**1.4** **Mapping references**

**Reading material**

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| Now that you know more about GIS, the types and models of data and how to collect them, we will dive into Mapping references.  Our planet is round so we can’t project it on a plane map without deformations. People in the past used different projections and developed different coordinate systems to display data. In this session you will learn more about geographic coordinate system and projections. |
| A **geographic coordinate system (GCS)** is a reference system for identifying locations on the curved surface of the earth. Locations on the earth’s surface are measured in angular units from the centre of the earth relative to two planes: the plane defined by the equator and the plane defined by the prime meridian (which crosses Greenwich England). A location is therefore defined by two values: a latitudinal value and a longitudinal value.    Source : <https://mgimond.github.io/Spatial/chp09_0.html>  A latitude measures the angle from the equatorial plane to the location on the earth’s surface. A longitude measures the angle between the prime meridian plane and the north-south plane that intersects the location of interest. In a GIS system, the North-South and East-West directions are encoded as signs. North and East are assigned a positive (+) sign and South and West are assigned a negative (-) sign |
| In GIS, a GCS is defined by an **Ellipsoid, Geoid and Datum**.   1. **Ellipsoid:** Assuming that the earth is a perfect sphere greatly simplifies mathematical calculations and works well for small-scale maps (maps that show a large area of the earth). However, when working at larger scales, an ellipsoid representation of earth may be desired if accurate measurements are needed. An ellipsoid is defined by two radii: the semi-major axis (the equatorial radius) and the semi-minor axis (the polar radius).      1. **Geoid:** Representing the earth’s true shape, the geoid, as a mathematical model is crucial for a GIS environment. However, the earth’s shape is not a perfectly smooth surface. It has undulations resulting from changes in gravitational pull across its surface. These undulations may not be visible with the naked eye, but they are measurable and can influence locational measurements. Note that we are not including mountains and ocean bottoms in our discussion, instead we are focusing solely on the earth’s gravitational potential which can be best visualized by imagining the earth’s surface completely immersed in water and measuring the distance from the earth’s centre to the water surface over the entire earth surface.     Source: The COMET Program/ESA   1. **Datum:** So how are we to reconcile our need to work with a (simple) mathematical model of the earth’s shape with the undulating nature of the earth’s surface (i.e., its geoid)? The solution is to align the geoid with the ellipsoid (or sphere) representation of the earth and to map the earth’s surface features onto this ellipsoid/sphere. The alignment can be local where the ellipsoid surface is closely fit to the geoid at a particular location on the earth’s surface or geocentric where the ellipsoid is aligned with the centre of the earth. How one chooses to align the ellipsoid to the geoid defines a datum.       Source: The COMET Program/ESA |
| To prepare a map, the earth is first reduced to a globe and then projected onto a flat surface:  The surface of the earth is curved but maps are flat. **A projected coordinate system (PCS)** is a reference system for identifying locations and measuring features on a flat (map) surface. It consists of lines that intersect at right angles, forming a grid. Projected coordinate systems (which are based on Cartesian coordinates) have an origin, an x axis, a y axis, and a linear unit of measure.      Source: [**https://kartoweb.itc.nl/geometrics/Map%20projections/mappro.html**](https://kartoweb.itc.nl/geometrics/Map%20projections/mappro.html)  Going from a GCS to a PCS requires mathematical transformations:    Source: www.mathworks.com  The myriad of projection types can be aggregated into three groups: **planar, cylindrical and conical.**    Source**:** [**https://kartoweb.itc.nl/geometrics/Map%20projections/mappro.html**](https://kartoweb.itc.nl/geometrics/Map%20projections/mappro.html) |
| No place for a flat-Earther’s here!  We know that understanding of how we get from a ball to a plane map is hard. Here is a short video to better understand how different projections works.  Why all world maps are wrong - YouTube  <https://www.youtube.com/watch?v=kIID5FDi2JQ> |

**Exercise materials and tasks**

**Quiz questions**

Instructions: Answer the following five questions to check if you have understood everything so far:

1. What does it mean if you are located at 0° longitude?
2. I am at the Equator.
3. **I am located on the Greenwich line or prime meridian.**
4. I am located nowhere.
5. I am located at the Artic circle.

1. How is a geographic coordinate system defined in a GIS?
2. With Latitude and Longitude
3. With Elipsoid and Geoid
4. **With Elipsoid, Geoid and Datum**

1. Which shape represents the earth’s true shape as a mathematical model is:
2. Spheroid
3. **Geoid**
4. Ellipsoid

1. Which projection is recommended for topographic mapping by the United Nations Cartography Committee?
2. Transverse Mercator (TM) projection
3. **Universal Tranverse Mercator (UTM) projection**
4. WGS84 projection
5. The distortion properties of map are typically classified according to what is not distorted on the map. What is true for equidistant map projection?
6. **the length of particular lines in the map are the same as the length of the original lines on the curved reference surface.**
7. the angles between lines in the map are indentical to the angles between the original lines on the curved reference surface.
8. the areas in the map are identical to the areas on the curved reference surface.