy. No. 33-B, La Paz Proper			

GABU ES	Bgy. No. 34-B, Gabu Norte East			Medium
GABU NHS	Bgy. No. 34-B, Gabu Norte East	Low	Low	Low
CAVIT-ARANIV ES	Bgy. No. 36, Araniw			Medium
CALAYAB ES	Bgy. No. 37, Calayab			
BALATONG IS	Bgy. No. 39, Santa Rosa			
SAVIOURS ACADEMY	Bgy. No. 4, San Guillermo			Medium
BALATONG IS	Bgy. No. 40, Balatong			
BALACAD ES	Bgy. No. 41, Balacad	Low	Low	Medium
APAYA ES	Bgy. No. 42, Apaya		Medium	High
NORTH WESTERN UNIVERSITY	Bgy. No. 45, Tangid	Low	Medium	High
TANGID ES	Bgy. No. 45, Tangid		Medium	High
NORTH WESTERN UNIVERSITY	Bgy. No. 46, Nalbo		Medium	High
CABEZA ES	Bgy. No. 48-B, Cabungaan South		Medium	High
SIXTO PEDRO MES	Bgy. No. 48-B, Cabungaan South			Medium
DARAYDAY ES	Bgy. No. 49-A, Darayday	Low	Medium	High
BUTTONG ES	Bgy. No. 49-B, Raraburan		Medium	Medium
MARANATHA CA	Bgy. No. 49-B, Raraburan		High	High
ILOCOS NORTE ADVENTIST SCHOOL	Bgy. No. 5, San Pedro			
INTERNATIONAL SCHOOL OF THE ARTS, THE LANGUAGES AND THE ACADEME	Bgy. No. 5, San Pedro	Medium	Medium	Medium
NORTH WESTERN UNIVERSITY	Bgy. No. 50, Buttong			Medium
SAN MATEO ES	Bgy. No. 52-A, San Mateo			Medium
FAUSTINO REYES MEM. ES	Bgy. No. 53, Rioeng		Low	High
RIOENG ELEMENTARY SCHOOL	Bgy. No. 53, Rioeng		Medium	High
LAGUI-SAIL ES	Bgy. No. 54-A, Lagui-Sail	Low	Low	Low
PADRE ANNIBALE SCHOOL	Bgy. No. 54-A, Lagui-Sail	Low	Low	High
SALET ELEMENTARY SCHOOL	Bgy. No. 54-A, Lagui-Sail			
LABORATORY ELEMENTARY SCHOOL, MMSU-CTE (TL)	Bgy. No. 55-A, Barit-Pandan			High
MARIANO MARCOS STATE UNIVERSITY	Bgy. No. 55-A, Barit-Pandan			Medium
MMSU LABORATORY HIGH SCHOOL	Bgy. No. 55-A, Barit-Pandan			Medium
MMSU LAOAG LIBRARY BUILDING	Bgy. No. 55-A, Barit-Pandan			Medium
BARIT ES	Bgy. No. 55-B, Salet-Bulangon			
DIVINE WORD COLLEGE OF LAOAG	Bgy. No. 55-B, Salet-Bulangon		Medium	High

ST. SANTIAGO SCHOOL FOUNDATION	Bgy. No. 55-B, Salet-Bulangon	Medium	Medium	High
VIRA ES	Bgy. No. 55-C, Vira			
BACSIL ES	Bgy. No. 56-B, Bacsil South			
BACSIL NORTH DAYCARE CENTER	Bgy. No. 56-B, Bacsil South			
PILA ES	Bgy. No. 57, Pila		High	High
CASILI ES	Bgy. No. 58, Casili		High	High
A. P. SANTOS ES (SPED CENTER)	Bgy. No. 6, San Agustin	Low	Low	High
MMSU COLLEGE OF INDUSTRIAL TECHNOLOGY	Bgy. No. 7-B, Nstra. Sra. De Natívid		Low	High
NORTHERN CHRISTIAN COLLEGE	Bgy. No. 7-B, Nstra. Sra. De Natívid		Low	Medium
NORTHERN CHRISTIAN COLLEGE ELEMENTARY BUILDING	Bgy. No. 7-B, Nstra. Sra. De Natívid	Low	Low	Medium
NOTHERN CHRISTIAN COLLEGE EZE BLDG.	Bgy. No. 7-B, Nstra. Sra. De Natívid		Low	Medium
NOTHERN CHRISTIAN COLLEGE SCIENCE AND TECHNOLOGY BUILDING	Bgy. No. 7-B, Nstra. Sra. De Natívid			
ILOCOS NORTE COLLEGE OF ARTS & TRADES	Bgy. No. 8, San Vicente		Low	High
MMSU COLLEGE OF INDUSTRIAL TECHNOLOGY	Bgy. No. 8, San Vicente	Low	Low	High
NOTHERN CHRISTIAN COLLEGE EZE BLDG.	Bgy. No. 8, San Vicente	Low	Low	Medium
NOTHERN CHRISTIAN COLLEGE SCIENCE AND TECHNOLOGY BUILDING	Bgy. No. 8, San Vicente			Medium
SHAMROCK ES	Bgy. No. 9, Santa Angela	Low	Medium	High
NORTH WESTERN UNIVERSITY	Bry. No. 48-A, Cabungaan North	Medium	High	High

Marcos				
Building Name	**Barangay**	**Rainfall Scenario**		
		5-year	**25-year**	**100-year**
CACAFEAN ES	Cacafean			
MARCOS NATIONAL HIGH SCHOOL	Cacafean			
SANTIAGO ES	Cacafean		Low	Low
F. DAQUIOAG MEM. ES	Daquioag		Medium	Medium
MARCOS AGRO-INDUSTRIAL SCHOOL	Daquioag			
MARCOS CENTRAL SCHOOL	Daquioag			
TESDA	Daquioag			
ELIZABETH ES	Elizabeth			
MARCOS NHS (AGUNIT CAMPUS)	Escoda			
IMELDA ES	Imelda	High	High	High
MABUTI ES	Mabuti		Low	Low
BIDING ES	Valdez	Low	Medium	High

Nueva Era				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
BUGAYONG ELEMENTARY SCH.	Bugayong			
NAGUILIAN ES	Garnaden			
NAGUILIAN ES	Naguillan			
QUIAOIT MEMORIAL ES	Naguillan			
NUEVA ERA CENTRAL ELEMENTARY SCHOOL	Poblacion			
SANTO NINO ES	Santo Niño	Low	Medium	Medium

Paoay				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
NAGBACALAN WEST PS	Nagbacalan			
PASIL ELEMENTARY SCHOOL	Pasil			
NAGBACALAN DAY CARE CENTER	Suba			
NAGBACALAN ES	Suba			
SUBA ES	Suba			

Paoay Lake				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
NAGBACALAN ES	Paoay Lake			
PAOAY LAKE NHS	Paoay Lake		Low	Low

Piddig				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
TANGAOAN ES	Ab-Abut			
ESTACIA ES	Abucay			
SAINT ANNE ACADEMY	Anao			
PIDDIG CES	Cabaroan			
PIDDIG CS	Cabaroan			
PIDDIG SOUTH CES	Cabaroan			
SAINT ANNE ACADEMY	Cabaroan			
CALAMBEG ES	Calambeg			Medium
ESTANCIA ES	Estancia	Low	Low	Low
LIBNAOAN ES	Libnaoan			
LAGANDIT ES	Maab-Abaca			
LIBNAOAN ES	Maab-Abaca			
MARUAYA PS	Maruaya			
AB-ABUT ES	Sucsuquen			
PIDDIG NATIONAL HIGH SCHOOL	Tonoton			

San Nicolas				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
BINGAO ES	San Agustin			
BUGNAY ES	San Agustin			
SAN NICOLAS ES	San Baltazar		Low	High
STA. ROS ACADEMY	San Baltazar			Medium
ELADIO V. BARANGAN MES	San Gregorio	Medium	Medium	High
CATUGUING ES	San Guillermo	Low	Low	Medium
ASUNCION ES	San Ildefonso	Low	Medium	High
SAN NICOLAS ES	San Ildefonso	Low	Medium	High
STA. ROS ACADEMY	San Ildefonso		Low	Medium
FILIPINAS WEST ES	San Juan Bautista		Medium	High
PAYAS ES	San Marcos	Low	Medium	Medium
BARABAR ES	Santa Monica	Medium	High	High
FILIPINAS EAST ES	Santa Monica	Medium	High	High
FILIPINAS ES	Santa Monica			
PASION BARANGAN MES	Santa Monica	Medium	High	High

Sarrat				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
SAN JOAQUIN DAY CARE CENTER	San Agustin	Low	Low	Medium
SAN ANTONIO ES	San Antonio	Medium	High	High
SAN BERNABE ES	San Bernabe			Low
SAGPATAN ES	San Cristobal	Low	Low	Low
RUIZ ES	San Felipe			
SARRAT NATIONAL HIGH SCHOOL	San Francisco			Low
SARRAT NORTH CS	San Francisco			
SAN MATEO ES	San Joaquin			Medium
PANDAN INTEGRATED SCHOOL	San Juan			
SAN PEDRO ELEMENTARY SCHOOL	San Juan			
SARRAT CS	San Leandro			
DAYCARE	San Manuel	Medium	High	High
PASION BARANGAN MES	San Manuel	Low	High	High
PATAD ES	San Manuel	Medium	High	High
SAN MATEO ES	San Manuel			Medium
PARANG ES	San Marcos			High
SARRAT NHS	San Nicolas	High	High	High
STA. ROSA ES	San Nicolas	Medium	High	High
SAN PEDRO ELEMENTARY SCHOOL	San Pedro			
SAN MATEO ES	San Roque			Medium
VER ES	San Vicente	Low	Medium	Medium
VER ES	Santa Barbara	Low	Low	Medium
STA. ROSA ES	Santa Rosa	Low	Medium	High
GOLGOL ES	Santo Tomas			

Solsona				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
SOLSONA NHS (BAGBAG CAMPUS)	Bagbag	High	High	High
DARASDAS ES	Darasdas	Low	Medium	Medium
BARCELONA AGUITAP ES	Juan			Low
SOLSONA CENTRAL ES	Laureta			
SOLSONA NATIONAL HIGH SCHOOL, MAANANTENG CAMPUS	Manalpac			
MANALPAC ES	Mariquet			
SOLSONA NATIONAL HIGH SCHOOL	Mariquet		Low	Low
NAGPATPATAN ES	Nagpatpatan	Low	Low	Low
SOLSONA NATIONAL HIGH SCHOOL	Talugtog	Low	Medium	Medium
TALUGTOG ELEMENTARY SCHOOL	Talugtog		Low	Medium
Vintar				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
PALLAS INTEGRATED SCHOOL	Bulbulala	Medium	Medium	Medium
SALET ES	Bulbulala			
ESTER ES	Ester			
NAMOROC-MABANBANAG ES	Namoroc			

ANNEX 13. HEALTH INSTITUTIONS AFFECTED BY FLOODING IN LAOAG FLOODPLAIN

Table A-13.1. Health Institutions Affected by Flooding in Laoag Floodplain

Ilocos Norte				
Banna				
Building Name	**Barangay**	**Rainfall Scenario**		
		5-year	**25-year**	**100-year**
BANNA MUNICIPAL HEALTH CENTER	Marcos			
Laoag City				
Building Name	**Barangay**	**Rainfall Scenario**		
		5-year	**25-year**	**100-year**
DR. ANTONIO A. RANADA LYING-IN CLINIC AND HOSPITAL	Bgy. No. 10, San Jose		Low	Medium
LAOAG DIAGNOSTIC LABORATORY	Bgy. No. 10, San Jose	Low	Low	Low
LAOAG POLYCLINIC/AMS-ABELLON DERMASHOPPE	Bgy. No. 10, San Jose			Medium
RANADA GENERAL HOSPITAL	Bgy. No. 11, Santa Balbina			
RANADA GENERAL HOSPITAL	Bgy. No. 13, Nstra. Sra. De Visitaci			
MEDICAL DIAGNOSTIC CLINIC, ALLIED PROFESSIONAL SERVICES	Bgy. No. 16, San Jacinto	Low	Low	Medium
PROVINCIAL HOSPITAL	Bgy. No. 23, San Matias			
GOV. ROQUE ABLAN SR. MEMORIAL HOSPITAL	Bgy. No. 23, San Matias			
LAOAG EYE INFIRMARY	Bgy. No. 23, San Matias	Low	Low	Low
PHILIPPINE NATIONAL RED CROSS	Bgy. No. 23, San Matias			
PROVINCIAL HEALTH OFFICE	Bgy. No. 23, San Matias			
BARANGAY 3 HEALTH CENTER	Bgy. No. 4, San Guillermo			
RANADA CLINIC/CAREGIVER SCHOOL	Bgy. No. 49-B, Raraburan			Medium
LAOAG CITY GENERAL HOSPITAL	Bgy. No. 50, Buttong		Medium	High
RIOENG HEALTH CENTER	Bgy. No. 53, Rioeng			Medium
ST. CAMILLUS DE LELLIS GENERAL HOSPITAL	Bgy. No. 8, San Vicente	Low	Low	High
LAOAG POLYCLINIC/AMS-ABELLON DERMASHOPPE	Bgy. No. 9, Santa Angela		Low	Medium
OUR LADY OF FATIMA MEDICAL CLINIC AND HOSPITAL	Bgy. No. 9, Santa Angela	Low	Low	High
ST. CAMILLUS DE LELLIS GENERAL HOSPITAL	Bgy. No. 9, Santa Angela	Low	Low	High

San Nicolas				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
ST. THERESE HOSPITAL	San Agustin			Low
MUNICIPAL HEALTH CENTER	San Baltazar			Medium
THE BLACK NAZARENE HOSPITAL	San Baltazar			Medium
SAN NICOLAS MEDICAL LABORATORY	San Bartolome		Medium	High
CLINICA ACOSTA URGENT CARE UNIT	San Cayetano			Medium
ST. THERESE HOSPITAL	San Guillermo			
MAMACLAY FAMILY CLINIC	San Miguel			
BARABAR MOTHERING CENTER	Santa Monica	Medium	High	High
MEDICAL CLINIC	Santa Monica			

Sarrat				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
SARRAT HEALTH CENTER	San Leandro			Medium
HEALTH CENTER	San Manuel		Medium	High
DINGRAS DISTRICT HOSPITAL	San Marcos			
CALAYCAY DENTAL CLINIC	San Vicente	Medium	Medium	Medium

Solsona				
Building Name	Barangay	Rainfall Scenario		
		5-year	25-year	100-year
RURAL HEALTH UNIT	Laureta			