Grids & Datums

Kingdom of Lesotho

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

"People described as Sotho have lived in Southern Africa since at least the 10th century *AD*, moving throughout the high veldt of the region. By the 16th century, the Sotho people had arrived in the area known now as Lesotho, marrying and intermingling with the Khoisan people, and forming small chiefdoms. Extensive trade links were established between the groups, as well as with outside people. Grain and hides, for example, were traded for iron from the Transvaal area.

"By the early 19th century white traders were on the scene, exchanging their ever-reliable beads for cattle. In came the Voortrekkers (Boer pioneers), and suddenly the people of the area, now called Basotholand, had to recognize that constant expansion for 300 years was placing extreme pressure on the environment. At the same time, consolidation and expansion of the Zulu state was causing a chain-reaction of violence throughout southern Africa. Survival by the loosely organized southern Sotho society is attributed to the strong leadership of Moshoeshoe the Great.

"The Basotho emerged as a people around 1820 when Moshoeshoe the Great gathered the tribes scattered by Zulu raids and established a stronghold at Butha-Buthe, and later on the mountain of Thaba-Bosiu, about 30km from what is now Maseru. By 1840 his people numbered about 40,000. Worried by the Boers, Moshoeshoe the Great enlisted British support, but the British were equally worried about Moshoeshoe, and launched an unsuccessful attack on him. When the English left defeated, the Boers pressed their claims to the land, leading to the 1858 Free State-Basotho War (won by Moshoeshoe) and another in 1865 (in which Moshoeshoe lost much of the western lowlands). In 1868, under increasing pressure from the Boers, Moshoeshoe placed the region under the protection of the British government, but as part of the deal, lost even more land to the Boers.

"The British signed over control to the Cape Colony in 1871 - a year after the death of Moshoeshoe the Great - and the new government wasted no time reducing the power of the chiefs. After another war in 1880 the land was again shuttled back to British control. This turned out to be a lucky break for the people of Lesotho. Had they remained part of the Cape Colony, they would have become part of the newly-formed Union of South Africa and, under apartheid, would have become a homeland" (Lonely Planet, 2008).

"The Kingdom of Lesotho is completely surrounded by the Republic of South Africa. Its boundaries run with those of KwaZulu-Natal to the east, Eastern Cape to the south, and the Free State to the north and west. It lies between latitudes 28° and 31° South and longitudes 27° and 30° east. It covers an area of approximately 30,300 km² (*slightly smaller than Maryland – Ed.*), of which about one quarter in the west is lowland country, varying in height above sea level from 1,500 to 1,600 m, the remaining three quarters being highlands, rising to a height of 3,482 m at Thabana-Ntlenyana in the Maluti Range, which forms the eastern boundary with KwaZulu-Natal. The mountain ranges run from north to south and those in the central area, the Maluti, are spurs of the main Drakensberg, which they join in the north, forming a high plateau varying in height from 2,700 to 3,400 m. It is in this area where two of the largest rivers in Southern Africa, the Orange (Senqu) and the Tugela, and tributaries of the Caledon, have their source. This phenomenon has caused Lesotho to be called the 'sponge' of Southern Africa.

"The original Lesotho consisted of the high plains of the Mohokare (Caledon) valley and adjacent areas. Modern Lesotho has lost much of the western part of this land but has gained the high mountain ranges in the east, known as the Maloti. The present boundaries of Lesotho follow in part a series of rivers, the Tele, the Senqu, the Makhaleng and the Mohokare. Between the Makhaleng and Mohokare, the south-western boundary follows a beaconed boundary fence, while between the sources of the Mohokare and Tele, the long eastern and southern boundaries follow a high mountain watershed. This section of the boundary is for much of its distance the Continental Divide between the Atlantic and Indian Oceans, and it is seldom far from dramatic escarpment cliffs which make access to Lesotho on this side extremely difficult.

"The soils in the mountain area are of basaltic origin, and those in the lowlands are derived mainly from the underlying cave sandstone. In the lowlands, the soil has been cropped continuously for upwards of 100 years. Because of the absence of fuel, practically all cattle manure is burnt, so that little or no organic matter is returned to the land. Thus, with increasing population, both human and livestock, excessive demands have been made on the soil which has lost its structure and has become seriously eroded. The soils in the mountains have been brought into cultivation comparatively recently and are rich, but shallow. With uncontrolled grazing, the areas above the arable land, in many places, became denuded of the grass cover, and the rush of surface water caused serious gully erosion on the arable land situated below. Several measures have been, and are being, taken to control this erosion and restore and preserve the grass cover" (Kingdom of Lesotho).

"In the early days of the white settlement of the Cape of South Africa, surveys of land were largely dependent on the isolated efforts of surveyors who established coordinates, each limited to the area covered by a particular survey; so that, with the serious discrepancies arising from the absence of a common measure and a common orientation in contiguous surveys, their correlation for the purpose of compiling even approximately correct maps was a difficult if not impossible task. Eventually, however, after about 1883, part of the Cape Colony and Natal was provided with a skeleton of geodetic survey undertaken by Colonel Sir William Morris – a survey which owed its conception and completion to the energetic and persistent efforts of Sir David Gill. This fundamental triangulation made it possible for the first efforts to be made in these two provinces towards a unification of all survey work, by providing a precise and rigid system of secondary triangulation. The positions of the stations of this triangulation were defined in terms of the geographical coordinates of latitude and longitude, and from these were computed the corresponding rectangular spheroidal coordinates. Their use, however, in precise computations involves an amount of work which private (practicing) surveyors could not be asked to undertake, and therefore, when used in connection with farm (cadastral) survey work, they were regarded as plane coordinates,

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and used as such. Consequently, the spheroidal systems had to be limited within narrow boundaries so that the neglect of the curvature would not impair their value for controlling property surveys. The use of these spheroidal coordinates as though they are plane coordinates is what is commonly called the Cassini-Soldner projection. (The readers will recall that the Cassini-Soldner projection is one of the aphylactics; it is neither equal-area (authalic), nor conformal (orthomorphic) and is a nightmare to use for computing survey adjustments [Hong Kong - *PE&RS*, January 1998] – Ed.)."

"The geodetic frame work of the Cape Colony was completed in 1893, and in the years 1903-1906 was extended through the Orange Free State and Transvaal. The final results of this triangulation were published in the form of geographical and Cassini-Soldner coordinates; but the inherent disadvantages of these Cassini coordinates for purposes of cadastral survey decided the late Dr. van der Sterr to abandon all the existing coordinate systems upon his appointment as Director of Trigonometrical Survey in 1919. He then established a series of parallel systems of conform coordinates in which each system is limited to a width of two degrees of longitude and the several origins of the coordinates are defined by the point of intersection of the Equator with the odd numbered meridians" (Trigonometrical Survey, D. R. Hendrikz, Union of South Africa 1955) .

In December of 1989, Mr. S. Mosisili, chief surveyor for the Lesotho Department of Land, Surveys and Physical Planning sent a letter to me regarding the mapping grid used in Lesotho. Repeated later in a 1995 Hoofdirektoraat:Opmetings en Grondingligting (Chief Directorate: Surveys and Land Information) letter to a protégé of mine, Robert M. Frost, P.L.S., "The coordinate system used in … Lesotho is the Gauss Conform Transverse Mercator projection which uses 2° longitude belts based on all the odd meridians (… 27°, 29°, … etc.). No arbitrary scale factors or false origins are applied to the coordinates: X is measured positive southwards from the equator and Y positive westwards from the nearest odd meridian. The unit of measurement since the 1970s is the international meter. The ellipsoid used in … Lesotho is the Modified Clarke 1880 where a = 6,378,249.145 m, and b = 6,356,514.967 m. This ellipsoid, together with the coordinates of the initial point (*i.e.* origin) of the geodetic survey, define the Cape or South African Datum. The initial point of the Cape Datum is Buffelsfontein near the coastal city of Port Elizabeth. The coordinates of Buffelsfontein are: Φ_o = 33° 59' 32.000" S, Λ_o = 25° 30' 44.622" E, h = 280.1 m."

The seminal paper by J. Rems and Dr. Charles L. Merry in Survey Review, 30, 236 (April 1990) entitled, Datum Transformation Parameters in South Africa goes into exquisite detail of the individual characteristics of each of the geodetic networks of the nations of South Africa. With regard to "(b) Lesotho: It is somewhat meaningless in a country of this small size to determine a full seven-parameter transformation. Even the scale factor is hopelessly correlated with the translations. The only purpose of using more than a simple three-parameter transformation would be to model systematic distortions in the geodetic network. There is little improvement in σ_o in going from a three- to a seven-parameter transformation, so this argument falls away in the case of Lesotho. Again, it appears that the three-parameter model would be adequate for all transformations." Parameters derived by Rems & Merry for Lesotho from Cape Datum to WGS 84 Datum are: ΔX = –136.0m ±0.4m, ΔY = –105.5m ±0.4m, ΔZ = –291.1m ±0.4m. Details on recent developments in research should be directed to Professor Merry at the University of Cape Town.