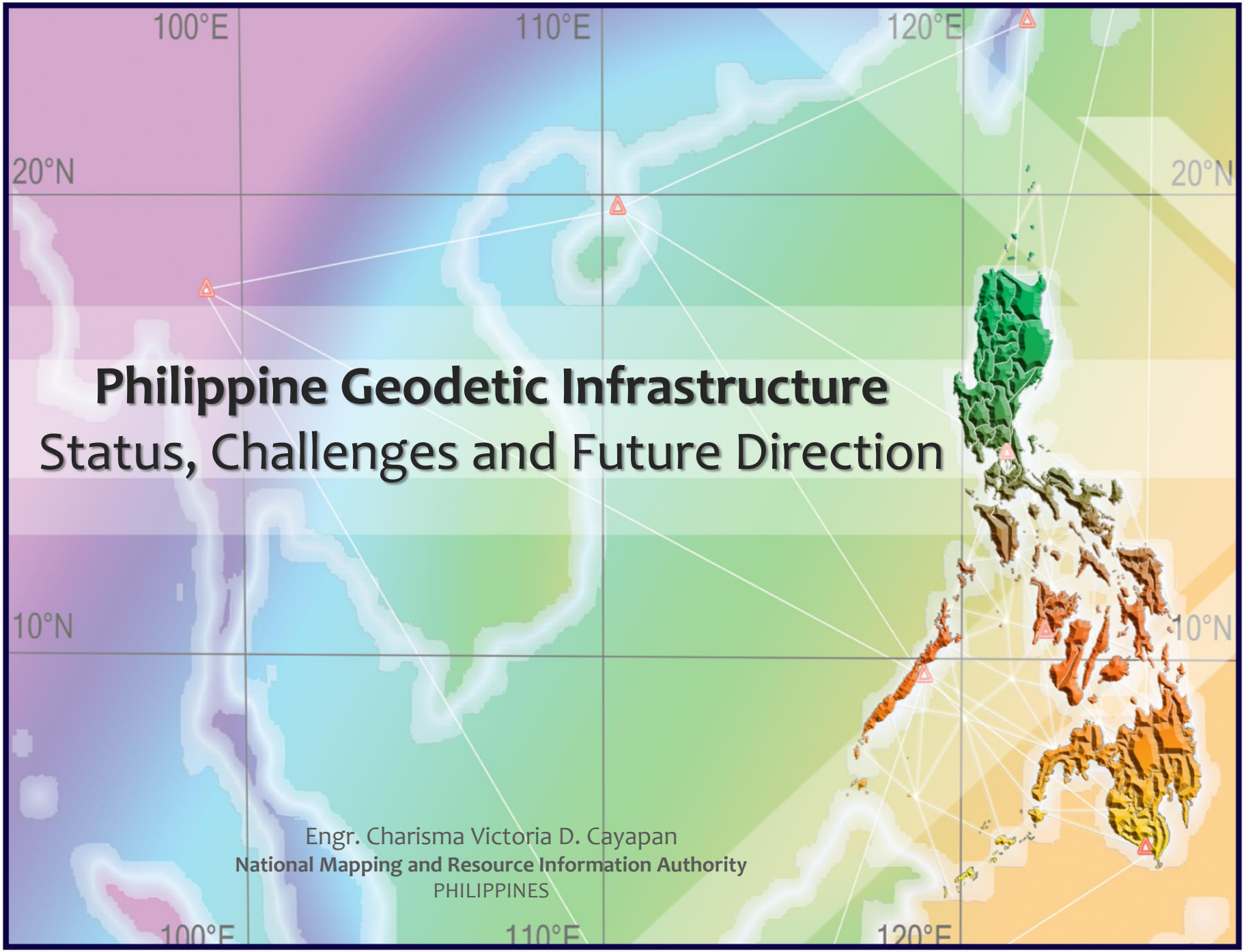


Philippine Geodetic Infrastructure

Status, Challenges and Future Direction

Engr. Charisma Victoria D. Cayapan
National Mapping and Resource Information Authority
PHILIPPINES

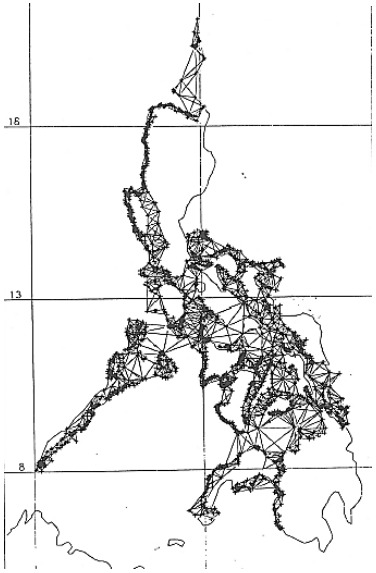
Outline

- Evolution of Geodetic Infrastructure
- Manager
- Geodetic Control Points
- Data and Control Center
- Geodetic services
- Users
- Challenges
- Modernization of the Philippine Geodetic Reference System

Evolution of Geodetic Infrastructure

Primary Triangulation Network of the Philippines

1901 – 1927



- Established by the US Coast and Geodetic Surveys
- Coordinates computed in the 1927 adjustment designated as Luzon Datum
- Network established generally very weak structurally with stations widely scattered throughout the islands

Evolution of Geodetic Infrastructure

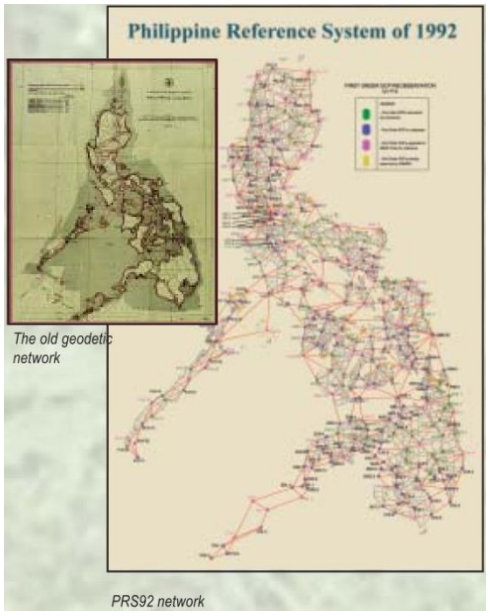
Primary Triangulation Network of the Philippines

1901 – 1926

Philippine Reference System of 1992

PRS 92

1989 – 1992



- Modified Luzon Datum established using GPS
  - Reference Ellipsoid: Clarke Spheroid of 1866
  - Origin: Station Balanacan
  - New geoid-spheroid separation at origin: 0.34m
- Local definition of the WGS84 datum using TRANSIT Doppler and GPS defined to facilitate processing of baselines and adjustment (approximates WGS84 to a tolerance of 6 meters)
- Transformation parameters between PRS92 and WGS84 available

Evolution of Geodetic Infrastructure

Primary Triangulation Network of the Philippines

1901 – 1926

Philippine Reference System of 1992

PRS92

1989 – 1992

PRS92 Project

PageNET
PHILIPPINE ACTIVE GEODETIC NETWORK

2007 – 2010

- Full scale and nationwide implementation of PRS92 as standard reference for surveys and maps
- Upgrading of PRS92
  - Densification of geodetic control points, benchmarks and gravity stations
  - **Establishment of the Philippine Active Geodetic Network (PageNET)**
  - Establishment and upgrading of tide stations
  - i-systems development support
  - Research and development
  - Policy formulation

Evolution of Geodetic Infrastructure

Primary Triangulation Network of the Philippines

1901 – 1926

Philippine Reference System of 1992

PRS92

1989 – 1992

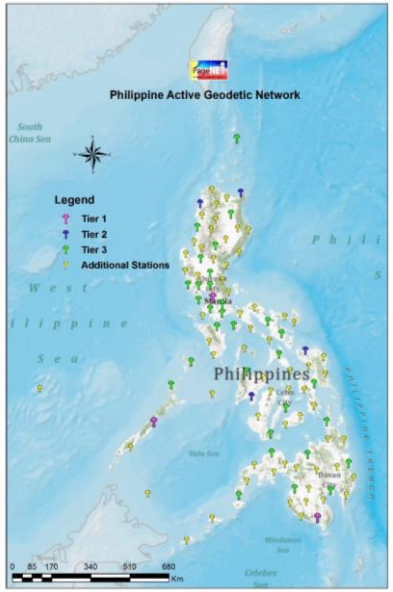
PRS92 Project

PageNET
Philippine Active Geodetic Network

2007 – 2010

Modernization of the Philippine Geodetic Reference System

2016 – 2020



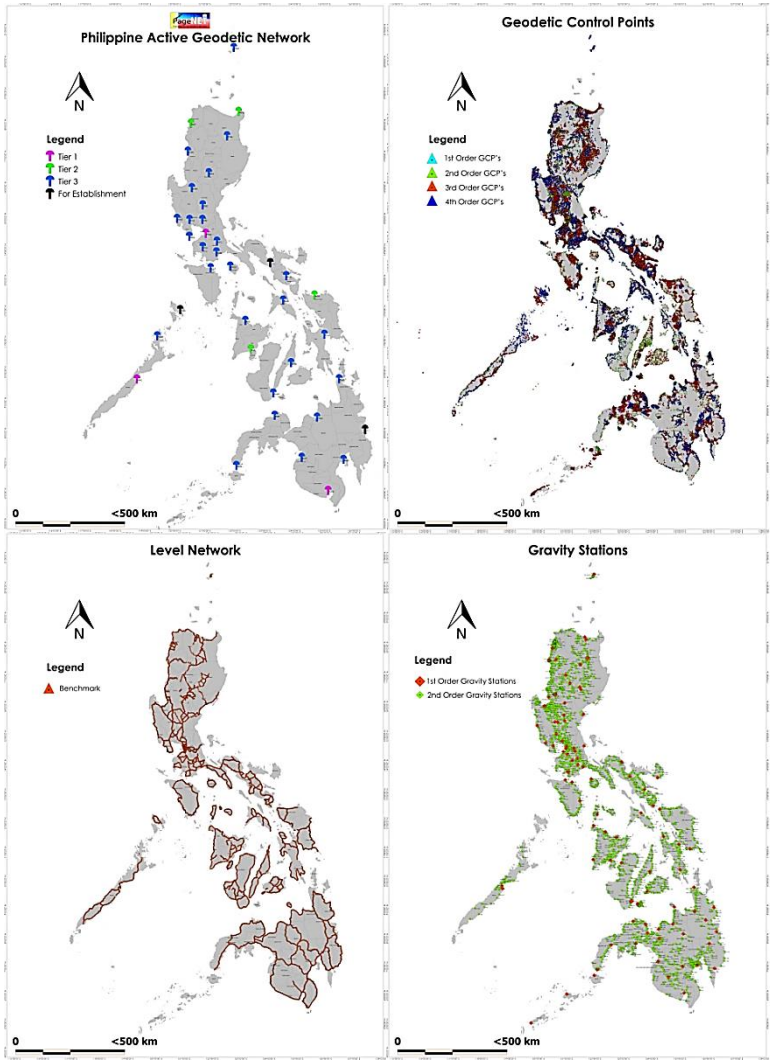
- Philippine Geocentric Datum 2016 (201x?)
  - Densification of PageNET (200 stations)
  - Development and refinement of a deformation model
  - Migration to semi-dynamic geocentric datum
- Philippine Geodetic Vertical Datum 2020
  - Development and refinement of the Philippine Geoid Model
  - Densification of gravity stations
  - Unification of the national vertical datum
- Strengthening of core competencies on geodesy
  - Revision of laws, standards and procedures
  - Research and development
  - Capacity building and IEC campaigns

Evolution of Geodetic Infrastructure

Datums in Use

Horizontal	Vertical	Gravity
Luzon Datum	Mean Sea Level	NAMRIA absolute gravity station
Philippine Reference System of 1992		
World Geodetic System 1984 (or ITRF)		
- *Propagated by GNSS observation* - *Physical realization: geodetic control points (passive and active)*	- *Propagated by geodetic leveling* - *Physical realization: benchmarks*	- *Densified using gravity observations* - *Physical realization: gravity stations*

Evolution of Geodetic Infrastructure



	Accuracy Standard	Spacing	Number
Horizontal			
AGS	1 ppm	100km	35 + 1 (shared)
Zero order	1 ppm	70km	65
First order	10 ppm	50km	318
Second order	20 ppm	20 km	2,360
Third order	50 ppm	10km	5,266
Fourth order	100 ppm	5km	29,591
Vertical			
First order	$4\sqrt{K}$ (mm)	1 km (national roads)	20,902
Second order	$8.4\sqrt{K}$ (mm)	0.5 km (city streets)	1,950
Gravity			
First order		50km	87
Second order		20km	1,624
International Collaborations			
IGS sites	4 (PIMO, PTAG, PPPC, PGEN)		
DORIS site	1 (Manille)		
APREF / APRGP	PTAG / All PageNET AGS		
MGM-Net	2 (PLUZ, PMIN)		
REGINA	1 (PTGG)		

Manager

National Mapping and Resource Information Authority

Department of Environment and Natural Resources (Lands Sector)

Philippine Institute of Volcanology and Seismology

Office of primary responsibility

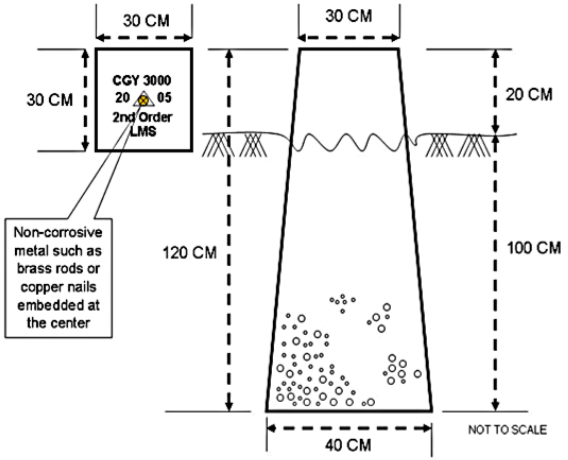
- *Central mapping agency mandated to establish and maintain the geodetic control network (zero to third order)*
- *Responsible for the establishment and operation of the Philippine Active Geodetic Network (PageNET)*
- *Data available to the public for a minimal fee **

- *Establishes and maintains 4th to 5th order geodetic control network for cadastral purposes*
- *Network consists of passive geodetic control points*

- *Maintains a nationwide network of CORS for crustal deformation studies*
- *Network consists of 80 active geodetic stations, all roof based*
- *Most of the sites are established in partnership with foreign organizations*
- *Data may be requested, subject to approval*

Geodetic Control Points

- **Typical passive geodetic control points**

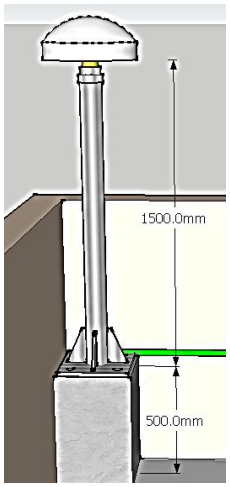


Dimension of Survey Control Monument

Order of Accuracy	Top Cross-Section	Bottom Cross-section	Length	Above Ground	Below Ground
First	30 x 30 cm	40 x 40 cm	120 cm	20 cm	100 cm
Second	30 x30 cm	40 x 40cm	120 cm	20 cm	100 cm
Third	25 x 25 cm	35 x 35 cm	120 cm	20 cm	100 cm
Fourth	20 x 20 cm	35 x 35 cm	100 cm	20 cm	80 cm

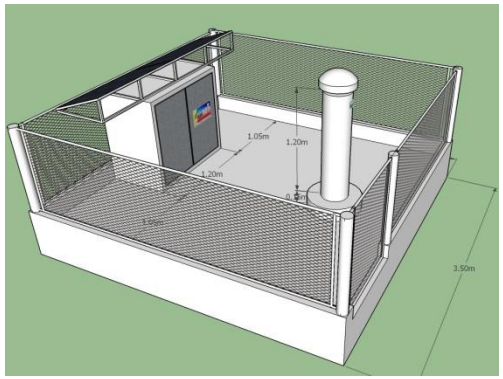
Geodetic Control Points

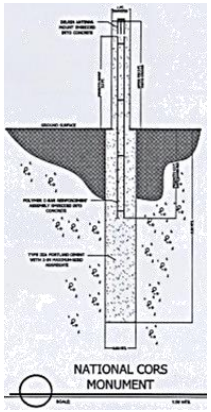
- **Typical active geodetic station**



Roof-based Installation
Pillars are anchored on reinforcement bars of the building using four (4) 20mm expansion bolts.

Type	Number
Roof-based	**25**
Ground-based	**10**

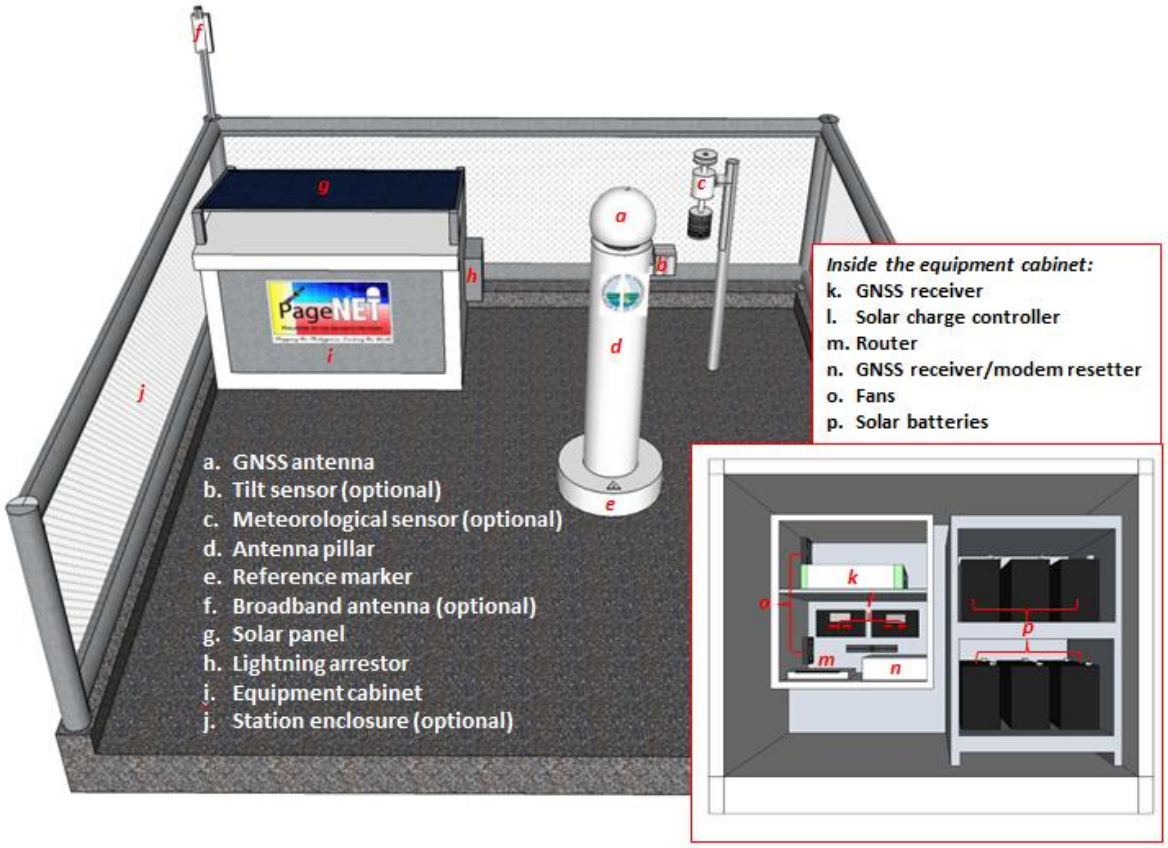




Ground-based Installation
Made of concrete pillar embedded on a ~3m-deep drilled hole. Delrin reinforcement assembly is also embedded on the concrete pillar for stability.

Active Geodetic Stations

- **Typical installation**



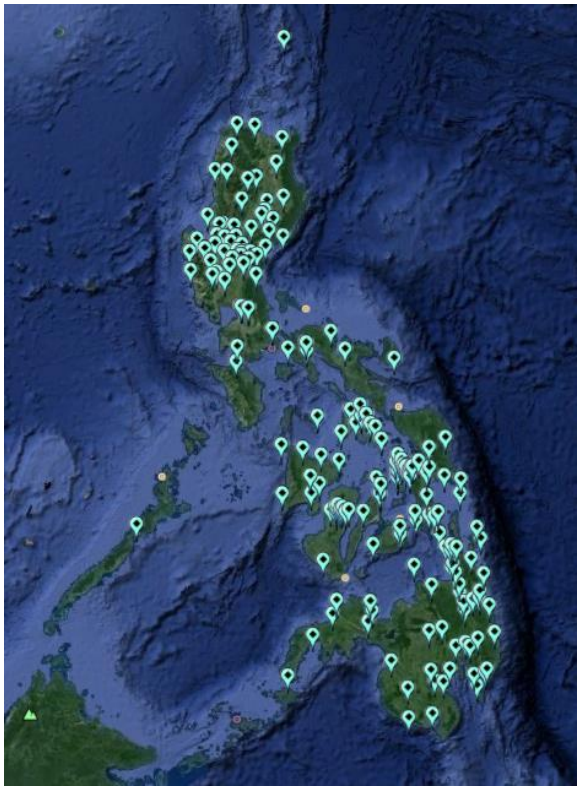
- GNSS receiver:
  - Leica GRX1200 GG Pro (5)
  - Leica GRX1200+GNSS (6)
  - Leica GR10 (3)
  - Leica GR25 (10)
  - Leica GR50 (5)
  - Trimble NetR9 (5)
- GNSS antenna:
  - Leica AT504 GG LEIS (6)
  - Leica AR25 (7)
  - Leica AR10 (7)
  - Leica AR20 (10)
  - Trimble Zephyr Geodetic (5)

GNSS	Number
GG	**22**
GGGBQ	**13**

Active Geodetic Stations

- **PHIVOLCS stations**

PHIVOLCS

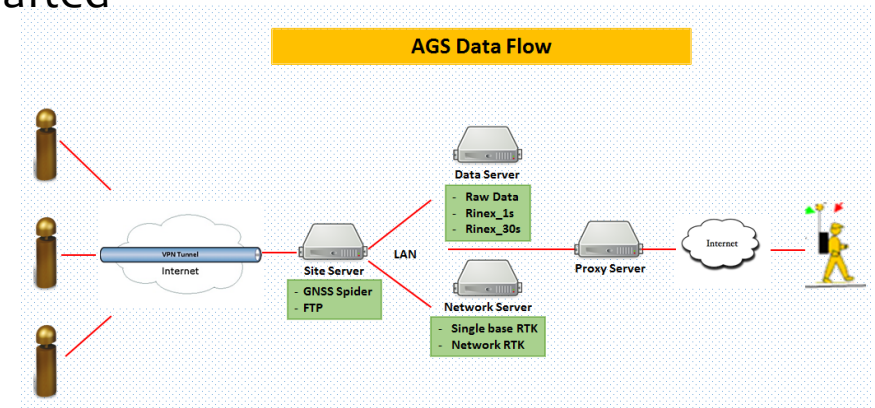


- GNSS equipment:
  - Alliscom MG700 (18)
  - Leica GRX1200 GG (3)
  - Leica GRX1200 GG Pro* (5)
  - Leica GRX1200 Pro (10)
  - Leica GRX1200+GNSS (6)
  - Leica MC500 (5)
  - Trimble NetR8* (6)
  - Trimble NetR9* (11)
  - Trimble NetRS (13)

  ***Total:** 77 (* multi-GNSS)*
- All roof-based stations; online (3)

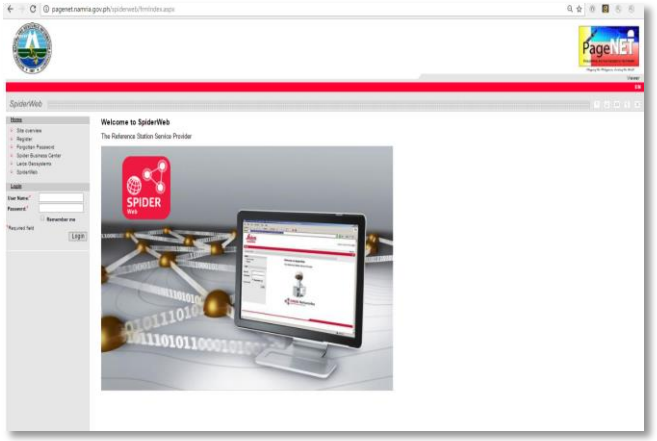
Data and Control Center

- The ICT facility for network monitoring, online processing, as well as storage and distribution of PageNET data
- CORS management software:
  - Leica GNSS Spider Software Suite
  - Trimble VRS^3
- Operationalization of daily network solution computation using Bernese GNSS software
- Virtualization of the DCC is ongoing
- Plans for an off-site back-up/mirror site are being drafted

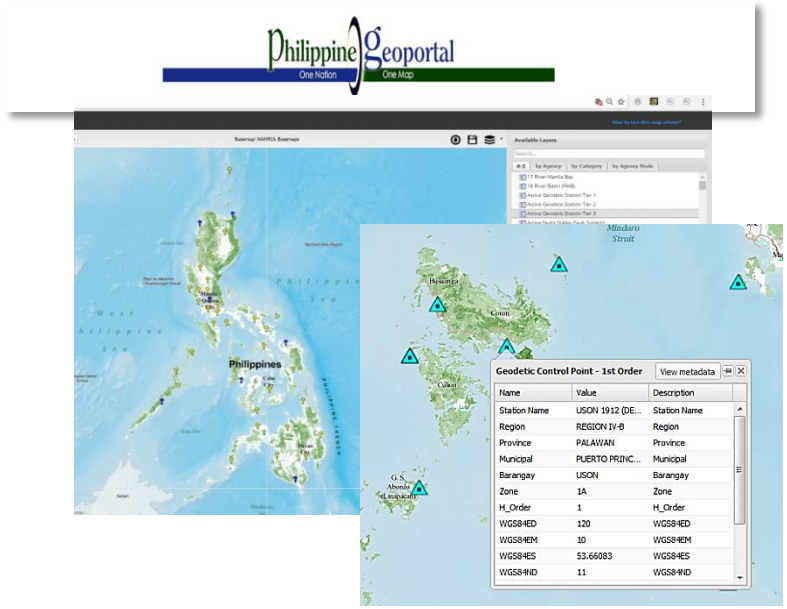


Geodetic Services

- **PageNET**
  1. RINEX download for post-processing
  2. Real-time correction service
     (single base and network RTK)
  - **User access**
    - http://pagenet.namria.gov.ph



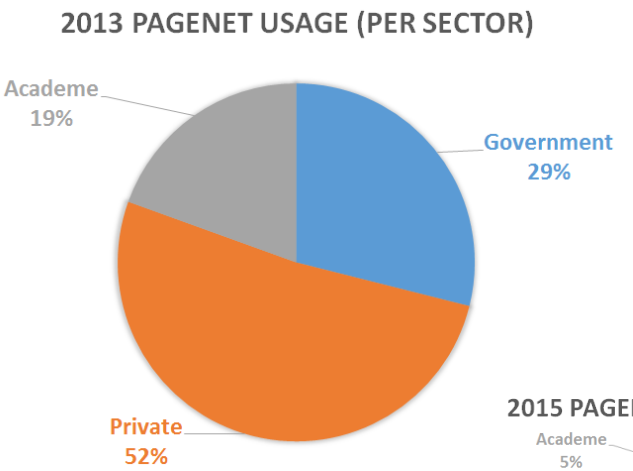
- **Geodetic Control Points**
  1. GCP Certification
  - **User access**
    1. Complete dataset is accessible via GNIS (Geographic Network Information System) at the NAMRIA Fort Bonifacio office

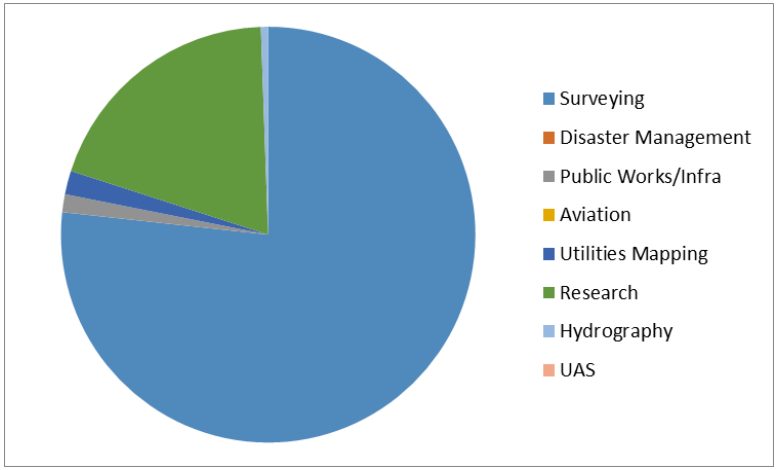


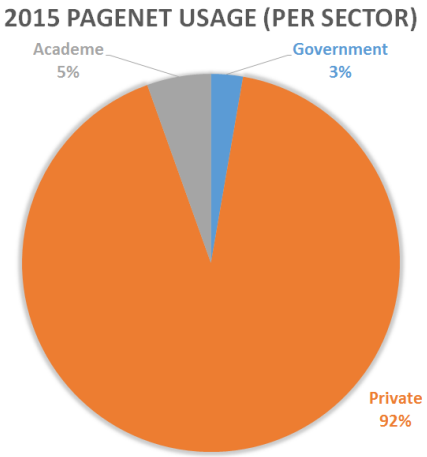
- Data access covered by MOA/MOU
- Map of GCPs available for download at the Philippine Geoportal website (www.geoportal.gov.ph)

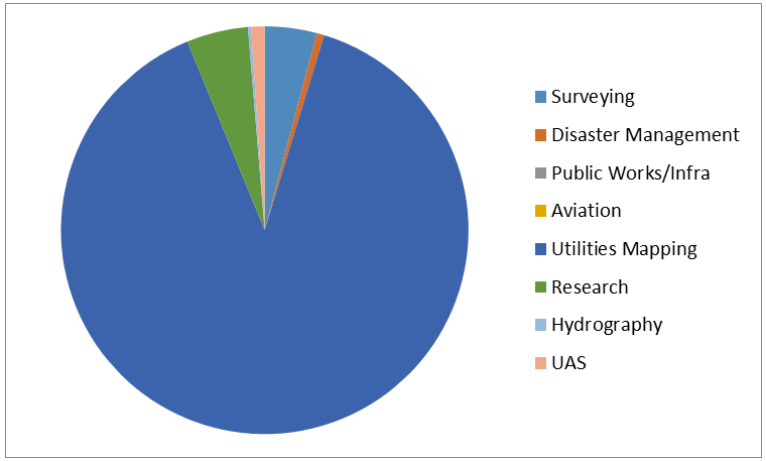
  -> needs passcode to download geodatabase

Users


2013 PAGENET USAGE (PER SECTOR)
Academe
19%
Government
29%
Private
52%

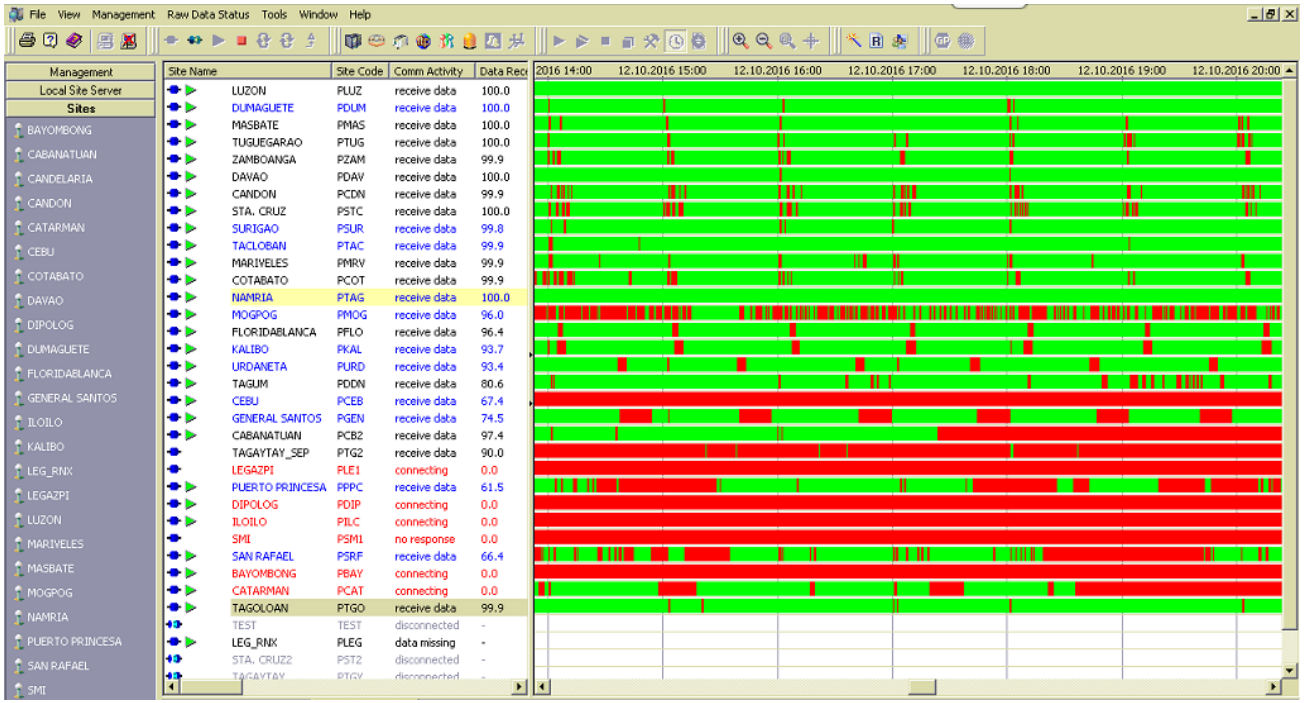

Surveying
Disaster Management
Public Works/Infra
Aviation
Utilities Mapping
Research
Hydrography
UAS


2015 PAGENET USAGE (PER SECTOR)
Academe
5%
Government
3%
Private
92%


Surveying
Disaster Management
Public Works/Infra
Aviation
Utilities Mapping
Research
Hydrography
UAS

Challenges

- **Operational:** Communication



- **Work-around**
  - Use back-up communications
  - Tap local resources for basic troubleshooting

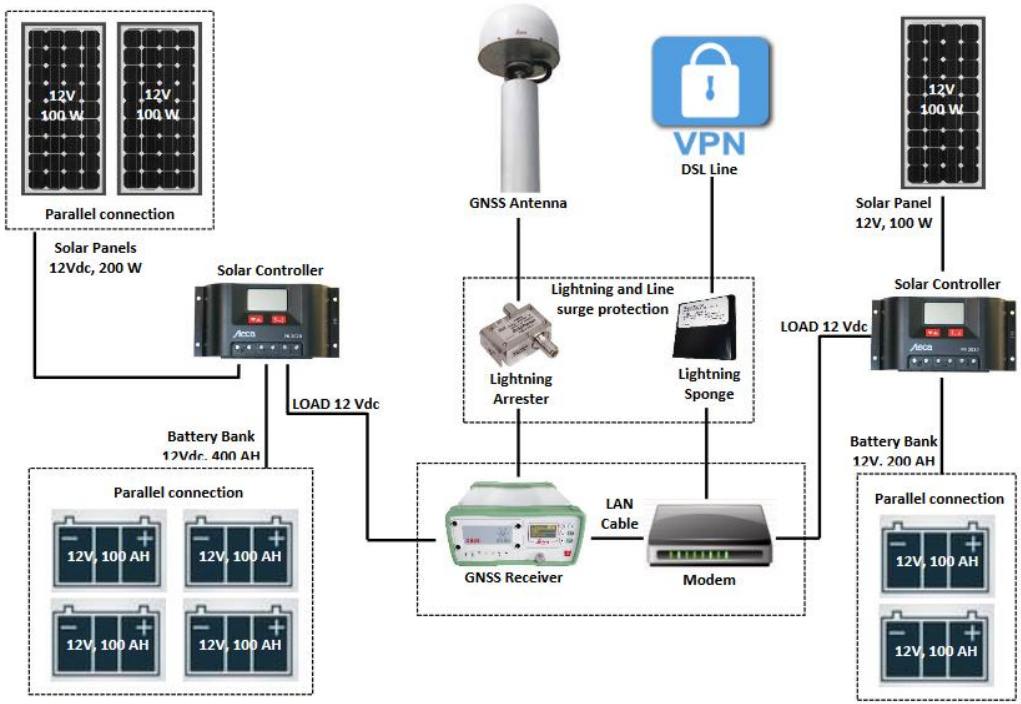
Challenges

- **Operational:** Natural and man-made hazards

- **Work-around**
  - Robust system installation, e.g. surge protection, back-up batteries
  - Engage local stakeholders e.g. Adopt a Mojon program

Challenges

- Operational: Power



- Work-around
  - Convert to solar power
  - Dedicated power supply for GNSS receiver

Challenges

- **Operational:** Cost-recovery scheme
  - PageNET primarily a government-ran facility currently not focused on income generation -> *marketing of PageNET services not prioritized*
  - Cost for operating the network does not break even with income generated from the network

- **Work-around**
  - Exploring feasibility of partnership with 3rd party entities for the distribution of PageNET data and services, including the installation and maintenance of active geodetic stations, e.g.
    - Agreement with GNSS suppliers to bundle PageNET subscription with units sold

Challenges

- **Technical:** Datum issues
  - PRS92 is a local and static datum -> *decreasing network integrity*
  - The country is located in a tectonically active region subject to regular ground deformation
- Work-around
  - Modernization of the Philippine Geodetic Reference System

The Philippine Mobile Belt (PMB) moves at an average of 2-3cm per year

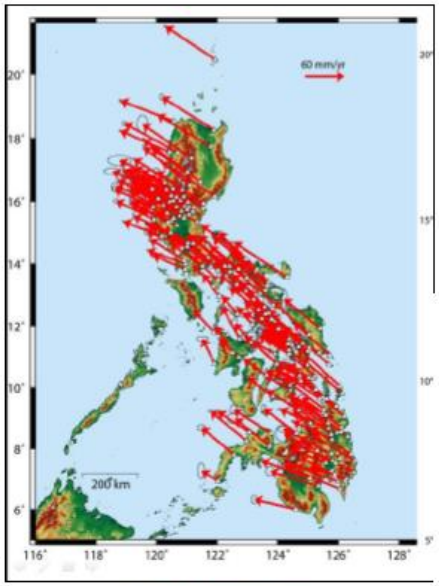
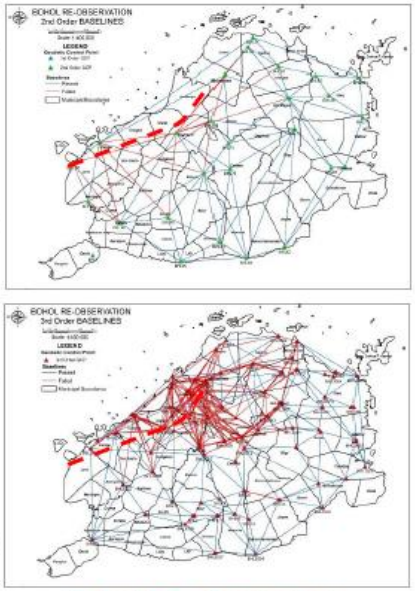


Plate tectonics

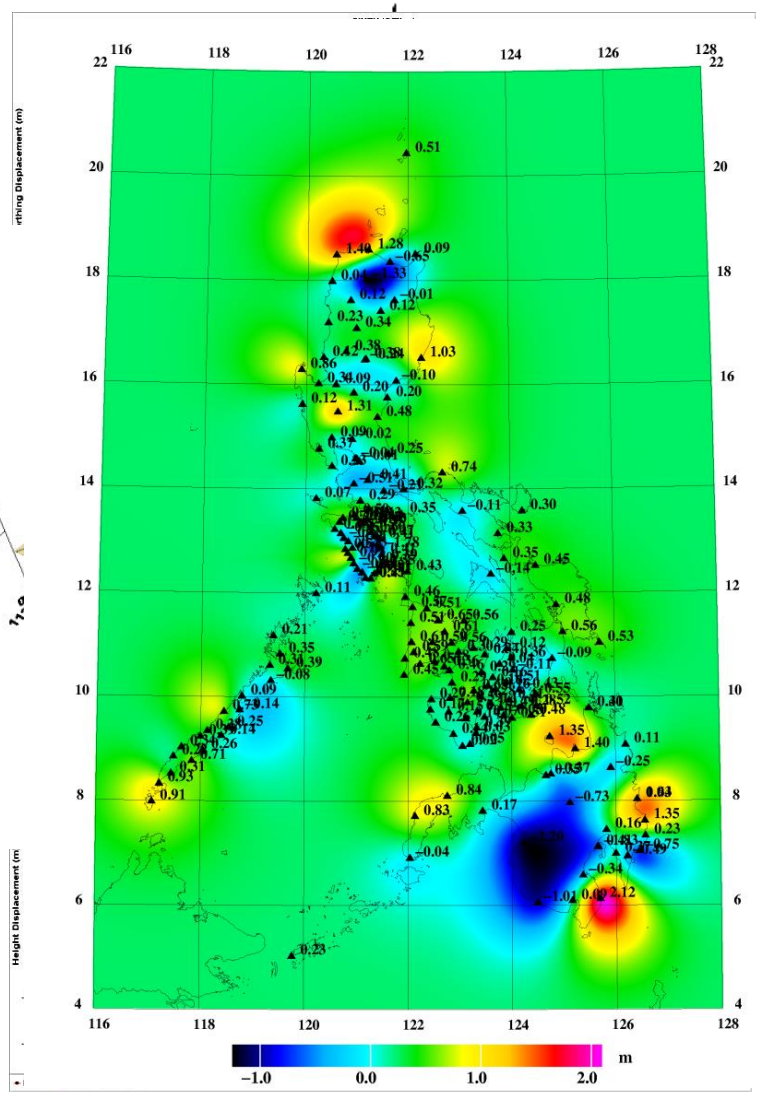


Bohol Re-observation

Re-observation of ground control points after the 2013 Bohol earthquake showed a maximum 2D displacement of 0.46m

PGRS Modernization

- **PGRS Modernization**
  - PGD2016
    - ✓ Established 35 active geodetic stations
    - ✓ Completed re-observation of zero-order GCPs
    - ✓ Procured Bernese GNSS Software and started processing of PageNET data
  - PGVD2020
    - ✓ Computed preliminary geoid model (PGM2014)
    - ✓ Troubleshooting of level network
    - ✓ Densification of gravity stations
    - ✓ Connection to the IVRF *



Maximum	45.6 cm (BHL-94)

PGRS Modernization

- **Modernization challenges**
  - Amendment of law
  - Deformation modeling
  - Capacity building
  - Change management

MALACAÑANG
Manila

EXECUTIVE ORDER NO. ____

ADOPTING THE PHILIPPINE GEOCENTRIC DATUM OF 2020 (PGD2020) AS THE STANDARD GEOMETRIC REFERENCE OF SURVEYS AND MAPS IN THE PHILIPPINES

WHEREAS, the Philippine Reference System of 1992 (PRS92) was adopted as the standard reference system for surveying and mapping activities Executive Order (EO) No. 45, dated 5 January 1993, as amended b 2000 and EO 321 dated 2 July 2004.

WHEREAS, PRS92 is a local and static reference s unchanged since its establishment in 1989-1992, despite the c regular ground deformations such as earthquakes and crustal dr consistency of positioning in the country.

WHEREAS, in order to meet the accuracy requiremen reference, there is a need to upgrade and modernize the national g order to deliver global, interoperable and more accurate geospatia socio-economic, environmental, scientific, and other development including climate change adaptation and disaster risk reduction and

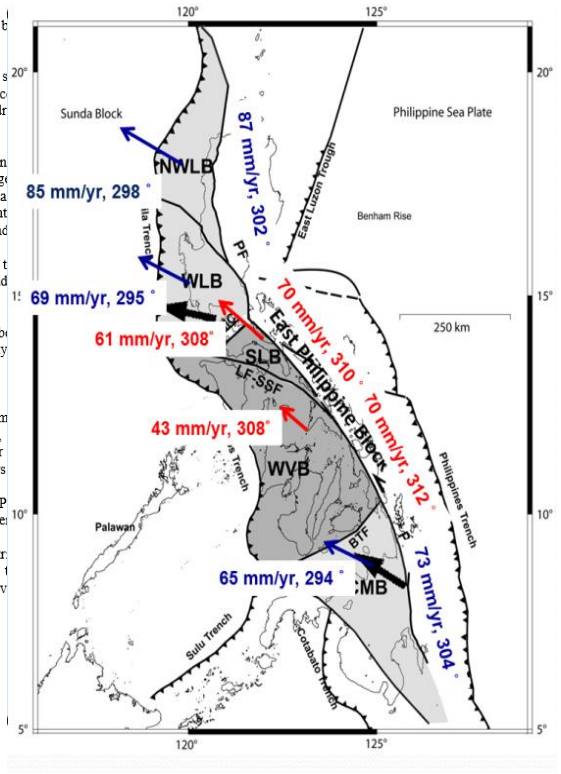
WHEREAS, the Philippines is one of the co-sponsors of t Assembly resolution A/RES/69/266 of 26 February 2015 on the ad reference frame for sustainable development.

WHEREAS, a modern geodetic reference system must b international terrestrial reference system (ITRS) for globally coordinate reference system.

WHEREAS, the new geodetic reference system is positioning technologies such as global navigation satellite system multi-sectoral applications such as surveying and mapping, precision agriculture, natural resources management, disaster response, aviation, maritime and land transportation, among others

NOW, THEREFORE, I, BENIGNO S. AQUINO, III, P the Philippines, by virtue of the powers vested in me by law, do he

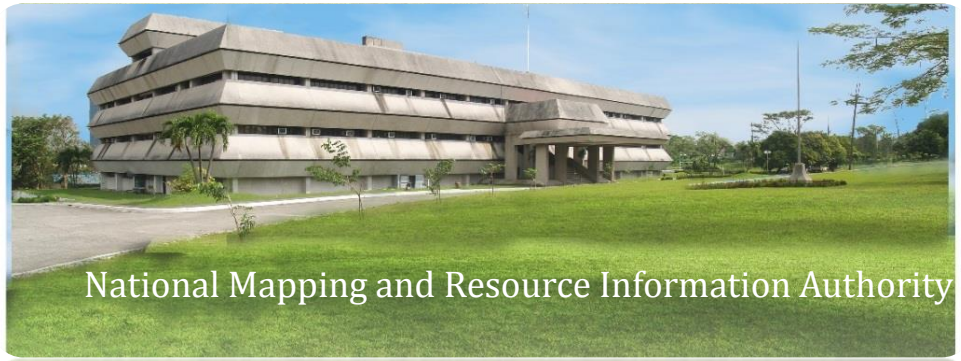
SECTION 1. The development of a modern geocentr known as the Philippine Geocentric Datum of 2020 (PGD2020) new standard reference system for all surveying and mapping activ



Contact Information

- Philippine Active Geodetic Network
  - pagenet@namria.gov.ph
  - +63 2 810 4831 local 615
  - +63 2 884 2849

- National Mapping and Resource Information Authority
  - oss@namria.gov.ph
  - +63 2 810 4831
  - Lawton Ave., Fort Andres Bonifacio Taguig City, 1634 PH



Maraming salamat po!