Grids & Datums

Malaysia

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The south Malay peninsula, Sumatra, central Java, and east Borneo has been settled from *circa* 1st century *B.C.* by Hindu Pallavas from southeast India. In the early 15th century the Malay states came under Chinese influence but later Muslim traders gained ascendency in several states such as Malaka. After the early 16th century Malaya was dominated by the Portuguese who were succeeded by the British (*Merriam-Webster's Geographical Dictionary* 3rd Ed., 1997). Set up as the Union of Malaya in 1946, later formed the Federation of Malaya which became independent in 1957. Malaysia was formed in 1963 when the former British colonies of Singapore and the East Malaysian states of Sabah and Sarawak on the northern coast of Borneo joined the Federation. Singapore (*PE&RS*, January 2006), seceded from the Federation in 1965. Bordered by Thailand (506 km), Brunei (381 km), and Indonesia (1,782 km), Malaysia is slightly larger than New Mexico and has a coastline totaling 4,675 km, Peninsular Malaysia (2,068 km) and East Malaysia (2,607 km). The lowest point is the Indian Ocean (0 m), and the highest point is Gunung Kinabalu (4,100 m) (*The 2008 World Factbook*).

"The Survey Department, Federated Malay States and Straits Settlements (*FMS&SS*) accomplished most of the basic surveying and mapping of Malaya between 1923 and 1945. Topographic sheets for most of the country were based on planetable surveys at 1:31,680 and 1:63,360 (*2 inches to a mile and 1 inch to a mile scales – Ed.*); for areas on the east coast, however, the sheets were based on sketch and reconnaissance surveys and poor planetable work. Numerous city plans, small-scale maps, and planimetric state maps also were produced. Most of the work done by this agency has been superseded or revised by World War II mapping" (*TM 5-248, Foreign Maps 1963*).

"The first attempt at triangulation survey was made in Penang in 1832 by Lieutenant Woore of the British Royal Navy. About 1880, the governor of the Straits Settlements, Sir Frederick Weld conceived the idea of introducing the Torrens System of registration of land titles into the Straits Settlements. Accordingly in 1882, he commissioned Sir W. E. Maxwell, who was at the time the Commissioner of Lands in the Straits Settlements to go to Australia to report on the suitability of the Torrens Act. Passed by the South Australian Legislature in 1858 with a view to its introduction in the Straits Settlements. Maxwell returned an enthusiastic supporter of the system and brought in legislation to effect its introduction. Bitter opposition to his proposals was aroused and lengthy arguments ensued. Eventually it was the Malay States that took the initiative to introduce a modified Torrens System. Maxwell realized that the Torrens System could not be operated successfully unless it was based and maintained on a survey sufficiently accurate to permit the re-identification of property boundaries. Arising from this need, the various States began to organize and form their own Survey Departments. The history of the Department of Survey and Mapping is therefore the history of these various State Survey Departments and their gradual amalgamation into a Federal organization as it is today. In 1885, the Johore Survey Department began under Dato Yahya Bin Awal-ed-din as Chief Surveyor, trained as a surveyor by Major McCallum in Singapore in 1868. Also in 1885, H.G. Deanne, a contract surveyor from Ceylon was appointed by the Public Works Department, Perak, to carry out the trigonometrical survey of Perak. He measured the 4.6 mile Larut baseline and carried out astronomical determinations for latitude and azimuth near Taiping. This trignometrical survey in Perak together with the Penang and Province Wellesley triangulations and Malacca Triangulation (1886-1888), laid the foundation of the existing control framework. … by the end of 1901, the major triangulation of Perak and Selangor had been completed and work had been in progress in Negeri Sembilan since 1899. This period also witnessed the commencement of trigonometrical surveys in various parts of the country."

The two earliest datums extant in Malaysia were the Perak System and the Bukit Asa System, both referenced to the Everest 1830 ellipsoid. However, the quality of the early works were so inconsistent that it was decided to re-observe the principal triangles of the general triangulation with the object of bringing the work up to modern standards. This triangulation scheme in Peninsular Malaysia was known as the Primary or Repsold Triangulation which was completed in 1916. The datum origin is at Kertau, where astronomical latitude and azimuth were determined. The longitude of the datum is derived from the value Λ_o = 100° 20' 44.4" E. for Fort Cornwallis Flagstaff, Penang, obtained by Commander M. Field in 1893 by the exchange of telegraphic signals at Singapore, Old Transit Circle. The longitude accepted for Singapore was that fixed in 1881 by Lt. Commander Green with respect to the Transit circle of Madras Observatory, the corresponding longitude of the later being taken as Λ_o = 80° 14' 51.51" E. (*Geographical Positions in Malaya and Siam, A. G. Bazley, Empire Survey Review No. 30, pp. 450-457*). At that time, there were two Grids used for Peninsular Malaysia, the Malay Cassini-Soldner Grid and the Johore Cassini-Soldner Grid, both referenced to the Indian Datum of 1916, the ellipsoid of revolution was the Everest 1830 where: a = 6,974,310 Indian Yards and $^1/_f$ = 300.80. The Malay Grid projection origin was φ_o = 4° 00' N, λ_o = 102° E, Scale Factor at Origin (m_o) = 1.0, False Easting = 500,000 yards, and False Northing = 300,000 yards. The Johore Grid projection origin was φ_o = 2° 02' 33.30" N, λ_o = 103° 33' 45.93" E, Scale Factor at Origin (m_o) = 1.0, False Easting = 450,000 yards, and False Northing = 300,000 yards (*Personal communication, DMATC Form 5000-1, 6 December 1974*). In 1948, it was replaced by a new system known as the Malayan Revised Triangulation (MRT). This was followed by a lengthy process of additional measurements and re-computation until 1968. As a result, this system is then referred to as MRT68. On the other hand, the geodetic network used in Borneo is called the Borneo Triangulation (BT68).

The Malayan Revised Triangulation has been used for geodetic, mapping, cadastral and several other activities since 1948 in Peninsular Malaysia. This network consists of 77 geodetic, 240 primary, 837 secondary and 51 tertiary stations. This network is based on the conventional observations with many of the triangulation points are

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dated as far back as 1885. The MRT 1948 has been adopted as a result of the re-computations of the earlier network together with the Primary (Repsold) Triangulation carried out between 1913 and 1916. The reference ellipsoid used for the MRT 1948 is the Modified Everest where a = 6,377,304.063 m and $^1/_f$ = 300.8017, and the MRT 1948 datum origin is *also* at Kertau, Pahang where: Φ_o = 03° 27' 50.71" North, Λ_o = 102° 37' 24.55" East of Greenwich. The map projection for Peninsular Malaysia is the Rectified Skew Orthomorphic (RSO) developed by the late Brigadier Martin Hotine specifically for Malaysia and Borneo. The Hotine RSO defining parameters for MRT 1948 consist of: Conversion Factor (1 chain = 20.11678249 m *from Chaney & Benoit, 1896*), projection origin φ_o = 4° 00' N, λ_o = 102° 15' E, Scale Factor at Origin (m_o) = 0.99984, basic or initial line of projection passes through the Skew Origin at an azimuth of (γ_o) = $-Sin^{-1}$ (– 0.6) or 323° 01' 32.8458", False Easting = 804,671 m, False Northing = zero. The Bursa-Wolf transformation from WGS84 to MRT48 (Kertau) listed by (*Aziz, W., Sahrum, M., and Teng, C., in Cadastral Reform in Malaysia: A vision to the 2000s*) is as follows: ΔX = +379.776 m, ΔY = –775.384 m, ΔZ = +86.609m, scale = not given, R_X = +2.59674", R_Y = +2.10213", R_Z = –12.11377" (*Note that the rotations as published are the left-handed convention favored by most Europeans and are opposite the convention used by the U.S. and Australian militaries – Ed.*) According to *TR 8350.2*, the transformation parameters **from** "Kertau 1948 Datum" **to** WGS 84 Datum are: ΔX = –11 m ±10 m, ΔY = +851 m ±8 m, ΔZ = +5m ±6 m, and the solution is based on 6 satellite stations. (*Notice the whopping magnitude of the ΔY component … likely the result of errors in time transfers to determine longitudes. – Ed.*)

The Geodetic Datum of Malaysia 2000 (GDM 2000) has re-defined the Cassini-Soldner (cadastral) Grid origins of the various states of Peninsular Malaysia as follows: Johor State is @ GPS Station GP58, Institut Haiwan Kluang where: φ_o = 02° 07' 18.04708" N, λ_o = 103° 25' 40.57045" E, Cassini Northing = +8,758.320 m, Cassini Easting = –14,810.562 m, Offset Northing = +8,758.320 m, Offset Easting = –14,810.562 m. North Sembilan & Melaka State is @ GPS Station GP10, K. Perindustrian Senawang, Seremban where: φ_o = 02° 40' 56.45149" N, λ_o = 101° 58' 29.65815" E, Cassini Northing = –4,240.573 m, Cassini Easting = +3,673.785 m, Offset Northing = –3,292.026 m, Offset Easting = +3,915.790 m. Pahang State is @ GPS Station GP31, Sek. Ren. Keb. Kuala Mai, Jerantut where: φ_o = 03° 46' 09.79712" N, λ_o = 102° 22' 05.87634" E, Cassini Northing = +6.485.858 m, Cassini Easting = –7,368.228 m, Offset Northing = +6.485.858 m, Offset Easting = –7,368.228 m. Selangor State is @ GPS Station 251D, Felda Soeharto, K. Kubu Baharu where: φ_o = 03° 41' 04.73658" N, λ_o = 101° 23' 20.78849" E, Cassini Northing = +56,464.049 m, Cassini Easting = –34,836.161 m, Offset Northing = +503.095 m, Offset Easting = –13,076.704 m. Terenggaru State is @ GPS Station P253, Kg. Matang, Hulu Terenganu where: φ_o = 04° 58' 34.62672" N, λ_o = 103° 04' 12.99225" E, Cassini Northing = +3,371.895 m, Cassini Easting = +19,594.245 m, Offset Northing = +3,371.895 m, Offset Easting = +19,594.245 m. P. Pinang & S. Pereai State @ GPS Station P314, TLDM Georgetown where: φ_o = 05° 25' 17.46315" N, λ_o = 100° 20' 39.75707" E, Cassini Northing = +62.283 m, Cassini Easting = –23.414 m, Offset Northing = +62.283 m, Offset Easting = –23.414 m. Kedah & Perlis State is @ GPS Station TG35, Gunung Perak, Kuala Muda where: φ_o = 05° 57' 52.82177" N, λ_o = 100° 38' 10.93600" E, Cassini Northing = 0 m, Cassini Easting = 0 m, Offset Northing = 0 m, Offset Easting = 0 m. Perak State is @ GPS Station TG26, Gunung Larut Hiijau, Taiping where: φ_o = 04° 51' 32.62688" N, λ_o = 100° 48' 55.47811" E, Cassini Northing = +133,454.779 m, Cassini Easting = –1.769 m, Offset Northing = +0.994 m, Offset Easting = –1.769 m. Finally, for Kelantan State is @ GPS Station P243, B. Polis Melor, Kota Bharu where: φ_o = 05° 58' 21.15717" N, λ_o = 102° 17' 42.87001" E, Cassini Northing = +8,739.894 m, Cassini Easting = +13,227.851 m, Offset Northing = +8,739.894 m, Offset Easting = +13,227.851 m. The new GDM2000 RSO for Peninsula Malaysia retains the exact same parameters as for MRT 48 except for the basic or initial line of projection that passes through the Skew Origin at an azimuth of (γ_o) = $-Sin^{-1}$ (– 0.6) or 323° 01' 32.86728", and the fact that the new ellipsoid of revolution is the GRS 80 where a = 6,378, 137 m and $^1/_f$ = 298.2572221.

The Borneo Triangulation network in Sabah and Sarawak consists of the Borneo West Coast Triangulation of Brunei and Sabah (1930-1942), and was established with the origin at Bukit Timbalai, Labuan Island in 1948 where: Φ_o = 05° 17' 03.55" North, Λ_o = 115° 10' 56.41" East of Greenwich. The reference ellipsoid used for the BT 1948 is the (*other*) Modified Everest where a = 6,377,298.556 m and $^1/_f$ = 300.8017. The BT68 results from the readjustment of the primary control of East Malaysia (Sabah, Sarawak plus Brunei) made by the Directorate of Overseas Surveys, United Kingdom (DOS), and the old Borneo West Coast Triangulation of Brunei and Sabah (1930-1942), the Borneo East Coast Triangulation of Sarawak and extension of the West Coast Triangulation in Sabah (1955-1960), and some new points surveyed between 1961 and 1968. The Hotine RSO defining parameters for BT 1948 and for BT68 consist of: Conversion Factor (1 chain = 20.11676512 m *from Sears, Jolly, & Johnson, 1927*), projection origin φ_o = 4° 00' N, λ_o = 115° 00' E, Scale Factor at Origin (m_o) = 0.99984, basic or initial line of projection passes through the Skew Origin at an azimuth of (γ_o) = Sin^{-1}(0.8) or 53° 19' 56.9537", False Easting = False Northing = zero. The new GDM2000 RSO for Borneo retains the exact same parameters as for BT 1948 and BT 68 except for the basic or initial line of projection that passes through the Skew Origin at an azimuth of (γ_o) = $-Sin^{-1}$ (– 0.8) or 53° 18' 56.91582", and the fact that the new ellipsoid of revolution is the GRS 80. According to *TR 8350.2*, the transformation parameters **from** "Timbalai 1948 Datum" **to** WGS 84 Datum (Sarawak and Sabah) are: ΔX = –679 m ±10 m, ΔY = +669 m ±10 m, ΔZ = –48m ±12 m, and the solution is based on 8 satellite stations.

Except where otherwise explicitly cited, the historical details and current transformation parameters have been obtained from *A Technical Manual on the Geocentric Datum of Malaysia (GDM2000), Department of Survey and Mapping Malaysia, Kuala Lumpur, August 2003*. Other Malaysian datums known to exist at one time or another include: Blumut, Johore, BS76, East Malaysia, Bukit Panau, Fort Cornwallis Flagstaff, Panang, Gun Hill, Negri Sembilan, Gunung Hijau Larut, Perak, Gunung Gajah Trom, Trengganu, Jesselton, North Borneo, Kuching Survey Origin, Sarawak 1930, Mount Robertson, Perak Kedah, Semporna, Sinyum, Pahang, Timbalai 1936, Timbalai 1938, and Timbalai 1968. Probably most of these "datums" were temporarily used for local cadastres as a result of triangulation chains observed within individual Malaysian States before comprehensive datum adjustments could be performed. The remainder were likely used for local hydrographic harbor surveys.