3. PLANE RECTANGULAR COORDINATE SYSTEMS - *B) HORIZONTAL DATUMS*

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Ellipsoids have varying position and orientations. An ellipsoid is positioned and oriented with respect to the local mean sea level (or Geoid) by adopting a latitude (φ) and longitude (λ) and ellipsoidal height (h) of a so-called fundamental point and an azimuth to an additional point. We say that this defines a local horizontal datum. Notice that the term ***horizontal datum*** and ***geodetic datum*** are being treated as equivalent and interchangeable words. We make a distinction between ***local*** and ***global*** horizontal datums.

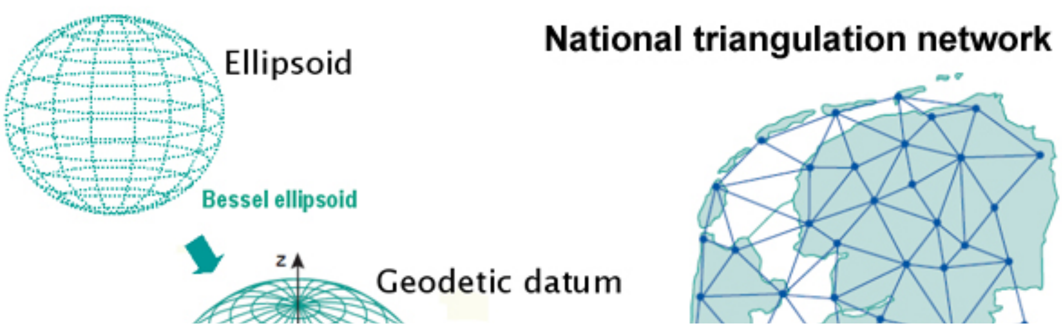
Several hundred local horizontal datums exist in the world. The reason is obvious: Different local ellipsoids with varying position and orientation had to be adopted to best fit the local mean sea level in different countries or regions.

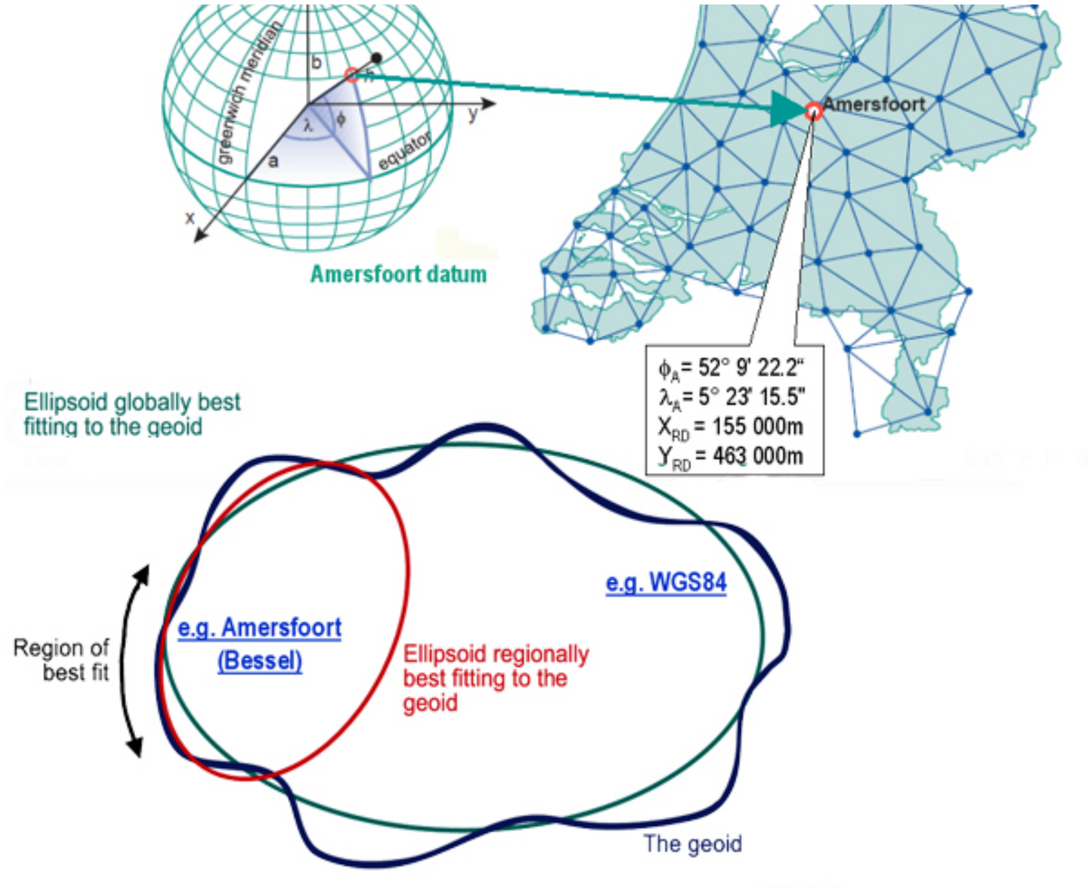
For examples of local horizontal datums with their underlying ellipsoid and difference in position (datum shift) with respect to ***WGS84,*** see image below.

Datum	Ellipsoid	Datum shift (m) (Dx, Dy, Dz)
Alaska (NAD-27)	Clarke 1866	-5, 135, 172
Bahamas (NAD-27)	Clarke 1866	-4, 154, 178
Bermuda 1957	Clarke 1866	-73, 213, 296
Central America (NAD-27)	Clarke 1866	0, 125, 194
Bellevue (IGN)	Hayford	-127, -769, 472
Campo Inchauspe	Hayford	-148, 136, 90
Hong Kong 1963	Hayford	-156, -271, -189
Iran	Hayford	-117, -132, -164

Source: Knippers, 2002

Below, the situation in the Netherlands.





Source: Knippers, 2010

In the above case, the local horizontal datum is realized through a so-called triangulation network (or survey network). Such a network consists of monumented points forming a network of triangular mesh element (figure below). The angles in each triangle are measured in addition to at least one side of a triangle; the fundamental point is also a point in the triangulation network. The angle measurements and the adopted coordinates of the fundamental point are then used to derive geographic (or geodetic) coordinates (φ, λ) for all monumented points of the triangulation network.

Global horizontal datums

With increasing demands for global surveying activities are underway to establish global reference surfaces. The motivation is to make geodetic results mutually comparable and to provide coherent results also to other disciplines like astronomy and geophysics.

The most important global (or geocentric) spatial reference system for the GIS community is the ***International Terrestrial Reference System*** (ITRS). It is a three-dimensional coordinate system with a well-defined origin (the centre of mass of the Earth) and three orthogonal coordinate axes (X,Y,Z). The Z-axis points towards a mean Earth north pole. The X-axis is oriented towards a mean Greenwich meridian and is orthogonal to the Z-axis. The Y-axis completes the righthanded reference coordinate system.

The ITRS is realized through the ***International Terrestrial Reference Frame*** (ITRF), a distributed set of ground control stations that measure their position continuously using GPS.

The trend is to use the ITRF everywhere in the world for reasons of global compatibility. The World Geodetic System of 1984 (WGS84) datum has been refined on several occasions and is now aligned with the ITRF to within a few centimetres worldwide. The Global Positioning System (GPS) uses the WGS84 as its reference system.

Global horizontal datums, such as the ITRF2000 or WGS84, are also called ***geocentric datums*** because they are geocentrically positioned with respect to the centre of mass of the Earth. They became available roughly after the 1960's, with advances in extra-terrestrial positioning techniques.

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