Islamic State of Afghanistan

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In early times Afghanistan formed part of the empires of Persia and of Alexander the Great. The Turkoman dynasty was set up at Ghaznî in the 10th century, and was conquered by the Turkic ruler Timur in the 15th century. A steady series of wars and conquering invaders have passed through the country ever since. At the present time, a democratically elected government appears to be on the horizon along with a new constitution.

Afghanistan is comprised mostly of rugged mountains with plains in the north and southwest. Slightly smaller in area than Texas, it borders China (76 km) (*PE&RS*, May 2000), Iran (936 km), Pakistan (2,430 km), Tajikistan (1,206 km), Turkmenistan (744 km), and Uzbekistan (137 km) (*PE&RS*, December 1998). The lowest point is Amu Darya (258 m), and the highest point is Nowshak (7,485 m). The Hindu Kush Mountains run southeast to northeast and divide the northern provinces from the rest of the country. The highest peaks are in the northern Vakhan (Wakhan Corridor), and this finger of the country reaches between Tajikistan and Pakistan to connect with China. Thanks to the Library of Congress: "Mountains dominate the landscape, forming a terrigenous skeleton, traversing the center of the country, running generally in a northeast-southwest direction. More than 49 percent of the total land area lies above 2,000 meters. Although geographers differ on the division of these mountains into systems, they agree that the Hindukush [*sic*] system, the most important, is the westernmost extension of the Pamir Mountains, the Karakorum Mountains, and the Himalayas. The origin of the term Hindukush [*sic*] (which translates as Hindu Killer) is also a point of contention. Three possibilities have been put forward: that the mountains memorialize the Indian slaves who perished in the mountains while being transported to Central Asian slave markets; that the name is merely a corruption of Hindu Koh, the pre-Islamic name of the mountains that divided Hindu southern Afghanistan from non-Hindu northern Afghanistan; or, that the name is a posited Avestan appellation meaning water mountains."

The first geodetic work in the Afghan region was done for the Northern Trans-Indus Frontier Survey (1852 – 1869) by the Survey of India, and this was part of the work associated with the "Measure of the Great Arc." In the late 19th century, British authorities in India feared the encroachment of Czarist Russia into Central Asia, Sinkiang, and Tibet. The British obtained a buffer region between Russia and India by extending the Afghan claim to the Wakhan Corridor. Subsequent boundary treaties between Great Britain and Russia were signed in 1873, 1885, and 1895. Treaties were signed between Afghanistan and Russia in 1921, 1932, 1946, 1958, and 1981. All of the surveys performed by the British Survey of India in Afghanistan were based on the Indian principal triangulation that referenced the Everest 1830 ellipsoid where a = 6,377,301.243 m and $1/f$ = 300.80176. The datum origin for the subcontinent of India (and most of southern Asia) is considered to be at Kalianpur Hill Station where Φ_o = 24° 07' 11.26" N and Λ_o = 77° 39' 17.57" East of Greenwich.

Taking "mapping" out of "NIMA" must not take the map out of the hands of infantryman!

The Office of the Geographer, U.S. Department of State in their International Boundary Study No. 26, Revised in 1983 says: "The Wakhan Corridor River boundary from Eshkashem to Lake Sari-Qul (Victoria) results from Anglo-Russian diplomatic agreements of 1869-73. From Lake Sari-Qul to the Afghanistan-China-U.S.S.R. tripoint, the 218 kilometers of boundary, which follows the watershed of the Vakhanskiy Khrebet Range, was delimited by the Anglo-Russian Pamir Boundary Commission of 1895. The Commission demarcated the boundary at 12 points. The location of the boundary pillars, as noted by the Russian surveyor Zaliessky, was calculated east of the Russian observatory located at Pulkowa [*actually Pulkovo – Ed.*] (13° 19' 38.55" east of the Royal Greenwich Observatory). The location was recalculated during the Indo-Russian Trigonometrical survey in 1921. Geographic values for the 12 pillars noted on the Wakhan Corridor map are taken from the World Geodetic System (WGS72) employed by the United States Defense Mapping Agency." The coordinates of the pillars are listed and arithmetic is presented showing a coordinate shift to the Indian 1916 Datum by correcting for both a re-determination of the Madras Observatory longitude as well as a correction for latitude to all points for the entire datum. In *Triangulation in India and Adjacent Countries, Sheet 42.G (Great Pamir)*, Dehra Dun, 1921: "Excluding Trotter's latitude stations which are now impossible to identify, there is one astronomical station of interest in the area. Boundary Pillar No. 1 is described as 'a Conical Stone Pillar, 9 feet high, built at the eastern end of Lake Victoria on a mound rising 10 feet above the level of the lake.'" The latitude of this point was observed astronomically by Colonel Wahab (Wauhope) with an 8" transit theodolite, the value obtained being 37° 26' 33". Zalesky, of the Russian Commission, during the same work, obtained a longitude 73° 46' 32" for the same point by a comparison of local time with that shown by six chronometers brought from Osh, the longitude of which place had been determined telegraphically from Pulkowa [*sic*] via Tashkent. He considered his probable error not greater than 5 seconds of arc – it is not known whether Struve's longitude value of Pulkowa [*sic*] (30° 19' 40.11") or the *Nautical Almanac* value 30° 19' 38.55" was adopted by the Russians. The interest in these figures lies in the fact that Boundary Pillar No. 1 was fixed trigonometrically by the British Commission; corrected for the latest value of Madras and adjusted to the Indian Triangulation on the Everest spheroid, these values are 37° 26' 27.5" and 73° 46' 30.1".

Examination of the listed coordinates of the 12 pillars indicate four different versions of the same points for the Pamir Boundary Commission 1895 (PBC95), the Indian 1916 Datum, the WGS72 Datum, and the System 1942 Datum (with an origin at Pulkovo). For instance, "Pillar 1" coordinates for the (PBC95 datum) are φ = 37° 26' 32.2" N and λ = 73° 49' 00.6" E and, for "Pillar 12," are φ = 37° 21' 25" N and λ = 74° 50' 22" E.

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The "other" datum coordinates (for "Pillar 1") show a difference for the Indian Datum 1916 of $\Delta\varphi$ = –4.7" and $\Delta\lambda$ = –2' 30.3", for the WGS72 Datum of $\Delta\varphi$ = –8.1" and $\Delta\lambda$ = –2' 32.8", and for the System 42 Datum of $\Delta\varphi$ = –8.4" and $\Delta\lambda$ = –2' 30.3". For "Pillar 12," the "other" datum coordinates show a difference for the Indian Datum 1916 of $\Delta\varphi$ = –4.7" and $\Delta\lambda$ = –2' 30.3", for the WGS72 Datum of $\Delta\varphi$ = –8.0" and $\Delta\lambda$ = –2' 33.5", and for the System 42 Datum of $\Delta\varphi$ = –8.3" and $\Delta\lambda$ = –2' 31.1". Although the differences between the PBC95 and the WGS72 datums seem plausible at first glance, when we look at how Indian 1916 and System 42 compare with the same points, my conclusion is that the veracity of this "analysis" is somewhere between a "high geodetic crime" and "pulp fiction!" The only thing that is believable is the Pamir Boundary Commission of 1895 coordinates – the remarkably close correspondence of the other three listed datum coordinates have no semblance with reality. Incidentally, the difference between Indian 1916 Datum and WGS72 is about a kilometer, which is more than 10 times that as reported in International Boundary Study No. 26. I have been reading these Office of the Geographer International Boundary Studies for over 30 years, and I must admit that this is the first and only one with which that I have had a problem.

International Boundary Study No. 89 reports the treaty between Afghanistan and China on 22 November 1963. There are no attempts at geodesy in this report, but an interesting part of the summary observes: "The problem also exists that the geographic coordinates given in the treaty for the initial point of the boundary – 37° 03' North, 74° 36'East – do not conform with the same point in the China-Pakistan agreement. The problem obviously is related directly to the poor quality of mapping in the frontier."

International Boundary Study No. 6 reports on the treaties between Afghanistan and Iran. The first arbitration, under the supervision of Sir Frederick Goldsmid, occurred in 1872 between Persia and Afghanistan. Between 1888 and 1891, a compromise boundary was laid down as the Hari Rud system and 39 pillars to the south marked the arbitration award from the Russian tripoint latitude 34° 20' North. In 1896 the Helmand River changed course and the boundary again became a point of conflict. Trig surveys were carried from India and, by 1905, the McMahon Commission placed 90 markers along the boundary from the tripoint on the Kuk-I-Malik Siah to the Kuh Siah. "The 550-mile boundary is demarcated by 172 pillars, or approximately one pillar for every three miles of boundary."

Thanks to John W. Hager, now retired from the Defense Mapping Agency (no longer DMA **nor NIMA,** but the National Geospatial-Intelligence Agency – NGA), there are a number of datums that have been established in Afghanistan. "Bogra Datum – I have no data but note that there is a Bogra Dam on the Helmand at approximately latitude 31° 56' N, and longitude 64° 44'E. A guess is that is was a local system used for the construction of the dam."

The oldest of the *local* Afghan datums is the Ishpushta Datum of 1940 where, as Hager states, "Point is Observatory Station at latitude (geodetic) = 35° 18' 53.5" N, ξ = 10.80"±0.9", longitude (geodetic) = 68° 05' 08.53" E, η = 7.40"±2.7", Everest. Reference is 'Triangulation in Afghanistan,' published by Survey of India in 1947." I was curious as to where this location is in the country and I noticed that this is about 75 km northeast of the ruins of the Buddhas of Bamian, destroyed by the Taliban regime. The Swiss Office of Topography has done terrestrial photogrammetric restitutions of the originals, and there are a number of fascinating papers in print on the topic of the statues. In 1951, the U.S. Army Map Service (AMS) performed a cartometric analysis of boundary points between Afghanistan and what is now the Republic of Turkmenistan that were based on the Ishpushta Datum of 1940. The geodetic station comparisons between the Afghan Ishpushta Datum minus the Indian Datum of 1916 show a trend of $\Delta\varphi$ = –6.1" and $\Delta\lambda$ = +32.0".

Hager mentioned something surprising. "Kalianpur Hill station … is the definition of Indian datum except for the ellipsoid. About 1954 AMS produced 1:250,000[-scale] maps in northern Afghanistan on the International Ellipsoid. To differentiate from Indian datum (Everest), the datum name Kalianpur was used. The dividing line is longitude 61° 30' N, latitude 36° E, thence east to 66°, north to 37°, east to 72°, north to 38° N, thence to longitude 78° E. Note that the horizontal segments are multiples of 1° 30' and the vertical are 1°, the size of the standard 1:250,000[-scale map]. When Zone 0 was eliminated, the northern limit of Zone I was redefined, I believe as above."

For the now obsolete India Zone 0 (all of the India Zones were cast on the Lambert Conical Orthomorphic Projection), Everest ellipsoid where a = 6,974,310.600 Yards, e^2 = 0.006637846630200, Latitude of Origin, φ_o = 39° 30' N, Central Meridian, λ_o = 68° E of Greenwich, Scale Factor at the Parallel of Origin m_o = 649/650 = 0.998461538, False Northing, FN = 2,590,000 Yards, and False Easting, FE = 2,355,500 Yards. An example test point for India Zone 0 is: φ = 42° 38' 51.627" N, λ = 61° 41' 57.291" E, X = 1,790,983.28 Yards, and Y = 2,991,605.57 Yards. For India Zone I, Latitude of Origin, φ_o = 32° 30' N, Central Meridian, λ_o = 68° E of Greenwich, Scale Factor at the Parallel of Origin m_o = 823/824 = 0.998786408, False Northing, FN = 1,000,000 Yards, and False Easting, FE = 3,000,000 Yards. An example test point for India Zone I is φ = 30° 33' 49.893" N, λ = 62° 12' 13.613" E, X = 2,392,655.35 Yards, and Y = 782,000.02 Yards.

Thanks again to Hager, the Herat North Datum of 1959 origin is Φ_o = 34° 23' 09.08" N and Λ_o = 62° 10' 58.94" East of Greenwich, H_o = 1,111.7 m and is referenced to the International ellipsoid where a = 6,378,388 m and $1/f$ = 297. This is the datum that shift parameters are published for by NIMA (now NGA) from local (Herat North 59) to WGS84. To my amazement, Hager said, [This was] "established by the Soviets (Technoexport). There was a joint U.S.S.R. and U.S.A. mapping project at that time, we did the south half of the country and they did the north half. One part was done by a consortium (I can't remember what they were called) made up of Aero Services Corp. out of Philadelphia and Fairchild Aero Services. They flew Shoran controlled photography at a scale approximately 1:60,000 using B-17s, based on a Shoran measured trilateration net."

Never short on surprises, Hager transmitted to me a facsimile of a paper translated by John M. Willis of the DMA Aerospace Center in 1990. The surprise paper was entitled, *The Local Coordinate System of Kabul (Mestnaya Systema Koordinat Kabula)*, *Geodeziya I Kartografiya*, No. 12, 1988, pp. 21-33. As I have touted for years, the local use of a municipal or county coordinate system must take into account the elevation for the implementation of a simple system for the use of GIS technicians. The author of the Kabul System was Bakhavol' Darvesh, and this individual ingeniously utilized the Australian Map Grid (AMG) (*PE&RS*, December 2003) with its concomitant ellip-

soid for the City of Kabul and surrounding region! The choice of the ellipsoid and scale factor at origin just happened to perfectly fit the elevation and latitude of Kabul. That's what proper cartographic/geodetic design is all about for a project/city coordinate system.

Many readers of this journal are professional cartographers and photogrammetrists. We need to design systems that will facilitate a GIS for local governments with the educational level of the average municipal GIS technician in mind. What's "common sense" to us is not necessarily obvious to the neophyte. Darvesh applied superb design engineering for facile local use. That system has been used since 1984 and I'll bet it's still in use in Kabul. The Republic of Colombia (*PE&RS*, September 1997), and the states of Minnesota, Wisconsin, etc., have designed local city or county coordinate systems that are designed to compensate for heights above the ellipsoid such that land surveyors can submit their ground surface measurements and "fit" to the local GIS without mathematical manipulation. As I teach my Louisiana State University students every semester, the "K.I.S.S." principle is preferable to complicated solutions – (Keep It Simple, Stupid).

The only published datum shift parameters for Afghanistan are those by NGA from Herat North 1959 Datum to WGS84: $\Delta a = -251$ m, $\Delta f \times 10^4 = -0.14192702$, $\Delta X = -333$ m, $\Delta Y = -222$ m, and $\Delta Z = +114$ m. The astute reader will notice that there is no accuracy estimate offered, and there is no information offered regarding the number of stations used to compute the shift parameters. This "guess," published by NGA, is listed as "Non-Satellite Derived Transformation Parameters."

So what is an infantry soldier to do over there? My youngest son, Philippe, was in the 82nd Airborne Division, 504th Parachute Infantry Regiment over there in 2002-2003. He went on many patrols searching for the "bad guys," and he had the dubious distinction of being a short Louisiana Frenchman; therefore, he had the job of the "Tunnel Rat" for his Company. Apart from this awful but necessary duty task, he tells me that his unit was supplied with 1:100,000-scale topographic maps referenced to the WGS84 Datum. Philippe tells me that the maps had the towns and hamlets placed where they should be, and the coordinates on the paper maps appeared to match their personal GPS receivers. The U.S. military has not yet issued personal GPS receivers to all of their combat troops, except for the Squad Leaders. As a measure for individual survival, my son tells me that most of the Paratroopers over there purchase their own personal consumer-grade GPS receivers just to record their own treks in order to retrace if separated. The GPS units are thankfully in stock at the Post Exchanges in Kandahar and elsewhere in-country, and they offer a "comfort factor" to the combat soldiers that walk the valleys of Afghanistan looking for the "bad guys." Hopefully, Lieutenant General Clapper of NGA will produce 1:50,000-scale paper topographic maps to support our troops in Iraq better than has been done so far in Afghanistan.

Although my youngest son is finished with his term of enlistment in the Army, he's got a lot of buddies that are "rotating" to the Sunni Triangle this month. They personally write to me (from the Task Force rotating out), and the highly computerized NGA needs to better support the "grunt on the ground." There are still bad guys in Afghanistan, and I think that the 1:100,000-scale *paper* maps are not good enough. Air Force brass are obviously not the best judges of what the grunt needs on the ground, in the tunnels, and in the caves. Taking "mapping" out of "NIMA" must not take the map out of the hands of the infantryman!

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