& Grids & Datums

United Arab Emirates

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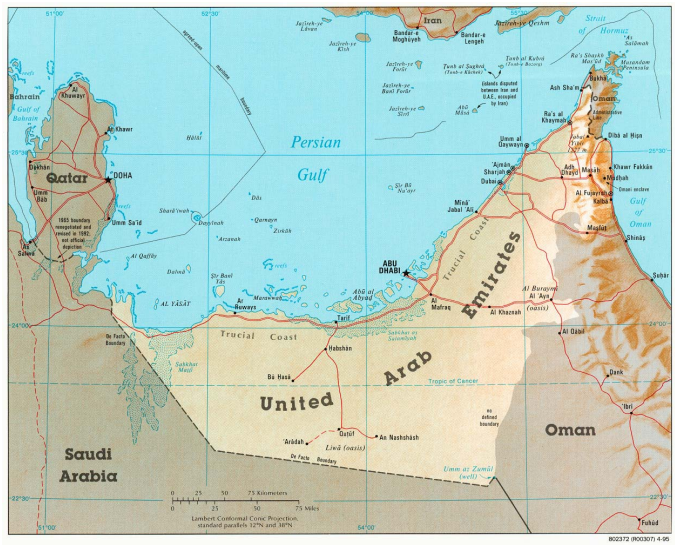
The Grids & Datums column has completed an exploration of every country on the Earth. For those who did not get to enjoy this world tour the first time, *PE&RS* is reprinting prior articles from the column. This month's article on the United Arab Emirates was originally printed in 2001 but contains updates to their coordinate system since then.

Originally settled in the Bronze Age, the Umm an-Nar's culture established itself near modern Abu Dhabi in the 3rd century B.C., and its influence extended to the interior of the Arabian Peninsula as well as along the coast to Oman. Some later settlements by the Greeks have been found, and in the Middle Ages most of the region was part of the Kingdom of Hormuz, which controlled trade in the Arabian Gulf. The Portuguese arrived in 1498 and stayed until 1633 until the British took control of the area. By 1820, the British had destroyed or captured all Qawasim pirate ships, imposed a General Treaty of Peace on nine Arab sheikhdoms in the area, and installed a garrison. The area was known as the Trucial Coast until 1971.

The seven emirates are Abu Dhabi (Abu Zaby), 'Ajman, Dubai (Dubayy), Al Fujayrah, Ra's al Khaymah, Sharjah (Ash Shariqah), and Umm al Qaywayn. The United Arab Emirates (UAE) cover an area slightly smaller than the state of Maine. Much of the interior of the UAE is desert and runs to the edge of the Empty Quarter of Saudi Arabia, the largest sand desert in the world. The northern and eastern sections are mountainous and green while the coastal areas are marked with salt flats.

The first major geodetic datum of the Arabian Gulf area was established by W.E. Browne of the Iraq Petroleum Company in 1927-1931 at the South End Base at station Nahrwan (East of Baghdad) such that: Φ_o = 33° 19′ 10.87″ North, Λ_o = +44° 43′ 25.54″ East of Greenwich, and the Clarke 1880 is the ellipsoid of reference where: a = 6,378,300.782 m, and $^1/_f$ = 293.4663077. The Nahrwan Datum of 1929 is the most prevalent coordinate system of the entire Arabian Gulf area and is still found to this day.

The Sir Bani Yas Island Datum of 1933 was established by the British Royal Navy in 1933 such that: Φ_o = 24° 16′ 44.83″ North, Λ_o = 52° 37′ 17.63″ East of Greenwich, and the Clarke 1880 is the ellipsoid of reference.



The Ajman Datum of 1946 origin is such that: Φ_o = 25° 23' 50.19″ North, Λ_o = 55° 26' 43.95″ East of Greenwich and is referenced to the Helmert 1906 ellipsoid where a = 6,378,200 m, and $^1/_f$ = 298.3. The first Grid was the WWII Trucial Coast/Qatar Grid on the Cassini-Soldner projection. The Central Meridian λ_o = +50° 45' 41″ E, the False Northing Latitude of Origin (φ_{FN}) = 25° 22' 56.5″ N, and both the False Eastings and False Northings are 100 km. Of course, the scale factor at origin by definition is equal to unity.

In 1967, the Directorate of Military Surveys recomputed the Mainland Trucial Coast and Qatar triangulations on the International Ellipsoid, European Datum 1950. Those coordinates were then transformed into Nahrwan Datum 1929. The Trucial Coast Transverse Mercator Grids became preferred to the old Cassini Grid. The Central Meridian λ_o = +55° 00' E, and the False Eastings have had values of 100 km and 1,200 km. The False Northings are –2,000 km as measured from the Equator. The series covered the entire UAE. Topograph-

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ic mapping was compiled in the 1960s by the British Directorate of Military Surveys, and a 1:50,000 scale map series (K763) comprising 155 sheets was completed in 1969.

Limited 1:50,000 mapping was produced in the early 1980s with the assistance of Syria, but coverage of Dubai was based on only four third-order points in the southeast corner of the Emirate. A military survey department was set up by the Emirates and new mapping was published between 1989 and 1991 as 138 orthophoto sheets on the Nahrwan Datum of 1929 with the UTM Grid. A new GPS network was initiated for Dubai in 1991 with a new local Grid. The Dubai Local Transverse Mercator (DLTM) Grid is referenced to the WGS 84 ellipsoid, the Central Meridian λ_o = +55° 20' E, and the False Easting = 500 km. The Northings are presumably measured from the Equator. Analysis of the old network indicated a potential positional error of the old classical control of up to 9 meters horizontal. The First Order Geodetic GPS Network of Dubai is composed of 62 monumented points with distances between points ranging from 5 to 10 km. Of particular interest is that Dubai has completely abandoned the previous classical geodetic work extant in the Emirate. Zero effort was (apparently) made to relate the old to the new! I personally do not agree with this philosophy because I prefer to relate historical records to current and future work. However, I suspect that this unfortunate tack may be chosen from time-to-time for the sake of expediency.

Satellite positioning studies (by others) in the United Arab Emirates derived a set of Datum shift parameters from WGS72 Datum to Nahrwan Datum of 1929 where: ΔX = +225.4 m, ΔY = +158.7 m, ΔZ = +378.9 m, based on observations of 8 stations. I personally would consider the tenths of a meter used in these parameters as very optimistic. Interestingly, NIMA lists the transformation from Nahrwan 1929 to WGS 84 as ΔX = –249 m, ΔY = –156 m, ΔZ = –381 m, ±25 m, based on two stations observed in 1987.

Update

Significant developments have been implemented in the coordinate reference systems for two primary areas of the United Arab Emirates: in Al Ain Region, Abu Dhabi and in Dubai. In Al Ain Municipality, Professor Kamal A. Abdalla of the University of Khartoum, Sudan spent a number of years as a consultant to the region, and in 2005 published a paper that stated,

> *"The local geodetic network adopt(ed) Ras Ghantut datum and (is) based on the modified Clarke 1880 ellipsoid. The local control stations are non-homogeneous, unadjusted and have many limitations in terms of spatial data applications. While the global geodetic network is tied to the ITRF system, containing 33 well-distributed geodetic control stations. The transformation parameters between the global datum and the local datum were computed."* [1]

In the Dubai Municipality Survey Department,[2] a Leica SmartNet™ has been established in order to provide a virtual reference system (VRS) to the emirate.[3] Furthermore, the paper, *An Absolute/Relative Gravity Base Net in the Emirate of Dubai*,[4] details a new fundamental gravity network of nine relative and absolute gravity stations and that "These measurements were the first absolute gravity determinations in the whole South-West Asia."

1 Al Ain Local and Global Spatial Reference Systems, Map Middle East 2005.
2 http://www.m1.ae/DVRS.html.
3 Al Marzooqi, Y., H. Fashir, T. Babiker. *Establishment & Testing of Dubai Virtual Reference System (DVRS) National GPS-RTK Network*. 2009. Geospatial Word. www.geospatialworld.net/article/establishment-testing-of-dubai-virtual-reference-system-dvrs-national-gps-rtk-network/. Accessed 11 January 2019.
4 www.m1.ae/gravity-%20survey%20section.pdf, Accessed 11 January 2019.

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