

— without communications and full of jungles, wild animals, robbers and disease. The average length of a side of the triangulation was about 31 miles, the maximum being about 62 miles. One cannot imagine how such long-distance observations were planned, laid down on the ground, line of sight cleared of all trees and sometimes even houses, and how big rivers and swamps were crossed. Everest, devoted to his work, did all this despite his partial paralysis and bad health. Based on his conceptualization, the gridiron network today covers the entire country and forms a solid foundation for accurate surveys and mapping for defense, development and efficient administration. It was with the help of this gridiron network that the highest peak of the world was observed and discovered in 1852 and its height declared as 29,002 ft. - *i.e.* about 8840 meters. After fresh observations and computations, the Survey of India declared its height in 1954 as 8848 meters. In 1975, the Chinese put a metallic beacon on Everest and observed it from 9 stations. They also carried out sufficient astronomical and gravimetric measurements, the coefficient of refraction was reliably determined and the final result of the determination was declared as 8848.13 ± 0.35 meters. Sir Thomas Holdick concluded in the Standard of January 24, 1905 that 'It was officers of the Survey of India who placed his name just near the stars, than that of any other lover of eternal glory of the mountains and let it stay in witness to the faithful work not of one man but scores of men.' Everest was the first from amongst the eight Surveyors General of India to be knighted" (*Survey of India Through the Ages, by Lt. General S. M. Chadha, delivered at the Royal Geographical Society on 8 November 1990, on the eve of Sir George Everest Bicentenary celebration by the Surveyor General of India*).

Slightly more than one-third the size of the U.S., India is bordered by Bangladesh (4,053 km) (*PE&RS*, March 2008), Bhutan (605 km), Burma (1,463 km) (*PE&RS*, September 2013), China (3,380 km) (*PE&RS*, May 2000), Nepal (1,690 km) (*PE&RS*, June 2013), and Pakistan (2,912 km) (*PE&RS*, July 2009). The lowest point is the Indian Ocean (0 m), and the highest point is Kānchenjunga (8,598 m) (*World Factbook, 2014*).

"The bulk of the geodetic triangulation in India was carried out with large theodolites between 1802 and 1882. Its simultaneous adjustment involved a decade's labor. In the 20th century, very little was done in the way of geodetic triangulation – only a few outlying series in Baluchistan and Burma having been observed. The presence of Military Survey Companies in the different theaters during WWII and in the period immediately following it enabled important gaps between the triangulation of India and its neighboring countries like Iraq, Iran, Siam and Malaya to be filled. A continuous chain of triangulation now exists from Syria to Malaya" (*Geodetic Work in India – War and Post-War, B.L.Gulatee, Empire Survey Review, No. 77, Vol. X, 1950*).

The origin of the Indian Adjustment of 1916 is at station Kalianpur (Strong Base) where: $\Phi_0 = 24^\circ 07' 11.26''$ N, $\Lambda_0 = 77^\circ 39' 17.57''$ East of Greenwich, $\alpha_0 = 190^\circ 27' 05.10''$

from Kalianpur to Surantal, and the ellipsoid of reference is the Everest 1830 (*India*) where: $a = 6,377,301.243$ m, $1/f = 300.8017$ (*UK Military Survey, 1982*). The adjustment depended on baselines evenly distributed throughout India. The use of LaPlace stations had not yet been adopted by the Survey of India; consequently errors in azimuth and position were introduced. These errors are particularly evident in the triangulation series of southern India. The 1880 adjustment has however, remained the basis of all Indian triangulation and mapping. Therefore there is no such thing as an "Indian Datum;" it is only an adjustment! (*JMN, 21 June 1997*)

In 1924 the "Minute Mesh" was introduced. This is a reference system consisting of meridians and parallels at one minute intervals: descriptive references are given by a convenient system of lettering, and all survey computations are done in spherical terms in the usual way" (*Geodetic Report, Survey of India, CPT. G. Bomford, R.E., 1930*). "As the result of a decision arrived at the artillery survey conference held at Akora on 12th January 1926, two forms and a set of tables were prepared for the conversion of the spherical co-ordinates to rectangular, and *vice versa*, on Lambert's conical orthomorphic projection. This projection is also known as Lambert's second projection with two standard parallels" (*Geodetic Report, Survey of India, CPT. G. Bomford, R.E., 1928*).

Seven separate India Zones were created in 1926 by the Survey of India, all seven having the same scale factor at origin (m_0) = $823/824 = 0.998786408$, the same False Easting = 3,000,000 Indian Yards, and the same False Northing = 1,000,000 Indian Yards. The following parameters differ: Zone I has $\phi_0 = 32^\circ 30' \text{ N}$ & $\lambda_0 = 68^\circ \text{ E}$; Zone IIA has $\phi_0 = 26^\circ \text{ N}$ & $\lambda_0 = 74^\circ \text{ E}$; Zone IIB has $\phi_0 = 26^\circ \text{ N}$ & $\lambda_0 = 90^\circ \text{ E}$; Zone IIIA has $\phi_0 = 19^\circ \text{ N}$ & $\lambda_0 = 80^\circ \text{ E}$, Zone IIIB has $\phi_0 = 19^\circ \text{ N}$ & $\lambda_0 = 100^\circ \text{ E}$, Zone IVA has $\phi_0 = 12^\circ \text{ N}$ & $\lambda_0 = 80^\circ \text{ E}$, and Zone IVB has $\phi_0 = 12^\circ \text{ N}$ & $\lambda_0 = 104^\circ \text{ E}$. As a hint for the readers that need the actual two standard parallels for each of the above India Zones expressed with the British Method of defining Lambert parameters; for India Zone I, the equivalent standard parallels are $35^\circ 18' 50.3486'' \text{ N}$ and $29^\circ 39' 18.7703'' \text{ N}$. The requisite equations to solve for the other India Zones are in Chapter 3 of the Manual of Photogrammetry, editions 5 and 6.

Because there is no unified datum in existence for the sub-continent of India, there is a significant difference in transformation parameters from Indian 1916 to WGS84 from region to region. The Survey of India is slowly releasing geodetic and cartographic data to the general public after maintaining a significant degree of secrecy for centuries. Curiously, the India Lambert Zones are for restricted military use, and civilian applications in GIS for India seem to prefer the U.S. military's Universal Transverse Mercator Grid System.

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 (C⁴G).