Grids & Datums

THE REPUBLIC OF POLAND

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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 Poland was originally printed in 2000 but contains updates to their coordinate system since then.

In the 10th century Poland was a Slavic duchy. The crown became elective after 1572, and various wars caused much loss of territory. Napoleon partly reestablished the kingdom (1807-15), which was later to become closely aligned with Russia. Poland was declared a republic in 1918, but it wasn't until after nearly another century of being overrun and controlled by others, that the new constitution was dated 16 October 1997.

The north and central regions are essentially flat and characterized by morainic topography. This lack of natural barriers on the North European Plain was a major reason for so many invasions of Poland through-out history. The southern boundary is mountainous, with the highest peak being Rysy at 2499 m (8197 ft.); the lowest point in Poland is Raczki Elblaskie at –2 m.

Early mapping of Poland was instituted by the Prussians for the western half of the present country, and ap-proximately 17% of the southeast was mapped by the Austro-Hungarian Empire. The remainder of Poland was surveyed and mapped by czarist Russia. The date of this early mapping activity goes back to 1816. The early Prussian Landesaufnahme characteristically used the Cassini-Soldner projection in its spherical form that was based on equivalent (Gaussian) spheres referenced to the Bohnenberger ellipsoid and the Zach ellipsoids, and later the Bessel 1841 ellipsoid. [See also the Republic of Hungary (*PE&RS* April'99) and the Czech Republic (*PE&RS* Jan '00).] The Prussians and the Austrians introduced the concept of the cadaster, or system of surveys and land registration for ownership and taxation. The Austro-Hungarian surveyors had similar preferences for ellipsoids, but the Russians were a different story.

The tsarist Russians performed surveys and topographic mapping of Poland in the 19th and early 20th centuries, but these works were for military purposes only. They did nothing with respect to individual land ownership registration,

and they preferred the sazhen for their unit of measurement. In the years between the two world wars, this source material was responsible for some very strange-looking contour maps of Poland when the unit of measurement was changed from sazhens to meters where 1 sazhen = 2.134 meters. (The only time I see similar strange values for contours is when I grade some of my sophomores' campus topo maps). The Russians preferred the Walbeck 1819 ellipsoid where a = 6,376,896 meters and the reciprocal of flattening, $(^1/_f)$ = 302.78. Some of these old maps also referred longitudes to Ferro in the Canary Islands; a practice dropped after WW II.

New geodetic triangulation started after the founding of the re-public, and the origin of the Polish National Datum of 1925 (PND 1925) is at station Borowa Gora (gora is Polish for mountain) where:(Φ_o) = 52° 28′ 32.85″ North, and (Λ_o) = 21° 02′ 12.12" East of Greenwich. The ellipsoid

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of reference is the Bessel 1841 where a = 6,377,397.155 and $^1/_f$ = 299.1528128. Instruments used by the Polish military included theodolites manufactured by Bamberg, Fennel, Wild-Heerbrugg, and Aerogeopribor. Over 120 triangles were observed from 1927 to 1935, with the average angular error of figure not exceeding 0.56 arc seconds. (Post WW II observations with T-3 theodolites yielded errors not exceeding 0.46 arc seconds). Baselines were measured at Grodno, Kobryn, Warsaw, Lomža, Luniniec, Mir, and Braslaw. Laplace stations (astro shots) were observed at Varsovic (initial point Borowa Góra), Borkowo, Kopciowka, and Skopowka.

The 1:25,000, 1:100,000, and 1:300,000 maps produced by the Wojskowy Instytut Geograficzny (WIG) or Military Geographical Institute, were products of carto-graphic datum shifts (scissors and paste) to PND 1925 and are cast on the Polish Stereographic Grid. The old Polish Stereographic Grid is based on the mathematical model by Rousilhe, who was the Hydrographer of the French Navy. All ellipsoidal oblique stereographic projections developed and used worldwide before WWI are based on Rousilhe's work that was originally published in *Annals Hydrographique*. The development of the projection for nearby Romania (STEREO 70) was done by the Bulgarian geodesist, Hristow in the late 1930's. The PND 1925 WIG Military Stereo-graphic Latitude of Origin (ϕ_o) = 52° 00′ N, Central Meridian (λ_o) = 22° 00′ E, the Scale Factor at Origin (m_o) = 1.0, the False Easting = 600 km, and the False Northing = 500 km. The PND 1925 Grids developed for the Cadastre around the same time were cast on the Gauss-Krüger Transverse Mercator where the Scale Factor at Origin (m_o) = 1.0, the False Easting = 90 km, the False Northing = *minus* 5,700 km *at the equator*, and the Central Meridians (λ_o) = 15°, 17°, 19°, and 21° East of Greenwich.

During WWII, the Generalstab des Heerres, Reichsamt für Landesaufnahme (German Army) produced topographic maps of Poland cast on the Deutches Herres Gitter (DHG) Grid, which is identical to the UTM except for the Scale Factor at Origin (m_o) = 1.0. Of course, the Datum used was the PND 1925, as was the equivalent treatment of Poland by the USSR with the Russia Belts TM that had the same defining parameters as the DHG except for the Datum and ellipsoid. The Russian coverage during the war had *double* Grids in Poland that exhibited unresolved horizontal Datum discrepan-

cies ranging from 160 to 250 meters. After the war, the USSR converted their *military* topographic coverage of the Warsaw Pact countries to the System 42 Datum that has its origin at Pulkovo Observatory and is referenced to the Krassovsky ellipsoid. In the Republic of Poland, their preferred terminology of that Datum is "Polish National 1942" or "PN 42."

Large scale topographic maps of Poland published in the latter part of the 20th century are on the "UKŁAD 65 System," the parameters of which have been a closely held secret. In the past few years, little information has dribbled out of Poland on these "Strefa" or Zones. In February of 2000, Wojtek Hanik sent the de-classified parameters to me! There are five Strefa comprising the UKŁAD 65 System, four are based on the "Quasi-Stereographic" Grid (Rousilhe Oblique Stereographic), and the fifth is a Gauss-Krüger Transverse Mercator Grid. Strefa 1 covers the following provinces: Biala Podlaska, Eastern Bielsko, Chełm, Kielce, Kraków, Krosno, Lódź, Lublin, Nowy Sącz, Piotrków, Premysl, Radom, Rzeszów, Sieradz, Tarnobrzeg, Tarnów, and Zamość. The UKŁAD 65 Strefa 1 Quasi-Stereographic Grid Latitude of Origin (ϕ_o) = 50° 37′ 30″ N, Central Meridian (λ_o) = 21° 05′ 00″ E, the Scale Factor at Origin (m_o) = 0.9998, the False Easting = 4,637 km, and the False Northing = 5,467 km. Strefa 2 covers the following provinces: Bialystok, Ciechanów, Lomźa, Olsztyn, Ostrolęka, Plock, Siedlce, Skierniewice, Suwałki, and Warszawa. The UKŁAD 65 Strefa 2 Quasi-Stereographic Grid Latitude of Origin (ϕ_o) = 53° 00′ 07″ N, Central Meridian (λ_o) = 21° 30′ 10″ E, the Scale Factor at Origin (m_o) = 0.9998, the False Easting = 4,603 km, and the False Northing = 5,806 km. Strefa 3 covers the following provinces: Bydgoszcz, Elbąg, Gdańsk, Koszalin, Słupsk, Szczecin, Toruń, and Włocławek. The UKŁAD 65 Strefa 3 Quasi-Stereographic Grid Latitude of Origin (ϕ_o) = 53° 35′ 00″ N, Central Meridian (λ_o) = 17° 00′ 30″ E, the Scale Factor at Origin (m_o) = 0.9998, the False Easting = 3,703 km, and the False Northing = 5,627 km. Strefa 4 covers the following provinces: Gorzów, Jelenia Gora, Kalisz, Konin, Legnica, Leszno, Opole, Pila, Poznań, Wałbrzych, Wrocław, and Zielona Góra. The UKŁAD 65 Strefa 4 Quasi-Stereographic Grid Latitude of Origin (ϕ_o) = 51° 40′ 15″ N, Central Meridian (λ_o) = 16° 40′ 20″ E, the Scale Factor at Origin (m_o) = 0.9998, the False Easting = 3,703 km, and the False Northing = 5,627 km. Strefa 5 covers the following provinces: Western Bielsko, Częstochowa, and Katowice. The UKŁAD 65 Strefa 5 Gauss-Krüger Transverse Mercator Grid Central Meridian (λ_o) = 18° 57′ 30″ E, the Scale Factor at Origin (m_o) = 0.999983, the False Easting = 237 km, and the False Northing = *minus* 4,700 km.

For small scale mapping, the GUGiK 80 Quasi-Stereographic (Rousilhe) projection is used where the Latitude of Origin (ϕ_o) = 52° 12′ N (approx.), Central Meridian (λ_o) = 19° 10′ E. The scale factor at a point is designed to be equal to unity at a distance of 215 km from the projection origin. These mysterious parameters, of which some are still held and some are now public, reflect the history of the nation. Those countries that have a long and recent history of war, occupation, or blood spilled at borders will be particularly sensitive about releasing Grid and/or Datum relation parameters. The release of some of this previously secret data may be an indication of the Republic's confidence in the future.

Update

"The ETRS89 was introduced in Poland technically by the GNSS technique in the last years of the 20th century and by law in 2000. On 2 June 2008, the Head Office of Geodesy and Cartography in Poland (GUGiK) commenced operating the multifunctional precise satellite positioning system named ASG-EUPOS. The ASG-EUPOS network defines the European Terrestrial Reference System ETRS89 in Poland. A close connection between the ASGEUPOS stations and 18 Polish EUREF Permanent Network (EPN) stations controls the realization of the ETRS89 on Polish territory. In 2010-2011 GUGiK integrated the ASG-EUPOS with the existing geodetic networks (horizontal and vertical) using GNSS and spirit levelling. Those actions resulted in developing and then legal introduction in 2012 new technical standards: to the National Spatial Reference System (PSOP) and to establish and maintain the geodetic (horizontal and vertical), gravity and magnetic control in the country. Thus, the geodetic, gravimetric and magnetic system in Poland has been associated with the European one (previous and current). This allowed for the next step of networks integration in Poland, namely, in 2013 started integration of national geodetic control with gravimetric control. Modern geodetic, gravimetric and magnetic networks in Poland are to be fully consistent with the European system. In 2011, following the initiative by the Section of Geodetic Networks and the Section of Earths' Dynamics of the Committee on Geodesy of the Polish Academy of Sciences, a new research network "Polish Research Network for Global Geodetic Observing System" (acronym GGOS-PL) has been established" *(Jarosław Bosy, and Jan Kryński, POLISH NATIONAL REPORT ON GEODESY 2011– 2014, Vol. 64, Warsaw, 2015).*

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