& Grids & Datums

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THE REPUBLIC OF HONDURAS

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 Honduras was originally printed in 1999 but contains updates to their coordinate system since then.

Maya settlement at Copán in western Honduras is evident from 1000 BC. Columbus first set foot on the American mainland at Trujillo in northern Honduras in 1502, and named the country after the deep water off the Caribbean coast. ("Hondo" means "depths" in Spanish.) Comayagua was established as the capital in the cool highlands of central Honduras in 1537, and remained the political and religious center of the country until Tegucigalpa (Lempira Indian language for "silver mountain") became the capital in 1880. Honduras gained independence from Spain in 1821. It was briefly part of independent Mexico, but then declared independence as a separate nation in 1838. It shares borders with Guatemala, El Salvador, and Nicaragua.

The northern coast is on the Caribbean Sea and the country's only exit to the Pacific Ocean to the south is through the Gulf of Fonseca, a condominium water body shared with El Salvador and Nicaragua. The Nicaragua-Honduras border crosses the Central American isthmus at its widest part and is 917 km (573 miles) long. Continuing disputes between the two nations led to the submission of the problem to the King of Spain for arbitration in 1906. The matter was temporarily resolved, but no surveying or mapping of the border was performed at that time. The oldest known map, called "Mapa Español Oficial" (Official Spanish Map), was compiled in 1527 by Fernando Colón, the son of Admiral Christopher

Columbus. Prominent features were mapped on the northern coast, but little detail of the country's interior was shown. The first complete map of Honduras was by Professor Jesus Aguilar Paz, a pharmacist and cartographer. In 1915, he undertook the labor to produce an adequate map for use in the country's schools without official support. The map was compiled at a scale of 1:500,000, and is extraordinarily exact when the method of compilation (no geodetic control) is taken into consideration. The professor published his map in 1933. The Guatemala-Honduras boundary is 256 km (160 miles) long and extends between the Caribbean Sea and the tri-point with El Salvador on Cerro Monte Cristo (mountain). That tri-point in Honduras is in the Departamento de Ocotepeque (state or province). Boundary disputes between Honduras and Guatemala began shortly after the dissolution of the Federation of Central America in 1843. In accordance with the terms of the Treaty of Arbitration that was signed in Washington in 1930, the disputed line was submitted to the Chief Justice of the United States for a decision on the delimitation of the boundary. Because available topographic data were inadequate for the boundary work in many of the disputed areas, the Tribunal directed the making of an aerial photogrammetric survey. Chief Justice Hughes appointed Sidney H. Birdseye of the U.S. Coast & Geodetic Survey (USC&GS) as Chief of the boundary demarcation commission after Mr. Birdseye completed the photogrammetric mapping

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of the area. Birdseye's commission erected 1,028 pillars and completed its work between 1933 and 1936. The award of the Special Boundary Tribunal was based on the principle of u*ti possidetis* as of 1821. Thus, the award referred to the territory under the administrative control of Guatemala and Honduras at the time of their independence from Spain. Furthermore, El Salvador, Guatemala, and Honduras signed a protocol on 26 March 1936 accepting Cerro Monte Cristo as the tri-point of the boundaries of the three states. A fascinating aspect of the Guatemala-Honduras boundary is that part of the boundary is "established on the right banks of the Tinto and Motagua rivers at mean high water mark, and in the event of changes in these streams in the course of time, whether due to accretion, erosion or avulsion, the boundary shall follow the mean high water mark upon the ***actual right banks of both rivers***." (Emphasis added). Boundaries commonly do not change with avulsions. Apparently, this was intended to avoid future squabbles.

The Ocotepeque Datum of 1935 was established at Base Norte where ϕ_o = 14° 26′ 20.168″ North, λ_o = 89° 11′ 33.964″ West of Greenwich, and H_o = 806.99 meters above mean sea level. The defining geodetic azimuth to Base Sur is: α_o = 235° 54′ 21.790″, and the ellipsoid of reference is the Clarke 1866 where a = 6,378,206.4 meters and $^1/_f$ = 294.9786982. The corresponding astronomic observations at that mountainous location are: Φ_o = 14° 26′ 13.73″ North (±0.07″), Λ_o = 89° 11′ 39.67″ West (±0.045″), and the defining astronomic azimuth to Base Sur is: α_o = 235° 54′ 20.37″ (±0.28″). The difference between these two sets of coordinates is due to the local gravimetric deflection of the vertical. There was no Grid system associated with this Datum, although that's not surprising since Mr. Birdseye was with the USC&GS. Their custom was to compute their chains of quadrilaterals in geodetic coordinates.

Nothing much happened (geodetically) anywhere in Central America during World War II. After the war, the U.S. Army Map Service (AMS) established the Inter American Geodetic Survey (IAGS) headquartered in the U.S. Canal Zone of Panamá. Co-operative agreements negotiated with most countries in Latin America included the Republic of Honduras. In November of 1946, the Comisión Geográfica Nacional (CGN) was established under the Secretary of War to satisfy the conditions of agreement with the IAGS. The previous geodetic boundary work of the USC&GS was integrated into the new IAGS observations along with the chains of quadrilaterals observed in Guatemala (with the IAGS). With connections to the classical triangulation in Mexico, the North American Datum of 1927 (NAD 27) was eventually introduced to the Republic of Honduras. Of particular convenience was the fact that the Ocotepeque Datum of 1935 was referenced to the same ellipsoid! (That was courtesy of the USC&GS.)

The IAGS method of computing chains of quadrilaterals was the "Army way" of doing things. That way was different from the USC&GS because AMS was concerned with unifying the mish-mash of Datums in post-war Europe. The planning and design for that spectacular computational chore in Europe was ultimately accomplished with a conformal projection and Grid. The complexity of existing systems in the Americas was much simpler, but the Topographic Engineers of AMS were trained according to the "Army way." That way consisted of computing classical triangulation on a conformal Grid. Central American countries, with the exception of Belize, are greater in east-west extent than in north-south extent. Therefore, the Lambert Conformal Conic projection was used as the basis of all IAGS-developed Grid systems in Central America for triangulation computations and the published "Trig Lists" of coordinates.

The Honduras Lambert Conformal Grid (1946 - present) on the Ocotepeque Datum of 1935 covers two secant zones, Norte and Sud. Both zones use the same Central Meridian (λ_o) = 86° 10′ 00″ West of Greenwich and False Easting of 500 km. Zone Norte has a Latitude of Origin (ϕ_o) = 15° 30′ North, the False Northing = 296,917.439 meters, and the scale factor at origin (m_o) = 0.999932730. Zone Sud has a Latitude of Origin (ϕ_o) = 13° 47′ North, the False Northing = 296,215.903 meters, and the scale factor at origin (m_o) = 0.999951400.

In 1960, the Nicaragua-Honduras border dispute was finally settled by the International Court of Justice (ICJ). The determination was that the 1906 Award of the King of Spain should be carried out based on the line of *uti possidetis*. In 1969, El Salvador and Honduras went to war over another border dispute. This war involved six contested "bolsones" (pockets) of land encompassing a total area of 436.9 square kilometers, two islands (Meanguera and El Tigre) in the Gulf of Fonseca, and the right of passage for Honduras to the Pacific Ocean from its southern coast. A peace treaty was signed in 1980, an arbitration agreement was signed in 1986, and the entire matter was resolved in 1993 after an ICJ ruling the previous year.

Military mapping of Honduras at 1:50,000 scale (100% coverage) and smaller is on the NAD 27 and uses the UTM Grid exclusively. An estimate of the transformation parameters among the active datums in Honduras can be gleaned from those pertinent to nearby Costa Rica. For example, (in Costa Rica) from Ocotepeque 1935 to WGS 72: ΔX = –193.798 m, ΔY = –37.807 m, ΔZ = +84.843 m. Furthermore, (in Costa Rica) from Ocotepeque 1935 to NAD1927: ΔX = +205.435 m, ΔY = –29.099 m, ΔZ = –292.202 m.

In Costa Rica, the fit of Ocotepeque Datum 1935 to WGS 72 is better than ±3 m; the fit of NAD 27 to WGS 72 is better than ±6 m. Considering the quality of classical geodetic work done by the IAGS, the accuracy of these identical transformation parameters applied in Honduras would probably be less than double these values.

Update

A primary GPS network of Continuously Operating Reference Stations (CORS) was established in 2000. Honduras is now (as of 2004) part of the SIRGAS network of Latin American countries, and it has developed Second-Order and Third-Order networks for the entire republic. A high-order network was observed and published in 2011 for the capital city of Tegucigalpa through the cooperation of the Spanish University of Alcala, the Universidad Nacional Autonoma de Honduras, the Instituto de la Propiedad, and the Direccion General de Catastro y Geografia. *(Red Geodesica Activa de Honduras Y Su Enlace con SIRGAS, 2004), (ESTABLECIMIENTO DE UNA RED GEODESICA EN TEGUCIGALPA (HONDURAS) MEDIANTE TECNOLOGIAS GPS Y ENLACE CON LAS REDES DE REFERENCIA OFICIAL DE CENTROAMERICA, 2010)*

The contents of this column reflect the views of the author, who is responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the American Society for Photogrammetry and Remote Sensing and/or the Louisiana State University Center for GeoInformatics (C^4G).

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Book Review

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world stage, but also to watershed events within the United States such as the woman's and civil rights movements of the 1960's and 1970's. The book is honest about a culture challenged by changing norms in society, technology, world events, and inter-agency strife that the directors of the center had to contend with while still managing to accomplish the mission and develop an effective organization.

Throughout the book the author recounts stories, facts, and his and other's personal experience at NPIC to illustrate every facet of the events that influenced Mr. Lundhal's and Huffstutler's steering of the organization. From the development of a personnel review system and how new analysts were treated, to the impacts of the U-2 and KH programs the book is able to clearly outline how this organization became a shining example of what a well-led government organization is capable of and how these two leaders were instrumental in getting NPIC there. For the casual reader with little or no experience in the Intelligence Community the book can be a difficult read. The amount of descriptive detail and organizational jargon throughout the book sometimes lends itself to some redundancy and the author skips around a bit making the sequence of events sometimes hard to follow. The book requires some additional editing to address these shortcomings. Overall, the book offers an incredible insight into the events, people, and technology that shaped modern intelligence efforts and established a leadership template that is still followed today in our intelligence circles.

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