

## CASE STUDY

# 3D Elevation Data and Decision Support Systems for Developing Nations: Philippines

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The development of a national digital elevation model basemap for developing countries can make collaboration more streamlined and bolster resource management country wide.

## Introduction

The Philippines is an archipelago formerly marketed as 7,107 islands. As of January 2016, the country has an officially announced total of 7,641 islands. The additional islands were derived from a 2013 airborne radar survey by Intermap Technologies, Inc. This paper outlines the origins of that project, and the benefits the Philippines has reaped since their initial investment in the program by developing a national digital elevation model (DEM) basemap.

## Project Origins

Over 100 million people inhabit over 300,000 km<sup>2</sup> of land. It's the 7th most populated country in SE Asia. However, the last major program undertaken to map the country was in the 1950's. This map, the 711 Series, was obtained and published by the US Army compiled from aerial photography taken between 1947 and 1953. The Filipinos had an idea of roughly how many islands, though neither an exact amount nor locations of all.

The Philippines is the fourth in the world among countries hit by the highest number of disasters over the past 20 years, according to the United Nations Office for Disaster Risk Reduction (UNISDR). Spurred by a fast-growing population, exploding GDP growth, and increasing population densities near disaster-prone areas, the need for a new national basemap for multiple use cases was imminent.



In 2001, a World Bank project titled “The Establishment of a Technical, Operational and Legal Framework for the Management of Geographic Information in the Philippines” was undertaken to develop a basic framework for coordinated management of geographic information by multiple agencies in the Philippines. The National Mapping and Resource Information Authority (NAMRIA), an office attached to the Department of Environment and Natural Resources (DENR), is the central mapping agency of the government. They were tasked to lead this effort.

NAMRIA provides the public with mapmaking services and is the repository of and distribution facility for base maps, nautical charts, and other resource data.



Because of the high initial cost requirements for development of a National Spatial Data Infrastructure (NSDI), NAMRIA launched an incremental NSDI Development Program. A major milestone to the program was in 2005, when they produced a seamless digital topographic database from the nearly 60 year old 1:50,000 topographic maps. While this was a great feat, the program needed another major boost.

Administrative Order No. 16, signed on 16 July, 2011, was a huge leap forward. The order directs all government entities to coordinate with NAMRIA in the acquisition of data from airborne and spaceborne platforms for use in their respective projects. This led to the formation of the Philippine Geoportal: One Nation One Map.

The year 2011 also saw Typhoon Pedring, which made landfall in the Philippines causing 85 deaths and an estimated \$361M USD in damage<sup>1</sup>. Soon to follow was Typhoon Pablo in 2012, which caused over \$1B USD in damage. In July of 2012, President Benigno Aquino III demanded a better disaster prevention and mitigation system. He formed a Nationwide Operational Assessment of Hazards (NOAH) program. The Department of Science and Technology (DOST) was the agency in charge of the project, and they needed a national 3-dimensional DEM.

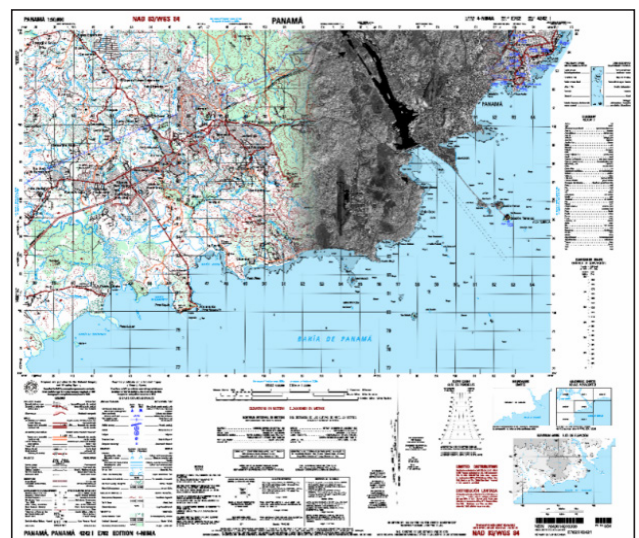


Image of a topographic line map

<sup>1</sup> Ramos, Benito T. (2011-12-30). 2011 Top 10 Philippine Destructive Tropical Cyclones (PDF) (Report). National Disaster Risk Reduction and Management Center.



The Land Management Bureau (LMB), in charge of managing the cadastral survey projects and the digital cadastral mapping in the country, also needed better 3D data for cadastral mapping. As an agency of the DENR, in order to determine boundaries of land ownership, the LMB must conduct surveys. Outdated maps prove useless in many instances. More precise land boundaries mean more accurate tax assessment, and potentially the prevention of lost income to the state.

As you can see, in 2012, the Philippines were at a critical juncture in the need for new national maps, thematic and disaster maps, land use and taxation, and a better general understanding of their natural resources.

It was then that the Philippine government, under the direction of NAMRIA, sought to create the very best nationwide DEM that could be acquired. They turned to Intermap Technologies®.

## The Project

The NAMRIA mapping project involved the acquisition of airborne interferometric synthetic aperture RADAR (IFSAR) data over approximately 300,000 km<sup>2</sup> of the Philippines using Intermap's Learjets.



*Intermap's STAR-3 LearJet equipped with IFSAR*

Included within the project was the development of a comprehensive network of ground control points (GCP), verification check points (VCP), the production of orthorectified radar images (ORI), digital surface models (DSM), and digital terrain models (DTM).

The mandate from NAMRIA was that the DEM needed to have a vertical accuracy of

1.0 meter root mean square error (RMSE) in unobstructed areas of slope less than 10 degrees. Horizontal accuracy had to be 2.0 meters RMSE. Further the requirement in post spacing of elevation data had to be 5.0 meters. Essentially, this means that wherever you are at within the Philippines, this digital model can tell you within 1 meter, up or down, your precise geographic location.

Intermap mobilized their Learjet into the Philippines in April of 2013. Within a net of 89 days, flying two sorties a night, the company collected DEM and ORI data over the entire country with accuracies in many cases superior to the specifications required. The DEM data obtained



accuracies of 49 centimeters RMSE, in low-slope (<10 degrees) areas. Within a total of nine months, Intermap had produced and delivered all products by the end of the fiscal year that December.

## Data Applications

### Unified Mapping Program

The Philippines is now underway with a Unified Mapping Program (UMP), 10-year project which will update the country's topographic map series and implement a 1:10,000 map series for more than 50 percent of the country's land mass. The basemap of the UMP is the Intermap IFSAR dataset.

The UMP serves as the official government base data for all detailed planning initiatives including:

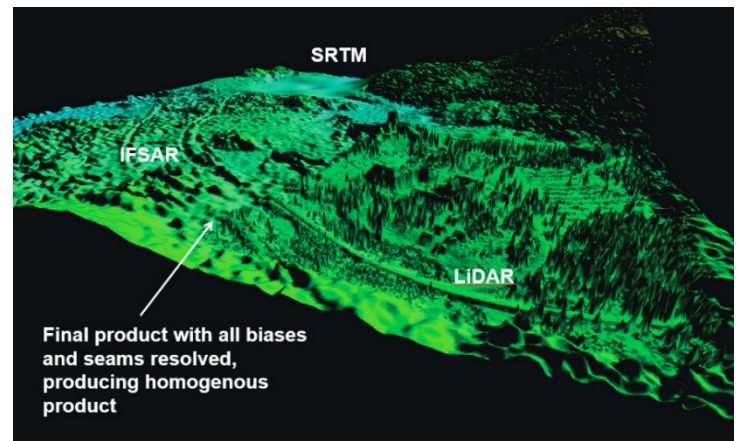
- Urban and land use planning
- Conservation of natural resources
- Protection of the environment
- Land use and disaster management
- Zoning and development
- Communications, transport, defense, and public safety

One of the key values in a nationwide DEM is ensuring the accuracy of all other imagery datasets. The consistency and accuracy of

the imagery is directly dependant on the accuracy of the DEM that is used to position the imagery in the precise location that it represents on the Earth's surface. An accurate and consistent DEM as the foundation for imagery ensures that imagery datasets are spatially accurate, and avoids misinformation, uncorrelated datasets, and unusable data.

According to the DENR, instead of the typical approach wherein different government agencies do their own mapping and GIS initiatives, this UMP effort will pool funds for the acquisition of aerial photography and satellite imagery to go along with the nationwide DEM acquired by Intermap's airborne IFSAR system.

DENR Secretary Ramon Paje said in a statement that, around 80 percent of planning, decision making, and operations in different government agencies are being influenced by locations. He further added that the government uses spatial data for purposes such as legislation, policy development, management of resources, environment protection, urban planning, and disaster management, among others.



DEM using IFSAR and LiDAR





The agency also stresses the importance of using spatial information in government agencies in the country as it would not only improve business processes but could also potentially reduce the loss of lives when used for disaster management and Geohazard mapping given the unique location of the Philippines as an archipelago.

## Philippine Geoportal

The Philippine Geoportal – One Nation One Map project ([www.geoportal.gov.ph/](http://www.geoportal.gov.ph/)) is a collaborative effort between NAMRIA, and the Advanced Science and Technology Institute/Department of Science and Technology (ASTI). The project is funded and conducted under the budget theme of: Anti-Corruption, Transparent, Accountable, and Participatory Governance.

The Geoportal aims to establish a web portal that provides an ICT platform for collaboration, data and resource sharing, integration, transparency and resource optimization. The system provides a mechanism for a clearinghouse network, data management, exchange standards and protocols, and an institutional interface that facilitates the flow of information across all levels of government, the private and non-profit sectors, academia, and other stakeholders, with safeguards to protect misuse and potential risks to individuals, community and country.



Philippine Geoportal partner agencies

The Geoportal intends to hold and serve to the general public the IFSAR basemaps and fundamental datasets that NAMRIA produces and eventually all of the thematic datasets of the other stakeholder agencies. It also promotes the participation of local government units having mandate to produce sub-national level geospatial data (e.g., land use plans), which is otherwise not being carried out by the national government agencies.

## Geoportal Benefits

- Provides authoritative, consistent, relevant, and updated maps
- Facilitates thematic mapping
- Facilitates mash-ups and integration of information



- Avoids duplication of effort
- Avoids wasting money
- Facilitates collaboration and cooperation among agencies
- Provides platform for integration of data from many sources
- One multi-scale framework map served and used for government planning, decision making, monitoring of projects, and for the simple requirements of the general public for their personal and ordinary needs and activities

## University of Philippines DREAM Project

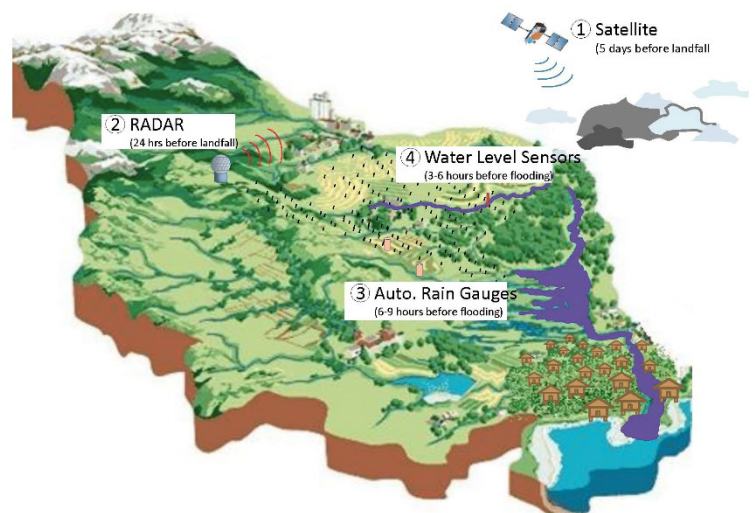
One major application is that of the University of Philippines Disaster Risk and Exposure Assessment for Mitigation (DREAM) Program (<https://dream.upd.edu.ph/>). This project is tasked with producing up-to-date, detailed, and high-resolution flood hazard maps for the critical river basins in the Philippines.

The DREAM program is also collecting Light Detection and Ranging (LiDAR) data throughout the critical river basins. By using a homogenous IFSAR dataset, the DREAM project can correct any anomalies present in the various and scattered LiDAR datasets to enhance their overall flood models.

## Nationwide Operational Assessment of Hazards

The NOAH project (<http://noah.dost.gov.ph/>) mission is to undertake disaster science research and development, advance the use of cutting edge technologies and recommend innovative information services in government's disaster prevention and mitigation efforts.

NOAH concurs that the existing 1:50,000 scale maps are insufficient to capture the hazard susceptibility details at the community level and were therefore not useful at all for detailed planning and emergency response. They have since utilized IFSAR data for a variety of projects, including conducting landslide and debris flow susceptibility maps and models of highly vulnerable areas and simulated storm surge maps.



Landslide hazard maps, when combined with other hazard maps such as flood and storm surge



maps, can be used to identify locations that are favorable for development. Critical facilities such as hospitals and evacuation centers should be situated in areas that are accessible and least likely to be affected by hazards. The use of these maps can facilitate the visualization and deeper understanding of possible disaster scenarios and serve as a guide in hazard preparedness and mitigation.

## Conclusion

The Philippines, having established a nationwide DEM, is implementing large-scale topographic maps that form the foundation for economic growth and development, security, natural resources, disaster management, and many more applications. This effort will make collaboration amongst government agencies more streamlined, reduce redundancy, improve communications, and bolster resource management country wide.

An airborne mapping project can yield geospatial data good for up to 1:5,000 scale mapping initiatives. A project may be conducted in a few months for data acquisition, implementing an NSDI within a year. Public-Private Partnership programs advance technology transfer and sharing of the data and applications.

By adopting a strategic DEM infrastructure program, countries can reap long-term benefits. Imagery, datasets, and analytics will be more accurate, reliable and meaningful. Data and derivatives will be integrated and shared between all projects to maximize investment and applications. Long term analytical results will be consistent over time so that trends are linked to actual changes and not compromised by a patchwork of location updates and modifications to information quality.

Tracing its legacy back almost 100 years, Intermap Technologies is an industry leader in creating geospatial solutions-on-demand. Intermap has an IFSAR data suite that is unparalleled in accuracy and consistency throughout the industry and proprietary elevation fusion technologies for foundation elevation maintenance. Having a nationwide DEM provides developing nations a common frame of reference to accurately share data and information with each other.



Intermap Technologies is an industry leader serving a diverse geospatial marketplace. We provide highly accurate geospatial information to help commercial enterprises and government agencies make better location-based decisions.

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