REGION 6

Jalaur River Flood Plain:

DREAM LiDAR Data Acquistion and Processing Report



TRAINING CENTER FOR APPLIED GEODESY AND PHOTOGRAMMETRY

2015





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1.1 About the DREAM Program 2 1.2 Objective and Target Outputs 2 1.3 General Methodological Framework 3 2. STUDY AREA 5 3. METHODOLOGY 9 3.1 Aqcuisition Methodology 10 3.1.1 Pre-site Preparations 10 3.1.1.1 Creation of Flight Plans 10 3.1.1.2 Collection of Existing Ref. Points and Benchmarks 12 3.1.1.3 Preparation of Flied Plan 12 3.1.2 Ground Base Set-up 13 3.1.4 Transmittal of Acquired LiDAR Data 13 3.1.5 Equipment 14 ALTM Pegasus 14 ALTM Pegasus 4.1 Trajectory Computation 16 3.2.2 Trocessing Methodology 15 3.2.1 Data Transfer 16 3.2.2 Trajectory Computation 16 3.2.3 LiDAR Point Cloud Rectification 17 3.2.4 LiDAR Data Quality Checking 18 3.2.5 LiDAR Point Cloud Classification and Rasterization
1.2 Objective and Target Outputs 2 1.3 General Methodological Framework 3 2. STUDY AREA 5 3. METHODOLOGY 9 3.1 Aqcuisition Methodology 10 3.1.1 Presite Preparations 10 3.1.1 Presite Preparation of Flight Plans 10 3.1.1.1 Creation of Flight Plans 10 3.1.2 Ground Base Set-up 13 3.1.3 Acquisition of Digital Elevation Data (LiDAR Survey) 13 3.1.4 Transmittal of Acquired LiDAR Data 13 3.1.5 Equipment 14 ALTM Pegasus 14 ALTM Regmini 3.2.2 Trajectory Computation 16 3.2.3 LiDAR Point Cloud Rectification 17 3.2.4 LiDAR Data Quality Checking 18 3.2.5 LiDAR Point Cloud Classification and Rasterization 20 3.2.6 DEM Editing and Hydro-correction 24 4. RESULTS AND DISCUSSION 25 4.1 LiDAR ACQUISITION IN JALAUR FLOODPLAIN 26 4.1.1
1.3 General Methodological Framework 3 2. STUDY AREA 5 3. METHODOLOGY 9 3.1 Aqcuisition Methodology 10 3.1.1 Pre-site Preparations 10 3.1.1 Collection of Flight Plans 10 3.1.1.1 Creation of Flight Plans 10 3.1.1.2 Collection of Existing Ref. Points and Benchmarks 12 3.1.2 Ground Base Set-up 13 3.1.3 Acquisition of Digital Elevation Data (LiDAR Survey) 13 3.1.4 Transmittal of Acquired LiDAR Data 13 3.1.5 Equipment 14 ALTM Pegasus 14 ALTM Gemini 15 3.2 Processing Methodology 15 3.2.1 Data Transfer 16 3.2.2 Trajectory Computation 16 3.2.3 LiDAR Point Cloud Rectification 17 3.2.4 LiDAR Data Quality Checking 18 3.2.5 LiDAR Point Cloud Classification and Rasterization 20 3.2.6 DEM Editing and Hydro-correction 24
2. STUDY AREA 5 3. METHODOLOGY 9 3.1 Aqcuisition Methodology 10 3.1.1 Pre-site Preparations 10 3.1.1 Pre-site Preparation of Flight Plans 10 3.1.1 Creation of Flight Plans 10 3.1.1 Creation of Flight Plans 10 3.1.1 Creation of Flight Plans 12 3.1.2 Coround Base Set-up 13 3.1.3 Acquisition of Digital Elevation Data (LiDAR Survey) 13 3.1.4 Transmittal of Acquired LiDAR Data 13 3.1.5 Equipment 14 ALTM Pegasus 14 ALTM Gemini 15 3.2 Processing Methodology 15 3.2.1 Data Transfer 16 3.2.2 Trajectory Computation 16 3.2.3 LiDAR Point Cloud Rectification 17 3.2.4 LiDAR Data Quality Checking 18 3.2.5 LiDAR Point Cloud Classification and Rasterization 20 3.2.6 DEM Editing and Hydro-correction 24 4.
3. METHODOLOGY 9 3.1 Aqcuisition Methodology 10 3.1.1 Pre-site Preparations 10 3.1.1 Pre-site Preparations 10 3.1.1 Creation of Flight Plans 10 3.1.1 Creation of Flight Plans 10 3.1.1 Creation of Existing Ref. Points and Benchmarks 12 3.1.2 Ground Base Set-up 13 3.1.3 Acquisition of Digital Elevation Data (LiDAR Survey) 13 3.1.4 Transmittal of Acquired LiDAR Data 13 3.1.5 Equipment 14 ALTM Pegasus 14 ALTM Pegasus 14 ALTM Pegasus 16 3.2.2 Trajectory Computation 16 3.2.2 Trajectory Computation 17 3.2.4 LiDAR Point Cloud Rectification 17 3.2.5 LiDAR Point Cloud Classification and Rasterization 20 3.2.6 DEM Editing and Hydro-correction 24 4. RESULTS AND DISCUSSION 25 4.1 LiDAR ACQUISITION IN JALAUR FLOODPLAIN 26 <t< td=""></t<>
3.1 Aqcuisition Methodology 10 3.1.1 Pre-site Preparations 10 3.1.1 Creation of Flight Plans 10 3.1.1.1 Creation of Flight Plans 10 3.1.1.2 Collection of Existing Ref. Points and Benchmarks 12 3.1.2 Ground Base Set-up 13 3.1.3 Acquisition of Digital Elevation Data (LiDAR Survey) 13 3.1.4 Transmittal of Acquired LiDAR Data 13 3.1.5 Equipment 14 ALTM Pegasus 14 ALTM Gemini 15 3.2 Processing Methodology 15 3.2.1 Data Transfer 16 3.2.2 Trajectory Computation 16 3.2.3 LiDAR Point Cloud Rectification 17 3.2.4 LiDAR Data Quality Checking 18 3.2.5 LiDAR Point Cloud Classification and Rasterization 20 3.2.6 DEM Editing and Hydro-correction 24 4. RESULTS AND DISCUSSION 25 4.1 LiDAR ACQUISITION IN JALAUR FLOODPLAIN 26 4.1.1 Flight Plans <td< td=""></td<>
3.1.1Pre-site Preparations103.1.1.1Creation of Flight Plans103.1.2Collection of Existing Ref. Points and Benchmarks123.1.3Preparation of Field Plan123.1.4Transmittal of Acquired LiDAR Data133.1.5Equipment14ALTM Pegasus14ALTM Gemini153.2Processing Methodology153.2.1Data Transfer163.2.2Trajectory Computation163.2.3LiDAR Point Cloud Rectification173.2.4LiDAR Data Quality Checking183.2.5LiDAR Point Cloud Classification and Rasterization203.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.2LiDAR DATA PROCESSING36
3.1.1.1 Creation of Flight Plans 10 3.1.1.2 Collection of Existing Ref. Points and Benchmarks 12 3.1.1.3 Preparation of Field Plan 12 3.1.2 Ground Base Set-up 13 3.1.3 Acquisition of Digital Elevation Data (LiDAR Survey) 13 3.1.4 Transmittal of Acquired LiDAR Data 13 3.1.5 Equipment 14 ALTM Pegasus 14 ALTM Gemini 15 3.2 Processing Methodology 15 3.2.1 Data Transfer 16 3.2.2 Trajectory Computation 16 3.2.3 LiDAR Point Cloud Rectification 17 3.2.4 LiDAR Data Quality Checking 18 3.2.5 LiDAR Point Cloud Classification and Rasterization 20 3.2.6 DEM Editing and Hydro-correction 24 4. RESULTS AND DISCUSSION 25 4.1 LiDAR ACQUISITION IN JALAUR FLOODPLAIN 26 4.1.1 Flight Plans 26 4.2 LiDAR DATA PROCESSING 28 4.2 LiDAR DATA PROCESSING 36
3.1.1.2Collection of Existing Ref. Points and Benchmarks123.1.3Acquisition of Field Plan133.1.4Transmittal of Acquired LiDAR Data133.1.5Equipment14ALTM Pegasus14ALTM Gemini153.2Processing Methodology153.2.1Data Transfer163.2.2Trajectory Computation163.2.3LiDAR Point Cloud Rectification173.2.4LiDAR Data Quality Checking183.2.5LiDAR Point Cloud Classification and Rasterization203.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.2LiDAR DATA PROCESSING36
3.1.1.3Preparation of Field Plan123.1.2Ground Base Set-up133.1.3Acquisition of Digital Elevation Data (LiDAR Survey)133.1.4Transmittal of Acquired LiDAR Data133.1.5Equipment14ALTM Pegasus14ALTM Gemini153.2Processing Methodology153.2.1Data Transfer163.2.2Trajectory Computation163.2.3LiDAR Point Cloud Rectification173.2.4LiDAR Data Quality Checking183.2.5LiDAR Point Cloud Classification and Rasterization203.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.2LiDAR DATA PROCESSING284.2LiDAR DATA PROCESSING36
3.1.2Ground Base Set-up133.1.3Acquisition of Digital Elevation Data (LiDAR Survey)133.1.4Transmittal of Acquired LiDAR Data133.1.5Equipment14ALTM Pegasus14ALTM Gemini153.2Processing Methodology153.2.1Data Transfer163.2.2Trajectory Computation163.2.3LiDAR Point Cloud Rectification173.2.4LiDAR Data Quality Checking183.2.5LiDAR Point Cloud Classification and Rasterization203.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.2LiDAR DATA PROCESSING36
3.1.3 Acquisition of Digital Elevation Data (LiDAR Survey) 13 3.1.4 Transmittal of Acquired LiDAR Data 13 3.1.5 Equipment 14 ALTM Pegasus 14 ALTM Gemini 15 3.2 Processing Methodology 15 3.2.1 Data Transfer 16 3.2.2 Trajectory Computation 16 3.2.3 LiDAR Point Cloud Rectification 17 3.2.4 LiDAR Data Quality Checking 18 3.2.5 LiDAR Point Cloud Classification and Rasterization 20 3.2.6 DEM Editing and Hydro-correction 24 4. RESULTS AND DISCUSSION 25 4.1 LiDAR ACQUISITION IN JALAUR FLOODPLAIN 26 4.1.1 Flight Plans 26 4.1.2 Ground Base Station 28 4.2 LiDAR DATA PROCESSING 36
3.1.4Transmittal of Acquired LiDAR Data133.1.5Equipment14ALTM Pegasus14ALTM Gemini153.2Processing Methodology153.2.1Data Transfer163.2.2Trajectory Computation163.2.3LiDAR Point Cloud Rectification173.2.4LiDAR Data Quality Checking183.2.5LiDAR Point Cloud Classification and Rasterization203.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.1.1Flight Plans264.2LiDAR DATA PROCESSING36
3.1.5Equipment14ALTM Pegasus14ALTM Gemini153.2Processing Methodology153.2.1Data Transfer163.2.2Trajectory Computation163.2.3LiDAR Point Cloud Rectification173.2.4LiDAR Data Quality Checking183.2.5LiDAR Point Cloud Classification and Rasterization203.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.1.1Flight Plans264.2LiDAR DATA PROCESSING36
ALTM Pegasus14ALTM Gemini153.2Processing Methodology153.2.1Data Transfer163.2.2Trajectory Computation163.2.3LiDAR Point Cloud Rectification173.2.4LiDAR Data Quality Checking183.2.5LiDAR Point Cloud Classification and Rasterization203.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.1.1Flight Plans264.2LiDAR DATA PROCESSING36
ALTM Gemini153.2Processing Methodology153.2.1Data Transfer163.2.2Trajectory Computation163.2.3LiDAR Point Cloud Rectification173.2.4LiDAR Data Quality Checking183.2.5LiDAR Point Cloud Classification and Rasterization203.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.1.1Flight Plans264.1.2Ground Base Station284.2LiDAR DATA PROCESSING36
3.2Processing Methodology153.2.1Data Transfer163.2.2Trajectory Computation163.2.3LiDAR Point Cloud Rectification173.2.4LiDAR Data Quality Checking183.2.5LiDAR Point Cloud Classification and Rasterization203.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.1.1Flight Plans264.2LiDAR DATA PROCESSING36
3.2.1Data Transfer163.2.2Trajectory Computation163.2.3LiDAR Point Cloud Rectification173.2.4LiDAR Data Quality Checking183.2.5LiDAR Point Cloud Classification and Rasterization203.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.1.1Flight Plans264.2LiDAR DATA PROCESSING36
3.2.2Trajectory Computation163.2.3LiDAR Point Cloud Rectification173.2.4LiDAR Data Quality Checking183.2.5LiDAR Point Cloud Classification and Rasterization203.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.1.1Flight Plans264.2LiDAR DATA PROCESSING36
3.2.3LiDAR Point Cloud Rectification173.2.4LiDAR Data Quality Checking183.2.5LiDAR Point Cloud Classification and Rasterization203.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.1.1Flight Plans264.2LiDAR DATA PROCESSING36
3.2.4LiDAR Data Quality Checking183.2.5LiDAR Point Cloud Classification and Rasterization203.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.1.1Flight Plans264.2Ground Base Station284.2LiDAR DATA PROCESSING36
3.2.5LiDAR Point Cloud Classification and Rasterization203.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.1.1Flight Plans264.1.2Ground Base Station284.2LiDAR DATA PROCESSING36
3.2.6DEM Editing and Hydro-correction244.RESULTS AND DISCUSSION254.1LiDAR ACQUISITION IN JALAUR FLOODPLAIN264.1.1Flight Plans264.1.2Ground Base Station284.2LiDAR DATA PROCESSING36
4. RESULTS AND DISCUSSION 25 4.1 LiDAR ACQUISITION IN JALAUR FLOODPLAIN 26 4.1.1 Flight Plans 26 4.1.2 Ground Base Station 28 4.2 LiDAR DATA PROCESSING 36
 4.1 LIDAR ACQUISITION IN JALAUR FLOODPLAIN
4.1.1Flight Plans264.1.2Ground Base Station284.2LiDAR DATA PROCESSING36
4.1.2Ground Base Station284.2LiDAR DATA PROCESSING36
4.2 LIDAR DATA PROCESSING
4.2.1 Trajectory Computation
4.2.2 LiDAR point cloud computation
4.2.3 LiDAR Data Quality Checking
4.2.4 LiDAR Point Cloud Classification and Rasterization
4.2.5 DEM Editing and Hydro-correction
5. ANNEXES
Annex A. Optech Technical Specifications of the Pegasus Sensor
Annex A. Optech Technical Specifications of the Gemini Sensor
Annex B. Optech Technical Specifications of the D-8900
Annex C. The Survey Team
Annex D. NAMRIA Certification
Annex E. Data Transfer Sheet for Jalaur Floodplain



List of Figures

Figure 1.	General Methodological Framework of the Program	3			
Figure 2.	Jalaur River Basin Location Map				
Figure 3.	Jalaur River Basin Soil Map				
Figure 4.	Jalaur RIver Basin Land Cover Map	7			
Figure 5.	Flowchart of Project Methodology 1				
Figure 6.	oncept of LiDAR Data Acquisition Parameters				
Figure 7.	LiDAR Data Management for Transmittal				
Figure 8.	he ALTM Pegasus System				
Figure 9.	The ALTM Gemini System				
Figure 10.	Schematic Diagram of the Data Processing				
Figure 11.	Misalignment of a Single Roof Plane from Two Adjacent Flight Lines,				
0	Before Rectification	17			
Figure 12.					
Figure 13.					
Figure 14.	Ground Classification Technique Employed in Terrascan	21			
Figure 15.	Resulting DTM of Ground Classification Using the Default Parameters				
Figure 16.	Default Terrascan Building Classification Parameters	23			
Figure 17.	Different Examples of Air Points Manually Deleted in the TerraScan	-			
0	Window	23			
Figure 18.	Jalaur Floodplain Flight Plans	-			
Figure 19.	Ground Base Station Observation at ILO-89				
Figure 20.	Jalaur Flooplain Flight Plans and Base Station				
Figure 21.	Jalaur Floodplain Data Acquisition LAS Output				
Figure 22.	Smoothed Performance Metric Parameters of Jalaur Flight				
Figure 23.	Solution Status Parameters of Jalaur Flight				
Figure 24.	Coverage of LiDAR Data for the Jalaur Mission				
Figure 25.	Image of Data Overlap for the Jalaur Mission				
Figure 26.	Density Map of Merged LiDAR Data for the Jalaur Mission				
Figure 27.	Elevation Difference Map between Flight Lines				
Figure 28.	Quality Checking with the Profile Tool of QT Master				
Figure 29.	Jalaur Floodplains and Jalaur Classification Results in TerraScan	41			
Figure 30.	Point Cloud Before and After Classification				
Figure 31.	Images of DTMs Before and After Manual Editing	42			
Figure 32.	Map of Agno River System with Validation Survey Shown in Blue				
Figure 33.	One-one Correlation Plot Between topographic and LiDAR Data				
Figure 34.	Final DTM of Jalaur with Validation Survey Shown in Blue				
Figure 35.	Final DSM in Jalaur				
Figure 36.	Sample 1x1 Square Kilometer DSM				
Figure 37.	Sample 1x1 Square Kilometer DTM				



Table 1.	Relevant LiDAR Parameters	11
Table 2.	List of Target River Systems in the Philippines	12
Table 3.	Smoothed Solution Status Parameters in POSPAC MMS v6.2	
Table 4.	Parameters Investigated During Quality Checks	18
Table 5.	Ground Classification Parameters Used in Terrascan for Floodplain and	
	Watershed Areas	21
Table 6.	Classification of Vegetation According to the Elevation Points	22
Table 7.	Parameters Used in LiDAR System During Flight Acquisition	26
Table 8.	Details of the Recovered NAMRIA Horizontal Control Point ILO-64 used as	
	Base Station for the LiDAR Acquisition	28
Table 9.	Details of the Recovered NAMRIA Horizontal Control Point ILO-66 used	
	as Base Station for the LiDAR Acquisition	28
Table 10.	Details of the Recovered NAMRIA Horizontal Control Point ILO-69 used	
	as Base Station for the LiDAR Acquisition	29
Table 11.	Details of the Recovered NAMRIA Horizontal Control Point ILO-89 used	
	as Base Station for the LiDAR Acquisition	29
Table 12.	Details of the Recovered NAMRIA Horizontal Control Point ILO-91 used	
	as Base Station for the LiDAR Acquisition	-
Table 13.	Details of the Revovered NAMRIA Vertical Control Point in Jalaur Flooplain	30
Table 14.	Flight Missions for LiDAR Data Acquisition in Jalaur Floodplains	33
Table 15.	Area of Coverage of the LiDAR Data Acquisition in Jalaur Flooplain	34
Table 16.	Jalaur Classification Results in TerraScan	41
Table 17.	Statistical Values for the Calibration of Flights	43



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









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.

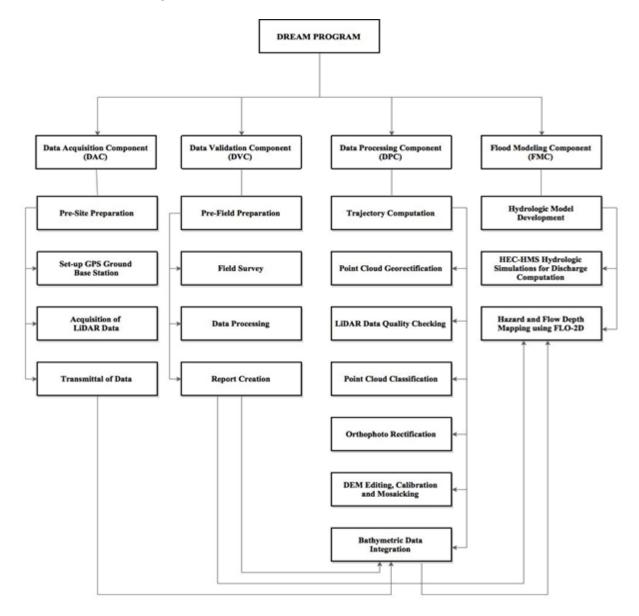


Figure 1. The General Methodological Framework of the Program









Study Area

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.

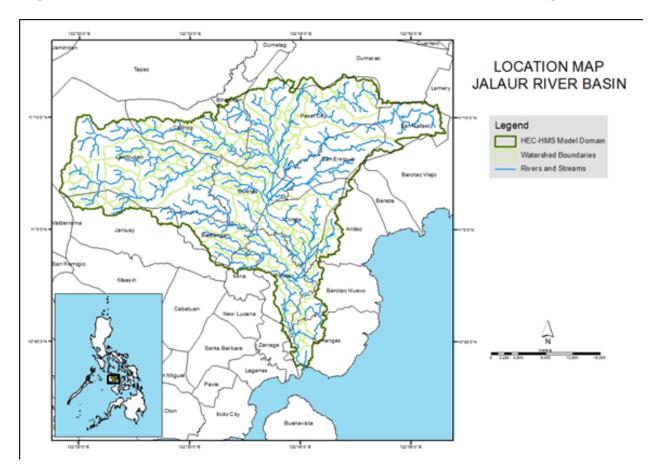


Figure 2. The Jalaur River Basin Location Map

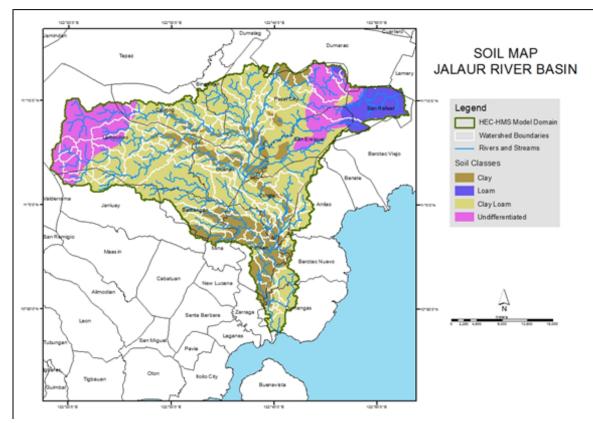
It drains the eastern portion of the island and traverses through Passi City and the towns of Leganes, Zarraga, Dumangas, Barotac Nuevo, Pototan, Dingle, Duenas, and Calinog. Jalaur River Basin records the highest annual flow and is the major source of irrigation water for the province of Iloilo. The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





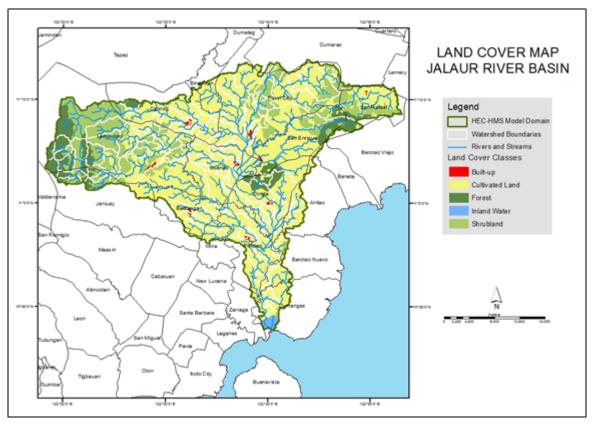


Figure 4. Jalaur River Basin Land Cover Map









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.

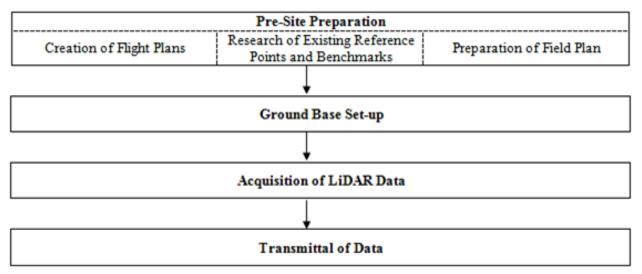


Figure 5. Flowchart of project methodology

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.



Parameter		Formula	Description
SW (Smat	h Width)	SW = 2 * H * tan	H – altitude
SW (Swat	n width)	(θ/2)	Θ – angular FOV
Point Spacing	ΔX _{across}	$\frac{\Delta X_{accoss}}{(N\cos^2(\Theta/2))} = (\Theta * H) /$	ΔX _{BCCOSS} – point spacing across the flight line H – altitude Θ – angular FOV N – number of points in one scanning line
	ΔX_{along}	$\Delta X_{along} = v / f_{sc}$	∆X _{along} - point spacing along the flight line v – forward speed (m/s) f ₅₀ – scanning rate or scan frequency
Point density, dmin		$\frac{d_{\min} = 1 / (\Delta X_{across} * \Delta X_{along})}{\Delta X_{along}}$	<u>ΔXacross.</u> ΔXalong point <u>spacings</u>
Flight line separation, e		e = SW * (1 – overlapping factor)	SW – swath width
# of flight lines, n		n = w / [(1 – overlap) * SW]	<u>w-width</u> of the map that will be produce in meters. The direction of flights will be perpendicular to the width.

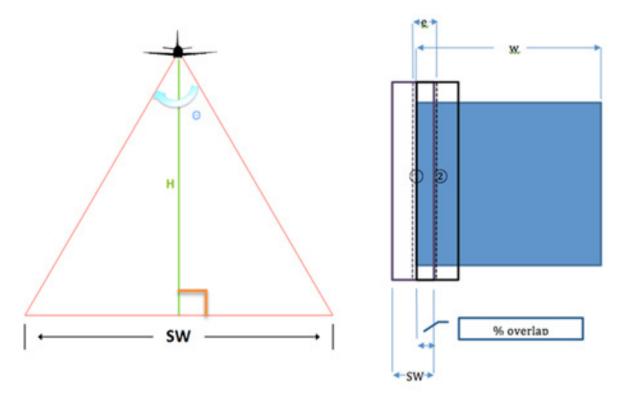


Figure 6. Concept of LiDAR data acquisition parameters



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.

	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

Table 2. List of Target River Systems in the Philippines



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.

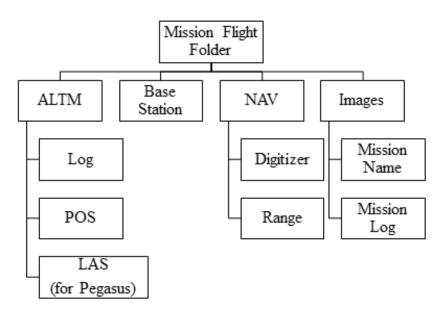
As the system collected LiDAR data, ranges and intensities are recorded on hard drives dedicated to the system while the images are stored on the camera hard drive. Position Orientation System (POS) data is recorded on the POS computer inside the control rack. It can only be accessed and downloaded via 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.



13





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)

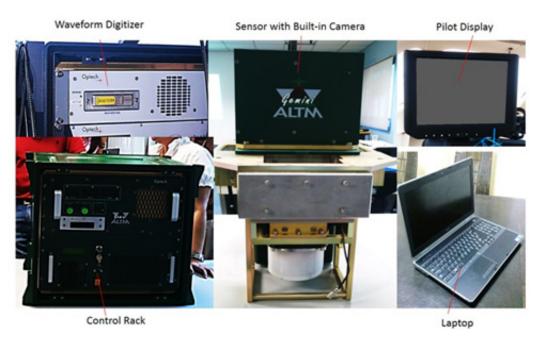


Figure 9. The ALTM Gemini System

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 PO-SPac, 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.



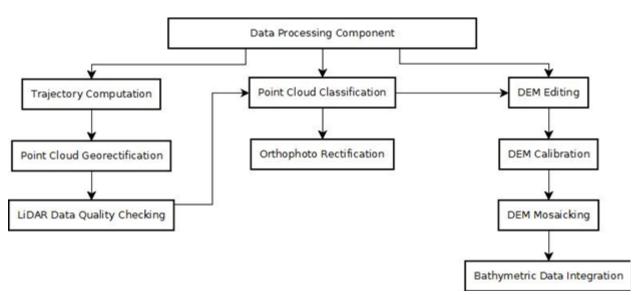


Figure 10. Schematic diagram of the data processing

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.



-	
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.

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

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.

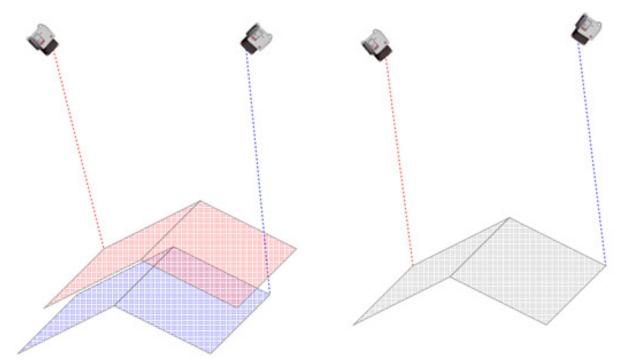


Figure 11. Misalignment of a single roof plane from two adjacent flight lines, before rectification (left). Least squares adjusted roof plane, after rectification (right).



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.

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

Table 4. Parameters investigated during quality checks

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.



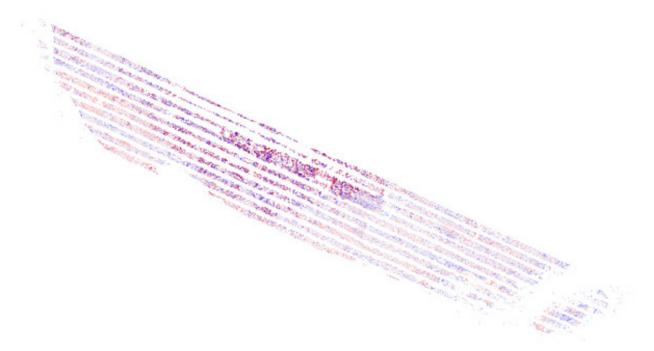
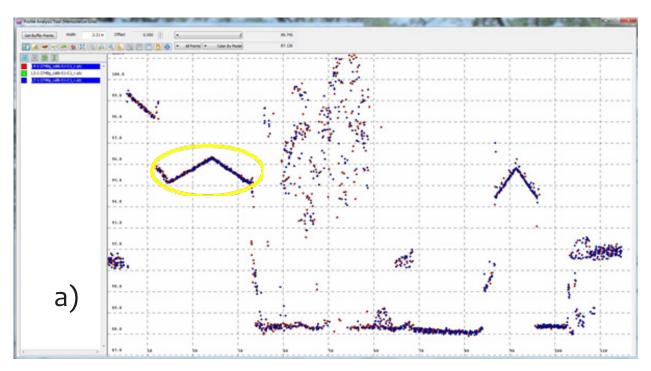
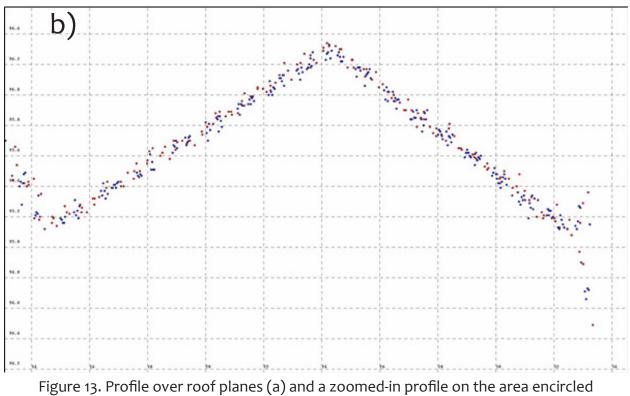


Figure 12. Elevation difference between flight lines generated from LAStools

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.







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.

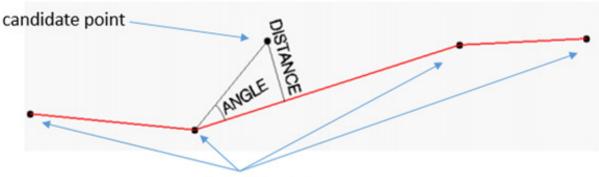
3.2.5 LiDAR Point Cloud Classification and Rasterization

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 AS-CII-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.



ground model points

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.



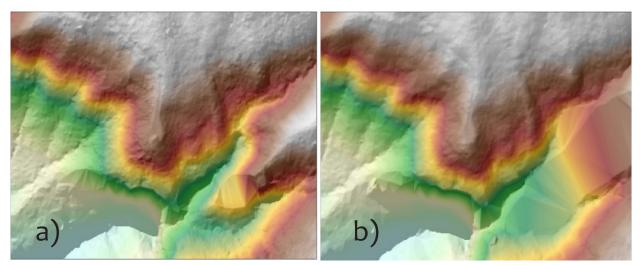


Figure 15. Resulting DTM of ground classification using the default parameters (a) and adjusted parameters (b)

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	

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

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.



Ground class:	2 - Ground 🔹				
From class:	5 - High Vegetation 💌				
To class:	6 - Building 💌				
Accept using:		e fence only rules			
	40	m ² building			
Z tolerance:	0.20	m			
	Use echo information				

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.

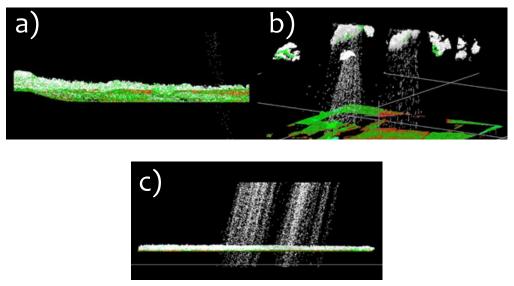


Figure 17. Different examples of air points manually deleted in the TerraScan window

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



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.

, , , , , , , , , , , , , , , , , , , ,	<u>.</u>		
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

Table 7. Parameters used in LiDAR System during Flight Acquisition



Results and Discussion

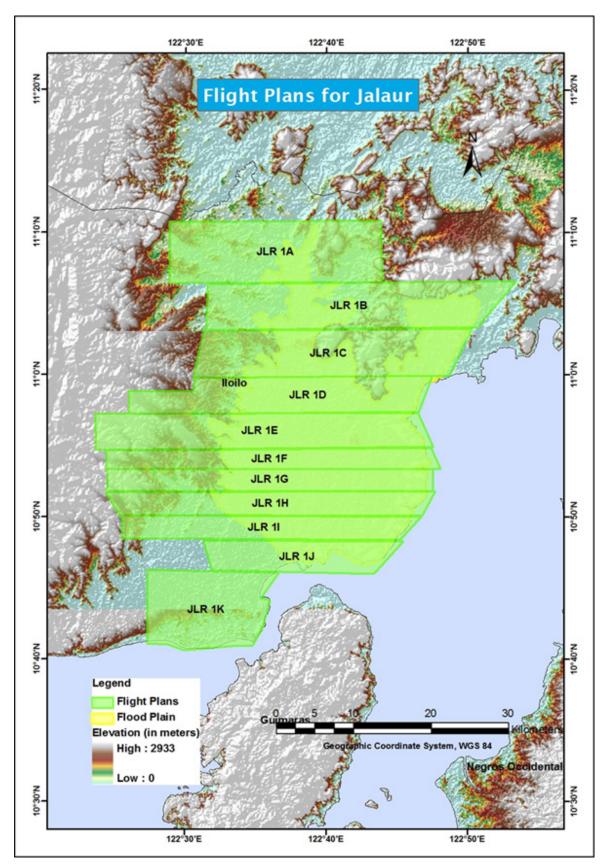


Figure 18. Jalaur floodplain flight plans



27

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.

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

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

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

Station Name	ILC)-69
Order of Accuracy	21	nd
Relative Error (horizontal positioning)	1 in 5	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	ILC)-89	
Order of Accuracy	21	nd	
Relative Error (horizontal positioning)	1 in 5	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)	Easting456446.39 metersNorthing1195521.70 meters		



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 Refer- ence 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
		Latitude	Longitude	Height (m)
WCC-1	WCC Airport, Binalonan, Pan- gasinan	16° 03' 12.65810	120° 34' 56.38599	80.125
WCC-2	WCC Airport, Binalonan, Pan- gasinan	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.



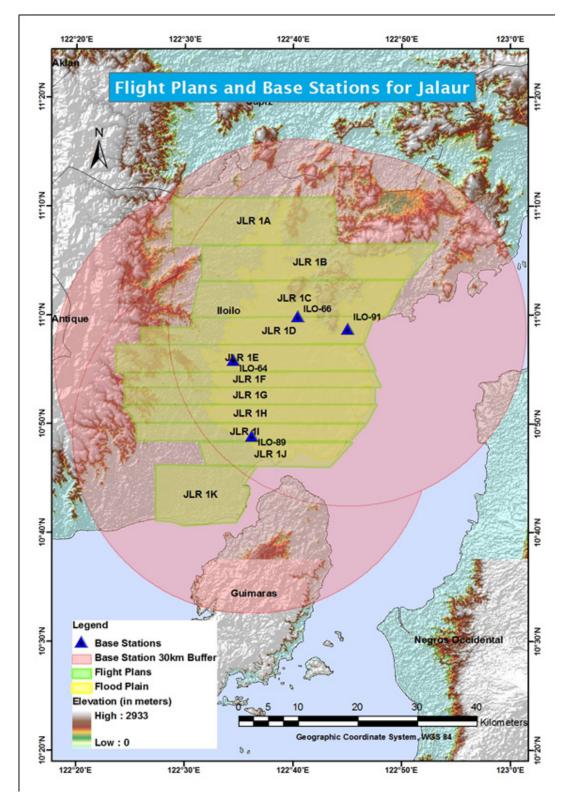


Figure 20. Jalaur floodplain flight plans and base station



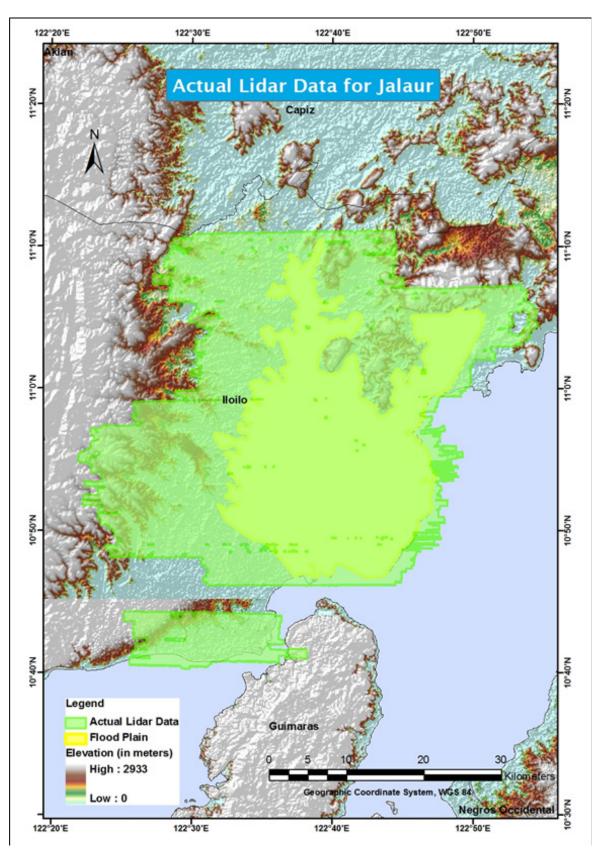


Figure 21. Jalaur floodplain data acquisition LAS output



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.

Date Sur- veyed	Name	Flight Plan	Surveyed Area	Area Surveyed	Area Surveyed	No. of Images	Flying Hour	-
		Area (km2)	(km2)	within the River Systems (km2)	Outside the River Systems (km2)	(Frames)		
							Hr	Min
Apr 30, 2013	PAN 6A	80.304	89.949	34.583	55.366	566	3	45
May 3, 2013	PAN 6B	110	125.86	62.083	63.777	807	3	55
May 4, 2013	PAN 6C	116.04	125.99	80.097	45.893	780	3	46
May 3, 2013	PAN 6D	127.25	120.48	78.374	42.106	681	4	17
May 2, 2013	PAN 6E	104.91	108.32	73.458	34.862	681	3	54
May 4, 2013	PAN 6F	161.62	181.66	424.224	50.420	No Cam- era data	3	8
May 9, 2013	PAN 6F	101.02	101.00	131.231	50.429	702	3	10
May 9, 2013	PAN 6G	169.23	162.85	162.85	0	443	2	23
May 2, 2013	PAN 6H					No Cam- era data	2	37
May 10, 2013	PAN 6H					4	1	14
May 11, 2013	PAN 6H		228 (278	2	25
May 15, 2013	PAN 6H	204.88	238.6	217.568	21.032	210	3	о
May 16, 2013	PAN 6HS					340	3	45
May 17, 2013	PAN 6HS					387	3	5

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



May 5, 2013	PAN 6I		250.9	226.306 2		0 data data No Camera data	2	0
May 12, 2013	PAN 6I	223.88			24.594	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)					148	2	0
May 15, 2013	PAN 6K	150.31	102.66	0	102.66	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.

Loca- tion	Date Sur- veyed	Operator	Mission Name	Flood- plain Surveyed Area (km2)	Total Flood- plain Area (km2)	Water- shed Surveyed Area (km2)	Total Water- shed 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				

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



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

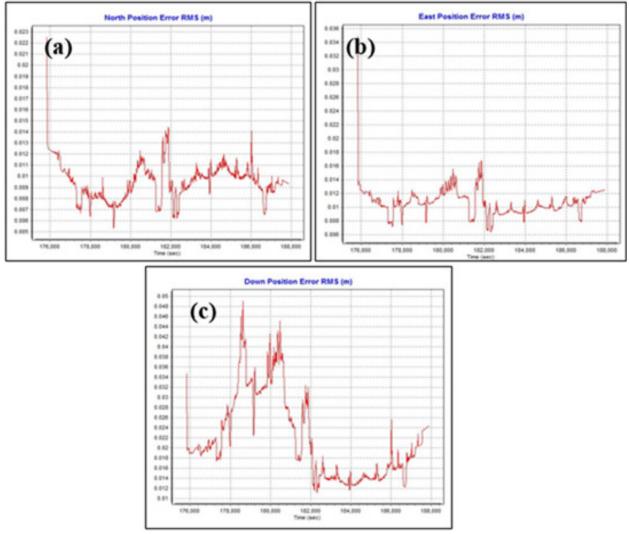


Figure 22. Smoothed Performance Metric Parameters for North (a), East (b), and Down (c) of Jalaur flight.

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.



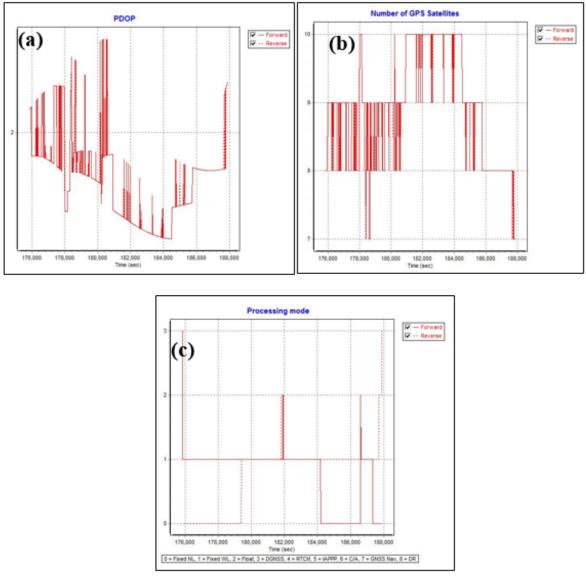


Figure 23. Solution Status Parameters of Jalaur flight

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



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.

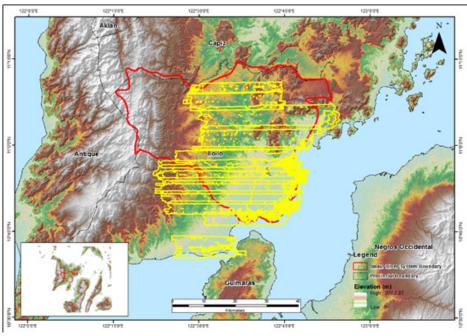


Figure 24. Coverage of LiDAR data for the Jalaur mission

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%.



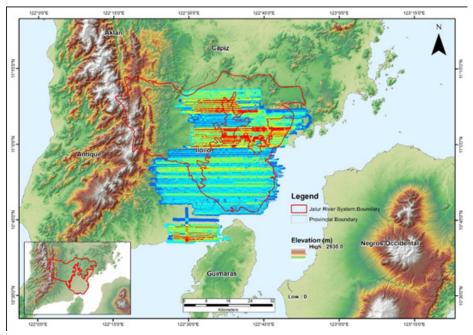


Figure 25. Image of data overlap for the Jalaur mission

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.

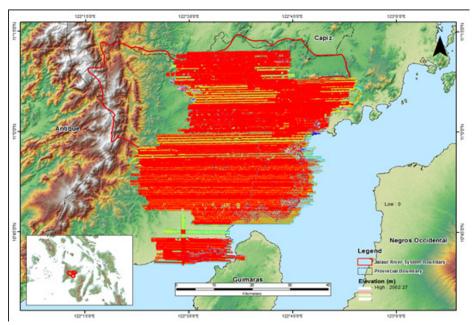


Figure 26. Density map of merged LiDAR data for the Jalaur mission

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.



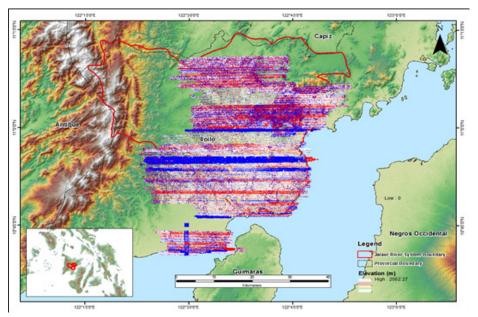


Figure 27. Elevation difference map between flight lines

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.

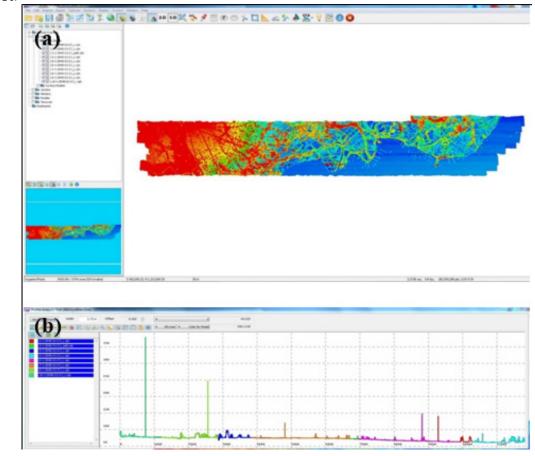


Figure 28. Quality checking with the profile tool of QT Modeler



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.

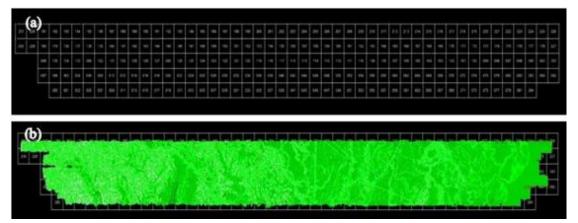


Figure 29. (a) Jalaur floodplains and (b) Jalaur classification results in TerraScan

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

Table 16. Jalaur classification results in TerraScan

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.



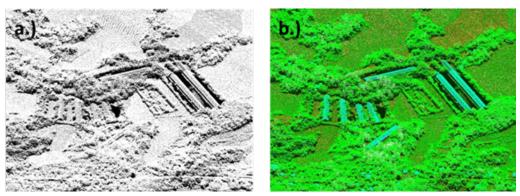


Figure 30. Point cloud (a) before and (b) after classification

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.

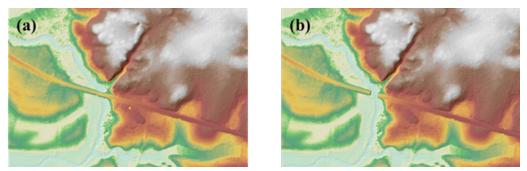


Figure 31. Images of DTMs before and after manual editing

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.



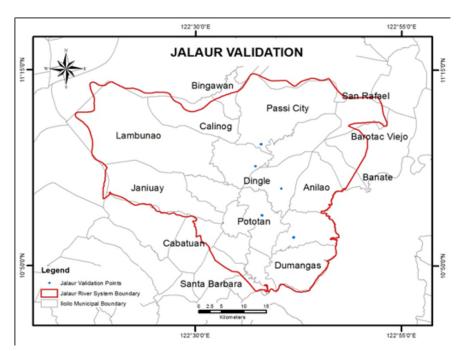


Figure 32. Map of Jalaur River System with validation survey shown in blue

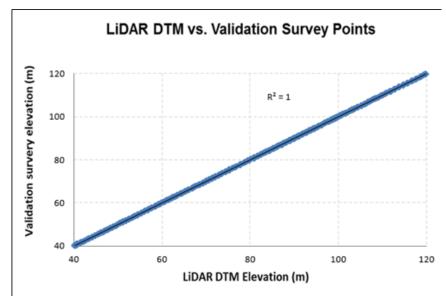


Figure 33. One-one Correlation plot between topographic and LiDAR data

Table 17. Statistica	I values for the	e calibration of flights
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Statistical Information	Values (cm)
Min	-42.069
Max	54.725
RMSE	16.646
Standard Deviation	16.653
LE90	22.676



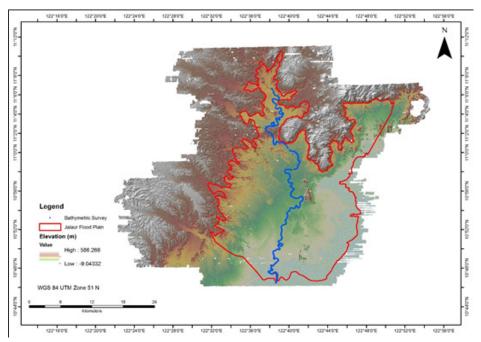


Figure 34. Final DTM of Jalaur with validation survey shown in blue

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.

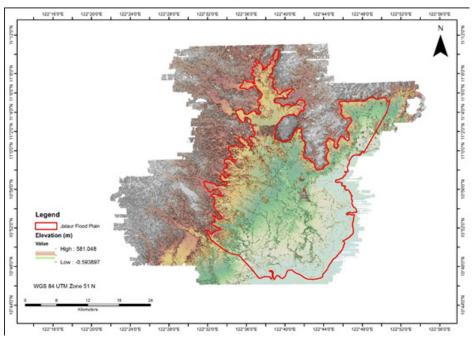


Figure 35. Final DSM in Jalaur



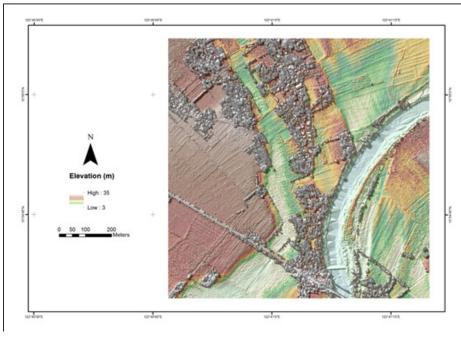


Figure 36. Sample 1x1 square kilometer DSM

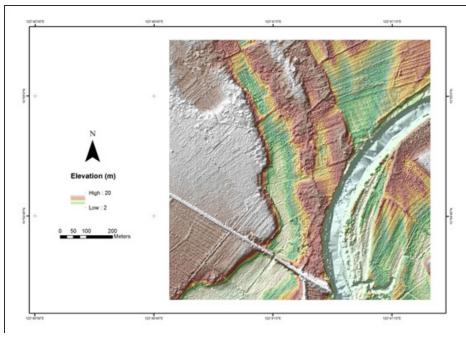
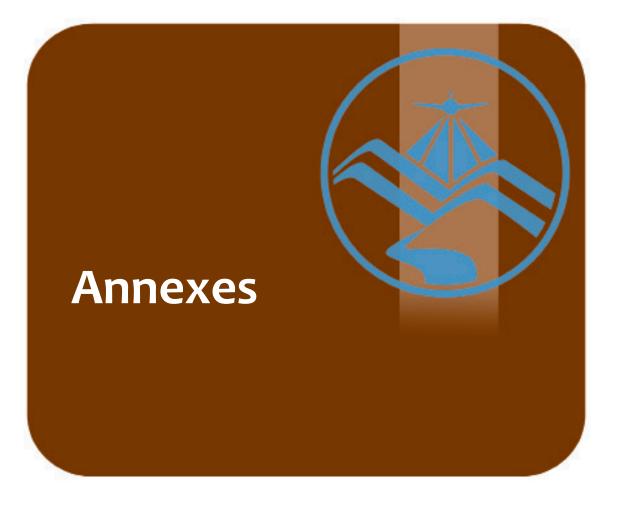


Figure 37. Sample 1x1 square kilometer DTM









OPTECH TECHNICAL SPECIFICATIONS OF THE PEGA-SUS SENSOR

Parameter	Specification
Operational envelope (1,2,3,4)	150-5000 m AGL, nominal
Laser wavelength	1064 nm
Horizontal accuracy (2)	$1/5,500 \text{ x}$ 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, in- cluding 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



OPTECH TECHNICAL SPECIFICATIONS OF THE GEM-INI 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 fre- quency 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, in- cluding last (12 bit)
Video Camera	Internal video camera (NTSC or PAL)
Image capture	Compatible with full Optech camera line (op- tional)
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 technolo- gy (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
Imag	e 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)



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 Re- search 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 JOA- QUIN	UP TCAGP
Ground Survey	Senior Science Research Specialist (SSRS)	ENGR. GEROME HIPOLITO	UP TCAGP
Ground Survey	Research Associate	ENGR. JAMES BEL- TRAN	UP TCAGP
Data Download and Transfer	Research Associate	PATRICIA YSABEL ALCANTARA	UP TCAGP
LiDAR Operation	Airborne Security	SSG. EDILITO NAN- QUIL, ERWIN DE LOS SANTOS	Philippine Air Force (PAF)
LiDAR Operation	Pilot	JAMAAL CLEMENTE	AAC
LiDAR Operation	Co-pilot	LAWRENCE MADAY- AG	AAC
LiDAR Operation	Co-pilot	FERDINAND DE OC- AMPO	AAC
LiDAR Operation	Co-pilot	MARK TANGONAN	AAC

NAMRIA CERTIFICATION

1.) ILO-64

			May 10, 2013
		CERTIFICATION	May 10, 2010
o whom it	may concern:	CERTIFICATION	
		ne records on file in this office, the	requested survey information is as follows -
		Province: ILOILO	
		Station Name: ILO-64	
lolond: 1	/ISAYAS	Order: 2nd	Deserve BODI ACION
	lity: MINA		Barangay: POBLACION
Latitude	400 551 54 504070	PRS92 Coordinates	B The statut
Latitude:	10° 55' 54.58427"	Longitude: 122º 34' 23.77840'	" Ellipsoidal Hgt: 40.62000 m.
		WGS84 Coordinates	
Latitude:	10° 55' 50.18711"	Longitude: 122º 34' 28.98100'	" Ellipsoidal Hgt: 97.63900 m.
		PTM Coordinates	
Northing	1208822.191 m.	Easting: 453354.591 m.	Zone: 4
Northing	1,208,399.08	UTM Coordinates Easting: 453,370.92	Zone: 51
.O-64 rom Iloilo (City, travel N for about 34 k	Location Description m. passing by the towns of Sta. Ba	arbara, Cabatuan and Janiuay. It is located xout 12 m. W of Mina Nati. High School,
n the W si bout 25 m ne sixth pla	NNW of the Rizal monum ant box from the N side of the	ent, 3 m. N of the third plant box fro	om the Rizal monument and 1.5 m. S of a copper nail centered on a 30 cm. x 30
n the W si bout 25 m ne sixth pla m. concret	NNW of the Rizal monum ant box from the N side of the block and flush with the g Party: Christopher Cruz	ent, 3 m. N of the third plant box fr ne plaza. Mark is the head of a 4 in ground surface, with inscriptions "IL	om the Rizal monument and 1.5 m. S of a copper nail centered on a 30 cm. x 30
n the W si bout 25 m he sixth pla m. concret equesting upose:	NNW of the Rizal monum ant box from the N side of the block and flush with the g Party: Christopher Cruz Reference	ent, 3 m. N of the third plant box fr ne plaza. Mark is the head of a 4 in ground surface, with inscriptions "IL	om the Rizal monument and 1.5 m. S of a copper nail centered on a 30 cm. x 30
n the W si bout 25 m le sixth pla m. concret equesting upose: IR Number	NNW of the Rizal monum ant box from the N side of the block and flush with the g Party: Christopher Cruz Reference	ent, 3 m. N of the third plant box fr ne plaza. Mark is the head of a 4 in ground surface, with inscriptions "IL	om the Rizal monument and 1.5 m. S of . copper nail centered on a 30 cm. x 30 .0-64, 2005, NAMRIA".
n the W si bout 25 m he sixth pla m. concret equesting upose: IR Number	NNW of the Rizal monum ant box from the N side of the block and flush with the g Party: Christopher Cruz Reference r: 3943636B	ent, 3 m. N of the third plant box fr ne plaza. Mark is the head of a 4 in ground surface, with inscriptions "IL	om the Rizal monument and 1.5 m. S of . copper nail centered on a 30 cm. x 30 .0-64, 2005, NAMRIA". RUEL DM. BELEN, MNSA tor, Mapping and Geodesy Department
n the W si bout 25 m he sixth pla m. concret equesting upose: IR Number	NNW of the Rizal monum ant box from the N side of the block and flush with the g Party: Christopher Cruz Reference r: 3943636B	ent, 3 m. N of the third plant box fr ne plaza. Mark is the head of a 4 in ground surface, with inscriptions "IL	om the Rizal monument and 1.5 m. S of . copper nail centered on a 30 cm. x 30 .0-64, 2005, NAMRIA". RUEL DM. BELEN, MNSA
n the W si bout 25 m ne sixth pla m. concret	NNW of the Rizal monum ant box from the N side of the block and flush with the g Party: Christopher Cruz Reference r: 3943636B	ent, 3 m. N of the third plant box fr ne plaza. Mark is the head of a 4 in ground surface, with inscriptions "IL	om the Rizal monument and 1.5 m. S of . copper nail centered on a 30 cm. x 30 .0-64, 2005, NAMRIA". RUEL DM. BELEN, MNSA tor, Mapping and Geodesy Department
n the W si bout 25 m he sixth pla m. concret equesting upose: IR Number	NNW of the Rizal monum ant box from the N side of the block and flush with the g Party: Christopher Cruz Reference r: 3943636B	ent, 3 m. N of the third plant box fr ne plaza. Mark is the head of a 4 in ground surface, with inscriptions "IL	om the Rizal monument and 1.5 m. S of . copper nail centered on a 30 cm. x 30 .0-64, 2005, NAMRIA". RUEL DM. BELEN, MNSA tor, Mapping and Geodesy Department



.) ILO-66

<text><section-header> April 26, 2013 Participations Acternations Addition of the second proteins Insistic conditions of the second proteins on file in this office, the requested survey information is as follows - Province: LineLine Batterna (1999) Characterna (1999) Marcine (1990) Marcine (1990) <!--</th--><th></th><th>CER</th><th>TIFICATION</th><th></th><th>April 20, 2015</th></section-header></text>		CER	TIFICATION		April 20, 2015
o 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 Municipality: DINGLE Latitude: 10° 59' 56.14968" Latitude: 10° 59' 56.14968" Latitude: 10° 59' 51.74412" Longitude: 122° 40' 18.68063" Latitude: 10° 59' 51.74412" Longitude: 122° 40' 23.87665" Morthing: 1216230.423 m. Easting: 464.151.51 Sone: 51 Location Description Location Description Location Description Location Sone: 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions" ILO-66 2005 <th></th> <th>CER</th> <th>TIFICATION</th> <th></th> <th></th>		CER	TIFICATION		
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 Barangay: Municipality: DINGLE Cation Set 2000 Latitude: 10° 59' 56.14968" Longitude: 122° 40' 23.87665" Ellipsoidal Hgt: 34.81500 m. <i>WGS84 Coordinates WGS84 Coordinates</i> Latitude: 10° 59' 51.74412" Longitude: 122° 40' 23.87665" Ellipsoidal Hgt: 34.81500 m. <i>MGTMCoordinates MTM Coordinates MTM Coordinates MTM Coordinates</i> Northing: 1,215,804.72 Easting: 464,151.51 Zone: 51 Socated inside the grounds of Dingle Elem. School, SW of the Science Bldg., W of the Main Bldg. and NE of the diministration Bldg. It is also situated at the S corner of the basketball court. Mark is the head of a 4 in. copper nail entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface. with inscriptions" ILO-66 2005<					
Province: ILOILO Station Name: ILO-66 Order: 2nd 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 0-66 s located inside the grounds of Dingle Elem. School, SW of the Science Bidg., W of the Main Bidg, and NE of the diministration Bidg. It is also situated at the S comer of the basketball court. Mark is the head of a 4 in cooper nail entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 LATER SCHORE SCHOOL SW OF the Science Bidg., W of the Main Bidg, and NE of the diministration Bidg. It is also situated at the S comer of the basketball court. Mark is the head of a 4 in cooper nail entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 LATER SCHORE SCHORE SCHORE SCHORE SURGER STRUCTURE SCHORE SURGER SCHORE SURGER STRUCTURES SURGER STRUCTURES Northing: 213-0380	This is to certify that acc	anding to the recentle on t	De in this office the requi	ested survey inform	ation is an fallouus
Biand: VISAYAS Barangay: Municipality: DINGLE PRS92 Coordinates Latitude: 10° 59' 56.14968" Longitude: 122° 40' 18.68063" Ellipsoidal Hgt: 27.71400 m. WGS84 Coordinates WGS84 Coordinates Ellipsoidal Hgt: 84.81500 m. Latitude: 10° 59' 51.74412" Longitude: 122° 40' 23.87665" Ellipsoidal Hgt: 84.81500 m. MGS84 Coordinates MGS84 Coordinates MGS84 Coordinates Latitude: 10° 59' 51.74412" Longitude: 122° 40' 23.87665" Ellipsoidal Hgt: 84.81500 m. Morthing: 1216230.423 m. Easting: 464138.956 m. Zone: 4 Morthing: 1,215,804.72 Easting: 464,151.51 Zone: 51 Location Description Location Description Location Description 0-66 Socated inside the grounds of Dingle Elem. School, SW of the Science Bldg, W of the Main Bldg, and NE of the doministration Bldg. It is also situated at the Scormer of the basketball court. Mark is the head of a 4 in. copper nail entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 MARIA". Requesting Party: UP-TCAGP Marketball Marketball Marketball Marketball Marketball N: 2013-0360 Marketball		braing to the records on	nie in this once, the requ	lested survey informa	ation is as follows -
Drder: 2nd Barangay: Municipality: DINGLE PRS92 Coordinates Latitude: 10° 59' 56.14968" Longitude: 122° 40' 18.68063" Ellipsoidal Hgt: 27.71400 m. WGS84 Coordinates WGS84 Coordinates Ilipsoidal Hgt: 27.71400 m. Latitude: 10° 59' 51.74412" Longitude: 122° 40' 23.87665" Ellipsoidal Hgt: 84.81500 m. Latitude: 10° 59' 51.74412" Longitude: 122° 40' 23.87665" Ellipsoidal Hgt: 84.81500 m. Morthing: 1216230.423 m. Easting: 464138.956 m. Zone: 4 Morthing: 1,215,804.72 Easting: 464,151.51 Zone: 51 Location Description Location Description Location Description C-66 Socated inside the grounds of Dingle Elem. School, SW of the Science Bldg, W of the Main Bldg, and NE of the doministration Bldg. It is also situated at the Scorner of the basketball court. Mark is the head of a 4 in. copper nail entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 MARIA". Requesting Party: UP-TCAGP Munber: 3943584 B Munber: 3943584 B N: 2013-0360 Munber: 1943-0360 Munber: 1943-0360					
Island: VISAYAS Barangay: Municipality: DINGLE PRS92 Coordinates Latitude: 10° 59' 56.14968" Longitude: 122° 40' 18.68063" Ellipsoidal Hgt: 27.71400 m. WGS84 Coordinates WGS84 Coordinates Latitude: 10° 59' 51.74412" Longitude: 122° 40' 23.87665" Ellipsoidal Hgt: 84.81500 m. PTM Coordinates PTM Coordinates Northing: 1216230.423 m. Easting: 464138.956 m. Zone: 4 UTM Coordinates Done: 4 Northing: 1,215,804.72 Easting: 464,151.51 Zone: 51 Location Description Co-66 Is located inside the grounds of Dingle Elem. School, SW of the Science Bldg., W of the Main Bldg, and NE of the dministration Bldg. It is also situated at the S corner of the basketball court. Mark is the head of a 4 in. copper nail entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 VAMRIA". VP-TCAGP Pupose: Reference PR Number: 3943584 B N: 2013-0360					
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. Latitude: 10° 59' 51.74412" Longitude: 122° 40' 23.87665" Ellipsoidal Hgt: 84.81500 m. PTM Coordinates PTM Coordinates Date: 4 Date: 4 Northing: 1216230.423 m. Easting: 464138.956 m. Zone: 4 Morthing: 1,215,804.72 Easting: 464,151.51 Zone: 51 Location Description Decated Socated inside the grounds of Dingle Elem. School, SW of the Science Bldg., W of the Main Bldg. and NE of the intered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 MAMRIA". Requesting Party: UP-TCAGP VP-TCAGP Wapose: Reference N: 2013-0360 N: 2013-0360 A A	Island: VISAYAS	Order	200	Barangay:	
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 MC Coordinates Northing: 1,215,804.72 Easting: 464,151.51 Zone: 51 Location Description Co-66 Incation Description Sone: 64 in. copper nail corrected inside the grounds of Dingle Elem. School, SW of the Science Bidg., W of the Main Bidg. and NE of the intered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 Co-66 Requesting Party: UP-TCAGP Wapose: Reference IR Number: 3943584 B N: 2013-0360	Municipality: DINGLE	PRS	92 Coordinates		
WGS84 Coordinates Latitude: 10° 59' 51.74412" Longitude: 122° 40' 23.87665" Ellipsoidal Hgt: 84.81500 m. <i>PTM Coordinates</i> Northing: 1216230.423 m. Easting: 464138.956 m. Zone: 4 Morthing: 1,215,804.72 Easting: 464,151.51 Zone: 51 Location Description Location Description 0-66 Isocated inside the grounds of Dingle Elem. School, SW of the Science Bldg., W of the Main Bldg. and NE of the Idministration Bldg. It is also situated at the S corner of the basketball court. Mark is the head of a 4 in. copper nail entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 LAMRIA". Requesting Party: UP-TCAGP Wippose: Reference IN Number: 3943584 B N: 2013-0360	Latitude: 10º 59' 56.149			Ellipsoidal Hgt:	27.71400 m.
Latitude: 10° 59' 51.74412" Longitude: 122° 40' 23.87665" Ellipsoidal Hgt: 84.81500 m. <i>PTM Coordinates</i> Northing: 1216230.423 m. Easting: 464138.956 m. Zone: 4 Morthing: 1216230.423 m. Easting: 464138.956 m. Zone: 4 Northing: 1,215,804.72 Easting: 464,151.51 Zone: 51 Location Description Co-66 Soloated inside the grounds of Dingle Elem. School, SW of the Science Bidg., W of the Main Bidg. and NE of the diministration Bidg. It is also situated at the S corner of the basketball court. Mark is the head of a 4 in. copper nail entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 LAMRIA". Requesting Party: UP-TCAGP Wapose: Reference N: 2013-0360		WGS	84 Coordinates		
PTM Coordinates Northing: 1216230.423 m. Easting: 464138.956 m. Zone: 4 Morthing: 1,215,804.72 Easting: 464,151.51 Zone: 51 Location Description C0-66 Slocated inside the grounds of Dingle Elem. School, SW of the Science Bldg., W of the Main Bldg. and NE of the dministration Bldg. It is also situated at the S corner of the basketball court. Mark is the head of a 4 in. copper nail entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 WarkIA". Hequesting Party: UP-TCAGP Wapse: Reference N: 2013-0360 N: 2013-0360 Head State B	Latitude: 10° 59' 51.744			Ellipsoidal Hot	84.81500 m.
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 .0-66 Iocated inside the grounds of Dingle Elem. School, SW of the Science Bldg., W of the Main Bldg. and NE of the dministration Bldg. It is also situated at the S corner of the basketball court. Mark is the head of a 4 in. copper nail entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 IAMRIA". Requesting Party: UP-TCAGP 'upose: Reference 'R Number: 3943584 B 'N.: 2013-0360				,	
UTM Coordinates Northing: 1,215,804.72 Easting: 464,151.51 Zone: 51 Location Description C0-66 Solocated inside the grounds of Dingle Elem. School, SW of the Science Bidg., W of the Main Bidg. and NE of the dministration Bidg. It is also situated at the S corner of the basketball court. Mark is the head of a 4 in. copper nail entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 IAMRIA". Requesting Party: UP-TCAGP 'upose: Reference 'R Number: 3943584 B 'N.: 2013-0360	Northing: 1216230 423 n			Zone: 4	
Northing: 1,215,804.72 Easting: 464,151.51 Zone: 51 Location Description C0-66 Iocation Description Socated inside the grounds of Dingle Elem. School, SW of the Science Bidg., W of the Main Bidg. and NE of the indministration Bidg. It is also situated at the S corner of the basketball court. Mark is the head of a 4 in. copper nail entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 IAMRIA". Requesting Party: UP-TCAGP 'upose: Reference 'R Number: 3943584 B 'N.: 2013-0360	Noraling. 1210200.42011			20110. 4	
LO-66 a located inside the grounds of Dingle Elem. School, SW of the Science Bldg., W of the Main Bldg. and NE of the diministration Bldg. It is also situated at the S corner of the basketball court. Mark is the head of a 4 in. copper nail entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 IAMRIA". Requesting Party: UP-TCAGP Pupose: Reference DR Number: 3943584 B N.: 2013-0360	Northing: 1,215,804.72			Zone: 51	
LO-66 a located inside the grounds of Dingle Elem. School, SW of the Science Bldg., W of the Main Bldg. and NE of the diministration Bldg. It is also situated at the S corner of the basketball court. Mark is the head of a 4 in. copper nail entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 IAMRIA". Requesting Party: UP-TCAGP Pupose: Reference DR Number: 3943584 B N.: 2013-0360					
entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 IAMRIA". Requesting Party: UP-TCAGP rupose: Reference DR Number: 3943584 B .N.: 2013-0360 RUELDM. BELEN, MNSA	_O-66				
entered on a 30 cm. x 30 cm. concrete monument and flushed with ground surface, with inscriptions "ILO-66 2005 IAMRIA". Requesting Party: UP-TCAGP rupose: Reference DR Number: 3943584 B .N.: 2013-0360 RUELDM. BELEN, MNSA	s located inside the grounds dministration Bldg. It is also	of Dingle Elem. School, situated at the S corner	SW of the Science Bldg of the basketball court.	., W of the Main Bldg Mark is the head of a	g. and NE of the 4 in. copper nail
Pupose: Reference DR Number: 3943584 B .N.: 2013-0360 RUELDM. BELEN, MNSA	entered on a 30 cm. x 30 cl IAMRIA".	m. concrete monument a	nd flushed with ground s	surface, with inscription	ons "ILO-66 2005
Pupose: Reference DR Number: 3943584 B .N.: 2013-0360 RUELDM. BELEN, MNSA					
OR Number: 3943584 B .N.: 2013-0360 RUELDM. BELEN, MNSA					/
N.: 2013-0360 RUELDM. BELEN, MNSA				/Ale	
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9 9 0 4 2 6 2 0 1 3 1 6 3 2 4 0				0426201316	3240
			Director, N	happing and Geodes	y Department
9904262013163240				0426201316	3240



3.) ILO-69

					June 13, 2013
		CERT	IFICATION		
o whom it may cor	ncern:				
This is to certify	that according to t	he records on file	in this office, the requ	lested survey info	rmation is as follows
		Province	e: ILOILO		
			ame: ILO-69		
Island: VISAYA	-	Order: 2	2nd	Barangay:	
Municipality: PA	SSI CITY	PRS92	Coordinates		
Latitude: 11º 7	7.97593"		122º 38' 42.65948"	Ellipsoidal Hg	at: 63.94700 m.
		WGS84	Coordinates		
Latitude: 11º 7	3.53798"		122° 38' 47.84510"	Ellipsoidal Hg	at: 120.69300 m.
		PTM	Coordinates		
Northing: 12295	00.996 m.	Easting: 4	461239.791 m.	Zone: 4	
		UTM	Coordinates		
Northing: 1,229	,070.65	Easting: 4	61,253.36	Zone: 5	1
LO-69 2005 NAMI equesting Party: upose:	u near the new Pas the flagpole. It is a 30 cm. x 30 cm. c RIA". UP-TCAGP Reference FREE ISSUE 2013-0571	si City Hall, abou lso situated N of oncrete block/mo	t 22.11 m. NE form the the Passi Police Statio onument and 30 cm. at nument and 30 cm. at R Director, M		5
R Number: N.:				/	~

54 | 🐳

4.) ILO-89

				May 10, 2013
		CERTIFICATION	J	Way 10, 2015
To whom it may	concern:			
		the records on file in this office	, the requested survey i	information is as follows -
		Province: ILOILO		
		Station Name: ILO-89		
Island: VISA		Order: 2nd	Barangay	CAGAMUTAN NORTE
Municipality:	LEGANES	PRS92 Coordinate		
Latitude: 10	° 48' 55.43533"	Longitude: 122º 36' 5.65	-	Hat: 0 70000
				Hgt: 9.79800 m.
Latitudo: 10	° 48' 51.06990"	WGS84 Coordinate		
Lautude. 10	48 51.06990	Longitude: 122º 36' 10.8	6897" Ellipsoidal	Hgt: 67.16300 m.
		PTM Coordinates		
Northing: 11	95940.297 m.	Easting: 456431.138 n	n. Zone:	4
Northing: 1,	195,521,70	UTM Coordinates Easting: 456,446.39	Zone:	51
			20116.	51
LO-89		Location Description		
From Iloilo City, Bray, Cagamuta	travel NE to the Mun. n Norte, Station is loc	of Leganes. From Leganes To	wn Proper, travel NW fo	or about 3.5 km. to
		ated on the right side of the set tan Elem. School.		
Mark is the head nscriptions "ILO	of a 4 in. copper nail -89 2007 NAMRIA".	set flushed and cemented on a	a 30 cm. x 30 cm. ceme	ent putty, with
Convocting Dart	Christopher Cru Reference	z	M	ha.
Requesting Party Pupose:	3943636B		117	they
Pupose: DR Number:			RUEL DM. BELI	EN, MNSA
Pupose: DR Number:	2013-0424			
Pupose:		D	irector, Mapping and G	eodesy Department
Pupose: DR Number:		D	Director, Mapping and G	eodesy Department
Pupose: DR Number:		D	birector, Mapping and G	eodesy Department
Pupose: DR Number:		D	birector, Mapping and G	eodesy Department
Pupose: DR Number:		D	irector, Mapping and G	eodesy Department مربع
Pupose: DR Number:		D	irector, Mapping and G	eodesy Department



5.) ILO-91

A THE THE				May 10, 0010
	0503			May 10, 2013
o uham it may appears	CERI	FIFICATION		
o whom it may concern: This is to certify that according to th	e records on fil	le in this office, the requ	lested survey infor	mation is as follows -
	Provinc			
		ame: ILO-91		
	Order:	2nd		
Island: VISAYAS Municipality: ANILAO			Barangay: PC	BLACION
		2 Coordinates		
Latitude: 10° 58' 46.51769"	Longitude:	122° 44' 53.92299"	Ellipsoidal Hg	t 22.74100 m.
	WGS8	4 Coordinates		
Latitude: 10° 58' 42.12357"	Longitude:	122° 44' 59.12020"	Ellipsoidal Hg	t: 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	
LO-91 From Iloilo City, travel NE to the Mun. o Station is located on the NE quadrant o ind about 10 m. W from the circular pla of Anilao Covered Gym and 40 m. N op of a 30 cm. x 30 cm. concrete mont IAMRIA". Requesting Party: Christopher Cruz Pupose: Reference OR Number: 3943636B T.N.: 2013-0422	f the said plaza ant base, 20 m. V of Anilao Mu ument protrudir	a about 7 m. from the st from the road centerlin n. Hall. Mark is the hea ig 20 cm. above the gro	age, about 7 m. N ne, 45 m. NE of An d of a 4 in.copper	of the lamp post ilao Church, 33 m. nail set flushed on ons "ILO-91 2007
		\$ \$ I	5 1 0 2 0 1 3 1	6 0 4 4 3

56



6.) IL-381A

	Department of Environm NATIONAL MAPPI	nest nent and Natural Resources ING AND RESOURCE INFORMATION	AUTHORITY
1997			
			April 24, 2013
		CERTIFICATION	
To whom it may co	oncern:		
This is to certify	y that according to the	records on file in this office, the requ	ested survey information is as follows -
		Province: ILOILO Station Name: IL-381A	
Island: Visayas	5	Municipality: ZARRAGA	Barangay: GINES
Elevation: 6.94	62 m.	Order: 1st Order	Datum: Mean Sea Level
National Highway	. The station is located	d on the top of a concrete pavement	nes, along the Barotac Nuevo-Zarraga at the road junction to Phase 1B Grand
National Highway Subdivision, 9m fr Mark is the head	The station is located rom the waiting shed and rom the waiting shed she rom the waiting	b, Municipality of Zarrage, Brgy. Gid on the top of a concrete pavement of 15m from the road centerline.	nes, along the Barotac Nuevo-Zarraga at the road junction to Phase 1B Grand at putty with inscriptions "IL-381A, 2012,
National Highway Subdivision, 9m fr Mark is the head NAMRIA". Requesting Party:	The station is located rom the waiting shed an of a 4" copper nail se Christopher Cruz	b, Municipality of Zarrage, Brgy. Gid on the top of a concrete pavement of 15m from the road centerline.	at the road junction to Phase 1B Grand
National Highway Subdivision, 9m fr Mark is the head NAMRIA". Requesting Party: Pupose: OR Number:	 The station is located rom the waiting shed ar of a 4" copper nail se Christopher Cruz Reference 3943573 B 	b, Municipality of Zarrage, Brgy. Gid on the top of a concrete pavement of 15m from the road centerline.	at the road junction to Phase 1B Grand
National Highway Subdivision, 9m fr Mark is the head NAMRIA". Requesting Party: Pupose: OR Number:	 The station is located rom the waiting shed an of a 4" copper nail se Christopher Cruz Reference 	b, Municipality of Zarrage, Brgy. Gi d on the top of a concrete pavement nd 15m from the road centerline. It flushed on a 15cm x 15cm cemer	at the road junction to Phase 1B Grand
National Highway Subdivision, 9m fr Mark is the head NAMRIA". Requesting Party: Pupose: OR Number:	 The station is located rom the waiting shed ar of a 4" copper nail se Christopher Cruz Reference 3943573 B 	b, Municipality of Zarrage, Brgy. Gi d on the top of a concrete pavement nd 15m from the road centerline. It flushed on a 15cm x 15cm cemer	t the road junction to Phase 1B Grand to putty with inscriptions "IL-381A, 2012, MARKAN BELEN, MNSA
National Highway Subdivision, 9m fr Mark is the head NAMRIA". Requesting Party: Pupose: OR Number:	 The station is located rom the waiting shed ar of a 4" copper nail se Christopher Cruz Reference 3943573 B 	b, Municipality of Zarrage, Brgy. Gi d on the top of a concrete pavement nd 15m from the road centerline. It flushed on a 15cm x 15cm cemer	t the road junction to Phase 1B Grand to putty with inscriptions "IL-381A, 2012, MARKAN BELEN, MNSA
National Highway Subdivision, 9m fr	 The station is located rom the waiting shed ar of a 4" copper nail se Christopher Cruz Reference 3943573 B 	b, Municipality of Zarrage, Brgy. Gi d on the top of a concrete pavement nd 15m from the road centerline. It flushed on a 15cm x 15cm cemer	t the road junction to Phase 1B Grand to putty with inscriptions "IL-381A, 2012, MARKAN BELEN, MNSA



7.) IL-391A

. 1987			
			April 24, 2013
		CERTIFICATION	
To whom it may co	ncern:		
This is to certify	that according to the	records on file in this office, the reques	sted survey information is as follows -
		Province: ILOILO Station Name: IL-391A	
Island: Visayas		Municipality: BAROTAC NUEVO	Barangay: JT BRETAÑA
Elevation: 12.15	93 m.	Order: 1st Order	Datum: Mean Sea Level
National Highway.	The station is locate	Municipality of Barotac Nuevo, Brgy. d at the top of the sidewalk beside a lar	JT Bretaña, along the Zarraga-Anila np post fronting Ara Grace Food Store
and 6m from the ro Mark is the head o NAMRIA".	of a 4" copper nail se		putty with inscriptions "IL-391A, 2012,
Mark is the head on NAMRIA". Requesting Party:		et flushed on a 15cm x 15cm cement	putty with inscriptions "IL-391A, 2012,
Mark is the head on NAMRIA". Requesting Party: Pupose:	Christopher Cruz Reference	et flushed on a 15cm x 15cm cement	putty with inscriptions "IL-391A, 2012,
Mark is the head on NAMRIA". Requesting Party:	Christopher Cruz	et flushed on a 15cm x 15cm cement	Amb
Mark is the head on NAMRIA". Requesting Party: Pupose: OR Number:	Christopher Cruz Reference 3943573 B	et flushed on a 15cm x 15cm cement	BELEN, MNSA
Mark is the head on NAMRIA". Requesting Party: Pupose: OR Number:	Christopher Cruz Reference 3943573 B	et flushed on a 15cm x 15cm cement	BELEN, MINSA





DATA TRANSFER SHEET FOR JALAUR FLOODPLAIN

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

NN RANGE DIGITIZER BASE COMMENTS FLIGHT 21.9 GB N/A 3.43MB 1.09KB 55.9KB 1.09KB 55.9KB 21.9 GB N/A 5.62MB 437 BYTES 561KB 24.3KB 21.9 GB N/A 5.62MB 437 BYTES 561KB 23.3KB 22.8 GB N/A 5.91MB 464BYTES 271KB 1.09KB 23.3KB 22.8 GB N/A 10.9MB 32.9 BYTES 271KB 271KB 19.8 GB N/A 10.9MB 32.9 BYTES 271KB 271KB 19.8 GB N/A 10.9MB 32.9 BYTES 853KB 21.6 GB N/A 10.4MB 821 BYTES 853KB 61 P PRIEV APALET APALET 4.13 61 P PRIE APALET 4.13 821 BYTES 853KB								May 1	May 14, 2013						
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	pr 30, 2013	204G		GEMINI	N/A	667KB	312MB	39.7GB	284KB	14.4GB	N/A	5.62MB	437 BYTES	561KB	Z:\Airborne_R aw\204G
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FLIG RAW HT HT NO. MISSION NAME SENSOR LOGS PEGASUS 140MB 1, 2013 207P 1ASNC121A PEGASUS 140MB 1.18MB	RAW IMAGES				OPEDATOR		
		LOG FILE	RANGE DIGITIZER		BASE COMMENTS STATION(S) (DPC LOGS)	FLIGHT	SERVER
	B 34.3GB	264KB	22.4GB N/A	3.97MB		55.9KB	Z:\Airborne_R aw\207P
May 2, 2013 209P 1ASD122B PEGASUS 53.4MB 0 286MB	B 36.2GB	270KB	29.6GB N/A	2.34MB	15 BYTES	118KB	Z:\Airborne_R aw\207P
May 3, 2013 211P 1ASN1S123A PEGASUS 165MB 1.50MB 248MB	B 26.4GB	193KB	19.9GB N/A	2.02MB		43.7KB	Z:\Airborne_R aw\211P
May 3, 2013 212G 2PAN6D123B GEMINI N/A .98MB 298MB	B 50.6KB	432KB	21.6GB N/A	10.4MB	821BYTES	853KB	Z:\Airborne_R aw\212G
May 4, 2013 214G 2PAN6F124A GEMINI N/A 279MB	B 31.9GB	251KB	11.8GB N/A	13.3MB			Z:\Airborne_R aw\214G
May 4, 2013 216G 2PAN6C124B GEMINI N/A 324MB	B 46.7GB	393KB	22.4GB N/A	13.3MB			Z:\Airborne_R aw\216G
May 9, 2013 217P 1PAN6F129A PEGASUS 125MB 1.7MB 193MB	B 38.6GB	353KB	23.7GB N/A *	12.5MB	753KB		Z:\Airborne_R aw\217P
PEGASUS	B 25.6GB	221KB 1	18.6GB N/A	12.5MB	322KB	78.9KB	Z:\Airborne_R aw\219P
May 11, 2013/225P 1PAN6H131A PEGASUS 55.3MB 935KB 149MB	B 17.9GB	139KB 1	10.4GB N/A	7.56MB	444KB	86.7KB	aw\225P

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

Annex E

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

CEDVED	LOCATION	Z:\Airborne_ Raw\221P	Z:\Airborne_ Raw\223P	Z:\Airborne_ Raw\227P	Z:\Airborne_ Raw\229P	Z:\Airborne_ Raw\231P	Z:\Airborne_ Raw\233P	Z:\Airborne_ Raw\235P	Z:\Airborne_ Raw\237P	Z:\Airborne_ Raw\239P	
FLIGHT	PLAN										
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RASF	STATION(S)	7.12MB	4.65MB	2.41MB	8.43MB	7.16MB	9.87MB	9.87MB	10.3 MB	9.44 MB	et x
	RANGE DIGITIZER	N/A	N/A	N/A	N/A	NIA	N/A	NIA	N/A	N/A	the at
	RANGE	908MB	5.27GB	1.89GB	27GB 1	12.4GB I	15.2GB	12.9GB	17.9GB	21.8GB	9 F.Phe
MISSION	LOG FILE	2.60KB	74.3KB	14.4KB	265KB	1.24KB	142KB	29KB	193KB	325KB	y ture Toida P SSRS
RAW MISS	IMAGES	257MB	8.30GB	1.91GB	23.9GB	NO DATA (see Flight Status Report)	12.9GB	NO DATA (see Flight Status Report)	26.6GB	37.2GB	Received by Name/Signature $\overline{100}$ f. P_{10} et p_{10}
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DATE	DAIE	May 10, 2013 221P	May 10, 2013 223P	May 12, 2013 227P	May 13, 2013 229P	May 14, 2013 231P	May 15, 2013 233P	May 15, 2013 235P	May 16, 2013 237P	May 17, 2013 239P	

FLIGHT LOGS

1.) Flight log for 2PAN6A120A Mission

Flight Log No.: 244	ILOILO							٢
Flight	6 Aircraft Identification:		18 Total Flight Time:				Lidar Operator	
	5 Aircraft Type: CesnnaT206H 6 Aircraft Identification: 1\L01L_D	12 Airport of Arrival (Airport, City/Province): [1] A	17 Landing:				200	anted Name Disarter Rick Exposure
	4 Type: VFR	12 Airport of Arrival (16 Take off: JOCG				Pilot-in-Commanc	Signahura Duart
(Orthe) And C	3 Mission Name: 2000 Notest		15 Total Engine Time:	4 11 11 11 11 11 11 11 11 11 11 11 11 11		os setup.	Acquisition Flight Certified by	(PAF Representative)
	A Model: (42M/N)	0.	14 Engine Off:	good		- experienced (HU failure during Pas set up. restarted Pas. did of unic out. restarted system. Sk no:)		
DitEAM Data Acquisition Flight Log	1 LIDAR Operator: ATRL MARC 2 ALTA	10 Date:	13 Engine On:	19 Weather	20 Remarks :	21 Problems and Solutions: - experience restate	Acquisition Flight Approved by	Signature over Printed Name (End User Representative)

62

Annex F

2.) Flight log for 2P6E122A Mission

8 CO-PI				
ilot: L. Modayon 8 Co-Pilot: 2. Samar	Miri 3 Mission Name 2 PC	4 Type: VFR	5 Aircraft Type: CesnnaT206H 6 Aircraft Identification:	6 Aircraft Identification:
•	10t: 2. Saway 9 Route: 10/0	_	12 Airport of Arrival (Airport, City/Province):	
13 Engine On: 14 Engine Off:	15 Total Engine Time:	16 Take off:	17 Landing:	18 Total Flight Time:
bool youds	with child	Formeranis along ferring		
20 Remarks: on Singly planned to sure	art job . to do by . day at the	artist		
21 Problems and Solutions:				
			UN ~	
Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-comm	CAMPAR 7	Lidar operator
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature of	Signature ofer Printed Name	Signature over Printed Name
			Disaster Risk Fsposirre	D R E A M



3.) Flight log for 2P6N122B Mission

and a sco-Pilot: R. Samor old 12 Airport of Depa old 12 Airport of Depa old scored to PG44. Sta is school of Scored is school of S	1 8 Corplicit: Comment (Niport, CityProvince): 12 Airport of Arrival (Airport, CityProvince): 14 Engine Off: 12 Airport of Departure (Niport, CityProvince): 12 Airport of Niport, CityProvince): 16 Cost 16 Cost 15 Total Engine Time: 15 Total Engine Time: 16 Cost 16 Cost 17 Total Engine Time: 12 Airport of Arrival (Airport, CityProvince): 17 Cost 12 Airport 17 Total Engine Time: 12 Four of Arrival (Airport, CityProvince): 17 Cost 16 Cost 18 Engine Off: 17 Landing: 17 Cost 17 Start 10 Cost 17 Engine Off: 18 Cost 18 Cost 18 Cost 10 Cost 18 Cost 18 Cost 18 Cost 10 Cost 19 Cost 18 Cost 10 Cost 10 Cost 10 Cost 18 Cost 10 Cost 10 Cost 10 Cost 18 Cost 10 Cost 10 Cost 10 Cost 10 Cost 10 Cost 10 Cost <tr< th=""><th>the second secon</th><th>a 2 ALTM Model: Geniñ</th><th>1 LIDAR Operator: lo wely think 2 ALTM Model: Genis 3 Mission Name: 2PGND2B</th><th>4 Type: VFR</th><th>5 Aircraft Type: Cesnna T206H</th><th>6 Aircraft Identification:</th></tr<>	the second secon	a 2 ALTM Model: Geniñ	1 LIDAR Operator: lo wely think 2 ALTM Model: Genis 3 Mission Name: 2PGND2B	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification:
1 12 Airport of Capature (Airport, CityProvince): 12 Airport of Capature (Airport, CityProvince): 03 114 Engine Off: 15 Total Engine Time: 15 Take off: 12 Airport, CityProvince): 1 A Engine Off: 15 Total Engine Time: 15 Take off: 12 Airport, CityProvince): Aranyed 10 pout 14 Engine Off: 117 Landing: 117 Landing: Aranyed 10 pout 14 Engine Off: 117 Landing: 117 Landing: Aranyed 10 pout 16 for struct yint 76 N 117 Landing: Aranyed 10 pout 16 for struct yint 76 N 117 Landing: Aranyed 10 pout 10 for struct yint 76 N 117 Landing: Aranyed 10 pout 10 for struct yint 76 N 110 for struct Aranyeit 16 for struct yint 76 N 10 for struct 10 for struct Aranyeit 16 for struct for struct 10 for struct 10 for struct 10 for struct Aranyeit 10 for struct for struct 10 for struct 10 for struct 10 for struct Aranyeit 10 for struct for struct 10 for struct for struct 10 for struct 10 for struct	3.1 12 Airport of Departure (Airport, CIV/ 10 Cole Fingine Time: 12 Airport of Airival (Airport, CIV/ 10 Finding 11 Finding 12 Finding 12 Finding 12 Airport of Airival (Airport, CIV/ 12 Finding 12 Finding 12 Finding 12 Finding 12 Airport of Airival (Airport, CIV/ 12 Finding 12 Finding 12 Finding 12 Finding 12 Airport of Airival (Airport, CIV/ 12 Finding 12 Finding 12 Finding 12 Airport of Airival (Airport, CIV/ 12 Finding 12 Finding 12 Finding 12 Airport of Airival (Airport, CIV/ 12 Finding 11 Finding 12 Finding 11 Finding 12 Airport of Airival (Airport, CIV/ 12 Finding 11 Finding 11 Finding 12 Finding 11 Finding 12 Airport of Airval 12 Finding 11 Finding 11 Finding 11 Finding 11 Finding 11 Finding 11 Finding 11 Finding 12 Airport of Airval 12 Finding 11 Finding 12 Finding 11 Finding 12 Finding 11 Finding 12 Airport of Airval 12 Airval 12 Finding 12 Airval 12 Airval		D-Pilot: R.Samor]	9 Route:			
14 Engine Off: 15 Total Engine Time: 16 Take off: 17 Landing: 16 Coo 2 233 100 cm 2 333 10 cdy 14 aciry into picry Janey 2 433 10 cdy 14 aciry into picry Janey 2 433 10 cdy 14 aciry into picry Janey 2 433 10 cdy 14 aciry into picry 2 433 11 aciry Rey 15 court of aciry 2 433 11 aciry Rey 12 court of aciry 2 433 11 aciry Rey 12 court of aciry 12 court of aciry 11 aciry Rey 12 court of aciry 12 court of aciry 11 aciry Rey 12 court of aciry 12 court of aciry 11 aciry Rey 12 court of aciry 12 court of aciry 12 aciry Reg 12 court of aciry 12 court of aciry 13 aciry Reg 10 court of aciry 10 court of aciry 14 aciry Approved by Acquisition Flight Contribut 10 court of aciry 14 aciry Reg 10 court of aciry 10 court of aciry 10 court of aciry 14 aciry Reg 10 court of aciry 10 court of aciry 10 court of aciry 14 aciry Reg 10 court of aciry 10 court of aciry 10 court of aciry 14 aciry Reg 10 court of aciry 10 court of aciry 10 court of aciry <td>14 Engine Off: 15 Total Engine Time: 16 Take off: 17 Landing 1.12 Landing 2433 2433 24 .clouch th exity interferent Struct Area 2433 24 .clouch th exity interferent Struct 2433 24 .clouch th exity interferent Struct 24 24 .clouch th exity interferent Struct 24 24 .clouch th exity interferent Struct 24 24 .clouch the exity interferent Struct 24 24 .clouch th exity interferent Struct 24 24 .clouch th exit Struct 24 24 .clouch th Struct 24 .clouch Stru</td> <td>500</td> <td>12 Airport of Departure</td> <td>(Airport, City/Province):</td> <td>12 Airport of Arrival</td> <td>(Airport, City/Province):</td> <td></td>	14 Engine Off: 15 Total Engine Time: 16 Take off: 17 Landing 1.12 Landing 2433 2433 24 .clouch th exity interferent Struct Area 2433 24 .clouch th exity interferent Struct 2433 24 .clouch th exity interferent Struct 24 24 .clouch th exity interferent Struct 24 24 .clouch th exity interferent Struct 24 24 .clouch the exity interferent Struct 24 24 .clouch th exity interferent Struct 24 24 .clouch th exit Struct 24 24 .clouch th Struct 24 .clouch Stru	500	12 Airport of Departure	(Airport, City/Province):	12 Airport of Arrival	(Airport, City/Province):	
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d by Acquisition Flight Certified by Pilot-in-Command/ Pilot-in-	d by Acquisition Flight Certified by Pilot-In-Commandy Mart J <u> F. CFT-CAMMART J</u> <u> Signature over Printed Name</u> (PAF Representative)						
ne Signature over Printed Name Signature over Printed Name (PAF Representative)	ne Signature over Printed Name Signature over Printed Name (PAF Representative)	Acquisition Flight Approved		tion Flight Certified by	Pilot-in-comm	A	Lidar Operator
		Signature over Printed Nam (End User Representative)		rre over Printed Name ipresentative)	P. C.W.		Lovely Ariva Signature over Printed Name
							UDEAM

4.) Flight log for 2P6B123A Mission

DAR Operator: Reirl Mirry 2 ALTM Mc	del: CAMINI 3 Mission Name: 2908234	4 Type: VFR	5 Aircraft Type: CesnnaT206H 6 Aircraft Identification:	6 Aircraft Identification:
Date: 2 May 2015 12 Airport	of Departure (Airport, City/Province):	12 Airport of Arriva	12 Airport of Arrival (Airport, City/Province):	
Engine On: 14 Engine Off: ののなっつ 14 Engine Off: してる	13 Engine On: 14 Engine Off: 14 Engine Off: 15 Out Engine Time: 15 Out Engine Time: 16 Out Engine Time: 17 Out Engine Time: 18 Out Engine Time: 19 Out Engine Time: 19 Out Engine Time: 10 Out Engine Time: 10 Out Engine Time: 10 Out Engine Time: 11 O	16 Take off: Mol	17 Landing:	18 Total Flight Time:
19 Weather				
20 Remarks: Finstrol mision with possible doop wids due	Finstral mission into due to cloud formething day the wary	•		
21 Problems and Solutions:				
Acquisition Flight Approved by	Acquisition Flight Certified by	Pilot-in-Comman	A Maren	Lidar Operator
Signature over Printed Name (End User Representative)	Signature over Printed Name (PAF Representative)	Signature ov	L. C.Z. & M. W. A.L.U. Signature over Printed Name	Signature over Printed Name
				DRFAM



5.) Flight log for 2PAN6D123B Mission

7 Dilot 1 Kacda. da 8 Co.	1 LIDAR Operator: budy Jung 2 ALTM Model: Genin 3 Mission Name:		4 Type: VFR	S Aircraft Type: CesnnaT206H 6 Aircraft Identification:	6 Aircraft Identification:
mal [manand . A main	Pilot: R. Samor	9 Route: 1010			
10 Date: 3 May 20 B	12 Airport of Departure (Airport, City/Province):	Airport, City/Province):	12 Airport of Arrival	12 Airport of Arrival (Airport, City/Province):	
:"	14 Engine Off: しんしつ	15 Total Engine Time:	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather					
20 Remarks:					
21 Problems and Solutions: (00 % draps.re) collected fest	spected the whole says strip to at a ma	ems and solutions: (00 la draps. respected the unalo system in air realignment collected test strip to ok m range & intensity	Sament		
Acquisition Flight Approved by		Acquisition Flight Certified by	Pilot-in-Command	Charles Charle	Lidar Operator
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					CDEAM (



6.) Flight log for 2PF6124A Mission

:0								3
6 Aircraft Identificatio		18 Total Flight Time:				Lidar Operator	Signature over Printed Name	DREAM
S Aircraft Type: CesnnaT206H 6 Aircraft Identification:	12 Airport of Arrival (Airport, City/Province):	17 Landing:	. سه ای که			THU WHICH		
4 Type: VFR	2 Airport of Arrival	16 Take off: 02 14	it the w			Pilot-in-Command	Signature over	
1 LIDAR OPERATOR: POOR MARC 2 ALTM Model COMUN 3 Mission Name: 20 612 44	ity/Province):	Engine Off: 15 Total Engine Time: 16 Take o HEDT (103 05/42 05/14 Doct frair with base clads @ \$50m orthom	originally planned @ 1000m. the cloudy. decided to head instead to BC but areaiscloudier. went back to that & changed attitude to 850 m planetsored due to (on truel -love & truel + stisting the mission.	*		Acquisition Flight Certified by	Signature over Printed Name (PAF Representative)	
DAR Operator: POPRL MARC 2 ALTM MO	H-mo &		20 Remarks: originally planned @ decided to head inst went back to to plandported due to		21 Problems and Solutions:	Acquisition Flight Approved by	Signature over Printed Name (End User Representative)	



7.) Flight log for 2PAN6C124B Mission

]		
	6 Aircraft Identification:			18 Total Flight Time:				Lidar Operator	Signature over Printed Name	DREAM
	5 Aircraft Type: Cesnna T206H		12 Airport of Arrival (Airport, City/Province):	17 Landing:			amera			
9 22	+	4:108	12 Airport of Arrival (16 Take off:			ta / retts fell 0	Pilot-in-Comman	2. Signaturgover Printed Name	
and the second of a	Mission Na	9 Route: [[ails [not]		ngine Time: すくら			is and solutions: diops hary restarced diops / Still missing stoms destar/ restarked converg	Acquisition Flight Certified by	Signature over Printed Name (PAF Representative)	
(Cemin	2 ALTM Model:	8 Co-Pilot: R. Samer	ure 1 (tar		provod diops !	Acquisi	Signatu (PAF Re	
) at p - 1	Operator: Wow	L. Mcdayor	Derhaw no	3 1 Le 14 Engi	-	arks:	21 Problems and Solutions: هذ مولا المعري حدي	Acquisition Flight Approved by	Signature over Printed Name (End User Representative)	
	LIDAR Opera	7 Pilot: U-	10 Date: OU	13 Engine On:	19 Weather	20 Remarks:	21 Problems	Acqui	Signal (End L	



8.) Flight log for 2P6125A Mission

	and a second sec		the second s	
1 LIDAR Operator: Pacel made 2 ALTM Model: Centre 3 Mission Name: 201 120	3 Mission Name: 201 UCA	4 Type: VFR	5 Aircraft Type: CesnnaT206H 6 Aircraft Identification:	6 Aircraft Identification:
7 Pilot: R. Canada 8 Co-Pilot:	9 Route: lisilo			
10 Date: 5 Mer. 2012 12 Airport of Departure	12 Airport of Departure (Airport, City/Province):	12 Airport of Arrival	12 Airport of Arrival (Airport, City/Province):	
14 Engine Off:	15 Total Engine Time:	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather Joud				
20 Remarks: 1 hrs dechn agund for th	for de car.			
21 Problems and Solutions: AUTN Cordig channed my my parts.				
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which by the first the for her her the certific Acquisition Flight Certific	Acquisition Flight Certified by	Pilot-in-Com/ŋaŋ	- Diel	Lidar Operator
		R- SHANDIN	MARIE	Partmas
Signature over Printed Name (End User Representative) (PAF	Signature over Printed Name (PAF Representative)	Signature	Signature over Printed Name	Signature over Printed Name
			Disaster Risk Exposure	DREAM Construction of Assessment for Milipartion



9.) Flight Log for 1PAN6F129A Mission

1 LIDAR Operator: Mar C AND 2 ALT	3	FI29 4 Type: VFR	5 Aircraft Type: CesnnaT206H	S Aircraft Type: Cesnna T206H 6 Aircraft Identification
ate: 12 Alt	10 Date: 12 Albort of Departure (Aliport, City/Province):	12 Airport of Arriva	12 Airport of Arrival (Airport, City/Province):	
13 Engine On: 14 Engine Off: 11 0810 13 Partly Ob welly	Light 15 Total Engine Time: 1120 340 540	16 Take off:	17 Landing:	18 Total Flight Time:
20 Remarks:				
provolation 100	provolic read- due to clause.			
mission complete	put.			
21 Problems and Solutions:				
I	•			
Acquisition Flight Approved by Mask Arros Signature over Printed Name (End User Representative)	Acquisition Flight Certified by BIC ERUIN OFFICE State Signature over Printed Name (PAF Representative)	Pilot-in-comman	Pilot-in-Command Signature over Prined Name	Lidar Operator
1			Discontractified for even	DREAM

70



10.) Flight Log for 1P6G129B Mission

11DAR OPERATOR: J. Alvian 2 AITM Model: Receive 3 Mission Name: 1PG12A B 4 Type: VFR 5 Aircraft Type: Cesn 7 Pilot: J. Chuncult 800-Pilot: R. Samary 9 Route: Joho - Joho 10Date: og May 2013 12 Airport of Operature (Airport, Gity/Province): 12 Airport of Arrival (Airport, Gity/Province): 13 Engine On: 14 Engine Off: 12 Airport of Carlene: 12 Airport of Arrival (Airport, Gity/Province): 13 Engine On: 14 Engine Off: 15 Total Engine Time: 16 Take off: 17 Landing: 14 AIL - Very daudy w/ chances of Acuader Sterm 20 Remarks: . changed plan to 8 Sro m AdL . changed plan to 8 Sro m AdL . changed lines 1, 7, 2, 8, 3) . Conveyed lines 1, 7, 2, 8, 3)	5 Aircraft Type: Cesnna T206H urport, Gty/Province): 17 Landing:	6 Alrcraft Identification: I2P-C 4703 2 18 Total Flight Time:
Iot: J. Chunche 8 Co-Pilot: R. Samar 9 Route: Iloilo - Il	irport, City/Province): 17 Landing:	18 Total Flight Time:
Date: On Many 2013 12 Airport of Eperature (Airport, City/Province): 12 Airport of Arrival (Airport of Arr	17 Landing:	18 Total Flight Time:
ine Off: irou It Is Total Engine Time: 1704 It at 23 1704 It at 23 and to 850 m AdL and the 850 m AdL and after 5/12 lives du sion after 5/12 lives du lives 1, 7, 2, 8, 3)	17 Landing:	18 Total Flight Time:
Very douch us chances of funderstorm changed plan to 850 m AdL aborted mussion after 5/12 lives due to Csurreyed lines 1, 7, 2, 8, 3)		
changed plan to 850 m Adl aborted invision after 5/12 lives due to Csurreyed lives 1, 7, 2, 8, 3)		
21 Problems and Solutions: * Camera thine stamp allong aror * Pynamical Parameters up t uppated warming		
Acquisition Flight Approved by Acquisition Flight Certified by Pilot-in-Command Mary H And Assertation Flight Certified by Pilot-in-Command Mary H And Assertation Flight Certified by Pilot-in-Command Mary H And Signature over Minited Name (Find Name (Fi	and the second s	Lidar Operator
	Disator Risk Exposim	DREAM Construction Accessment for Mitigation



11.) Flight Log for 1P6H130A Mission

2 ALTM Model: Rossing 3 Mission Name: Irochized 1 Type: VFR 5 Arcart Type: Cessma 2004 Plot: 3 Room of Departure (Airport, City/Province): 12 Airport of Arrival (Airport, City/Province): 12 Airport of Departure (Airport, City/Province): 12 Airport of Arrival (Airport,						
Is Co-Fliot: 9 foure: I.alio Iz Airport of Departure (Airport, City/Province); Iz Airport of Arrival (Airport, City/Province); Iz Fingine Off: Jate off: Iz Airport of Arrival (Airport, City/Province); Iz Fingine Off: Jate off: Iz Airport of Arrival (Airport, City/Province); Afront Off: Jate off: Iz Airport of Arrival (Airport, City/Province); Afront Afront It = 14 Is Total Engine Time: Afront Afront It = 14 Is Total Engine, Time: Afront Afront Afront It = 14 Afront Macsuce Aut. Actual Afront Aut. Aut. Aut. Afront Macsuce Aut. Aut. Afront Arap Aut. Aut. Afront Macsuce Aut. Aut. Afront Arap Aut.		2 ALTM Model: Pagasus	3 Mission N	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: RP-C40 2 2
12 Airport of Departure (Airport, City/Province): 12 Airport of Arrival (Airport, City/Province): 14 Engine Off: 35 Total Engine Time: 16 Take off: 14 Engine Off: 0 a a q 15 Total Engine Time: 16 Take off: Aborted 15 Total Engine Time: 16 Take off: 17 Landing: Aborted Mussuce Aute 1 - Lud Aborted Wussuce Aute 1 - Lud Aborted Wussuce Aute 1 - Lud Aborted Mussuce Arap 1 - Lud Aborted Arap Arap 1 - Lud Aborted Mussuce Arap 1 - Lud Aborted Mussuce Arap 1 - Lud Aborted Arap 1 - Lud 1 - Lud Aborted Arap 1 - Lud 1 - Lud Aborted Arap 1 - Lud 1 - Lud Aborte	8 Co-P	ilot: 0	9 Route:			
14 Engine Off. 15 Total Engine Time: 16 Take off. 17 Landing: 14 Engine Off. 00224 H 15 Total Engine Time: 16 Take off. 17 Landing: 14 Ported WUGSUDE BUL To Lind S 10 Ported WUGSUDE BUL To Lind S 10 Ported WUGSUDE BUL To Chind S 10 Ported WUGSUDE BUL TO CHING S 10 Ported	O Date: 10 May 2013	12 Airport of Departure	(Airport, City/Province):	12 Airport of Arrival	(Airport, City/Province); ±1₀i1₀	
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Horted wesser due to ched s and solutions: Loser D drep ont Loser D drep ont unisition right approved by And Mo ERDIN The strate pre Martin Approved by Martin Approv	9 Weather	Genery				
ved by Republic To Chap and Plant Plant Plant and A	0 Remarks:		due 1	clad S		
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ved by Acquisition Flight Certified by Acquisition Flight Certified by Acquisition Flight Certified by Acquisition Flight Command Ac						
Acquisition Flight Certified by Plot-in-Command A-	21 Problems and Solutions:	aver	I dropant			
Acquisition Flight Certified by Plot-in-Command -		5	-			
	Acquisition Flight Approved by	R	ition Flight Certified by	Pilot-in-Comm		idar Operator
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72

12.) Flight Log for 1P6K130B Mission

1 LIDAR Operator: L. Acuña	2 ALTM Model: PCCASUS	2 ALTM Model: Perasus 3 Mission Name: 1Perasor	30IS 4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RPC 402 &	RP-CG023
7 Pilot: J. Gremente 8 Co-P	8 Co-Pilot: M. Tangonan	9 Route: Iloilo				
20	12 Airport of Departure (Airport, City/Province):	(Airport, City/Province): کارەنالە	12 Airport of Arrival (A \mathcal{I}_{oi}) U	12 Airport of Arrival (Airport, City/Province): \mathbb{T}_{oi}/o		
	14 Engine Off: Les-H	15 Total Engine Time: 2 + o 0	16 Take off:	17 Landing:	18 Total Flight Time:	
19 Weather						
20 Remarks: Abortrol	no issina p	hue to a	clouds 5 pr	5 Precipition .		
21 Problems and Solutions:						
Acquisition Flight Approved by Marker A W Signatyreforer Printed Name (End bser Representative)		Acquisition Flight Certified by Earlin free for for ALC ERUIN JEPOS JANTAS PAR Signature over Printed Name (PAF Representative)	Pilot-to-Command Pilot-to-Command Signaturg over Printed	Name	Lidar Operator	
					DREAM	9



13.) Flight Log for 1P6H131A Mission

LLIDAR Operator: C. Joaquin	in in	2 ALTM Model: Pegasus 3 Mission Name: 1 P& H131A	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-C4022
7 Pilot: 1. Clamenta	8 CO-Pilot: M. Tangonau	9 Route: ±loi]o			
	h		12 Airport of Arrival (TIoil o	12 Airport of Arrival (Airport, City/Province): エーー	
	14 Engine Off: 1000 H	ne Time: .25	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather	Claudy				
20 Remarks:	otherted witssibun @	the to twick	Marche		
Ser	Smeyed lines 1-	a-2-2-6- 1-3-1	1		
21 Problems and Solutions:	laser	streday 7			
Acquisition Flight Approved by Mor White Signature over Printed Name (End UserRepresentative)		Acquisition Flight Certified by ALC ERDIN DEFOS JANTON PHP Signature over Printed Name (PAE Representative)	Pilot-in-Comman	d Miled Name	Lidar Operator
					DREAM

74 | 💉

14.) Flight Log for 1P6I132A Mission

5 Aircraft Type: Cesnna T206H 6 Aircraft Identification: <i>KP-Cfor</i> Liport, City/Province): 17 Landing: 18 Total Flight Time: 17 Landing: 14 Total Flight Time:			Lidar Operator
5 Aircraft Type: Cesnna1206H 6 irport, Glty/Province): 17 Landing: C.			ed Hame
A Type: VFR Airport of Arrival (A i.Take off: Take off: B Chry &			Plot-in-Command
Area 2 ALTM Model: Regards 3 Mission Hame: 19611524 9 8 Co-Pilot: MTanganan 9 Route: 1016 GH 12 Airport of Departure (Airport, CIty/Province): 12 Air 14 Engine Off: 0, 15 Total Engine Time: 15 Tak JA Engine Off: 0, 15 Total Engine Time: 15 Tak JA Engine Off: 0, 444 15 Total Engine Time: 15 Tak	offeel		AC ERCIN Flight Certified by AC ERCIN TRZ - JALAP AN Signature over Printed Name (PAF Representative)
11DAR Operator: Mark Arto 2 ALTIM Model: Pequer 3 Mission Hame: 19611524 7 Pilot: J Clemente 8 Co-Pilot: M.Tangener 9 Route: 1616 GA 12 10 Date: LMay 2013 12 Airport of Departure (Airport, CIty/Province): 12 13 Encine On: 14 Engine Off: C.H. 15 Total Engine Time: 16 13 Encine On: 0815 Jatengine Off: 0335 Jave 15 Total Engine Time: 16 19 Weather Jacob Jone Charles Charles Charles Land, User	21 Problems and Solutions:	*	Acquisition Flight Approved by Nerver Accord Signature over Printed Name (End User Picpresentative)



15.) Flight Log for 1P6I133A Mission

1 UDAR Operator: Christoph	1 LIDAR Operator: Ontrologing Aut Model: Persons 3 Mission Name: por 1920	3 Mission Name: p61 B32	4 Type: VFR	5 Aircraft Type: Cesnna T206H	6 Aircraft Identification: 9022
-	5.		12 Airport of Arrival $Z/_{0}$	12 Airport of Arrival (Airport, City/Province): $\vec{I} = \frac{1}{2} \sqrt{2}$	
	14 Engine Off: 1120H	15 Total Engine Time: 4 +00	16 Take off:	17 Landing:	18 Total Flight Time:
20 Remarks:					
21 Problems and Solutions:					
Acquisition Flight Approved by Account of the Approved by Account of the Approved by Signature over Printed Name (End User Representative)	Jby (22 ca 10 ca 1	Acquisition Flight Certified by AC ERJUN MELLON JANDY GAF Signature over Printed Name (PAF Representative)	Pilot-in-Command		lidar Operator
					DREAM



16.) Flight Log for 1P6J134A Mission

and the good of the	Pegnows RP. C4022							
	6 Aircraft Identification: Persona RP 0402		18 Total Flight Time:					Lidar Operator J. Alvia Signature over Printed Name
	5 Aircraft Type: Cesnna T206H	12 Airport of Arrival (Airport, City/Province): $\mathbb{T}^{ _{b_i} _{b_i}}$	17 Landing:	-	loud build up		is, desired works	Pilot-in-Command
	4 Type: VFR	12 Airport of Arrival T	16 Take off:		fart .		he, dealed	Pilot-in-confin
3 Mission Name: 1 003134A	9 Route: Dloilo		I Engine Time: 2 + 5 5	fast build up	I due to they fair		replacement of caller, desired	Acquisition Flight Centified by EPOIN DEPOS Stanton MF Signature over Printed Name (PAF Representative)
2 ALTM Model: Peasure		2	14 Engine Off: //00/H	Party cloudy,	but abortin		7 F	Acquisiti Arc ERUL
	J. Clementer 8 CO-PI	2013			20 Remarks: Pata aquired but	21 Problems and Solutions:	Pilot display problem - Restarted Fry give bene "	Acquisition Fight Approved by M.e. VIL And Signat/Holover Printed Name (End User Representative)



17.) Flight Log for 1P6H135A Mission

			11.6/ 11.2					
7 Pilot: J. Clemente 8 co-Pilot: W. Tandonan 9 Route: ANAL Province): 10 Date: Was IC 72 12 Airport of Departure (Airport, City/Province): 1	12 Airport of Departure	9 Route: 05445	ce): CONNS	2 Airport of Arrival	2 Airport of Arrival (Airport, City/Province):			
13 Engine On: 0642 14 Engi	14 Engine Off: 0040	15 Total Engine Time: 3 + 00	me:	6 Take of	17 Landing:	1	18 Total Flight Time:	
19 Weather	Goudy							
70 Remarks: dota	data acquited but aborted wission	but a	porte	15sma p	Se			
8	due	due to clouds	Spr	•				
21 Problems and Solutions:								
	d birner A	According to Cartelling According to Accordi		Pitoria Com	(June	Udar	Lidar Operator	
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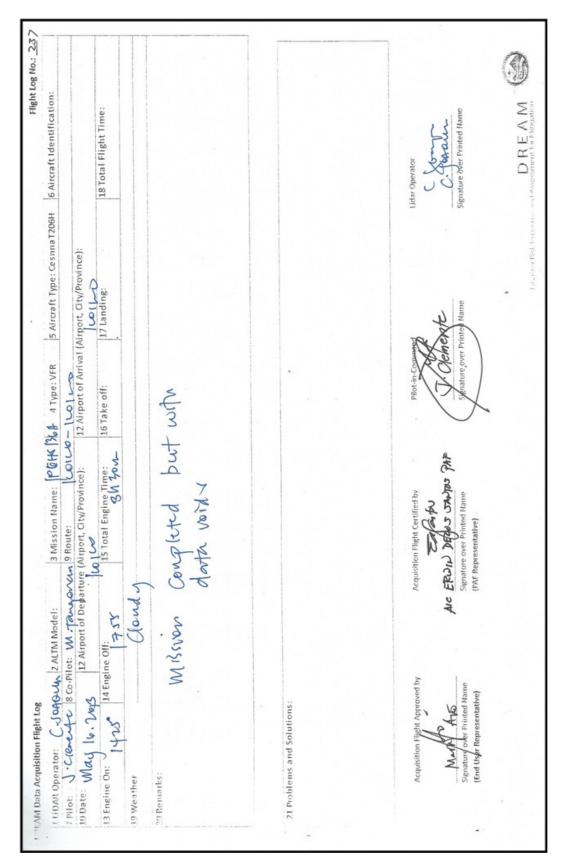
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18.) Flight Log for 1P6K135B Mission

1 LIDAR Operator: Mark A	states and the state of the sta	AN AVAILABLE OF AN AVAILABLE A	Contraction of the second seco	the second	A REAL PROPERTY AND A REAL PROPERTY A REAL PROPERTY AND A REAL PROPERTY A REAL PROPERT
	The 2 ALTM Model: De	1 LIDAR Operator: Mark And 2 ALTM Model: Penasus 3 Mission Name: (PCK1358	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: RP-C902x
J. Churche	8 Co-Pilot: M. Tangano	AN 9 Route: 1010			
Sals	12 Airport of Depa	12 Airport of Departure (Airport, City/Province):	12 Airport of Arrival	12 Airport of Arrival (Airport, Gty/Province): الكراف كريم	
	14 Engine Off: 1730H	15 Total Engine Time: $3 \neq / O$	16 Take off:	17 Landing:	18 Total Flight Time:
19 Weather		shyld thurden to rw			
20 Remarks:					
- cloudu	- cloudy weether				
- COWER	- comere Filmer, trugger	automatically,	bleck imager		
21 Problems and Solutions:					
- analyze	Canela	logs and report to optich.	optre a.		
Acquisition Flight Approved by	ved by	Acquisition Flight Certified by	Pilot-in-compa		Lidar Operator
Marthe Kno	AIC	AIC ERDIN DELAS JANTOS PAR	J. Olem	exte	Work Kies
Signature over Printed Name (End User Representative)		Signature over Printed Name (PAF Representative)	Signature over Printed Name		Signature over Printed Name
				Disaster Risk Exposition at	Disease field Fundation and Assessment for Mithantion







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20.) Flight Log for 1P6IS136B Mission

*EAM Data Acquisition Flight Log					Flight Log No.: 237
1 LIDAR Operator:] . الماسمة 2 ALTM Model: الجومونية 3 Mission Name: 1 PUISI34	1 Model: Provins 3 h	Nission Name: PGISI36B	4 Type: VFR	5 Aircraft Type: CesnnaT206H	6 Aircraft Identification: PP-C902 >
7 Pilot: J. C/ Emerge 8 Co-Pilot: A	4. Tanconen 9R			and the second se	
10 Date: And 20/3 12 Airport of Departure (Airport, City/Province):	oort of Départure (Airp		2 Airport of Arrival	12 Airport of Arrival (Airport, Gity/Province):	
13 Engine On: 14 Engine Off: 175 Sr H	H	15 Total Engine Time: 10 3730	16 Take off:	17 Landing:	18 Total Flight Time:
Pa	, churchy				
20 Remarks:					
Mission comp lated	, Irtic				
21 Problems and Solutions:					
(aur B dropout; protunded filet droplay	nothimated	Pulot dueplay			
6. martus for	opticher ru	some	•		
Acquisition Flight Approved by	Acquisition	Acquisition Hight Certified by	Pilot-in-Count	pue	Lidar Operator
Met W A Maine Signature dver Printed Name (End Used/Representative)	ALC ERUN DEPON Signature over Printee (PAF Representative)	ERDIN DEPOS JANTA PAP Signature over Printed Name (PAF Representative)	Strature over Prin	ed Name	Signature over Printed Name
				r 1.4 justor Pick A structors	DREAM - Control Accession of the CAM -

81

21.) Flight Log for 1P6HS137A Mission

Acquisition flight Approved by Acquisition flight Certified by			Some data acquired but aborties injection idea to claude ; problematic puted degray		charlo .	10 Date: Demonstration of Departure (Airport, Gtv/Province): 12 Airport of Arrival (Airport, Gtv/Province): Development (Airport, Gtv/Province): Development (Airport, Gtv/Province): 14 Engine Off) Development (Airport, Gtv/Province): 15 Take off): 15 Tak	re wigner due to Candre ; problemtric put diepted interior due to Candre ; problemtric put diepted interior interior interior interior interior diene signature over Printed Anne signature over Printed Anne
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22.) Flight Log for 1P6IS137B Mission

6 Aircraft Identification: 18 Total Flight Time:			Lidar Operator C.S. C.
1206H 6 Aircraf 18 Total			Lidar Operator C.Johaniki Signature over Printed Name
3 4 Type: VFR 5 Aircraft Type: CesnnaT206H 6 Aircraft Identification: 10 12 Airport of Arrival (Airport, City/Province): 12 Airport of Arrival (Airport, City/Province): 15 Take off: 17 Landing:	two		ane
2 4 Type: VFR 5 A olub 12 Airport of Arrival (Airp 12 Airport of Arrival (Airp 15 Take off: 17	Laser 13 d		Pilot-in-Compared
111DAR Operator: C. DOO JHN [2 ALTM Model: BCASUS 3 Mission Name: Melloc 4 Type: VFR 7 Pilot: J. Oftwerk 8 Co-Pilot: M. J. J. M. Andonan 9 Route: 10 JLO - 100 JLO 10 Date: Way 17, 2013 12 Airport of Departure (Airport, City/Province); 12 Airport of Arriva 13 Engine On: 14 Engine Off; 14 Engine Off; 15 Total Engine Time: 16 Take off; 19 Weather 20 HO 21 HO 21 HO 16 Take off;	to air traithe. Laser is dropout		Acquisition Flight Certified by ERMIN DELLA PN ERMIN DELLA SAMTAS PAP Signature over Printed Name (PAF Representative)
Model: RCASS 3 Mi 1. TANGener 9 Ro ont of Departure (Airpo (Loi Lo			Acquisition Flight Cert
2011 ALTM Mode 2018 8 CO-PILOE: W. TA 2013 12 Airport of 14 Engine Off: 011: 011: 011: 011: 011: 011: 011: 011: 011: 011: 011: 011: 011: 011: 011: 011: 011: 011: 01: 0	Alborted due	utions:	Acquisition Flight Approved by Market Amo Signature over Printed Name (End User Representative)
1 LIDAR Operator: C 7 Pilot: J. Oftwww 10 Date: Way 17 13 Engine On: 1450 19 Weather	00 Remarks:	21 Problems and Solutions:	Acquisition Flight Approved Mark And Signature Ever Printed Nan (End User Representative)



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D R E A M Disaster RIsk and Exposure Assessment for Mitigation