Republic of Zimbabwe

The republic is populated primarily by the Bantu group of peoples and is divided into two major language groups. The Shona-speaking Mashona constitute 75 percent of the population and the Sindebele-speaking Ndebele constitute about 20 percent of the population. The latter group arrived in the southwest around Bulawayo within the last 150 years and is an offshoot of the South African Zulu. They maintained control over the Mashona until the European occupation in 1890. Stone-age implements have been found in Zimbabwe, and ruins suggest an early civilization. The "Great Zimbabwe" ruins are located near Masvingo, and evidence suggests that it was built between the 9th and 13th centuries by Africans that established trading contacts with commercial centers on the continent's southeastern coast. In 1888, Sir Cecil Rhodes obtained a concession for mineral rights from local chiefs and later the area was proclaimed a British sphere of influence. The British South Africa Company was chartered the following year and Salisbury (now Harare, the capital) was established in 1890. In 1895, the area was formally named Rhodesia in honor of Sir Cecil. The United Kingdom (*PE&RS*, October 2002) annexed Southern Rhodesia from the South Africa Company in 1923. A 1961 constitution was formulated that favored Caucasians in power. In 1965, the government declared Rhodesian independence, but the UK did not recognize the act and demanded more complete voting rights for the black majority in the country. United Nations sanctions and a guerilla uprising finally led to free elections in 1979 and independence as Zimbabwe in 1980. A land redistribution policy in 2000 has caused an exodus of white farmers, it has crippled the economy, and it has caused widespread shortages of basic commodities.

Zimbabwe is slightly larger than Montana, it is landlocked, and it is bordered by Botswana (813 km), South Africa (225 km), Zambia (797 km), and Moçambique (1,231 km), (*PE&RS*, September 1999). The terrain is mostly high plateau with a high veldt with mountains in the east. The lowest point is the junction of the Runde and Save Rivers at 162 m, and the highest point is Mount Inyangani (2,592 m).

In 1901, Alexander Simms completed a chain of quadrilaterals that spanned the west central part of the country. This chain started in the south near Bulawayo with the Inseza Base observed in 1898, it passed through Gwero, through Salisbury (now Harare) with the Gwibi Base observed in 1900, and it terminated in the north about 75 km east of where the Kariba Dam is now located on the Zambezi River**.** The geodetic coordinates of all the stations were referred to the origin point in Salisbury where: Φ_o = 17° 50' 25.440" S and Λ_o = 31° 02' 19.000" E, with an azimuth to Mt. Hampden α_o = 273° 13' 48.456"and were fixed by interchange with the Royal Observatory at the Cape for longitude. After the work was published in 1905 in the *Geodetic Survey of South Africa, Volume iii*, little geodetic work was surveyed in Zimbabwe for about 25 years except by Capt. H.W. Gordon, R.E. (Prof. Charles L. Merry had some difficulty looking up those coordinates for me since his library had misplaced that volume!) Capt. Gordon connected Simms' system to the Transvaal system of South Africa in 1906-7. He was seriously handicapped by having a budget of only £1,600 for the task, but his work was of excellent quality. The Transvaal system had already been completed by Col. W.G. Morris, R.E., in 1905. Capt. Gordon also later ran a short chain westward from Simms' chain at about latitude 17° 10' S to provide control for the Copper Queen mining area in 1928. The Eastern Circuit was started shortly thereafter; it ran from Harare (the capitol) eastward to the border with Moçambique, southward through Mutare to about latitude 20° S and then westward, joining Simms' chain again to the east of Bulawayo. Another short chain was run north from Bulawayo for about 70 km to the Lonely Mine area. In 1936, Gordon's connecting chain with the Transvaal was strengthened and re-observed as well as the new Nuanetsi Series was observed to the east that ran north-south from the Limpopo River to near the Zimbabwe ruins and to Rutenga. The Nuanetsi Series was completed in December 1937.

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The result of Gordon's Connection showed a difference between the Transvaal chain and the Salisbury Datum of –3.503" in latitude, –0.602" in longitude, –8.89" in azimuth at point Standhaus, and a difference of 40 feet in the mean between the vertical heights of the two systems. The work in both Zimbabwe and Zambia suggested that Gordon's connection had introduced a swing of some 9" into the arc, from the northern Transvaal upwards. In 1930 at the Stockholm Conference of the International Union of Geodesy and Geophysics, a resolution was therefore passed recommending an examination of the Transvaal-Zimbabwe connecting chain.

In 1932, an astronomical determination of the azimuth Wedza – Standhaus was made with a Wild T-3 theodolite that gave the astro-geodetic difference in azimuth between the two systems of approximately 4.5". In 1936, J.E.S. Bradford observed a connection series that widened and strengthened Gordon's chain, and all angles were re-observed. Heliographs were employed throughout for the re-observations (by repetition) of this chain except for two points in the Transvaal system. Those exceptions were direction angles observed by F.W.J. de Roes of the South African Trigonometrical Survey. The adjustment of the revised chain was made to the Transvaal system, which was an extension of the South African Cape Datum. The adjusted coordinates of the tie-point Standhaus changed to φ = 20° 21' 54.654" S and λ = 29° 35' 54.631" E, and the azimuth to station Filabusi changed to α = 273° 13' 48.456". The obsolete datum of Southern Rhodesia is now referred to as the "Old Circuit Datum" in Zimbabwe.

In 1944, D.R. Hendrikz of the South African Trigonometrical Survey wrote, "For the computation of the geographical coordinates of the stations of the Geodetic Survey, Sir David Gill adopted the numerical values of the semi-major and semi-minor axes of Clarke's 1880 figure or *a* = 20,926,202 ft and *b* = 20,854,895 ft. At that time this result

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was the most recent determination of the figure of the Earth. But, because the baselines were reduced to S.A.G. *(South African Geodetic – ed.)* feet, the computations were really carried out on a 'Modified Clarke 1880 Spheroid' defined by a = 6,378,249.145 326 int. metre and b = 6,356,514.966 721 int. metre. It may be remarked, in passing, that this value of the flattening for this spheroid is $1/f$ = 293.466 307 656, which differs slightly from the value 293.465 given by Clarke himself." Later in the document, Hendrikz went on to present relations of the "Geodetic Cape rood" = 12.396 S.A.G. feet, and 1 Cape morgen = 600 square Cape roods = 2.116 539 816 acres. Note that the acre was originally the amount of English land that could be plowed in one day, and the morgen was roughly the amount of German land that could be plowed in a morning. Hendrikz stated that 1 Rhynland morgen = 0.634 282 acres!

Thanks to Professor Charles L. Merry of the University of Cape Town, "The ellipsoid is the Clarke 1880, oriented using astronomic observations of latitude, longitude and azimuth at a point near Port Elizabeth in the late 1800s. The offset from the geocentre is about 350m. An unusual feature is that it is the so-called 'modified' Clarke 1880 ellipsoid, because the conversion factor 'yard-to-legal metre' was used to convert Clarke's values to international metres. The legal metre is based upon a defined relationship between the toise and the metre, not a physical standard, and is about 13ppm larger. Nevertheless, the official length standard is the international metre.

"Although local grid systems were common in the 19th and early 20th century, since the 1920s the Transverse Mercator (Gauss-Krüger) system has been exclusively used. It uses 2-degree wide panels, scale factor of unity on the central meridian and no false origin. The co-ordinate axes are directed South and West (no northings and eastings for us southerners!), and are labeled x and y respectively. It is a legal requirement for all cadastral surveys to use this grid system, and the large and medium scale national map series also uses it. The military use the UTM system, overprinted on the standard map sheets (false northing as well as false easting). …Contrary to what DMA *(now NIMA-ed.)* believe, they do not use the Arc datum. The Arc datum is used in parts of East Africa. It is based upon the same initial point near Port Elizabeth and the same ellipsoid (modified Clarke 1880), but uses a single chain of triangulation extracted from the national networks of South Africa, … and Zimbabwe, more or less along the 30th meridian. Close to Port Elizabeth, it is practically identical to the Cape datum, but diverges as one moves away. A GPS network is in place in Zimbabwe and the control networks are being re-adjusted. Although no final decision has been taken, it is likely that Zimbabwe will also convert to the WGS84 around the same time that South Africa does." (Personal communication, July 1997).

In April 1990, Professor Merry and J. Rens published a paper in *Survey Review* that described their solution for datum shift parameters in southern Africa that included Zimbabwe. The astronomic coordinates of the initial point of the Cape Datum near Port Elizabeth are for Buffelsfontein where Φ_o = 33° 59' 32.000" S and Λ_o = 25° 30' 44.622" E. With respect to Zimbabwe, Prof. Merry and Rens wrote, "The situation here is unique. Large rotations are evident and cannot be ignored. However, because of the relatively small size of Zimbabwe, these cannot be considered to represent a true misorientation of the Zimbabwean datum, but probably reflect regional distortions in the geodetic networks. Including the rotations in the transformation model reduces the standard deviation from near four metres to one metre – almost a fourfold reduction. Unlike the case in South Africa there is no significant scale factor. Nevertheless we recommend a full seven-parameter transformation – neglect of the scale factor would cause significant changes in the translation components shown …, due to the high correlation between them." Those parameters recommended are ΔX = –121.7 m ±17.5 m, ΔY = –121.0 m ±18.4 m, ΔZ = –258.5 m ±21.2 m, R_x = +5.377" ± 0.527", R_y = +1.857" ±0.680, R_z = –2.989" ±0.636", and Δs = +0.8 ´ 10^{-6}±2.3. The Hartebeesthoek 94 Datum is the official coordinate system of the Republic of South Africa and presumably also may someday be of the Republic of Zimbabwe.

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