Grids & Datums

Republic of Djibouti

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

Thanks to *Lonely Planet*, "Despite the inhospitable climate, Djibouti's arid plains have been populated since the Paleolithic era, fought over by Afar and Somali nomadic herds people. Islam spread its prayer rugs from around 825 *AD* in a region that was then used as grazing lands by several tribes, including the Afars from eastern Ethiopia and the Issas from Somalia. Arab traders controlled the region until the 16th century, but the Afar sultans of Obock and Tadjoura were in charge by the time the French arrived in 1862. The French were seeking to counterbalance the British presence in Aden on the other side of the Bab al-Mandab Strait and, after negotiating with the sultans for the right to settle, they bought the place for 10,000 thalers.

"In 1884 and 1885, France expanded its territorial holdings both along the coast and inland of the Gulf of Tadjoura by signing treaties of protection with the Sultans of Tadjoura and Gobad and various chiefs of the Issas Somalis. In 1884, following the completion of Anglo-Somali treaties replacing the earlier trade accords, the protectorate of British Somaliland was established. France and the United Kingdom reached an agreement, February 2-9, 1888 that delimited a boundary between their respective holdings on the Gulf of Aden:

1. "The protectorates exercised, or to be exercised by France and Great Britain shall be separated by a straight line starting from a point of the coast situated opposite the wells of Hadou [at Loyada], and leading through the said wells to Abassouen; from Abassouen the line shall follow the caravan road as far as Bia-Kabouba, and from this latter point it shall follow the caravan route from Zeyla [Zeila] to Harrar [Hārer] passing by Gildessa [Jaldēa]. It is expressly agreed that the use of the wells of Hadou shall be common to both parties.
2. "The Government of Her Britannic Majesty recognizes the Protectorate of France over the coasts of the Gulf of Tajourra [Golfe de Tadjoura], including the group of the Mushah Islands [Îles Musha] and the Islet Bab [Île Bab], situated in the Gulf, as well as over the inhabitants, tribes, and fractions of tribes situated to the west of the line above mentioned.

"The Government of the French Republic recognizes the Protectorate of Great Britain over the coast to the east of the above lines as far as Bender Ziadah [Bender Ziada], as well as over the inhabitants, tribes, and fractions of tribes situated to the east of the same line."

"The Anglo-French agreement of 1888 determines the alignment of the present Djibouti – Somalia boundary. In 1892 the town of Djibouti was made the capital of the French territory, which became known in 1896 as French Somaliland (*Côte Français des Somalis*). Following WWII, the colony of French Somaliland was made an overseas territory of the French Union; in 1958 it became an overseas territory of the French Community. On July 5, 1967, French Somaliland was renamed the French Territory of the Afars and Issas (*Territoire Français de Afars et Issas*). The French Territory of the Afars and Issas became independent on June 27, 1977 as the Republic of Djibouti." (*International Boundary Study No. 87 (Rev.) Djibouti – Somalia Boundary May 18, 1979, Office of the Geographer, Bureau of Intelligence and Research*) The boundary with Ethiopia is considerably more complex, and is treated fully in *International Boundary Study No. 154.*

Djibouti is slightly smaller than the state of Massachusetts, and is bordered by Eritrea (113 Km), Ethiopia (337 km) (*PE&RS*, March 2003), and Somalia (58 km). The coastline along the Red Sea is 314 km, the lowest point is Asal at –155 m and the highest point is Moussa Ali (2,028 m) (*CIA Factbook*).

The first geodetic and hydrographic expeditions of the French Navy to the coast of French Somaliland were in 1864, 1881, and 1888 to the ports of Obock, Tadjura, and the anchorage of Khor Ambadu. In 1889, a survey was conducted of the port of Djibouti by *Lieutenant de Vaisseau* Cacqueray and *Commandant le Météore*. The *first* Djiboutian geodetic network was originally established by *Lieutenant de Vaisseau* M.R. de Carfort of the French Navy and *Commandant la Canonnière l' Etoile* during the 1890-1891 triangulation of the littoral (coastal) cape colony, d'Obock, north of the city of Djibouti and on the northern coast of the Gulf of Tadjura. The origin of the local coordinate system and datum, Cape Obock 1890, was at the Obock Signal Post (*Mât de Signaux*) where: Φ_o = 11° 57' 18" N, Λ_o = 40° 56' 58.9" East of Paris, the azimuth to the Ras-Bir Lighthouse, α_o = 74° 08' 46", the baseline distance was 8,118.08 meters, and the ellipsoid of reference was the Germain where a = 6,378,284 m, and $^1/_f$ = 294. The entire triangulation spanned the distance from Djibouti to the Isle of Périm (*Annales Hydrographiques 2e Série, Tome Treizième, Année 1891*).

"The ensign was particularly proud of his choice of origin for his secant Lambert as it was prominently displayed on the Trig List diagram, a rarity in such diagrams for the Annals of the French Navy.!"

The *second* Djiboutian geodetic survey was conducted by the famous French Hydrographer, M.A. Gougenheim, from 5 December 1927 to 3 April 1928. Gougenheim noted that de Carfort's 1891 determination of the lighthouse at Périm was: Φ = 12° 39' 15.44" N, Λ = 43° 25' 53.38" East of Greenwich, but that the British Navy actually adopted: Φ = 12° 39' 13" N, Λ = 43° 25' 53" E. Gougenheim said that the two positions are satisfactory, especially since de Carfort admitted that the triangulation of Obock (including Djibouti) to Périm had a relative closure of $^1/_{2000}$ with ±2" for (*la difference de latitude*)

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Périm-Djibouti and ±0.5" for (*la difference de longitude*). Gougenheim inferred that the slight difference was likely due to the deviation of the vertical (*la deviation de la verticale*). The great Ayabelle Lighthouse (*Phare d'Ayabelé*) was therefore determined (in 1928) to have the coordinates: Φ = 11° 33' 10.36" N, Λ = 43° 01' 23.02" East of Greenwich as based on published hydrographic charts of the region.

The British Admiralty Office executed a survey from Aden to l'Île Périm in 1876 and in 1904. A point in Aden was observed in 1876-1877 by Captain W.J. Heaviside with a 10-pound theodolite for the determination of latitude, and the longitude of the point was observed in 1882 by Dr. Gill of the Cape Town Observatory. In 1901-1904, the British Survey of India performed a small triangulation survey in the Gulf of Tadjura that included the port of Djibouti, Mt. Désiré, and the Îles Moucha. The ellipsoid used was not indicated in their report. A position later adopted by the British Admiralty Office for the lighthouse at Périm was: Φ = 12° 39' 13.05" N, Λ = 43° 25' 52.82" East of Greenwich.

In 1933-1934 an Italian mission (*bâtiments hydrographes Ammiraglio Magnaghi et Ostia*) executed a complete triangulation survey from Assab to l'Île Dumeira and to the Italian - French frontier border. *La Triangulation d'Assab* established two astro stations; Signal Humarrasuh where: Φ = 12° 44' 24.38" N, Λ = 43° 01' 06.78" E, and Signal Gaabla, of particular importance, where: Φ_o = 12° 42' 43.33" N, Λ_o = 43° 08' 07.36" E, a baseline was also observed there of 1,032.15 meters and with an azimuth from the South End to the North End of α_o = 336° 39' 21.4" observed with a Wild theodolite and the ellipsoid of reference was the Bessel 1841 where: a = 6,377,397.15 m, $^1/_f$ = 299.1528. The Italian observations of the geodetic distance from Gaabla-Humarrasuh (1933-1934) was 13,060.72 m, with an azimuth of α = 283° 45' 52.9" and the French observations of the geodetic distance (1934-1935) was 13,060.53 m, with an azimuth of α = 283° 45' 57.6". These differences were attributed to differences in the observations of the deflection of the vertical because of the ellipsoids and geoids adopted.

Note that nowadays when we perform a block aerotriangulation of an area in the United States with GPS RTK for camera station control, it's pretty easy to shrug off the magnitude of the areas and the distances that we map. Look at the distances that were physically measured on the ground with invar tapes and the corresponding

In Memoriam

Andrew Piscitello
1943-2008

Andrew Piscitello (64) died of cancer at his home in Plymouth, Wisconsin on Friday August 22, 2008. A member of ASPRS for 17 years, Piscitello retired from Aero-Metric, Inc. in 2007 as Vice President – Production and Chief Photogrammetrist after 35 years of service. He was an ASPRS Certified Photogrammetrist.

His photogrammetric career began with assignments to a U.S.A.F. Reconnaissance Technical Squadron from 1961-1965. In 1969 he joined Aero-Metric and was responsible for managing production and researching new technologies for procedures and equipment. His experience included compilation of digital and graphical data acquired from aerial and terrestrial photography by stereo-photogrammetric restitution of instrumentation of analog, analytical and digital design.

In addition to his love of photogrammetry, Piscitello also enjoyed open wheel racing and he participated in many SCCA amateur race events.

He is survived by his with Joyce; three children Chairmaine Thessien, Dayne Piscitello, and Scott Piscitello; three stepchildren Tamera Brousseau, Darren Struebing and Dean Struebing; four grandchildren and eight step grandchildren; three sisters; and, two brothers. A memorial fund in his name has been established with the American Cancer Society and the Sharon S. Richardson Hospice.

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checks! That is less than a foot in eight miles as determined by two different European militaries three-quarters of a century ago!

On the 7th of December 1934, the beginning date of survey, the French Naval officers of the Frigate Fleet Bougainville were as follows: Frigate Captain Mazen, Commandant; Corvette Captain Robain, second in command; *Lieutenant de Vaisseau* Lassave, *Lieutenant de Vaisseau* Guyot (in charge of hydrography); *Enseignes de Vaisseau de 1re classe* Salmon (in charge of triangulation); Burser Allain-Dupré; and *Enseignes de Vaisseau de 2e classe* Parfond. Ensign Salmon reported that he used a Wild universal theodolite #13, and had 6 male helpers furnished by the local militia. Using a S.O.M. (*Societe d'Optique et de Mecanique*) prismatic astrolabe and a Bréguet chronometer controlled by radio signals from *la Croix d'Hins Bordeaux*, he determined the position of the Ayabelle Lighthouse as: Φ = 11° 33' 10.21" N, Λ = 43° 07' 23.83" East of Greenwich. With that as an origin, he initially established a local coordinate system with the Musha Lighthouse as: X = +9,729.76, Y = +19,595.54, Maskali Lighthouse as: X = +2,891.62, Y = 17,626.72, and Ras Duan (Dallaï) benchmark as: X = – 3,591.45, Y = +33,382.60. For calculating his chain of triangles from the French-Italian frontier border to I'Îles Musha, Ensign Salmon established a secant Lambert Conformal Conic projection (just south of I'Îles Musha), where: Latitude of Origin (φ_o) = 11° 42' N, Central Meridian (λ_o) = 43° 12' East of Greenwich, Scale Factor at Origin (m_o) = 0.99987634, "corresponding to the two standard parallels that are a distance of one *grade* (1^G) apart on either side of the parallel of origin," (where $400^G = 360°$). The ellipsoid of reference chosen was the International (Madrid 1924) where: a = 6,378,388, $^1/_f$ = 297. The ensign was particularly proud of his choice of origin for his secant Lambert as it was prominently displayed on the Trig List diagram, a rarity in such diagrams for the Annals of the French Navy. (*Reconnaissance Hydrographique de La Côte Française des Somalis au Nord d'Obock, Annales Hydrographiques, 3e Série, Tome Quatorzième, Annés 1935-1936, Paris 1937.*)

According to DMA/NIMA/NGA *TR 8350.2*, the 3-parameter datum shift from "Ayabelle Lighthouse" datum on the **Clarke 1880** ellipsoid to WGS 84 Datum is: ΔX = –79 m, ΔY = –129 m, and ΔZ = +145 m, each component is listed with an uncertainty of ±25 meters and this relation was determined with **one** collocated point as of 1991. NGA needs to loosen up and release a better collection of shift relations to the myriad of native datums in the world.

I once thought that the "local" coordinate system for Ayabelle Lighthouse was the azimuthal equidistant projection. I'm now pretty sure that was wrong – since I have actually read the French papers in my files (regarding the Lambert Conformal Conic), but prior to that – it probably resulted in a lot of other folks taking that as "gospel." I do have a blurb regarding the "Ayabelle Datum," an associated (probably wrong) grid system and shift parameters to WGS'84. It is similar to the NGA published shift values, so they are plausible: ΔX = –65.958m, ΔY = –120.429 m, and ΔZ = +148.056 m. The decimal points to the millimeters suggest that somebody actually made some observations – but that's just a guess. Beware of "published relations" in Djibouti. Extra anonymously supplied decimal points do not automatically relate to reality. The French *Institut Géographique National* (IGN) initiated topographic mapping of Djibouti in the 1940s and completed its 1:100,000 scale in the 1960s. In September 1950, IGN reported that "triangulation was in progress," and that the computation was being performed on the Clarke 1880 ellipsoid and they were using the "Gauss-Laborde System" for the triangulation computations (*meaning a local Transverse Mercator rather than the Laborde oblique – Ed.*). The ellipsoid of reference is still the Clarke 1880, and the grid on the native sheets is the UTM.

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).