REGION 6

Jalaur River Flood Plain:

DREAM LiDAR Data Acquistion and Processing Report

TRAINING CENTER FOR APPLIED GEODESY AND PHOTOGRAMMETRY

2015

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

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

UP TCAGP (2015), DREAM LiDAR Data Acquisition and Processing in the Jalaur River Flood-plain, Disaster Risk and Exposure Assessment for Mitigation (DREAM) Program, DOST Grants-In-Aid Program, 83 pp.

For questions/queries regarding this report, contact:

Engr. Czar Jakiri S. Sarmiento, MSRS
Project Leader, Data Acquisition Component, DREAM Program
University of the Philippines Diliman
Quezon City, Philippines 1101
Email: czarjakiri@gmail.com

Engr. Ma. Rosario Concepcion O. Ang, MSRS
Project Leader, Data Processing Component, DREAM Program
University of the Philippines Diliman
Quezon City, Philippines 1101
Email: concon.ang@gmail.com

Enrico C. Paringit, Dr. Eng.
Program Leader, DREAM Program
University of the Philippines Diliman
Quezon City, Philippines 1101
Email: paringit@gmail.com

National Library of the Philippines
ISBN: 978-621-9695-11-0

Table of Contents

List of Figures

List of Tables

Abbreviations

ALTM	Airborne Laser Terrain Mapper
DAC	Data Acquisition Component
DEM	Digital Elevation Model
DSM	Digital Surface Model
DTM	Digital Terrain Model
DVC	Data Validation Component
FOV	Field of View
FTP	File Transfer Protocol
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
POS	Position Orientation System
PRF	Pulse Repetition Frequency
NAMRIA	National Mapping and Resource Information Authority

Introduction

Introduction

1.1 About the DREAM Program

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

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

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

1.2 Objectives and Target Outputs

The program aims to achieve the following objectives:

a) To acquire a national elevation and resource dataset at sufficient resolution to produce information necessary to support the different phases of disaster management,
b) To operationalize the development of flood hazard models that would produce updated and detailed flood hazard maps for the major river systems in the country,
c) To develop the capacity to process, produce and analyze various proven and potential thematic map layers from the 3D data useful for government agencies,
d) To transfer product development technologies to government agencies with geospatial information requirements, and,
e) To generate the following outputs
    1) flood hazard map
    2) digital surface model
    3) digital terrain model and
    4) orthophotograph

1.3 General Methodological Framework

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

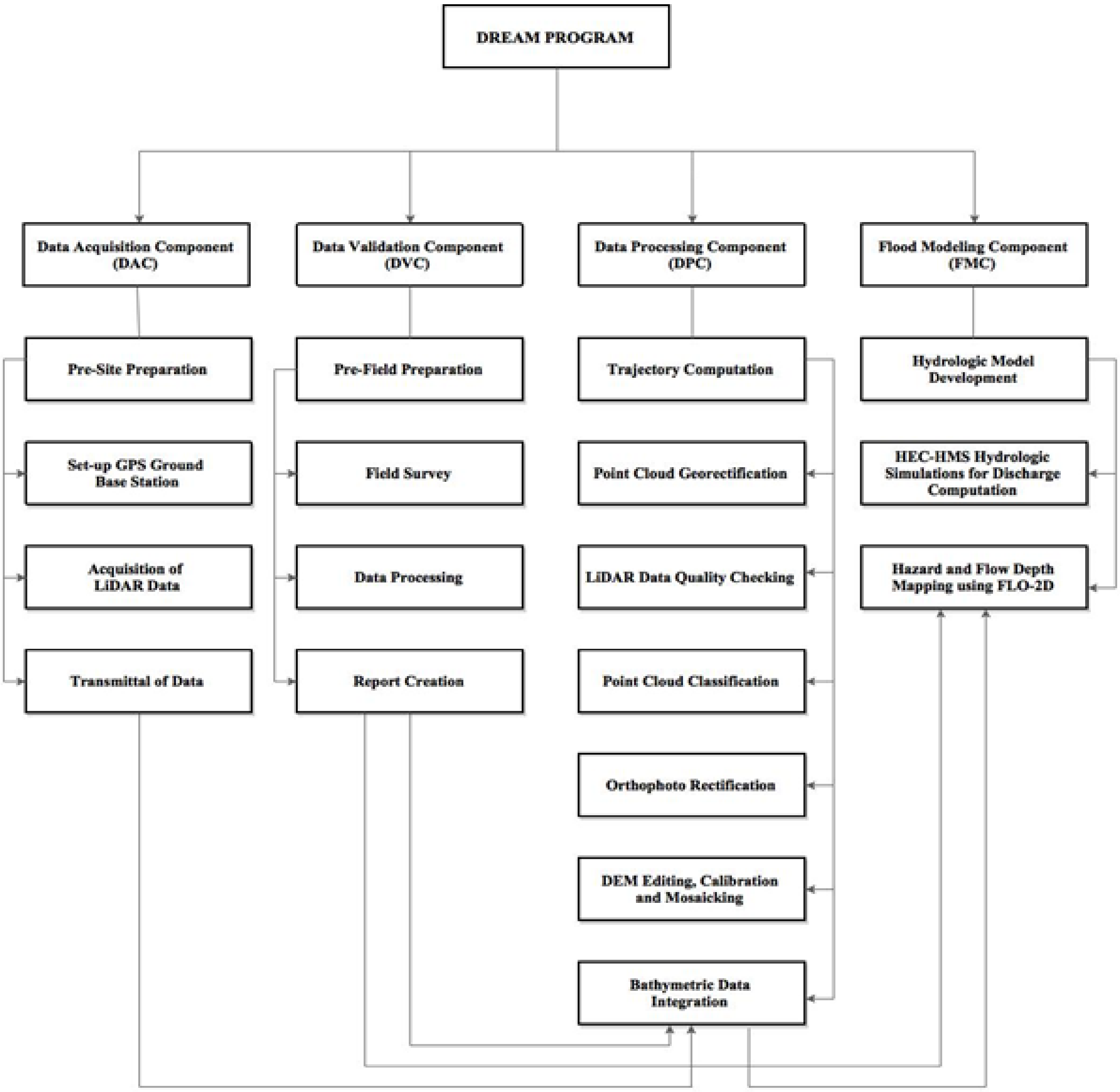


Figure 1. The General Methodological Framework of the Program

Study Area

Study Area

The Jalaur River Basin is located in Region VI. It is the seventeenth largest river basin in the Philippines. It covers an estimated basin area of 1503 square kilometres which includes parts of Iloilo, Capiz, and Antique. Its river, Jalaur River (also known as Jalaud River), is the second largest in the island of Panay. Thelocation of Jalaur River Basin is as shown in Figure 2.

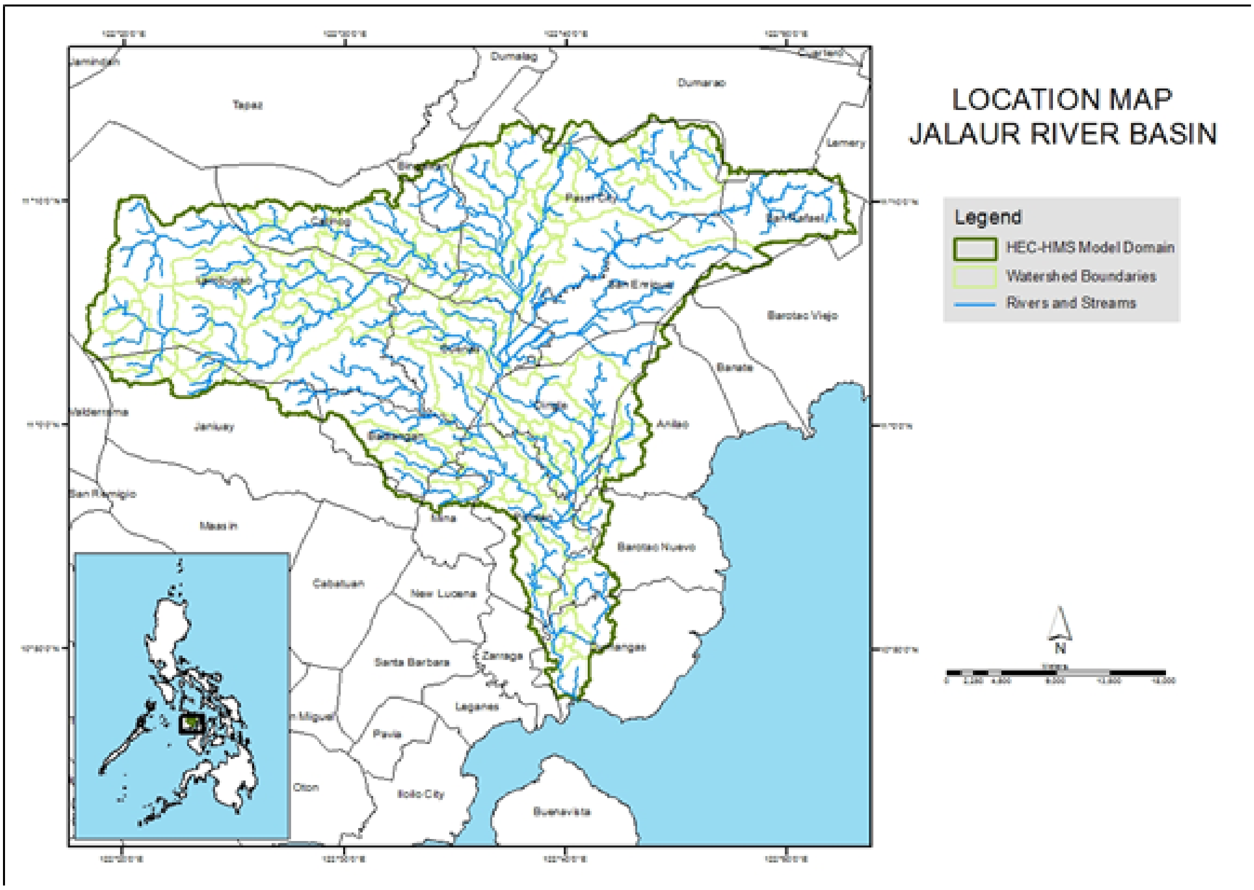


Figure 2. The Jalaur River Basin Location Map

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

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

The shape files of the soil and land cover were taken from the Bureau of Soils, which is under the Department of Environment and Natural Resources Management, and National Mapping and Resource Information Authority (NAMRIA). The soil and land cover of Jalaur River Basin are shown in Figure 3 and Figure 4, respectively.

Study Area

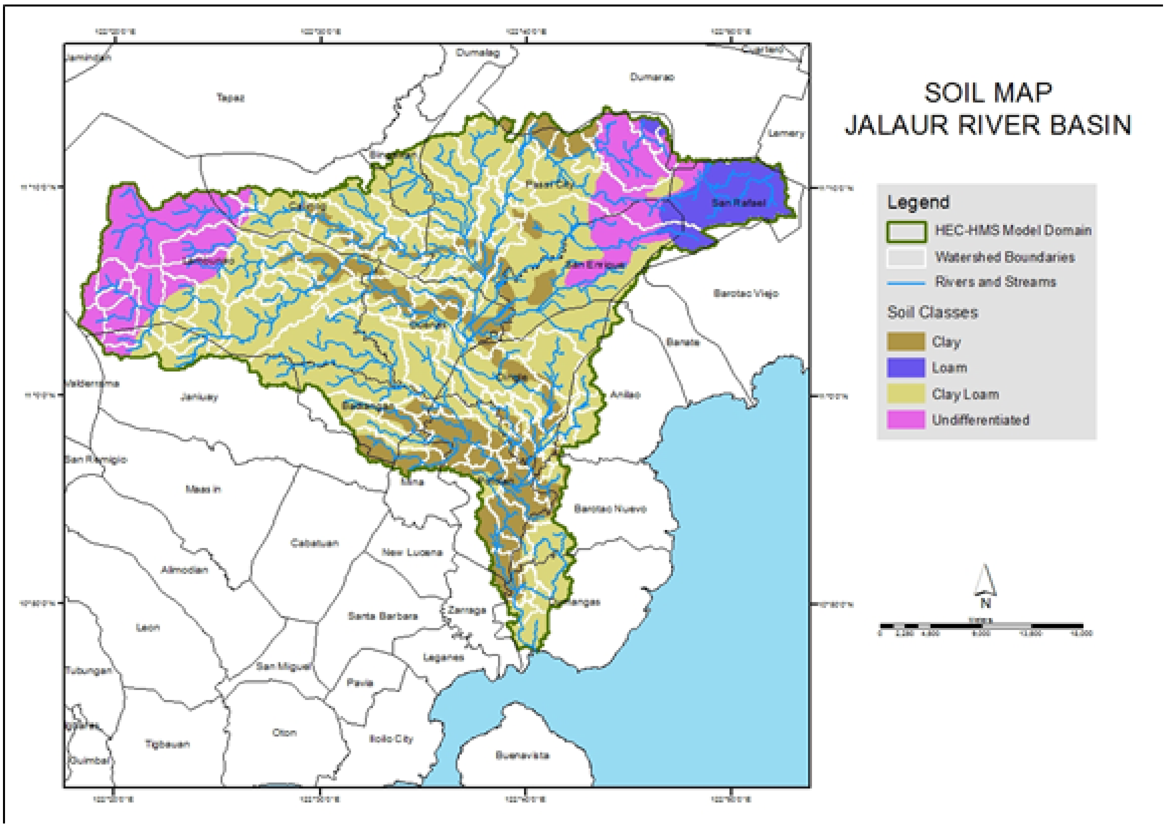


Figure 3. Jalaur River Basin Soil Map

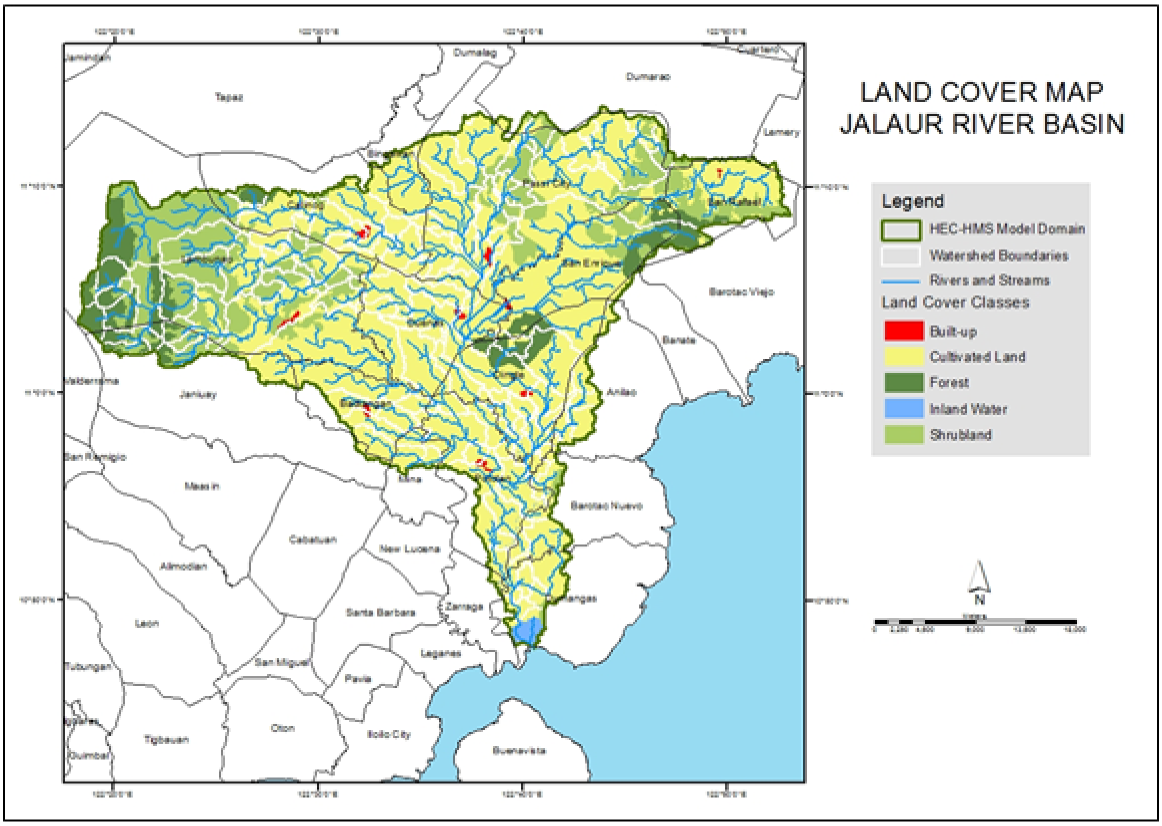


Figure 4. Jalaur River Basin Land Cover Map

Methodology

Methodology

3.1 Acquisition Methodology

The methodology employed to accomplish the project's expected outputs are subdivided into four (4) major components, as shown in Figure 5. Each component is described in detail in the following sections.

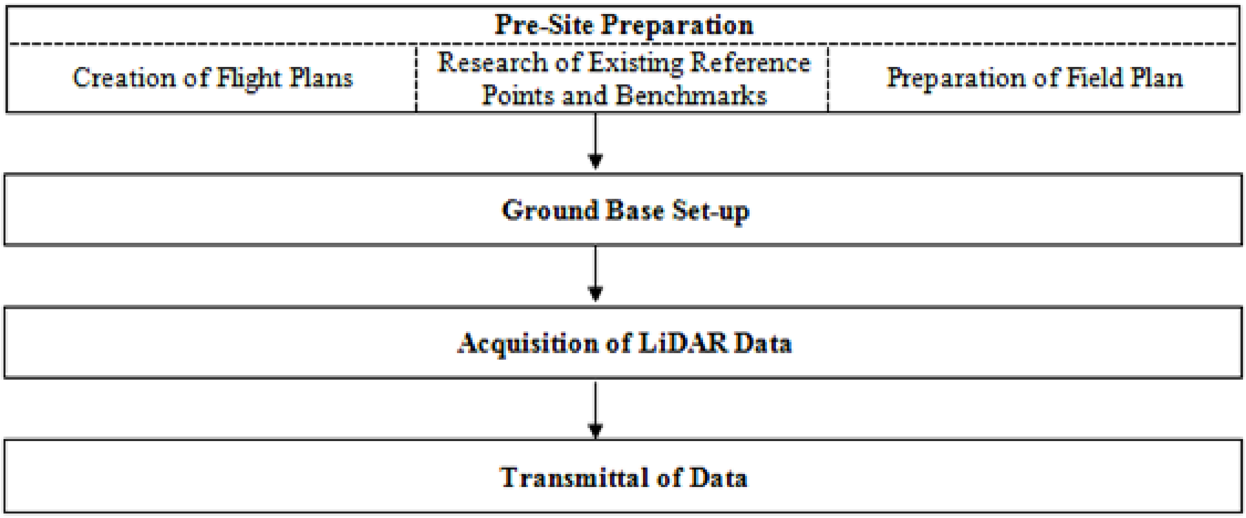


Figure 5. Flowchart of project methodology

3.1.1 Pre-Site Preparations

3.1.1.1 Creation of Flight Plans

Flight planning is the process of configuring the parameters of the aircraft and LiDAR technology (i.e., altitude, angular field of view (FOV)), speed of the aircraft, scans frequency and pulse repetition frequency) to achieve a target of two points per square meter point density for the floodplain. This ensures that areas of the floodplain that are most susceptible to floods will be covered. LiDAR parameters and their computations are shown in Table 1.

The parameters set in the LiDAR sensor to optimize the area coverage following the objectives of the project and to ensure the aircraft's safe return to the airport (base of operations) are shown in Table 1. Each flight acquisition is designed for four operational hours. The maximum flying hours for Cessna 206H is five hours.

Table 1. Relevant LiDAR parameters

Parameter		Formula	Description
SW (Swath Width)		$SW = 2 * H * \tan(\theta/2)$	H – altitude Θ – angular FOV
Point Spacing	ΔX_{across}	$\Delta X_{across} = (\Theta * H) / (N\cos^2(\Theta/2))$	ΔX_{across} – point spacing across the flight line H – altitude Θ – angular FOV N – number of points in one scanning line
	ΔX_{along}	$\Delta X_{along} = v / f_{sc}$	ΔX_{along}- point spacing along the flight line v – forward speed (m/s) f_{sc} – scanning rate or scan frequency
Point density, d_{min}		$d_{min} = 1 / (\Delta X_{across} * \Delta X_{along})$	ΔX_{across}, ΔX_{along} point spacings
Flight line separation, e		e = SW * (1 – overlapping factor)	SW – swath width
# of flight lines, n		n = w / [(1 – overlap) * SW]	w-width of the map that will be produce in meters. The direction of flights will be perpendicular to the width.

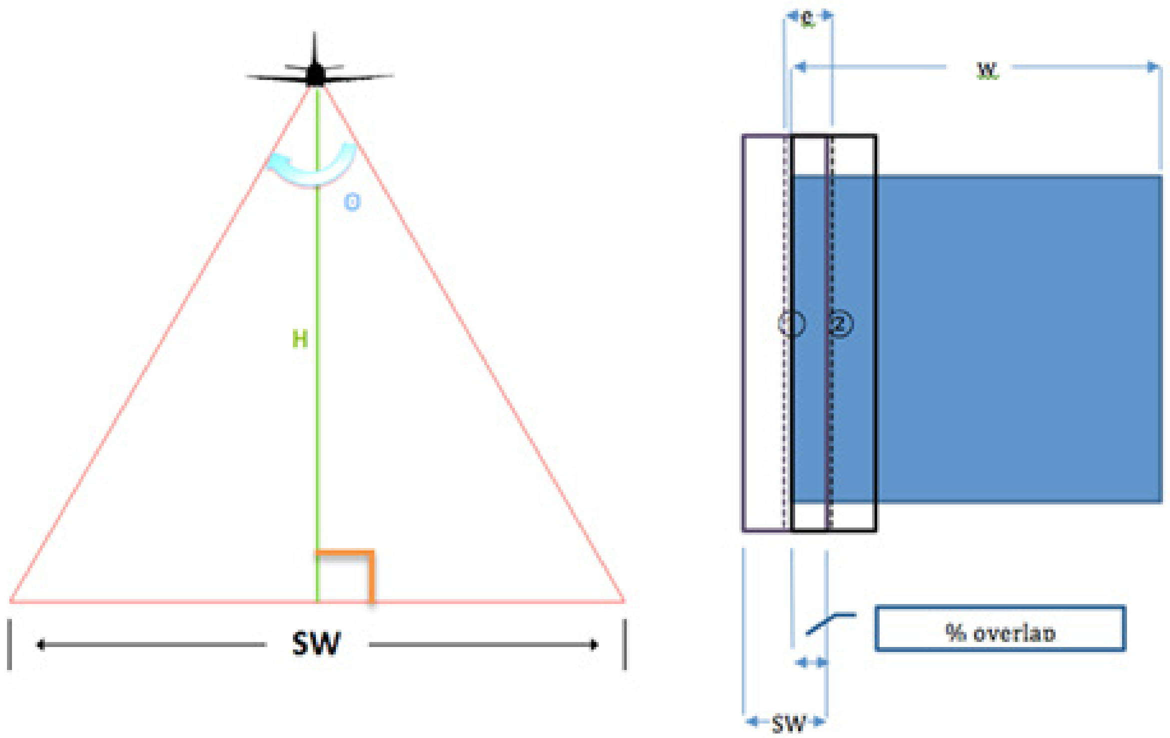


Figure 6. Concept of LiDAR data acquisition parameters

Methodology

The relationship among altitude, swath, and FOV is show in Figure 6. Given the altitude of the survey (H) and the angular FOV, the survey coverage for each pass (swath) can be calculated by doubling the product of altitude and tangent of half the field of view.

3.1.1.2 Collection of Existing Reference Points and Benchmarks

Collection of pertinent technical data, available information, and coordination with the National Mapping and Resource Information Authority (NAMRIA) is conducted prior to the surveys. Reference data collected includes locations and descriptions of horizontal and vertical control (elevation benchmarks) points within or near the project area. These control points are used as base stations for the aerial survey operations. Base stations are observed simultaneously with the acquisition flights.

3.1.1.3 Preparation of Field Plan

In preparation for the field reconnaissance and actual LiDAR data acquisition, a field plan is prepared by the implementation team. The field plan serves as a guide for the actual fieldwork and included personnel, logistical, financial, and technical details. Three major factors are included in field plan preparation: priority areas for the major river basin system; budget; and accommodation and vehicle rental.

LiDAR data are acquired for the floodplain area of the river system as per order of priority based on history of flooding, loss of lives, and damages of property. The order of priority in which LiDAR data surveys are conducted by the team for the floodplain areas of the 18 major river systems and 3 additional systems is shown in Table 2.

Table 2. List of Target River Systems in the Philippines

	Target River System	Location	Area of the River System (km2)	Area of the Flood Plain (km2)	Area of the Watershed (km2)
1	Cagayan de Oro	Mindanao	1,364	25	1,338.51
1.1	Iponan	Mindanao	438	33	404.65
2	Mandulog	Mindanao	714	7	707.41
2.1	Iligan	Mindanao	153	7	146.38
2.2	Agus	Mindanao	1,918	16	1,901.60
3	Pampanga	Luzon	11,160	4458	6702
4	Agno	Luzon	6,220	1725	4495
5	Bicol	Luzon	3,173	585	2,587.79
6	Panay	Visayas	2,442	619	1823
7	Jalaur	Visayas	2,105	713	1,392.00
8	Ilog Hilabangan	Visayas	2,146	179	1967
9	Magasawang Tubig	Luzon	1,960	483	1,477.08
10	Agusan	Mindanao	11,814	262	11,551.62
11	Tagoloan	Mindanao	1,753	30	1,722.90

12	Davao	Mindanao	1,609	54	1555
13	Tagum	Mindanao	2,504	595	1,909.23
14	Buayan	Mindanao	1,589	201	1,388.21
15	Mindanao	Mindanao	20,963	405	20,557.53
16	Lucena	Luzon	238	49	189.31
17	Infanta	Luzon	1,029	90	938.61
18	Boracay	Visayas	43.34	43.34	n/a
19	Cagayan	Luzon	28,221	10386	17,835.14

3.1.2 Ground Base Set-up

A reconnaissance is conducted one day before the actual LiDAR survey for purposes of recovering control point monuments on the ground and site visits of the survey area set in the flight plan for the floodplain. Coordination meetings with the Airport Manager, regional DOST office, local government units and other concerned line government agencies are also held.

Ground base stations are established within 30-kilometer radius of the corresponding survey area in the flight plan. This enables the system to establish its position in three-dimensional (3D) space so that the acquired topographic data will have an accurate 3D position since the survey required simultaneous observation with a base station on the ground using terrestrial Global Navigation Satellite System (GNSS) receivers.

3.1.3 Acquisition of Digital Elevation Data (LiDAR Survey)

Acquisition of LiDAR data is done by following the flight plans. The survey uses a LiDAR instrument mounted on the aircraft with its sensor positioned through a specially modified peep hole on the belly of the aircraft. The pilots are guided by the flight guidance software which uses the data out of the flight planning program with a mini-display at the pilot's cockpit showing the aircraft's real-time position relative to the current survey flight line. The reference points established by NAMRIA are also monitored and used to calibrate the data.

As the system collected LiDAR data, ranges and intensities are recorded on hard drives dedicated to the system while the images are stored on the camera hard drive. Position Orientation System (POS) data is recorded on the POS computer inside the control rack. It can only be accessed and downloaded via file transfer protocol (ftp) to the laptop computer. GPS observations were downloaded each day for efficient data management.

3.1.4 Transmittal of Acquired LiDAR Data

All data surrendered are monitored, inspected and re-checked by securing a data transfer checklist signed by the downloader (Data Acquisition Component) and the receiver (Data Processing Component). The data transfer checklist shall include the following: date of survey, mission name, flight number, disk size of the necessary data (LAS, LOGS, POS, Images, Mission Log File, Range, Digitizer and the Base Station), and the data directory within the server. Figure 7 shows the arrangement of folders inside the data server.

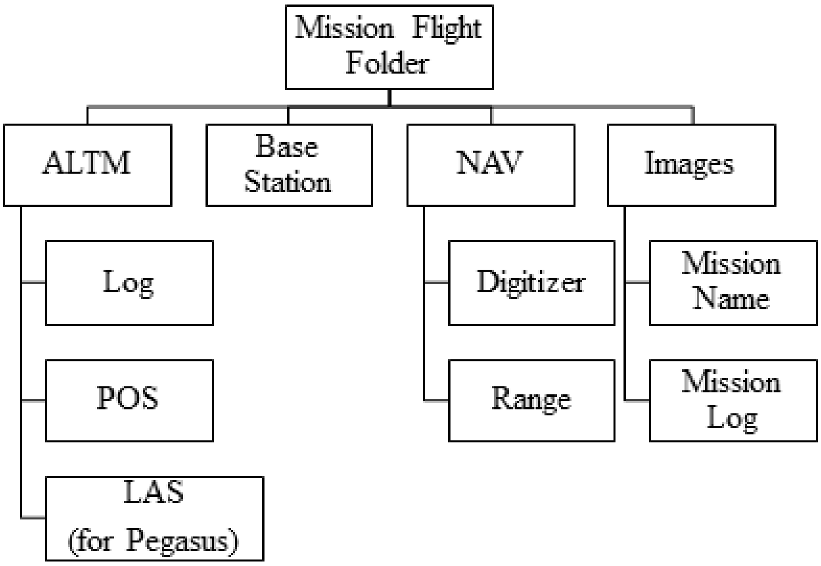


Figure 7. LiDAR Data Management for transmittal

3.1.5 Equipment

ALTM Pegasus

The ALTM Pegasus (Optech, Inc) is a laser based system suitable for topographic survey (Figure 8). It has a dual output laser system for maximum density capability. The LiDAR system is equipped with an Inertial Measurement Unit (IMU) and GPS for geo-referencing of the acquired data (Annex A contains the technical specification of the system).

The camera of the Pegasus sensor is tightly integrated with the system. It has a footprint of 8,900 pixels across by 6,700 pixels along the flight line (Annex B contains the technical specification of the D-8900 aerial digital camera).

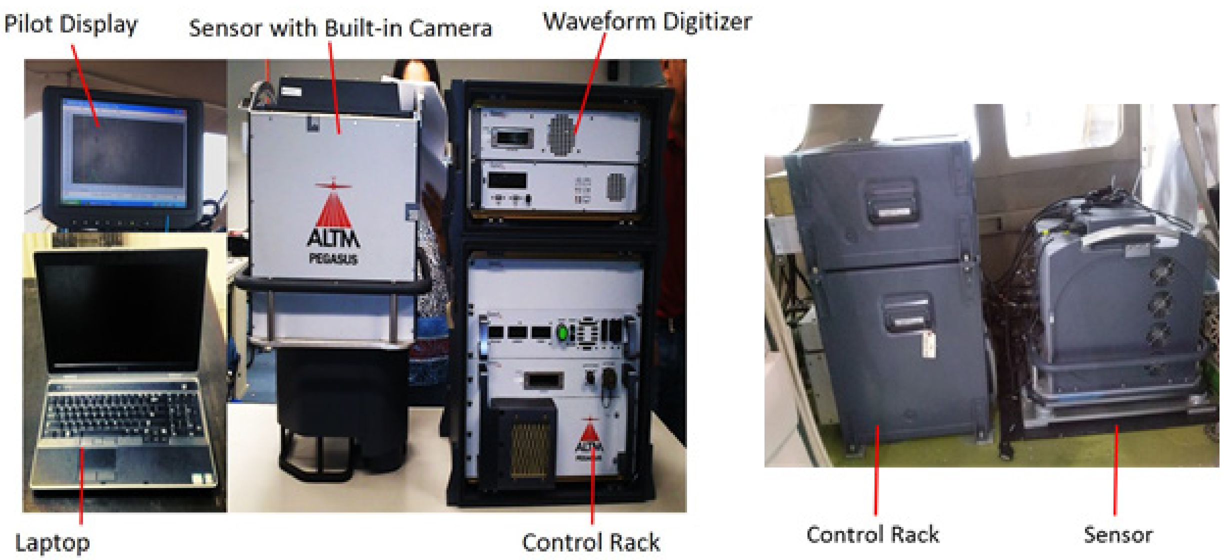


Figure 8. The ALTM Pegasus System: a) parts of the Pegasus system, b) the system as installed in Cessna T206H

ALTM Gemini

The ALTM Gemini (Optech, Inc) is a laser based system suitable for topographic survey especially in high altitude areas with 16 kHz of effective laser rate (Figure 9). It has an integrated camera and waveform digitizer (Annex A contains the technical specifications of the system)

Figure 9. The ALTM Gemini System

3.2 Processing Methodology

The schematic diagram of the workflow implemented by the Data Processing Component (DPC) is shown in Figure 10. The raw data collected by the Data Acquisition Component (DAC) is transferred to DPC. Pre-processing of this data starts with the computation of trajectory and georectification of point cloud, in which the coordinates of the LiDAR point cloud data are adjusted and checked for gaps and shifts, using POSPac, Lidar Mapping Suite (LMS), LAStools and Quick Terrain (QT) Modeler software.

The unclassified LiDAR data then undergoes point cloud classification, which allows cleaning of noise data that are not necessary for further processing, using TerraScan software. The classified point cloud data in ASCII format is used to generate a data elevation model (DEM), which is edited and calibrated with the use of validation and bathymetric survey data collected from the field by the Data Validation and Bathymetry Component (DVBC). The final DEM is then used by the Flood Modeling Component (FMC) to generate the flood models for different flooding scenarios.

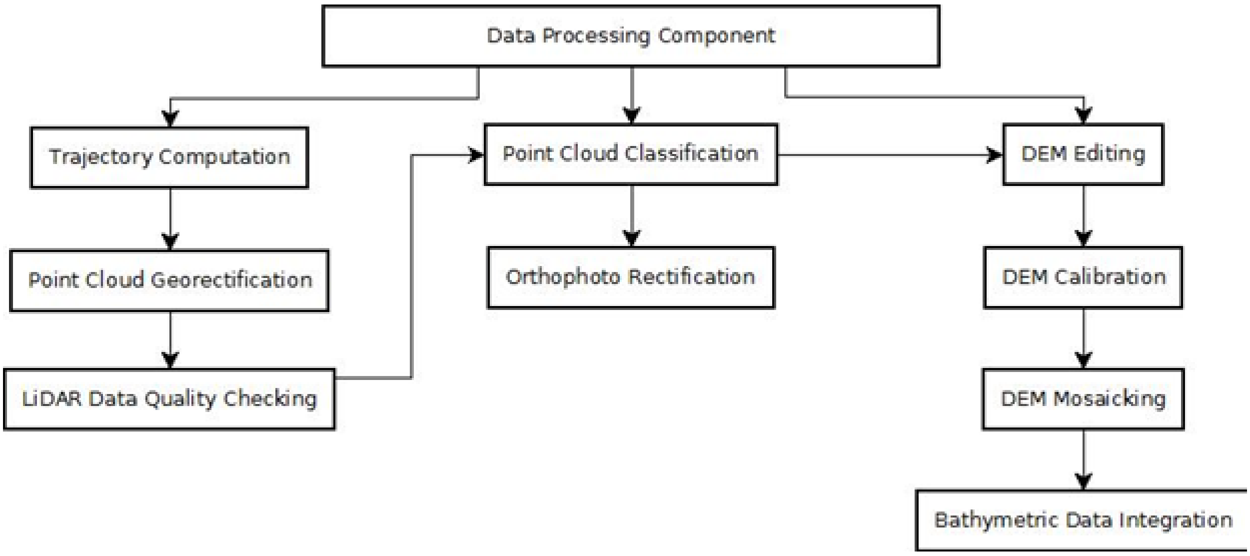


Figure 10. Schematic diagram of the data processing

3.2.1 Data Transfer

The Jalaur mission, named 2PAN6K130B, was flown with the Airborne LiDAR Terrain Mapper (ALTM™ Optech Inc.) by Gemini system on May 10, 2013. The Data Acquisition Component (DAC) transferred 908 Megabytes of Range data, 60.4 Megabytes of POS data, 7.12 Megabytes of GPS base station data, and 257 Megabytes of raw image data to the data server on May 21, 2013.

3.2.2. Trajectory Computation

The trajectory of the aircraft is computed using the software POSPAC MMS v6.2. It combines the POS data from the integrated GPS/INS system installed on the aircraft, and the Rinex data from the GPS base station located within 25 kilometers of the area. It then computes the Smoothed Best Estimated Trajectory (SBET) file, which contains the best estimated trajectory of the aircraft, and the Smoothed Root Mean Square Estimation error file (SMRMSG), which contains the corresponding standard deviations of the position parameters of the aircraft at every point on the computed trajectory.

The key parameters checked to evaluate the performance of the trajectory are the Solution Status parameters and the Smoothed Performance Metrics parameters. The Solution Status parameters characterize the GPS satellite geometry and baseline length at the time of acquisition, and the processing mode used by POSPAC. The acceptable values for each Solution Status parameter are shown in Table 3.
The Smoothed Performance Metrics parameters describe the root mean square error (RMSE) for the north, east and down (vertical) position of the aircraft for each point in the computed trajectory. A RMSE value of less than 4 centimeters for the north and east position is acceptable, while a value of less than 8 centimeters is acceptable for the down position.

Table 3. Smoothed Solution Status Parameters in POSPAC MMS v6.2

Parameter	Optimal values
Number of satellites	More than 6 satellites
Position Dilution of Precision (PDOP)	Less than 3
Baseline Length	Less than 30 km
Processing mode	Less than or equal to 1, however short bursts of values greater than 1 are acceptable.

3.2.3 LiDAR Point Cloud Rectification

The trajectory file (SBET) and its corresponding accuracy file (SMRMSG) generated in POSPAC are merged with the Range file to compute the coordinates of each individual point. The coordinates of points within the overlap region of contiguous strips vary due to small deviations in the trajectory computation for each strip. These strip misalignments are corrected by matching points from overlapping laser strips. This is done by the Lidar Mapping Suite (LMS) software developed by Optech.

LMS is a LiDAR software package used for automated LiDAR rectification. It has the capability to extract planar features per flight line and to form correspondence among the identical planes available in the overlapping areas (illustrated in Figure 11). In order to produce geometrically correct point cloud, the redundancy in the overlapping areas of flight lines is used to determine the necessary corrections for the observations.

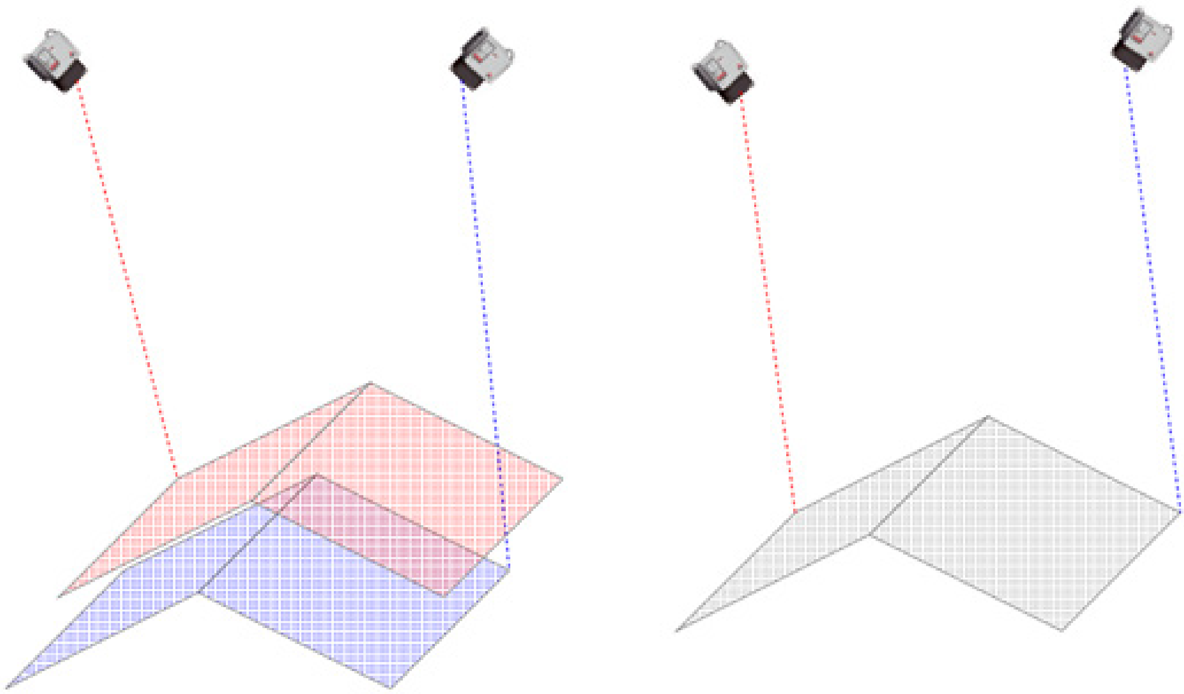


Figure 11. Misalignment of a single roof plane from two adjacent flight lines, before rectification (left). Least squares adjusted roof plane, after rectification (right).

The orientation parameters are corrected in LMS by using least squares adjustment to obtain the best-fit parameters and improve the accuracy of the LiDAR data. The primary indicators of the LiDAR rectification accuracy are the standard deviations of the corrections of the orientation parameters. These values are seen on the Boresight corrections, GPS position corrections, and IMU attitude corrections, all of which are located on the LMS processing summary report. Optimum accuracy is obtained if the Boresight and IMU attitude correction standard deviations are less than 0.001°, and if the GPS position standard deviations are below 0.01 m.

3.2.4 LiDAR Data Quality Checking

After the orientation parameters are corrected and the point cloud coordinates are computed, the entire point cloud data undergoes quality checking, to see if: (a) there are remaining horizontal and vertical misalignments between contiguous strips, and; (b) to check if the density of the point cloud data reach the target density for the site. The LAStools software is used to compute for the elevation difference in the overlaps between strips and the point cloud density. It is a software package developed by Rapidlasso GmbH for filtering, tiling, classifying, rasterizing, triangulating and quality checking Terabytes of LiDAR data, using robust algorithms, efficient I/O tools and memory management. LAStools can quickly create raster representing the computed quantities, which provide guiding images in determining areas where further quality checks are necessary. The target requirements for floodplain acquisition, computed by LAStools, are shown in Table 4.

Table 4. Parameters investigated during quality checks

Criteria	Requirement
Minimum per cent overlap	25%
Average point cloud density per square meter	2.0
Elevation difference between strips (on flat areas)	0.20 meters

LAStools can provide guides where elevation differences probably exceed the 20 centimeters limit. An example of LAStools output raster visualizing points in the flight line overlaps with a vertical difference of +/- 20 centimeters (displayed as dense red/blue areas) is shown in Figure 12.

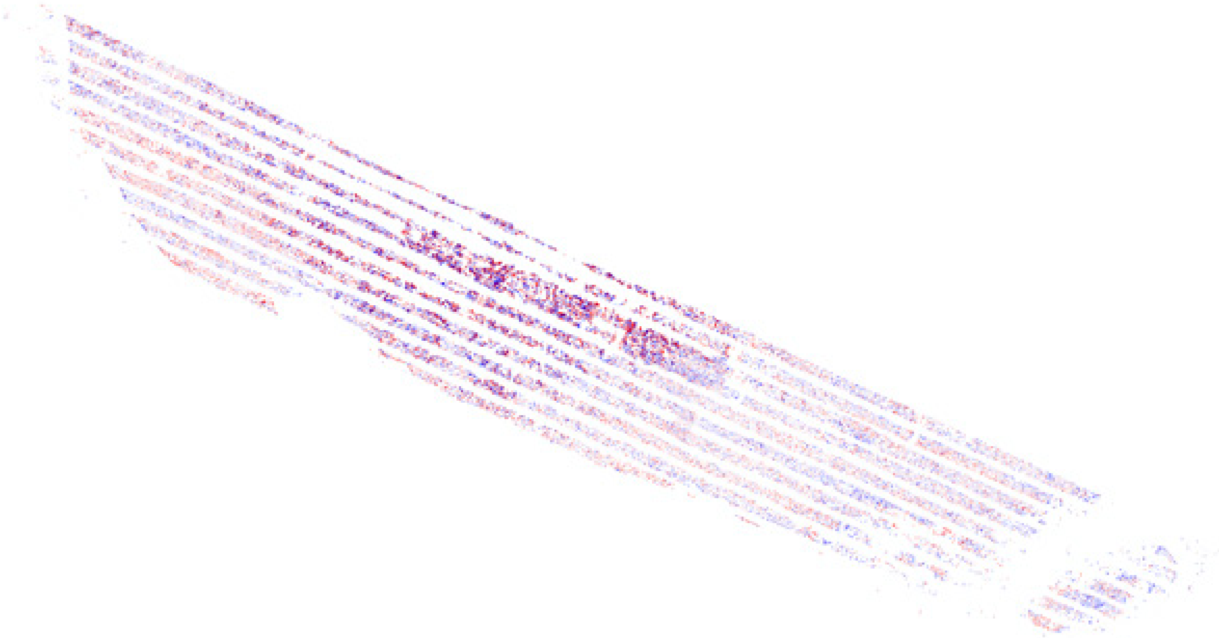
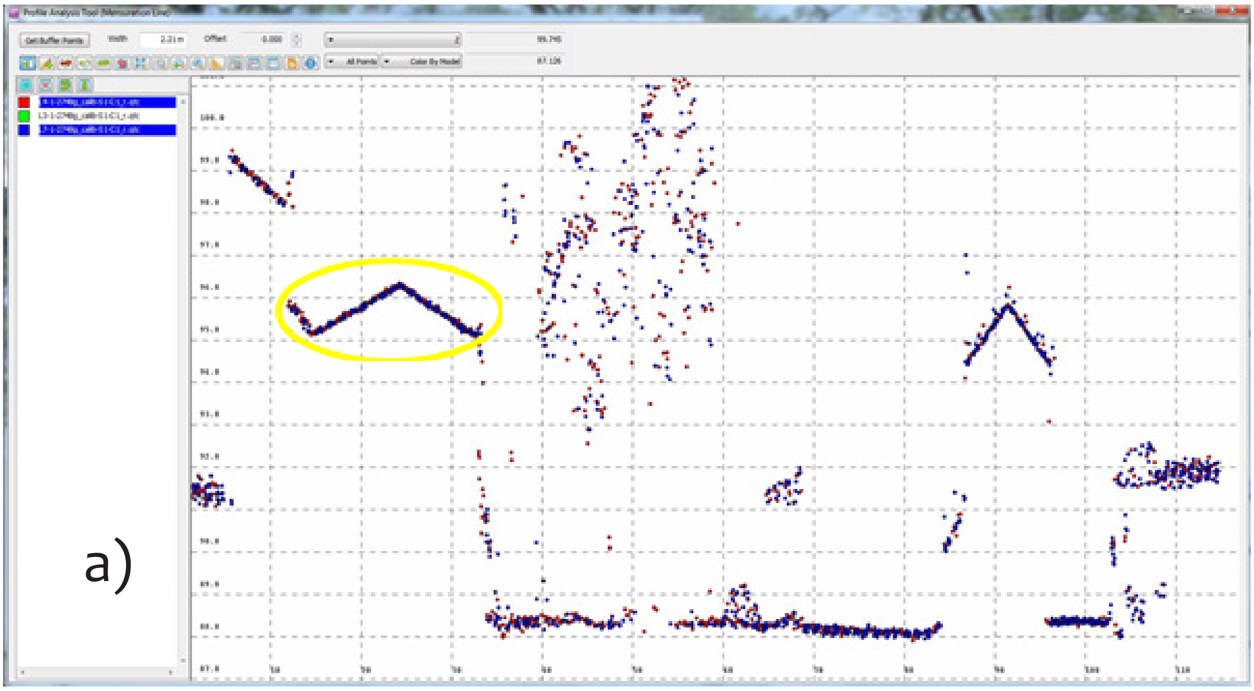


Figure 12. Elevation difference between flight lines generated from LAStools

To investigate the occurrences of elevation differences in finer detail, the profiling tool of Quick Terrain Modeler software is used. Quick Terrain Modeler (QT Modeler) is a 3D point cloud and terrain visualization software package developed by Applied Imagery, Inc. The profiling capability of QT Modeler is illustrated in Figure 13.



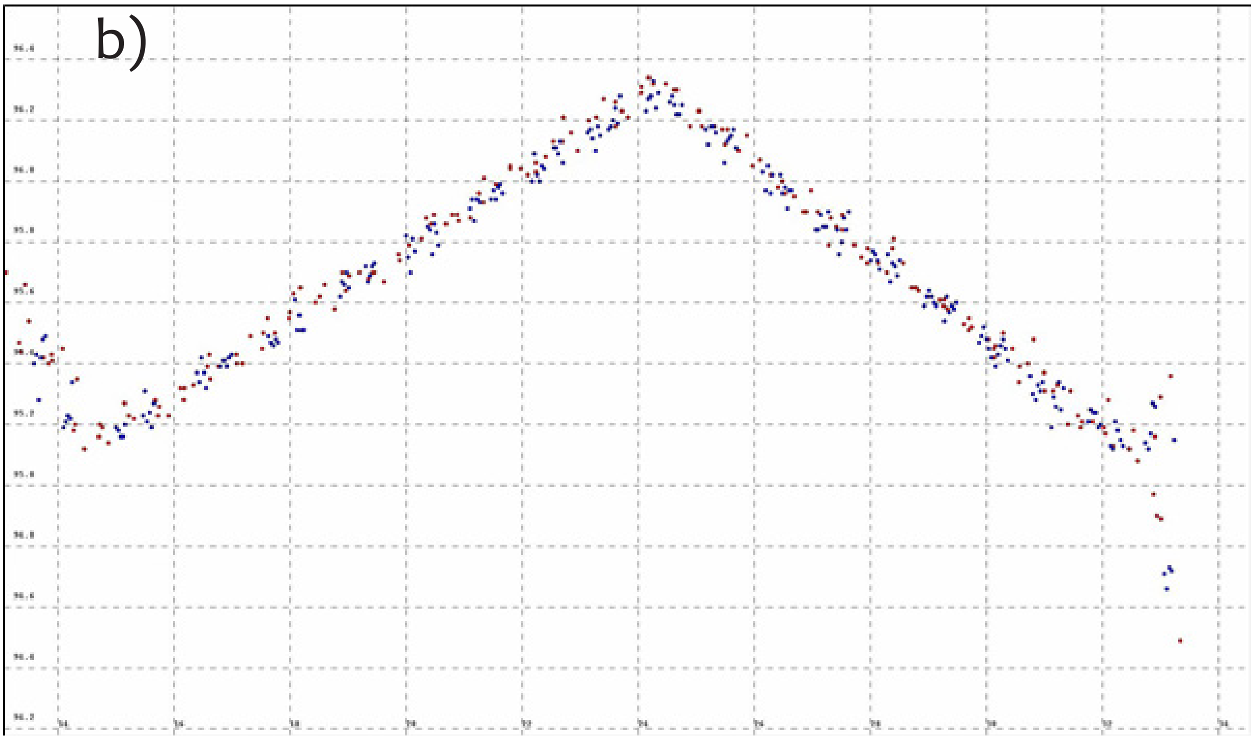


Figure 13. Profile over roof planes (a) and a zoomed-in profile on the area encircled in yellow (b)

The profile (e.g., over a roof plane) shows the overlapping points from different flight lines which serve as a good indicator that the correction applied by LMS for individual flight lines is good enough to attain the desired horizontal and vertical accuracy requirements. Flight lines that do not pass quality checking are subject for reprocessing in LMS until desired accuracies are obtained.

3.2.5 LiDAR Point Cloud Classification and Rasterization

Point cloud classification commences after the point cloud data has been rectified. TerraScan is a TerraSolid LiDAR software suite used for the classification of point clouds. It can read airborne and vehicle-based laser data in raw laser format, LAS, TerraScan binary or other ASCII-survey formats. Its classification and filtering routines are optimized by dividing the whole data into smaller geographical datasets called blocks, to automate the workflow and increase efficiency. In this study, the blocks were set to 1 kilometer by 1 kilometer with a 50 m buffer zone to prevent edge effects.

The process includes the classification of all points into Ground, Low Vegetation, Medium Vegetation, High Vegetation and Buildings. The classifier tool in TerraScan first filters air points and low points by finding points that are 5 standard deviations away from the median elevation of a search radius, which is 5 meters by default. It then divides the region into 60m by 60m search areas (the maximum area where at least one laser point hits the ground) and assigns the lowest points in these areas as the initial ground points from which a triangulated ground model is derived. The classifier then iterates through all the points and adds the points to the ground model by testing if it is (a) within the maximum iteration angle of 4° by default from a triangle plane, and (b) if it is within the maximum iteration distance (1.2 m by default) from a triangle plane. The ground plane is continuously updated from these iterations. The ground classification technique is illustrated in Figure 13. It is apparent that the smaller the iteration angle, the less eager the classifier is to follow changes in the point cloud (small undulations in terrain or hits on low vegetation). An angle close to 4° is used in flat terrain areas while an angle of 10° is used in mountainous or hilly terrains.

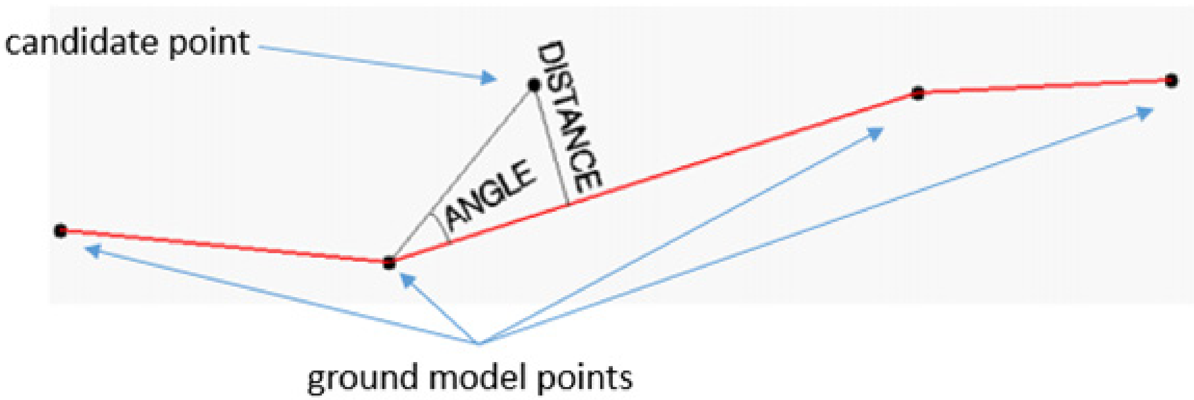


Figure 14. Ground classification technique employed in Terrascan

The parameters for ground classification routines used in floodplain and watershed areas are listed in Table 5.

Table 5. Ground classification parameters used in Terrascan for floodplain and watershed areas

Classification maximums	Floodplain (default)	Watershed (adjusted)
Iteration angle (degrees)	4	8
Iteration distance (meters)	1.20	1.50

The comparison between the produced DTM using the default parameters versus the adjusted is shown in Figure 15. The default parameters may fail to capture the sudden change in the terrain, resulting to less points being classified as ground that makes the DTM interpolated (Figure 15a). The adjusted parameters works better in these spatial conditions as shown in Figure 15b. Statistically, the number of ground points and model key points correctly classified can increase by as much as fifty percent (50%) when using the adjusted parameters.

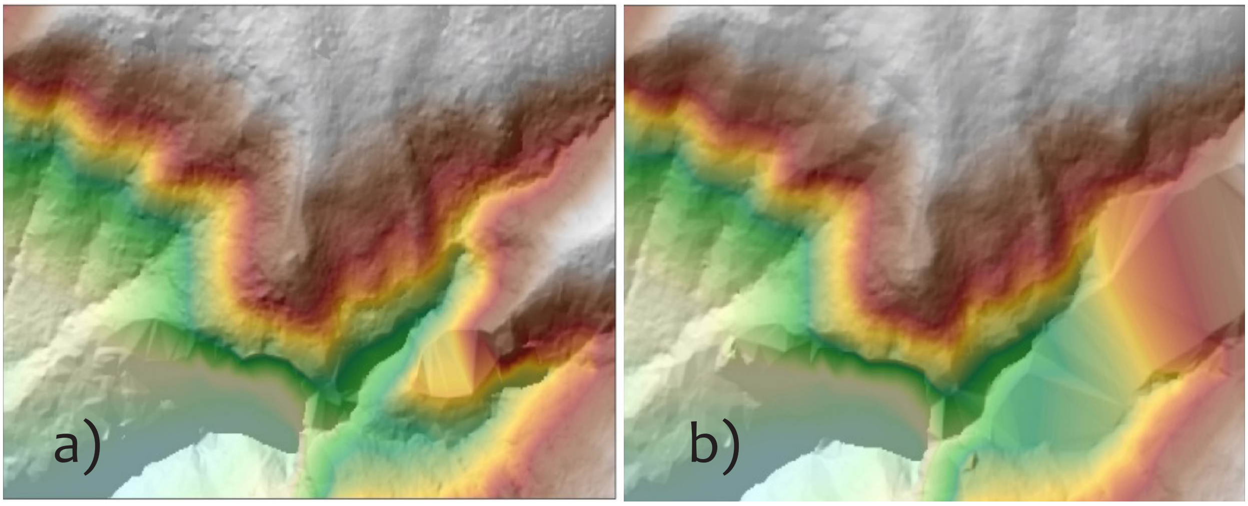


Figure 15. Resulting DTM of ground classification using the default parameters (a) and adjusted parameters (b)

The classification to Low, Medium and High vegetation is a straightforward testing of how high a point is from the ground model. The range of elevation values and its corresponding classification is shown in Table 6.

Table 6. Classification of Vegetation according to the elevation of points

Elevation of points (meters)	Classification
0.05 to 0.15	Low Vegetation
0.15 to 2.50	Medium Vegetation
2.50 to 50.0	High Vegetation

The classification to Buildings routine tests points above two meters (2.0 m) if they only have one echo, and if they form a planar surface of at least 40 square meters with points adjacent to them. Minimum size and Z tolerance are the parameters used in the classify buildings routine as shown in Figure 16.

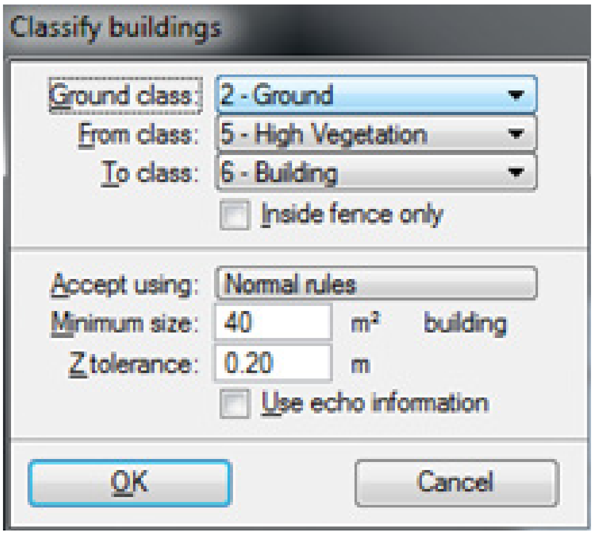


Figure 16. Default TerraScan building classification parameters

Minimum size is set to the smallest building footprint size of 40 square meters while the Z tolerance of 20 centimeters is the approximate elevation accuracy of the laser points.

The point cloud data are examined for possible occurrences of air points which are to be deleted manually in the TerraScan window. Air points are defined as groups of points which are significantly higher or lower from the ground points. The different examples of air points are shown in Figure 17.

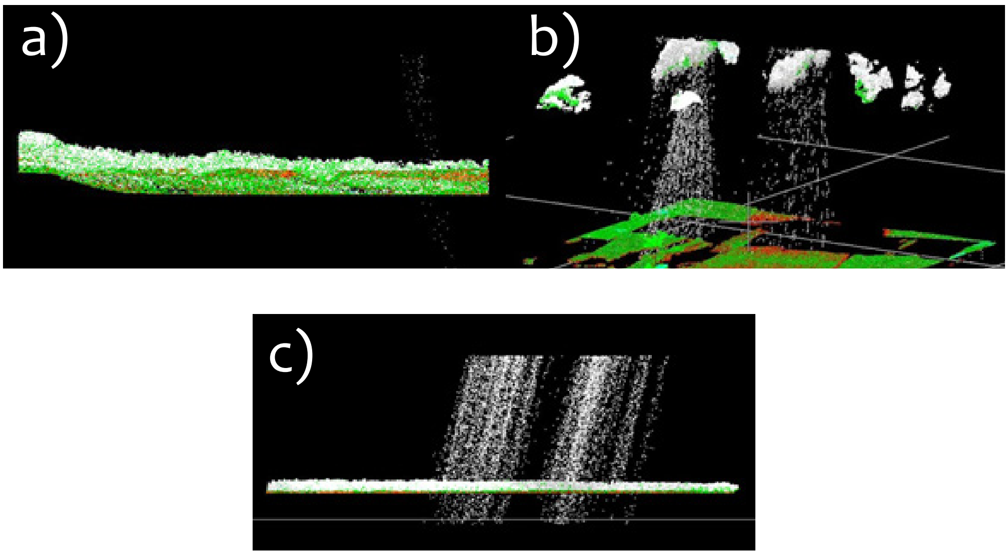


Figure 17. Different examples of air points manually deleted in the TerraScan window

The noise data can be as negligible as shown in Figure 17a or can be as severe as the one shown in Figure 17c. A combination of cloud points and shower of short ranges is displayed in Figure 17b. Shower of short ranges are caused by signal interference from the radio transmission of the tower and the aircraft. During every transmission on a specific frequency (around 120MHz), the signal is getting distorted due to the interference causing showers of short ranges in the output LAS.

Classified LiDAR point clouds that are free of air points, noise and unwanted data are processed in TerraScan to produce Digital Terrain Model (DTM) and the corresponding first and last return Digital Surface Models (DSM). These ground models are produced in the American Standard Code for Information Interchange format (ASCII) format. DTMs are produced by rasterizing all points classified to ground and model key points in a 1 m by 1 m grid. The last return DSMs are produced by rasterizing all last returns from all classifications (Ground, Model Key Points, Low, Medium, High Vegetation, Buildings and Default) in a 1 m by 1 m grid. The first return DSMs on the other hand are produced by rasterizing all first returns from all classifications. Power lines are usually included in this model. All of these ground models are used in the mosaicking, manual editing and hydro correction of the topographic dataset, in preparation for the floodplain hydraulic modelling.

3.2.6 DEM Editing and Hydro-correction

Even though the parameters of the classification routines are optimized, various digital elevation models (DTM, first and last return DSM) that are automatically produced may still display minor errors that still need manual correction to make the DEMs suitable for fine-scale flood modelling. This is true especially for features that are under heavy canopy. Natural embankments on the side of the river might be flattened or misrepresented because no point pierced the canopy on that area. The same difficulty might also occur on smaller streams that are under canopy. The DTM produced might have discontinuities on these channels that might affect the flood modelling negatively. Manual inspection and correction is still a very important part of quality checking the LiDAR DEMs produced.

To correctly portray the dynamics of the flow of water on the floodplain, the river geometry must also be taken into consideration. The LiDAR data must be made consistent to the topographic surveys done for the area, and the bathymetric data must be “burned”, or integrated, into the DEM to make the dataset suitable for hydraulic analyses. However, no cross-sectional survey was performed for this area.

Results and Discussion

Results and Discussion

4.1 LiDAR Data Acquisition in Jalaur Floodplains

4.1.1 Flight Plans

Plans were made to acquire LiDAR data within the Jalaur floodplain as shown in Figure 18. Each flight mission had an average of 15 flight lines and ran for at most 4 hours including take-off, landing and turning time. The parameter used in the LiDAR system for acquisition is found in Table 7. The maximum flying hours for Cessna 206H is five hours.

Table 7. Parameters used in LiDAR System during Flight Acquisition

Fixed Variables	Values		
Flying Height (AGL – Above Ground Level) (m)	750	1000	1200
Overlap	30 %	30 %	30 %
Max. field of View (θ)	50	50	50
Speed of Plane (kts)	130	130	130
Turn around minutes	5	5	5
Swath (m)	661.58m	882m	1058.53m

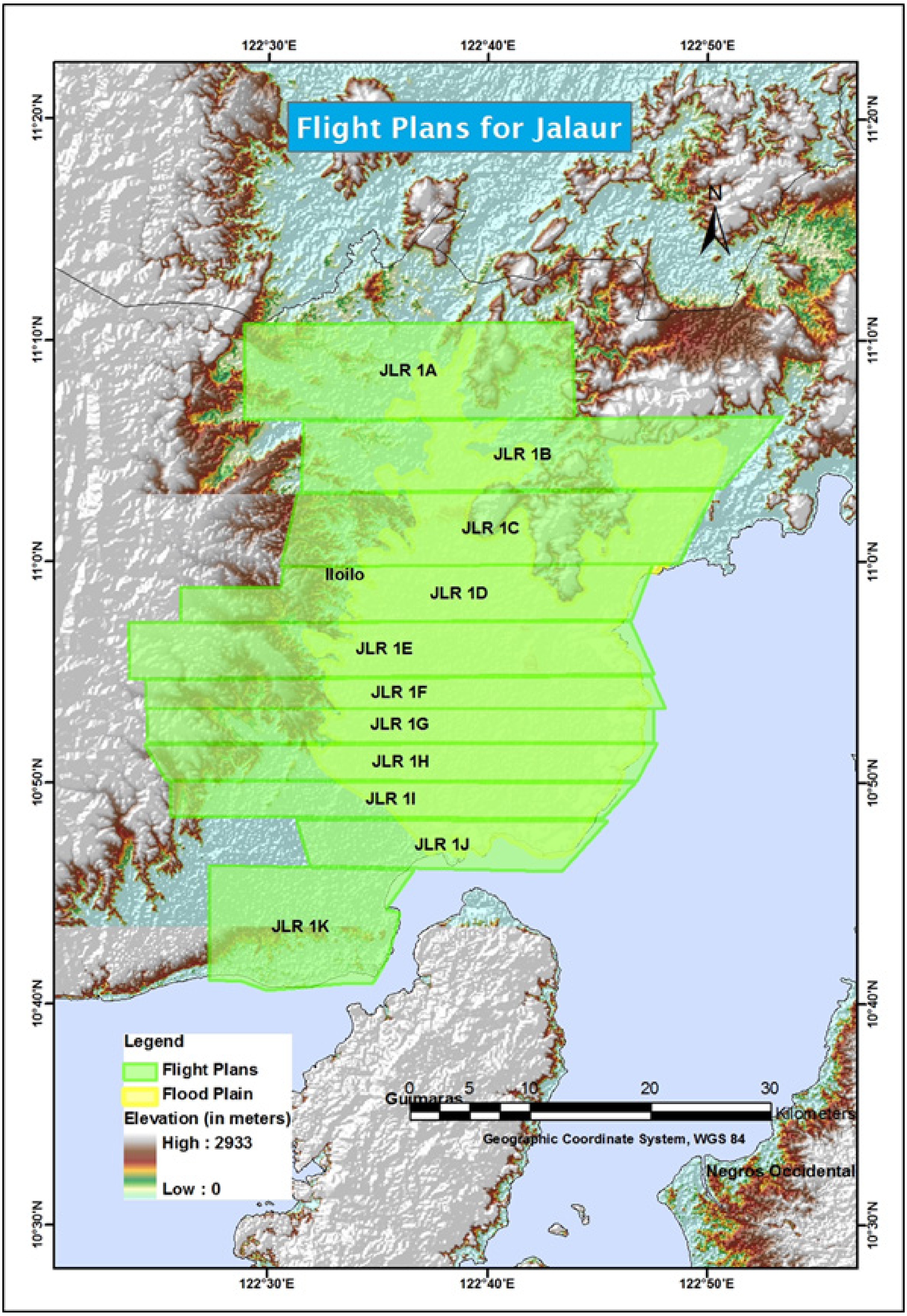


Figure 18. Jalaur floodplain flight plans

4.1.2 Ground Base Station

The project team was able to recover five (5) NAMRIA control stations; ILO-64, ILO-66, ILO-69, ILO-89, ILO-91 with second (2nd) order accuracy. The certification for the base station is found in Annex E. The team also recovered NAMRIA Benchmarks (IL-381A and IL-391A) with first (1st) order accuracy. The ground control point (GCPs) was used as a reference point during flight operations using TRIMBLE SPS R8, a dual frequency GPS receiver.

Table 8. Details of the recovered NAMRIA horizontal point ILO-64 used as base station for the LiDAR Acquisition

Station Name	ILO-64	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1:50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	10° 55' 54.58427" 122° 34' 23.77840" 40.62000 meters
Grid Coordinates, Philippine Transverse Mercator Zone 4 (PTM Zone 4 PRS 92)	Easting Northing	453354.591 meters 1208822.191 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	10° 55' 50.18711" North 122° 34' 28.98100" East 97.63900 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N WGS 1984)	Easting Northing	453370.92 meters 1208399.08 meters

Table 9. Details of the recovered NAMRIA horizontal point ILO-66 used as base station for the LiDAR Acquisition

Station Name	ILO-66	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	10° 59' 56.14968" 122° 40' 18.68063" 27.71400 meters
Grid Coordinates, Philippine Transverse Mercator Zone 4 (PTM Zone 4 PRS 92)	Easting Northing	464138.956 meters 1216230.423 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	10° 59' 51.74412" North 122° 40' 18.68063" East 84.81500 meters

Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N WGS 1984)	Easting Northing	2464151.51 meters 1215804.72 meters

Table 10. Details of the recovered NAMRIA horizontal control point ILO-69 used as base station for the LiDAR Acquisition

Station Name	ILO-69	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	11° 7' 7.97593" 122° 38' 42.65948" 63.94700 meters
Grid Coordinates, Philippine Transverse Mercator Zone 3 (PTM Zone 3 PRS 92)	Easting Northing	461239.791 meters 1229500.996 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	11° 7' 3.53797" North 122° 38' 47.84510" East 120.69300 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N WGS 1984)	Easting Northing	461253.36 meters 1229070.65 meters

Table 11. Details of the recovered NAMRIA horizontal control point ILO-89 used as base station for the LiDAR Acquisition.

Station Name	ILO-89	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	10° 48' 55.43533" 122° 36' 5.65628" 9.79800 meters
Grid Coordinates, Philippine Transverse Mercator Zone 3 (PTM Zone 3 PRS 92)	Easting Northing	456431.138 meters 1195940.297 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	10° 48' 51.06990" North 122° 36' 10.86897" East 67.16300 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N WGS 1984)	Easting Northing	456446.39 meters 1195521.70 meters

Results and Discussion

Table 12. Details of the recovered NAMRIA horizontal control point ILO-91 used as base station for the LiDAR Acquisition.

Station Name	ILO-91	
Order of Accuracy	2nd	
Relative Error (horizontal positioning)	1 in 50,000	
Geographic Coordinates, Philippine Reference of 1992 Datum (PRS 92)	Latitude Longitude Ellipsoidal Height	10° 58’ 46.51769” 122° 44’ 53.92299” 22.74100 meters
Grid Coordinates, Philippine Transverse Mercator Zone 3 (PTM Zone 3 PRS 92)	Easting Northing	472492.693 meters 1214083.04 meters
Geographic Coordinates, World Geodetic System 1984 Datum (WGS 84)	Latitude Longitude Ellipsoidal Height	10° 58’ 42.12357” North 122° 44’ 59.12020” East 80.07700 meters
Grid Coordinates, Universal Transverse Mercator Zone 51 North (UTM 51N WGS 1984)	Easting Northing	472502.32 meters 1213658.09 meters

Table 13. Details of the recovered NAMRIA vertical control point in Jalaur Floodplain.

Point Name	Location	WGS '84 Coodinates		Ellipsoidal Height (m)
		Latitude	Longitude	
WCC-1	WCC Airport, Binalonan, Pangasinan	16° 03’ 12.65810	120° 34’ 56.38599	80.125
WCC-2	WCC Airport, Binalonan, Pangasinan	16° 03’ 13.12892	120° 34’ 56.31340	80.855

Figure 19. Ground Base Station Observation at ILO-89 located on the right side of the second approach of the bridge crossing Canipaan River in the Municipality of Leganes in Iloilo Province.

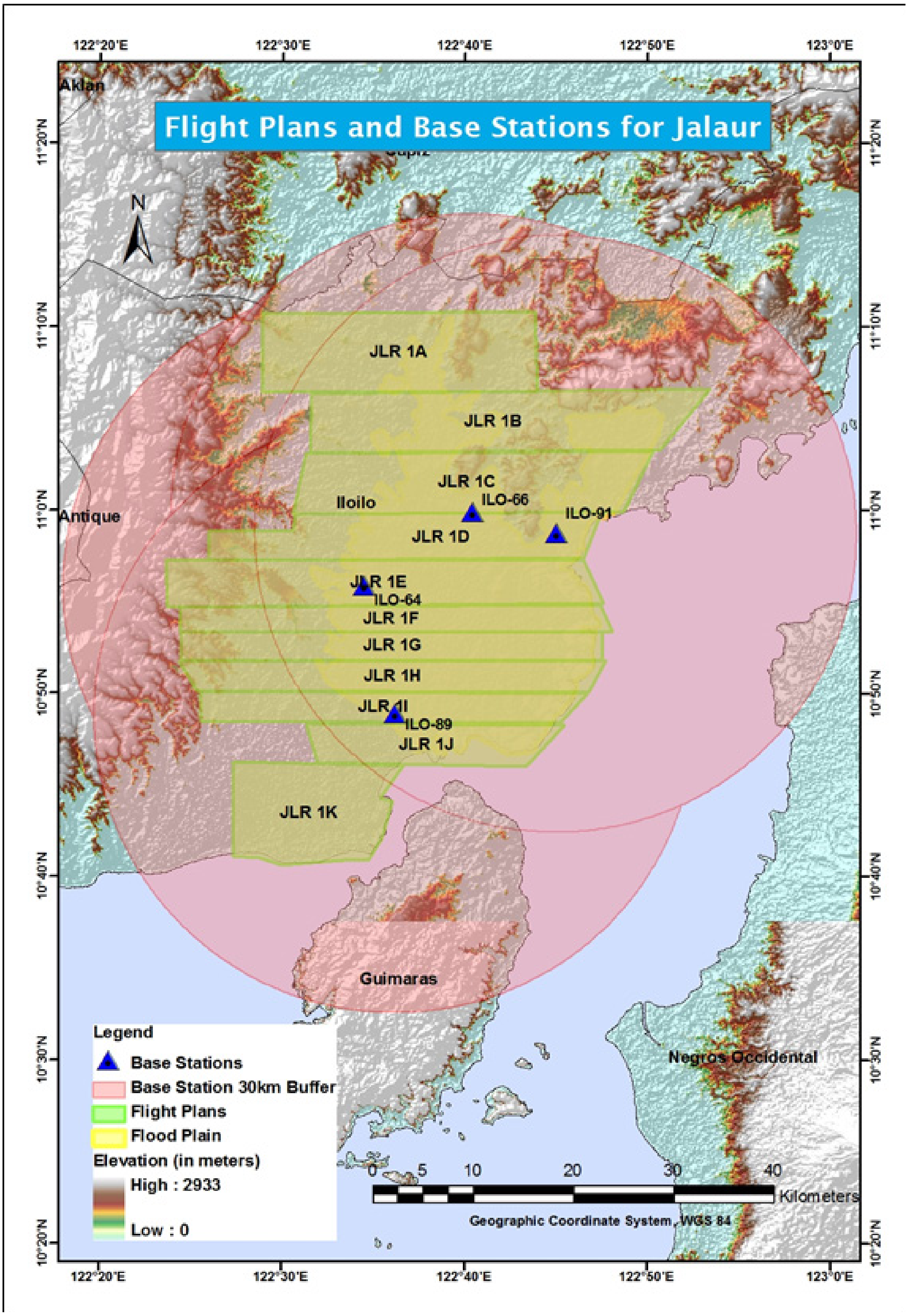


Figure 20. Jalaur floodplain flight plans and base station

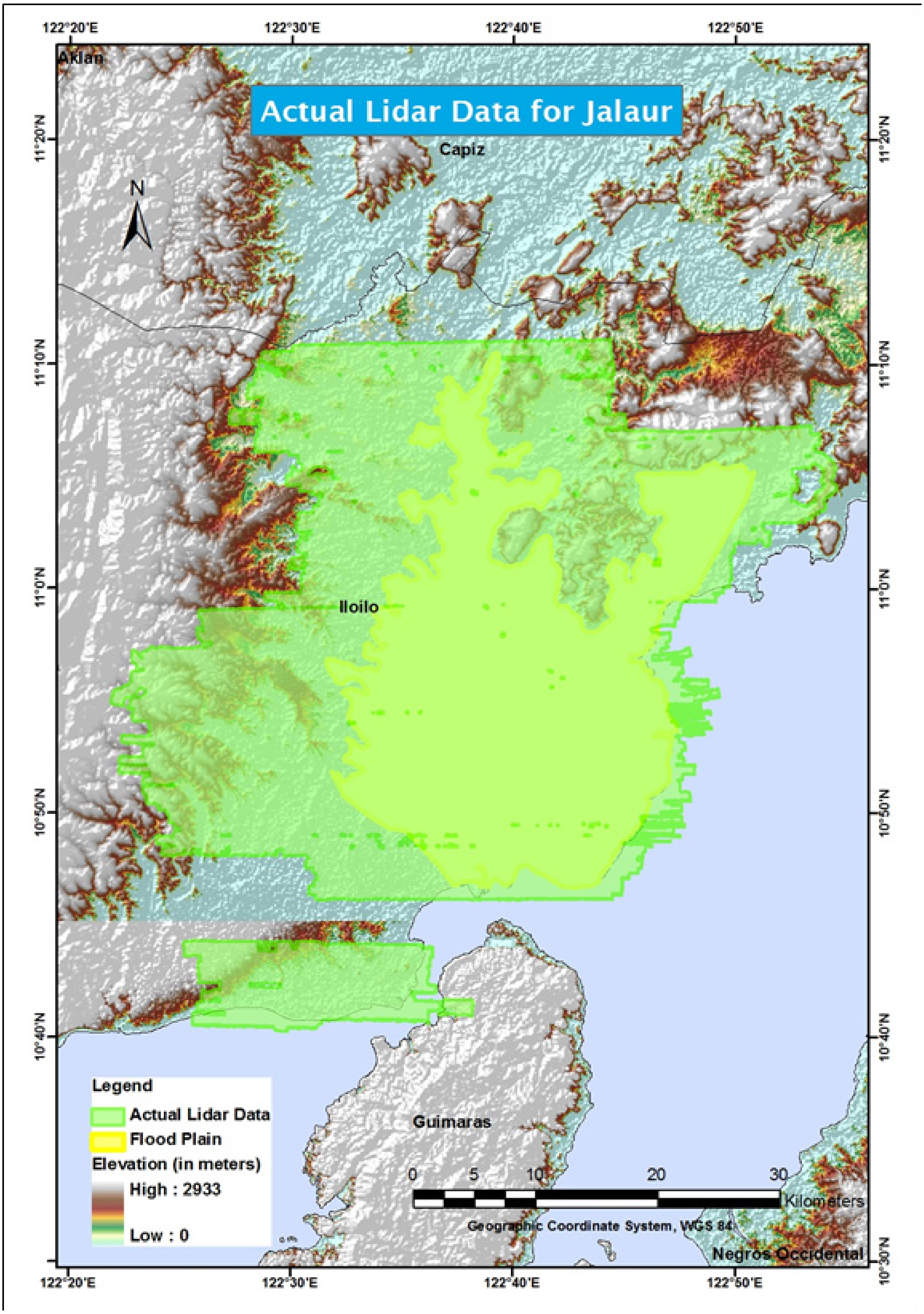


Figure 21. Jalaur floodplain data acquisition LAS output

Results and Discussion

Twenty two (22) missions were conducted to complete the LiDAR Data Acquisition in Jalaur floodplain, for a total of sixty seven (67) hours of flying time for RP-C9022 and RP-C9122. Eight (8) missions were acquired using the Gemini LiDAR System while fourteen (14) are surveyed using the Pegasus LiDAR System. Table 14 shows the total area to be surveyed according to the flight plan and the total area of actual coverage per mission.

Table 14. Flight Missions for LiDAR Data Acquisition in Jalaur floodplain

<table>
<tr><th rowspan="2">Date Surveyed</th><th rowspan="2">Name</th><th rowspan="2">Flight Plan Area (km2)</th><th rowspan="2">Surveyed Area (km2)</th><th rowspan="2">Area Surveyed within the River Systems (km2)</th><th rowspan="2">Area Surveyed Outside the River Systems (km2)</th><th rowspan="2">No. of Images (Frames)</th><th colspan="2">Flying Hours</th></tr>
<tr><th>Hr</th><th>Min</th></tr>
<tr><td>Apr 30, 2013</td><td>PAN 6A</td><td>80.304</td><td>89.949</td><td>34.583</td><td>55.366</td><td>566</td><td>3</td><td>45</td></tr>
<tr><td>May 3, 2013</td><td>PAN 6B</td><td>110</td><td>125.86</td><td>62.083</td><td>63.777</td><td>807</td><td>3</td><td>55</td></tr>
<tr><td>May 4, 2013</td><td>PAN 6C</td><td>116.04</td><td>125.99</td><td>80.097</td><td>45.893</td><td>780</td><td>3</td><td>46</td></tr>
<tr><td>May 3, 2013</td><td>PAN 6D</td><td>127.25</td><td>120.48</td><td>78.374</td><td>42.106</td><td>681</td><td>4</td><td>17</td></tr>
<tr><td>May 2, 2013</td><td>PAN 6E</td><td>104.91</td><td>108.32</td><td>73.458</td><td>34.862</td><td>681</td><td>3</td><td>54</td></tr>
<tr><td>May 4, 2013</td><td>PAN 6F</td><td rowspan="2">161.62</td><td rowspan="2">181.66</td><td rowspan="2">131.231</td><td rowspan="2">50.429</td><td>No Camera data</td><td>3</td><td>8</td></tr>
<tr><td>May 9, 2013</td><td>PAN 6F</td><td>702</td><td>3</td><td>10</td></tr>
<tr><td>May 9, 2013</td><td>PAN 6G</td><td>169.23</td><td>162.85</td><td>162.85</td><td>0</td><td>443</td><td>2</td><td>23</td></tr>
<tr><td>May 2, 2013</td><td>PAN 6H</td><td rowspan="6">204.88</td><td rowspan="6">238.6</td><td rowspan="6">217.568</td><td rowspan="6">21.032</td><td>No Camera data</td><td>2</td><td>37</td></tr>
<tr><td>May 10, 2013</td><td>PAN 6H</td><td>4</td><td>1</td><td>14</td></tr>
<tr><td>May 11, 2013</td><td>PAN 6H</td><td>278</td><td>2</td><td>25</td></tr>
<tr><td>May 15, 2013</td><td>PAN 6H</td><td>210</td><td>3</td><td>0</td></tr>
<tr><td>May 16, 2013</td><td>PAN 6HS</td><td>340</td><td>3</td><td>45</td></tr>
<tr><td>May 17, 2013</td><td>PAN 6HS</td><td>387</td><td>3</td><td>5</td></tr>
</table>

May 5, 2013	PAN 6I	223.88	250.9	226.306	24.594	0 data data No Camera data	2	0
May 12, 2013	PAN 6I					28	1	20
May 13, 2013	PAN 6I					359	4	0
May 16, 2013	PAN 6IS					648	3	30
May 14, 2013	PAN 6J	219.21	229.43	229.43	0	0	2	55
May 10, 2013	PAN 6K (ILOILO)	150.31	102.66	0	102.66	148	2	0
May 15, 2013	PAN 6K					0	3	10
May 17, 2013	PAN 6KS					364	3	40

Jalaur floodplain with a total of seven hundred thirteen square kilometers (713 sq. km) was completely surveyed from April 30, 2013 to May 17, 2013 by Christopher Cruz, Lovely Gracia Acuna, Pearl Mars, Mark Gregory V. Ano, Chrostopher Joaquin and Jasmine Alviar as shown in Table 15.

Table 15. Area of Coverage of the LiDAR Data Acquisition in Jalaur floodplain

Location	Date Surveyed	Operator	Mission Name	Floodplain Surveyed Area (km2)	Total Floodplain Area (km2)	Watershed Surveyed Area (km2)	Total Watershed Area (km2)
AGNO	Apr 30, 2013	PEARL MARS	2PAN6A119A	34.583	713	0	1392.00
	May 3, 2013	PEARL MARS	2P6B123A	62.083		0	
	May 4, 2013	LOVELY ACUNA	2P6C124B	79.535		0.562	
	May 3, 2013	LOVELY ACUNA	2P6D123B	70.508		7.866	
	May 2, 2013	PEARL MARS	2P6E122A	62.813		10.645	
	May 4, 2013	PEARL MARS	2P6F124A	97.435		33.796	
	May 9, 2013	MARK ANO	1PAN6F129A				

	May 9, 2013	JASMINE ALVIAR	1P6G129B	97.561		65.289	
	May 2, 2013	LOVELY ACUNA	2P6H122A	81.366		136.202	
	May 10, 2013	CHRIS JOAQUIN	1P6H130A				
	May 11, 2013	CHRIS JOAQUIN	1P6H131A				
	May 15, 2013	CHRIS JOAQUIN	1P6H135A				
	May 16, 2013	CHRIS JOAQUIN	1P6HS136A				
	May 17, 2013	MARK ANO	1P6HS137A				
	May 5, 2013	PEARL MARS	2P6I125A	72.706		153.6	
	May 12, 2013	MARK ANO	1P6I132A				
	May 13, 2013	CHRIS CRUZ	1P6I133A				
	May 16, 2013	JASMINE ALVIAR	1P6IS136B				
	May 14, 2013	JASMINE ALVIAR	1P6J134A	21.274		208.156	
	May 10, 2013	LOVELY ACUNA	1P6K130B	0		0	
	May 15, 2013	MARK ANO	1P6K135B				
	May 17, 2013	JASMINE ALVIAR	1P6KS137B				

4.2 LiDAR Data Processing

4.2.1 Trajectory Computation

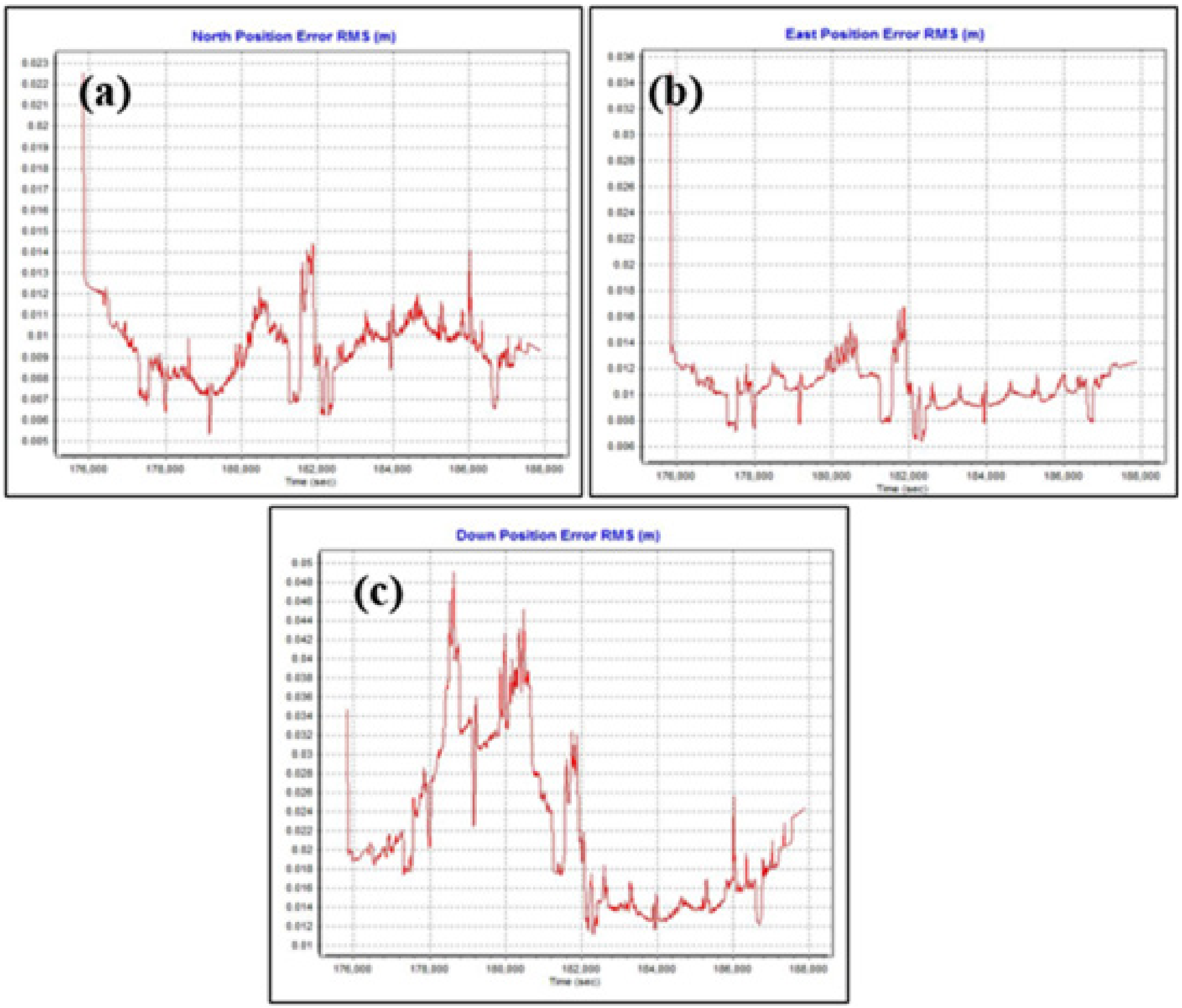


Figure 22. Smoothed Performance Metric Parameters for North (a), East (b), and Down (c) of Jalaur flight.

The Smoothed Performance Metric parameters of the Jalaur flight are shown in Figure 22. The x-axis is the time of flight, which is measured by the number of seconds from the midnight of the start of the GPS week. The y-axis is the RMSE value for a particular aircraft position with respect to GPS survey time. The North (Figure 22a) and east (Figure 22b) position RMSE values fall within the prescribed accuracy of 4 centimeters, and all Down (Figure 22c) position RMSE values fall within the prescribed accuracy of 8 centimeters.

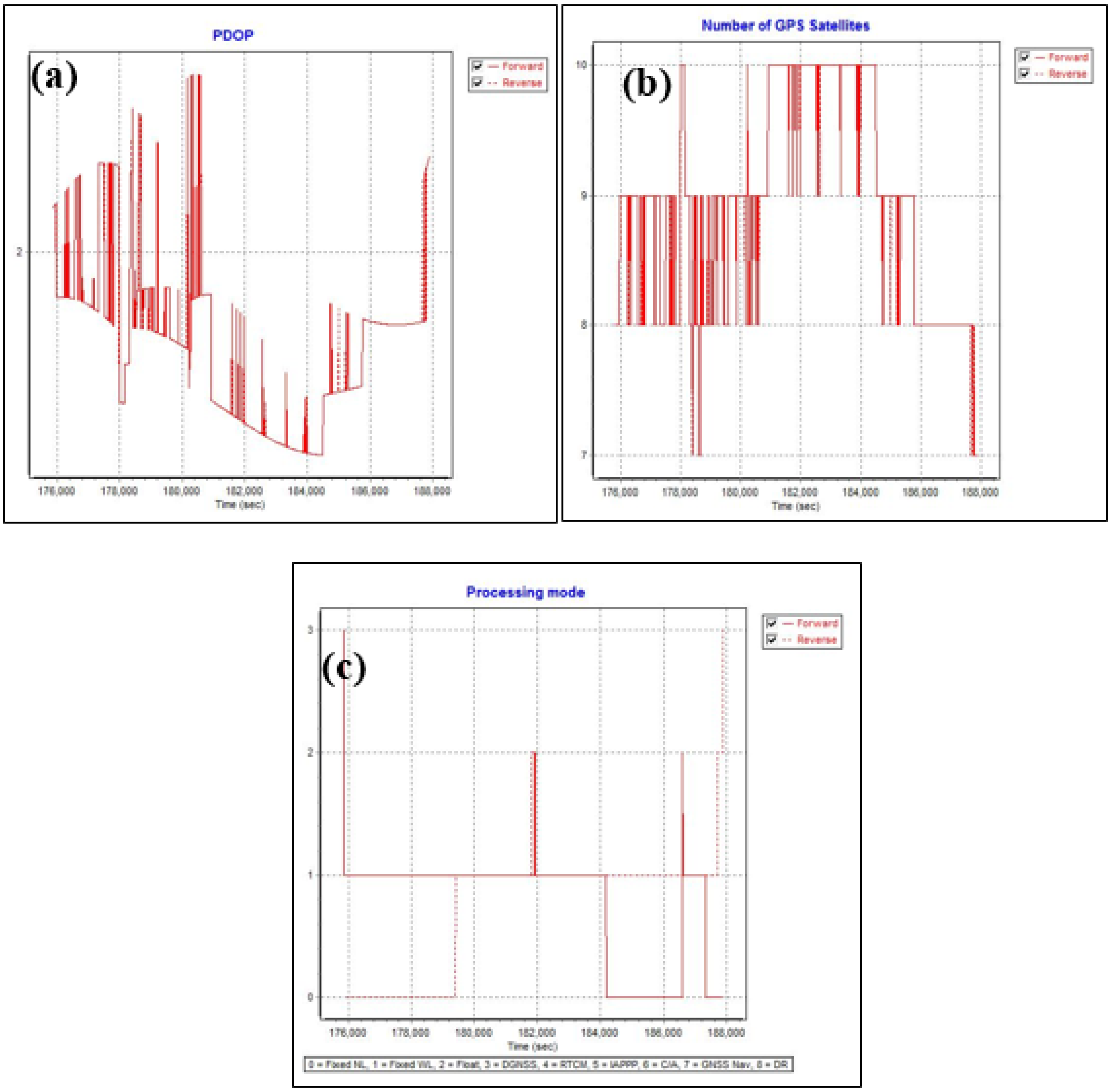


Figure 23. Solution Status Parameters of Jalaur flight

The Solution Status parameters of the computed trajectory for Jalaur flight, which are the number of GPS satellites, Positional Dilution of Precision (PDOP), and the GPS processing mode used are shown in Figure 22. The PDOP (Figure 23a) value does not exceed the value of 3, indicating optimal GPS geometry. The number of GPS satellites (Figure 23b) graph indicates that the number of satellites during the acquisition was between 8 and 10. The processing mode (Figure 23c) stays at a value of 0, which corresponds to a Fixed, Narrow-Lane mode, which indicates an optimum solution for trajectory computation by POSPac MMS v6.2. All of the parameters satisfied the accuracy requirements for optimal trajectory solutions as indicated in the methodology

Results and Discussion

4.2.2 LiDAR Point Cloud Computation

The LAS data output contains 10 flight lines, with each flight line containing one channel, a feature of the Gemini system. The result of the boresight correction standard deviation values for the channel better than the prescribed 0.001°. The position of the LiDAR system is also accurately computed since all GPS position standard deviations are less than 0.0097 meter. The attitude of the LiDAR system passed accuracy testing since the standard deviation of the corrected roll and pitch values of the IMU attitudes are less than 0.001 degrees.

4.2.3 LiDAR Data Quality Checking

The LAS boundary of the LiDAR data on top of the SRTM elevation data is shown in Figure 24. The map shows gaps in the LiDAR coverage that are attributed to cloud cover present during the survey.

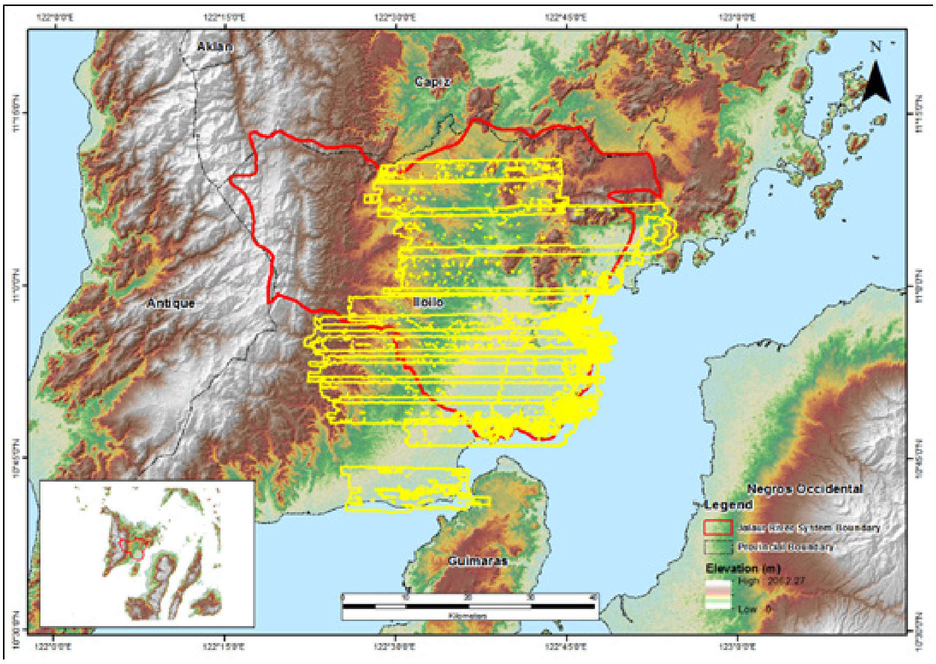


Figure 24. Coverage of LiDAR data for the Jalaur mission

The overlap data for the merged LiDAR data showing the number of channels that pass through a particular location is shown in Figure 25. Since the Gemini system employs one channel, an average value of 2 (blue) for areas where there are only two overlapping flight lines, and a value of 3 (yellow) or more (red) for areas with three or more overlapping flight lines, are expected. The average data overlap for Jalaur is 65%.

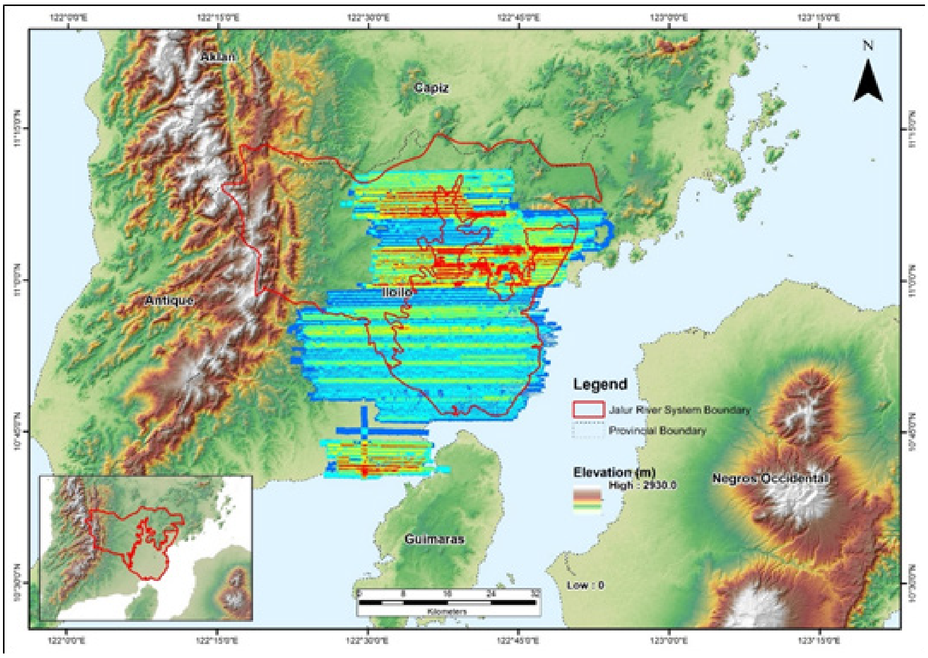


Figure 25. Image of data overlap for the Jalaur mission

The density map for the merged LiDAR data, with the red areas showing the portions of the data that satisfy the 2 points per square meter requirement, is shown in Figure 26. It was determined that 65.38% of the total area satisfied the point density requirement, and the average density for the entire survey area is 2.065 points per square meter.

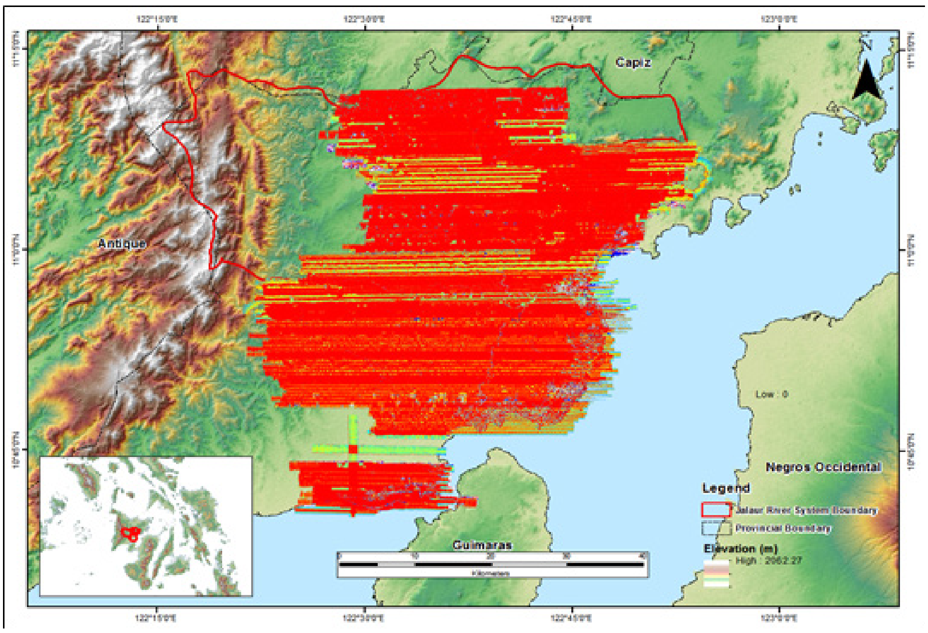


Figure 26. Density map of merged LiDAR data for the Jalaur mission

The elevation difference between overlaps of adjacent flight lines is shown in Figure 27. The default color range is from blue to red, where bright blue areas correspond to a -0.20 meter difference, and bright red areas correspond to a +0.20 meter difference. Areas with bright red or bright blue need to be investigated further using QT Modeler.

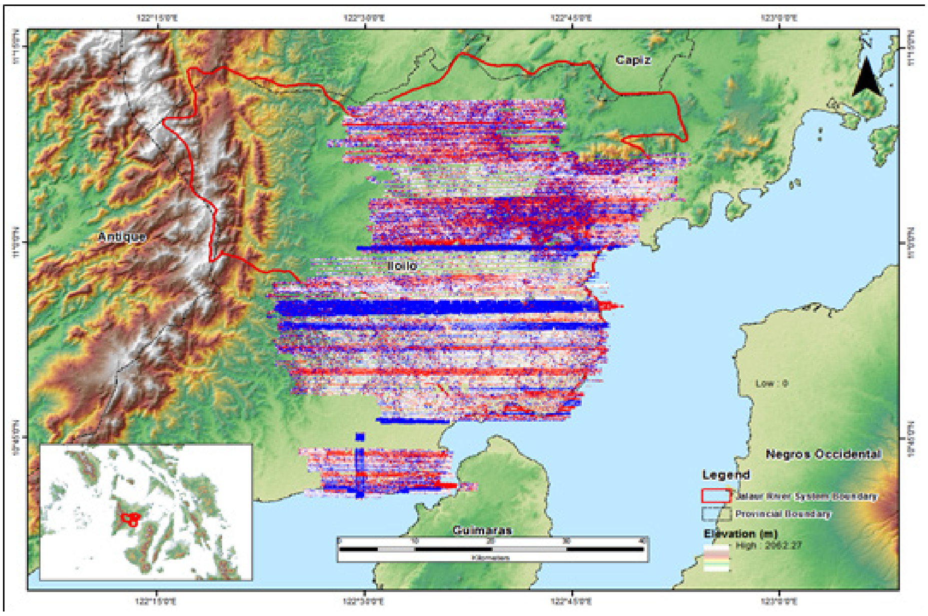


Figure 27. Elevation difference map between flight lines

A screen capture of the LAS data loaded in QT Modeler is shown in Figure 28a. A line graph showing the elevations of the points from all of the flight strips traversed by the profile in red line is shown in Figure 28b. It is evident that there are differences in elevation, but the differences do not exceed the 20-centimeter mark. No reprocessing was necessary for this LiDAR dataset.

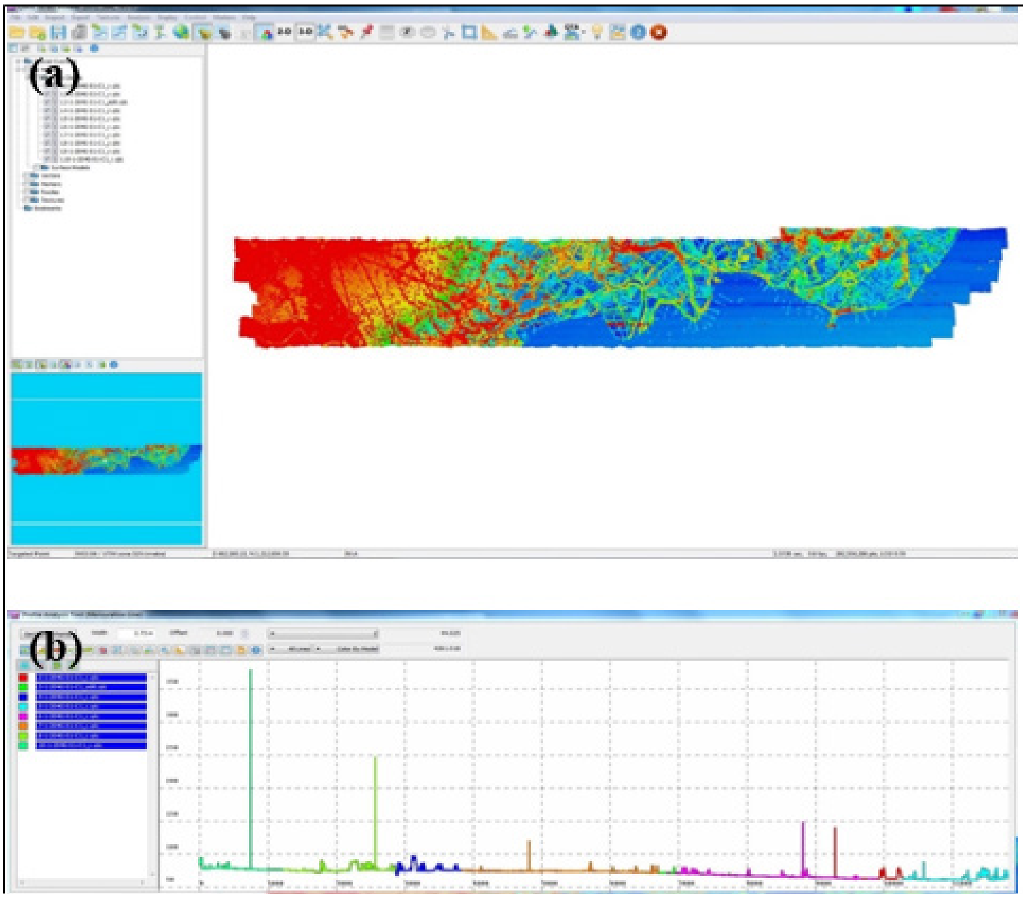


Figure 28. Quality checking with the profile tool of QT Modeler

4.2.4 LiDAR Point Cloud Classification and Rasterization

The block system that TerraScan employed for the LiDAR data is shown in Figure 29a generated a total of 3,458 1 kilometer by 1 kilometer blocks. The final classification of the point cloud for a mission in the Jalaur floodplain is shown in Figure 29b. The number of points classified to the pertinent categories along with other information for the mission is shown in Table 16.

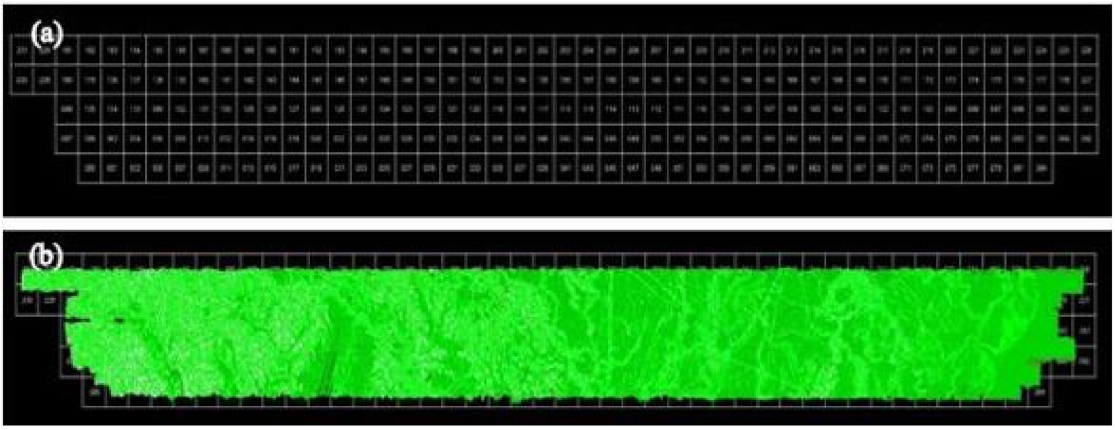


Figure 29. (a) Jalaur floodplains and (b) Jalaur classification results in TerraScan

Table 16. Jalaur classification results in TerraScan

Pertinent Class	Count
Ground	1,416,332,051
Low Vegetation	1,985,408,028
Medium Vegetation	2,070,817,103
High Vegetation	1,744,801,076
Building	99,194,577
Number of 1km x 1km blocks	3,458
Maximum Height	705.94 m
Minimum Height	48.65 m

An isometric view of an area before (a) and after (b) running the classification routines for the mission is shown in Figure 30. The ground points are in brown, 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.

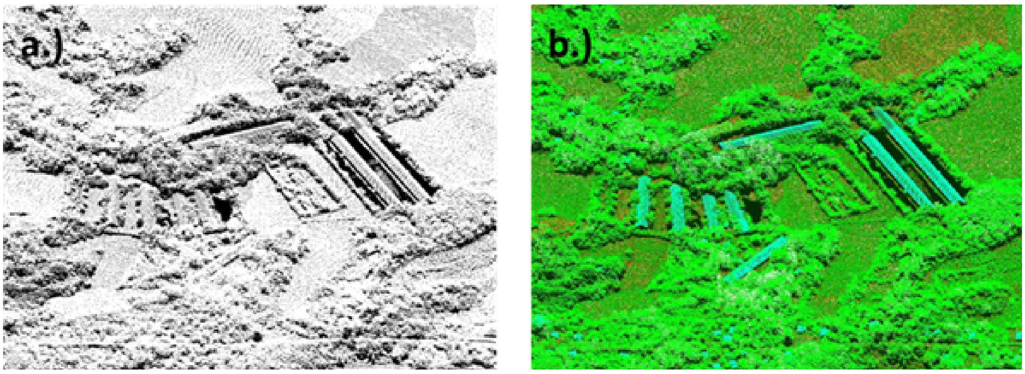


Figure 30. Point cloud (a) before and (b) after classification

4.2.5 DEM Editing and Hydro-correction

Portions of DTMs before and after manual editing are shown in Figure 31. It shows that the embankment might have been drastically cut by the classification routine in Figure 31a and clearly needed to be retrieved to complete the surface as in Figure 31b to allow to hydrologically correct flow of water.

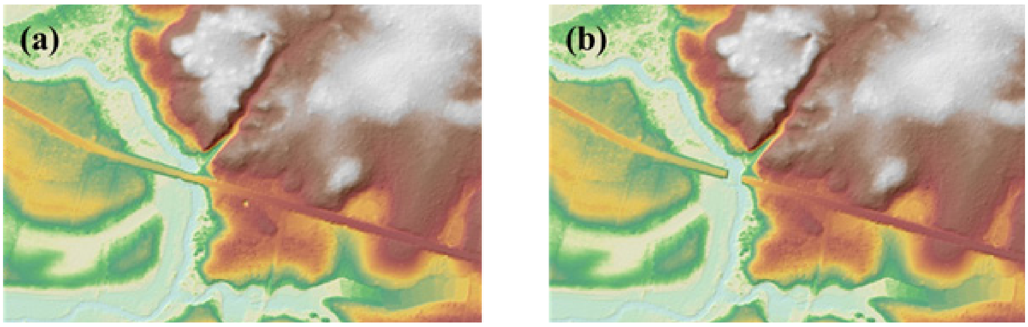


Figure 31. Images of DTMs before and after manual editing

The extent of the validation survey done by the Data Validation Component (DVC) in Jalaur to collect points with which the LiDAR dataset is validated is shown in Figure 32. A total of 323 control points were collected. The good correlation between the airborne LiDAR elevation values and the ground survey elevation values, which reflects the quality of the LiDAR DTM is shown in Figure 33. The computed RMSE between the LiDAR DTM and the surveyed elevation values is 16.646 centimeters with a standard deviation of 16.653 centimeters. The LE 90 value represents the linear vertical distance that 90% of the sampled DEM points and their respective DVC validation point counterparts should be found from each other. Other statistical information can be found in Table 12. The final DTM and extent of the bathymetric survey done along the river is shown in Figure 34.

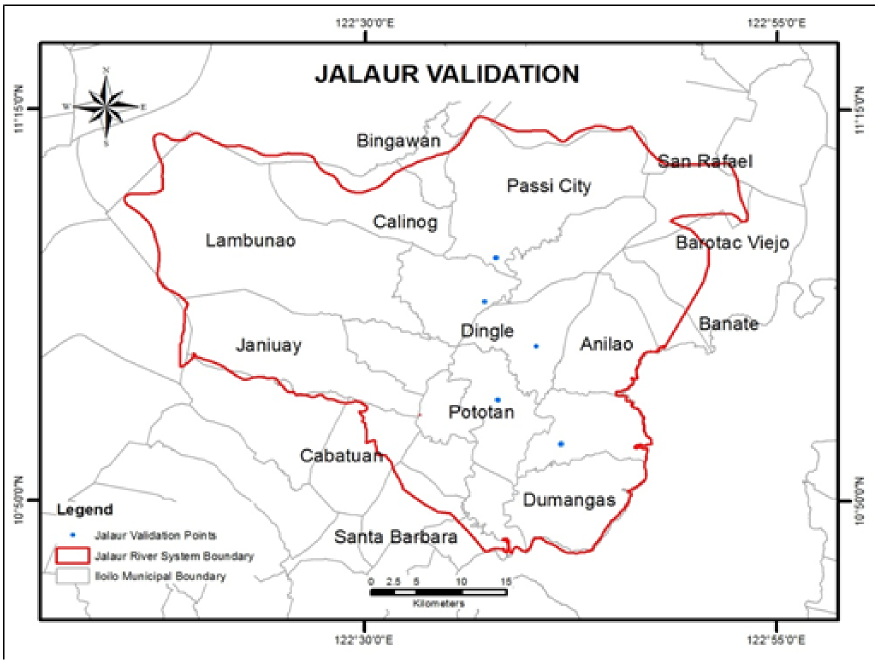


Figure 32. Map of Jalaur River System with validation survey shown in blue

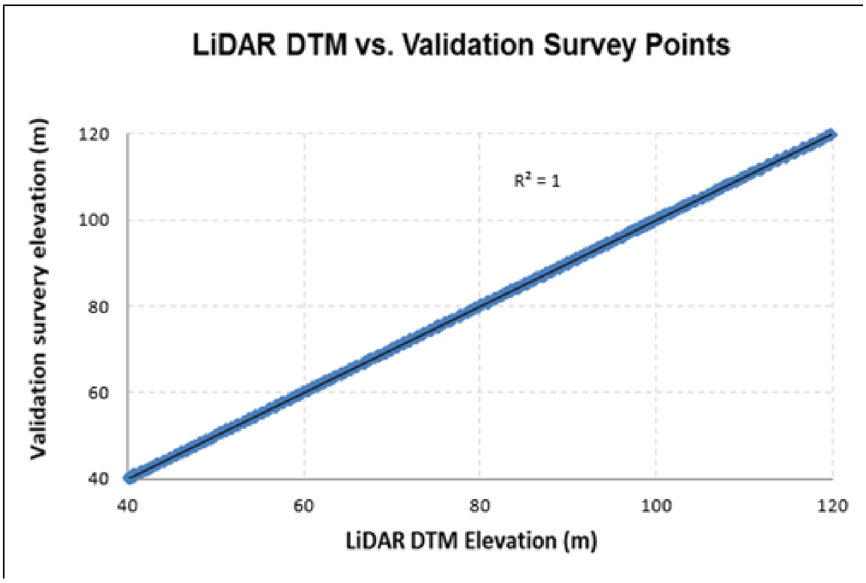


Figure 33. One-one Correlation plot between topographic and LiDAR data

Table 17. Statistical values for the calibration of flights

Statistical Information	Values (cm)
Min	-42.069
Max	54.725
RMSE	16.646
Standard Deviation	16.653
LE90	22.676

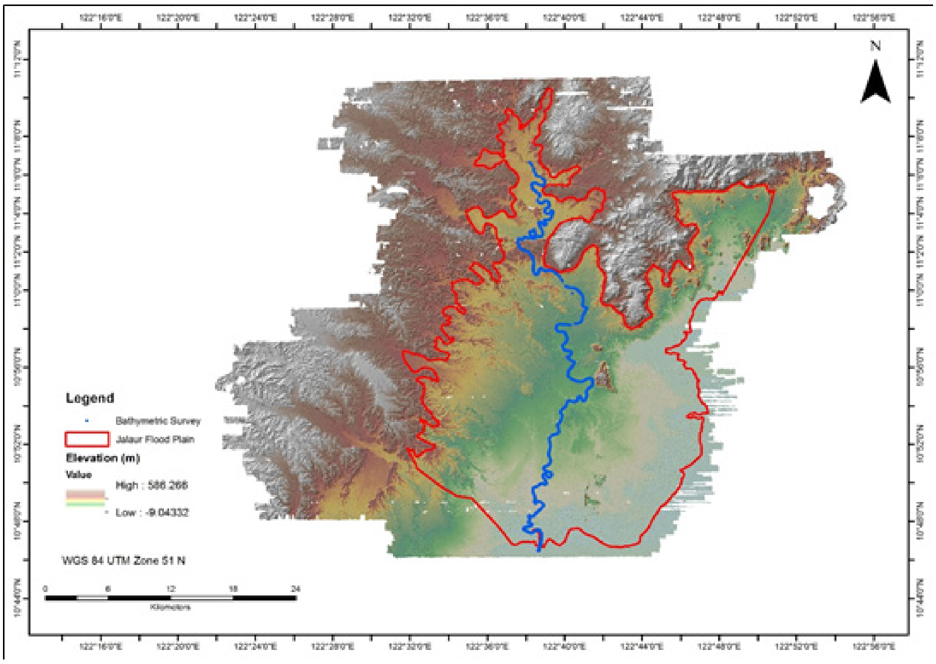


Figure 34. Final DTM of Jalaur with validation survey shown in blue

The floodplain extent for Jalaur is also presented, showing the completeness of the LiDAR dataset and DSM produced, is shown in Figure 35. Samples of 1 kilometer by 1 kilometer of DSM and DTM are shown in Figure 36 and Figure 37, respectively.

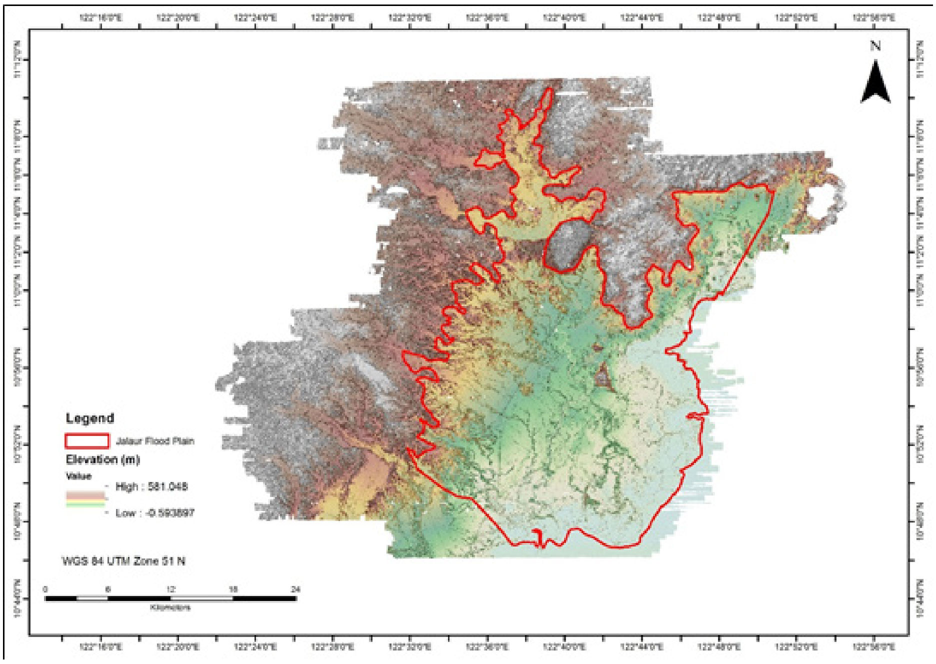


Figure 35. Final DSM in Jalaur

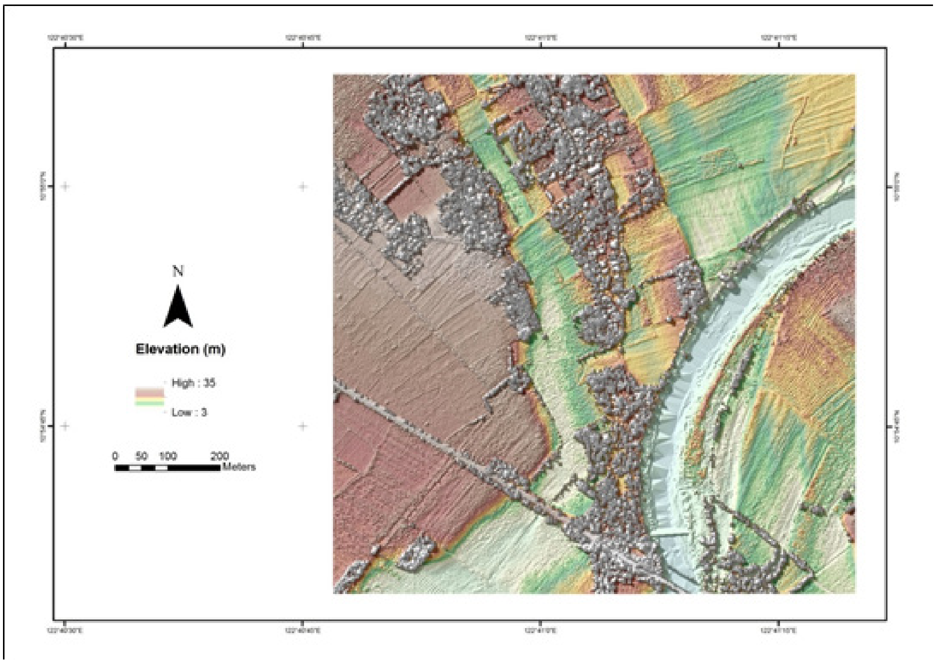


Figure 36. Sample 1x1 square kilometer DSM

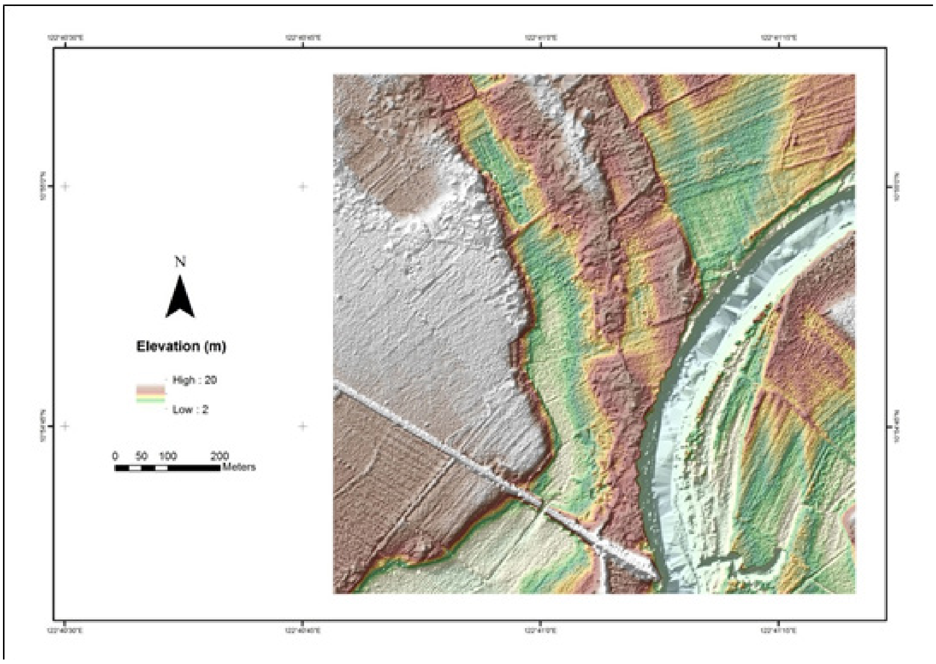


Figure 37. Sample 1x1 square kilometer DTM

Annexes

Annex A

OPTECH TECHNICAL SPECIFICATIONS OF THE PEGASUS SENSOR

Parameter	Specification
Operational envelope (1,2,3,4)	150-5000 m AGL, nominal
Laser wavelength	1064 nm
Horizontal accuracy (2)	1/5,500 x altitude, 1σ
Elevation accuracy (2)	< 5-20 cm, 1σ
Effective laser repetition rate	Programmable, 100-500 kHz
Position and orientation system	POS AV ™AP50 (OEM)
Scan width (FOV)	Programmable, 0-75 ˚
Scan frequency (5)	Programmable, 0-140 Hz (effective)
Sensor scan product	800 maximum
Beam divergence	0.25 mrad (1/e)
Roll compensation	Programmable, ±37˚ (FOV dependent)
Vertical target separation distance	<0.7 m
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)
Image capture	5 MP interline camera (standard); 60 MP full frame (optional)
Full waveform capture	12-bit Optech IWD-2 Intelligent Waveform Digitizer
Data storage	Removable solid state disk SSD (SATA II)
Power requirements	28 V, 800 W, 30 A
Dimensions and weight	Sensor: 630 x 540 x 450 mm; 65 kg;
	Control rack: 650 x 590 x 490 mm; 46 kg
Operating Temperature	-10°C to +35°C
Relative humidity	0-95% non-condensing

Annex A

OPTECH TECHNICAL SPECIFICATIONS OF THE GEMINI SENSOR

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

Annex B

OPTECH TECHNICAL SPECIFICATIONS OF THE D-8900 AERIAL DIGITAL CAMERA

Parameter	Specification
Camera Head	
Sensor type	60 Mpix full frame CCD, RGB
Sensor format (H x V)	8, 984 x 6, 732 pixels
Pixel size	6µm x 6 µm
Frame rate	1 frame/2 sec.
FMC	Electro-mechanical, driven by piezo technology (patented)
Shutter	Electro-mechanical iris mechanism 1/125 to 1/500++ sec. f-stops: 5.6, 8, 11, 16
Lenses	50 mm/70 mm/120 mm/210 mm
Filter	Color and near-infrared removable filters
Dimensions (H x W x D)	200 x 150 x 120 mm (70 mm lens)
Weight	~4.5 kg (70 mm lens)
Controller Unit	
Computer	Mini-ITX RoHS-compliant small-form-factor embedded computers with AMD TurionTM 64 X2 CPU 4 GB RAM, 4 GB flash disk local storage IEEE 1394 Firewire interface
Removable storage unit	~500 GB solid state drives, 8,000 images
Power consumption	~8 A, 168 W
Dimensions	2U full rack; 88 x 448 x 493 mm
Weight	~15 kg
Image Pre-Processing Software	
Capture One	Radiometric control and format conversion, TIFF or JPEG
Image output	8,984 x 6,732 pixels or 16 bits per channel (180 MB or 360 MB per image)

Annex C

THE SURVEY TEAM

Data Acquisition Component Sub-team	Designation	Name	Agency/Affiliation
Data Acquisition Component Leader	Data Component Project Leader –I	ENGR. CZAR JAKIRI S. SARMIENTO	UP TCAGP
Survey Supervisor	Chief Science Research Specialist (CSRS)	ENGR. CHRISTOPHER CRUZ	UP TCAGP
LiDAR Operation	Supervising Science Research Specialist (Supervising SRS)	LOVELY GRACIA ACUNA	UP TCAGP
LiDAR Operation	Senior Science Research Specialist (SSRS)	MARK GREGORY ANO	
	UP TCAGP		
LiDAR Operation	Senior Science Research Specialist (SSRS)	JASMINE ALVIAR	UP TCAGP
LiDAR Operation	Research Associate	PEARL MARS	UP TCAGP
LiDAR Operation	Research Associate	CHRISTOPHER JOAQUIN	UP TCAGP
Ground Survey	Senior Science Research Specialist (SSRS)	ENGR. GEROME HIPOLITO	UP TCAGP
Ground Survey	Research Associate	ENGR. JAMES BELTRAN	UP TCAGP
Data Download and Transfer	Research Associate	PATRICIA YSABEL ALCANTARA	UP TCAGP
LiDAR Operation	Airborne Security	SSG. EDILITO NANQUIL, ERWIN DE LOS SANTOS	Philippine Air Force (PAF)
LiDAR Operation	Pilot	JAMAAL CLEMENTE	AAC
LiDAR Operation	Co-pilot	LAWRENCE MADAYAG	AAC
LiDAR Operation	Co-pilot	FERDINAND DE OCAMPO	AAC
LiDAR Operation	Co-pilot	MARK TANGONAN	AAC

Annex D

NAMRIA CERTIFICATION

1.) ILO-64

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

May 10, 2013

CERTIFICATION

To whom it may concern:

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

Province: **ILOILO**
Station Name: **ILO-64**
Order: **2nd**

Island: **VISAYAS**
Municipality: **MINA**
Barangay: **POBLACION**

PRS92 Coordinates

Latitude: **10° 55' 54.58427"**	Longitude: **122° 34' 23.77840"**	Ellipsoidal Hgt: **40.62000 m.**

WGS84 Coordinates

Latitude: **10° 55' 50.18711"**	Longitude: **122° 34' 28.98100"**	Ellipsoidal Hgt: **97.63900 m.**

PTM Coordinates

Northing: **1208822.191 m.**	Easting: **453354.591 m.**	Zone: **4**

UTM Coordinates

Northing: **1,208,399.08**	Easting: **453,370.92**	Zone: **51**

Location Description

ILO-64
From Iloilo City, travel N for about 34 km. passing by the towns of Sta. Barbara, Cabatuan and Janiuay. It is located on the W side of the plaza, about 100 m. NE of the municipal hall. It is about 12 m. W of Mina Natl. High School, about 25 m. NNW of the Rizal monument, 3 m. N of the third plant box from the Rizal monument and 1.5 m. S of the sixth plant box from the N side of the plaza. Mark is the head of a 4 in. copper nail centered on a 30 cm. x 30 cm. concrete block and flush with the ground surface, with inscriptions "ILO-64, 2005, NAMRIA".

Requesting Party: **Christopher Cruz**
Pupose: **Reference**
OR Number: **3943636B**
T.N.: **2013-0423**

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

9 9 0 5 1 0 2 0 1 3 1 6 0 4 5 8

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

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

Annex D

2.) ILO-66

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

April 26, 2013

CERTIFICATION

To whom it may concern:

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

Province: **ILOILO**
Station Name: **ILO-66**
Order: **2nd**

Island: **VISAYAS**		Barangay:
Municipality: **DINGLE**		
	PRS92 Coordinates	
Latitude: **10° 59' 56.14968"**	Longitude: **122° 40' 18.68063"**	Ellipsoidal Hgt: **27.71400 m.**
	WGS84 Coordinates	
Latitude: **10° 59' 51.74412"**	Longitude: **122° 40' 23.87665"**	Ellipsoidal Hgt: **84.81500 m.**
	PTM Coordinates	
Northing: **1216230.423 m.**	Easting: **464138.956 m.**	Zone: **4**
	UTM Coordinates	
Northing: **1,215,804.72**	Easting: **464,151.51**	Zone: **51**

Location Description

ILO-66
Is located inside the grounds of Dingle Elem. School, SW of the Science Bldg., W of the Main Bldg. and NE of the Administration Bldg. It is also situated at the S corner of the basketball court. Mark is the head of a 4 in. copper nail centered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 NAMRIA".

Requesting Party: **UP-TCAGP**
Pupose: **Reference**
OR Number: **3943584 B**
T.N.: **2013-0360**

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

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

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

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

3.) ILO-69

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

June 13, 2013

CERTIFICATION

To whom it may concern:

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

Province: **ILOILO**
Station Name: **ILO-69**
Order: **2nd**

Island: **VISAYAS**		Barangay:
Municipality: **PASSI CITY**		
	PRS92 Coordinates	
Latitude: **11° 7' 7.97593"**	Longitude: **122° 38' 42.65948"**	Ellipsoidal Hgt: **63.94700 m.**
	WGS84 Coordinates	
Latitude: **11° 7' 3.53798"**	Longitude: **122° 38' 47.84510"**	Ellipsoidal Hgt: **120.69300 m.**
	PTM Coordinates	
Northing: **1229500.996 m.**	Easting: **461239.791 m.**	Zone: **4**
	UTM Coordinates	
Northing: **1,229,070.65**	Easting: **461,253.36**	Zone: **51**

Location Description

ILO-69
Is set on the ground near the new Passi City Hall, about 22.11 m. NE form the NE corner of the city hall, about 38.19 m. NNE from the flagpole. It is also situated N of the Passi Police Station. Mark is the head of a 4 in. copper nail embedded on a 30 cm. x 30 cm. concrete block/monument and 30 cm. above ground surface, with inscriptions "ILO-69 2005 NAMRIA".

Requesting Party: **UP-TCAGP**
Pupose: **Reference**
OR Number: **FREE ISSUE**
T.N.: **2013-0571**

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

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

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

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

4.) ILO-89

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

May 10, 2013

CERTIFICATION

To whom it may concern:

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

Province: **ILOILO**
Station Name: **ILO-89**
Order: **2nd**

Island: **VISAYAS**
Municipality: **LEGANES**
Barangay: **CAGAMUTAN NORTE**

PRS92 Coordinates

Latitude: **10° 48' 55.43533"**	Longitude: **122° 36' 5.65628"**	Ellipsoidal Hgt: **9.79800 m.**

WGS84 Coordinates

Latitude: **10° 48' 51.06990"**	Longitude: **122° 36' 10.86897"**	Ellipsoidal Hgt: **67.16300 m.**

PTM Coordinates

Northing: **1195940.297 m.**	Easting: **456431.138 m.**	Zone: **4**

UTM Coordinates

Northing: **1,195,521.70**	Easting: **456,446.39**	Zone: **51**

Location Description

ILO-89
From Iloilo City, travel NE to the Mun. of Leganes. From Leganes Town Proper, travel NW for about 3.5 km. to Brgy. Cagamutan Norte. Station is located on the right side of the second approach of the bridge crossing Canipaan River and about 200 m. N of Cagamutan Elem. School.

Mark is the head of a 4 in. copper nail set flushed and cemented on a 30 cm. x 30 cm. cement putty, with inscriptions "ILO-89 2007 NAMRIA".

Requesting Party:	**Christopher Cruz**
Pupose:	**Reference**
OR Number:	**3943636B**
T.N.:	**2013-0424**

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

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

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

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

5.) ILO-91

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

May 10, 2013

CERTIFICATION

To whom it may concern:

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

Province: **ILOILO**
Station Name: **ILO-91**
Order: **2nd**

Island: **VISAYAS**
Municipality: **ANILAO**
Barangay: **POBLACION**

PRS92 Coordinates

Latitude: **10° 58' 46.51769"** Longitude: **122° 44' 53.92299"** Ellipsoidal Hgt: **22.74100 m.**

WGS84 Coordinates

Latitude: **10° 58' 42.12357"** Longitude: **122° 44' 59.12020"** Ellipsoidal Hgt: **80.07700 m.**

PTM Coordinates

Northing: **1214083.04 m.** Easting: **472492.693 m.** Zone: **4**

UTM Coordinates

Northing: **1,213,658.09** Easting: **472,502.32** Zone: **51**

Location Description

ILO-91
From Iloilo City, travel NE to the Mun. of Anilao. Then proceed to the town plaza, where the station is located. Station is located on the NE quadrant of the said plaza about 7 m. from the stage, about 7 m. N of the lamp post and about 10 m. W from the circular plant base, 20 m. from the road centerline, 45 m. NE of Anilao Church, 33 m. N of Anilao Covered Gym and 40 m. NW of Anilao Mun. Hall. Mark is the head of a 4 in.copper nail set flushed on top of a 30 cm. x 30 cm. concrete monument protruding 20 cm. above the ground, with inscriptions "ILO-91 2007 NAMRIA".

Requesting Party: **Christopher Cruz**
Pupose: **Reference**
OR Number: **3943636B**
T.N.: **2013-0422**

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

9905102013160443

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

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

6.) IL-381A

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

April 24, 2013

CERTIFICATION

To whom it may concern:

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

Province: **ILOILO**
Station Name: **IL-381A**

Island: **Visayas**	Municipality: **ZARRAGA**	Barangay: **GINES**
Elevation: **6.9462 m.**	Order: **1st Order**	Datum: **Mean Sea Level**

Location Description

BM IL-381A is in the Province of Iloilo, Municipality of Zarrage, Brgy. Gines, along the Barotac Nuevo-Zarraga National Highway. The station is located on the top of a concrete pavement at the road junction to Phase 1B Grand Subdivision, 9m from the waiting shed and 15m from the road centerline.

Mark is the head of a 4" copper nail set flushed on a 15cm x 15cm cement putty with inscriptions "IL-381A, 2012, NAMRIA".

Requesting Party:	**Christopher Cruz**
Pupose:	**Reference**
OR Number:	**3943573 B**
T.N.:	**2013-0348**

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

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

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

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

7.) IL-391A

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

April 24, 2013

CERTIFICATION

To whom it may concern:

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

Province: **ILOILO**
Station Name: **IL-391A**

Island: **Visayas**	Municipality: **BAROTAC NUEVO**	Barangay: **JT BRETAÑA**
Elevation: **12.1593 m.**	Order: **1st Order**	Datum: **Mean Sea Level**

Location Description

BM IL-391A

The station is in the Province of Iloilo, Municipality of Barotac Nuevo, Brgy. JT Bretaña, along the Zarraga-Anila National Highway. The station is located at the top of the sidewalk beside a lamp post fronting Ara Grace Food Store and 6m from the road centerline.

Mark is the head of a 4" copper nail set flushed on a 15cm x 15cm cement putty with inscriptions "IL-391A, 2012, NAMRIA".

Requesting Party: **Christopher Cruz**
Pupose: **Reference**
OR Number: **3943573 B**
T.N.: **2013-0349**

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

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

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

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

Annex E

DATA TRANSFER SHEET FOR JALAUR FLOODPLAIN

1.) Data Transfer Sheet for 2PAN6A120A, 2PAN6E122A, 2PAN6H122B, 2PAN6N123A and 2PAN6D12B129B

DATA TRANSFER SHEET
May 14, 2013

DATE	FLIGHT NO.	MISSION NAME	SENSOR	RAW LAS	LOGS	POS	RAW IMAGES	MISSION LOG FILE	RANGE	DIGITIZER	BASE STATION(S)	OPERATOR COMMENTS (DPC LOGS)	FLIGHT PLAN	SERVER LOCATION
Apr 28, 2013	203P	1ASN1A118A	PEGASUS	110MB	1.45MB	244MB	26.6 GB		21.9 GB	N/A	3.43MB	1.09KB	55.9KB	Z:\Airborne_Raw\203P
Apr 30, 2013	204G	2PAN6A120A	GEMINI	N/A	667KB	312MB	39.7GB	284KB	14.4GB	N/A	5.62MB	437 BYTES	561KB	Z:\Airborne_Raw\204G
May 2, 2013	206G	2PAN6E122A	GEMINI	N/A	969KB	347MB	58.2GB	450KB	22.8GB	N/A	3.55MB	491 BYTES	34.3KB	Z:\Airborne_Raw\206G
May 2, 2013	208G	2PAN6H122B	GEMINI	N/A	975KB	203MB	22.3GB	198KB	9.75GB	N/A	5.91MB	464BYTES	271KB	Z:\Airborne_Raw\208G
May 3, 2013	210G	2PAN6B123A	GEMINI	N/A	864KB	349MB	55.2GB	402KB	19.8GB	N/A	10.9MB	329 BYTES		Z:\Airborne_Raw\210G
May 3, 2013	212G	2PAN6D123B	GEMINI	N/A	.98MB	298MB	50.6GB	432KB	21.6GB	N/A	10.4MB	821 BYTES	853KB	Z:\Airborne_Raw\212G

Received from

Name/Signature Aubrey Matira / (signature)
Position RA
Date 05-14-2013

Received by

Name/Signature JOIDA PRIETO / (signature)
Position SSRS
Date 5-14-13

Verified by

Name/Signature Benjamin Magallon
Position SSRS
Date 5/14/13

Page 1

2.) Data Transfer Sheet for 1PAN6F129A, 1P6G129B and, 1P6H131A Missions

DATA TRANSFER SHEET

May 15, 2013

DATE	FLIGHT NO.	MISSION NAME	SENSOR	RAW LAS	LOGS	POS	RAW IMAGES	MISSION LOG FILE	RANGE	DIGITIZER	BASE STATION(S)	OPERATOR COMMENTS (DPC LOGS)	FLIGHT PLAN	SERVER LOCATION
May 1, 2013	207P	1ASNC121A	PEGASUS	140MB	1.18MB	275MB	34.3GB	264KB	22.4GB	N/A	3.97MB		55.9KB	Z:\Airborne_Raw\207P
May 2, 2013	209P	1ASD122B	PEGASUS	53.4MB	0	286MB	36.2GB	270KB	29.6GB	N/A	2.34MB	15 BYTES	118KB	Z:\Airborne_Raw\207P
May 3, 2013	211P	1ASN1S123A	PEGASUS	165MB	1.50MB	248MB	26.4GB	193KB	19.9GB	N/A	2.02MB		43.7KB	Z:\Airborne_Raw\211P
May 3, 2013	212G	2PAN6D123B	GEMINI	N/A	.98MB	298MB	50.6KB	432KB	21.6GB	N/A	10.4MB	821BYTES	853KB	Z:\Airborne_Raw\212G
May 4, 2013	214G	2PAN6F124A	GEMINI	N/A		279MB	31.9GB	251KB	11.8GB	N/A	13.3MB			Z:\Airborne_Raw\214G
May 4, 2013	216G	2PAN6C124B	GEMINI	N/A		324MB	46.7GB	393KB	22.4GB	N/A	13.3MB			Z:\Airborne_Raw\216G
May 9, 2013	217P	1PAN6F129A	PEGASUS	125MB	1.7MB	193MB	38.6GB	353KB	23.7GB	N/A	12.5MB	753KB		Z:\Airborne_Raw\217P
May 9, 2013	219P	1PAN6G129B	PEGASUS	114MB	1.04MB	141MB	25.6GB	221KB	18.6GB	N/A	12.5MB	322KB	78.9KB	Z:\Airborne_Raw\219P
May 11, 2013	225P	1PAN6H131A	PEGASUS	55.3MB	935KB	149MB	17.9GB	139KB	10.4GB	N/A	7.56MB	444KB	86.7KB	aw\225P

Received from

Name/Signature Aubrey J. Matira

Position RA

Date 05-15-13

Received by

Name/Signature JOIDA PRIETO

Position SSRS

Date 05-15-13

Annex E

3.) Data Transfer Sheet for 1P6H130A, 1P6K130B, 1P6I132A, 1P6I133A, 1P6J134A, 1P6H135A, 1P6K135B, 1P6HS136A, 1P6IS136B , 1P6HS137A and 1P6IS137B Missions

DATA TRANSFER SHEET

May 21, 2013

DATE	FLIGHT NO.	MISSION NAME	SENSOR	RAW LAS	LOGS	POS	RAW IMAGES	MISSION LOG FILE	RANGE	DIGITIZER	BASE STATION(S)	OPERATOR COMMENTS (DPC LOGS)	FLIGHT PLAN	SERVER LOCATION
May 10, 2013	221P	1PAN6H130A	PEGASUS	3.48MB	323KB	60.4MB	257MB	2.60KB	908MB	N/A	7.12MB	584BYTES		Z:\Airborne_Raw\221P
May 10, 2013	223P	2PAN6K130B	PEGASUS	24.7MB	668KB	109MB	8.30GB	74.3KB	5.27GB	N/A	4.65MB	360BYTES		Z:\Airborne_Raw\223P
May 12, 2013	227P	1PAN6I132A	PEGASUS	13.5MB	363KB	71.9MB	1.91GB	14.4KB	1.89GB	N/A	2.41MB	140BYTES		Z:\Airborne_Raw\227P
May 13, 2013	229P	1PAN6I133A	PEGASUS	155MB	2.04MB	233MB	23.9GB	265KB	27GB	N/A	8.43MB	1.29KB		Z:\Airborne_Raw\229P
May 14, 2013	231P	1PAN6J134A	PEGASUS	110MB	1.23MB	167MB	NO DATA (see Flight Status Report)	1.24KB	12.4GB	N/A	7.16MB	899BYTES		Z:\Airborne_Raw\231P
May 15, 2013	233P	1PAN6H135A	PEGASUS	145MB	1.05MB	186MB	12.9GB	142KB	15.2GB	N/A	9.87MB	1015BYTES		Z:\Airborne_Raw\233P
May 15, 2013	235P	1PAN6K135B	PEGASUS	101MB	1.08MB	178MB	NO DATA (see Flight Status Report)	29KB	12.9GB	N/A	9.87MB			Z:\Airborne_Raw\235P
May 16, 2013	237P	1P6HS136A	PEGASUS	151MB	1.41MB	227MB	26.6GB	193KB	17.9GB	N/A	10.3 MB	570 BYTES		Z:\Airborne_Raw\237P
May 17, 2013	239P	1P6IS136B	PEGASUS	124MB	1.63MB	214MB	37.2GB	325KB	21.8GB	N/A	9.44 MB	1.06KB		Z:\Airborne_Raw\239P

Received from

Name/Signature Aubrey J. Mattia/ signature
Position RA
Date 05-21-13 revised on 05-28-13

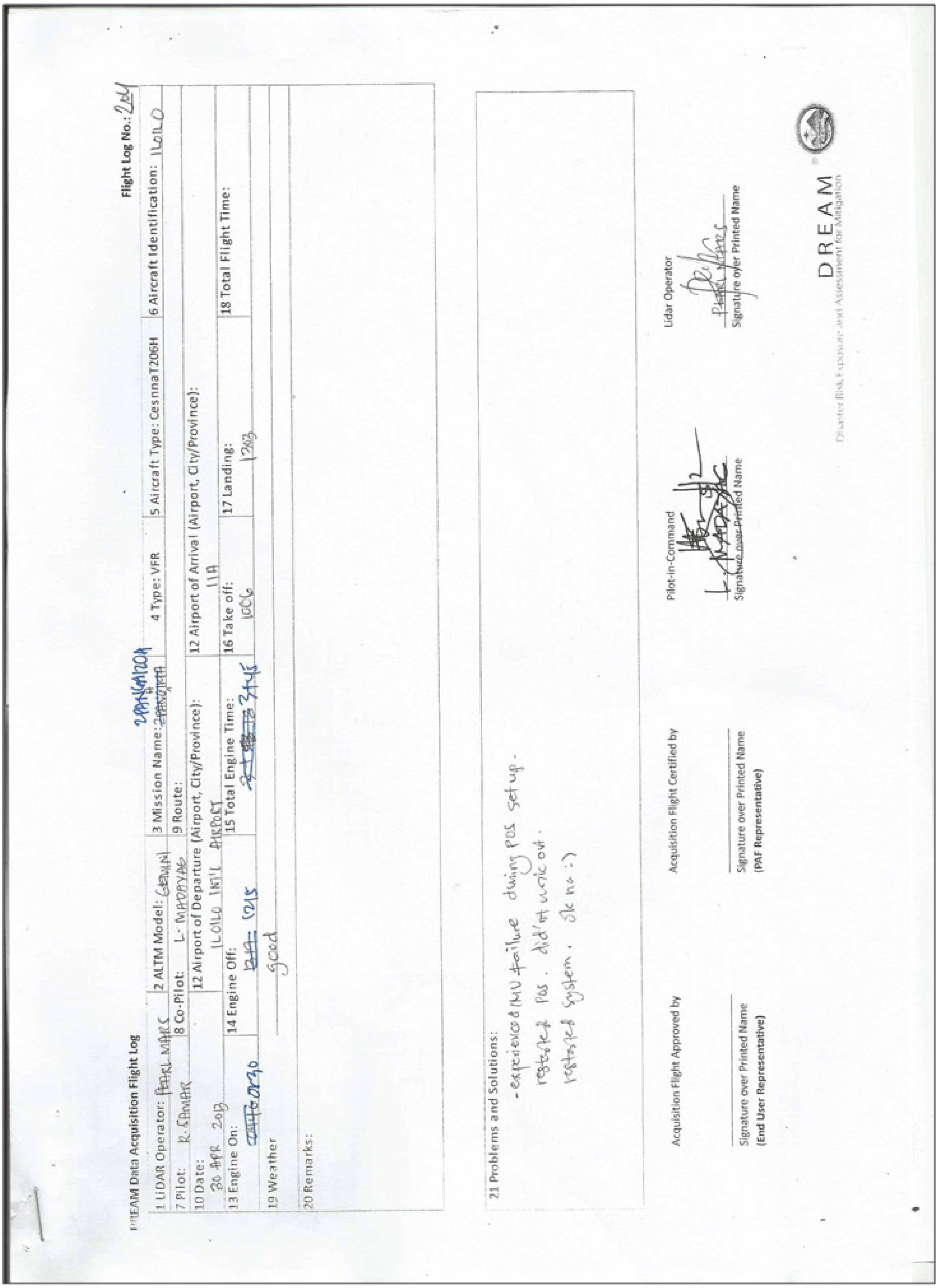
Received by

Name/Signature Jeida F. Prieto
Position SSRS
Date 05/28/2013

Annex F

FLIGHT LOGS

1.) Flight log for 2PAN6A120A Mission



DREAM Data Acquisition Flight Log

Flight Log No.: 2014

1 LIDAR Operator: PEARL MARS	2 ALTM Model: GEMINI	3 Mission Name: 2PAN6A120A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: ILOILO
7 Pilot: R. SAMAR	8 Co-Pilot: L. MADAYAG	9 Route:			
10 Date: 30 APR 2013	12 Airport of Departure (Airport, City/Province): ILOILO INT'L AIRPORT		12 Airport of Arrival (Airport, City/Province): IIA		
13 Engine On: 0830	14 Engine Off: 1215	15 Total Engine Time: 3+45	16 Take off: 1006	17 Landing: 1203	18 Total Flight Time:
19 Weather: good					
20 Remarks:					

21 Problems and Solutions:

- experienced IMU failure during POS set up. restarted POS. didn't work out. restarted system. ok na :)

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	L. MADAYAG Signature over Printed Name	PEARL MARS Signature over Printed Name

DREAM Disaster Risk Exposure and Assessment for Mitigation

Annex F

2.) Flight log for 2P6E122A Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 206

1 LiDAR Operator: Pearl Mars	2 ALTM Model: Gemini	3 Mission Name: 2P6E122A	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification:
7 Pilot: L. Modayag	8 Co-Pilot: R. Samar	9 Route: Iloilo			
10 Date: 02 May 2013	12 Airport of Departure (Airport, City/Province): IIA		12 Airport of Arrival (Airport, City/Province):		
13 Engine On: 0810	14 Engine Off: 1204	15 Total Engine Time: 3+54	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: cloudy good with cloud formations along ferry					

20 Remarks:

originally planned to survey PGA, too cloudy. changed to E

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. CB SAMAR III

Signature over Printed Name

Lidar Operator

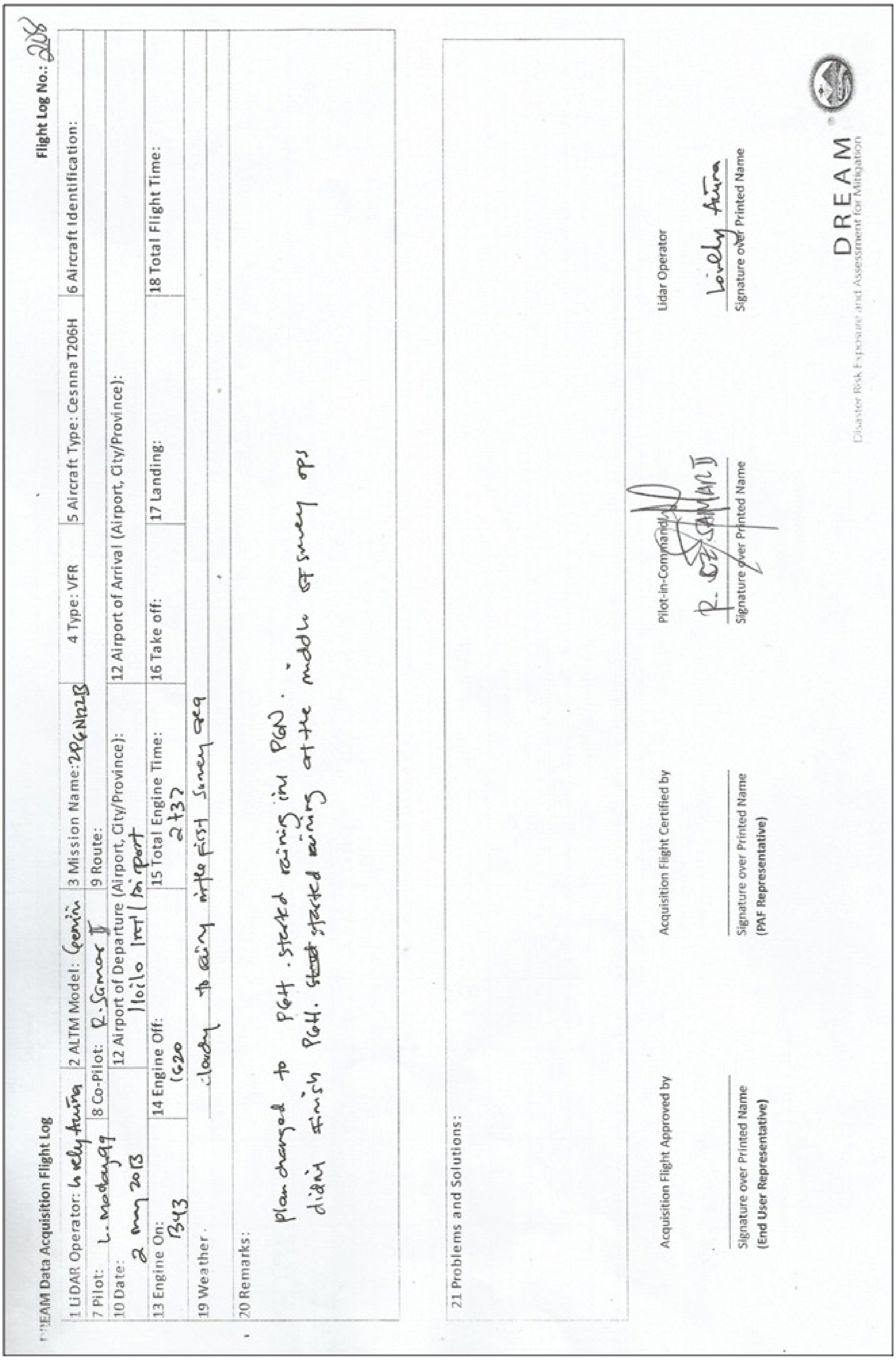
Pearl Mars

Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

3.) Flight log for 2P6N122B Mission



DREAM Data Acquisition Flight Log — Flight Log No.: 208

1 LiDAR Operator: Lovely Acuña	2 ALTM Model: Gemini	3 Mission Name: 2P6N122B	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification:
7 Pilot: L. Madayag	8 Co-Pilot: R. Samar II	9 Route:			
10 Date: 2 May 2013	12 Airport of Departure (Airport, City/Province): Iloilo Int'l Airport		12 Airport of Arrival (Airport, City/Province):		
13 Engine On: 1343	14 Engine Off: 1620	15 Total Engine Time: 2+37	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: cloudy to rainy in the first survey area					

20 Remarks:

plan changed to P64. started raining in P6N. didn't finish P64. ~~start~~ started raining at the middle of survey ops

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. DE SAMAR II

Signature over Printed Name

Lidar Operator

Lovely Acuña

Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

4.) Flight log for 2P6B123A Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 240

1 LiDAR Operator: Pearl Mars	2 ALTM Model: GEMINI	3 Mission Name: 2P6B123A	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification:
7 Pilot: L Madayag	8 Co-Pilot: R. Samar	9 Route: 1010			
10 Date: 3 May 2013	12 Airport of Departure (Airport, City/Province): Iloilo International Airport		12 Airport of Arrival (Airport, City/Province):		
13 Engine On: 0635	14 Engine Off: 1032	15 Total Engine Time: 3+55	16 Take off: 0701	17 Landing: 1020	18 Total Flight Time:

19 Weather

20 Remarks:

Finished mission
with possible deep winds due to cloud formations along the way

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

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

5.) Flight log for 2PAN6D123B Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 212

1 LiDAR Operator: Lovely Acuña	2 ALTM Model: Gemini	3 Mission Name: 2PAN6D123B	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification:
7 Pilot: L. Madayag	8 Co-Pilot: R. Samar	9 Route: Iloilo			
10 Date: 3 May 2013	12 Airport of Departure (Airport, City/Province): Iloilo Int'l Airport		12 Airport of Arrival (Airport, City/Province):		
13 Engine On: 1153	14 Engine Off: 1610	15 Total Engine Time: 4+17	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather					
20 Remarks:					

21 Problems and Solutions:

100% drops. restarted the whole system. in air realignment collected test strip to ok range & intensity

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
		R. C? Samar	Lovely Acuña
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

6.) Flight log for 2PF6124A Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 24

1 LiDAR Operator: PEARL MARC	2 ALTM Model: GEMINI	3 Mission Name: 2PF6124A	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification:
7 Pilot: R. SAMAR	8 Co-Pilot:	9 Route:			
10 Date: 4 MAY 2013	12 Airport of Departure (Airport, City/Province):		12 Airport of Arrival (Airport, City/Province):		
13 Engine On: 0755	14 Engine Off: 1103	15 Total Engine Time: 3+8	16 Take off: 0814	17 Landing: 1050	18 Total Flight Time:
19 Weather	~~good~~ fair with base clouds @ 850m ~~or higher~~				

20 Remarks:

originally planned @ 1000m. too cloudy.
decided to head instead to BC but area is cloudier.
went back to ~~BF~~ & changed altitude to 850m
planned bored due to low fuel - lack of fuel to ~~sustain~~ finish the mission.

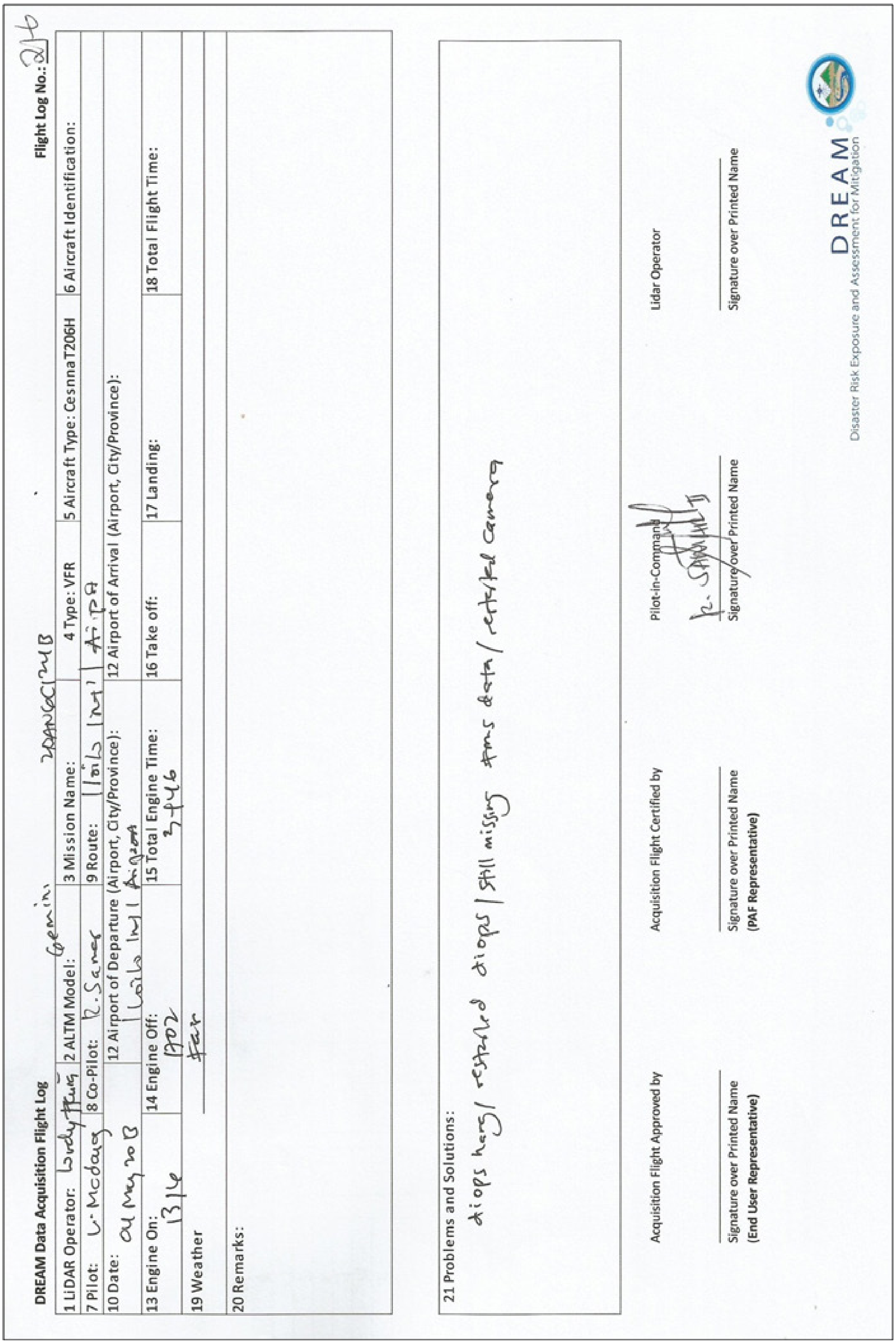
21 Problems and Solutions:

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

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

7.) Flight log for 2PAN6C124B Mission



DREAM Data Acquisition Flight Log — **Flight Log No.:** 216

1 LiDAR Operator: Lovely Hung	2 ALTM Model: Gemini	3 Mission Name: 2PAN6C124B	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification:
7 Pilot: L. Mcdaug	8 Co-Pilot: R. Samer	9 Route: Iloilo Int'l			
10 Date: 24 May 2013	12 Airport of Departure (Airport, City/Province): Iloilo Int'l Airport		12 Airport of Arrival (Airport, City/Province): Airport		
13 Engine On: 1314	14 Engine Off: 1702	15 Total Engine Time: 3+46	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: Fair					
20 Remarks:					

21 Problems and Solutions:

diops hang / restarted diops / still missing pos data / restarted camera

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

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

8.) Flight log for 2P6125A Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 218

1 LiDAR Operator: Paul Mas	2 ALTM Model: Gemini	3 Mission Name: 2P6125A	4 Type: VFR	5 Aircraft Type: Cesnna T206H
6 Aircraft Identification:				
7 Pilot: R. Sanz	8 Co-Pilot:	9 Route: Iloilo		
10 Date: 5 May 2013	12 Airport of Departure (Airport, City/Province): IIA	12 Airport of Arrival (Airport, City/Province):		
13 Engine On: 0807	14 Engine Off: 1009	15 Total Engine Time: 2+00	16 Take off:	17 Landing:
18 Total Flight Time:				
19 Weather: good				

20 Remarks:

no data acquired for the day.

21 Problems and Solutions:

ALTM Config doesn't respond.
ALTM nav start: no altm msg received
restart program: negative
restart system: negative
laser not firing
restart system & laptop: negative
still not firing (laser)

Acquisition Flight Approved by

Signature over Printed Name
(End User Representative)

Acquisition Flight Certified by

Signature over Printed Name
(PAF Representative)

Pilot-in-Command

[illegible]

Signature over Printed Name

Lidar Operator

[illegible]

Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

9.) Flight Log for 1PAN6F129A Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 217.

1 LiDAR Operator: Mark Año	2 ALTM Model: Pegasus	3 Mission Name: 1PAN6F129A	4 Type: VFR	5 Aircraft Type: Cesnna T206H
6 Aircraft Identification: RP-C9022				
7 Pilot: J. Clemente	8 Co-Pilot: M. Tangonan	9 Route: Iloilo City.		
10 Date: 09 May 2013	12 Airport of Departure (Airport, City/Province): Iloilo City	12 Airport of Arrival (Airport, City/Province): Iloilo City		
13 Engine On: 0810	14 Engine Off: 1120	15 Total Engine Time: 3+10	16 Take off:	17 Landing:
18 Total Flight Time: 2+50				
19 Weather: partly cloudy				

20 Remarks:

possible rain due to clouds.
mission complete.

21 Problems and Solutions:

–

Acquisition Flight Approved by: Mark Año — Signature over Printed Name (End User Representative)

Acquisition Flight Certified by: A1C Erwin Delos Santos PAF — Signature over Printed Name (PAF Representative)

Pilot-in-Command: J. Clemente — Signature over Printed Name

Lidar Operator: Mark Año — Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

10.) Flight Log for 1P6G129B Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 219

1 LiDAR Operator: J. Alviar	2 ALTM Model: Pegasus	3 Mission Name: 1P6G129B	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: RP-C9022
7 Pilot: J. Clemente	8 Co-Pilot: R. Samar	9 Route: Iloilo - Iloilo			
10 Date: 09 May 2013	12 Airport of Departure (Airport, City/Province): Iloilo		12 Airport of Arrival (Airport, City/Province): Iloilo		
13 Engine On: 1441 H	14 Engine Off: 1704 H	15 Total Engine Time: 2+23	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather	Very cloudy w/ chances of thunderstorm				

20 Remarks:

- changed plan to 850 m AGL
- aborted mission after 5/12 lines due to rain (surveyed lines 1, 7, 2, 8, 3)

21 Problems and Solutions:

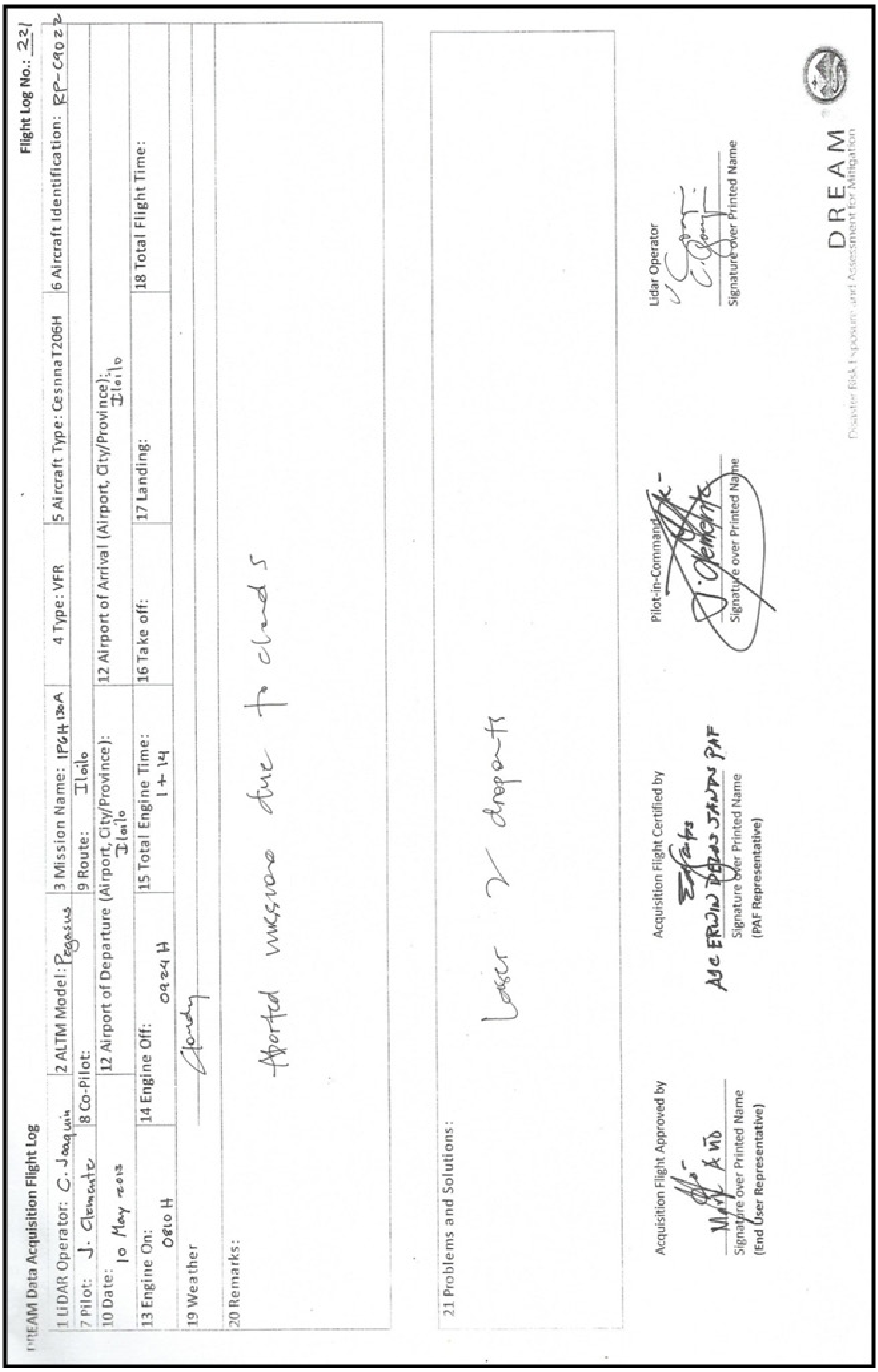
- * Camera time stamp delay error
- * Dynamical Parameters not updated warning

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Mark Ang	A1C Erwin Dagoo Santos PAF	J. Clemente	J. Alviar
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

11.) Flight Log for 1P6H130A Mission



DREAM Data Acquisition Flight Log — Flight Log No.: 221

1 LIDAR Operator: C. Joaquin	2 ALTM Model: Pegasus	3 Mission Name: 1P6H130A	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: RP-C9022
7 Pilot: J. Clemente	8 Co-Pilot:	9 Route: Iloilo			
10 Date: 10 May 2013	12 Airport of Departure (Airport, City/Province): Iloilo		12 Airport of Arrival (Airport, City/Province): Iloilo		
13 Engine On: 0810 H	14 Engine Off: 0924 H	15 Total Engine Time: 1+14	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: Cloudy					

20 Remarks:

Aborted mission due to clouds

21 Problems and Solutions:

Laser 2 dropouts

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

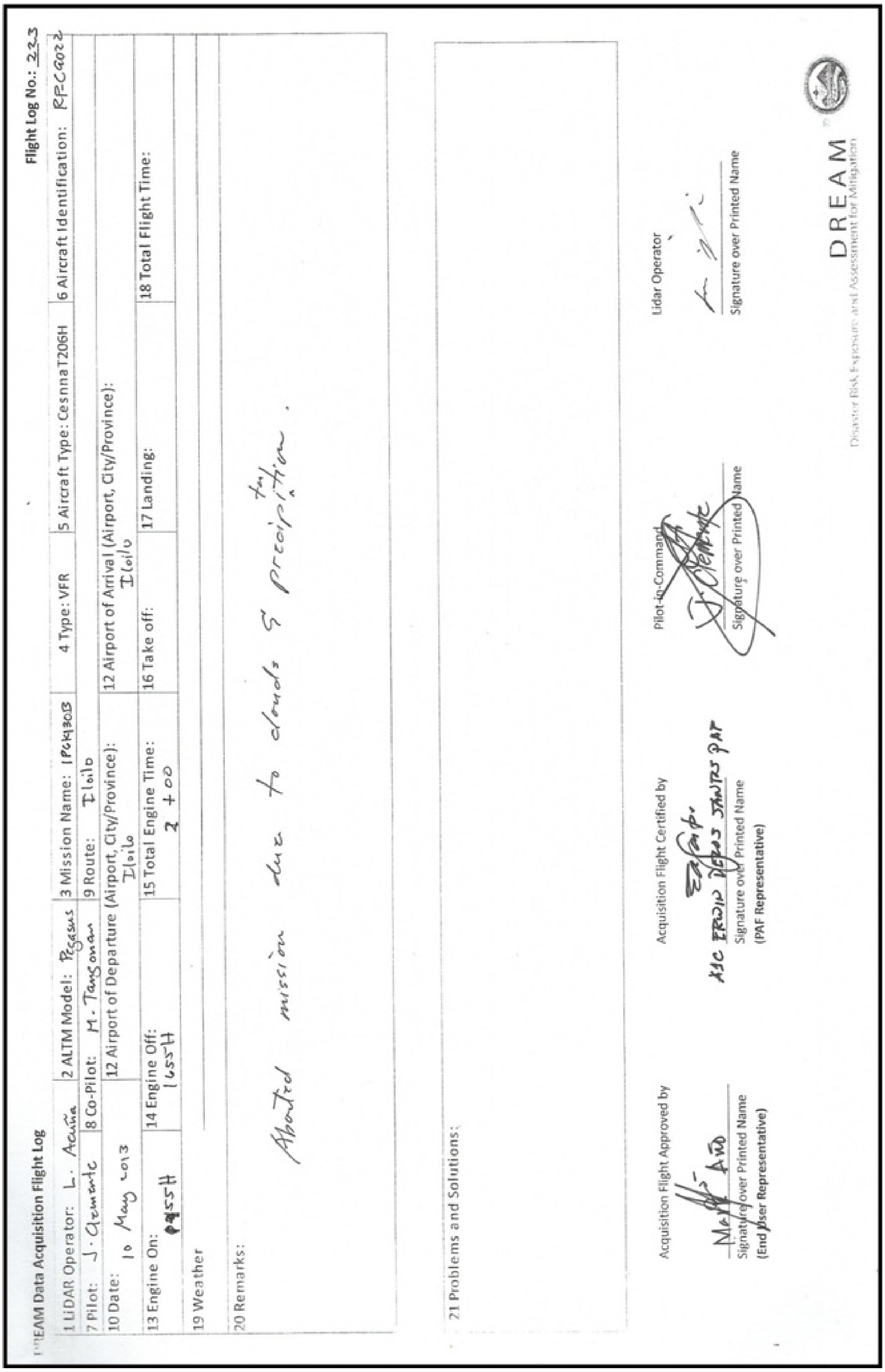
Acquisition Flight Certified by
A1C ERWIN DELOS SANTOS PAF
Signature over Printed Name
(PAF Representative)

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

Lidar Operator
C. Joaquin
Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

12.) Flight Log for 1P6K130B Mission



DREAM Data Acquisition Flight Log

Flight Log No.: 223

1 LiDAR Operator: L. Acuña	2 ALTM Model: Pegasus	3 Mission Name: 1P6K130B	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: RPC9022
7 Pilot: J. Clemente	8 Co-Pilot: M. Tangonan	9 Route: Iloilo			
10 Date: 10 May 2013	12 Airport of Departure (Airport, City/Province): Iloilo		12 Airport of Arrival (Airport, City/Province): Iloilo		
13 Engine On: 0955H	14 Engine Off: 1655H	15 Total Engine Time: 2+00	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather					
20 Remarks: Aborted mission due to clouds & precipitation.					

21 Problems and Solutions:

Acquisition Flight Approved by
Mary Ann ... Año
Signature over Printed Name
(End User Representative)

Acquisition Flight Certified by
A1C ERWIN DELOS SANTOS PAF
Signature over Printed Name
(PAF Representative)

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

Lidar Operator
Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

13.) Flight Log for 1P6H131A Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 225

1 LiDAR Operator: C. Joaquin	2 ALTM Model: Pegasus	3 Mission Name: 1P6H131A	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: RP-C9022
7 Pilot: J. Clemente	8 Co-Pilot: M. Tangonan	9 Route: Iloilo			
10 Date: 11 May 2013	12 Airport of Departure (Airport, City/Province): Iloilo		12 Airport of Arrival (Airport, City/Province): Iloilo		
13 Engine On: 0735H	14 Engine Off: 1000H	15 Total Engine Time: 2+25	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: cloudy					

20 Remarks:

aborted mission due to thick clouds

Surveyed lines 1-6-2-7-3-8-10

21 Problems and Solutions:

laser 2 dropouts

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

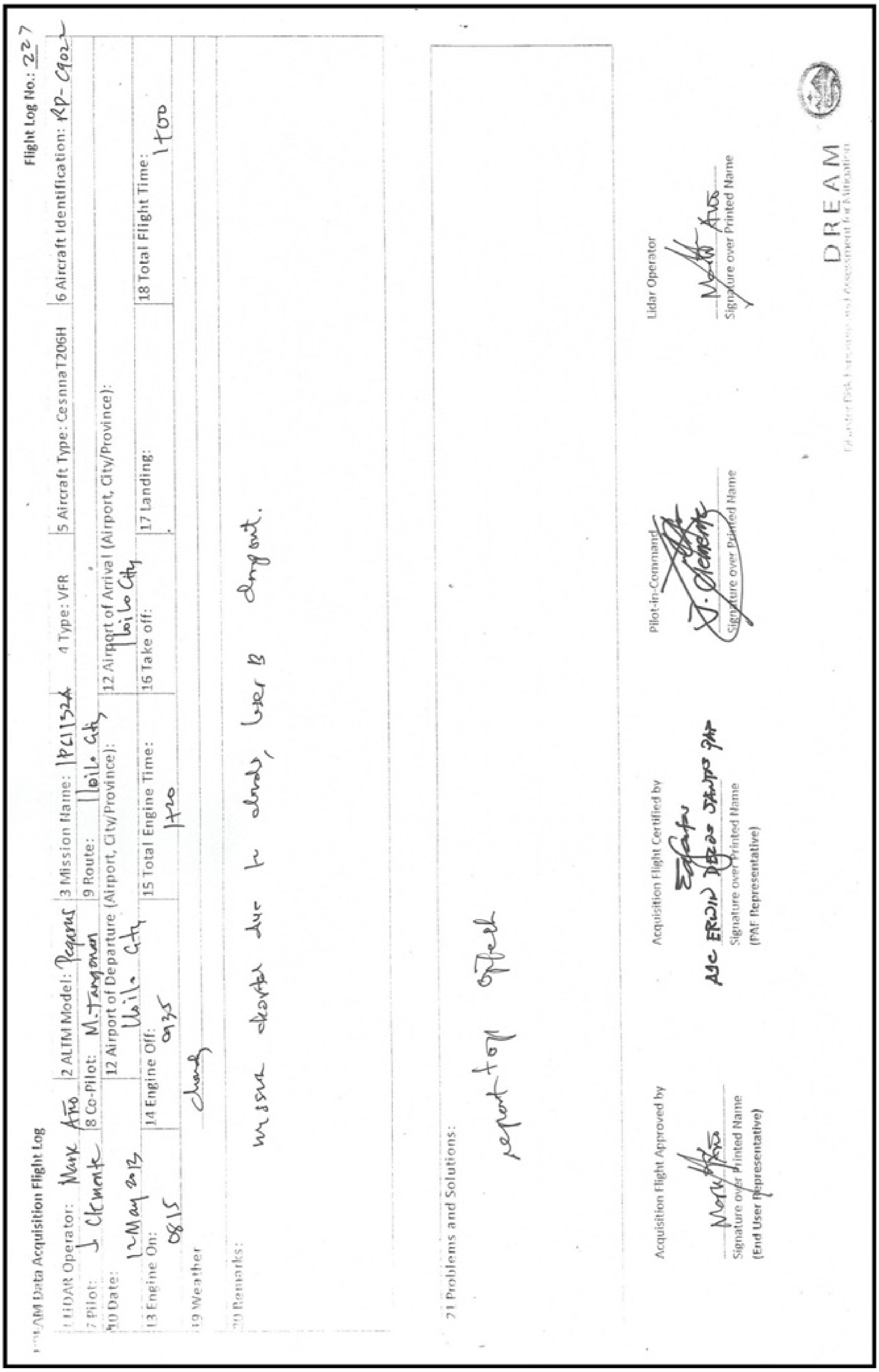
Lidar Operator

Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

14.) Flight Log for 1P6I132A Mission



DREAM Data Acquisition Flight Log

Flight Log No.: 227

1 LiDAR Operator: Mark Aňo	2 ALTM Model: Pegasus	3 Mission Name: 1P6I132A	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: RP-C9022
7 Pilot: J. Clemente	8 Co-Pilot: M. Tangonan	9 Route: Iloilo City			
10 Date: 12 May 2013	12 Airport of Departure (Airport, City/Province): Iloilo City		12 Airport of Arrival (Airport, City/Province): Iloilo City		
13 Engine On: 0815	14 Engine Off: 0935	15 Total Engine Time: 1+20	16 Take off:	17 Landing:	18 Total Flight Time: 1+00
19 Weather: cloudy					

20 Remarks: mission aborted due to clouds, laser B dropout.

21 Problems and Solutions: report to Optech

Acquisition Flight Approved by: Mark Aňo — Signature over Printed Name (End User Representative)

Acquisition Flight Certified by: A2C ERWIN DELOS SANTOS PAF — Signature over Printed Name (PAF Representative)

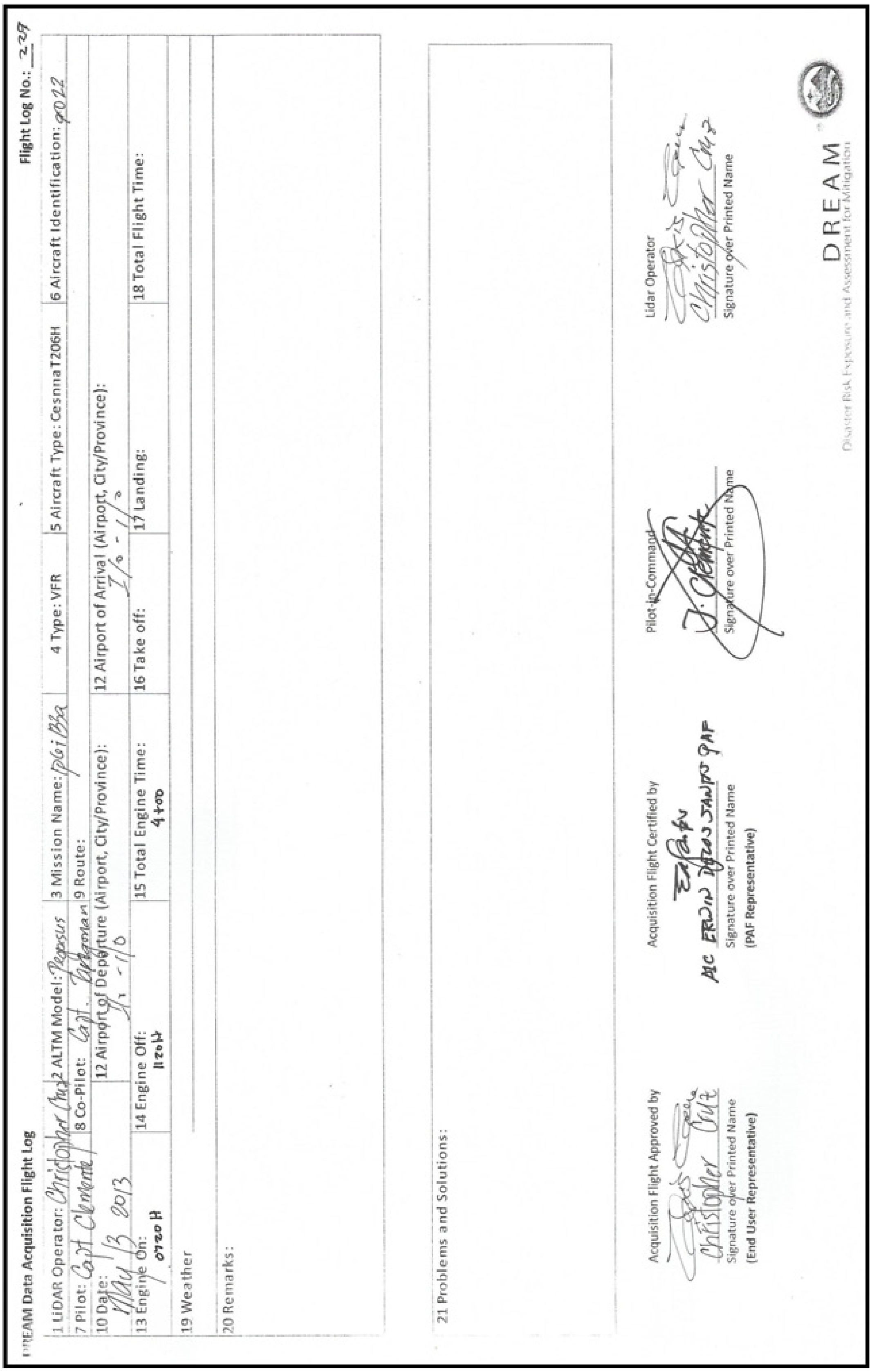
Pilot-in-Command: J. Clemente — Signature over Printed Name

Lidar Operator: Mark Aňo — Signature over Printed Name

DREAM — Disaster Risk Exposure and Assessment for Mitigation

Annex F

15.) Flight Log for 1P6I133A Mission



DREAM Data Acquisition Flight Log — Flight Log No.: 229

1 LiDAR Operator: Christopher Cruz	2 ALTM Model: Pegasus	3 Mission Name: 1P6I133A	4 Type: VFR	5 Aircraft Type: Cesnna T206H
6 Aircraft Identification: 9022				
7 Pilot: Capt. Clemente	8 Co-Pilot: Capt. Bahagonan	9 Route:		
10 Date: May 13, 2013	12 Airport of Departure (Airport, City/Province): I/o - I/o	12 Airport of Arrival (Airport, City/Province): I/o - I/o		
13 Engine On: 0720H	14 Engine Off: 1120H	15 Total Engine Time: 4+00	16 Take off:	17 Landing:
18 Total Flight Time:				
19 Weather				
20 Remarks:				
21 Problems and Solutions:				

Acquisition Flight Approved by: Christopher Cruz — Signature over Printed Name (End User Representative)

Acquisition Flight Certified by: A1C Erwin Delos Santos PAF — Signature over Printed Name (PAF Representative)

Pilot-in-Command: J. Clemente — Signature over Printed Name

Lidar Operator: Christopher Cruz — Signature over Printed Name

DREAM Disaster Risk Exposure and Assessment for Mitigation

Annex F

16.) Flight Log for 1P6J134A Mission

DREAM Data Acquisition Flight Log — Flight Log No.: 23#

1 LiDAR Operator: J. Alviar	2 ALTM Model: Pegasus	3 Mission Name: 1P6J134A	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: RP-C9022
7 Pilot: J. Clemente	8 Co-Pilot: M. Tangonan	9 Route: Iloilo			
10 Date: 19 May 2013	12 Airport of Departure (Airport, City/Province): Iloilo		12 Airport of Arrival (Airport, City/Province): Iloilo		
13 Engine On: 0805H	14 Engine Off: 1100H	15 Total Engine Time: 2+55	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: partly cloudy, fast build up					

20 Remarks:

Data acquired but aborted due to very fast cloud build up

21 Problems and Solutions:

Pilot display problem → replacement of cable, didn't work
Restarted FMS of laser several times due to lagging of software
Camera - not capturing, no images

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Mervin Ano	A1C Erwin Delos Santos PAF	J. Clemente	J. Alviar
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

17.) Flight Log for 1P6H135A Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 253

1 LIDAR Operator: C. Joaquin	2 ALTM Model: Pegasus	3 Mission Name: 1P6H135A	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification:
7 Pilot: J. Clemente	8 Co-Pilot: M. Tangonan	9 Route: ~~Boxes~~ ILOILO - ILOILO			
10 Date: May 15, 2013	12 Airport of Departure (Airport, City/Province): ILOILO		12 Airport of Arrival (Airport, City/Province): ILOILO		
13 Engine On: 0640	14 Engine Off: 0940	15 Total Engine Time: 3+00	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: Cloudy					
20 Remarks: data acquired but aborted mission due to clouds					

21 Problems and Solutions:

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Mark Año	A1C Erwin Delos Santos PAF	J. Clemente	C. Joaquin
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

DREAM

Disaster Risk Exposure and Assessment for Mitigation

Annex F

18.) Flight Log for 1P6K135B Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 235

1 LiDAR Operator: Mark Año	2 ALTM Model: Pegasus	3 Mission Name: 1P6K135B	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-C9022
7 Pilot: J. Clemente	8 Co-Pilot: M. Tangonan	9 Route: Iloilo			
10 Date: 15 May 2013	12 Airport of Departure (Airport, City/Province): Iloilo City		12 Airport of Arrival (Airport, City/Province): Iloilo City		
13 Engine On: 1420H	14 Engine Off: 1730H	15 Total Engine Time: 3+10	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: cloudy w/ slight thunderstorm					

20 Remarks:

- cloudy weather
- camera failure; does not trigger automatically, black images

21 Problems and Solutions:

- analyze camera logs and report to Optech.

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Mark Año	A1C ERWIN DELOS SANTOS PAF	J. Clemente	Mark Año
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

19.) Flight Log for 1P6HS136A Mission

DREAM Data Acquisition Flight Log — Flight Log No.: 237

1 LiDAR Operator: C. Joaquin	2 ALTM Model:	3 Mission Name: 1P6HS136A	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification:
7 Pilot: J. Clemente	8 Co-Pilot: M. Tangonan	9 Route: Iloilo - Iloilo			
10 Date: May 16, 2013	12 Airport of Departure (Airport, City/Province): Iloilo		12 Airport of Arrival (Airport, City/Province): Iloilo		
13 Engine On: 1425	14 Engine Off: 1755	15 Total Engine Time: 3h 30m	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: Cloudy					
20 Remarks: Mission completed but with data voids					
21 Problems and Solutions:					

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
M. Agas	A1C Erwin Delos Santos PAF	J. Clemente	C. Joaquin / C. Sapitan
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

DREAM

20.) Flight Log for 1P6IS136B Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 339

1 LiDAR Operator: J. Alviar	2 ALTM Model: Pegasus	3 Mission Name: 1P6IS136B	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: RP-C9022
7 Pilot: J. Clemente	8 Co-Pilot: M. Tangonan	9 Route: Iloilo			
10 Date: 16 Aug 2013	12 Airport of Departure (Airport, City/Province): Iloilo		12 Airport of Arrival (Airport, City/Province): Iloilo		
13 Engine On: 1425H	14 Engine Off: 1755H	15 Total Engine Time: 3+30	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather: partly cloudy					

20 Remarks:

Mission completed

21 Problems and Solutions:

laser B dropout; problematic pilot display & waiting for optech's response

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Mark Arao	A1C ERWIN DELOS SANTOS PAF	J. Clemente	J. Alviar
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

21.) Flight Log for 1P6HS137A Mission

DREAM Data Acquisition Flight Log

Flight Log No.: 241

1 LIDAR Operator: Mark Año	2 ALTM Model: Pegasus	3 Mission Name: 1P6HS137A	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: RP-C9022
7 Pilot: Jr. Clemente	8 Co-Pilot: M. Tangonan	9 Route: Roxas City			
10 Date: 17 May 2013	12 Airport of Departure (Airport, City/Province): Roxas City		12 Airport of Arrival (Airport, City/Province): Roxas City		
13 Engine On: 0740	14 Engine Off: 1045	15 Total Engine Time: 3+05	16 Take off:	17 Landing:	18 Total Flight Time: 2+50
19 Weather: cloudy					

20 Remarks:

Some data acquired but aborted mission due to clouds; problematic pilot display

21 Problems and Solutions:

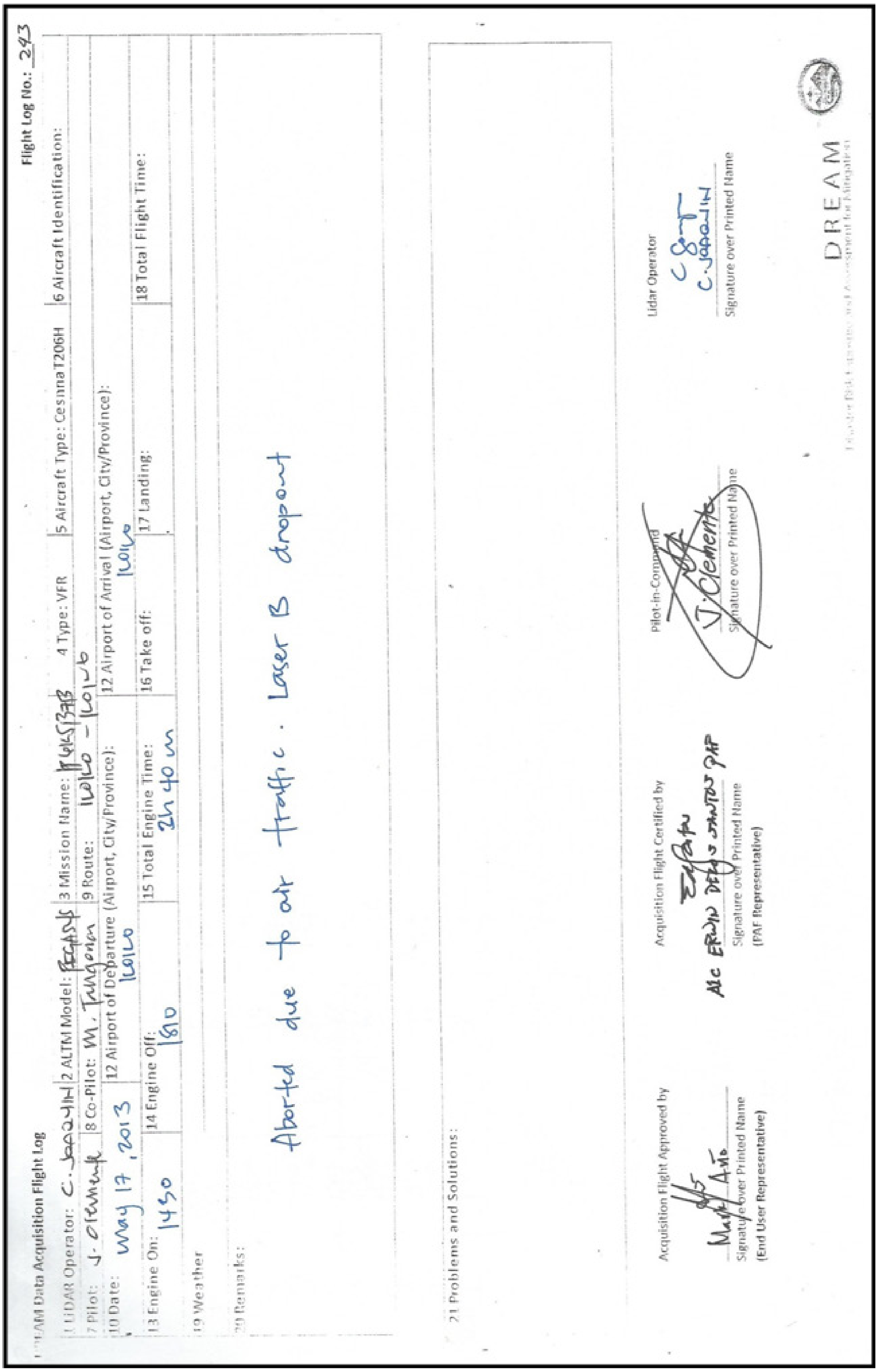
repaired to gtech

Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Command	Lidar Operator
Mark Año	A1C ERWIN DELOS SANTOS PAF	J. Clemente	Mark Año
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature over Printed Name	Signature over Printed Name

DREAM
Disaster Risk Exposure and Assessment for Mitigation

Annex F

22.) Flight Log for 1P6IS137B Mission



DREAM/LiDAR Data Acquisition Flight Log — Flight Log No.: 243

1 LiDAR Operator: C. Joaquin	2 ALTM Model: Pegasus	3 Mission Name: 1P6IS137B	4 Type: VFR	5 Aircraft Type: Cessna T206H	6 Aircraft Identification:
7 Pilot: J. Clemente	8 Co-Pilot: M. Tangonan	9 Route: Iloilo - Iloilo			
10 Date: May 17, 2013	12 Airport of Departure (Airport, City/Province): Iloilo		12 Airport of Arrival (Airport, City/Province): Iloilo		
13 Engine On: 1430	14 Engine Off: 1810	15 Total Engine Time: 2h 40 m	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather					

20 Remarks:

Aborted due to air traffic. Laser B dropout

21 Problems and Solutions:

Acquisition Flight Approved by: Mark Año — Signature over Printed Name (End User Representative)

Acquisition Flight Certified by: A1C Erwin Delos Santos PAF — Signature over Printed Name (PAF Representative)

Pilot-in-Command: J. Clemente — Signature over Printed Name

Lidar Operator: C. Joaquin — Signature over Printed Name

DREAM — Disaster Risk Exposure and Assessment for Mitigation

Bibliography

- Provincial Profile of the Province of Iloilo, Philippines. (n.d.). Retrieved October 29, 2015, from https://www.scribd.com/doc/33915404/Provincial-Profile-of-the-Province-of-Iloilo-Philippines#scribd

D R E A M

Disaster RIsk and Exposure Assessment for Mitigation