Grids & Datums

Kingdom of Thailand

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"Over the course of millennia, migrations from southern China peopled Southeast Asia, including the area of contemporary Thailand. Archaeological evidence indicates a thriving Paleolithic culture in the region and continuous human habitation for at least 20,000 years. The pace of economic and social development was uneven and conditioned by climate and geography. The dense forests of the Chao Phraya Valley in the central part of Thailand and the Malay Peninsula in the south produced such an abundance of food that for a long time there was no need to move beyond a hunting-and-gathering economy. In contrast, rice cultivation appeared early in the highlands of the far north and hastened the development of a more communal social and political organization. Excavations at Ban Chiang, a small village on the Khorat Plateau in northeastern Thailand, have revealed evidence of prehistoric inhabitants who may have forged bronze implements as early as 3000 *B.C.* and cultivated rice around the fourth millennium *B.C.* If so, the Khorat Plateau would be the oldest rice-producing area in Asia because the inhabitants of China at that time still consumed millet. Archaeologists have assembled evidence that the bronze implements found at the Thai sites were forged in the area and not transported from elsewhere. They supported this claim by pointing out that both copper and tin deposits (components of bronze) are found in close proximity to the Ban Chiang sites. If these claims are correct, Thai bronze forgers would have predated the Bronze Age, which archaeologists had traditionally believed began in the Middle East around 2800 *B.C.* and in China about a thousand years later. Before the end of the first millennium *B.C.*, tribal territories had begun to coalesce into protohistorical kingdoms whose names survive in Chinese dynastic annals of the period. Funan, a state of substantial proportions, emerged in the second century *B.C.* as the earliest and most significant power in Southeast Asia. Its Hindu ruling class controlled all of present-day Cambodia and extended its power to the center of modern Thailand. The Funan economy was based on maritime trade and a well-developed agricultural system; Funan maintained close commercial contact with India and served as a base for the Brahman merchant-missionaries who brought Hindu culture to Southeast Asia. On the narrow isthmus to the southwest of Funan, Malay city states controlled the portage routes that were traversed by traders and travelers journeying between India and Indochina. By the tenth century *A.D.* the strongest of them, Tambralinga (present-day Nakhon Si Thammarat), had gained control of all routes across the isthmus. Along with other city-states on the Malay Peninsula and Sumatra, it had become part of the Srivijaya Empire, a maritime confederation that between the seventh and thirteenth centuries dominated trade on the South China Sea and exacted tolls from all traffic through the Strait of Malacca. Tambralinga adopted Buddhism, but farther south many of the Malay city-states converted to Islam, and by the fifteenth century an enduring religious boundary had been established on the isthmus between Buddhist mainland Southeast Asia and Muslim Malaya. Although the Thai conquered the states of the isthmus in the thirteenth century and continued to control them in the modern period, the Malay of the peninsula were never culturally absorbed into the mainstream of Thai society. The differences in religion, language, and ethnic origin caused strains in social and political relations between the central government and the southern provinces into the late twentieth century" (*Library of Congress Country Study, 2009*).

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Bordered by Burma (1,800 km), Cambodia (803 km) (*PE&RS,* May 2008), and Malaysia (506 km) (*PE&RS*, April 2009), Thailand is slightly more than twice the size of Wyoming. The lowest spot is the Gulf of Thailand (0 m), and the highest spot is Doi Inthanon (2,576 m) in the province of Chiang Mai. Thailand's coastline is 3,219 km long, and the territorial sea claimed is 12 nautical miles.

A high spot in Chiang Mai was chosen by the U.S. Army Map Service (AMS) in the late 1960s as a site for a SECOR (Sequential Collation of Ranges) satellite receiving station in order to establish a precise geodetic position for a SHORAN (radiolocation) tower & beacon to provide positioning control to B-52 bombers for the bombing of North Vietnam. While I was a Company Commander of the enlisted detachment at AMS, I once had a soldier transported to me in chains and leg irons from the Chiang Mai SECOR site for a disciplinary action.

"The geodetic control network and basic topographic mapping in Thailand is the responsibility of the Royal Thai Survey Department (RTSD), which traces its origin to a small unit established in 1873 by King Rama V. (*Probably the origin of Rājburi Datum of 1878 – Ed.*) The first order control network consists (*as of 1985 – Ed.*) of 362 triangulation stations together with 200 first order traverse stations. The network includes 66 Laplace astronomic stations, 60 Doppler satellite stations and a large number of gravity stations. The geodetic coordinates are based on a 1975 adjustment. The RTSD has also sur-

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veyed a large number of second and third order stations as control for topographic mapping.

"The geodetic control was established on the pattern of the Survey of India geodetic network. It was made up of geodetic chains which formed a grid, with areas inside the grid which were not covered. Generally the chains ran along the mountain ridges. This was unfortunate as it meant that geodetic control was generally not available on the flat plains, where the centers of population and agricultural activity were located, and where the major activity for the Land Titling project would occur. For mapping the RTSD uses the Universal Transverse Mercator projection which covers Thailand with two zones. The country is covered by basic topographic mapping at 1:50,000, with 830 maps on a 15'×15' format.

"Since 1903, the Department of Lands has been carrying out cadastral surveying and mapping for land titles. At that date, there was no overall geodetic network in existence so a set of local systems was established, similar to the system in New Zealand (*PE&RS, May 2005 – Ed.*). These systems are still used for cadastral mapping (*as of 1985 – Ed.*). There are 29 local systems, each with its local origin and each covering one of more of the 72 provinces. Initially, the origins chosen were prominent local points but in systems established later, an intersection of geographical graticule lines was selected for the origins. The systems are based nominally on Spherical Rectangular (Cassini) coordinates.

"The control for cadastral surveying was extended from each origin by traverse loops measured with theodolite and steel tape. Control stations consisting of buried numbered concrete blocks are placed about every 500 m. Azimuth control is determined by solar observations about every 10 km. Loop was added onto loop so that, even though the traversing was to a good standard, serious errors accumulated. The theoretical formulae are available to transform the local spherical rectangular coordinates to UTM on the national system. But the resulting positions are not reliable because of discrepancies in the positions and, particularly, the accumulation of traverse error. Position discrepancies of up to 80 m are common" (*A Project for Upgrading the Cadastral System in Thailand, P.V. Angus-Leppan & I.P. Williamson,* Survey Review*, Vol. 28, 215, January 1985, pp. 2–14 & April 1985, pp. 63–73*). Records of the origin coordinates of those Cassini systems are no longer available *(Prof. Ian Williamson, University of Melbourne – personal communication, November 2010*).

Thanks to John W. Hager, "INDIAN 1916. At the commencement of operation of Survey of India in about 1802, Madras observatory, being the only institution equipped with precision instruments, was elected as the origin to which co ordinates of all of the trigonometrical stations were to be referred: Λ_o = 80° 18' 30"E (1805 - Lambton's value, used for the Atlas Sheets), and Λ_o = 80° 17' 21"E (1815 - Warren's value, used for Standard Sheets and all other mapping) (*Gulatee, B. L.,* Deviation of the Vertical in India*, Survey of India, 1955), and (Markham, Clements R.,* A Memoir on the Indian Surveys*, London, 1871*). In 1840 Everest chose Kalianpur Hill Station as origin. The geodetic triangulation of India was first adjusted to form a self consistent whole in about 1880 and that of Burma in 1916. These are also known as the Published Values. (*Army Map Service Geodetic Memorandum No. 1600,* Pakistan-India-North Burma Conversion of the Indian Datum

"Published Values" to South Asia Datum *by Isaac C. Lail, Washington, 10 November 1966*). Everest derived the weighted mean to be: Φ_o = 24° 07' 11.26"N. This value was accepted as the geodetic latitude of the origin for the calculation of the primary triangulation of India in 1878. The longitude, Λ_o = 77° 41' 44.75", was determined by Everest in 1840 based on Warren's determination of the longitude of Madras Observatory in 1815. Operations undertaken in 1894-95-96 determined a correction of –2' 33.94" in the longitude of Madras. To this is added a correction of –6.76" to the value of Kalianpur as determined in 1889. Except for this constant change of –2' 27.18" in longitude, the 1900 definition of the datum point is identical with that of 1880 (Account of the Operations of the Great Trigonometrical Survey of India; Volume XVII; Electro Telegraphic Longitude Operations Executed During the Years 1894-95-96; The Indo- European Arcs from Karachi to Greenwich, *Dehra Dun, 1901), (Bomford, Major G.,* Survey of India Professional Paper No. 28; The Readjustment of the Indian Triangulation, *Dehra Dun, 1939*). The origin was Kalianpur Hill Station as defined in 1900 where: Φ_o = 24° 07' 11.26"N, Λ_o = 77° 39' 17.57"E, α_o = 190° 27' 05.10" to Surantal from south, H_o = 1,765 feet, Everest 1830 ellipsoid.

"INDIAN 1937. Brigadier (then Major) Guy Bomford re-adjusted the geodetic triangulation adding in approximately 17 important new series, seven new base lines, recomputed values for the original 10 base lines, and including about 43 Laplace stations. The origin remains the same. As far as is known, no products have been produced on this system (*Bomford, Major G.,* Survey of India Professional Paper No. 28; The Readjustment of the Indian Triangulation, *Dehra Dun, 1939*).

"INDIAN 1954 (Thailand). In 1954, the triangulation was adjusted by the U. S. Coast and Geodetic Survey (USC&GS) for the Army Map Service. Positions were computed in terms of the Indian 1916 adjustment based on 10 stations along the Burma border. The defining parameters of the Indian 1916 Datum were retained.

"INDIAN 1960. The triangulation of Cambodia and Vietnam was adjusted to Indian Datum in 1960 holding fixed two Cambodian stations connected to the Thailand triangulation adjusted by the USC&GS in 1954 (INDIAN 1954). In turn, the primary triangulation of Laos was adjusted holding fixed four stations from the Cambodia Vietnam adjustment. North Vietnam was also adjusted to this system but with lower standards.

"INDIAN 1975. This is an adjustment of the primary network of South Burma and Thailand available to DMATC in 1975. Nine Doppler satellite positions were incorporated into this adjustment. Also included were 10 Geodimeter lengths, 4 Invar lengths, and 22 Laplace azimuths (*Geodetic Memorandum No. 1692,* 1975 Adjustment of the Primary Triangulation of Thailand *by J. W. Walker, Washington, June 1976*). Datum Origin: Khao Sakaerang where: Φ_o = 15° 22' 56.0487"N, Λ_o = 100° 00' 59.1906"E, Geoid Height = –20.46 meters, Everest 1830 ellipsoid. This is Doppler Station 10084." Note that for the Everest 1830 ellipsoid, a = 6,377,276.345 m, $^1/_f$ = 300.8017.

An earlier local datum origin west of Bangkok was "Khao Luang (1878-81) at Khao Luang Hill where Φ_o = 13° 43' 30.34"N, Λ_o = 99° 32' 22.94"E, α_o = 270° 15' 21.4" from Khao Luang to Khao Khieo, or α_o = 179° 44' 34.308" ±0.168" from Khao Ngem to Khao Ngu (1910), H_o = 1,382 feet, Everest 1830 ellipsoid. An alternate spelling (transliteration) is Khao Hluang. (*This is also known as Rājburi Datum, the name being derived from the triangulation baseline – Ed.*) This was found in a Thai book (or booklet) 1918-19 and from an Indian Publication published in 1947"(*ibid, Hager*). There are several pages of discussion on this old datum in *Survey Review, by A.G. Bazley, October 1938, No.30, Vol. IV, pp.450–457.*

The current UTM coordinates are still referenced to Indian Datum 1975, using Everest ellipsoid, which was the national geodetic datum then and so adopted by Department of Lands when the department migrated from the Cassini-Soldner system. The shift parameters from Indian 1975 to WGS84 have been derived many times. The current ones are: ΔX = +204.4 m, ΔY = +837.7 m, ΔZ = +294.7 m (*Prof. Itthi Trisirisatayawong, Chulalongkorn University – personal communication, November 2010*). "It should be noted that there is no rotation and scale factor change. The latest national reference frame for the zero and first order geodetic network is tied to ITRF2005 using the GPS data observed in Nov. 2008 campaign" (*Prof. Chalermchon Satirapod, Chulalongkorn University – personal communication, November 2010*).

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