Grids & Datums

Great Socialist People's Libyan Arab Jamahiriya

by Clifford J. Mugnier, C.P., C.M.S.

"Until Libya achieved independence in 1951, its history was essentially that of tribes, regions, and cities, and of the empires of which it was a part. Derived from the name by which a single Berber tribe was known to the ancient Egyptians, the name *Libya* was subsequently applied by the Greeks to most of North Africa and the term *Libyan* to all of its Berber inhabitants. Although ancient in origin, these names were not used to designate the specific territory of modern Libya and its people until the twentieth century, nor indeed was the whole area formed into a coherent political unit until then. Hence, despite the long and distinct histories of its regions, modern Libya must be viewed as a new country still developing national consciousness and institutions." (*Library of Congress Country Studies*) The climate of Libya is Mediterranean along the coast and is extreme desert in the interior. The Lowest point is Sabkhat Ghuzayyil (–47 m), and the highest is Bikku Bitti (2,267 m). Libya borders Algeria, 982 km (*PE&RS, October 2001*), Chad, 1,055 km, Egypt, 1,115 km, Niger, 354 km, Sudan, 383 km, and Tunisia, 459 km. Slightly larger than Alaska, the country's northern border is the Mediterranean Sea with a 1,770 km coastline. Its territorial sea claim is 12 nautical miles, but the unique claim is that approximately one-third of its coastline comprises the Gulf of Sirte and they claim a closing line defined by 32° 30' North! That is contrary to the *International Law of the Seas* definition of a bay – from which a territorial sea boundary is then measured from a line connecting the headlands of such a bay. A true bay must have headlands that are separated by no more than one-third of the depth of the bay. The Gulf of Sirte is truly a gulf and is not a bay. The only way a nation can claim a bay is through the exception of the Historical Bay Rule, but the international community must recognize that for at least 100 years! Some such Historical Bays do exist throughout the world as a result of that accepted convention. Since Libya has claimed such a closing line for the Gulf of Sirte, the United States has sent its Navy into the claimed territorial waters to upset the legal prescription of 100 years. More than once Libya has sent fighter planes to defend its claim and armed conflicts have occurred with the U.S. Navy. Spectacular when it happens, the purpose is to maintain the concept of *Freedom of the Seas* as promulgated by the United States and the rest of the international community of nations. Once upset by open and notorious occupation, the prescription of 100 years then restarts from zero.

Libya became an independent nation in 1951, and because no government organization existed that could accomplish mapping on a national scale, local native mapping was nonexistent until the Survey Department of Libya (SDL) was established in 1968. The Italian *Instituto Geografico Militare* (IGM) (Military Geographic Institute) performed the official topographic mapping prior to WWII. It established a second- and third-order geodetic network of control that covers all of the Libyan coastal area except for part of the Gulf of Sirte, where it used a fourth-order network. IGM produced topographic maps at scales ranging from 1:25,000 to 1:100,000, but the areas covered are limited to the coast and a few important oases of the interior. The Italian *Comando Superiore Forze Armate Africa Settentrionale Ufficio Topocartografico* (High Command, Armed Forces, North Africa, Topocartographic Office) compiled a 1:1,000,000 scale map that was the first "large scale" map of the entire country. The *Carta Topografica della Cirenaica* was produced at the scale of 1:50,000 by IGM from 1920-1936. These monochrome sheets cover the coastal area between Bengasi and Derna. They were based on 1920-1923 triangulation and planetable surveys. Two of the sheets were revised in 1936 and were standard topographic maps intended for civilian use. A marginal note on each sheet states the graphical shift necessary to adjust the sheets to the survey of 1933-1934. The *Carta della Tripolitania* was produced at the scale of 1:50,000 by IGM in 1933-1940, and covers scattered areas of northwest Libya. The *Carta della Libia* was produced at the scale of 1:100,000 by the IGM from 1915-1938. All of these maps produced by the IGM have no grid. However, the U.S. Army Map Service reported two grid systems created for Libya by the British Geographical Section, General Staff (GSGS) during the

continued on page 622

Since Libya has claimed such a closing line for the Gulf of Sirte, the United States has sent its Navy into the claimed territorial waters to upset the legal prescription of 100 years. More than once Libya has sent fighter planes to defend its claim and armed conflicts have occurred with the U.S. Navy.

continued from page 621

1940s that are referenced on the Clarke 1880 ellipsoid where a = 6,378,249.145 m and $1/f$ = 293.4660208. The Libya Zone is based on the Lambert Conical Orthomorphic projection where the Central Meridian (λ_o) = 18° East of Greenwich, the Latitude of Origin (φ_o) = 31° North, the Scale Factor at Origin, (m_o) = 0.99938949, the False Easting = 1,000,000 m, and the False Northing = 550,000 meters. The South Libya Zone is also based on the Lambert Conical Orthomorphic projection where the Central Meridian (λ_o) = 18° East of Greenwich, the Latitude of Origin (φ_o) = 23° North, the Scale Factor at Origin, (m_o) = 0.99907, the False Easting = 600,000 m, and the False Northing = 800,000 meters. An example South Libya Zone computational test point is: φ = 21° 13' 43.397" N, λ = 12° 19' 13.071" E, X = 210,785.725 m, Y = 415,440.430 m. Note that both of these zones are truly secant Lambert Conformal Conic projections with two standard parallels, but the British Convention of defining parameters is used. There are many commercially available software packages that incorrectly classify this sort of thing as a *single parallel* Lambert zone. Do not be mislead by projection nomenclature blunders misappropriated by ignorant computer programmers – instead, use the *Manual of Photogrammetry*, 5th edition as the definitive reference for the mathematics and the proper terminology.

Since North Africa has the highest density of geodetic enigmas, puzzles, rumors, etc., in January of 2006 I turned to John W. Hager for some historical insights of Libyan geodetic history: "The Italians did the pre-WWII surveys and it was done on the Bessel (1841 – Ed.) ellipsoid, not (on) the International. Misurata Marina Datum (1930) was based on an Astronomic station at Φ_o = 32° 22' 20.35" N, Λ_o = 15° 12' 45.86" E, initial azimuth (α_o) = 180° 00' 38.31" to an unknown station and unknown whether measured from north or south. Bessel ellipsoid. I do not find anything for Sirte 1930 and would suggest that this may be Brega (1930) at Magnaghi's Astronomical Pier Φ_o = 30° 25' 00.21" N, Λ_o = 19° 34' 18.60" E. The Italians published their data in a series of pamphlets. The U.S. Army Map Service probably adjusted these on European 1950 but there is some question as to how good the adjustment was. There was a grand scheme to adjust a loop around the Mediterranean. The problem was that there is one missing triangulation figure straddling the Libya – Egypt border. In the west, the triangulation observed by the French from Spain through Morocco (*PE&RS, June 1999*), Algeria (*PE&RS, October 2001*), and Tunisia is good. The Tunisian triangulation is connected to Italy through Pantelleria and Sicily. It was adjusted by IGN (French *Institut Geographique National – Ed.*) under contract from AMS in, I would guess, the 1950s. Thus Libya is cantilevered from Tunisia and the adjustment is weak. In 1956 or 1957 AMS contracted for SHORAN-controlled photography used to produce 1:250,000 scale maps of Libya on European Datum 1950. The error in the positioning of the photography could have been up to about 62 meters. I never had any indication that the actual error was anywhere near that."

During a 1970s Annual Meeting of the American Congress on Surveying and Mapping, a geodesist presented a paper on a new grid system that had been implemented in Libya. Termed the "Libyan Grid System," the projection was defined as a Gauss- Krüger Transverse Mercator with 2° "bands" where the first band termed zone #4 has a Central Meridian (λ_o) = 7° East of Greenwich and ends with zone #14 that has a Central Meridian (λ_o) = 27° East of Greenwich. The Scale Factor at Origin, (m_o) = 0.9999, and the False Easting of each band = 200,000 m. Of course, the Latitude of Origin is defined to be the Equator, and no False Northing was specified. An example Libyan Grid System computational test point for zone 6 is: φ = 23° 00' N, λ = 10° 25' E, X = 140,197.96 m, Y = 2,544,435.31 m, but I don't remember if this was included in the paper or it was something that I personally cooked up.

A few months ago, I applied for full membership in the American Petroleum Survey Group (APSG), and I was accepted. A very collegial group of petroleum-oriented geodetic surveyors publishes a (free) database of parameters and transformations through the EPSG website, and it is in the process of changing names – I think. Intended to service the needs of "Oil Patch Surveyors" worldwide, it is a very nice collection of tidbits and useful parameters. A 2006 presentation of Libyan geodetic data and transformations included a couple transforms that are pertinent to the current topic. Entitled "Esso (International 1924) to WGS72, ΔX = –69 m, ΔY = –91 m, ΔZ = –147 m, but no accuracy estimates are offered, nor the number of points used to derive this "mystery" transformation. Another datum relation listed is the "European Libyan Datum of 1979," (ELD79) to WGS84 which is reportedly referenced to the International 1929 ellipsoid is where: ΔX = –69 m, ΔY = –96 m, ΔZ = –152 m. Some parameter sets show a precision to the millimeter, but such is not worth publishing without a concomitant indicator of expected accuracy. The source referenced is EPSG.

Attempts over the years to request information from the Libyan government regarding geodetic transformation relations have never been answered, so how close these parameters conform to actual conditions is unknown. Thanks again to the APSG and to John W. Hager.

Correction

An error occurred in the Methodology section of the following article: Helmer, E.H. and B. Ruefenacht, 2005. Cloud-free satellite image mosaics with regression trees and histogram matching. *Photogrammetric Engineering and Remote Sensing*, 71(9):1079-1089.

In the sentence beginning on line 19 of the first column of page 1083, regarding how to strategically display and visualize land development, the bands to display in red and green were reversed. The sentence should read as follows: "To visualize land development, we displayed TM band 1 from the second mosaic period in red, ETM+ band 1 from the earlier mosaic period in green, and NDVI from the earlier mosaic period in blue."