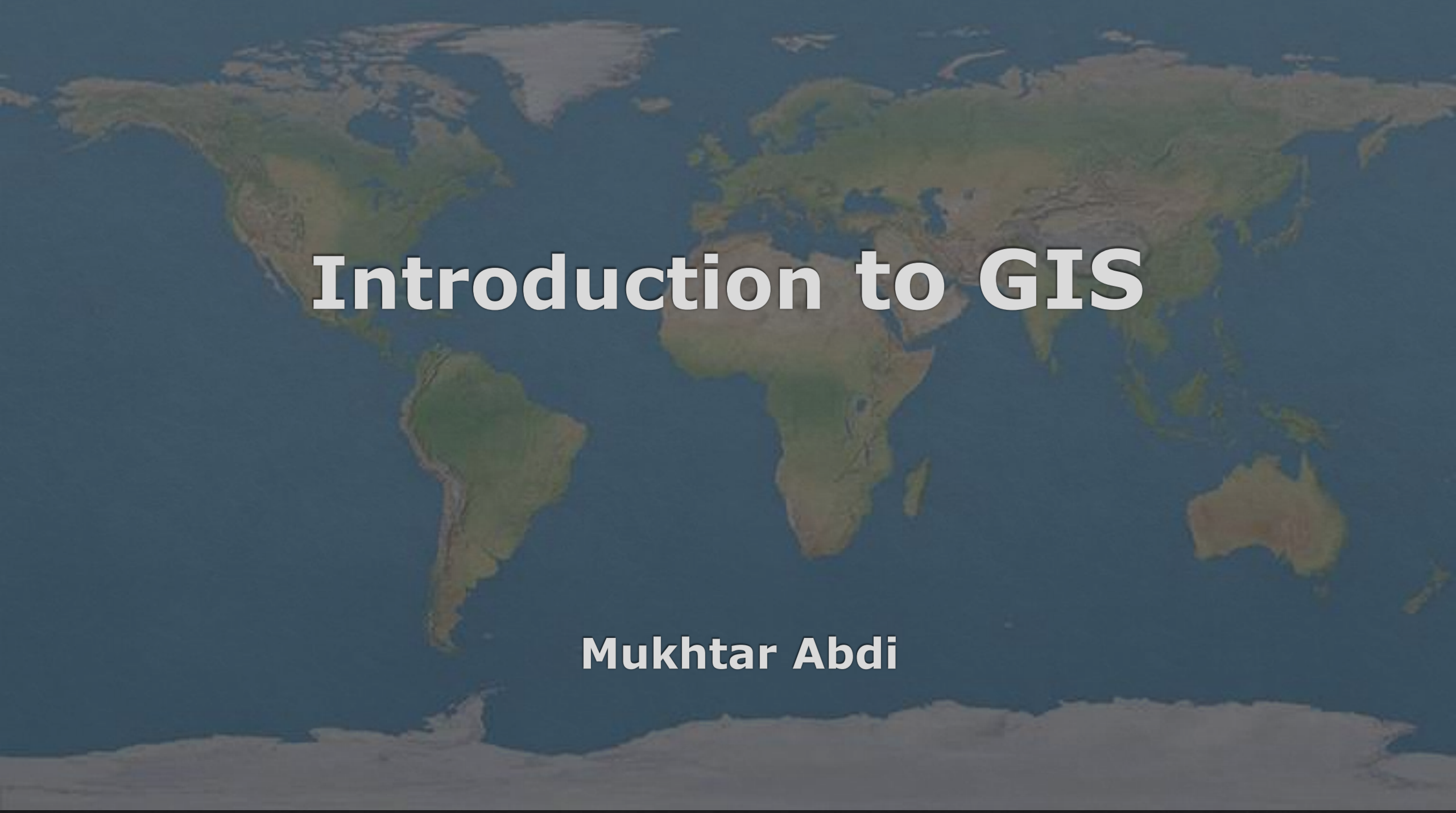


Introduction to GIS

Mukhtar Abdi

Outline

- Introduction
- Software options
- Why QGIS?
- GIS data types (Vector and Raster)
- Attribute table
- Map elements in Cartography
- Map Projections
- How to find and download free GIS data?

Introduction

GEOGRAPHIC INFORMATION SYSTEM

"A system for

capturing, storing, checking, integrating, manipulating, analyzing, and displaying

spatial data"

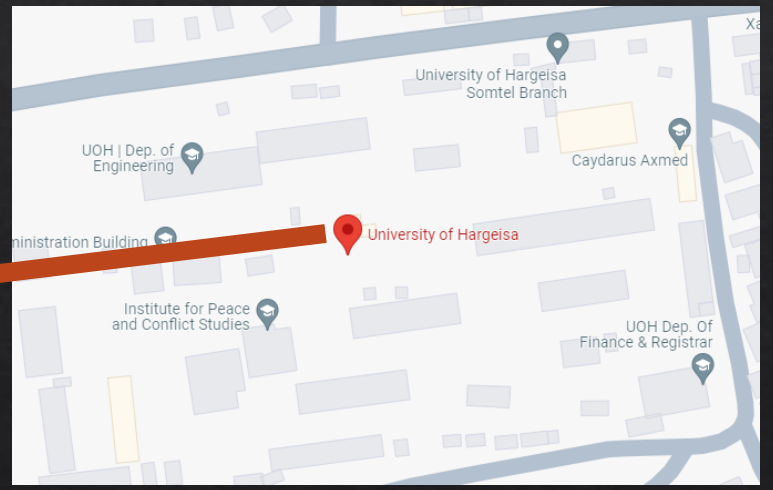
© source: https://ocw.mit.edu/courses/res-str-001-geographic-information-system-gis-tutorial-january-iap-2022/

Spatial data

also known as geospatial data or geographic information, GIS data,

refers to information that is associated with a specific geographic location or position

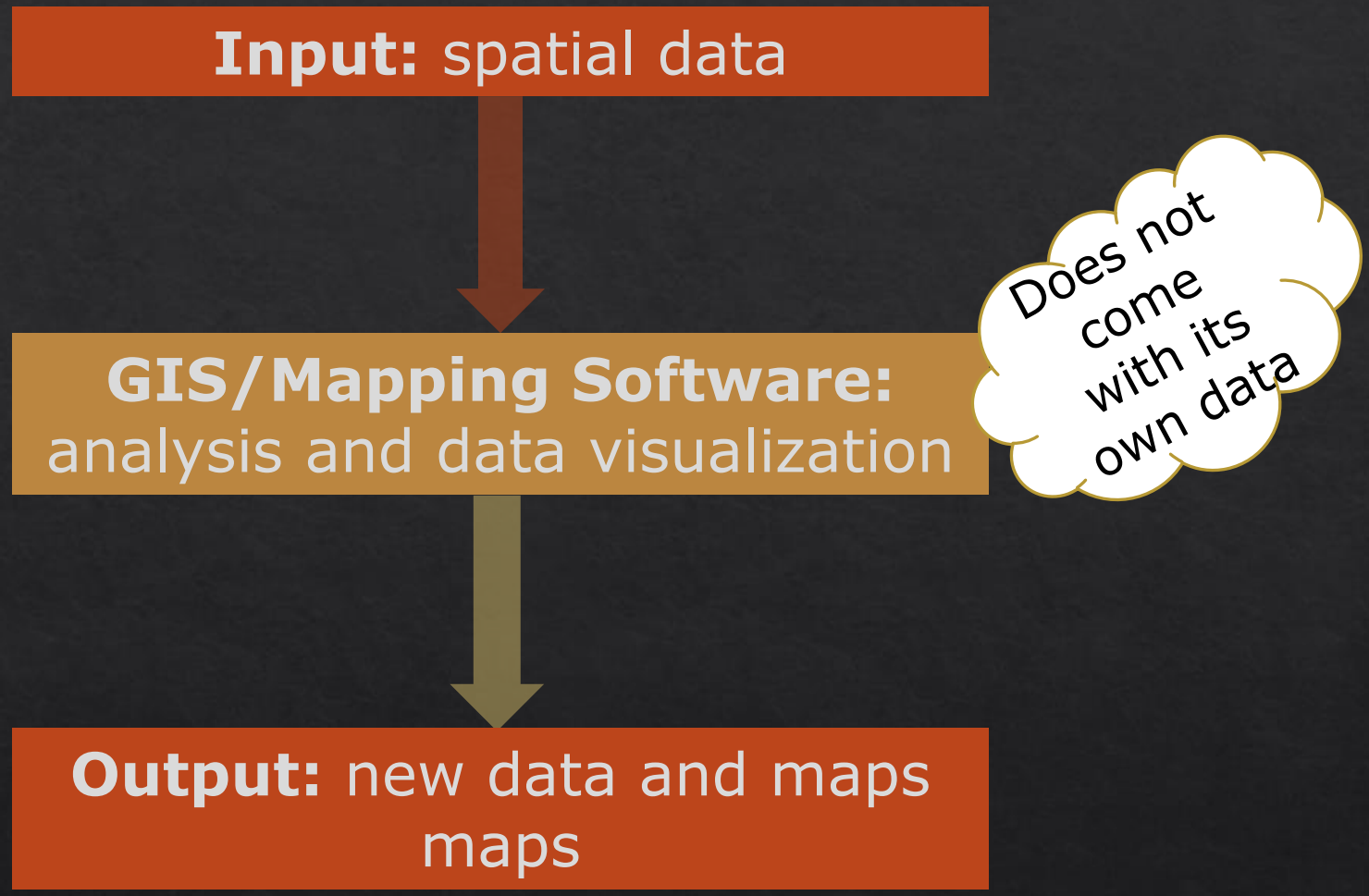
on the Earth's surface.



Coordinates
9.5465, 44.0473

Latitude/Northing/Y

Longitude/Easting/X



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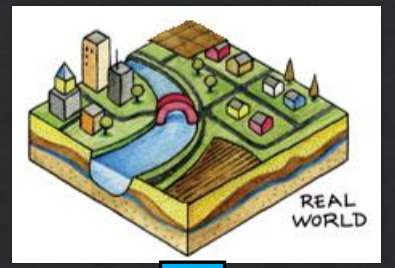
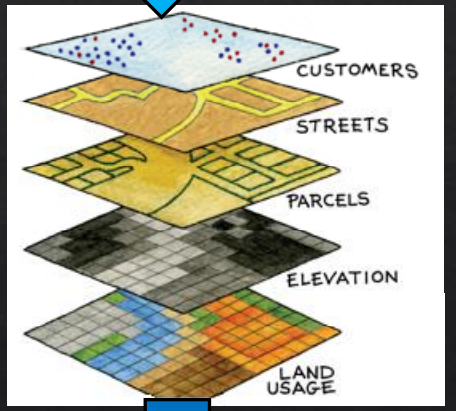
Theoretical Overview

GIS recreates real world spatial data



as digitized themed data "**layers**" (e.g. locations, boundaries, infrastructure, socioeconomic, health, natural resources and land use/cover)



assembled in any **combination**

And overlaid for analysis

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Software options

Types of GIS & Mapping Software

Type	Analysis Power	Example(s)
Geobrowser	**Weak** (mainly only to display data)	Google Maps, Google Earth, Apple Maps, Waze, etc.
Web-based	**Medium** (able to upload additional data, customize display, and perform basic analyses)	Carto, ArcGIS Online, Mapbox, Google MyMaps, etc.
Desktop	**Strong** (installed locally, provides full control of map creation, and perform advanced analyses)	ArcGIS Pro QGIS

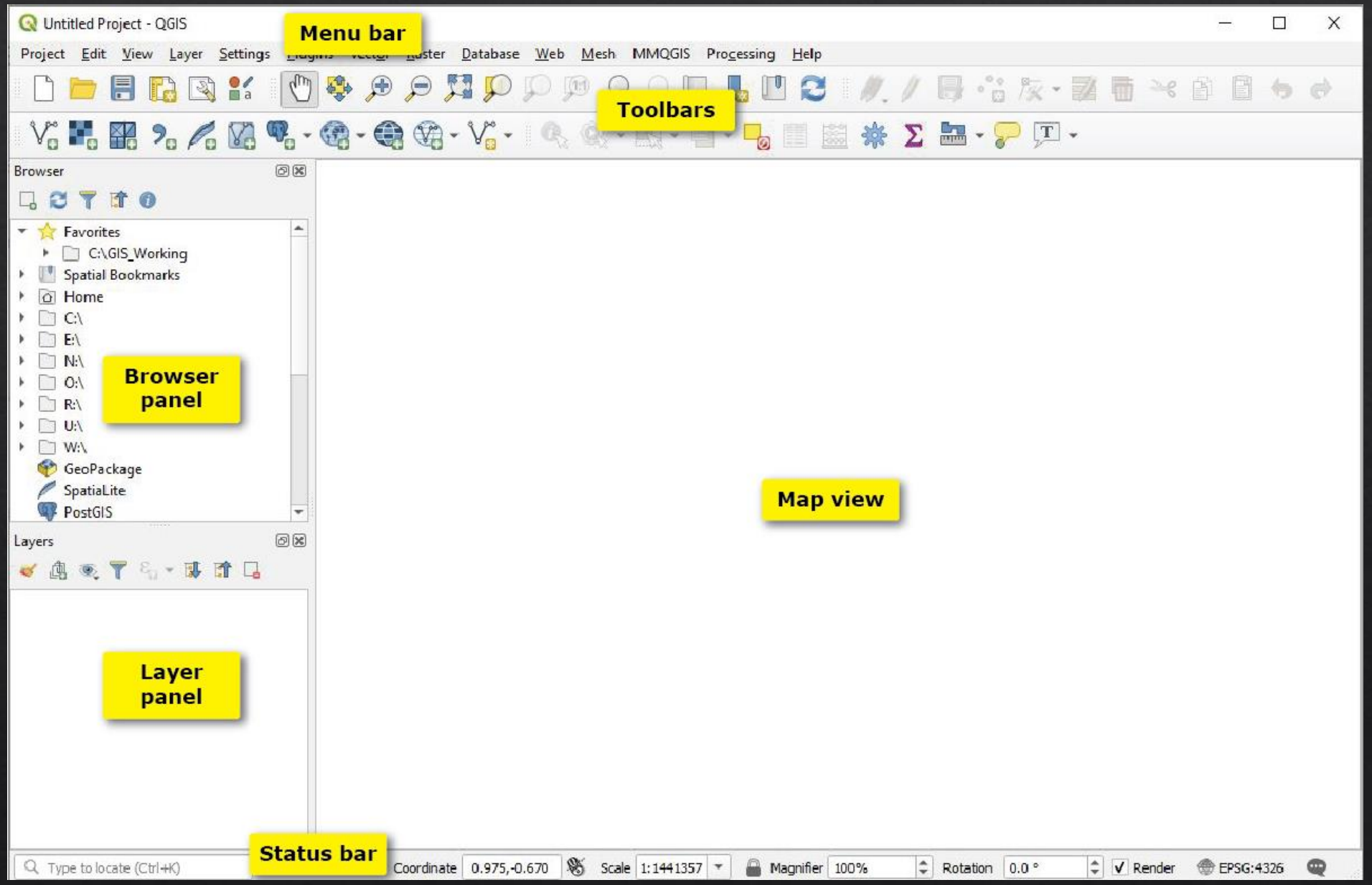
© source: https://ocw.mit.edu/courses/res-str-001-geographic-information-system-gis-tutorial-january-iap-2022/

Five Reasons To Start Using QGIS

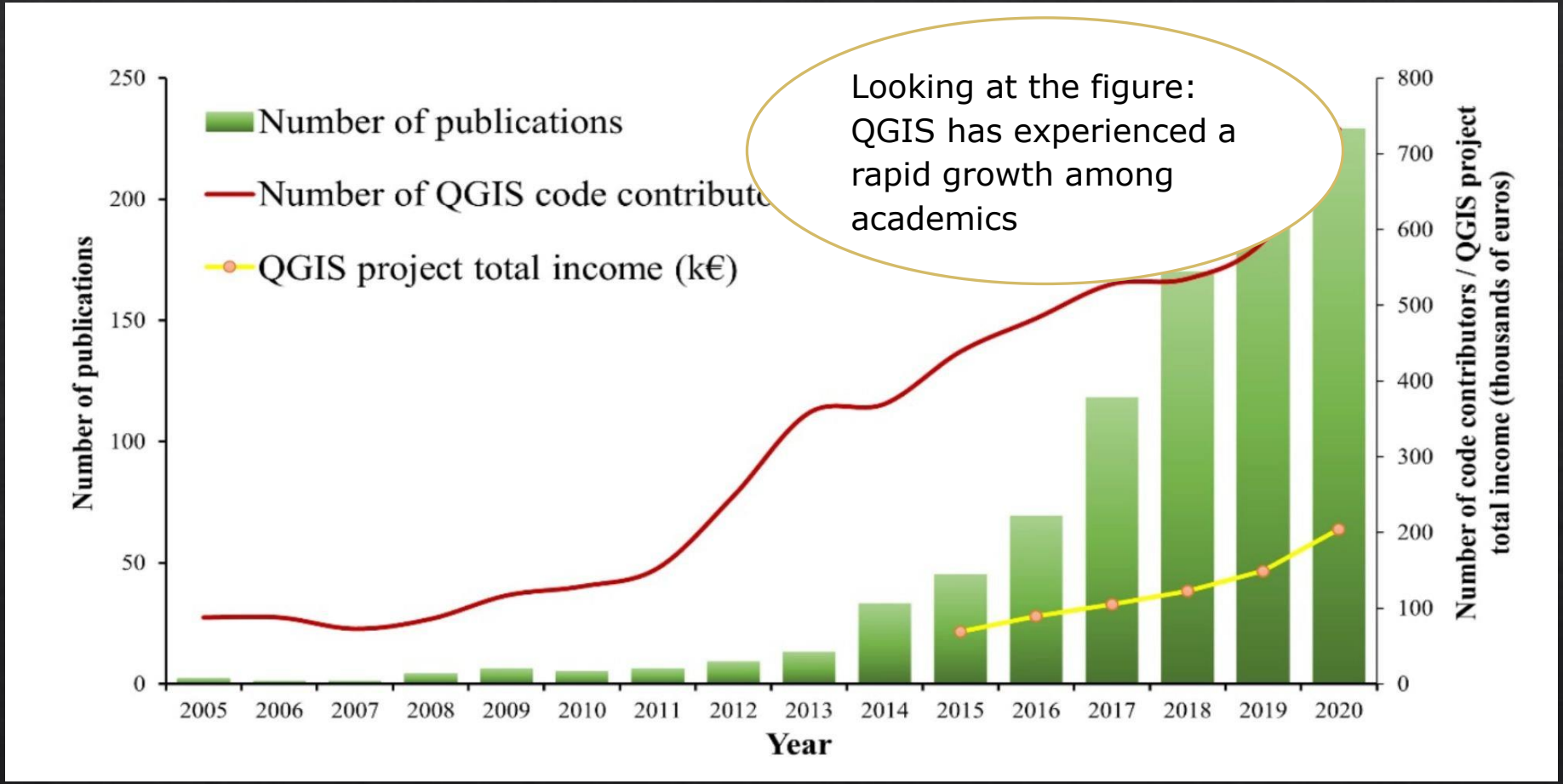
1. QGIS is free: QGIS is FOSS which stands for Free and Open-Source Software
2. QGIS is cross platform: Have a Mac, PC, OR Linux machine? It doesn't matter
3. The use of open source is growing: QGIS is growing in its use as a viable alternative to commercial GIS, such as Esri's ArcGIS.
4. Plenty of QGIS support and tutorials: QGIS has an active and thriving developer and user based support.
5. QGIS is flexible: QGIS can read a wide range of GIS vector and raster file formats including Esri shape files, KML, KMZ, GeoPackage, and JSON.

© source: https://www.geographyrealm.com/five-reasons-to-start-using-qgis/

QGIS Interface

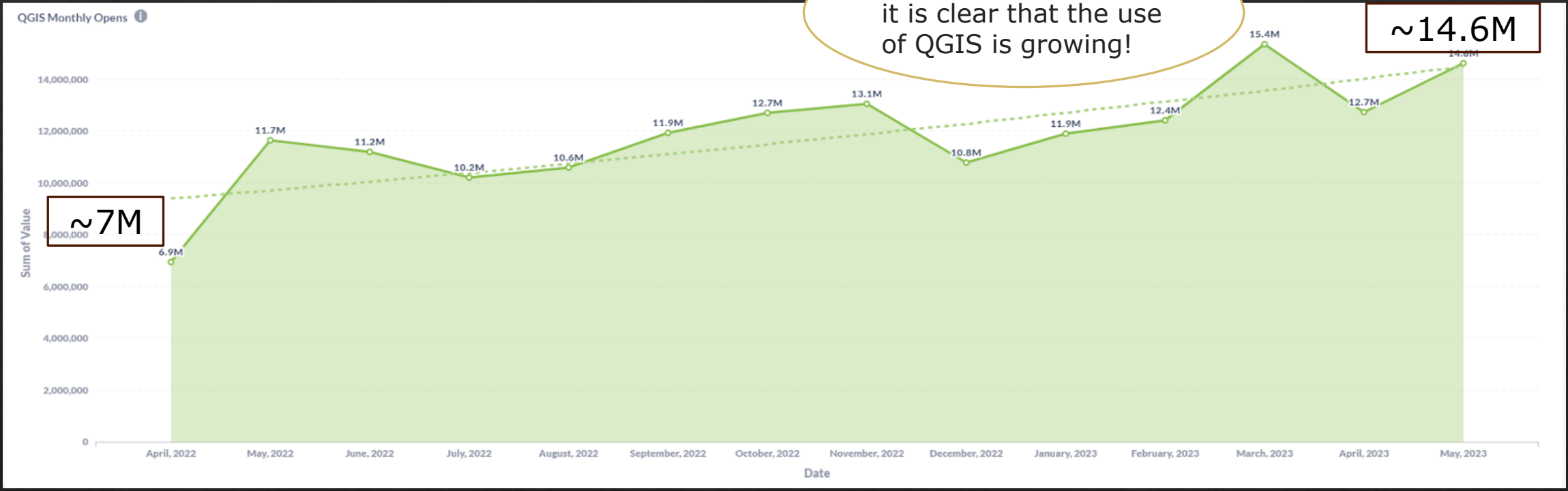


QGIS Is Growing As A Tool Of Choice In Academia



© source: https://www.geographyrealm.com/five-reasons-to-start-using-qgis/

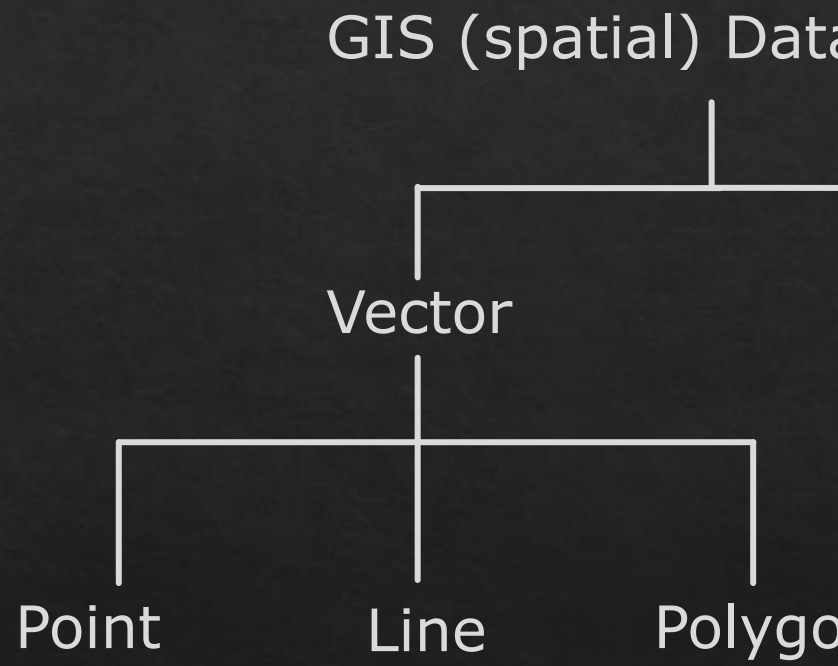
How big is the QGIS community in mid 2023?



© source: https://www.gispo.fi/en/blog/how-big-is-the-qgis-community-now/

GIS data types

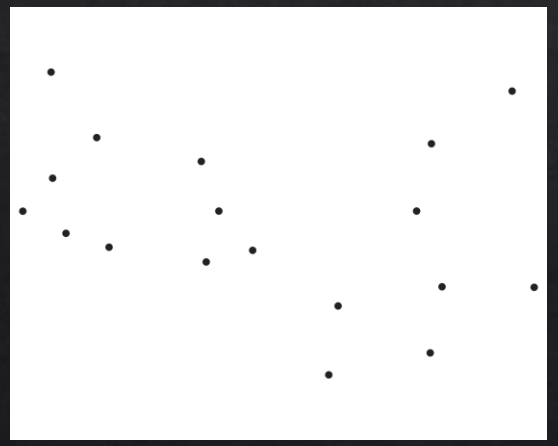
GIS data types



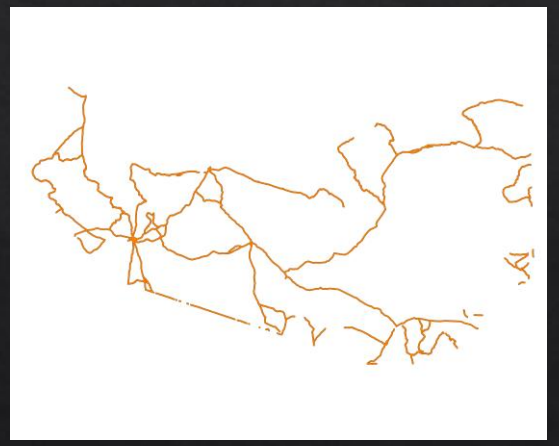
GIS data types: vector examples

- **Vector data** type represents the location and shape of geographic features using points, lines (polylines) and polygons.
- **Feature** is a real world thing/object such as roads, property/district boundaries, dam site, and so on.

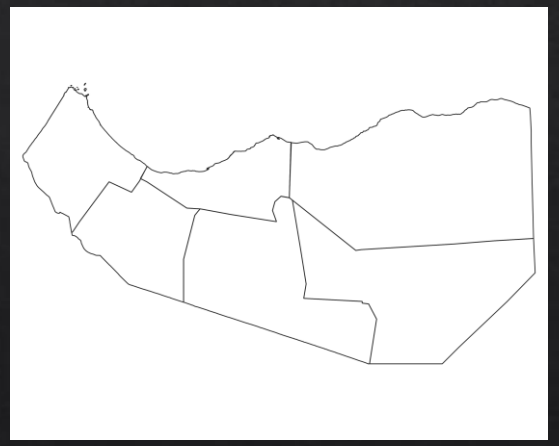
Points (bar)



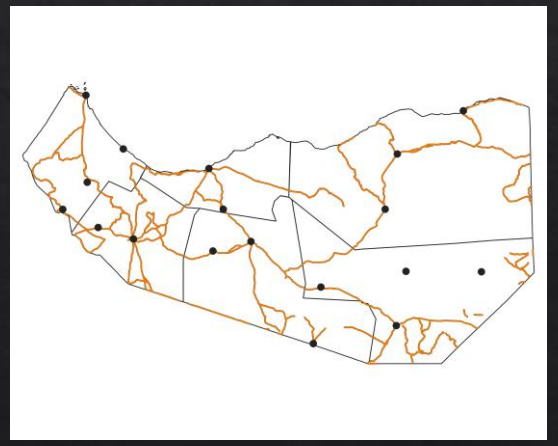
Lines (xariiq)



Polygons (geesoole)



Combined



GIS data types: Vector file formats

- The **shapefile** is the most common vector file format.
- "A" **shapefile** is actually a collection of several different files with different extensions.

When adding files to QGIS , you will only see one file (**.shp**), not every extension.

Shapefile =

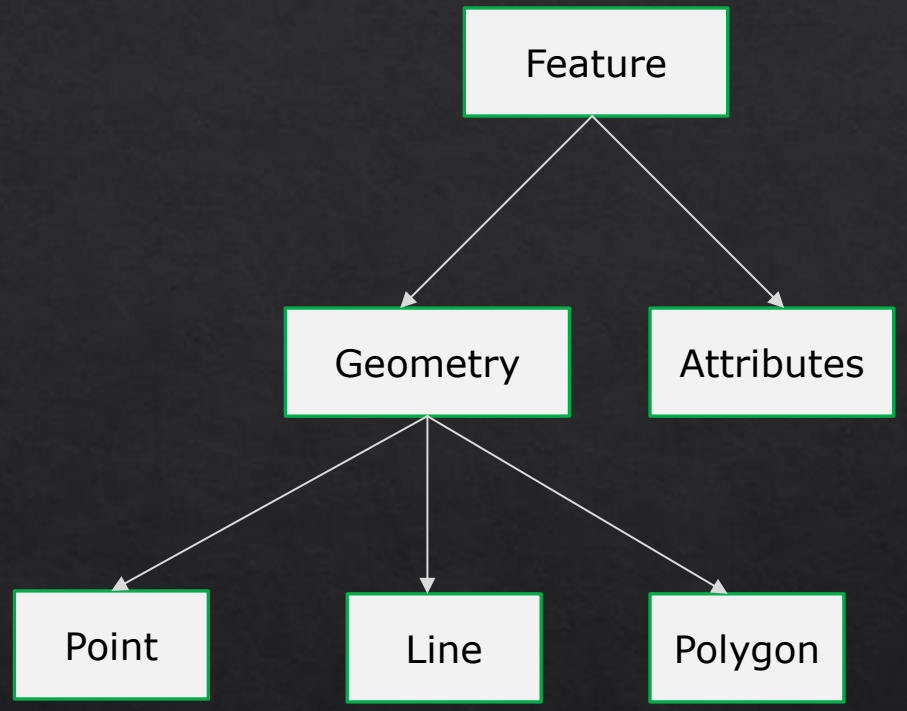
.shp .shx .sbx

.dbf .prj

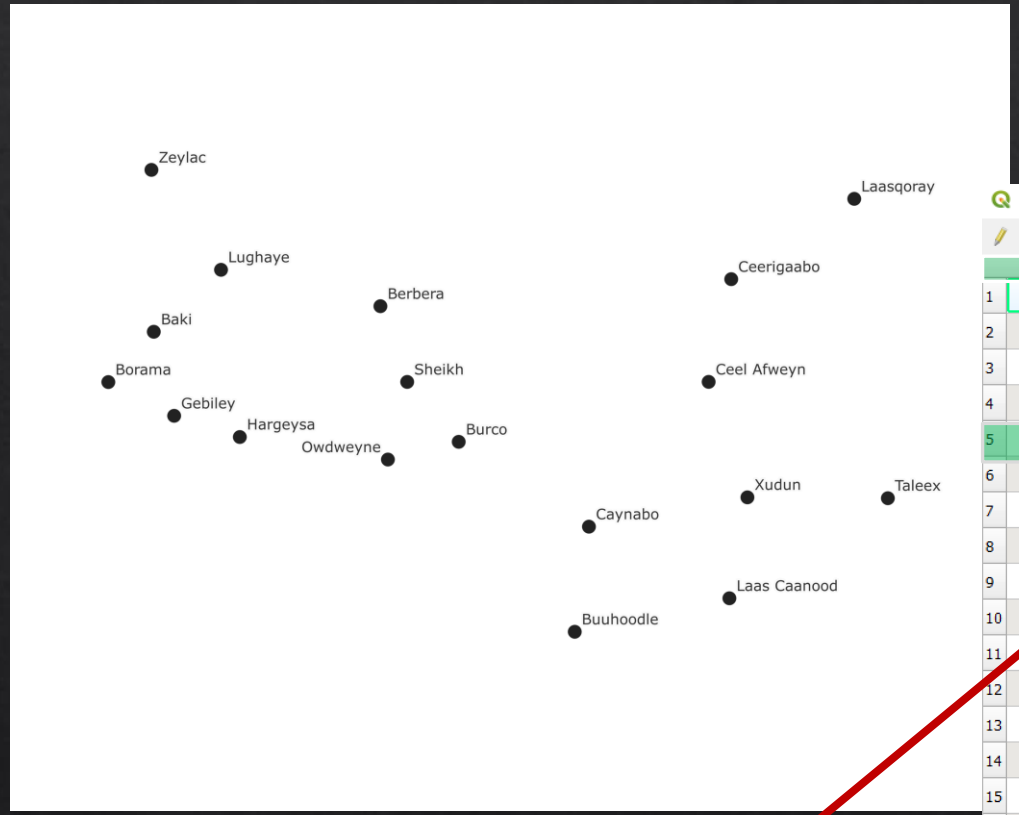
Make sure to keep all files together when moving a new folder.

Vector data type: Attribute table

- A feature has a **geometry** (which determines if it is a point, line or polygon) and **attributes** (which describe the feature).
- An **attribute table** in GIS is a table that shows information about geographic features.
- It is also known as **Attribute Table**



Vector data type: Attribute table (point)



Columns/fields represent attributes, which is details about the features (like district_name, coordinates, etc)

Somaliland-major-towns — Features Total: 18, Filtered: 18, Selected: 0

	fid	NAME	REGION	DISTRICT	SOURCE	Y_COORD	X_COORD	Country
1	2	Borama	Awdal	Borama	Survey	9.9289299999...	43.183349999...	Somaliland
2	1	Baki	Awdal	Baki	Survey	10.266890000...	43.488689999...	Somaliland
3	3	Lughaye	Awdal	Lughaye	Topomaps	10.683260000...	43.940530000...	Somaliland
4	4	Zeylac	Awdal	Zeylac	Topomaps	11.354550000...	43.472819999...	Somaliland
5	72	Gebiley	Maroodi Jeex	Gebiley	Topomaps	9.7023100000...	43.625509999...	Somaliland
6	73	Hargeysa	Maroodi-jeex	Hargeysa	Topomaps	9.5597499999...	44.066780000...	Somaliland
7	71	Berbera	Saaxil	Berbera	Topomaps	10.438720000...	45.011400000...	Somaliland
8	67	Burco	Togdheer	Burco	Topomaps	9.5274900000...	45.537469999...	Somaliland
9	68	Buuhoodle	Togdheer	Buuhoodle	Topomaps	8.2513500000...	46.317129999...	Somaliland
10	69	Owdweyne	Togdheer	Owdweyne	Topomaps	9.4085800000...	45.061709999...	Somaliland
11	70	Sheikh	Saaxil	Sheikh	Topomaps	9.9299400000...	45.191330000...	Somaliland
12	64	Laas Caanood	Sool	Laas Caanood	Topomaps	8.4764500000...	47.356130000...	Somaliland
13	63	Caynabo	Sool	Caynabo	Topomaps	8.9575499999...	46.412489999...	Somaliland
14	65	Taleex	Sool	Taleex	Topomaps	9.1487500000...	48.420870000...	Somaliland
15	66	Xudun	Sool	Xudun	Topomaps	9.1544399999...	47.477220000...	Somaliland
16	60	Ceel Afweyn	Sanaag	Ceel Afweyn	Topomaps	9.9302700000...	47.216780000...	Somaliland
17	61	Ceerigaabo	Sanaag	Ceerigaabo	Topomaps	10.620350000...	47.368470000...	Somaliland
18	62	Laasqoray	Sanaag	Laasqoray	Topomaps	11.160019999...	48.194940000...	Somaliland

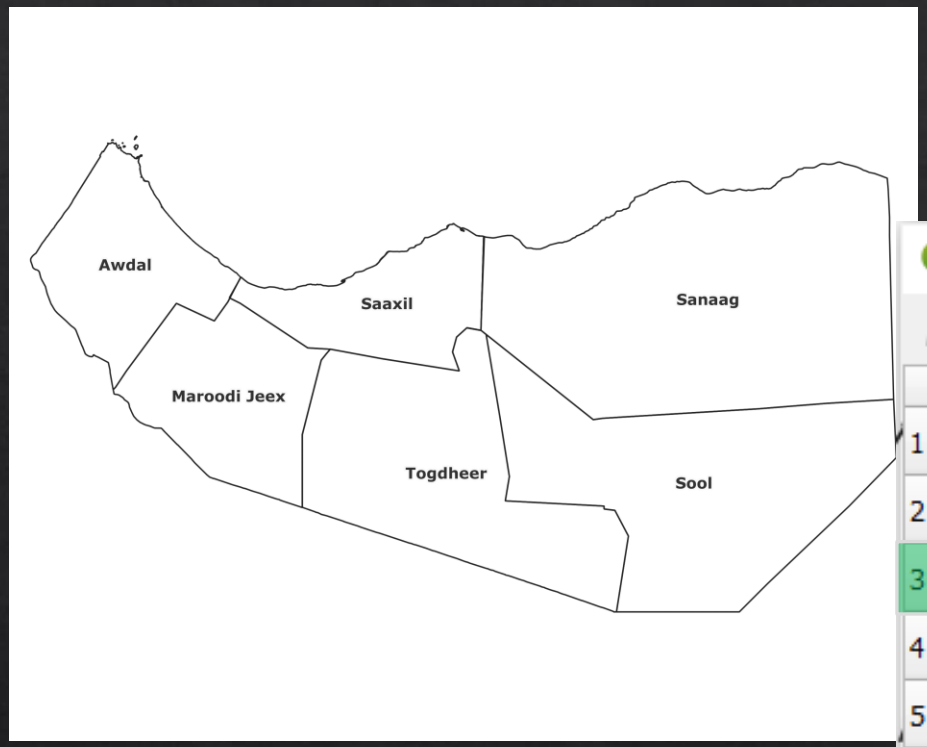
Show All Features

Fields

Rows/records represent individual feature (like point, line, or polygon)

Records

Vector data type: Attribute table (polygon)



This field represents the 'Area' attribute

Somaliland-Admin1 — Features Total: 6, Filtered: 6, Selected: 0

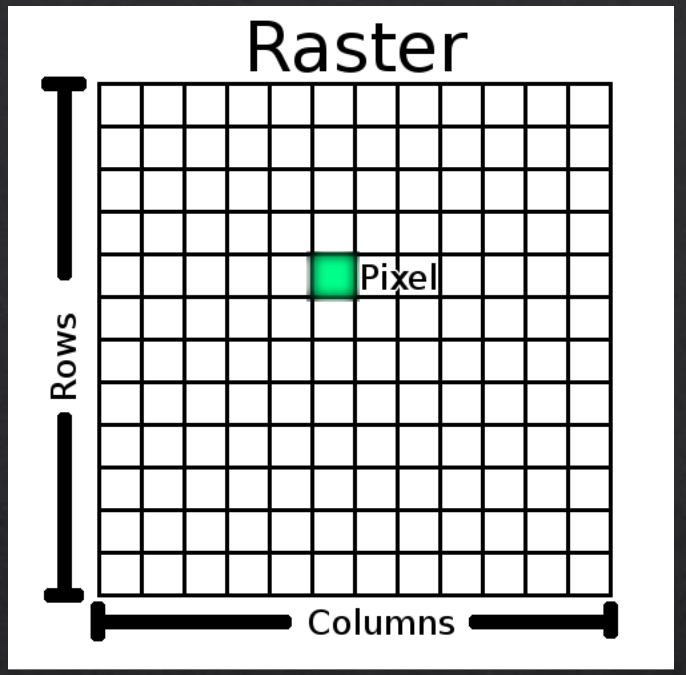
	fid	Region_nam	Type	Country	Area(km2)
1	6	Awdal	Region	Somaliland	16174
2	5	Maroodi Jeex	Region	Somaliland	17704
3	4	Saaxil	Region	Somaliland	13237
4	3	Sanaag	Region	Somaliland	54094
5	2	Sool	Region	Somaliland	38264
6	1	Togdheer	Region	Somaliland	31193

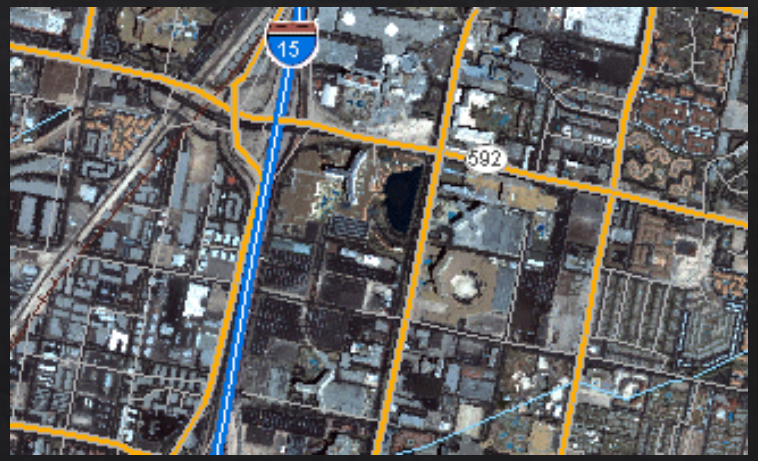
Show All Features

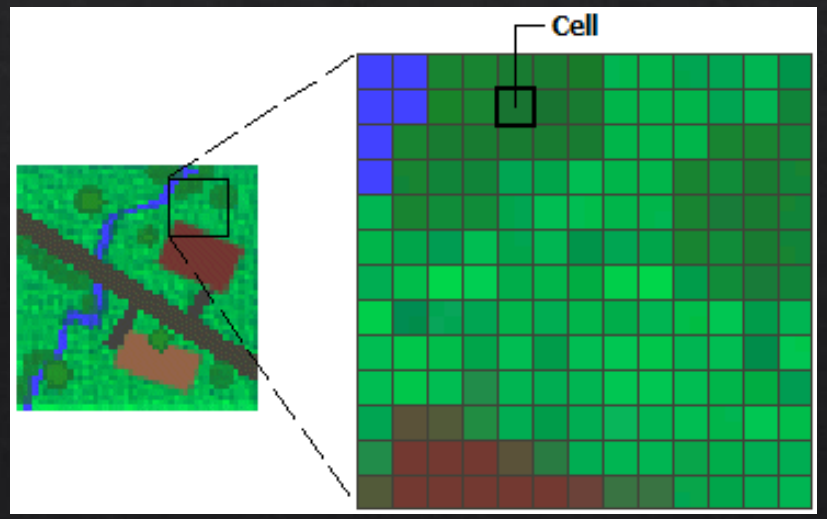
These records represents the feature 'Saaxil'

GIS data types: Raster

- Rasters are made up of a matrix of pixels (also called cells)
- Each pixel containing a value representing information, such temperature or rainfall
- Raster data is used in a GIS application to display information that is **continuous** across an area.
- A raster can only symbolize one variable at a time
- Each cells have a value as well a coordinates
- Common use of raster data in a GIS is as a basemap like Google Earth and Bing Satellite.

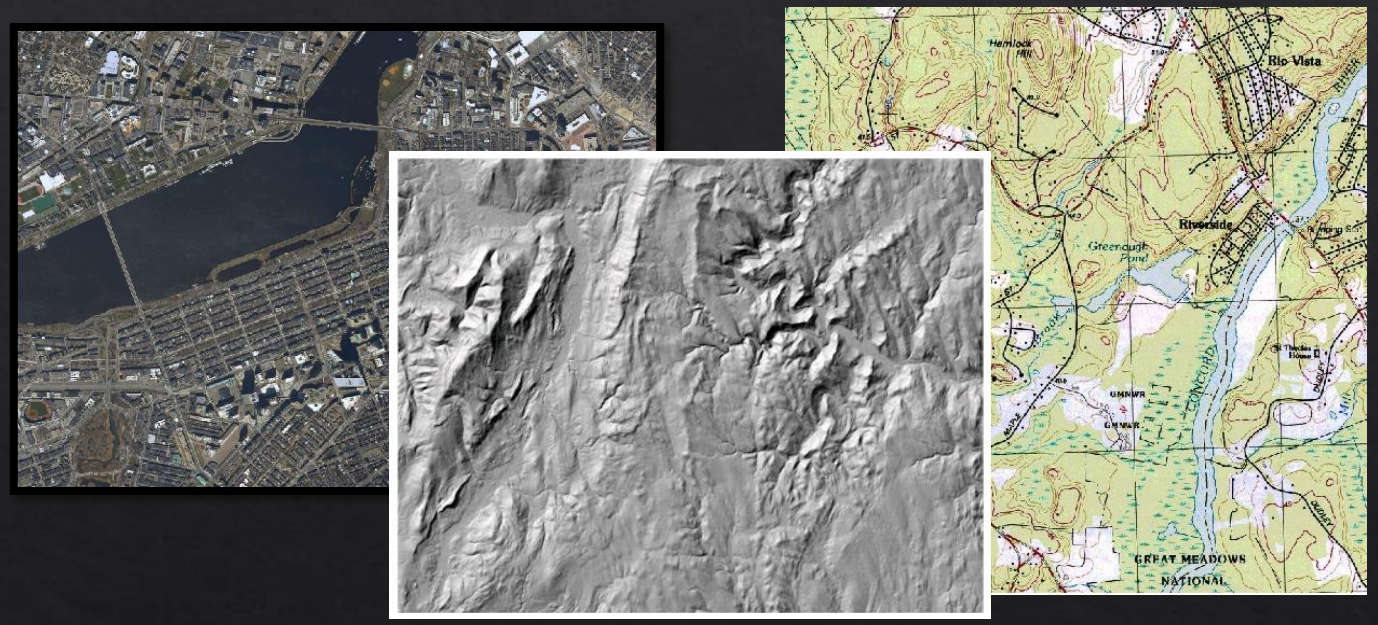






Data Types: Raster

Raster data includes digital pictures, aerial photographs, satellite images, digital elevation models, and scanned maps.



(Remember these are constructed from pixels)

© source: https://www.gispo.fi/en/blog/how-big-is-the-qgis-community-now/

Data Types: Raster file formats

There are many different raster file extensions, including common image formats.

.tiff

.asc

.img

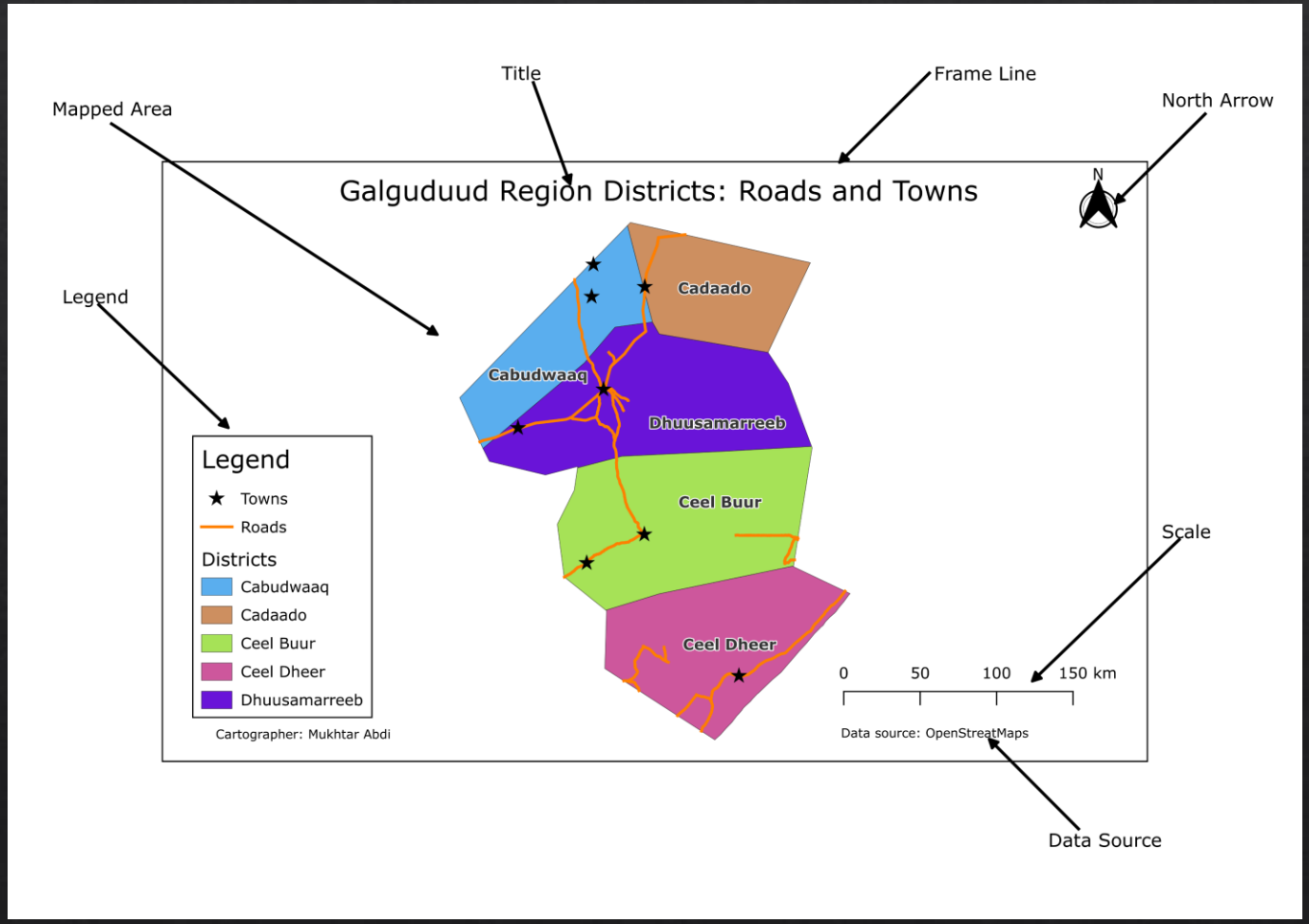
.jpg

Map elements

Map Elements in Cartography

Most maps have basic elements that help reader figure out what the map is about:

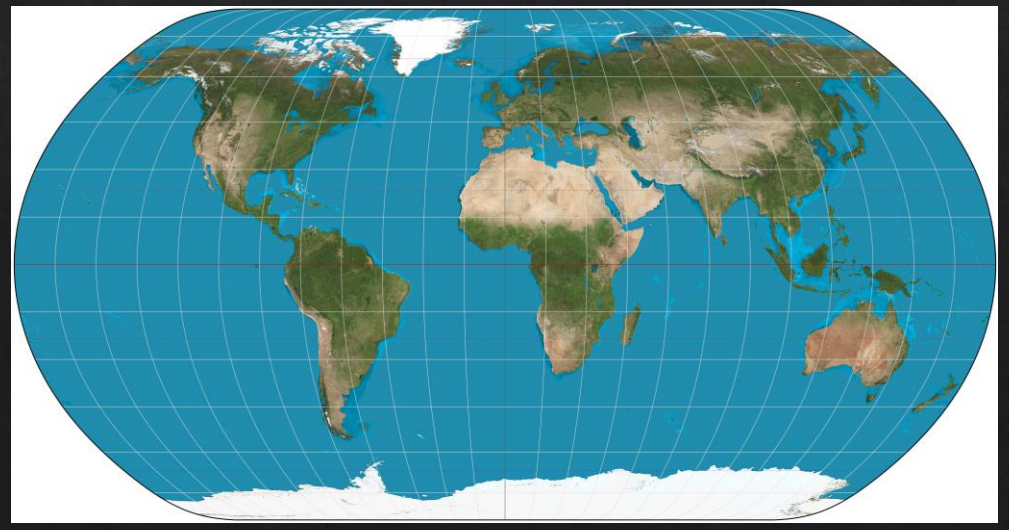
- Frame line
- Mapped area
- A title
- A legend
- Data source
- A scale
- A direction indicator (North arrow)
- Cartographer name



Map Projections

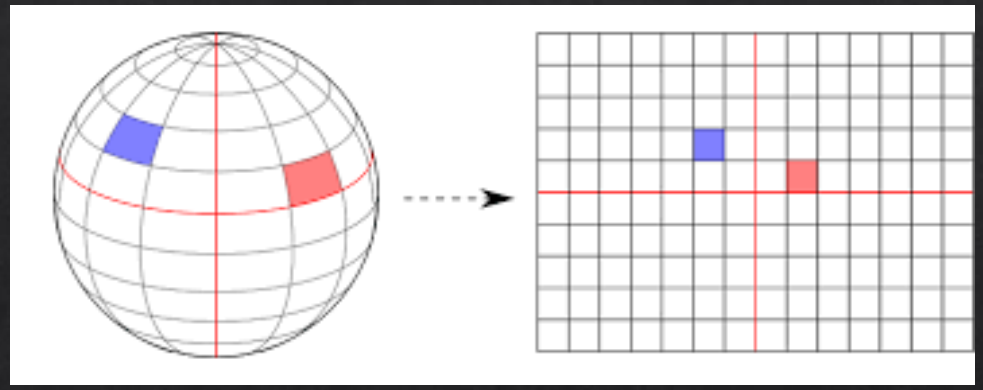
What is map projections?

- The Earth is nearly spherical, making a globe the best way to represent it accurately
- Globes are inconvenient for measuring distances and areas because we view only one side at a time
- **Map projections** try to draw the surface of the earth on a flat piece of paper or computer screen.
- **Map projections** try to transform the earth from its spherical shape (3D) to a planar shape (2D).



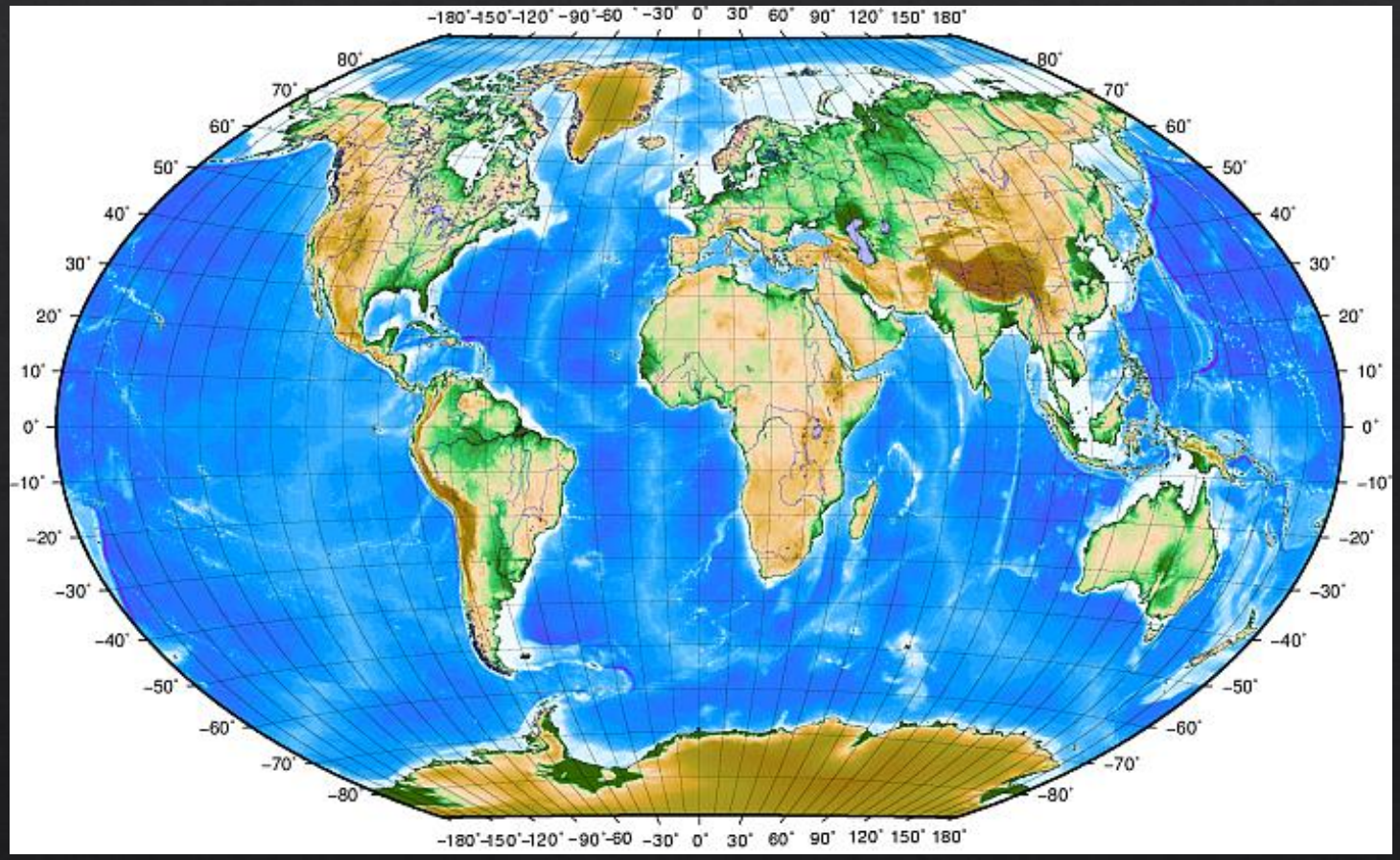
What is a Coordinate Reference System (CRS)?

- CRS is a reference system used to describe the locations of geographic features, imagery, and observations such as GPS locations
- Using CRS, every place on the earth can be specified by a set of three numbers, called **coordinates** (longitude (X), latitude (Y) and elevation (Z))
- CRS can be divided into **geographic coordinate systems** and **projected coordinate systems**



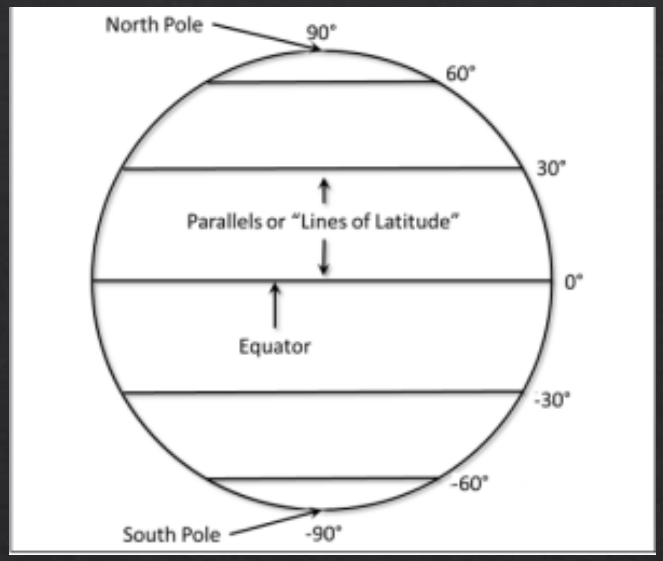
Geographic Coordinate Systems (GCS)

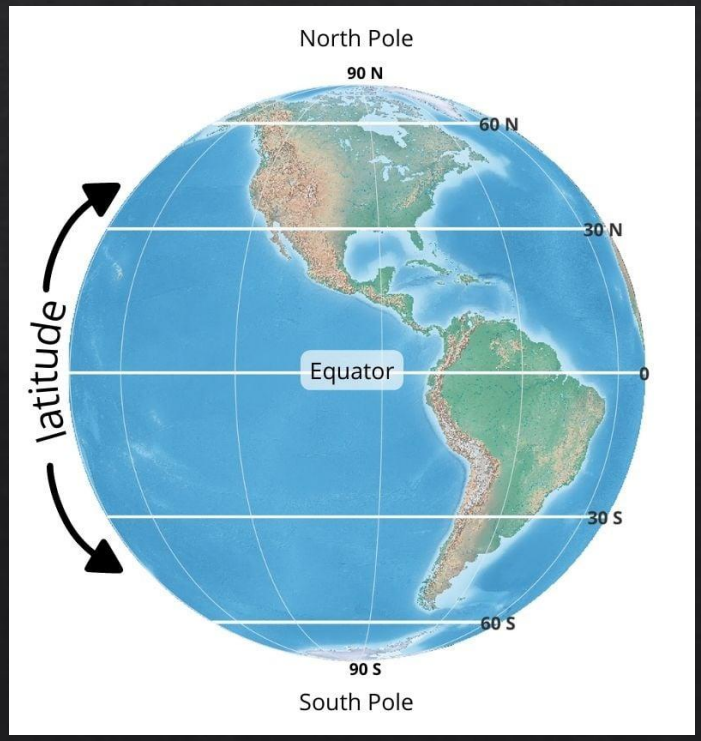
- GCS use degrees of longitude and latitude to describe a location on the earth’s surface. The most popular is called WGS 84:4326



Lines of Latitudes

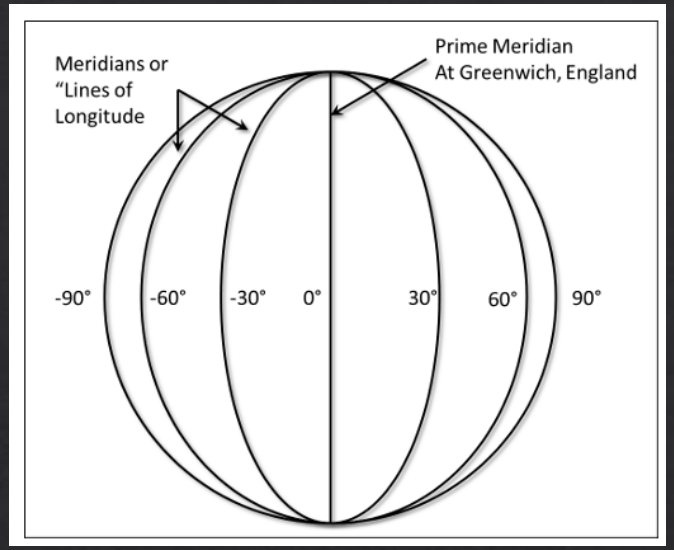
- Latitudes run from east to west
- Latitudes are used to measure distances that are north or south of the equator
- There are a total of 180 degrees of latitudes (90° north + 90° south)
- Latitudes are imaginary lines run parallel and never meet.
- The length of latitude decreases as we move from the equator to the poles
- They also known as Y because the numbers increase in the Y-direction

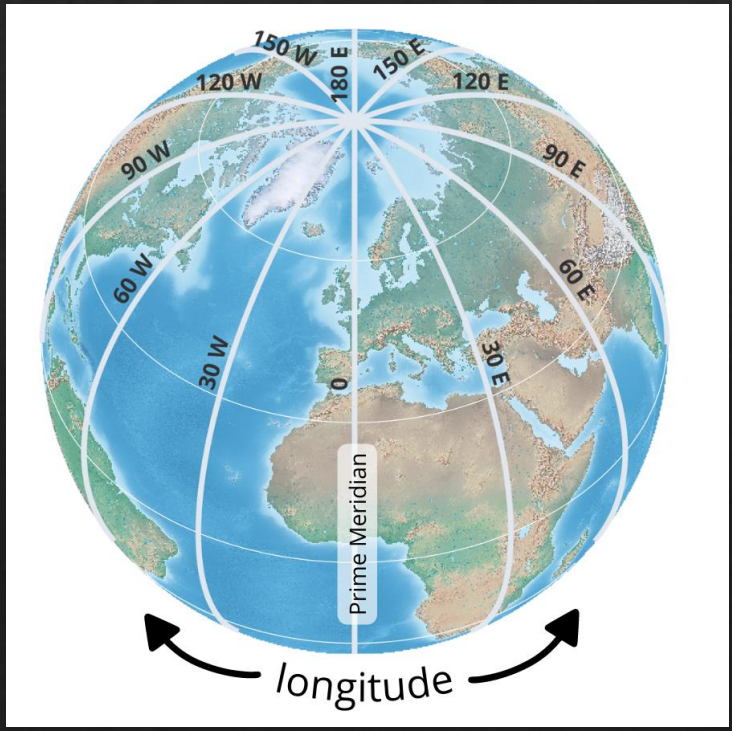




Lines of Longitudes

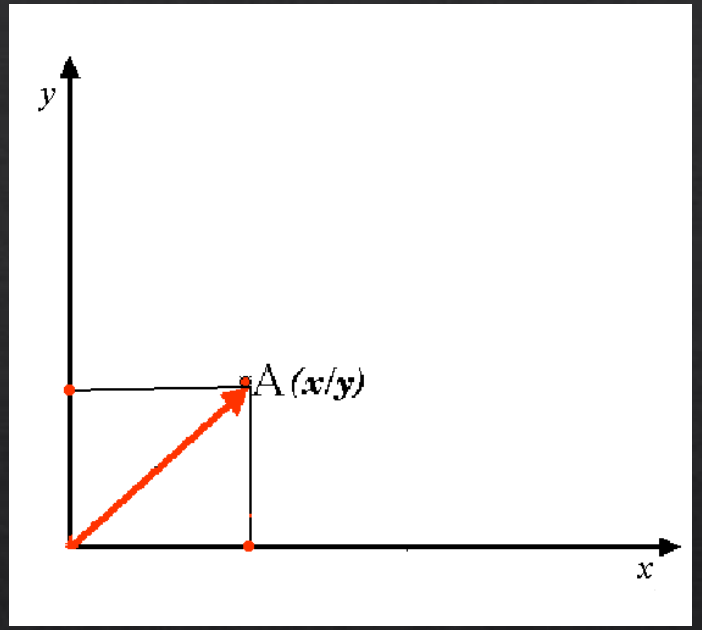
- Longitudes run from north to south
- Longitudes are used to measure distances that are east or west of the prime meridian
- There are a total of 360 degrees of longitudes (180° east + 180° west).
- Longitudes are imaginary lines meet the poles and they do not run parallel.

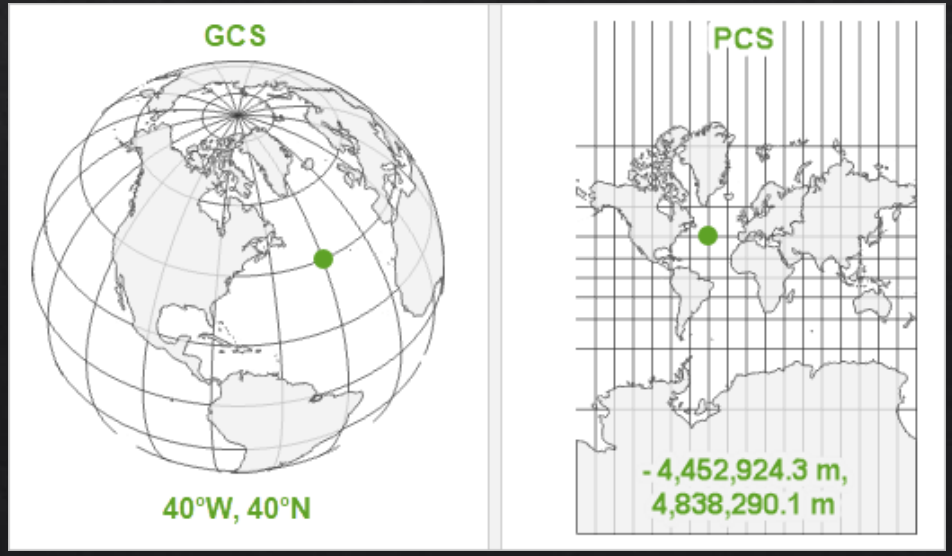




Projected Coordinate Systems (PCS)

- A PCS is a GCS that has been flattened using a map projection
- PCS is defined on a flat, two-dimensional surface
- PCS is defined by two axes that are right angles to each, called XY-plane
- PCS has a constant length and areas across the two dimensions





Coordinate Systems Characteristics

Geographic

- 3D spherical/spheroidal surface defines locations
- Units: degrees (angular)
- Lengths, distances, and areas change with distance away from equator

Projected

- 2D flat/planar surface defines locations
- Units: ft, meters, miles, etc. (linear)
- Lengths, distances, and areas constant across the two dimensions

How to find and download free GIS data?

Sources to find free GIS data

- https://www.openstreetmap.org/
- https://data.humdata.org/group/som
- https://spatial.faoswalim.org/