& GRIDS & DATUMS

THE REPUBLIC OF THE PHILIPPINES

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The Grids & Datums column has completed an exploration of every country on the Earth. For those who did not get to enjoy this world tour the first time, *PE&RS* is reprinting prior articles from the column. This month's article on the Republic of Philippines was originally printed in 1999 but contains updates to their coordinate system since then.

The Philippines has a long history of diverse settlers. Chinese traders visited the Philippines in the 10th century AD, and Muslims settled in the southern part of the islands during the 15th century. The Portuguese navigator Ferdinand Magellan discovered the islands in 1521, and the first successful European settlement was made by the Spanish under the explorer Miguel López de Legazpi in 1565. The battle of Manila Bay was fought during the Spanish-American War, and the Treaty of Paris with Spain ceded the Philippines to United States control in 1898. The treaty limits of the Philippines consisted of an enclosing box with appropriate zigzags to accommodate the island of Borneo.

The U.S. Coast and Geodetic Survey (USC&GS) executed the earliest topographic work of significance from 1901-1942. Numerous local datums were established at "Astro stations" that include: Bancalan Island, Cagayan Sulu Island, Davao, Iligan, Misamis Oriental, and Zamboanga on Mindanao Island, Legaspi and Vigan on Luzon Island, Ormoc and Tacloban on Leyte Island, and Iloilo on Panay Island. This large number of Datums is the result of numerous triangulation parties starting work in different areas of the Philippines all about the same time. For example, at one time in Luzon alone-detached surveys were based on 13 different astronomic stations. Eventually these surveys were brought together on what was known as the Vigan Datum of 1901. This Datum was the mean of the values for Vigan astronomic station as derived through the unadjusted field computations from five astronomic stations. This datum served its purpose for a time but as the triangulation was extended to the central and southern part of the islands it was found necessary to establish a new datum. The results of the basic trigonometric surveys were reported on topographic and hydrographic field sheets that have never been published. A 1:200,000 series of city plans and topographic sheets were the only series printed before World War II.

The Luzon Datum of 1911 is defined by its origin near San Andres Point on Marinduque Island in the Southern Tagalog Region. That point is at station Balanacan (a port name) where: Φ_o = 13° 33′ 41.000″ North, Δ = 121° 52′ 03.000″ East of Greenwich, and the geoid/spheroid separation H_o - h_o = 0.34 meters. The defining geodetic azimuth (from south) to station Baltasar is: α_o = 009° 12′ 37.000″, the ellipsoid of reference is the Clarke 1866 where: a = 6,378,206.4 meters, and $^1/_f$ = 294.9786982. All original survey work was Second-Order or lower. It was well controlled by 98 measured base lines, 52

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observed azimuths, and 49 latitude and telegraphic longitude stations. The supplementary triangulation extended along the shores of bays and harbors and up rivers and creeks. Most of the coast triangulation was Third-Order accuracy, notably the chain along the west and north coasts of Luzon Island and that on the west and south coasts of Panay Island.

The first Grid system used in the Philippines was devised by the USC&GS in 1919, which was also the first Grid used in the United States. The "Grid System for Progressive Maps in the United States" was the defining design for the World Polyconic Grid (WPG), the predecessor of the Universal Transverse Mercator (UTM) Grid. During the 1930's, the Work Projects Administration for the City of New York extended some of the specifications for the "Grid System for Military Maps." The first use of False Easting was introduced to the American Grid System at the Central Meridian (λ_o) where False Easting = 1,000,000 U.S. Survey yards. May of 1943 marked the first use of the WPG by the U.S. Army Map Service (AMS). The Philippines were based on a special local meridian (122°) of that Grid as computed and tabulated by the USC&GS. Although the WPG overprint color was purple for most of the world, the color used for the Philippines was black. The 1:200,000 maps had a 10,000-yard grid interval and the WPG was used in the Philippines until 1952.

Other Grids found in the Philippines include the Netherlands East Indies (NEI) Equatorial Zone British Metric Blue Grid based on the Lambert Conical Orthomorphic projection. The NEI Equatorial Zone Black or Brown Grid in U.S. yards is also found there (numerically the same Grid with different units), but the occurrences for both are only on Cagayan Sulu Island and in the Sibutu Island group. These two Grids commonly found in Malaysia and Indonesia flabbergasted me when I first encountered them some decades ago. Besides Bukit Rimpah Datum being referenced to the Bessel 1841 ellipsoid, the Scale Factor at the Latitude of Origin (m_o) = 0.997, False Easting = 900,000.000 m. (984,250.000 yd.), False Northing = 3,900,000.00 m. (4,265,083.333 yd.). The Central Meridian (λ_o) = 110°, and the Latitude of Origin (Φ_o) = 00° = the equator! I wasted my time trying to get these parameters to work with Lambert Conformal Conic formulas until I realized that the Lambert Conformal Conic with a Latitude of Origin at the equator decomposes to a Normal Mercator! The NEI transformations worked fine after that.

Straight baselines are a method for a sovereign nation to define its territorial waters by defining points along its coast from which lines are drawn (on a Mercator projection). This then establishes a line (ellipsoidal loxodrome or rhumb line) from which that nation's claim to territorial limits is measured. The straight baseline is a "new" development in international law. It had its inception in 1951 with the decision in the *Anglo-Norwegian Fisheries* case in which the International Court of Justice upheld Norway's method of delimiting an exclusive fisheries zone by drawing straight baselines along the Norwegian coast above the Arctic Circle, independent of the low-water mark. This established a new system of baselines from which the territorial sea could be measured, provided certain geographic situations were satisfied. This system with certain modifications was approved by the 1958 Geneva conference on the Law of the Sea.

On 17 June 1961, the Government of the Philippines approved Republic Act No. 3046, "An Act to Define the Baselines of the Territorial Sea of the Philippines." The Philippine government adopted the so-called "archipelago principle" in drawing a series of 80 straight baselines about the external group of islands. This baseline system in effect closed the important Surigao Strait, Sibuto Passage, Balabac Strait, and Mindoro Strait, as well as the more internal passages through the Philippine Islands. The largest body of water enclosed was the Sulu Sea. Other significant seas enclosed include the Moro, Mindanao, and Sibuyan. Furthermore, the Indonesian island of Pulau Miangas and the Indonesian Straight Baselines were enclosed within the Philippine territorial sea! The United States (and Indonesia) did not recognize this declaration of territorial waters, which represents a thorny issue in international boundary claims. Furthermore, to become recognized under international law, there must be an absence of formal protests from other nations, and the territorial waters declaration must be ratified by at least 22 other nations.

From 1947 to 1962, a national civil Grid was used on the Luzon Datum of 1911 known as the Philippine Transverse Mercator Grid with four zones. All four Gauss-Schreiber zones had a False Easting at the Central Meridian of 500 km, all four had a Scale Factor at Origin (m_o) = 0.99995, and all four had a False Northing Latitude of Origin of: (ϕ_{FN}) = 04° 00′ 00″ North. Zones II, III, and IV had Central Meridians (λ_o) = 121°, 123°, and 125°, respectively. For some reason unfathomable to me, Zone I had a Central Meridian (λ_o) = 118° 20′ East of Greenwich. In a recent telephone conversation with Mr. Joseph F. Dracup (retired Chief of Triangulation at USC&GS), he suggested that the weird Central Meridian might have been designed to minimize the Grid scale factor somewhere in the Philippine Islands. On examination of a map of the area, Palawan Island fits that criterion. Of course, the military 1:50,000 mapping was based on the Gauss-Krüger Transverse Mercator projection with the UTM Grid.

In 1962, a new national civil Grid was introduced for the Luzon Datum of 1911, and it was changed to the Gauss-Krüger Transverse Mercator projection. The previous Grid Scale Factor at Origin and False Easting was retained, the False Northing Latitude of Origin was changed to the equator, and the Central Meridians (λ_o) = 117°, 119°, 121°, 123°, and 125° for Zones I to V. A civilian edition of the 1:50,000 topographic series was produced in association with U.S. agencies starting in 1961 and completed in the 1970's. All 967 sheets have been published in color.

In 1987, the Philippine Bureau of Coast and Geodetic Survey was incorporated as a part of the National Mapping and Resource Information Authority (NAMRIA). A total of 467 GPS stations were observed which included 330 First Order stations, 101 Second Order stations, and 36 Third Order stations.

This series of new observations was adjusted and published as the Philippine Reference System of 1992 (PRS92). According to NAMRIA this included the establishment of an EDM calibration baseline, and the determination of the seven Bursa-Wolf transformation parameters between the Luzon Datum of 1911 and WGS 84. Those parameters from WGS84 to PRS92 are published as: $\Delta X = +127.623$ meters, $\Delta Y = +67.245$ meters, $\Delta Z = +47.043$ meters, Scale = $+1.06002 \times 10^{-6}$, $R_x = +3.07$", $R_y = -4.90$", and $R_z = -1.58$". No accuracy statements were published with the parameters. Since this work was done with Australian government assistance, the sign of the rotation parameters is assumed to be the standard right-handed system favored in Australian and U.S. practice. Although some may favor the designator "PRS92," it is in fact still the original Luzon Datum of 1911 with published transformation parameters from WGS84 Datum. The original Datum observations were not recomputed. It is hoped that NAMRIA will resume their collaboration with the U.S. National Imagery and Mapping Agency and seek consulting services to modernize their geodetic system. An individualized geoid model would be a welcome foundation to this hypothetical datum.

Update

"NAMRIA is spearheading the establishment of the Philippine Active Geodetic Network (AGN) as part of the implementation of the PRS92 Project. As envisioned, the AGN will be composed of stations strategically located all over the country which continuously provide geographic data. To date, all six Active Geodetic Stations (AGS) have already been set up: four are roof-based (NAMRIA Main Building in Taguig, Urdaneta City Hall in Pangasinan, Registry of Deeds Building in Tagaytay, and Basa Air Base in Floridablanca, Pampanga) while two are ground-based (Nueva Ecija University of Science and Technology in Cabanatuan City and 415th Police Provincial Mobile Group in Candelaria, Quezon). All six are ready for interconnection to the network. For the Data and Control Center (DCC), the installation of the Center's ICT requirements has been completed. Support systems needed in the operation and maintenance of the DCC, such as fire suppression and access control systems, have already been configured and tested. The Horizontal Control Network established 2,367 second-order and third-order GCPs, and established 5,286 fourth-order GCPs. For the Vertical Control Network, 17,410 km of level lines were surveyed. About 65 first-order GCPs were recovered and observed from 2009 until June 2010. Processing and adjustments of GCPs using the Active Geodetic Station (AGS) – PageNET in Taguig City as reference control were finished in July 2010. These zero-order points are now available for use as reference points in geodynamic studies. Around 362 first-order GCPs have been contracted out in six clusters for recovery and re-observation. This activity will update the coordinates of the first-order GCPs established under the Natural Resources Management Development Project (NRMDP) in 1989. Some 300 GCPs were recovered and observed by contractors and GPS data are being evaluated. Nine clusters of benchmarks in loops were recovered and observed using the Global Positioning System to determine the relationships of the Mean Sea Levels (MSL) of the major islands in the Philippines to the National Vertical Datum. As of May 2011, all of the nine clusters of benchmarks in loops were observed, processed and MSL relationships observed. Some 80 first-order gravity stations will be established nationwide for scientific applications and for the formulation of a Philippine geoid model. As of May 2011, established are 80 first-order and 68 second-order gravity stations. Around 5,000 kilometers of level line will be surveyed to connect the GCPs to the existing benchmarks to compute the Geoid undulations. The activity is essential in the computation of the Geoid model of the Philippines. The project is ongoing. The NAMRIA PRS92 Data Integration Task Group continued to under take the quality control of cadastral datasets for Ilocos province-Region I and the National Capital Region (NCR). All plotted lots are currently being converted from local to grid coordinates. In compliance with the agreements reached during the PRS92 Coordinating Conference held on 18 April 2011, the Task Group conducted a retraining program and lecture on the derivation of local transformation parameters of Regions III, VII, VIII, IX, and XIII. This is also in pursuance of the commitment of NAMRIA to Provide relevant technical assistance and support for the full adoption of PRS92 and enhancement on the capability of the regional offices. On the other hand, the surveying arm of the Task Group is presently establishing image control points (ICPs) at the northern portion of Bohol province. Said ICPs will be used for the transformation of satellite imageries into PRS92. A total of 48 ICPs for four map sheets covering the Province of Bohol is set to be established. Similarly, a total of 70 photo control points (PCPs) were established in the Province of Aklan. Additional 12 PCPs were established in Casiguran, Aurora. At present, the processing of Global Positioning Systems (GPS) raw data and of PCP Description Sheets was finished and they are ready for submission. A total of 161 PCPs covering Casiguran, Eastern Laguna de Bay, North Western Panay, and Pampanga is set to be established for use in the large scale topographic base mapping under the PRS92 project. There are three developed systems currently installed in 18 regions of the country. These are the regional Geodetic Network Information System (GNIS), the Land Survey Data Management System (LSDMS), and the Metadata Entry for environment and natural resources datasets. As of May 2011, Regions 1,2,5,7,8,11, and CAR were visited for the update of regional GNIS and LSDMS, and installation of the 4-parameter derivation program and online synchronization module of both systems." *(NAMRIA, 22 March 2017).*