



REGION 6

Boracay:

DREAM Ground Surveys Report



TRAINING CENTER FOR APPLIED GEODESY AND PHOTOGRAMMETRY

2015



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

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

UP TCAGP (2015), DREAM Ground Survey for Boracay River, Disaster Risk and Exposure Assessment for Mitigation (DREAM) Program, DOST Grants-In-Aid Program, 39 pp.

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National Library of the Philippines
ISBN: 978-971-9695-42-4



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List of Abbreviations

ADCP	Acoustic Doppler Current Profiler
AWLS	Automated Water Level Sensor
BM	Benchmark
DAC	Data Acquisition Component
DEM	Digital Elevation Model
DG	Depth Gauge
DOST	Department of Science and Technology
DPC	Data Processing Component
DREAM	Disaster Risk Exposure and Assessment for Mitigation
DVC	Data Validation Component
EGM 2008	Earth Gravitation Model 2008
FMC	Flood Modeling Component
GCP	Ground Control Point
GE	Geodetic Engineer
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
LGUs	Local Government Units
NAMRIA	National Mapping and Resource Information Authority
PCG	Philippine Coast Guard
PDRRMC	Provincial Disaster Risk Reduction Management Council
PPA	Philippine Ports Authority
PPK	Post Processed Kinematic
RG	Rain Gauge
TCAGP	Training Center for Applied Geodesy and Photogrammetry
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984



Introduction



Introduction

1.1 DREAM Program Overview

The UP training Center for Applied Geodesy and Photogrammetry (UP TCAGP) conducts a research program entitled “Nationwide Disaster Risk and Exposure Assessment for Mitigation” supported by the Department of Science and Technology (DOST) Grant-in-Aide 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 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, respectively. These accuracies are achieved through the use of state-of-the-art airborne Light Detection and Ranging (LiDAR) Systems 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 kilometer 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



Introduction

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.

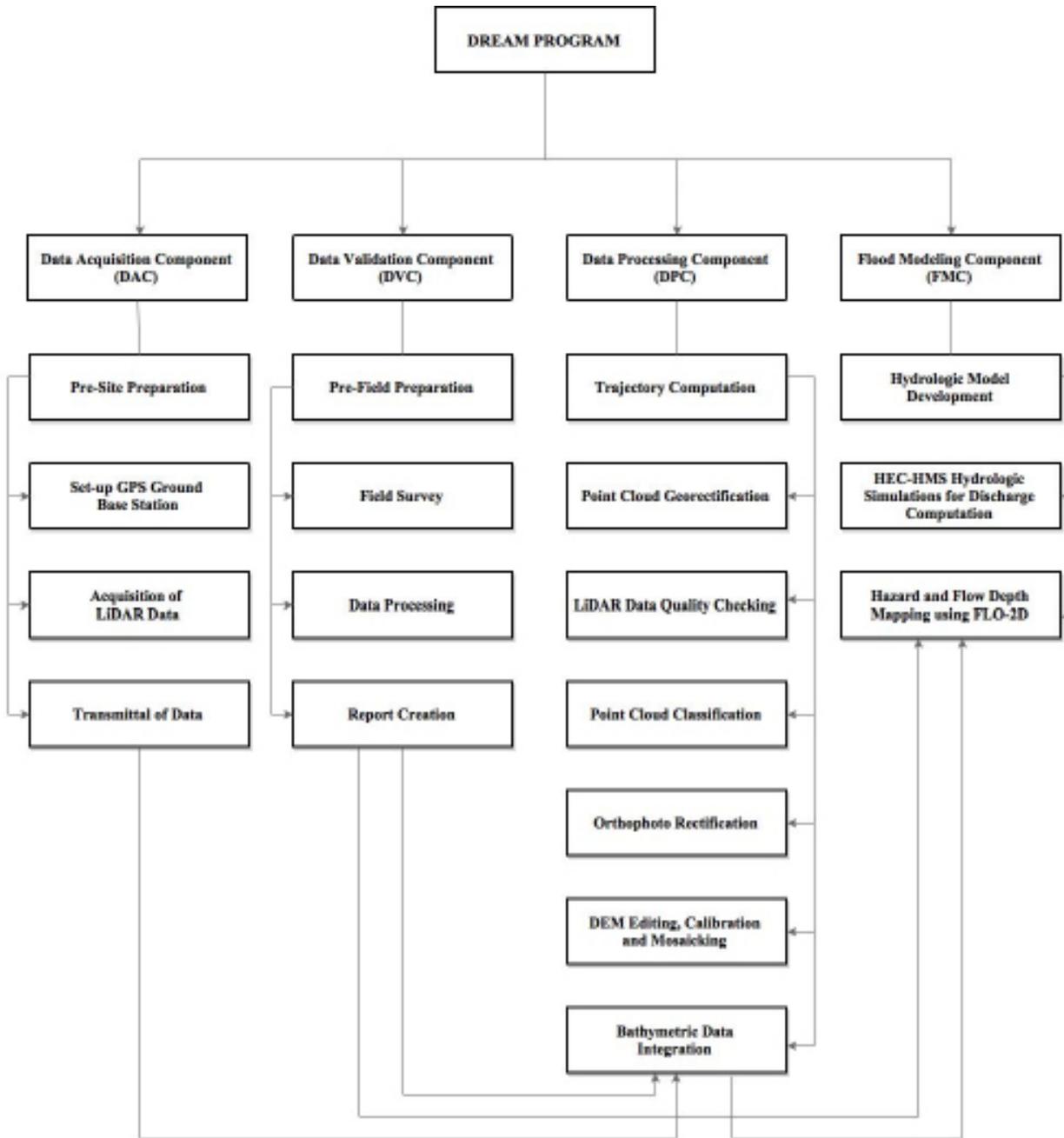


Figure 1. The General Methodological Framework of the Program

Boracay Overview



Boracay Overview

The island of Boracay has a total land area of 10.39 square kilometers and is situated approximately 345 kilometres south of Manila and 65 kilometres from Kalibo, the capital of Aklan in the Western Visayas region of the Philippines. The resort island is a part of the municipality of Malay in Aklan which comprises the barangays of Manoc-Manoc, Balabag, and Yapak.

With a four-kilometre white beach along the west coast, Boracay Island is well known to be one of Asia's finest beaches. It has two primary beach, White beach faces west and Bulabog which faces east. The island is declared . It is declared under Tourist Zone and Marine Reserve Pursuant to Proclamation No. 1801 dated November 10, 1973 as amended by the Executive Order No. 120 in January 1987 according to the Boracay Business Center. A variety of activities and sports can be done in Boracay. It is a venue for the Asian Windsurfing Tour, the Boracay International Funboard Cup, the Boracay Open Asian Beach Ultimate Tournament, and the 2014 Asian Beach Games. There is also a smaller Ati-Atihan Festival celebrated in the island during the second or third week of January

On July 2014, knee-deep flood waters were waded by tourists and residents due to the torrential rains brought by Typhoon Florita. While little damage was done, the flood had affected the commercial economy of the island. Flood waters seeped through the alleys connecting resorts, hotels, and restaurants.

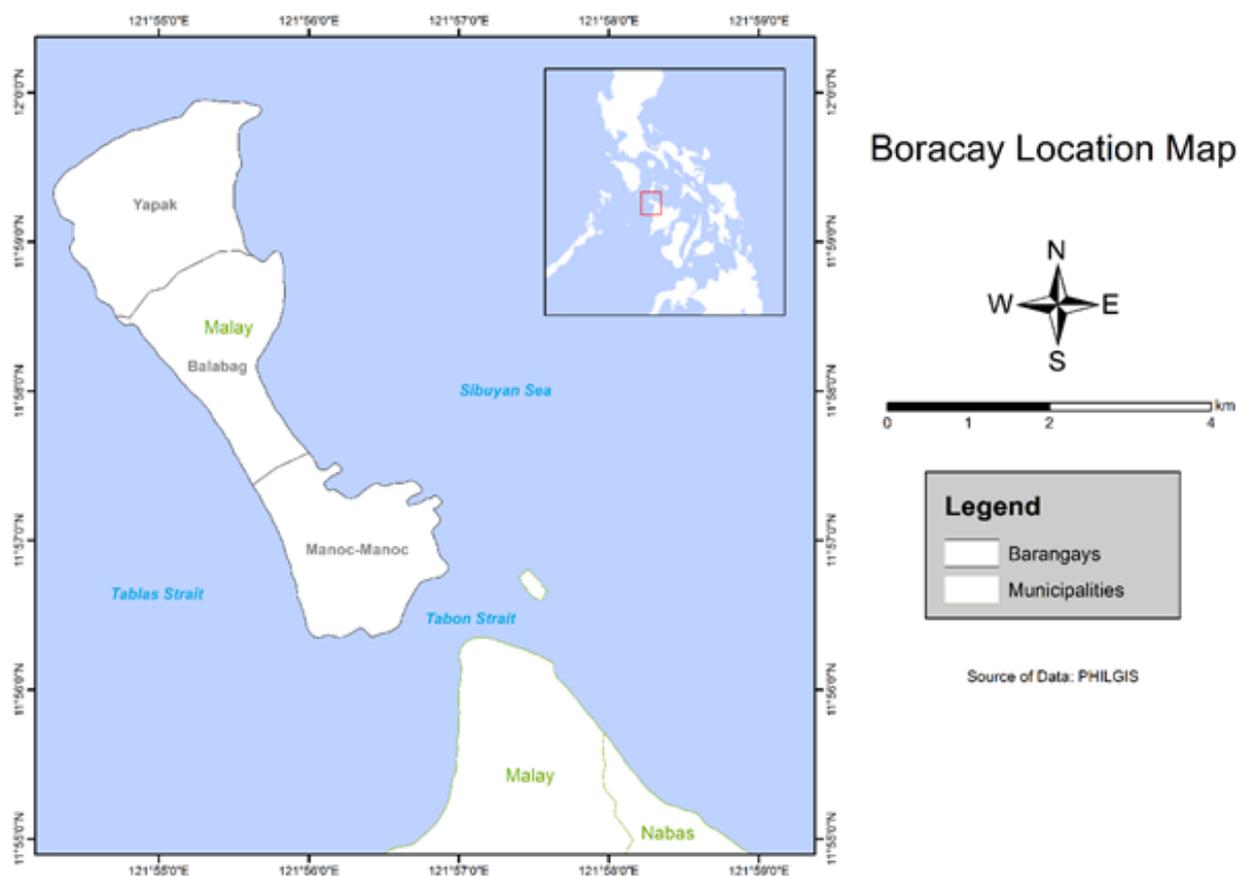


Figure 2. . Boracay Island Location Map



DVC Methodology

DVC Methodology

A set of activities were designed and implemented by DVC with four (4) main activities as shown in Figure 5.

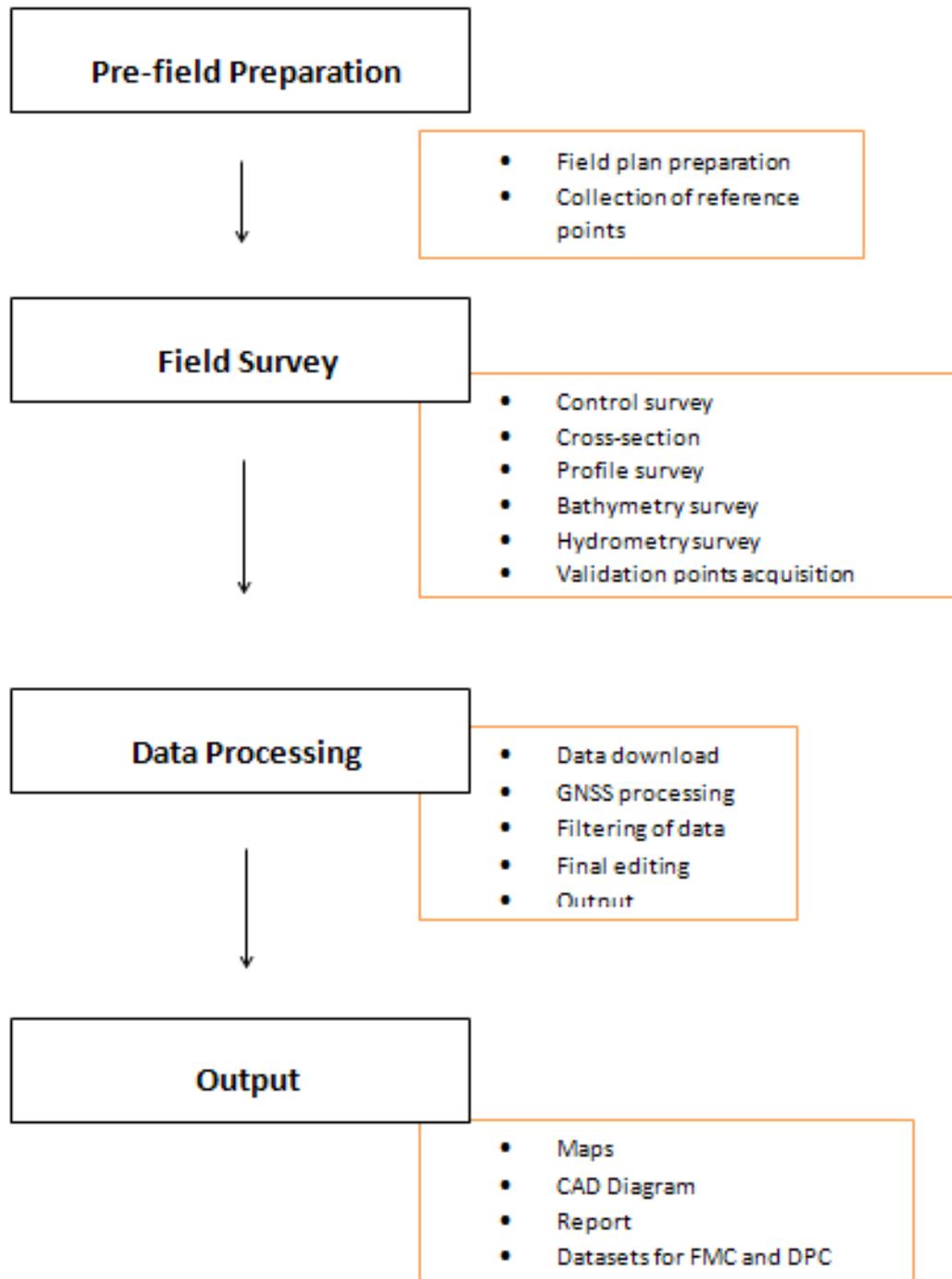


Figure 3. DVC Main Activities

DVC Methodology

3.1 Pre-field Preparation

3.1.1 Preparation of Field Plan

The planning for research fieldwork considers all the necessary technical and logistical concerns conceptualized in a field plan.

This serves as a basis and guide of the survey team in the implementation of the fieldwork activities and included the following activities:

- Delineation of bathymetry lines and determination of the river basin extent using Google Earth® images and available topographic maps;
 - Listing and preparation of the survey equipment and other materials needed;
 - Designation of tasks to DVC members for the field survey;
 - Approximation of field duration and cost based on the delineated survey extent;
- and
- Assessment of the initial field plan by the program management for approval and implementation.

3.1.2 Collection of Reference Points

Technical data and other relevant information are collected from the National Mapping and Resource Information Authority (NAMRIA) such as locations and descriptions of established horizontal and vertical control points with a minimum of 2nd order accuracy. These ground control points and benchmarks are selected and occupied as primary reference points for the establishment of a GNSS network for the survey.



3.2 Field Surveys

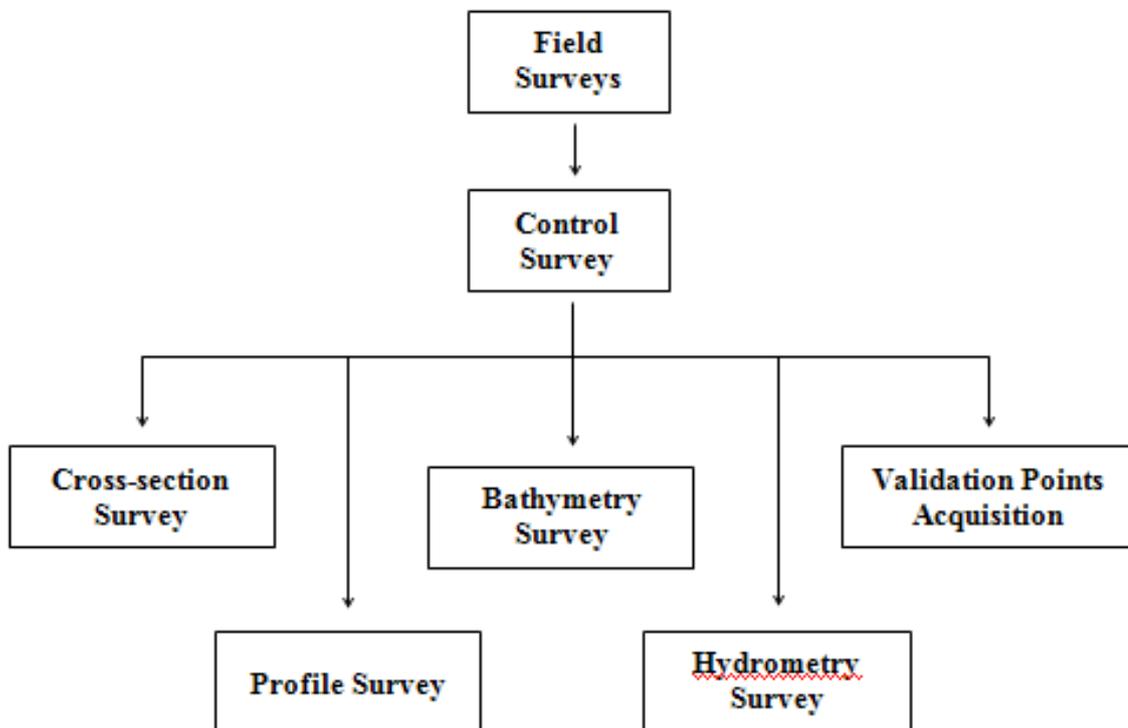


Figure 4. DVC Field Activities

3.2.1 Control Survey

A GNSS network is established through occupation of reference points with dual frequency GNSS receivers for four (4) hours. Reference points from NAMRIA only bear vertical coordinates (z or elevation value) and horizontal coordinates (x and y values) for benchmarks and ground control points, respectively.

Control survey aims to provide both the horizontal and vertical position for every control point established through network adjustment. Horizontal position is acquired through static survey while establishment of vertical position can be done either using a Total Station (TS) or digital level or through static survey.

For the vertical position control survey using a TS or Level, a double run is carried out connecting the nearest existing NAMRIA benchmarks (BMs) to the control point. A double run consists of a forward run (from BM to GCP) and backward run (from GCP to BM). The accuracy shall be assessed and accepted if it is within the third order differential leveling standard.

A benchmark may be used to refer elevation data to Mean Sea Level (MSL) within 20-km radius. Additional benchmarks are located for survey areas exceeding this 20-km radius.

Establishment of a GNSS network through control survey is pre-requisite for the conduct of other ground survey activities. Reference and control points occupied for the control survey may serve as base stations throughout the survey area.

DVC Methodology

3.2.2 Cross-section Survey

The objective of this activity is to derive a sectional view of the main river and the flood plain (right and left banks). Cross-sections are surveyed perpendicular to the riverbanks with an average length of 100 meters for each bank. The cross-section line shall follow the path of the nearby road or goat trails with a 10-meter interval for each point measurement. Additional points are obtained to describe apparent change in elevation along the cross-section line. Each cross-section is identified sequentially from upstream to downstream direction.

Cross-section surveys are done using dual frequency GNSS receivers and differential kinematic GNSS survey technique. The accuracy of the horizontal position and elevation of each individual cross-section surveys is within ± 20 cm for horizontal and ± 10 cm for vertical position residuals.

Areas where kinematic GNSS survey is not applicable due to the presence of obstructions such as tall structures and canopy of trees, conventional surveying techniques such as total stations and level are used to collect cross-sectional data.

DVC Methodology

3.2.3 Profile Surveys

Profile surveys are conducted to obtain the upper and lower banks of the river. This data is overlaid with LIDAR data to delineate the longitudinal extent of the river.

A profile survey consists of the Left Upper Bank (LUB) and Left Lower Bank (LLB), Right Upper Bank (RUB) and Right Lower Bank (RLB). An interval between successive profile points is approximately 10 meters. Additional points are gathered to describe apparent change in elevation along the profile line

Profile surveys are conducted using dual frequency GNSS receivers and kinematic survey technique with a prescribed vertical accuracies of ± 20 cm for horizontal and ± 10 cm for vertical position, respectively. Conventional surveying techniques such as total stations and level are used to collect profile data for areas where kinematic GNSS survey is not applicable due to obstructions such as tall structures and canopy of trees.

3.2.4 Bathymetric Survey

Bathymetric survey is performed using a survey-grade single beam echo sounder capable of logging time-stamped depth value in centimeter and dual frequency GNSS using kinematic survey technique, with prescribed vertical accuracies of ± 20 cm for horizontal and ± 10 cm for vertical position for rivers navigable by boat. Data acquisition is logged at one second intervals both for GPS positions and elevation and echo sounder depth reading

For portions of the river that is not navigable by boat due to shallow waterless than a meter, riverbed may be acquired using manual bathymetric survey. Manual bathymetric survey means manually acquiring riverbed points without the use of an echo sounder. It can be done using a GPS receiver, Total Station or Level.



DVC Methodology

3.2.5 Hydrometric Survey

Hydrometric survey consists of deployment of flow gathering sensors in order to produce a Stage-Discharge (HQ) computation for specific locations in the river such as in its upstream, tributaries, and downstream. This is done to determine the behavior of the river given specific precipitation levels.

The elements of discharge computation are the ff.:

- **River flow data** – river flow data can be acquired using an Acoustic Doppler Current Profiler (ADCP) or by mechanical or digital flow meters. River flow data sensors measure velocity of the river for a specific time period and interval.
- **Cross-section data** – cross section data is acquired using dual frequency GPS receivers to obtain the cross-section area of the river. Cross-section area of a river changes in time as influenced by water level change.
- **Water level change** – water level change is measured using either a depth gauge or an Automated Water Level Sensor (AWLS) installed by DOST. Depth gauges relates pressure to water level change while AWLS uses laser pulsed at specific time intervals for measurement.
- **Water surface elevation** – water surface elevation in MSL is measured near the banks of the river with dual frequency GPS receivers. This will refer the measured water level change to a corresponding elevation value in MSL in order to derive Stage or water level height a particular time.

Precipitation is the biggest factor influencing stage and river velocity. These two (2) sets of data must be synchronized by time in order to compute for its cross-section area, and subsequently, for discharge.

The element of time is crucial in determining the delay between the onset of precipitation and the time of significant water level change along key points of the river for early flood warning system of communities. The correlation of stage-discharge computation is used for calibrating flood-simulation programs utilized by the Flood Modeling Component (FMC).

The summary of elements for discharge computation is illustrated in Figure 7.

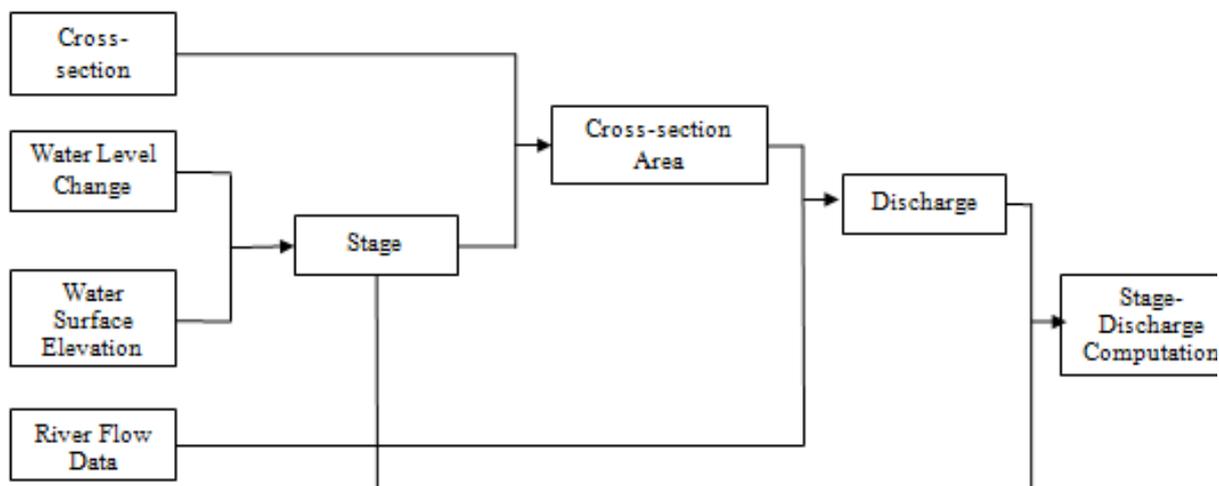


Figure 5. Flow Chart for Stage-Discharge Correlation Computation

3.2.6 Validation Points Acquisition Survey

Ground validation survey is conducted for quality checking purpose of the Aerial LiDAR data acquired by the Data Acquisition Component (DAC). A roving GNSS receiver is mounted on a range pole attached to a vehicle to gather points thru continuous topo method in a PPK Survey Technique. Points are measured along major roads and highway across the flight strips provided by DAC.

GNSS surveys setup used to accomplish DVC's field survey activities are illustrated in Figure 8.

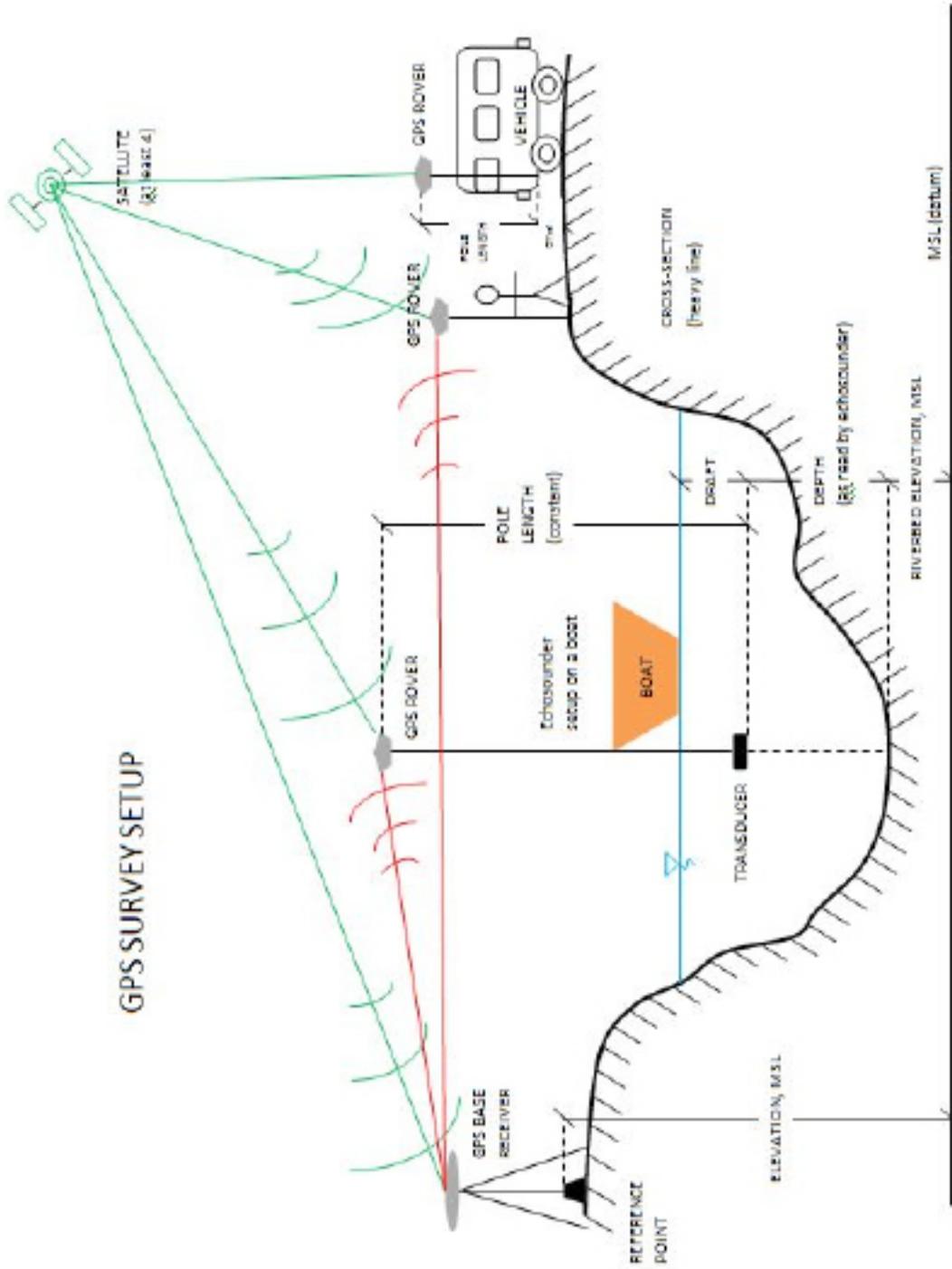


Figure 6. Set-up for GNSS Survey

3.3 Data Processing

Data processing procedures used by DVC are summarized in Figure 9.

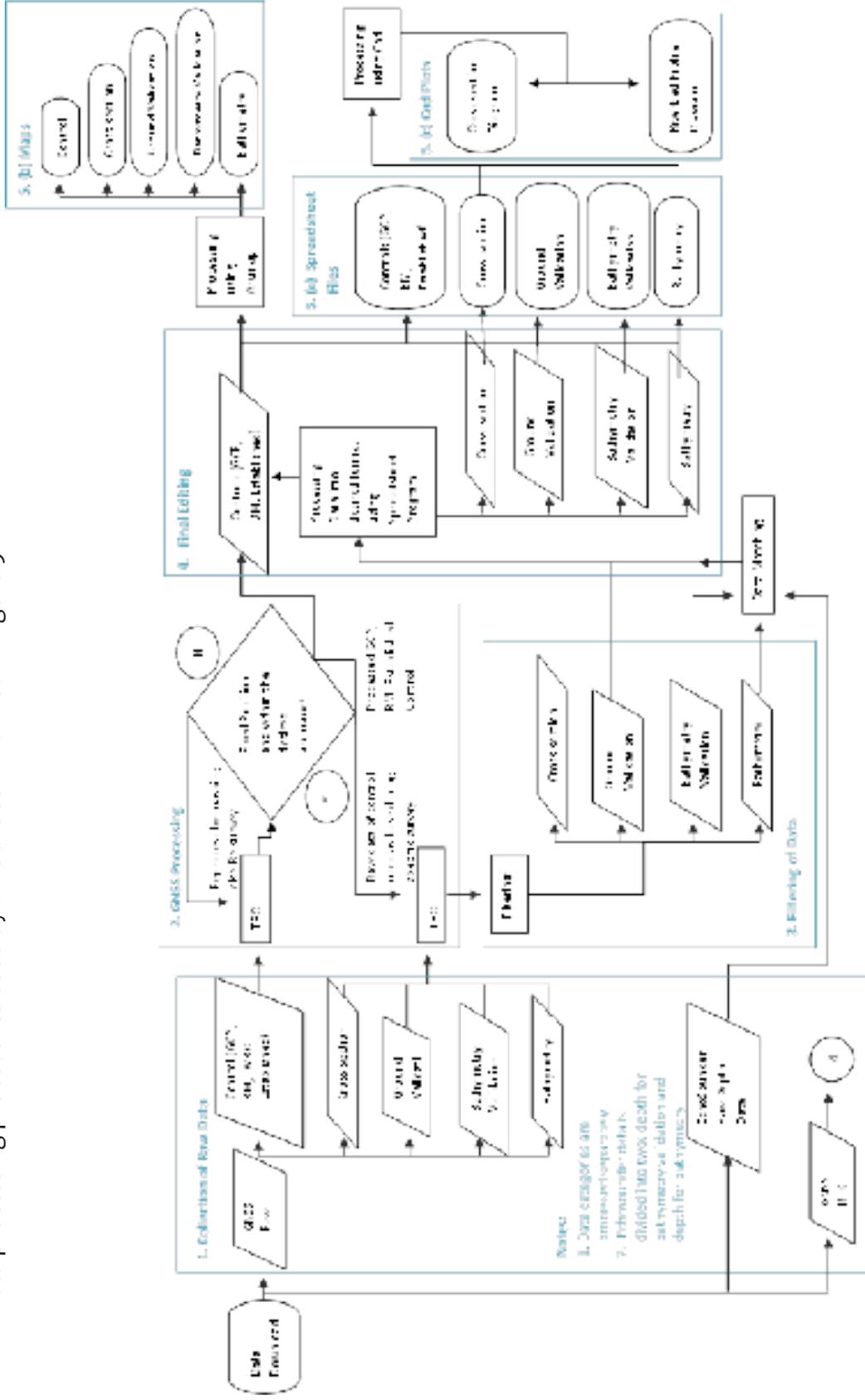


Figure 7. DVC Data Processing Methodology



DVC Methodology

3.3.1 Collection of Raw Data

GPS Raw data in (*.t02) format are downloaded from Trimble™ GPS receivers used in static, cross-section, LiDAR ground validation, and bathymetric surveys. Depth values in (*.som) files from bathymetric surveys are also downloaded from OHMEX® echo sounder.

3.3.2 Data Processing

Processing for GNSS Data

The horizontal and vertical coordinates of the reference point used as base station are held fixed, based on its NAMRIA certification, for the establishment of a GNSS network for the survey area. Coordinates of this fixed point is used to give horizontal and vertical coordinates for the other reference points occupied and control points established.

Data from GNSS control surveys are processed in Trimble™ Business Center (TBC) software and settings were set to the required accuracy of +/-10cm for vertical and +/-20cm for horizontal controls. The TBC coordinate system parameters were set to Universal Transverse Mercator (UTM) Zone 51 North, World Geodetic System of 1984 (WGS1984), and the geoid model EGM2008 for horizontal and vertical datum, respectively.

An offset is derived by comparing the MSL elevation of the benchmark stated in the NAMRIA certification and its elevation value that resulted from the processed and adjusted control survey. This offset is used to refer all elevation from other surveys into MSL (BM_Ortho).

The formulas used for offset and BM_Ortho computation are shown in Equations 1-2:

Computation for offset:

Equation 1:

$$OFFSET = BM - EGM$$

Computation for BM_ortho:

Equation 2:

$$BM_{ortho} = EGM_{ortho} \pm OFFSET$$

DVC Methodology

where:

OFFSET	= difference/offset between Geoid model, EGM 2008 and MSL datum. Can be a positive or negative value
BM	= MSL elevation of vertical control point certified by NAMRIA
EGM	= EGM2008 elevation of the same NAMRIA vertical control point derived from TBC software processing
EGM_{_Ortho}	= elevation of points referred to geoid model, EGM 2008
BM_{_Ortho}	= elevation of points referred to MSL

GNSS processing is also done for the other surveys with the coordinates from the occupied points for the control survey held fixed, depending on which base station is used for the survey.

Processed and adjusted data are exported to comma delimited (*.csv) file format with the ff. columns: Point Name, Latitude, Longitude, Ellipsoidal Height, Northing, Easting, and Elevation (EGM_Ortho). This file format can be accessed through Microsoft Excel/Spreadsheet program.

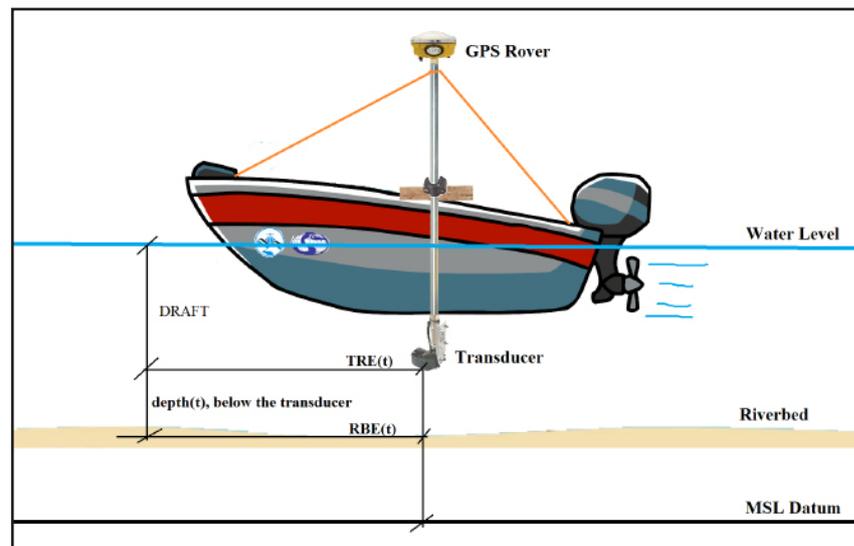


Figure 8. Illustration of Echo Sounder and GPS rover set-up for Bathymetric survey

There are two types of echo sounders used for bathymetric surveys – Hi-Target™ single beam echo sounder which is capable of recording depth data of one decimal place and the OHMEX™ single beam echo sounder capable of recording two-decimal places of depth data.

Raw depth data from Hi-Target™ single beam echo sounder is exported in (*.txt) file format with the ff. columns: Point No., Time, Depths H, Depths L, Draft, and Sound Velocity. This (*.txt) file is copied to a spreadsheet, retaining only the columns for Time and Depths H.

DVC Methodology

Raw depth data from OHMEX™ single beam echo sounder are exported in (*.som) file format. It is imported into SonarVista then exported into *.csv format with the ff. columns: Type, Date/Time, Sec, X/E, Y/N, Z/H, Tide, Depth and QA. SonarVista is used as file conversion tool only. The (*.csv) file opened using spreadsheet, making use of only the columns for Date/Time and Depth.

Data Matching for Bathymetric Data

Data matching is done by pairing an individual attribute of a bathymetric point to a depth data acquired using either OHMEX or HI-Target echo sounder. Matching is possible by ensuring that both bathymetric points and depth values acquisition has time stamp capability. These two sets of data are matched using VLOOKUP tool of a spreadsheet program, such that each point will have an accompanying (x,y,z) and depth data.

Below is the formula used for computing the elevation of the riverbed:

Equation 3:

$$RBE(t) = TRE(t) - \text{Depth}(t)$$

where:

- RBE(t)** = elevation of the riverbed during time t,
- TRE(t)** = transducer elevation (reckoned from EGM 2008)
- Depth(t)** = depth recorded by the echo sounder at time t, with the assumption that depth is measured from the bottom of the transducer down to the riverbed

The resulting RBE(t) data are referred to MSL (BM_ortho) by applying the offset for the established network.

Final processed data are imported to Google Earth™ and Geographic Information Systems (GIS) software for viewing and checking horizontal position.

Hydrometry Data Processing

The processes done for Hydrometry data for HQ computation are described in the ff. steps:

1. River Flow Data

a.) ADCP

Data from the ADCP is logged internally and can be downloaded using either SonUtils™ or View Argonaut™ software. River velocity is recorded for a specified time duration and interval can be exported in a (*.csv) format.

b.) Flow Meter

Acquisition of river velocity using flow meters is done manually. Measurements for a specified time duration and interval is recorded in a field notebook and saved in a spreadsheet program.

2. Cross Section and Water Surface Elevation Data

Cross Section data and water surface elevation data is acquired using GNSS receivers described in section 3.3.4 for GNSS data processing with a resulting file in (*.xls) format.

3. Water Level Change-Stage

a.) Depth Gauge

Data from depth gauge can be downloaded using HobowarePro™. Water level in meters are logged for a specific time interval and it can be exported in a (*.csv) format.

b.) AWLS

Data from installed AWLS can be accessed via the internet (<http://repo.pscigrd.gov.ph/predict/>). Water levels are logged in ten-minute time intervals and can be copied into a spreadsheet program.

4. Discharge Computation

River flow data and water level change is synchronized by time. Parameters were preset in its respective programs so the deployment of each instrument will begin and end in the same time. All data in (*.csv) and (*.csv) format are combined in a single worksheet wherein the computation for the coefficient of determination or R² are done.

The illustration in Figure 7 shows how each set of data from each instrument can be synchronized.

DVC Methodology

3.3.3 Filtering of Data

A processed point which resulted to float or did not meet the desired accuracy is filtered out. Resurveys are conducted immediately if data gaps are present for the ground surveys.

3.3.4 Final Editing

Final editing is performed to be able to come up with the desired data format: Point Value, Latitude, Longitude, Ellipsoidal Height, Northing, Easting, EGM_Ortho and BM_Ortho.

Processes discussed are valid for static, cross section, ground validation, and manual bathymetric surveys not employing echo sounders. For bathymetric surveys using a single beam echo sounder, the GPS rover is mounted on top of a 2m pole and a transducer at the bottom (see Figure 10). Figure is valid in both using OHMEX and HI-Target echo sounders. The GPS rover provides horizontal and vertical coordinates whereas the echo sounder transducer measures depth of the river from its bottom down to the riverbed.

3.3.5 Output

Filtered data are furthered processed into desired template using a spreadsheet program. Final data are generated into maps and CAD plots for cross-section, profile, and riverbed profiles. Cross-section, Profile, Validation Points, and Bathymetric data shall be turned-over to DPC while hydrometric data shall be turned-over to FMC.





Boracay Island Survey

Boracay Island Survey

The survey for Boracay Island was conducted on June 1 to 8, 2013 with the following activities: reconnaissance, control, profile survey using terrestrial LiDAR, and bathymetric surveys.

Boracay Island is situated in Malay, Aklan and has an approximate profile length of 20.7 kilometers which encompasses three (3) barangays, namely: Yapak, Manoc-Manoc, and Balabag.

4.1 Control Survey

Three (3) NAMRIA established reference points were considered for the static GNSS observations of the island. These include a benchmark, AK-214 which is located at Sambiray Bridge in Malay, Aklan; a tidal gauge benchmark, TGBM 2008, at Caticlan Jetty Port; and a second-order reference point, AKN-37 situated at Malay Elementary School in Malay, Aklan. In addition to these reference points, two (2) control points were established in Boracay Island namely, BRCY-01 and a point in Mt. Luho. The GNSS set-up for the five (5) base stations are shown in Figures 11-14 while the location of these controls are shown in Figure 9.

Continuous differential static observations were done simultaneously at these five (5) stations for two hours to provide reference control points for the ground and bathymetric surveys. The horizontal coordinates and elevations of the five control points were computed using Trimble™ Business Center GNSS processing software. The result of control survey for the control points are indicated in Table 1.



Boracay Island Survey

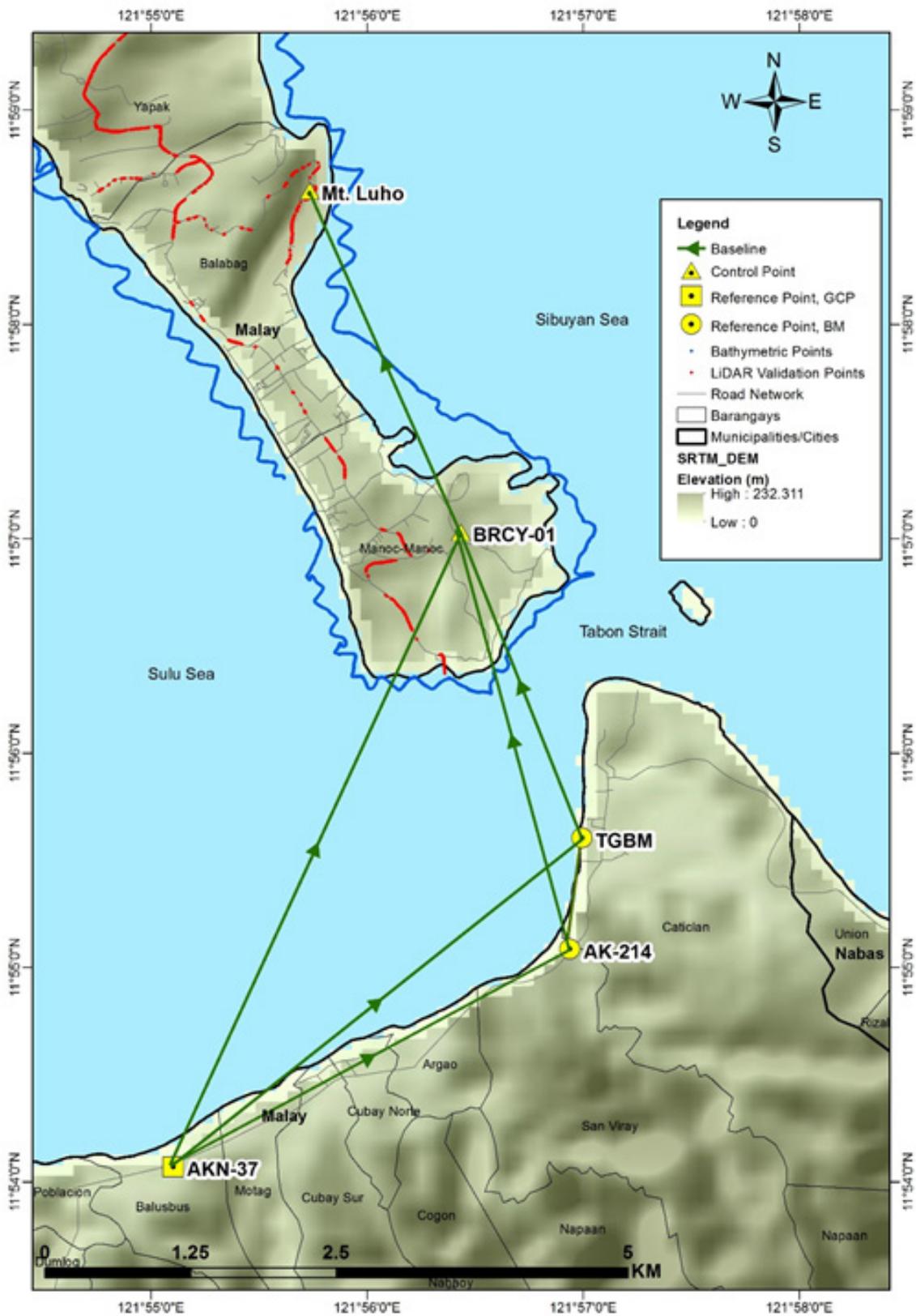


Figure 9. Location of control points

Boracay Island Survey

Table 1. Control points occupied during Boracay Survey (Source: NAMRIA, UP-TCAGP)

Point Name	WGS84 UTM Zone 51N					Elevation in (MSL)
	Latitude	Longitude	Ellipsoidal Height (m)	Northing (m)	Easting (m)	
AK-214	11d55'05.09604"	121d56'56.37362"	61.086	1317712.156	385547.957	5.912
AKN-37	11d54'04.24237"	121d55'06.15554"	58.504	1315855.49	382206.294	3.387
TGBM	11d55'36.22027"	121d56'59.68196"	57.448	1318667.936	385651.663	2.291
Mt. Luho	11d58'37.36321"	121d55'44.06533"	150.965	1324241.572	383385.689	95.953
BRCY-01	11d57'01.82008"	121d56'26.12135"	81.991	1321301.495	384646.464	26.904

The GNSS setup for the five (5) control points are illustrated in Figures 11-14:



Figure 10. Static GNSS observation at AKN-214 at Sambiray Bridge in Malay, Aklan

Boracay Island Survey

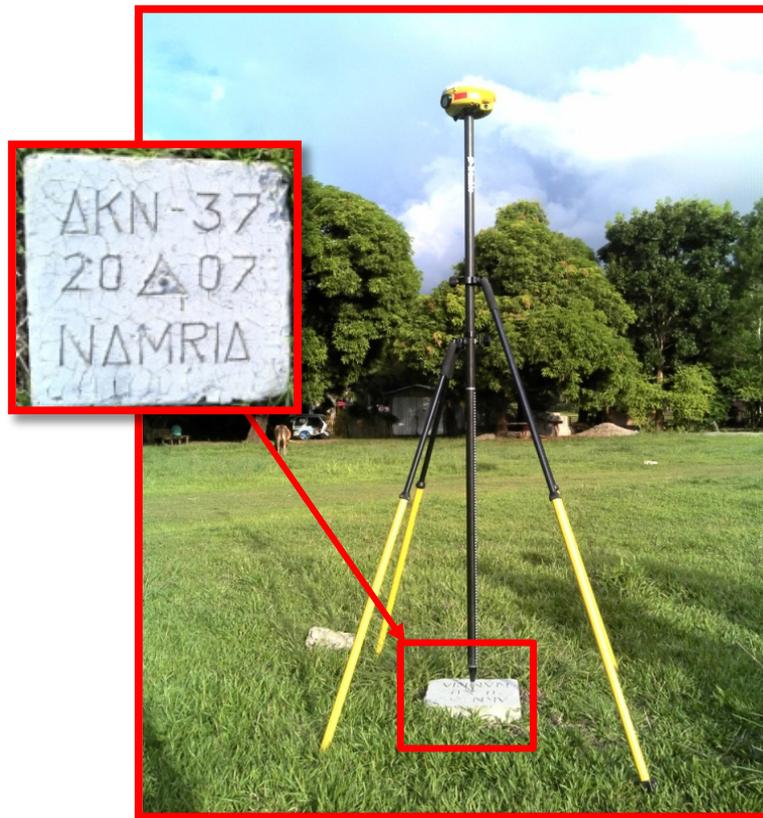


Figure 11. Static GNSS observation at AKN-37 at Malay Elementary School in Malay, Aklan

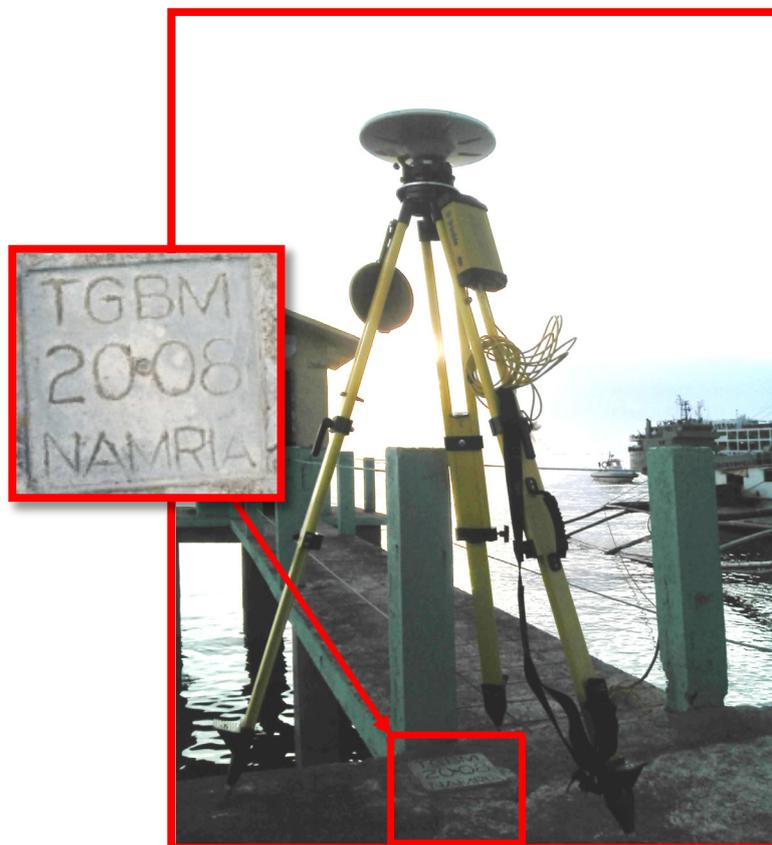


Figure 12. Static GNSS observation at TGBM at Caticlan Jetty Port in Malay, Aklan

Boracay Island Survey



Figure 13. Static GNSS observation at Mt. Luho in Boracay Island, Malay, Aklan



Figure 14. Static GNSS observation in Brgy. Manoc-Manoc in Boracay Island

Boracay Island Survey

4.2 Profile Survey

Profile survey of the island was conducted from June 3-6, 2013 using dual-frequency GNSS RTK surveying technique and terrestrial LiDAR technology, MDL Dynascan mobile mapping system (MMS).

The MMS acquires point-cloud data at a rate of 18,000 points per second in a 10-hertz scanning speed. The island was circumnavigated thrice with a distance of 80 km from the shore at 3-5 kph speed using the rubber boat from the PCG detachment in Boracay. The setup for this survey is illustrated in Figure 15.



Figure 15. The MMS setup for the Boracay terrestrial LiDAR survey with PCG Boracay

Boracay Island Survey

The base station occupied for this survey was at the established control point in Mt. Luho which permitted the unobstructed transmittal of radio signals to the MMS. The setup of the RTK base station is shown in Figure 16.

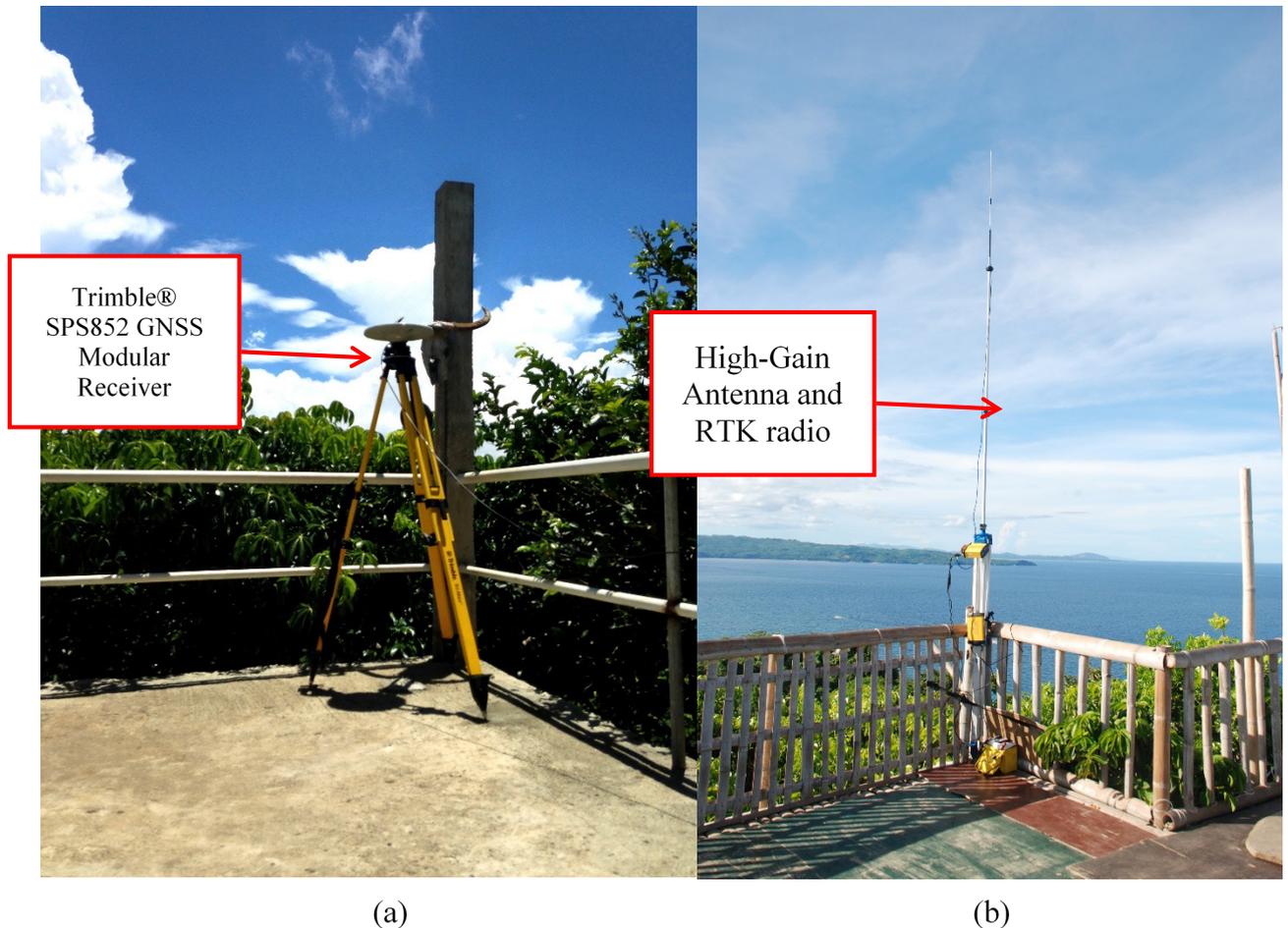
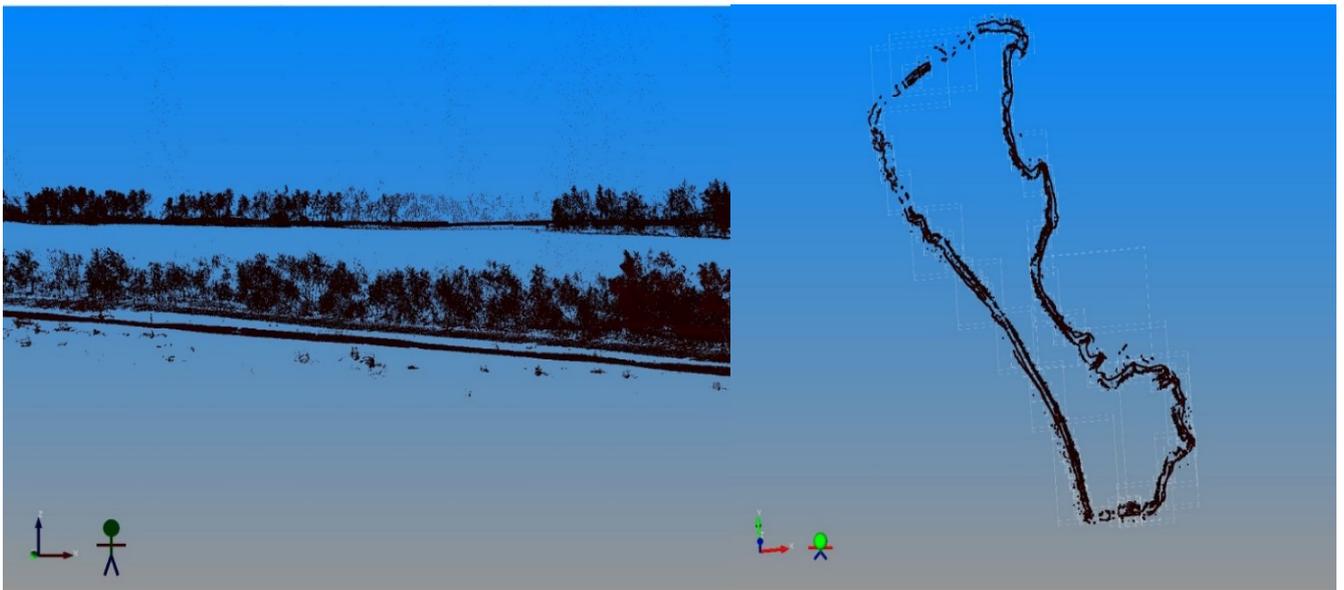


Figure 16. RTK base setup at Mt. Luho (a) Trimble SPS 852 GNSS receiver (b) RTK radio

Data collected from the MMS was previewed in GEXCEL Reconstructor 3D processing software (see Figure 17). All acquired point-cloud data were processed by DPC.

Boracay Island Survey



(a)

(b)

Figure 17. Boracay point cloud data previewed in GEXCEL (a) profile along station 1 (b) top view of the island

4.3 LiDAR Validation Survey

LiDAR Validation survey was conducted on June 5-6, 2013 using a GNSS RTK and PPK survey technique. It was conducted by walking along concrete roads using GNSS RTK survey technique and installing a GNSS rover receiver on a motorized vehicle on PPK mode as shown in Figure 18. A total length of 8.35 km validation points were acquired as shown in the map in Figure 19.

Boracay Island Survey



Figure 18. Validation Points Acquisition Survey using GNSS RTK technique by traversing the length of roads (a) by foot (b) as installed on a motorized vehicle

Boracay Island Survey



Figure 19. Bathymetric survey along the coast of Boracay Island

Boracay Island Survey

4.4 Bathymetric Survey

Bathymetric survey was conducted along the coast of the island on June 5-6, 2013 using a Teledyne Odom ES3PT™ multi-beam echo sounder and an OHMEX™ single-beam echo sounder as shown in Figure 19. An approximate length of 20.7 km zigzag bathymetric sweep was acquired, as illustrated in the map in Figure 20.



Figure 20. Setup of instruments for bathymetric survey using single-beam and multi-beam echo sounders

Annexes



Annexes

ANNEX A. PROBLEMS ENCOUNTERED AND RESOLUTIONS APPLIED

Limitation/ Problems	Solutions
June 3: The RTK signal cannot cover the entire survey area.	The base was transferred to an established control point at Mt. Luho.
June 4: The base station at Mt. Luho has canopy cover	The radio antenna was transferred to a higher part.
June 4: The team experienced technical problem on the base station	The team purchased a new battery for the RTK radio transmitter
June 5: The team was unable to utilize the multi-beam echo sounder because Hypack Software malfunctioned	Upon inspection, the team discovered that the laptop Hypack was not working. The team reported the said incident to the supplier right after the survey. Data from the single beam echo sounder was used instead



Annexes

ANNEX B. LIST OF EQUIPMENTS AND INSTRUMENTS

Type	Brand	Serial number	Owner	Quantity
GPS Receiver (Base)	Trimble™ SPS852		UP-TCAGP	Two (2) units
GPS Receiver (Rover)	Trimble™ SPS882		UP-TCAGP	Eight (8) units
GPS Controller	Trimble™ TSC3		UP-TCAGP	Eight (8) units
Mobile Mapping Scanner (MMS)	MDL Dynascan		UP- TCAGP	One (1) unit with dual-GNSS antenna, one (1) interface adapter and stainless steel mounting accessories
RTK radio and High-Gain Antenna			UP-TCAGP	Four(6) units
Multi Beam Echo-sounder	Teledyne Odom ES3PT		UP-TCAGP	One (1) unit with accessories
Coupler-2a and 2b			UP-TCAGP	One (1) unit each
Handheld GPS	Garmin Oregon™ 550	1MW086831	UP- TCAGP	Four (4) units
		1MW086842		
		1MW086920		
		1MW079764		
Laptops	Dell Laptop		UP- TCAGP	One (1) unit
Digital Level	Topcon DL502		UP-TCAGP	One (1) unit with two (2) level rods
Depth Gauge	Onset Hobo wares	9759371	UP-TCAGP	one (1) unit
Rain Gauge		1293784	UP- TCAGP	One (1) unit
Range Pole	Trimble™		UP-TCAGP	Six (6) units
Tripod	Trimble™		UP-TCAGP	Four (4) units
Bipod	Trimble™		UP-TCAGP	Six (6) units
Tribrach			UP-TCAGP	Three (3) units

Annexes

ANNEX C. THE SURVEY TEAM

Data Validation Component	Designation	Name	Agency/ Affiliation
Survey Supervisor	Project Leader	ENGR. JOEMARIE S. CABALLERO	UP TCAGP
Bathymetric Survey Team	Chief Science Research Specialist (CSRS)	ENGR. DEXTER LOZANO	UP TCAGP
	Research Associate	JMSON CALALANG	UP TCAGP
MMS TEAM	Senior Science Research Specialist	ENGR. BERNARD PAUL D. MARAMOT	UP TCAGP
	Research Associate	PATRIZCIA MAE DELA CRUZ	UP TCAGP
	Research Associate	MARY GRACE JASON	UP TCAGP
GROUND TEAM	Research Associate	CARL VINCENT CARO	UP TCAGP



ANNEX D. NAMRIA CERTIFICATION



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

July 11, 2013

CERTIFICATION

To whom it may concern:

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

Province: AKLAN	Station Name: AKN-37	Barangay: POBLACION
Island: VISAYAS	Order: 2nd	
Municipality: MALAY		
PRS92 Coordinates		
Latitude: 11° 54' 8.93737"	Longitude: 121° 55' 1.03389"	Ellipsoidal Hgt: 5.48100 m.
WGS84 Coordinates		
Latitude: 11° 54' 4.24237"	Longitude: 121° 55' 6.15554"	Ellipsoidal Hgt: 58.50400 m.
PTM Coordinates		
Northing: 1316379.102 m.	Easting: 382009.134 m.	Zone: 4
UTM Coordinates		
Northing: 1,315,918.35	Easting: 382,050.43	Zone: 51

Location Description

AKN-37

From Kalibo, proceed to the Mun. of Malay. From the town proper, proceed to Malay Elem. School, about 35 m. from the nat'l. road and the grocery store. Station is located in the SW portion of the said school's open field and about 60 m. N of the Nursery Bldg.

Mark is the head of a 4 in. copper nail set flushed on top of a 30 cm. x 30 cm. concrete monument protruding 20 cm. above the ground, with inscriptions "AKN-37 2007 NAMRIA".

Requesting Party: **UP-DREAM PROGRAM**
Purpose: **Reference**
OR Number: **3943907B**
T.N.: **2013-0676**


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



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

