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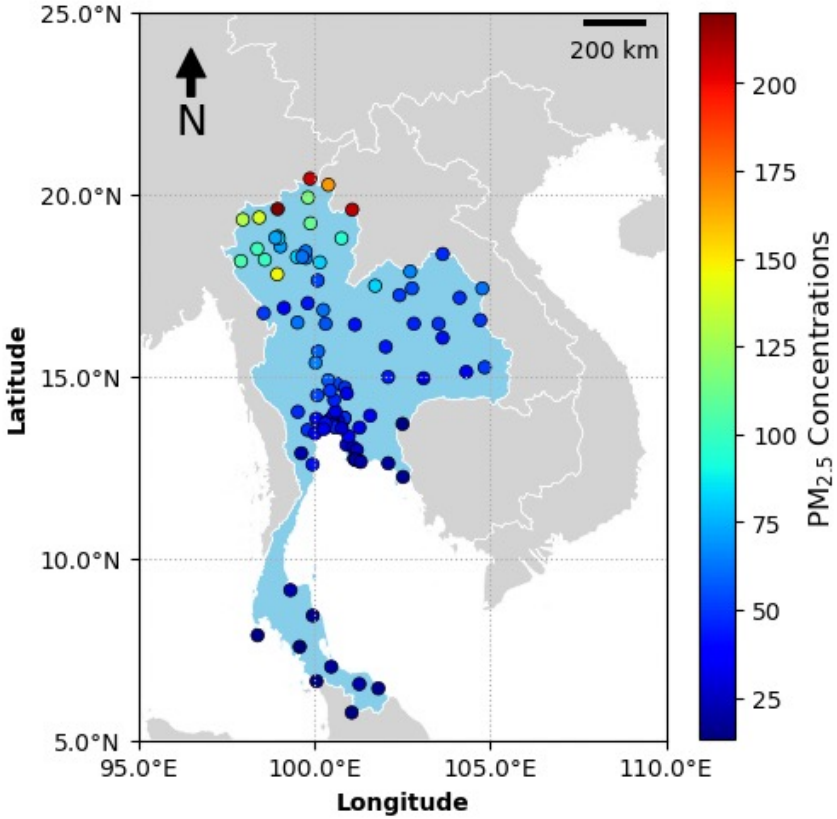

Intro to Python for Geospatial Visualization

(Lecture + Coding)

โหลดชีทมาเรียนกันเลย! (Click here)

Course Outlines

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1. Geospatial Basics

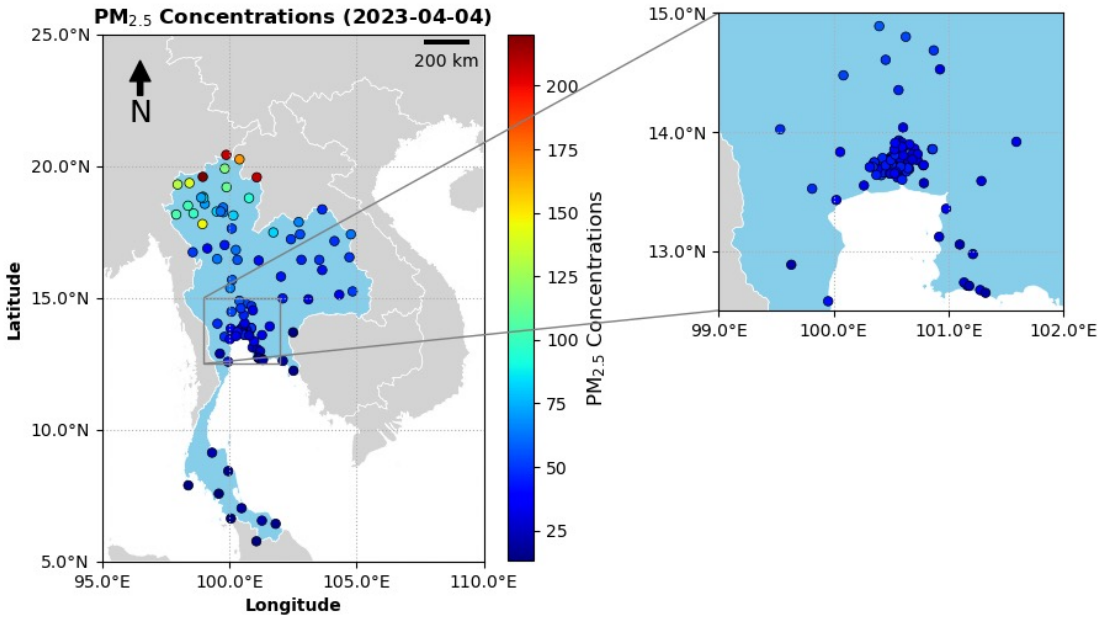
- 1.1 The shape of the Earth
- 1.2 Coordinate reference systems (CRS)
  - 1.2.1 Spherical/Geographical coordinate system (GCS)
  - 1.2.2 Projected coordinate system (PCS)
- 1.3 PROJ.4 String and EPSG Codes
- 1.4 Data model
  - 1.4.1 Vector data model
  - 1.4.2 Raster data model

2. Vector data basics with GeoPandas

- 2.1 Data structure
- 2.2 Basic methods and attributes
- 2.3 Clip data
- 2.4 Vector data visualization: $PM_{2.5}$ station data

3. Raster data basics with Xarray

- 3.1 Data structure
- 3.2 Basic methods and attributes
- 3.3 Clip data
- 3.4 Raster data visualization: $PM_{2.5}$ station data and others



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Intro to Python for Geospatial Visualization

Geospatial Basics

(พื้นฐาน Geospatial data เบื้องต้นที่ควรรู้)

The Shape of the Earth

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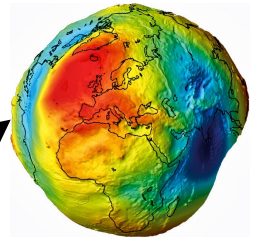
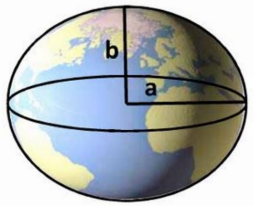
The Earth

- ✓ Not a perfect sphere
- ✓ Lumpy surface



1. Geoid

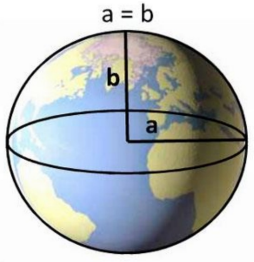
a > b



$\frac{a-b}{a}$ = flattening

2. Ellipsoid/Spheroid

a = b



a = Semi major axis
b = Semi minor axis

3. Perfect sphere

Image credit: Geocue

Coordinate reference systems

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Coordinate reference system (CRS): a reference system used to define the location of geographic elements on the Earth surface

1. **Spherical/Geographical coordinate system (GCS):** it represents locations using a 3D framework based on angles (common unit: degree)
2. **Projected coordinate system (PCS):** it contains a GCS, but converts the GCS into a 2D flat surface using mathematical transformation, also known as map projection (common unit: meter)

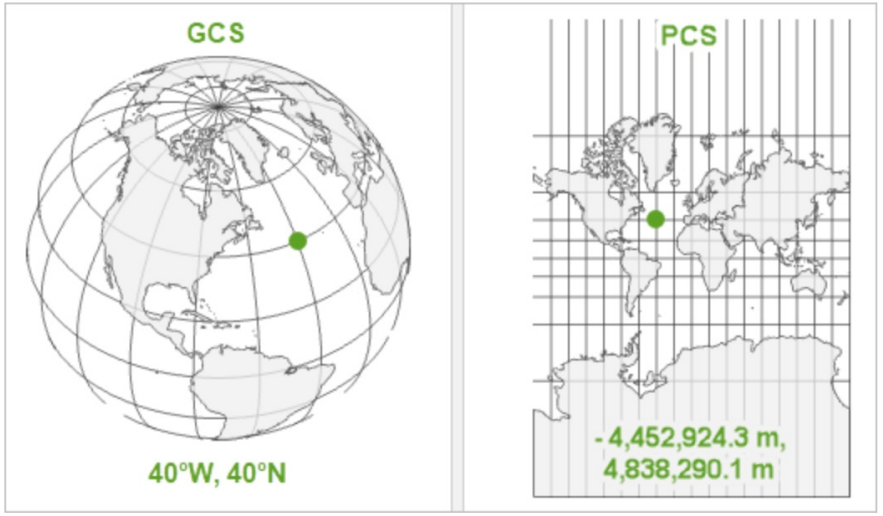

Image credit: esri.com

GCS's parameters

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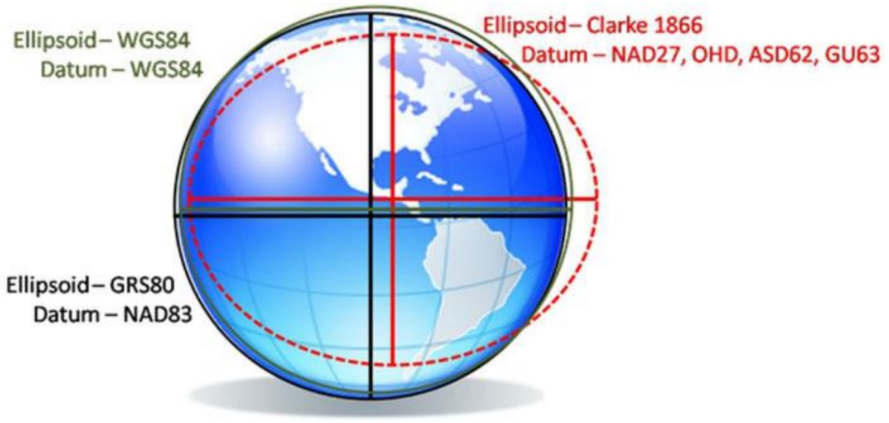
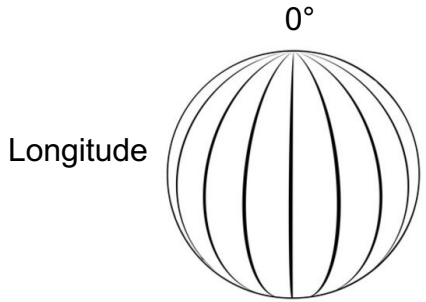
1. Datum

A set of information contains reference points when we create maps

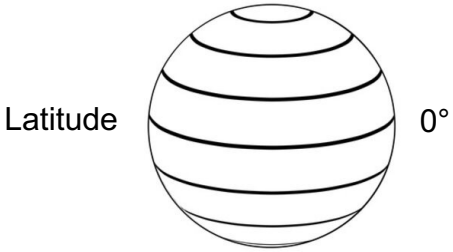


Common datum: NAD27, NAD83, WGS84

2. Prime meridian



the prime meridian
(Greenwich, London, U.K.)



the equator

3. Angular unit of measure

degree, °

Image credit: Geocue

PCS (Map projections)

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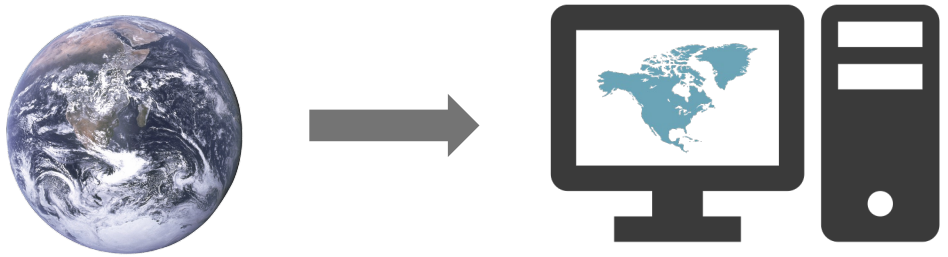

Projection: a mathematical transformation of 3D spherical coordinates to a 2D planar coordinates

- All projections are not perfect, they introduce some kind of distortion into the data.
- It is our choice to choose the one that match our purpose

Projection classification

- Classification by Information Preservation
- Classification by Developable Surface

PCS (Map projections)

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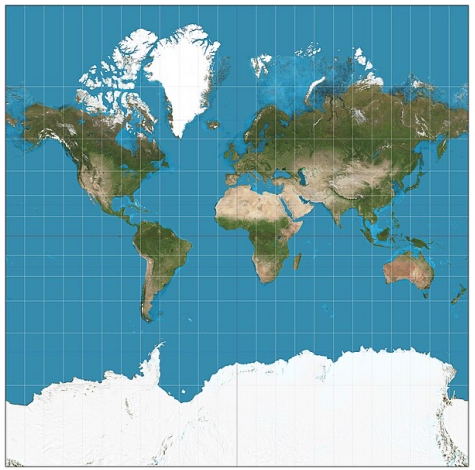
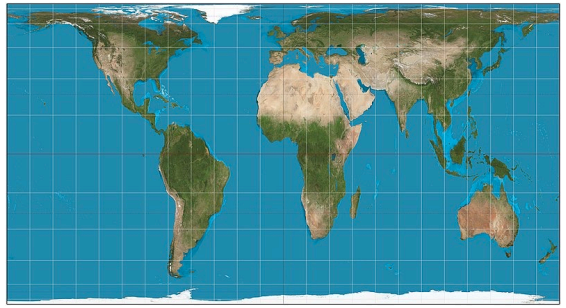
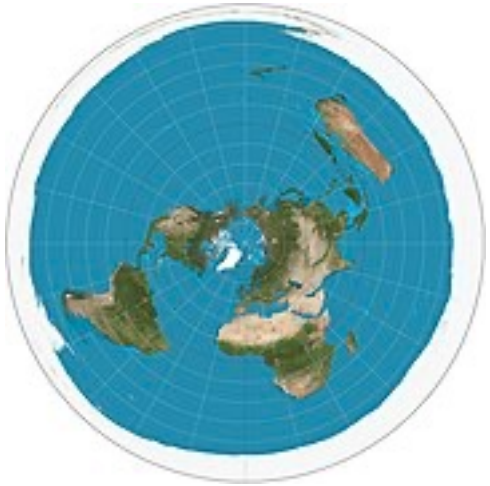
Classification by Information Preservation



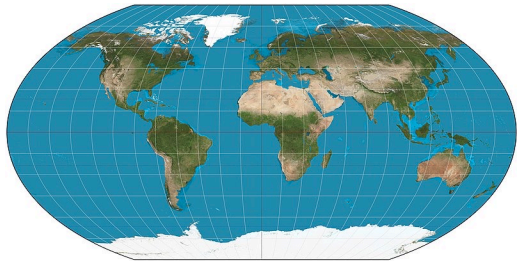
Conformal projection
(preserve shape/angle)



Equal-area projection
(preserve area)



Azimuthal projection
(preserve direction)
Equidistant projection
(preserve distance)



Compromise projection
(preserve nothing)

Image credit: Wikimedia Commons

PCS (Map projections)

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Classification by Developable Surface

Developable Surface:
A geometric figure that can be flattened into a plane without distortion

Generating globe:
An ellipsoid or a sphere model reduced to the scale of the desired flat map

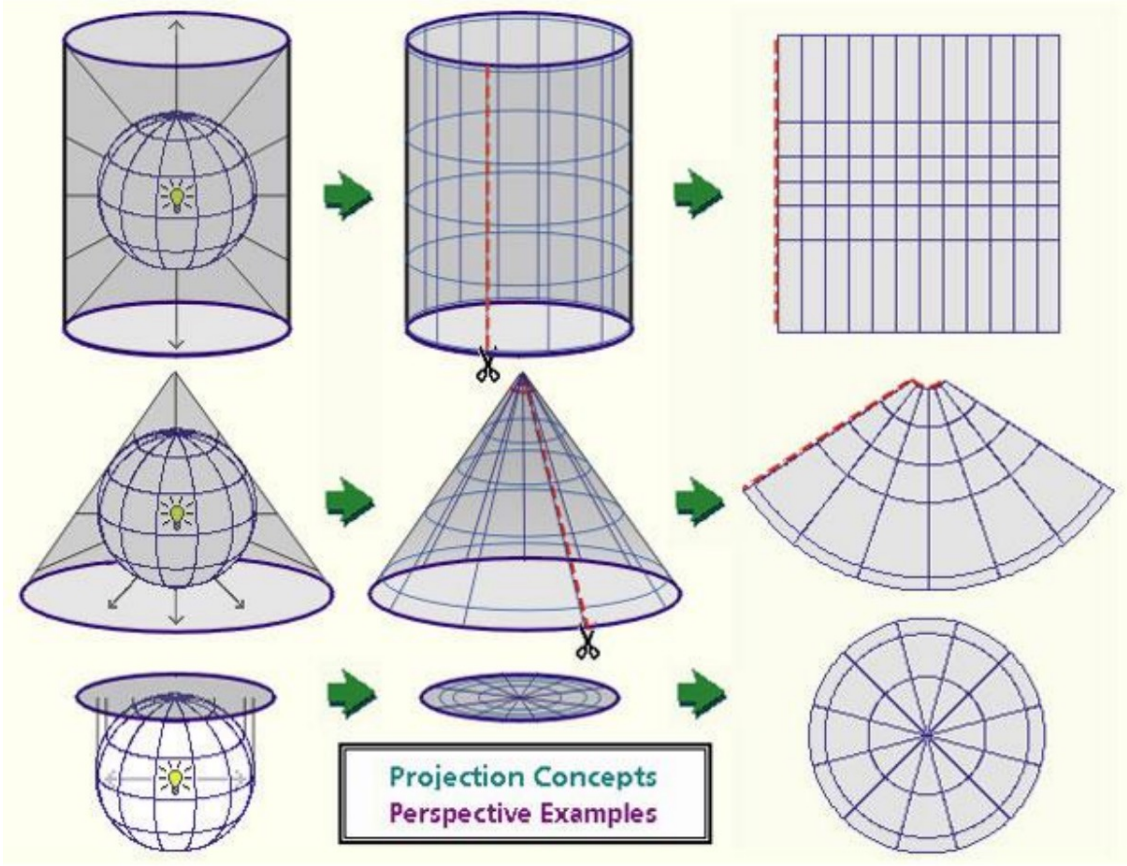

Image credit: Geocue

PCS (Map projections)

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Classification by Developable Surface

1. Cylindrical projection
2. Conic projection
3. Planar projection

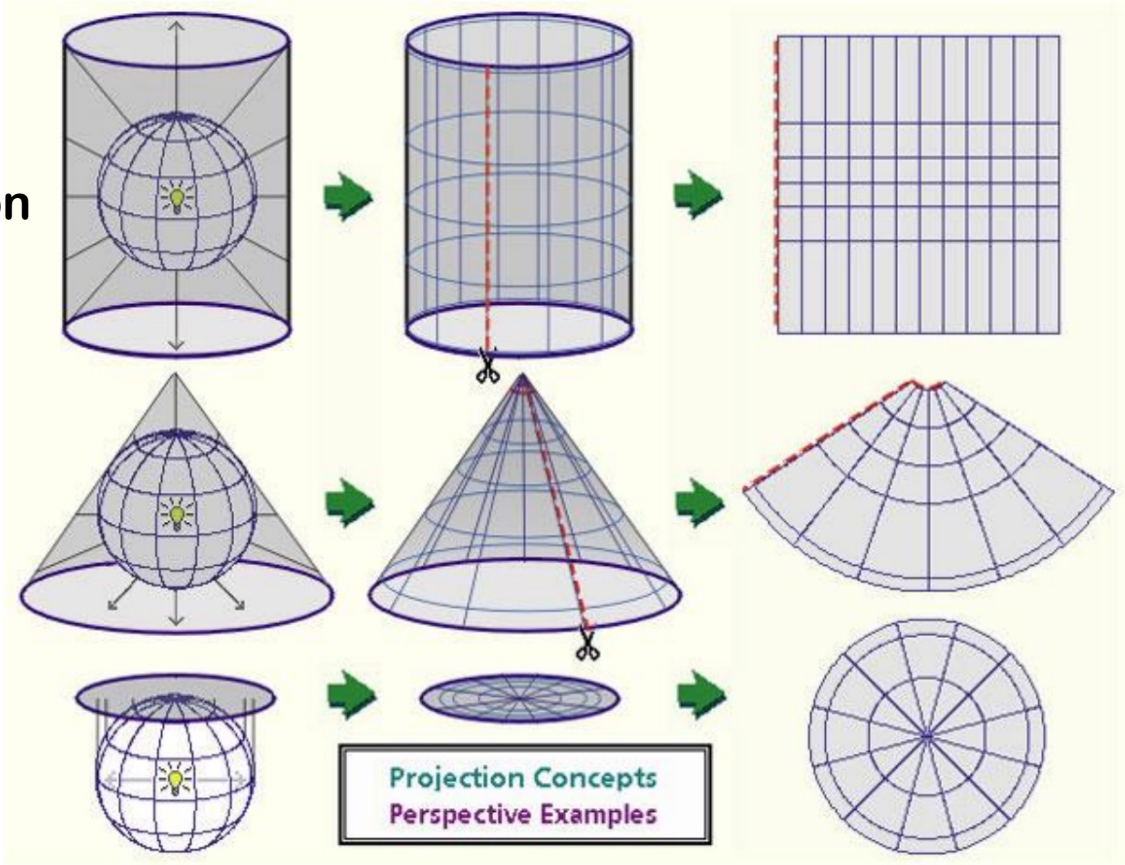

Image credit: Geocue

PCS (Map projections)

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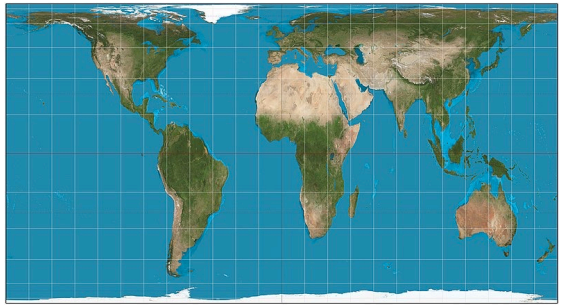
Mercator projection
(Type: conformal cylindrical)

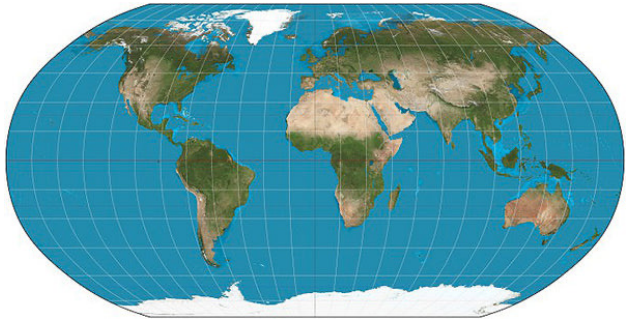
Developed by Gerardus Mercator in 1569

Gall-Peters projection
(Type: equal-area, cylindrical)



Developed by James Gall in 1855

Robinson projection
(Type: compromise, pseudo-cylindrical)



Developed by Arthur Robinson in 1963

PCS (Map projections)

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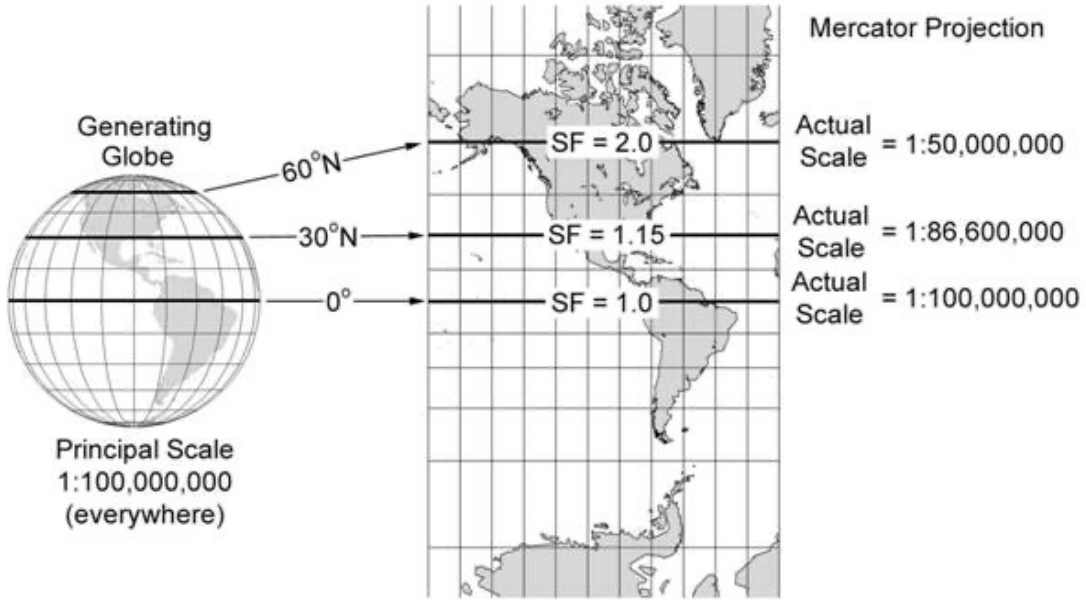
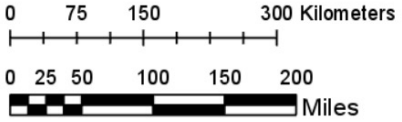
Line of tangency: the line at which the generating globe and the developable surface touch (Some projection have a point of tangency)





Map scale

Principal scale: The scale of the generating globe used to make a map projection

Actual scale: The local measurement of scale at any point on a map (can vary from one location on a map to another)

Scale factor (SF): the ratio of the principal scale to the actual scale for a particular location (SF =1 -> **True scale)**

PCS's parameters

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1. GCS parameters

2. Projection type: The method used to project the 3D Earth onto a 2D plane

3. Central meridian/Longitude of origin: The line of longitude at the center of the projection (defines the origin of x coordinates)

4. Central parallel/Latitude of origin: It defines the origin of y coordinates. It may or may not be the middle latitude of the projection

5. Standard parallel: A line of latitude that has true scale (not all projections have standard parallels and conic projections often have two)

6. Linear unit of measure: Usually meter

7. False easting and false northing: Offsets added to the x and y coordinates to avoid negative values

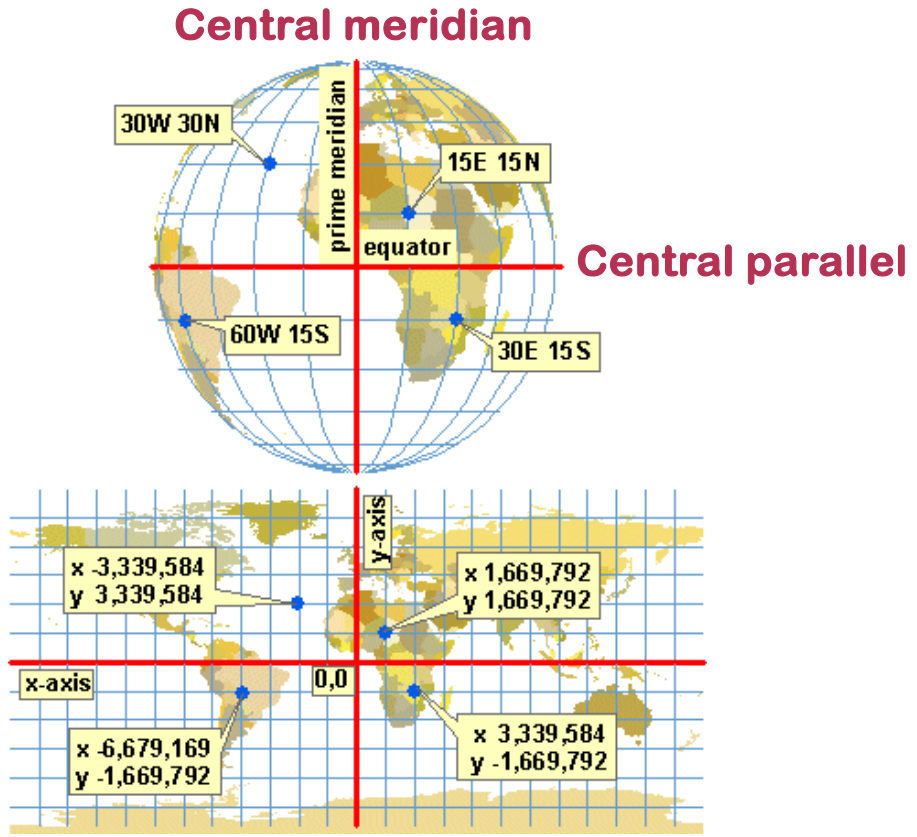

Image credit: geography.hunter.cuny.edu

PROJ.4 string

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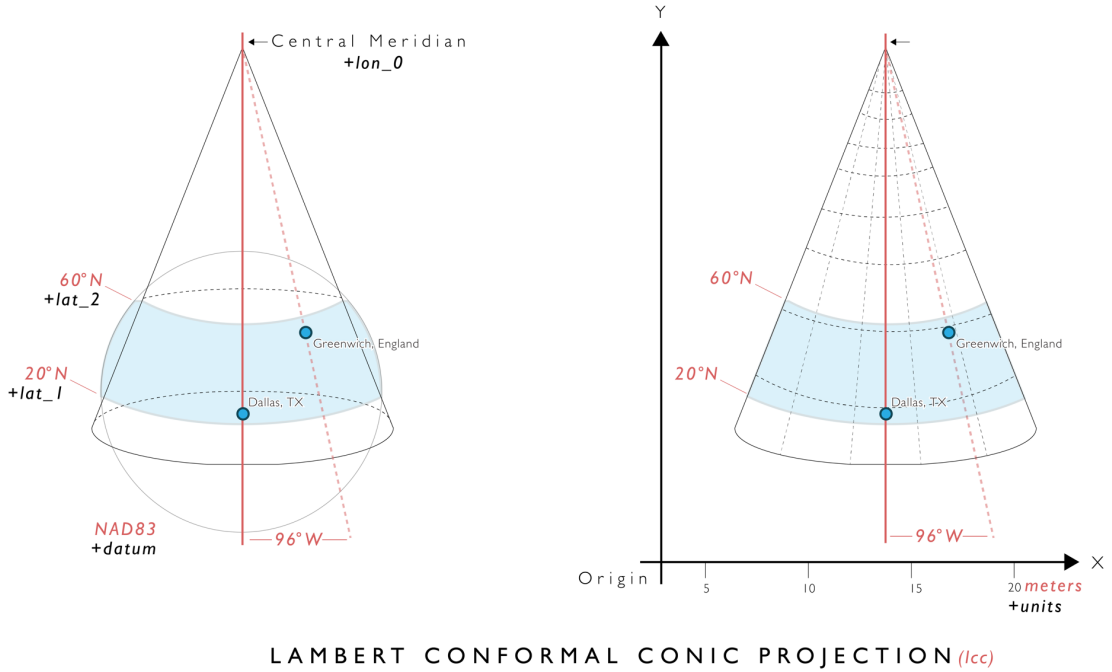
PROJ.4 string: A string holds the parameters of a certain CRS

Parameter	Description
+proj	Projection name
+datum	Datum name
+lat_0	Central parallel
+lat_1 or 2	Standard parallel
+lon_0	Central meridian
+units	meters, feet, etc.
+x_0	False easting
+y_0	False northing

crs="+proj=lcc +lat_1=20 +lat_2=60 lon_0=-96 +datum=NAD83 +units=m"



LAMBERT CONFORMAL CONIC PROJECTION (lcc)

Image credit: pygis.io

EPSG Codes

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EPSG Codes: A unique numerical identifier used to represent CRS (https://epsg.io/)

- More convenient than PROJ.4 String
- Not all CRSs have EPSG code

Example of EPSG Codes

EPSG:4326

+proj=longlat +datum=WGS84 +no_defs

EPSG:3875

+proj=tmerc +lat_0=0 +lon_0=21 +k=1 +x_0=21500000 +y_0=0 +ellps=GRS80 +towgs84=0,0,0,0,0,0,0
+units=m +no_defs

CRS

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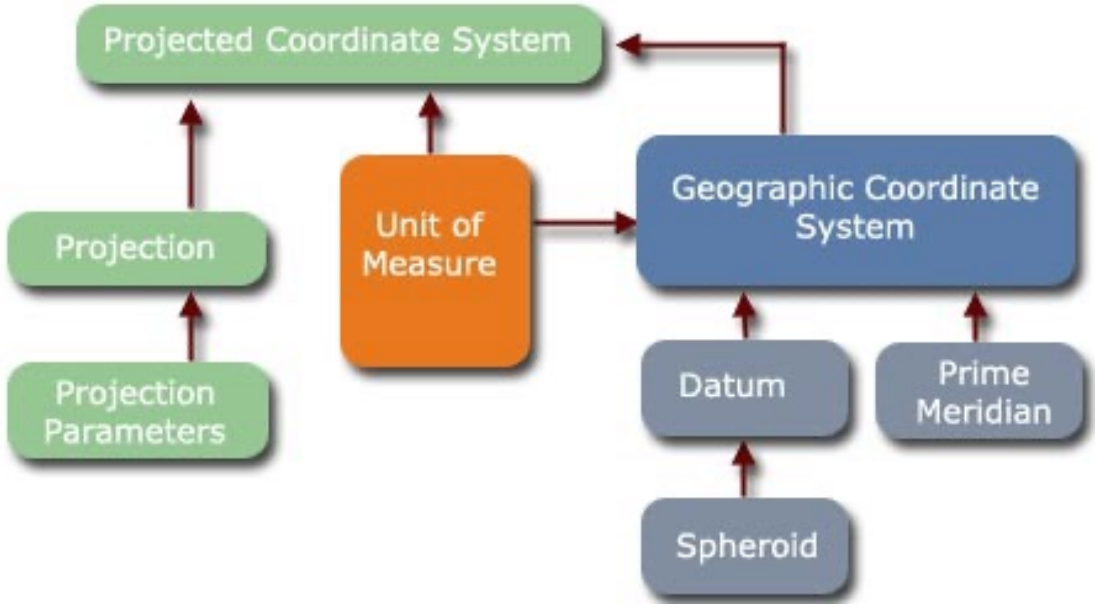

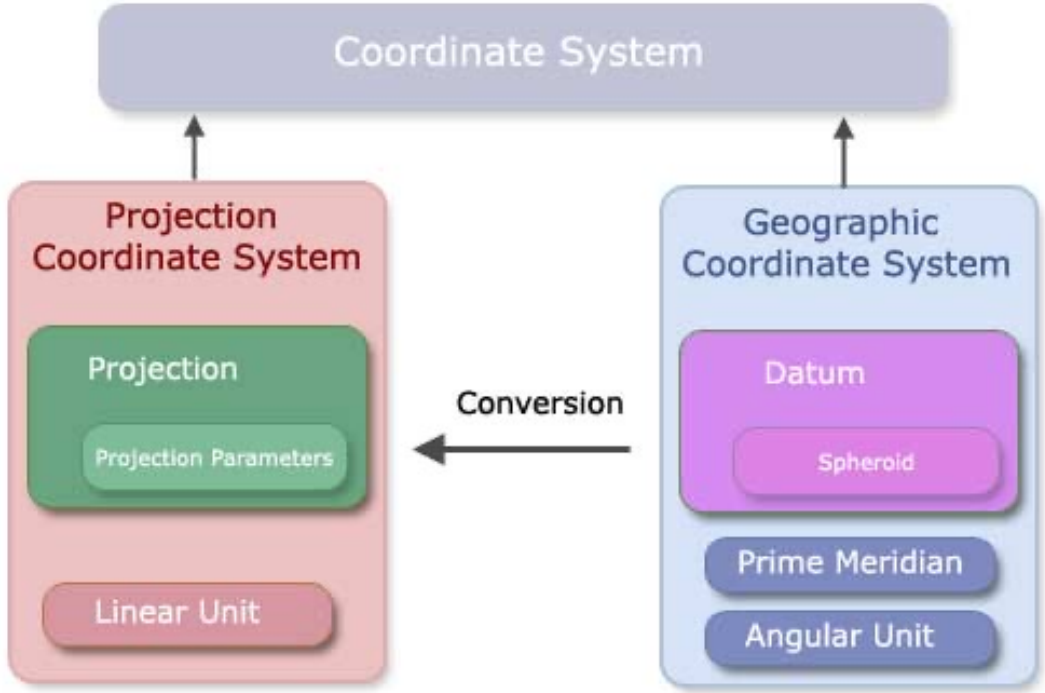

Image credit: arcgis.com

Data models

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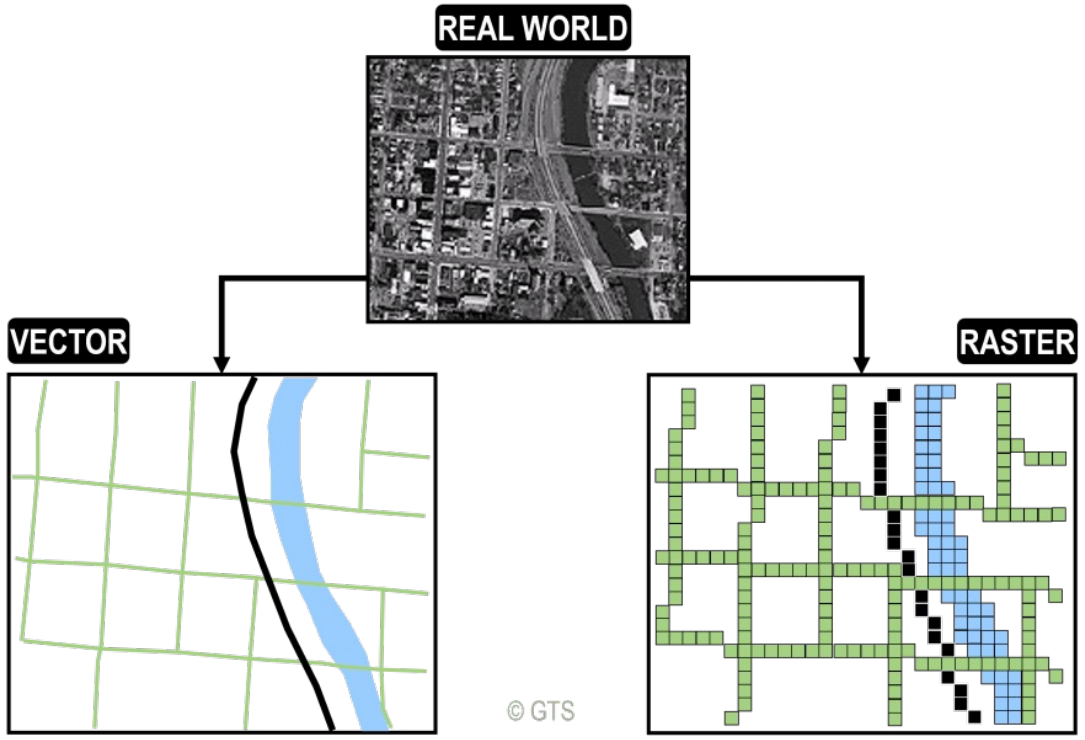
Data models: A mathematical and digital structure for representing real world geographical elements as data in a computer



Vector data model

Raster data model

Image credit: transportgeography.org

Vector data model

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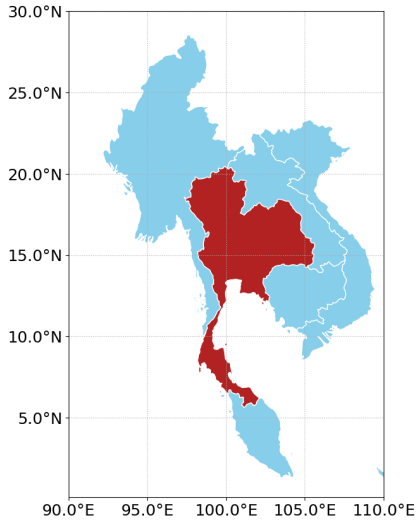
Vector data components

1. **Geometry:** points, lines, polygons (a closed figure made up of line segments)
2. **Attribute table:** it stores the information linked to each geometric shape
3. **A link** between 1. and 2.

For example, a polygon representing countries might have attributes such as country name, and region name



Administrative Boundaries Data

	name	region	geometry
163	Vietnam	South-Eastern Asia	MULTIPOLYGON (((104.08288 10.36486, 104.08663 ...
170	Thailand	South-Eastern Asia	MULTIPOLYGON (((99.66804 6.49639, 99.65263 6.4...
193	Cambodia	South-Eastern Asia	POLYGON ((104.44533 10.42274, 104.34608 10.492...
212	Malaysia	South-Eastern Asia	MULTIPOLYGON (((111.41152 2.37639, 111.36804 2...
227	Myanmar	South-Eastern Asia	MULTIPOLYGON (((98.15582 9.87666, 98.13602 9.8...
235	Lao People's Democratic Republic	South-Eastern Asia	POLYGON ((102.14074 22.39629, 102.15373 22.384...

Vector data format

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Shapefile: It is a common vector data storage format and not a single file. It made up of multiple component files

Component files

1. .shp = stores geometry information
2. .dbf = stores attribute information
3. .shx = index/link between .shp and .dbf
4. .prj = stores coordinate system information
5. .shp.xml = stores the metadata in an XML document

All component files have the same name but different extensions

Raster data model

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Raster data model: it represents real world geographical elements as a surface divided into an array of equally sized cells. Every cell can contain only one value.

0	0	0	0	0
0	0	0	0	0
0	0	1	0	0
0	1	1	1	0
0	0	1	1	1

Binary raster data

1 = water

0 = no water

Raster data format

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1. TIFF (Tagged Image File Format) / GeoTIFF
2. ESRI Grid
3. PNG
4. JPEG
3. NetCDF (Network Common Data Form)

https://www.igismap.com/raster-data-file-format/