Grids & Datums

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The Kingdom of Belgium

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 Kingdom of Belgium was originally printed in 1998 but contains updates to their coordinate system since then.

This month's topic features the Kingdom of Belgium, the birthplace of Mercator, which gained its independence from the Netherlands in 1830. Famous Belgian place names have become prominent in many battles, including Waterloo and part of the Battle of the Bulge. Triangulation was originally carried out by Snellius (1617), Cassini (1745-48), and General Krayenhoff (1802-11). Although largescale topographic coverage dates back to 1744, the organized national mapping was carried out by the military "Depot de la Guerre," originally founded in 1831. This national mapping organization has gone through a number of name changes until becoming a civilian agency in 1976 with the present name of "Institut Geographique National de Belgique" (IGNB).

The classical first-order triangulation of Belgium was carried out between the years 1851 and 1873, when 84 primary stations were established. The Observatoire Royale d'Uccle Datum of 1884 was based on the origin of the old Brussels Observatory: $\Phi_o = 51^\circ\ 10'\ 06.895''$ North, $\Lambda_o = 04^\circ\ 22'\ 05.89$ West of Greenwich, and the ellipsoid of reference was the "Carte de France" (Delambre 1810). The triangulation was dependent on two measured bases at Lommel and Ostend with Beverloo as a base of verification. The ellipsoidal Belgian Bonne Grid was used with this datum from 1884 to 1919 with no False Easting or False Northing, and was later referred to as the "Old Convention" Grid. The lack of a false origin is typical for late 19th century grid systems, and is a common theme found in European and colonial grids of that era. Negative grid coordinates (in the appropriate quadrants) were accepted as a normal way of doing things. Note that the Bonne projection is an authalic (equal-area) projection. Many countries in Europe followed the French preference for the Bonne, in spite of the fact that it is a miserable projection for large-scale military and civilian engineering applications. The Bonne projection tables were easy to compute on the ellipsoid. That advantage apparently helped to keep it popular, in addition to the prestige afforded by adopting the same system as used by the French.

After the "Great War" (WWI), the Kingdom modified the Grid such that the False Easting = 150 km and the False Northing = 120 km. The "New Convention" Bonne Grid (1919-1950) had a Latitude of Origin (ϕ_o) = $50^\circ\ 24'$ North, and a Central Meridian (λ_o) = $4^\circ\ 22'\ 05.91''$ West of Greenwich. In postwar years, the Belgians continued to re-observe and re-adjust their triangulation network. In 1924,

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the International Conference of Geodesy and Geophysics which conferred in Madrid, adopted the Hayford ellipsoid as the new standard. The Belgians adopted this new reference ellipsoid for their new Belgian Datum of 1927 with the origin altered to the astronomical values of Lommel Signal at: Φ_o = 51° 10′ 08.092″North, Λ_o = 04° 22′ 05.91″West of Greenwich. The azimuth was from Lommel Signal to Lommel Turm: α_o = 186° 58′ 47.05″. During WWII, the connection between the New Triangulation of France (NTF) Datum and the Belgian Datum of 1927 was accomplished in 1940 by considering the geodetic differences in longitude. The longitude difference between the meridians of Brussels and Paris, as determined by a comparison of the two triangulations through Mont Kemmel, gave the geodetic longitude of Brussels as 04° 22′ 12.7″. The observed astronomical difference between Brussels and Greenwich was not used. This discrepancy was one of the major factors that prompted the recomputation of all geodetic control in Western Europe after the war. The Bonne Grid "New Convention" is also referred to as the "Orange Report Net Grid" and was used through WWII until 1950.

After WWII, the Kingdom of Belgium adopted the Lambert Conformal Conic Projection and defined the new grid such that the False Easting = 150 km and the False Northing = 5,400 km at latitude 50° 30′ North. The Belgian Lambert "KM" Grid had a Northern Standard Parallel of (ϕ_N) = 51° 10′ North, a Southern Standard Parallel of (ϕ_S) = 49° 50′ North, and a Central Meridian (λ_o) = 4° 22′ 04.71″ West of Greenwich. Note that the Belgians defined their Lambert Zone with two standard parallels, which is the definition method favored by the French and the Americans. The British prefer to use a Latitude at Origin (ϕ_o) and a Scale Fact or at Origin (ϕ_o). The two methods of zone definition use slightly different formulae to produce the identical projection in most cases.

The U.S. Army Map Service (AMS) organized the recomputation of all the classical geodetic datums of Western Europe after the war, and the resultant coordinate system was termed the European Datum of 1950 (ED50). AMS directed the computations by initially computing common points between Belgium and France in 1945. The Belgian stations consisted of Arlon Church, Anlier, Bouillon, Willerzie, Rulles, Bon Secours, Mont Sainte Genevieve, and Mont Kemmel. The French stations were Aumets, Tellancourt, and Sighy-Mont Libert. The computations consisted of a least squares polynomial solution of the coordinates of the respective stations as computed on the conformal plane represented by the UTM Grid, International (Hayford) ellipsoid. The coefficients that were determined in Washington by AMS for these junction points were used to transform the respective interior points to ED50, with UTM used as the unifying connection tool for these two countries. The rest of Western Europe followed with French datum connections being the initial governing factor for the remaining countries. The ED50 remained a NATO military secret for some years. Belgium continued with independent observations, and established a new provisional adjustment for the country. The two Vlaanderen provinces, the northern half of Brabant, Antwerpen, and Limburg provinces were essentially held fixed from 1940. The southern provinces of Hainaut and Namur had minimal changes in coordinates, and the region in between received the major adjustment. The Kingdom then published the Belgian 1950 Datum with the "KM" Lambert 50 Grid, all of the Belgian 1927 defining parameters remaining unchanged.

New instruments and re-observations required another adjustment a couple decades later, and the Belgian Datum of 1972 is defined by the origin at the geodetic monument d'Uccle: $\Phi_o = 50^\circ\ 47'\ 57.704''$ North, $\Lambda_o = 04^\circ\ 21'\ 24.983''$ West of Greenwich. The azimuth was from d'Uccle to Kester: $\alpha_o = 262^\circ\ 08'\ 37.95''$. The International ellipsoid continued to be used, and the only change for the new Lambert 72 Grid was that the new central meridian matched the new datum origin ($\lambda_o = \Lambda_o$). Note that the plane coordinates for the Lambert 72 Grid are considerably different from the Lambert 50 Grid. The ellipsoid is defined to be tangent with the geoid at d'Uccle. The vertical datum, "Deuxieme Nivellement General" (DNG) was established at Oostende by conventional tide gauge observations. Curiously, the DNG is based on Mean Low Water and therefore is -2.33 meters with respect to local mean sea level.

The Readjustment of the European Triangulation Network (RETrig) has been involved for decades as an international cooperative effort that started with ED50. The latest fruit of their labors is the ED87 adjustment that is quite comprehensive and remarkably accurate. The Royal Observatory of Belgium is now operating four permanent GPS reference stations, and the accuracies of these observations are now at the sub-centimeter level. The stations are Brussels, Dentergemand, Dourbes, and Waremme.

Update

The Belgian Institut Géographique National has published a PDF document in *French* that addresses the approved transformation parameters **from** a UTM Grid on either the EU50 Datum or on the WGS84 Datum **to** Projection Lambert 72 or **to** Projection Lambert 50. See: http://www.ngi.be/Common/articles/G/naviguer_avec_GPS.pdf. Page 12 of the document has an easy-to-understand flow chart.

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[4]G).

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