Grids & Datums

State of Burma

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

"Tracing Burmese conflicts back to the 9th century, the Himalayan Bamar people, who comprise two-thirds of the population, were at war with the Tibetan Plateau's Mon people. The fight went on for so long that by the time the Bamar came out on top, the two cultures had effectively merged. The 11th-century Bamar king Anawrahta converted the land to Theravada Buddhism, and inaugurated what many consider to be its golden age. He used his war spoils to build the first temples at Bagan (Pagan). Stupa after stupa sprouted under successive kings, but the vast money and effort poured into their construction weakened the kingdom. Kublai Khan and his Mongol hordes swept through Bagan in 1287, hastening Burma's decline into the dark ages. There's not much known about the centuries that followed. History picks up again with the arrival of the Europeans – first the Portuguese, in the 16th century, and then the British, who had already colonized India and were looking for more territory in the East. In three moves (1824, 1852 and 1885), the British took over all of Burma. The Burmese king and queen were exiled to India and their grand palace at Mandalay was looted and used as a barracks to quarter British and Indian troops. The colonial era wrought great changes in Burma's demographics and infrastructure. Large numbers of Indians were brought in to work as civil servants, and Chinese were encouraged to immigrate and stimulate trade. The British built railways and ports, and many British companies grew wealthy trading in teak and rice. Many Burmese were unhappy with the colonial status quo. A nationalist movement developed, and there were demonstrations, often led, in true Burmese fashion, by Buddhist monks. During WWII, the Japanese, linked with the Burmese Independence Army (BIA), drove the British out of Burma and declared it an independent country. But the Japanese were able to maintain Burmese political support for only a short time before their harsh and arrogant conduct alienated the Burmese people. Towards the end of the war, the Burmese switched sides and fought with the Allies to drive out the Japanese. Independence followed in 1948" (*Lonely Planet, 2013*).

Burma is bordered by: Bangladesh (193 km) (*PE&RS*, March 2008), China (2,185 km) (*PE&RS*, May 2000), India (1,463 km), Laos (235 km) (*PE&RS*, April 2007), and Thailand (1,800 km) (*PE&RS*, February 2011). Slightly smaller than Texas, Burma is comprised of central lowlands ringed by steep, rugged highlands; the lowest point is the Andaman Sea (0 m), and the highest point is Hkakabo Raze (5,881 m) (*World FactBook and NGA GeoNames Server, 2013*).

"The credit of the first surveys of the Brahmaputra in Assam, in 1794, and that of the Irrawady River in Burma go to Thomas Wood. The mission also collected interesting information about people, tribes and general geography of Assam and Burma, about which nothing whatever had been known before" (*Survey of India through the Ages, LTGEN. S.M. Chadha, 1989-90*).

"At the end of 1930 I.M. Cadell was in charge of 15 Party (Triangulation), working in eastern Burma, with a detachment (M.N.A. Hashmie) in the extreme south of Burma. No 17 Party (levelling), with H.P.D. Morton in charge, was working as usual with three detachments on high precision leveling and five on lower order work.

"The programme of Cadell's own detachment was to observe at seven stations to close a primary triangulation circuit, including a connection with the Siamese (now Thai) system, and then to measure a baseline at Kenton (21°15' N, 99°30' E), with its extension to the adjacent primary. From central Burma a motor road went as far as the Salween, and in fair weather at the right time of the year, motors could reach Kengtung. Elsewhere there were plenty of tracks fit for mules and ponies, but these animals had to come from Yunnan. The base level of the country is below 1000 feet in the Salween and Mekong valleys, but elsewhere hill tops are between 5000 and 8000 feet.

"By mid-December, working with a 5½-inch Wild theodolite, Cadell had completed the Siamese connection and had closed the primary circuit except for one station, when he began to get ill with pneumonia. He managed to reach his last station on the 18 December, three days march from the main road, but died there ten days later. Cadell was very tough. He travelled light and took little notice of feeling ill, but it is hard to see what he or anyone else could have done about it.

"News of Cadell's death reached Dehra Dun on the 31 December, and on the 4 January I left to tidy things up, and to complete the programme if possible. From Dehra Dun it took nine days to reach Salween, where mules were waiting for me, and I got to Cadell's last station on 17 January. The long delay had naturally disarranged the helio squads and it was another 12 days before all were in place and the observations completed. After that measurement of the baseline and its extension went smoothly.

"Kengtung baseline. This was the first baseline measured in India since 1882. At Kengtung there is a flat open plain of rice-fields about ten miles by five with hills all round. An ideal site for a baseline. Cadell had reconnoitered the site the previous year, and an assistant L.R. Howard had spent November and December 1930 clearing the line, building stations, and laying out pegs for the tripods every 24 metres. For the base measurement we used six invar wires, two simultaneously for the south to north measure and two others for north to south. The other two were used as sub-standards against which the working wires were compared every morning. I had standardized all the wires in our Dehra Dun observatory in August 1930, and they were of course re-standardized on our return in April 1931. For their coefficients of expansion we had planned to rely on their Sèvres (1908) certificates, but as soon as we started work it was apparent that these certificates were wrong, as was shown by the difference between the two working wires between early morning (13°C) and the afternoon (33°C). To get a provisional figure we set up tripods over ten 24 m bays and made repeated measures with all the working wires in the morning and in the afternoon.

"The squad of about 35 survey khalasis and a recorder* had had some preliminary practice at Dehra Dun, and after the first two days everything went very smoothly. An assistant P.K. Chowdhury and I read the wires, and Howard with 15 khalasis set the tripods over the pegs, and recorded their heights above the pegs. The heights of the pegs were obtained by leveling along the line before and after the measurement. To start with we only managed 60 bays a day, but later increased it to 120. When we had finished we re-measured the first two days' work, where the discrepancies between fore and back were greater than elsewhere.

"*Khalasis are members of the most junior grade in the Survey Department, and include helio men, chain men, instrument carriers *etc*. In the 1930s their pay was between £1 and £2 per month according to skill and length of service. A recorder or computer was a member of the Lower Subordinate service, which also included plane-tablers, traversers and draughtsmen, the backbone of the department, whose pay was between £3 and £10 per month. Assistant, as used in this article, implies members of either the Upper Subordinate service or of the Class II Gazetted service.

"*Triangulation: Southern Burma*. While the work described above was proceeding, Hashmie's detachment was working on a connection between the long Burma Coast triangulation series and the Siamese triangulation in the Kra Isthmus (latitude 10°N), observing at eight stations with a 12-inch micrometer theodolite. They had severe trouble with rain, cloud and thick jungle, and one new station which was placed on what appeared to be a good hill with a clear view to the east had to be re-sited after observations had been made to it from the west. This practically involved a fresh start. Worse still, an outbreak of beri-beri resulted in the death of six khalasis. Fortunately, an improvement in the weather in January and February made it possible to get the connection completed.

"*Base measurement.* The programme of the triangulation party in 1932-33 was to measure three baselines and their extensions in Burma, at Mergui, Amherst, and Kalemyo (23°20' N, 94°E) with I.H.R. Wilson in charge, in preparation for which I standardized the six invar wires. The result was disconcerting. Since the last measurement in 1931, one 24-metre wire had decreased by 0.77 mm, one had increased by 2.69 mm, and the other four had changed by between 0.10 and 0.28 mm, all these figures being larger than they ought to be. Clearly some extraordinary misfortune had occurred, but when or how could not be discovered. However, the wires had been restandardized, the field party was ready to depart, and there was nothing to be done but to carry on and hope for the best.

"Wilson duly measured the three baselines with daily comparisons between the working wires and the two kept as field standards, which showed that there was at least reasonable stability. Restandardization at Dehra Dun in April 1933 showed changes of at most 0.24 mm (1 in 100 000) in the four working wires, and of 0.35 and 0.42 in the field standards. These figures are larger than one would have liked, but in the circumstances they might have been worse. The six wires were then re-measured in May 1933 to give the current rate of change of each wire. Given the lengths of the wires in September 1932, April 1933 and May 1933, and their relative lengths at the times of the measurement of each of the three baselines, I deduced a probable figure for the length of the mean wire at each baseline, which had an apparent probable error of 1 ppm or less, and I felt confident that the error did not exceed 1 in 300,000. In view of the likely error in the base extensions, an error of 3 ppm in the baseline itself is no disaster. But we had learned that damage to a wire may make it unreliable for at least the next year. (*This is an example of the reputation of Invar alloy steel wires, tapes, and leveling rods – they are known to "jump" for no apparent reason as a result of being a quench-annealed nickel alloy. Thus the reason for the U.S. National Geodetic Survey requiring periodic re-calibrations. – Ed*).

"*Geoid section.* For the field season 1932-33 I planned to observe a geoid section across Burma, to start the long section from Siam to Persia referred to earlier. I used a 60° Jobin prismatic astrolabe, but since the astrolabe has no impersonal device, I also took with me a portable bent Transit (*Broken-elbow astronomic theodolite – Ed.*) with a so-called impersonal micrometer, which I used in addition to the astrolabe at every fourth station. My personal equation with the Transit was determined by four nights (*of*) observations at Dehra Dun both before and after the field season. Anticipating a little, the field value of (Transit minus Astrolabe) varied between +0.08" and +0.14", mean +0.12". So in fact I got substantially the same result as I would have if I had got along without the Transit. I regretted not having calibrated myself on the astrolabe instead of on the Transit.

"For my triangulated (geodetic) position I had chosen a line through country which had been fairly recently surveyed topographically, and there were plenty of recognizable topo triangulation stations and intersected points, generally hill tops. During the preceding months I had selected promising sites from the maps about one day's march apart, say 12 miles in hilly country, and had obtained the coordinates of points likely to be useful. So at each station I observed angles (with a small Wild) to six or eight recognizable points, and generally observed a Polaris azimuth at Sunset. In a few cases I traversed from a single nearby point, or set up a short base and found a distance.

"The routine was that we marched one day, and pitched camp at or close to a place where I could get a triangulated fix, which I at once did. The next morning I computed the fix semi-graphically to ensure that all was well with it, and set up the astro instruments in time to get the Rugby 16:30 (Burma time) signal. After sunset I observed for two

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"I had with me a Survey of India recorder, 20 khalasis, 15 coolies from the Wa States (north of Kengtung), about 40 ponies and mules from Junnan with a dozen Chinese drivers, and two interpreters. Burma does not produce ponies, mules or coolies, and I got them from Syed Ismail of Kengtung, who had done the same for Cadell in previous years. Syed Ismail was a very useful man, with much influence in Kengtung. He was a Chinese Moslem, of which there is a colony in Yunnan."

hours with the astrolabe (30 stars), and finally got the 00:30 Rugby signal. I carried three chronometers which I compared with each other at wireless times, and during the star observations. While waiting for the 00:30 signal I marked up the chronograph sheets and worked out the comparisons between the three clocks, as a precaution against unsuspected trouble there. We moved on again the next day.

"Every fourth station where the Transit was to be used, required eight time stars and two azimuth stars with the bent Transit, about two hours work after completing the astrolabe. Apart from the trouble of setting up the Transit and getting it adjusted in level and azimuth, it set me back with reading the chronograph sheets and the clock comparisons, some of which had to wait until the next station. It was in fact a considerable nuisance.

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"We started work at Monywa, on the Chindwin. The coolies and ponies arrived only 12 hours late, having travelled the last 200 miles by rail, preceded by 200 miles on foot from Kengtung, and about the same again from their own countries, – Syed Ismail's work. We left Monywa on 2 November, and worked through Gangaw and Haka (22°40' N, 93°20' E) in the Chin Hills up to the Indian frontier. We then marched back to Monywa and worked eastwards through Ava, Taungyyi and Mongpan (20°20' N, 98°20' E) to the Burma-Siam – Indo China (now Laos) trijunction, south of Kengtung, 44 stations in all, finishing on 24 February. I then observed longitude for two nights at Kengtung to complete a Laplace station there" (*Geodetic Surveys in India 1930-35, Guy Bomford, Survey Review, No. 200, April 1981, pp. 65-78*).

"It is interesting to note that the Burma Survey Party manned by Survey of India personnel, continued to be under the technical control of the Surveyor General of India till the end of the Second World War" (*op. cit., Chadha, 1989-90*).

The datum used in Burma is the Indian Datum of 1916 with origin at Kalianpur Hill (1880) where: Φ_o = 24° 07' 11.26" N, Λ_o = 77° 39' 17.57" East of Greenwich, and the ellipsoid of reference is the Everest 1830 where: a = 6,377,276.345 m = 6,974,310.6 Indian Yards, and $^1/_f$ = 300.8017. Nowadays, some refer to the Indian Datum of 1975 which actually is a misnomer; it's still Indian Datum of 1916, but Burma is part of a regional adjustment performed by the U.S. Army Map Service/Defense Mapping Agency Hydro/Topo Center in 1975. The still-currently used Grid is the India Zone IIIB (Lambert Conical Orthomorphic/Lambert Conformal Conic) where: the central meridian, λ_o = 100° E, the latitude of origin ϕ_o = 19° N, the scale factor at the latitude of origin m_o = 0.998786408, and False Easting = 3,000,000 Indian Yards = 2,743,185.69 m, and the False Northing = 1,000,000 Indian Yards = 914,395.23 m. Note that India Zone IIIB as defined by the Survey of India in the early 20th century is a secant conic projection (2 standard parallels) but defined with (ϕ_o, m_o) as found on page 248 of the *Manual of Photogrammetry*, 6th edition, 2013. According to *TR8350.2*, the 3-parameter transformation in most of Thailand **from** Indian Datum 1975 **to** WGS84 Datum is: ΔX = +210 m ±3 m, ΔY = +814 m ±2 m, and ΔZ = +289 m ±3 m, based on 62 collocated points in 1997. My guess is that these shift parameters are ball-park for Burma.

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).