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DEVELOPMENT OF A TRAINING PROGRAM FOR ENHANCING THE USE OF ICT TOOLS IN THE IMPLEMENTATION OF PRECISION AGRICULTURE

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Training package 2

Real Time Positioning practical, services in your area

Tutor instructions

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Note to the teacher: This document contains mainly the same information as the document 'Student guidelines', except for the answers in blue color.

1 Earth shape

Maps are just a model of the world, or a small part of it (Clynch 2002). A model of the earth is needed to convert measurements made on the curved earth to maps or databases. Each model has advantages and disadvantages. Each is usually in error at some level of accuracy. Some of these error are due to the nature of the model, not the measurements used to make the model.

There are three common models of the earth,

- The spherical(or globe) model,
- The ellipsoidalmodel, and
- The real earth model.

The **spherical model** is the form encountered in elementary discussions. It is quite good for some approximations. The world is approximately a sphere. The sphere is the shape that minimizes the potential energy of the gravitational attraction of all the little mass elements for each other. The direction of gravity is toward the center of the earth. This is how we define down. It is the direction that a string takes when a weight is at one end - that is a plumb bob. A spirit level will define the horizontal which is perpendicular to up-down.

The **ellipsoidal model** is a better representation of the earth because the earth rotates. This generates other forces on the mass elements and distorts the shape. The minimum energy form is now an ellipse rotated about the polar axis. This is called an **ellipsoid**. (It is called a spheroid in some books.) The equatorial radius is longer than the polar axis by about 23 km. The direction of gravity does not point to the center of the earth. We still call the direction of a plumb bob down and use it to define coordinates. In the ellipsoidal model the direction of down can be shown to always be perpendicular to the ellipsoid. Thus the ellipsoid must be a surface of constant gravity potential. Fluids don't flow along it due to gravity. Gravity only pulls perpendicular to the ellipsoid. In the real world this will be slightly incorrect.

The **real world** is not homogeneous. There are mass variations such as oceans and mountains. There are also in homogeneities under the surface. These cause not only the mountains but also variations in the gravity field. Thus is the measured down direction is changed. The differences between the ellipsoidal down and the true down are very small. However they change the fundamental surface we use for height measurements. For practical reasons heights are measured from a bumpy surface everywhere perpendicular to the real down. There are many of these. We call the one that represents mean sea level in the open ocean the geoid. This is a surface of constant gravity potential - a level surface. Down is always perpendicular to the local level surface.

2 Positioning

What does it means to determine our "position" on the Earth? (Space Geodesy group) The usual method is to refer to a terrestrial position (i.e., position on the Earth) by its latitude and longitude. Therefore, most GPS receivers will displaying their current latitude and longitude. The usual format for displaying this information is in degrees and minutes. There are 360 degrees in a complete circle, and 60 minutes in one degree. The familiar symbol for "degree" is °. The symbol for minute is ‘. The minutes are usually displayed as a decimal number, like 36.2536’. Both latitude and longitude are angles, and they therefore have to be measured in reference to a well defined 0° line.

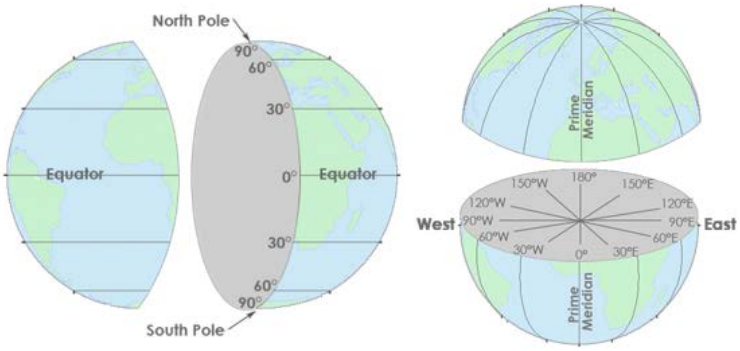
Latitude: North vs. South Hemispheres

The latitude is measured relative to the equator. The equator is latitude 0°, and is neither in the Northern or Southern Hemisphere. If a location is in the Northern Hemisphere, the latitude will be followed or preceded by the letter N. If a location is in the Southern Hemisphere, the latitude will be followed or preceded by the letter S. Sometimes no letter is given, and the latitudes in the Southern Hemisphere will be expressed as a negative number.

Longitude: Measured East vs. Measured West

By historical convention, longitude is measured relative to the "Greenwich" or "Prime" Meridian. ("Meridian" means "line of longitude.") Unlike latitude, we do not express the hemisphere (east or west) of the longitude, but rather the direction towards which the angle of longitude is measured from the Prime Meridian. If we measure an angle east of the Prime Meridian, we write the letter E preceding or following the longitude. If we measure an angle west of the Prime Meridian, we write the letter W preceding or following the longitude. Given the longitude measured one way, we can calculate the longitude measured the other way using the formulas: W = 360 - E and E = 360 - W.

Sometimes, negative values are used to express longitudes measured west. Thus, the following longitude values are all equivalent: W 90°; E 270°; and -90°.



3 Geodesy

Geodesy is the science of accurately measuring and understanding three fundamental properties of the Earth: its geometric shape, its gravity field, and its orientation in space, as well as the changes of these properties with time.

Geodesy supports critical applications across different sectors, provides significant benefits to the nation, and contributes to various coordinated federal activities.

Many sectors rely on accurate geodetic control. These include, but are not limited to, the following:

- Floodplain Mapping relies on accurate heights and supports FEMA, insurance companies, local officials and homeowners.
- Boundary Determination relies on accurate positioning and supports land surveyors as well as GIS analysts and property owners.
- Construction (e.g. roads, dams, airports and ports) relies on accurate positioning too, and supports engineers, pilots, and more.
- Physical sciences rely on accurate geospatial information, whether studying plate tectonics, hydrology, or more.

4 Positioning services of your area

To read more information about the advances and possiblities offered by the geodesy, take a look into this website: https://www.iag-aig.org/services

4.1 Exercise

Answer the following questions about the Real time positioning:

What is EUREF? What it offers?

http://www.epncb.oma.be/

The EUREF Permanent GNSS Network consists of

- A network of continuously operating GNSS (Global Navigation Satellite Systems, such as GPS, GLONASS, Galileo, Beidou, ...) reference stations,
- Data centers providing access to the station data,
- Analysis centers that analyze the GNSS data,
- Product centers or coordinators that generate the EPN products,
- A Central Bureau that is responsible for the daily monitoring and management of the EPN.

What should you do to get the data from any EUREF station? Explain it breafly

1: Download the software → https://igs.bkg.bund.de/ntrip/bnc. (a pdf about how this software works is attached int your learing platform)
2: Chose a station near your area → http://www.epncb.oma.be/_networkdata/data_access/real_time/map.php
3: Complete a user registration to grant you the authorization to access the EPN stations provided by the 3 broadcaster available→ http://www.epncb.oma.be/_networkdata/data_access/real_time/broadcasters.php
4: Acess to the EPN station through this broadcaster using the software

There are more global services like EUREF?

Yes, for example:

The International GNSS Service (IGS) has ensured open access, high-quality GNSS data products since 1994. These products enable access to the definitive global reference frame for scientific, educational, and commercial applications – a tremendous benefit

to the public, and key support element for scientific advancements. - http://www.igs.org/network

Can you find the same service in your country?

Usually each country have a public service:

Spain→ https://www.ign.es/web/en/ign/portal/gds-gnss-tiempo-real

France → http://rgp.ign.fr/

Denmark →https://gst.dk/

5 References

Clynch, James R., 2002, Earth models and maps, Naval Postgraduate Schools. https://www.oc.nps.edu/oc2902w/general/mapmodel.pdf

Space Geodesy group, Harvard – Smithsonian Center for Astrophysics. https://www.cfa.harvard.edu/space_geodesy/ATLAS/gps.html Consulted on May 2020.