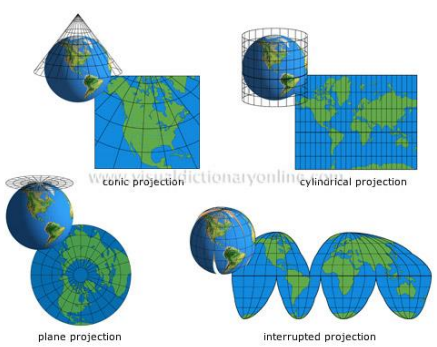
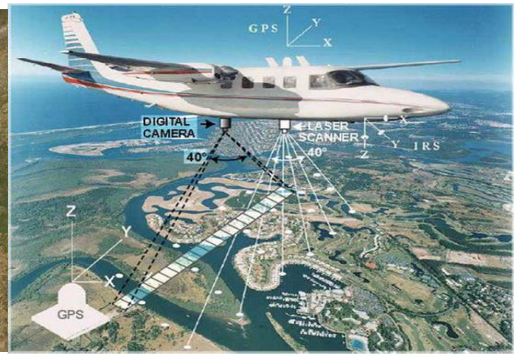
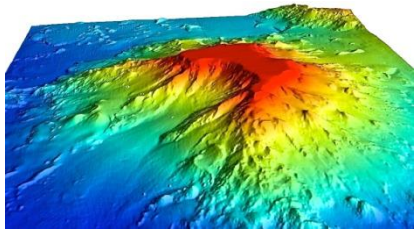
Spatial Information Engineering in Geoscience







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What is the Geodesy

- Geodesy is an origin of mapping and spatial analysis.

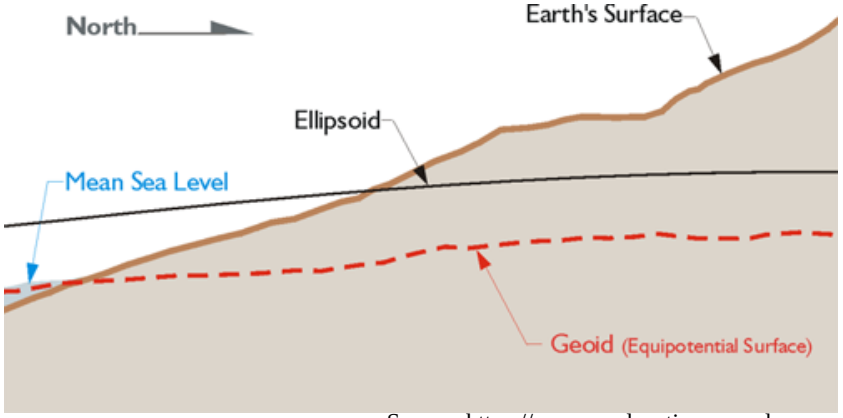
Geodesy is the science of precisely measuring three fundamental mathematical model shapes of the Earth: They are

I. Geometric shape
II. Orientation in space and
III. Gravity field

What is the Geoid

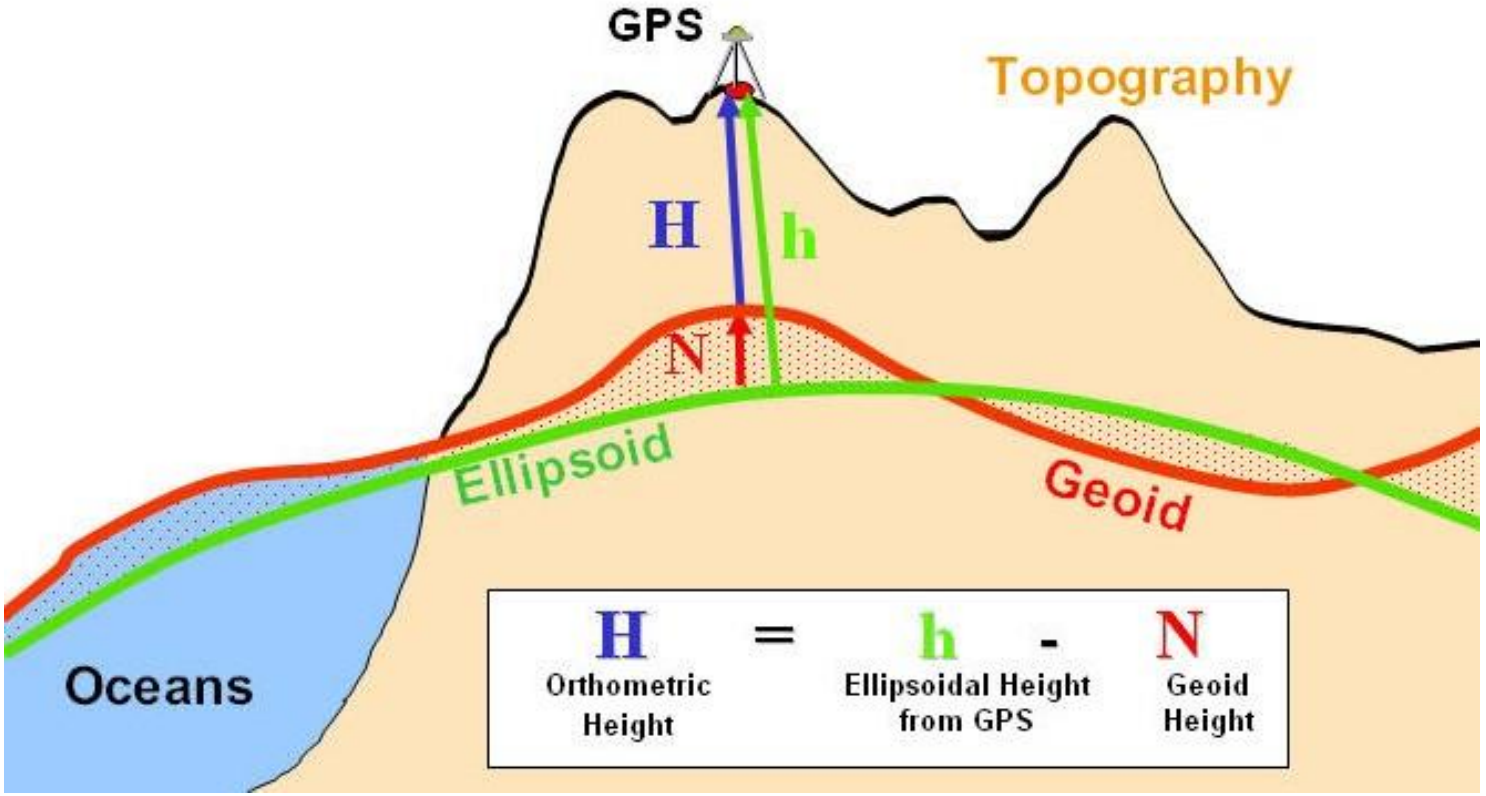
- The Geoid is an equal gravitation surface of the earth.

- The one which is frequently used for the starting point of the map is the equipotential surface that would correspond with mean sea level.



Source: https://www.e-education.psu.edu

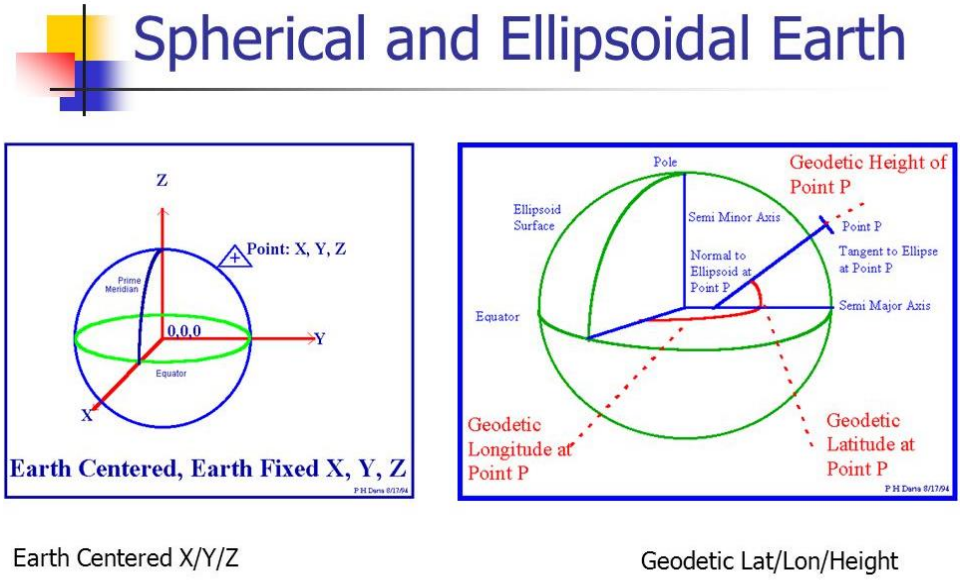
Relationship Between Earth, Geoid and Ellipsoid



Source:https://i.stack.imgur.com

An ellipsoid

- A three-dimensional object.
- An ellipsoid has three independent axes, and is usually specified by the lengths X, Y, Z of the three semi-axes. **(esri.com)**



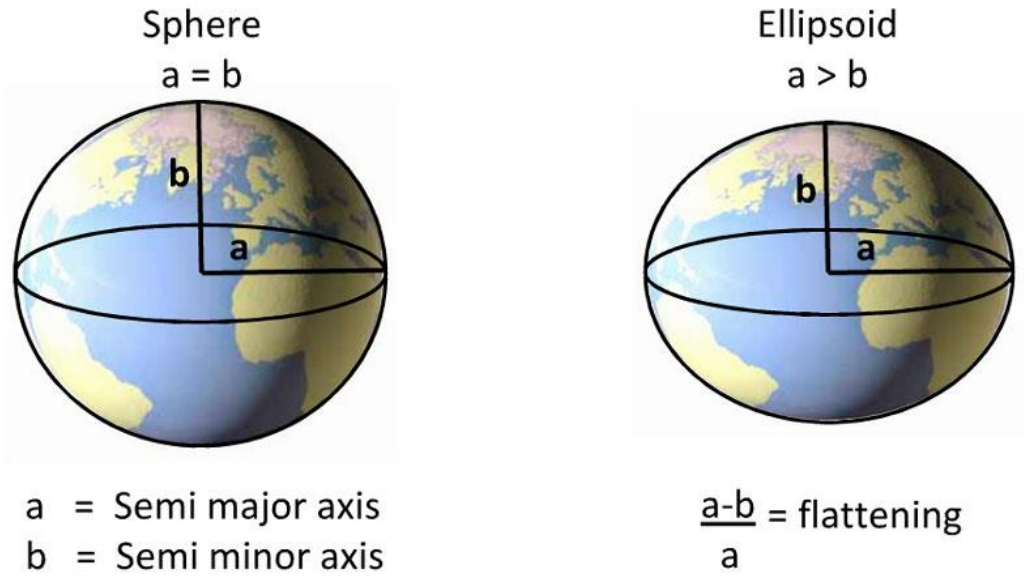
Source :http://slideplayer.com/slide/4678926/15/images/4/Spherical+and+Ellipsoidal+Earth.jpg

- Measurements on an ellipsoid are done in latitude (measure north /South) and longitude (measure east / west) .

For convenience :

- North /South from the equator
- East /West from Greenwich, England

Modeling the Ellipsoid



Source : http://lp360.com/newsletter

- Location shift from datum variation

- **Examples for reference ellipsoid –**

Everest	Bessel
WGS 84	GRS
Australian national	

Map Projections

- Map projections are attempts to represent the surface of the earth or a part of the earth on a flat surface.
- Any projections have distortions -

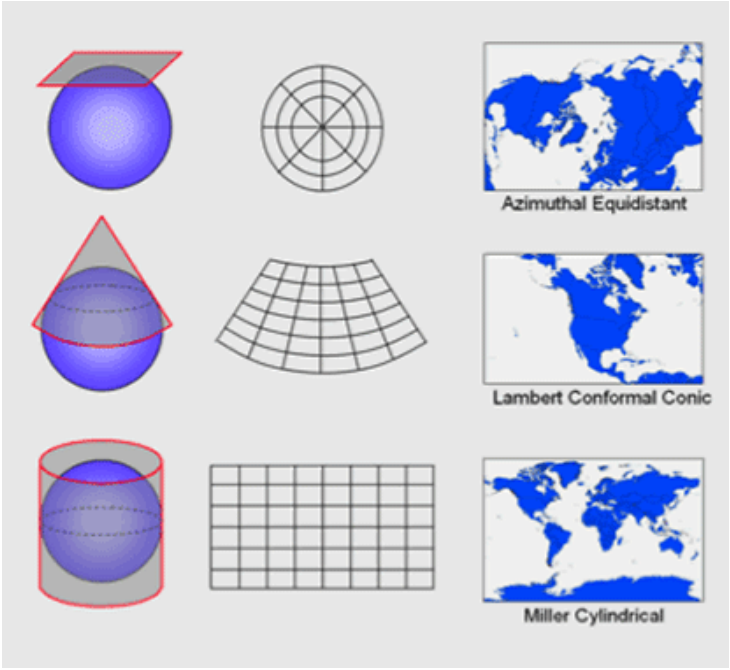
  Some projections distort – shape (angle)

  Some projections distort – distance

  Some projections distort – direction

  Some projections distort – area

Source: http://giscommons.org

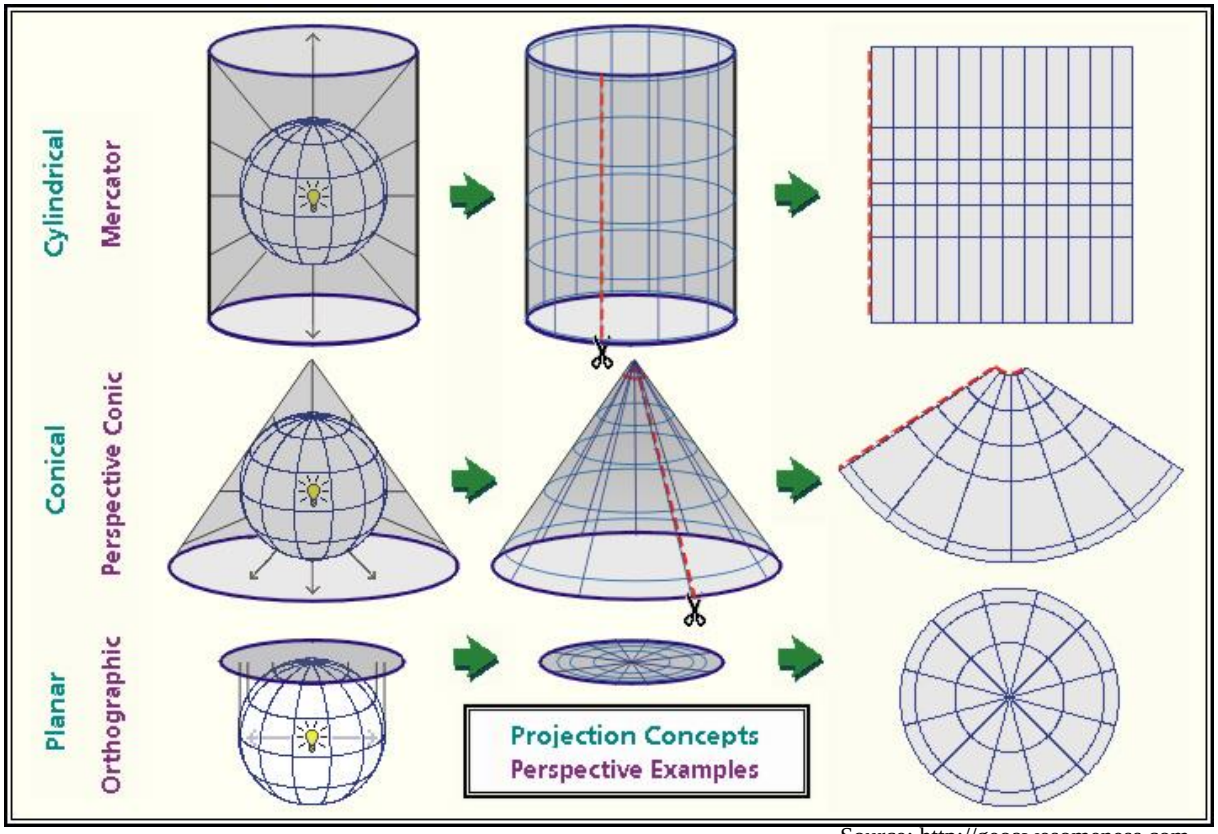


Source: http://giscommons.org

Three Projections to Solid Surface

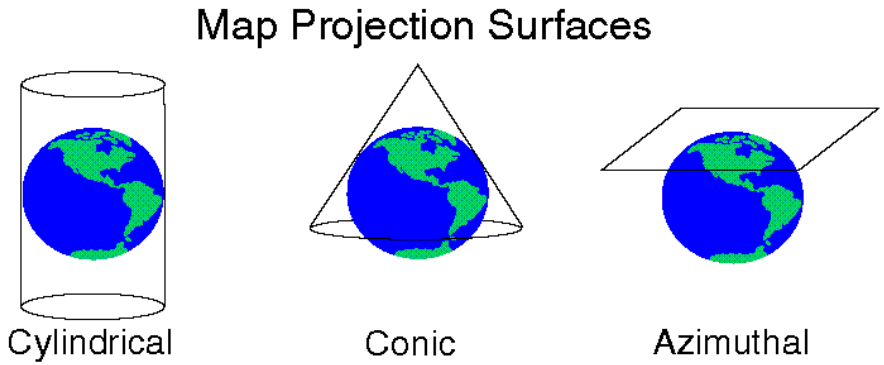
- There are three types of projections that are widely used.
  - Azimuthal projections
  - Cylindrical projections
  - Conical projection

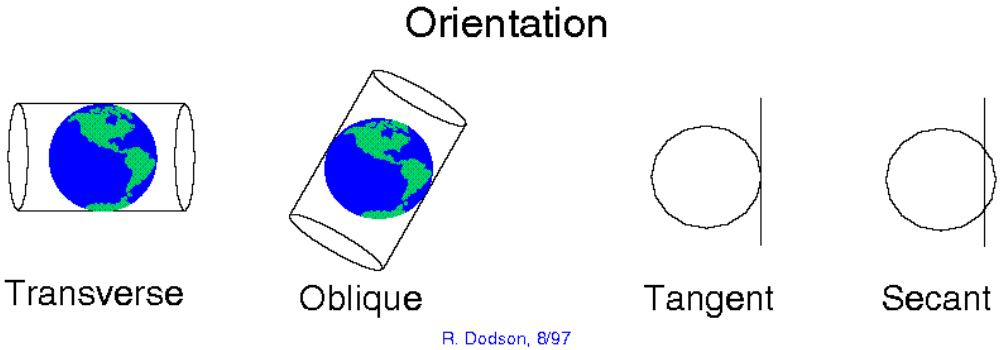
The earth is curved and maps are flat.

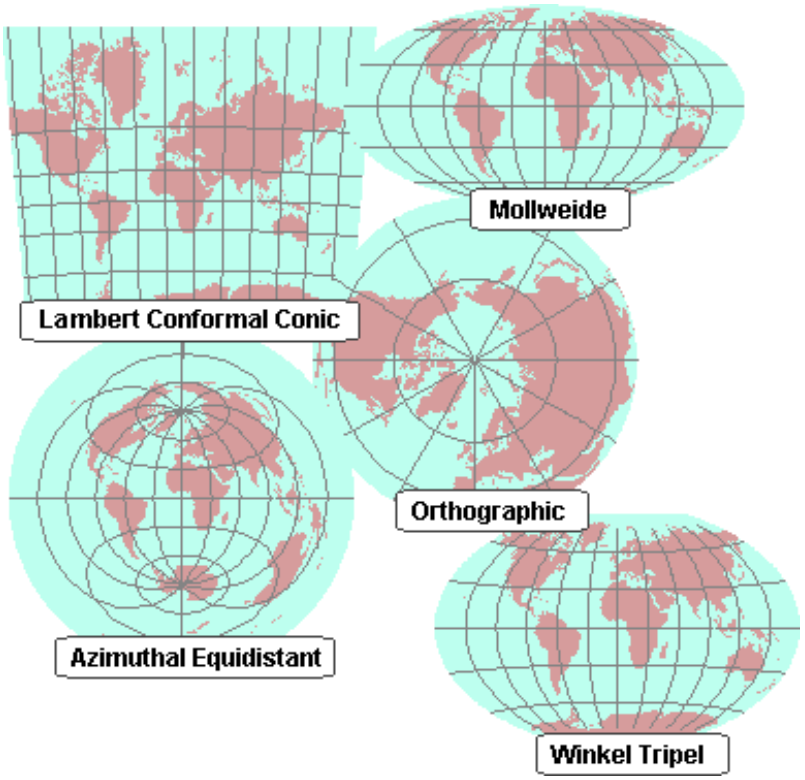


Source: http://geoawesomeness.com

Projections







www.wikipidia .com

Azimuthal projections -

Planar projection surface – Tangent
Secant planar projection…..etc

Conical projections -

Conical projection surface
Secant conical projection ….etc

Cylindrical projections -

Cylindrical projection surface
Oblique cylindrical projection surface
Secant cylindrical projection
Transverse cylindrical projection surface..etc

Some principal projections

1. Conical equal area
2. Polyconic
3. Zenithal orthomophic
4. Mercator***
5. Zenithal equidistant
6. Bonne
7. Simple conical two standard
8. Simple conical
9. Conical orthomophic
10. Zenithal equal area Sinusoidal…etc

Mercator Projection

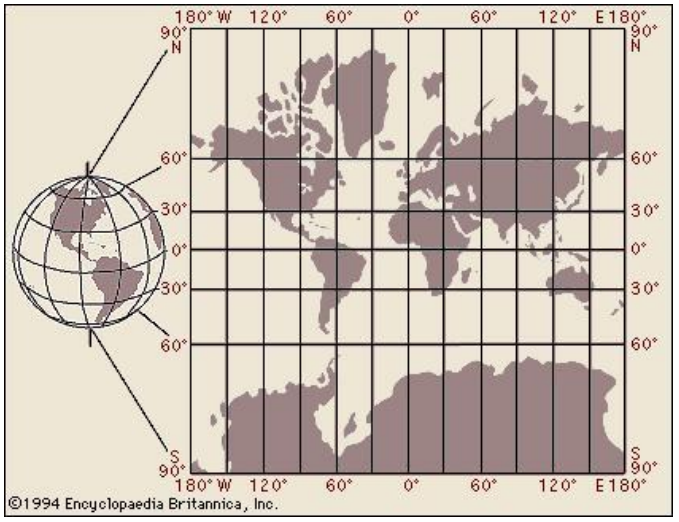
- **Gerardus Mercator** (5 March 1512 –2 December 1594) was a 16th-century German- Flemish cartographer, geographer and cosmographer.

- **Mercator projection,** type of map projection introduced in 1569. It is often described as a cylindrical projection.

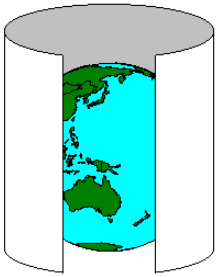
- Most famous map projection.

Gerardus Mercator

Mercator Projection



Source :https://www.britannica.com



Mercator projection

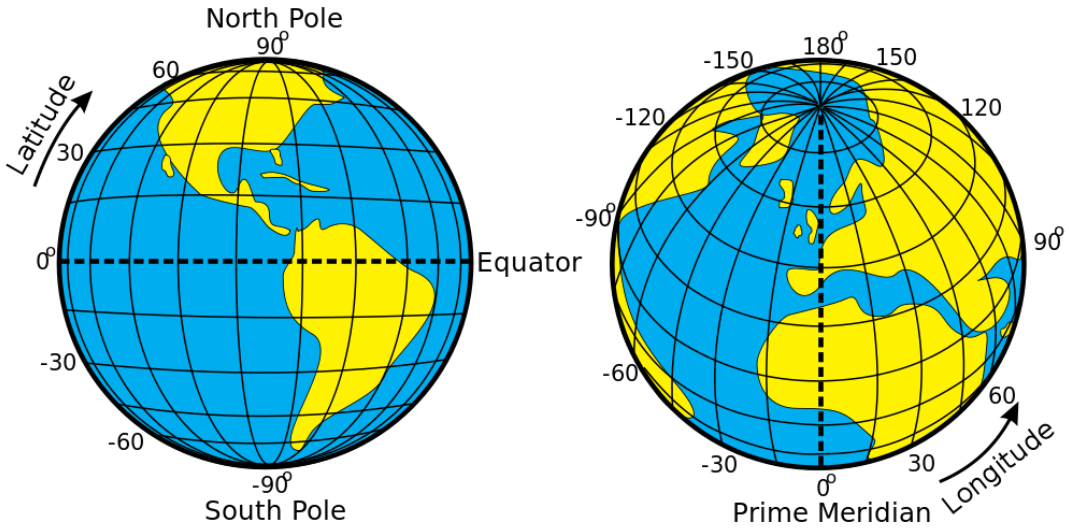
About Projections

- Each map projection has a particular purpose.
- Each projection has both advantages and disadvantages.
- Spherical models are useful for small maps such as world atlases and globes.
- The ellipsoid model is commonly used to create topographic map and other large and medium scale maps.

Coordinate System

- What is the coordinate system

  A way of explaining absolute location, a point location 2-D or 3-D.

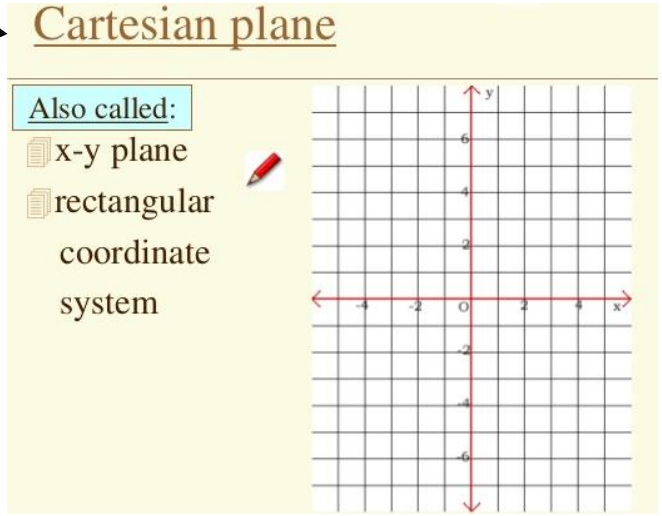


http://www.geographyalltheway.com

Coordinate Systems

- A projected coordinate system such as:

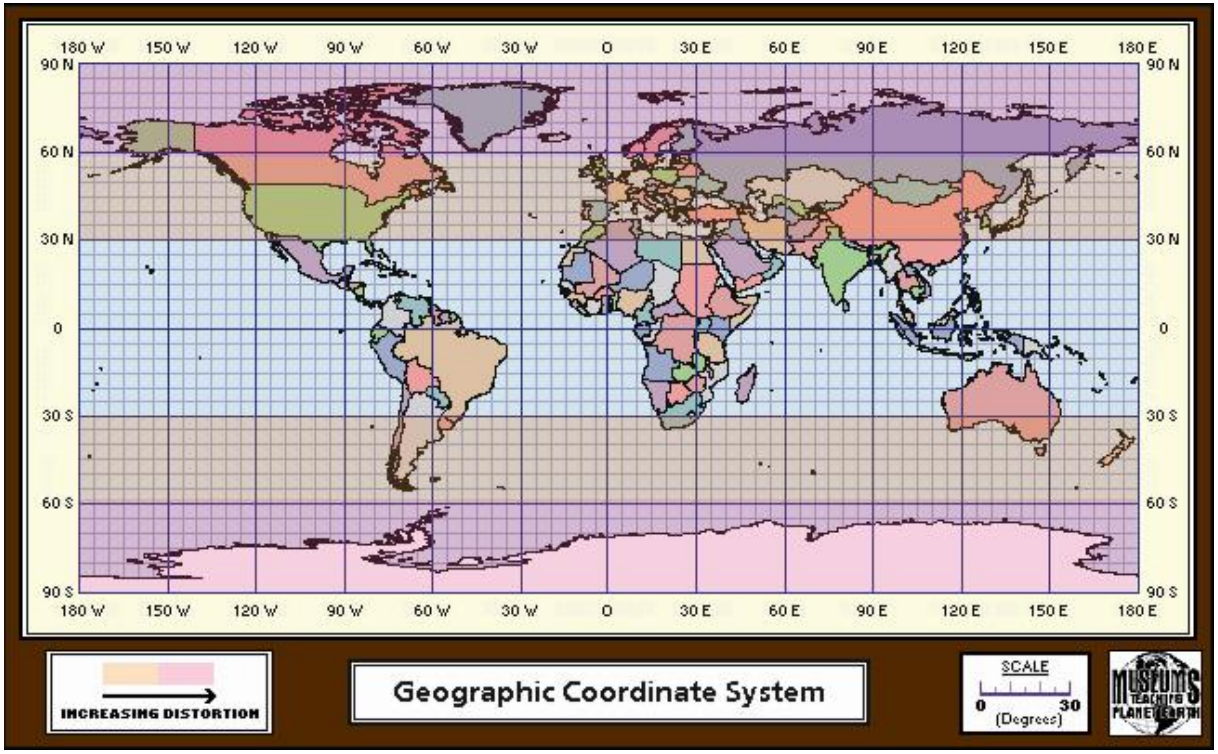
  - Geographic coordinate system (latitude, longitude)
  - Universal Transverse Mercator (UTM)
  - Albers Equal Area or Robinson
  - Cartesian coordinate plane →
  - Military grid
  - National grids ….etc



Source:https://www.slideshare.net

Geographic coordinate system

- Written as degree, minutes, seconds of the earth.



Source:http://earth.rice.edu

Degrees : 360 degrees is the circumference of the earth
Minutes : 60 minutes in the degree
Seconds: 60 seconds in the minutes

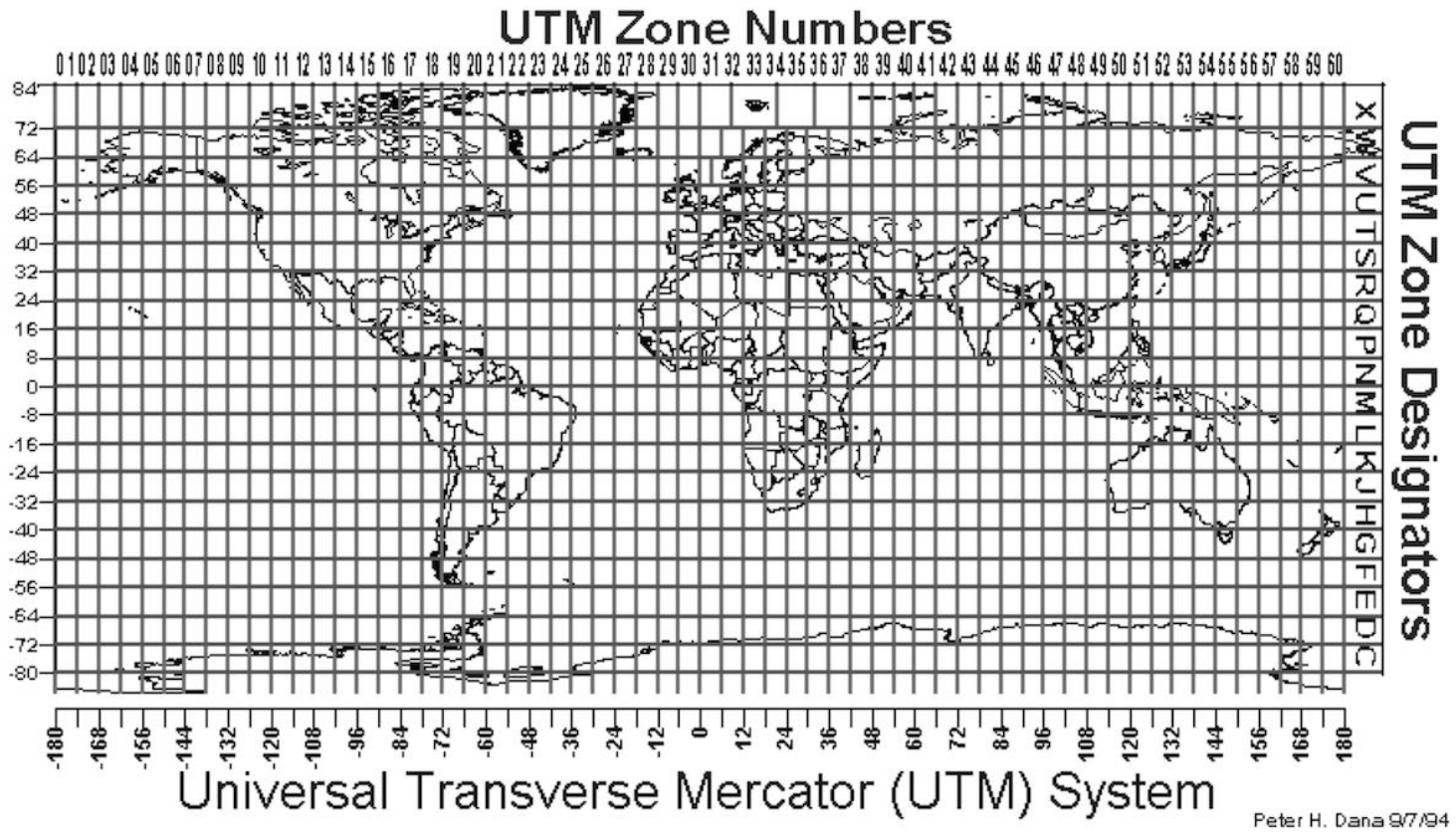
Example: 104^0 40' 00"

Latitude and Longitude

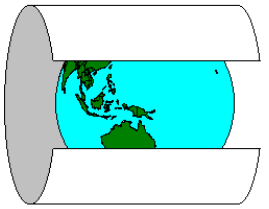
Latitude -
90 degrees South / 90 degrees North from equator

Longitude -
180 degrees West /180 degrees Earth from the Prime meridian at Greenwich

UTM- Universal Transverse Mercator



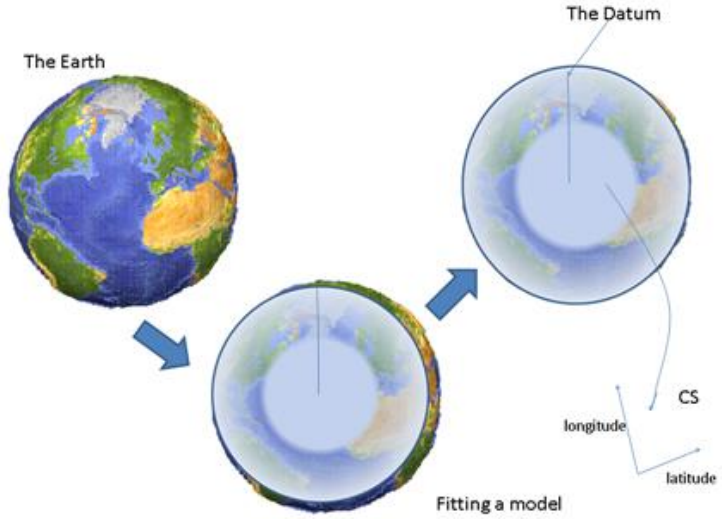
- Could map the whole world with one projection.
- Would be too much distortion.
- Portion the earth 60 zones.
- 6 degrees each in width.
- Each zone has own coordinate system.



Transverse Mercator projection

Map Datum

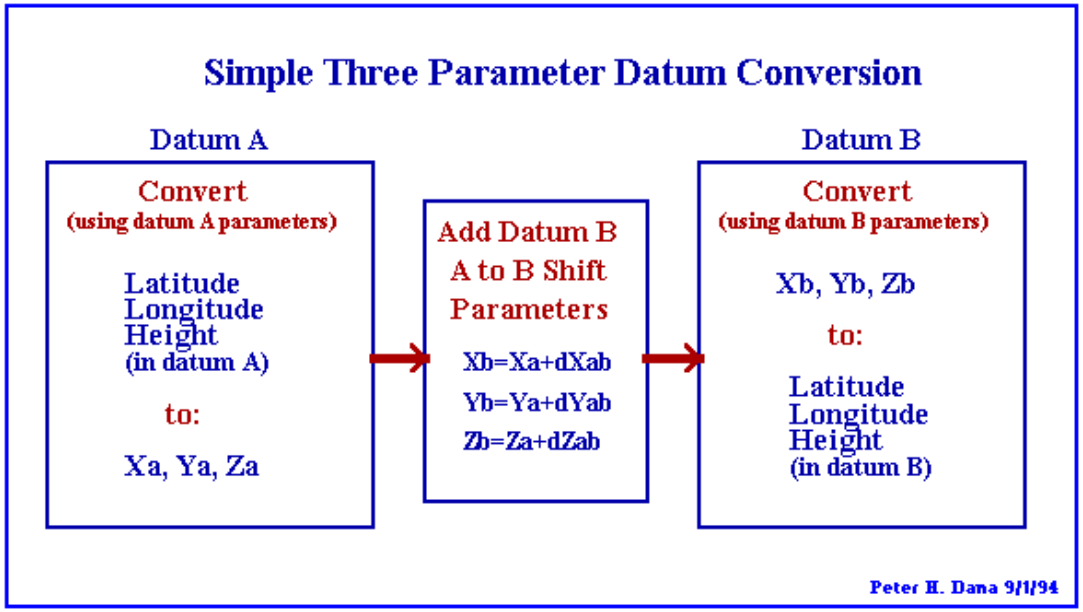
- A datum is selected to give the best possible fit to the true shape of the earth.
- The datum is the shape and size of the ellipsoid.
- WGS 84 was taken on as a world standard.
- The datum consist of a series of numbers.
- Some countries generate their own new datum.
- The latitude and longitude of any particular position are different for different datum.



Source: http://www.galdosinc.com

Why are datum significant?

- All coordinates are referenced to a particular datum.
- GIS layers must have the datum exact to overlay accurately.
- For GPS data must be sure to choose correct datum.

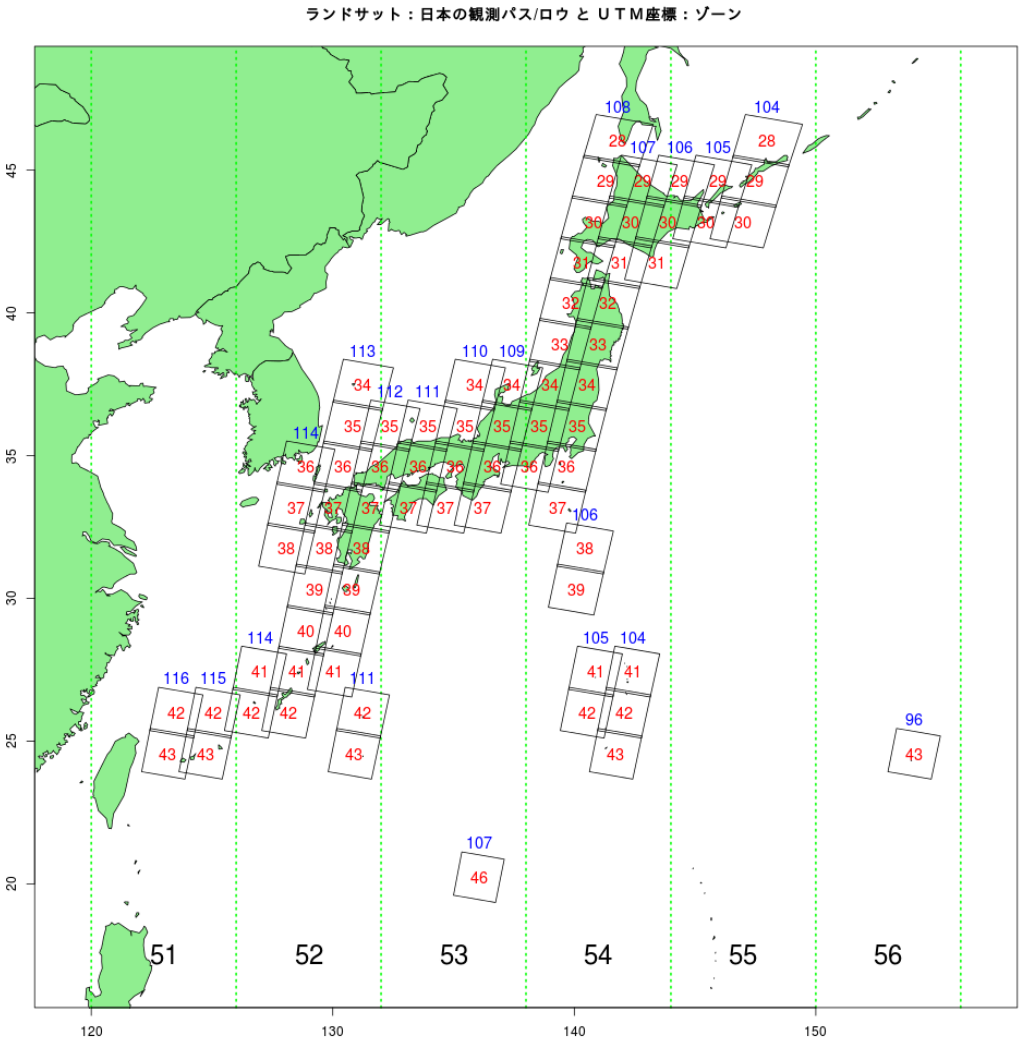


Source: https://github.com

Japan's National Grid /Japan UTM

- UTM projection
- WGS 84 datum
- Special zones -

  51N,52N,53N,54N,55N,56N



Examples of projected coordinate systems

Projected coordinate system	Projection type	Geographic coordinate system	Area of use
Japan UTM JGD 2000	Transverse Mercator	JGD 2000	Japan 120E-156E
Universal transverse Mercator WGS 1984	Transverse Mercator	WGS 84	World Northern and South hemisphere

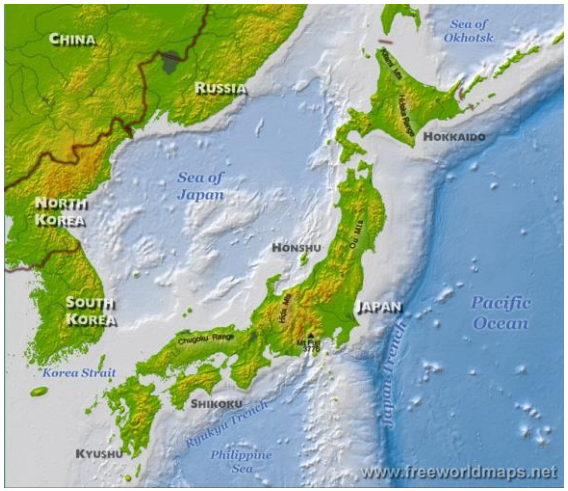
Maps

- A representation usually on a flat surface (on a paper or digital media) of the whole or a part of 3-D space.

Map types

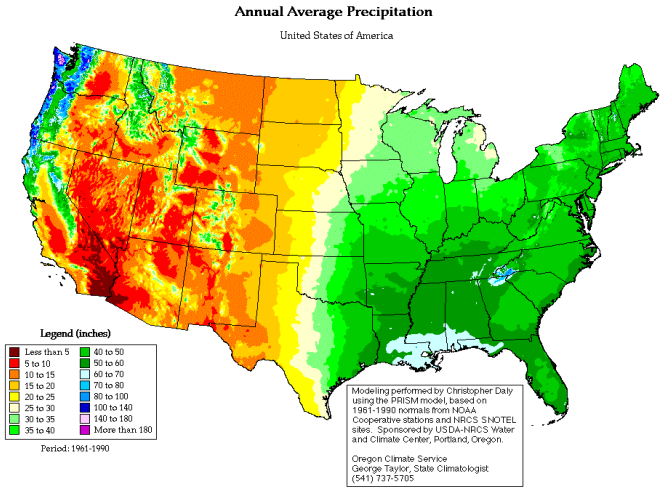
1. Physical Maps
2. Climate Maps
3. Road Maps
4. Thematic Maps
5. Map of Settlements
6. Topographic Maps
7. Economic or Resource Maps
8. Population Maps…etc

Physical map



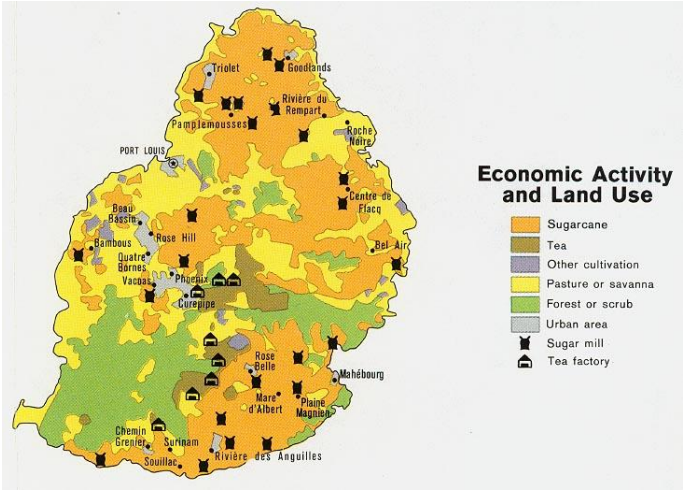
http://www.freeworldmaps.net

Climate map



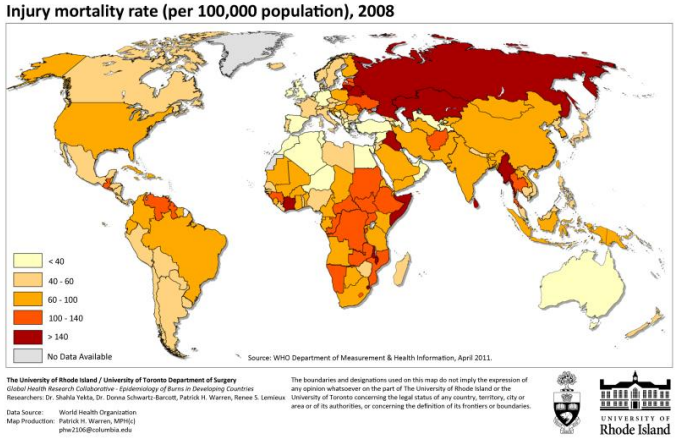
http://www.learnnc.org

Economic Map



https://simple.wikipedia.org

Thematic map



http://www.mapcruzin.com

Category of Maps

- Ordinary maps -

  rail way, road, villages, schools

- Scale of Map -

  1:1000, 1:25000, 1:50000 national large scale maps
  1:200,000, 1:100,000 world map, regional maps

- Thematic map - land use, housing density

- Special maps - blind maps, solid maps

Essential components of map

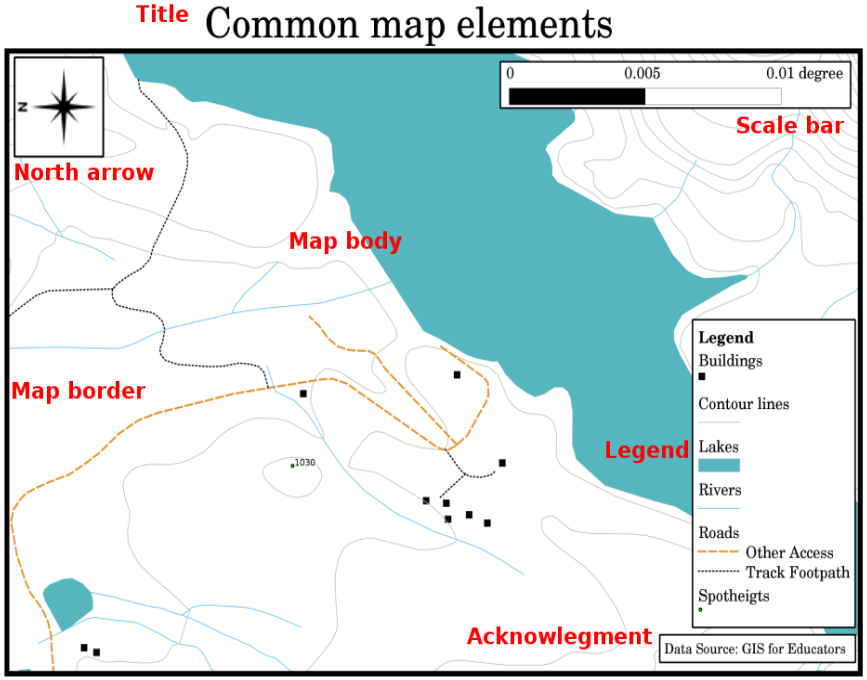
1. Scale of the map
2. Resolution of the digital map
3. Projection
4. Coordinate system
5. Legend …etc

Common map elements

1. Location
2. Distance
3. Elevation
4. Direction
5. Circumstance
6. Others

Other data of map

- Map title
- Legend
- Scale bar
- Scale text
- Lines of latitude and longitude
- Grid lines
- The north arrow
- Marginal frame
- Publish date
- Projection
- Coordinate system



Source: https://docs.qgis.org

References

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II. http://www.mapcruzin.com/

III. http://web.gps.caltech.edu/gislab/HowTo/ESRI - Map Projections.

IV. https://education.usgs.gov/lessons/coordinatesystems

V. http://greatlakeswormwatch.org/downloads/team/TheGeographicCoordinateSystem