Regional Training Workshop on the SEEA Ecosystem Accounting – Day 1

GIS concepts

Blanca Perez-Lapena, PhD

June 5, 2023

	Closed Forest	Open Forest	Brush/Shrubs	Open/Barren	Grassland	Annual Crop		Total
Opening area	2505074400.0	5566579200.0	4889535300.0	107920800.0	1985937300.0	2409678900.0	##	17985297600.0
Expansions	307079100.0	883788300.0	1171880100.0	77903100.0	494789400.0	526823100.0	##	3713033700.0
Regressions	164423700.0	805839300.0	1338323400.0	44153100.0	579357000.0	570425400.0	##	3713033700.0
Net change	142655400.0	77949000.0	-166443300.0	33750000.0	-84567600.0	-43602300.0	##	0.0
Closing area	2647729800.0	5644528200.0	4723092000.0	141670800.0	1901369700.0	2366076600.0	##	17985297600.0

Land cover change matrix

	>_Closing	Closed Forest	Open Forest	Brush/Shrubs	Open/Barren	Grassland	Annual Crop
V_Opening		1	4	10	13	14	16
Closed Forest	1	2340650700.0	147035700.0	10170000.0	940500.0	1851300.0	409500.0
Open Forest	4	290448900.0	4760739900.0	379714500.0	3848400.0	56559600.0	50959800.0
Brush/Shrubs	10	10765800.0	592208100.0	3551211900.0	9173700.0	355757400.0	289281600.0
Open/Barren	13	46800.0	1008900.0	3570300.0	63767700.0	10561500.0	8543700.0
Grassland	14	1014300.0	48394800.0	385114500.0	11777400.0	1406580300.0	112129200.0
Annual Crop	16	1112400.0	73788300.0	330057900.0	14897700.0	58254300.0	1839253500.0

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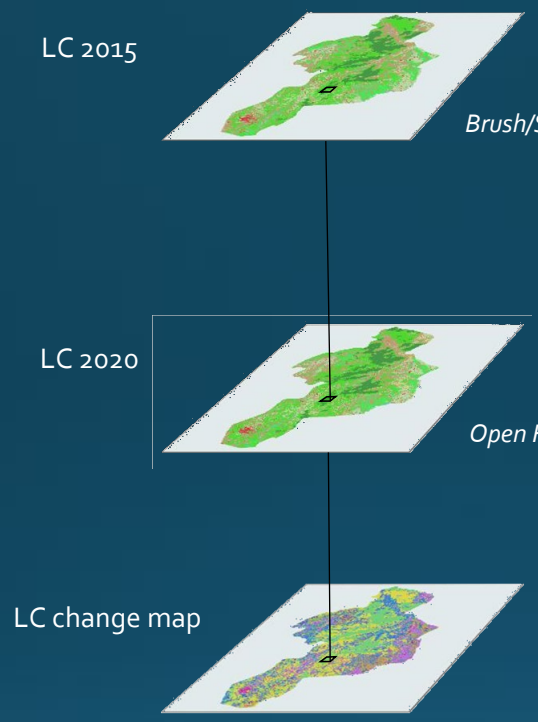

From Brush/Shrubs to Open Forest

Land cover change matrix

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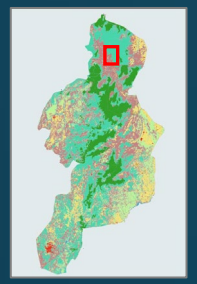
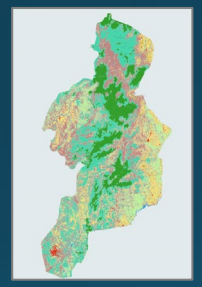
Vector

LC 2015



LC 2020

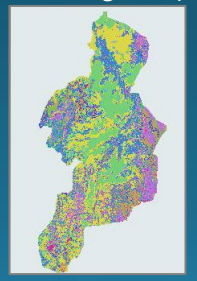


Raster

LC 2015

LC 2020

LC change map



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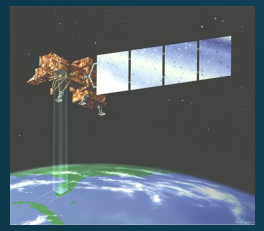
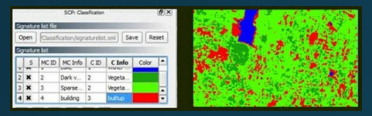
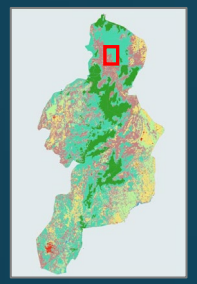




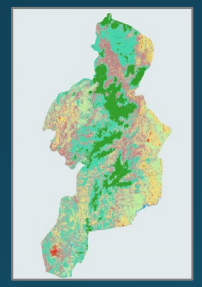
Vectorization

Vector

LC 2015



LC 2020

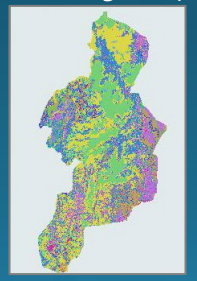


Raster

LC 2015

LC 2020

LC change map



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GIS

- Geographical Information System
- Captures, stores, analyses, and displays geospatial data on a computer screen.

Geospatial data

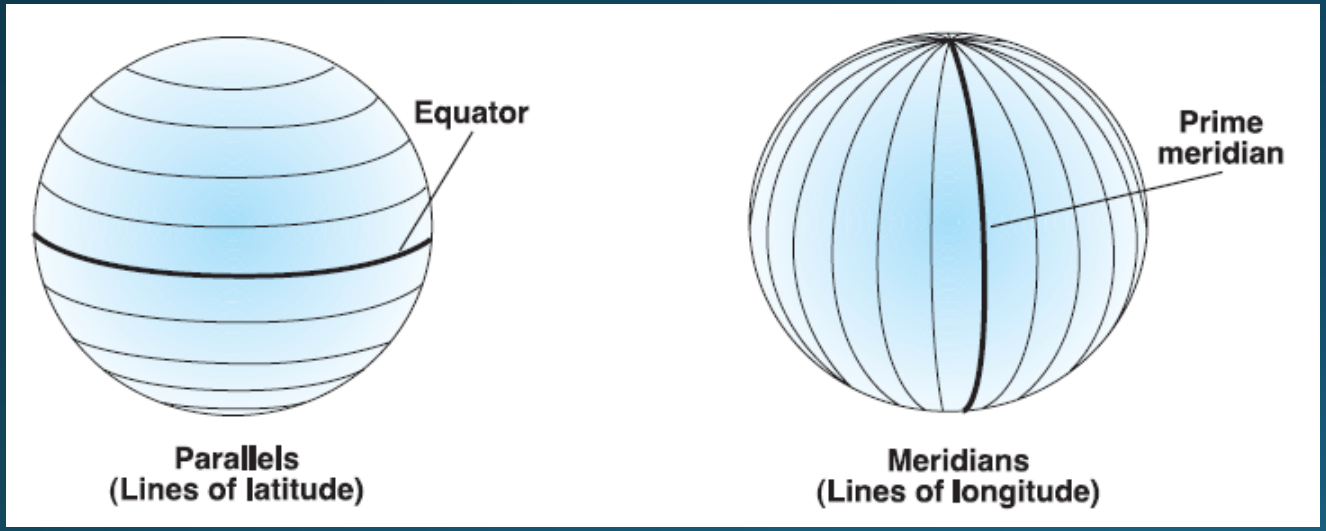
Data that is associated to a geographical location

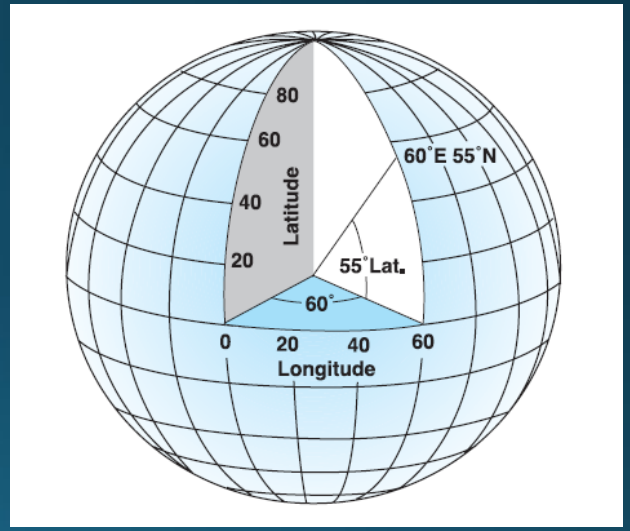
Coordinate systems

- Types:
  - **Geographic coordinate system**:
    defines ***where*** the data is located on the Earth's surface.
  - **Projected coordinate system**:
    defines ***how*** to draw the data on a flat surface, like on a paper map or a computer screen.

Geographic coordinate system (GCS)

- Uses Latitude and Longitude (angular units) to identify locations on the curved surface of the Earth.





ESRI, 2000

- It is defined by an ellipsoid, geoid and datum, angular unit of measure

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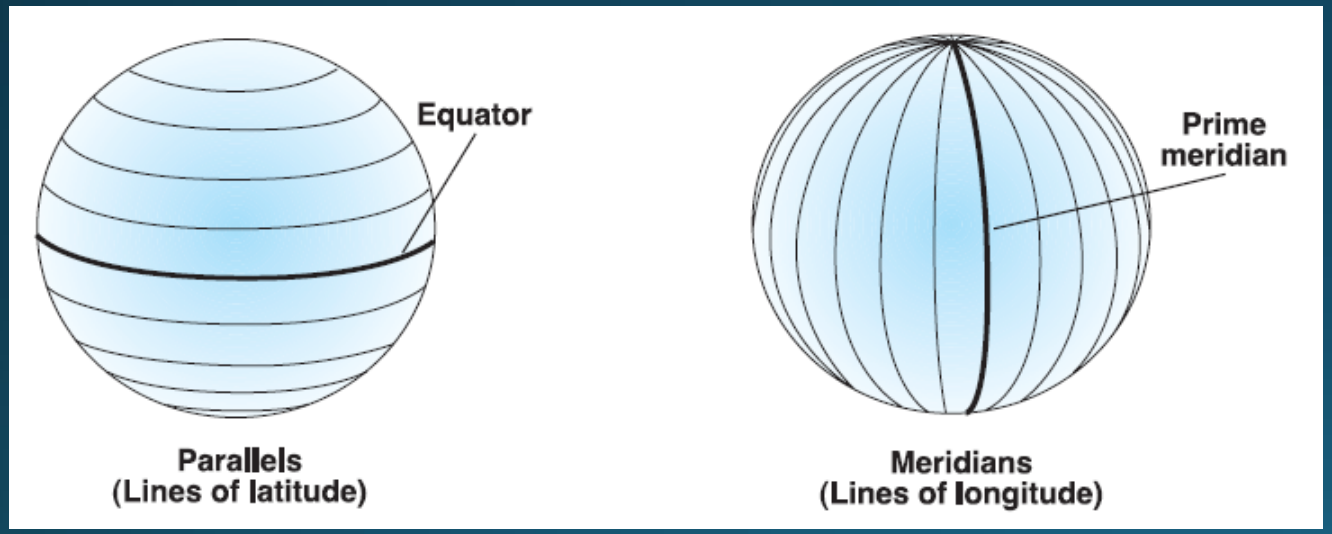
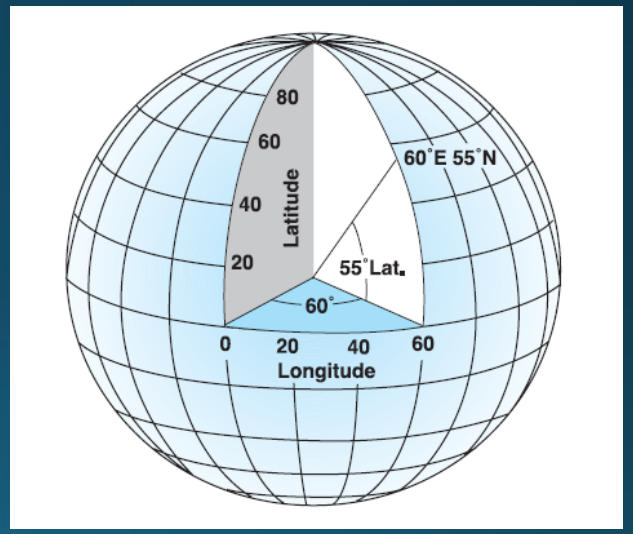


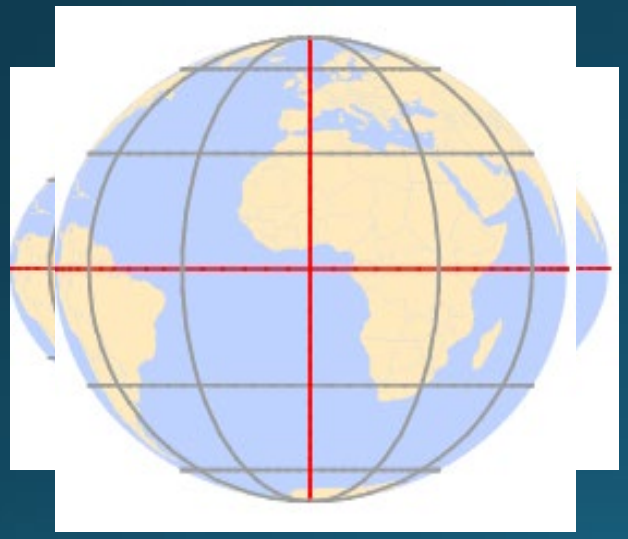


ESRI, 2000

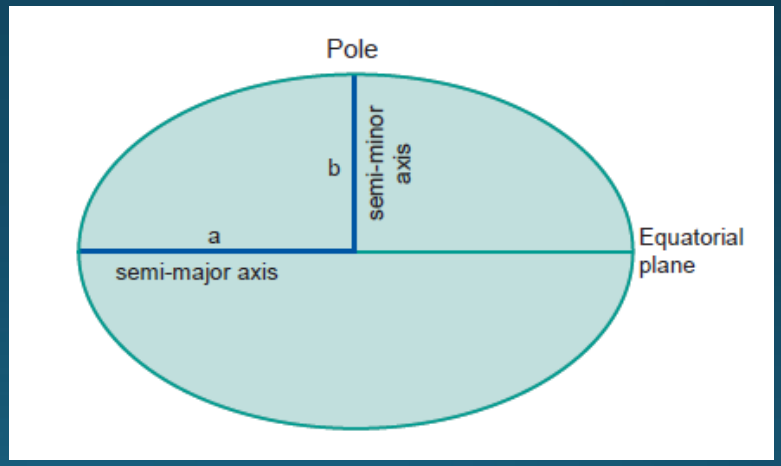
- It is defined by an ellipsoid, geoid and datum, angular unit of measure

GCS – Ellipsoid

- Used as a simplified mathematical representation of the Earth's shape
- The semi-major and semi-minor axes are of defined length



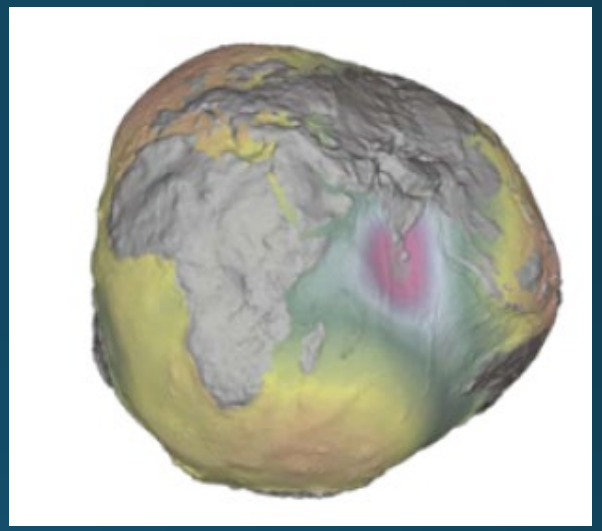
Gimond 2022



- Generally, an ellipsoid is chosen to fit one country or a particular area

GCS – Geoid

- Earth's true shape
- Not a perfectly smooth surface
- Constantly changing

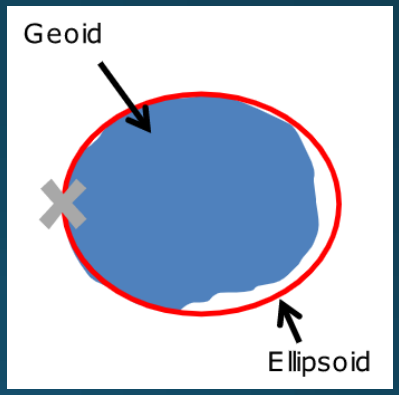


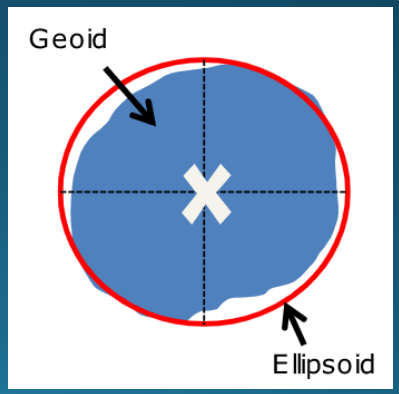
ITC, 2009

How to work with a simple mathematical model of the Earth's shape (ellipsoid) when dealing with the undulating nature of the Earth's surface (geoid)?

GCS – Datum

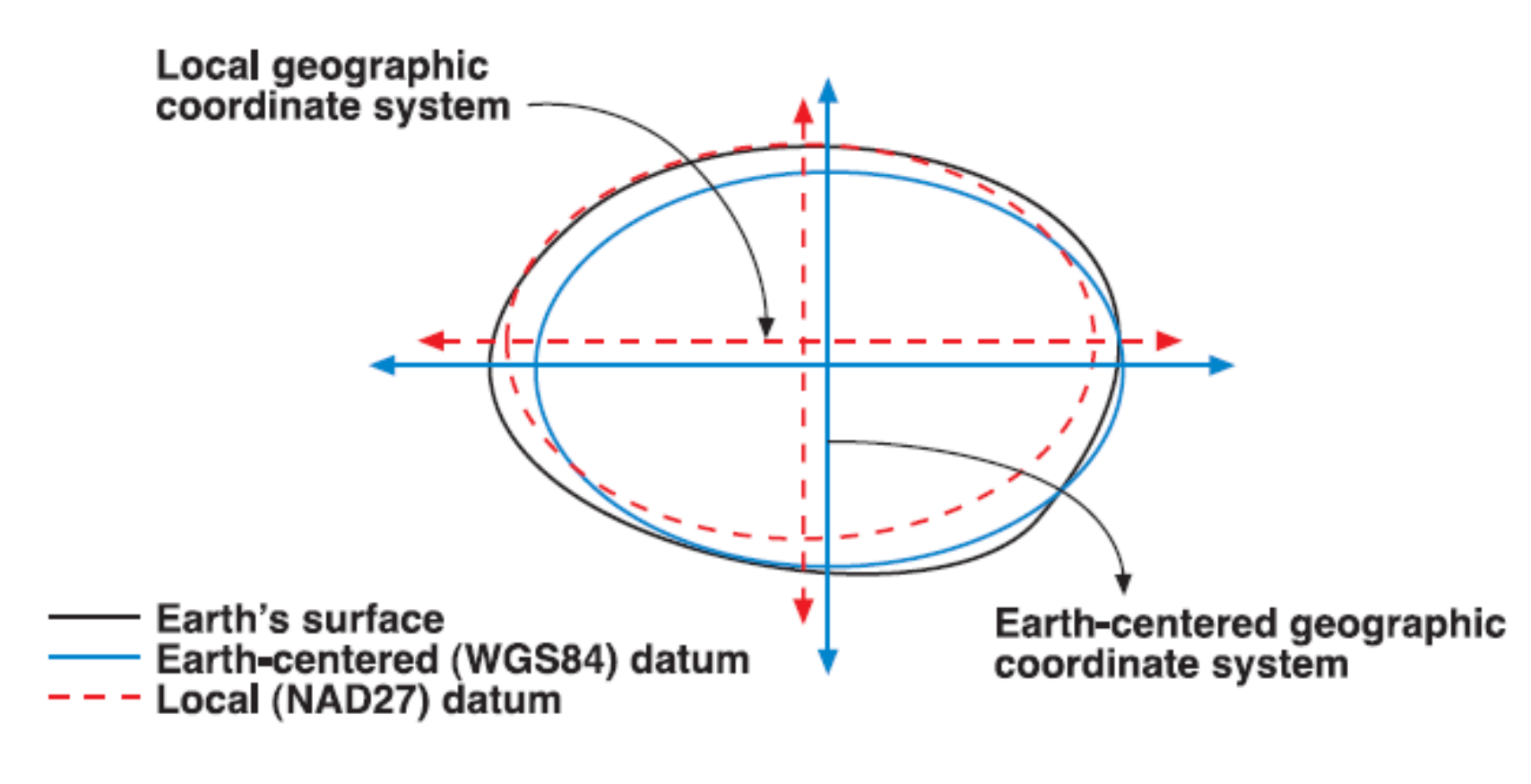
- Defines how the ellipsoid is aligned with the geoid
- Alignment:
  - Local datum: the ellipsoid surface is closely fit to the geoid at a particular location on the earth's surface
  - Geocentric datum: the ellipsoid is aligned with the center of the earth





Gimond, 2022

GCS – Datum



ESRI, 2000

GCS – Example

```
GEOGCS["GCS_PRS_1992",
        DATUM["D_Philippine_Reference_System_1992",
        SPHEROID["Clarke_1866",6378206.4,294.9786982]],
        PRIMEM["Greenwich",0.0],
        UNIT["Degree",0.0174532925199433]],
```

Projected coordinate system (PCS)

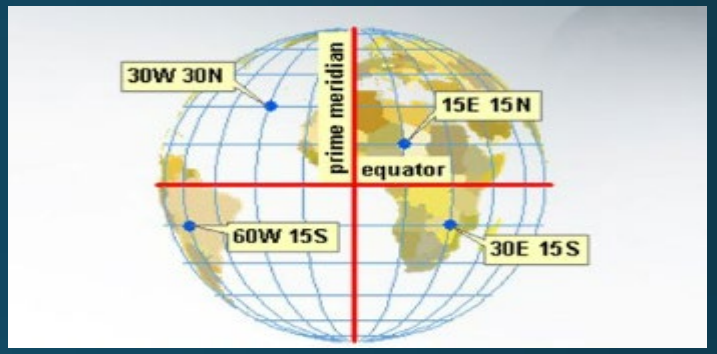
- **How** to draw the data on a flat surface, like on a paper map or a computer screen

Smith, 2020

PCS – Components

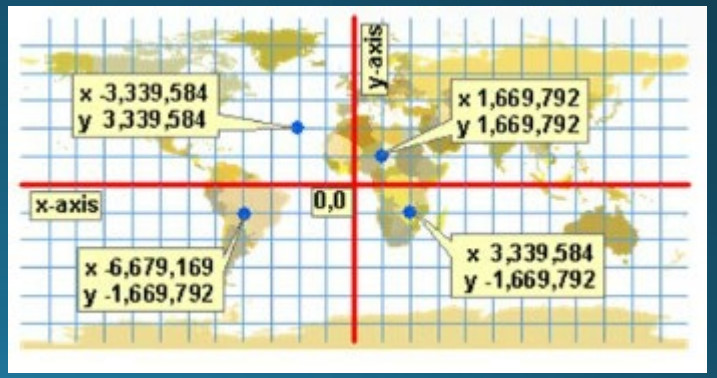
A projected coordinate system consists of:

- a geographic coordinate system
- a map projection
- the specific parameters used by the map projection
- a linear unit of measure (usually meters or feet)



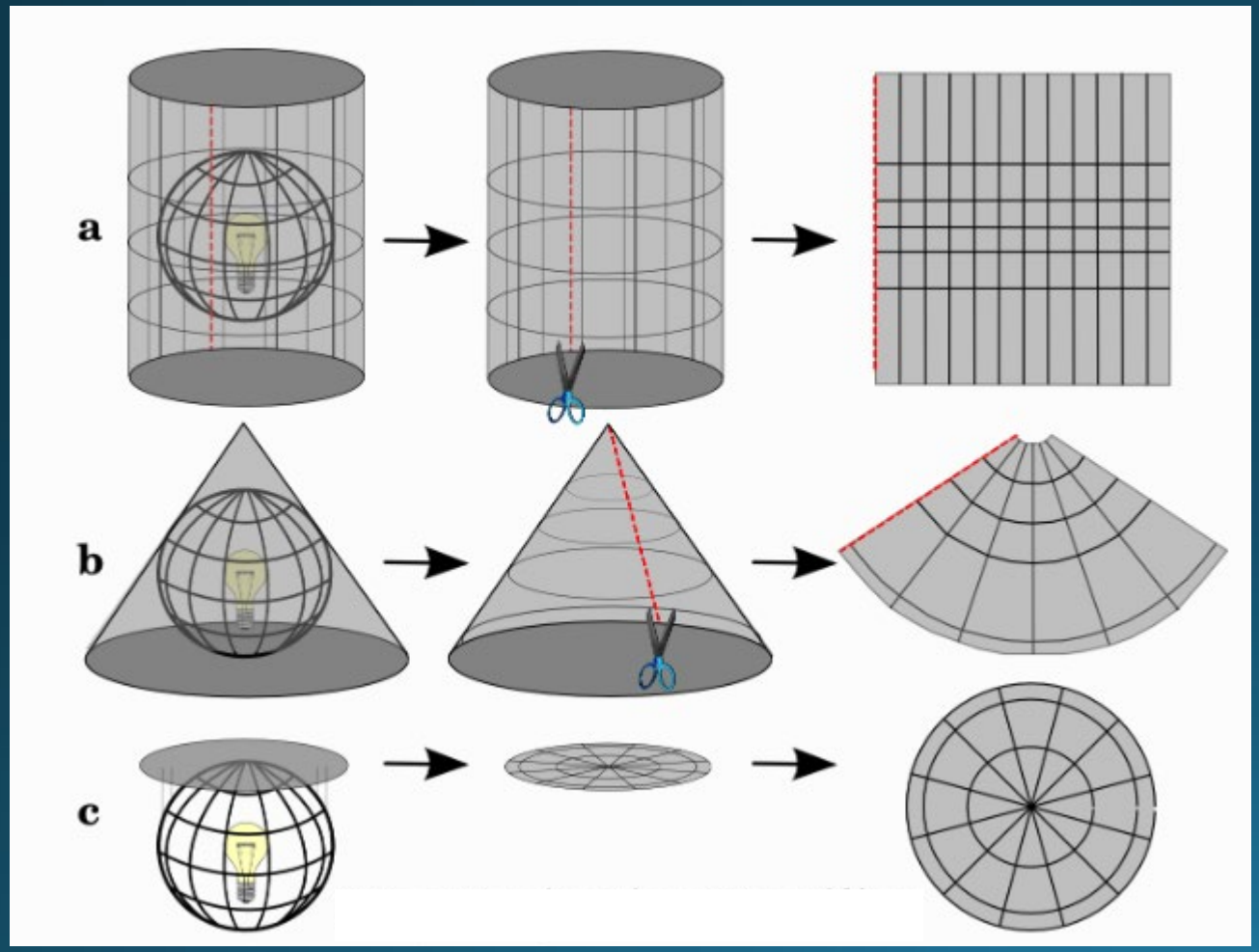
Map projection

Locations are identified by x,y coordinates on a grid, with the origin at the center of the grid.



Gould, 2013

PCS – Map projections: Classes



QGIS, 2022

Cylindrical

Conic

Planar (azimuthal)

PCS – Map projections: Properties

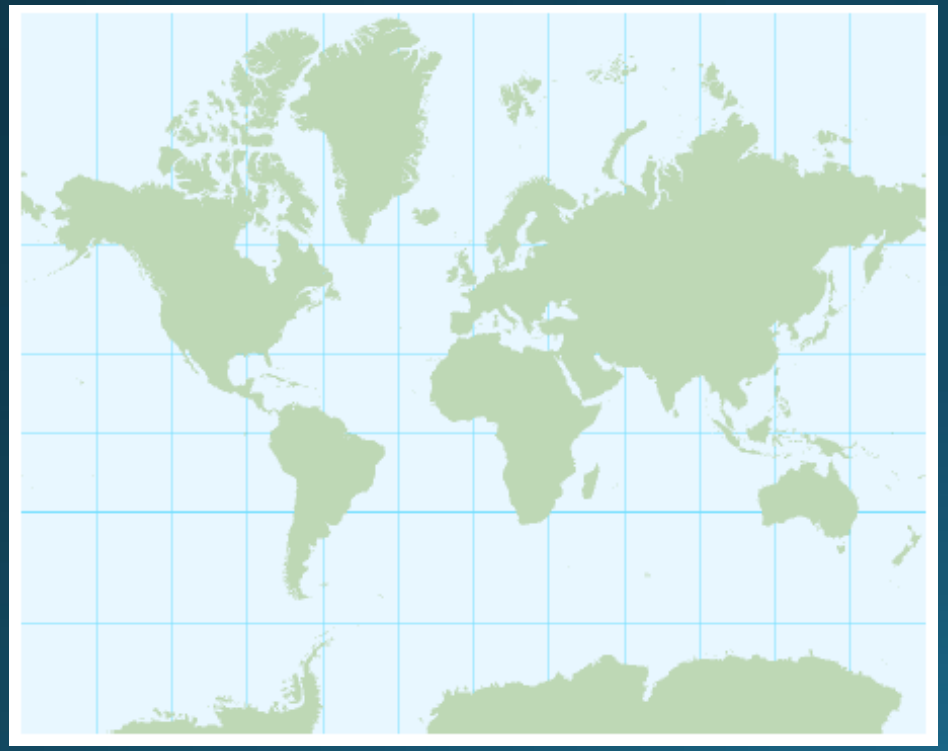
- The way the surface (cylinder or cone) is 'wrapped' around the Earth and the location of the plane (planar)

Determine which kind of **distortions** the map will have compared to the original curved surface.

- **Conformal** map projection: angles (with short sides) and shapes (of small areas) are shown correctly in the map
- **Equal-area** (equivalent) map projection: areas are represented correctly in the map.
- **Equidistant** map projection: lengths of particular lines in the map are the same as the lengths of the original lines on the curved reference surface.

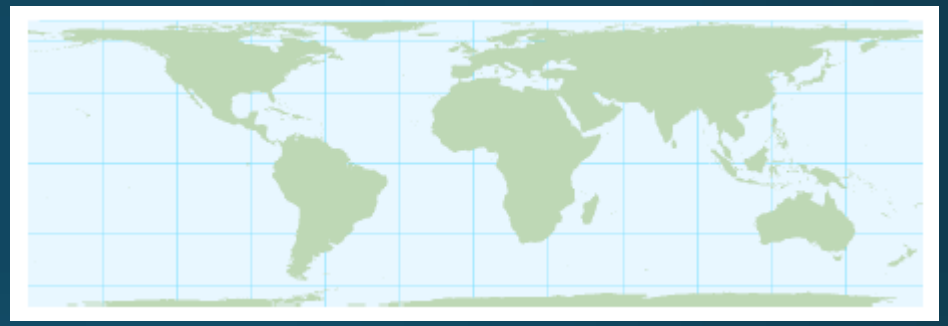
PCS – Map projections: Examples

Cylindrical with conformal property
(Mercator projection) Animation



ITC, 2009

Cylindrical with equal-area property
(Lambert cylindrical equal-area projection)



ITC, 2009

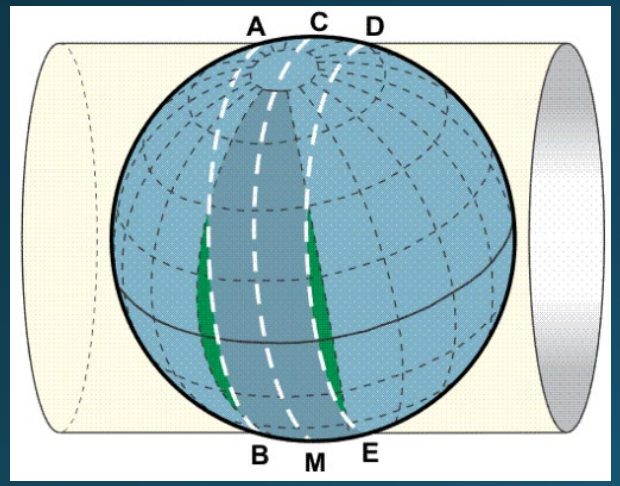
Cylindrical with equidistant property
(Plate Carrée projection)

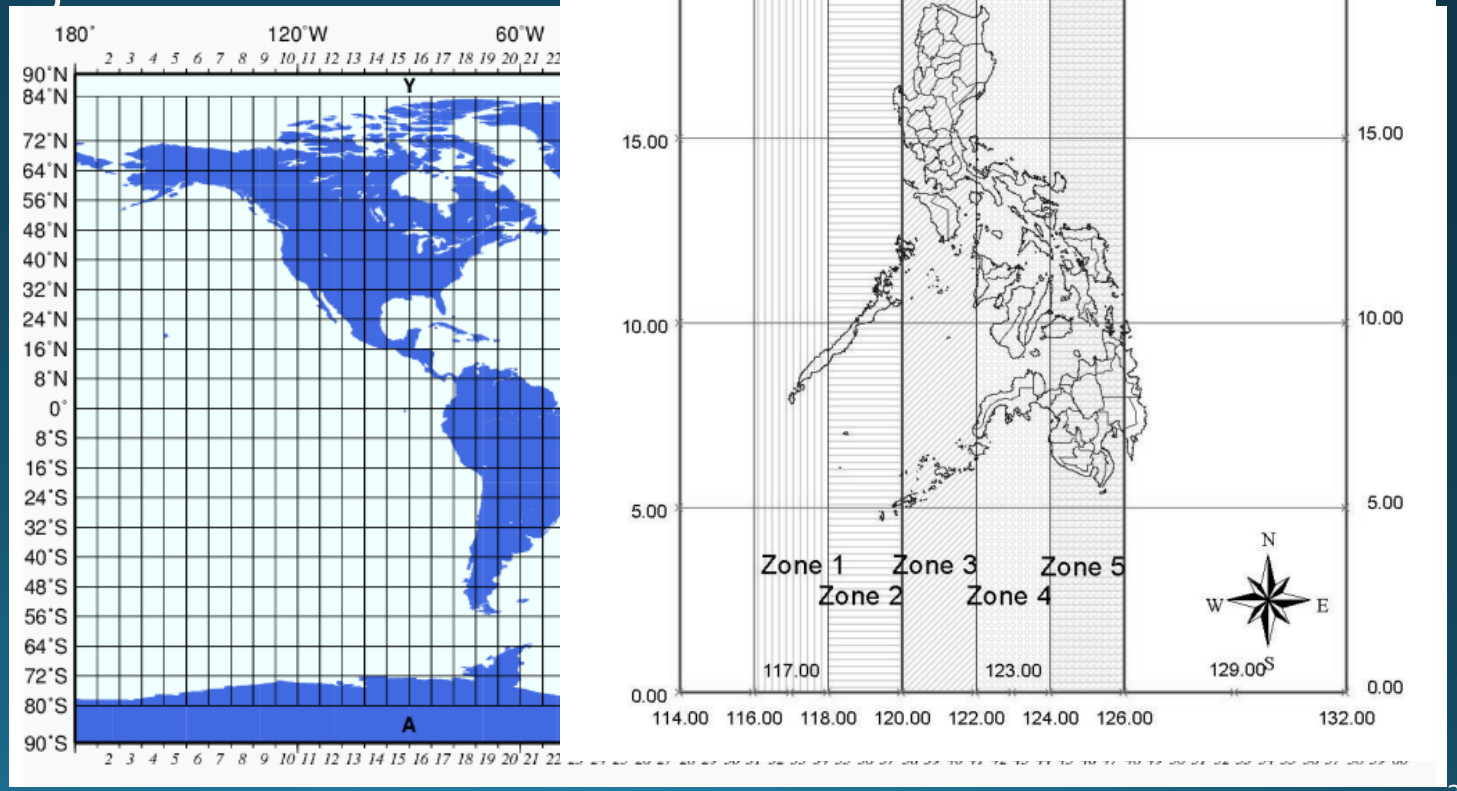
ITC, 2009

PCS – UTM

- Based on the secant Transverse Mercator
- The globe is divided into 60 zones,

each spanning six degrees of longitude.





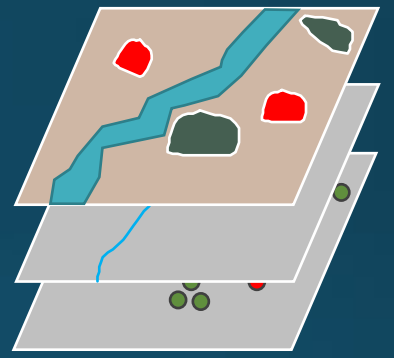
PCS – Example

```
PROJCS["PRS_1992_UTM_Zone_51N",
        GEOGCS["GCS_PRS_1992",
                DATUM["D_Philippine_Reference_System_1992",
                SPHEROID["Clarke_1866",6378206.4,294.9786982]],
                PRIMEM["Greenwich",0.0],
                UNIT["Degree",0.0174532925199433]],
        PROJECTION["Transverse_Mercator"],
                PARAMETER["False_Easting",500000.0],
                PARAMETER["False_Northing",0.0],
                PARAMETER["Central_Meridian",123.0],
                PARAMETER["Scale_Factor",0.9996],
                PARAMETER["Latitude_Of_Origin",0.0],
                UNIT["Meter",1.0]]
```

Data representation I

Real World

Vector

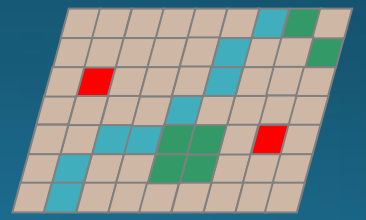


polygon

line

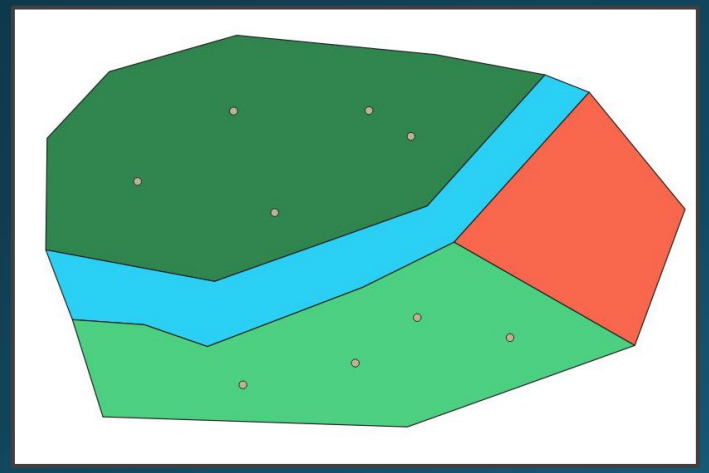
point

Raster

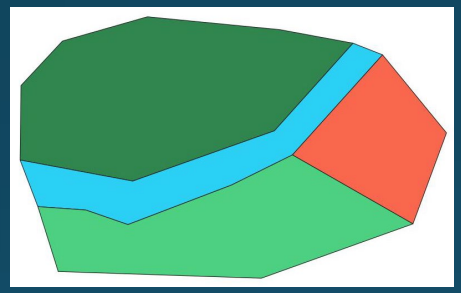


Vector

- A spatial object consists of a geometry and a set of attributes.



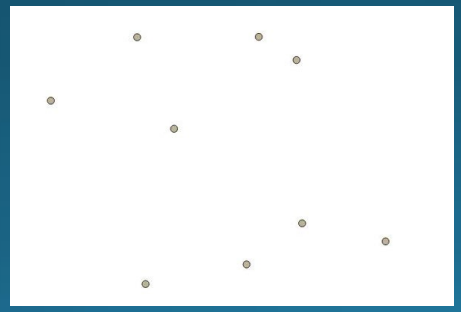
Polygon layer



Land_cover — Features Total: 4, Filtered: 4, Selected: 0

	id	LC_class	Area_km2
1	1	Forest	1.173
2	2	Water body	0.436
3	3	Urban	0.421
4	4	Grassland	0.795

Point layer

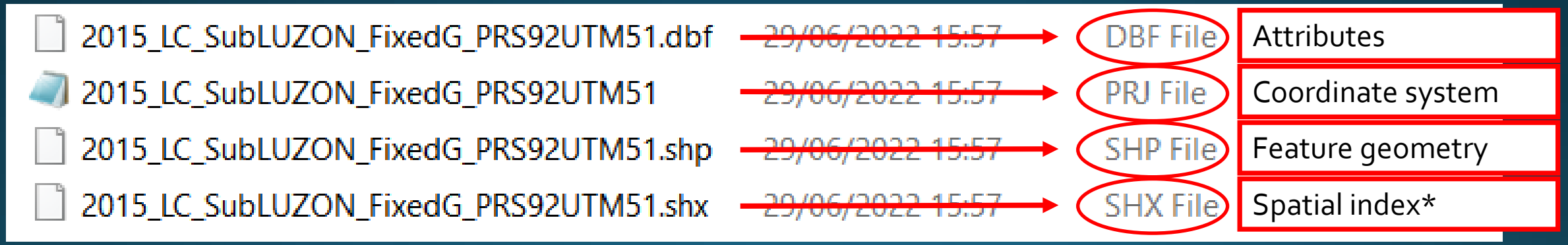


Tree_sp — Features Total: 9, Filtered: 9, Selected: 0

	id	TSpecies	height_m	diameter_m	age_years
1	1	Oak	8	50	40
2	2	Maple	6	40	30
3	3	Pine	7	45	35
4	4	Birch	5	35	25
5	5	Oak	10	55	45
6	6	Maple	8	45	35
7	7	Pine	9	50	40
8	8	Spruce	7	40	30
9	9	Fir	6	38	25

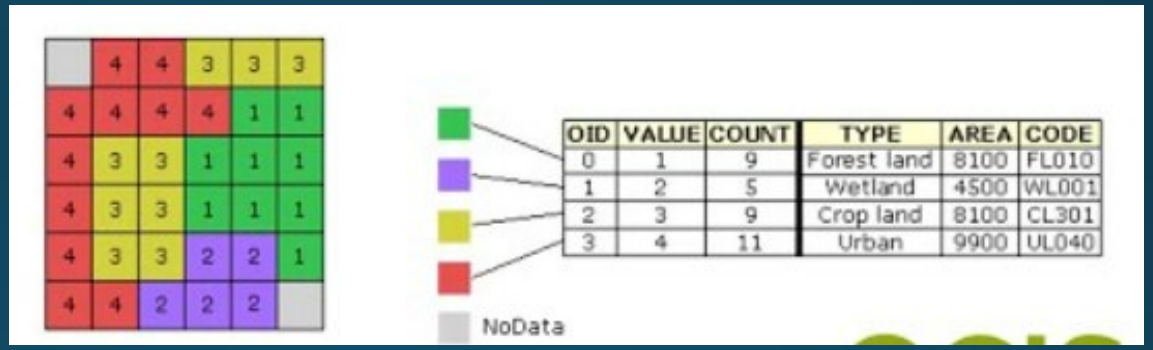
Shapefiles

- Common format for storing vector data
- Shapefiles store non-topological vector data with attribute data
- A shapefile consists of several files with the same filename, but different file endings:



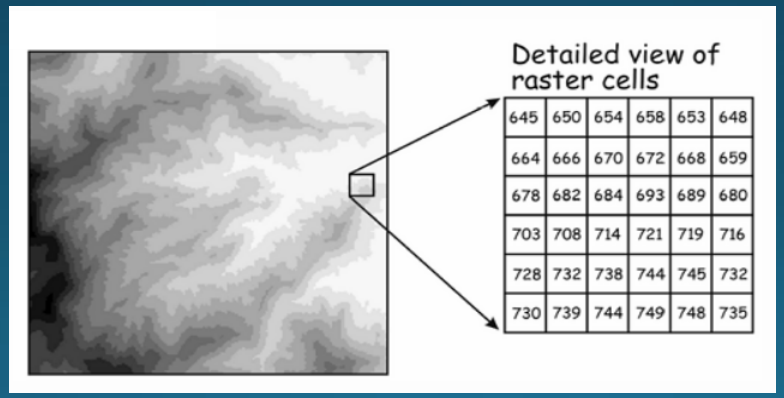
Raster

- Data associated to gridded cells identified by row and column
- Discrete Raster

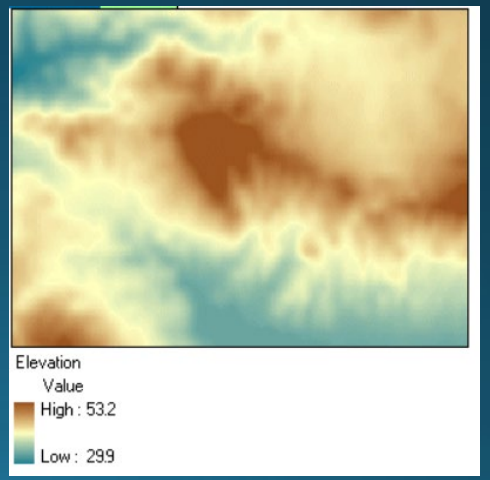


OID	VALUE	COUNT	TYPE	AREA	CODE
0	1	9	Forest land	8100	FL010
1	2	5	Wetland	4500	WL001
2	3	9	Crop land	8100	CL301
3	4	11	Urban	9900	UL040

- Continuous Raster



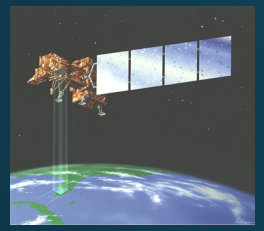
HSU, 2018

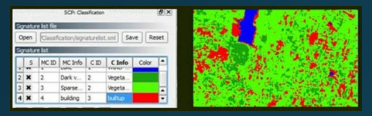


GeoTIFF

- Metadata standard which has the georeferencing information embedded within the raster file.

Name	Date	Type	Size
CAR_Improbable_Transitions20152020_v1_30m	29/03/2023 07:48	TIF File	12,530 KB

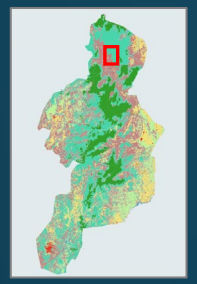




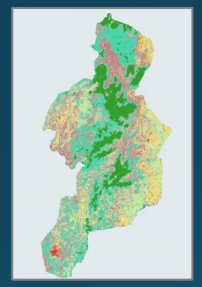
Vectorization

Vector

LC 2015



LC 2020

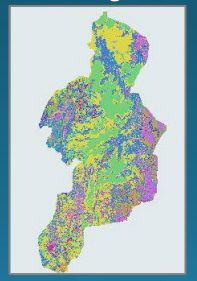


Raster

LC 2015

LC 2020

LC change

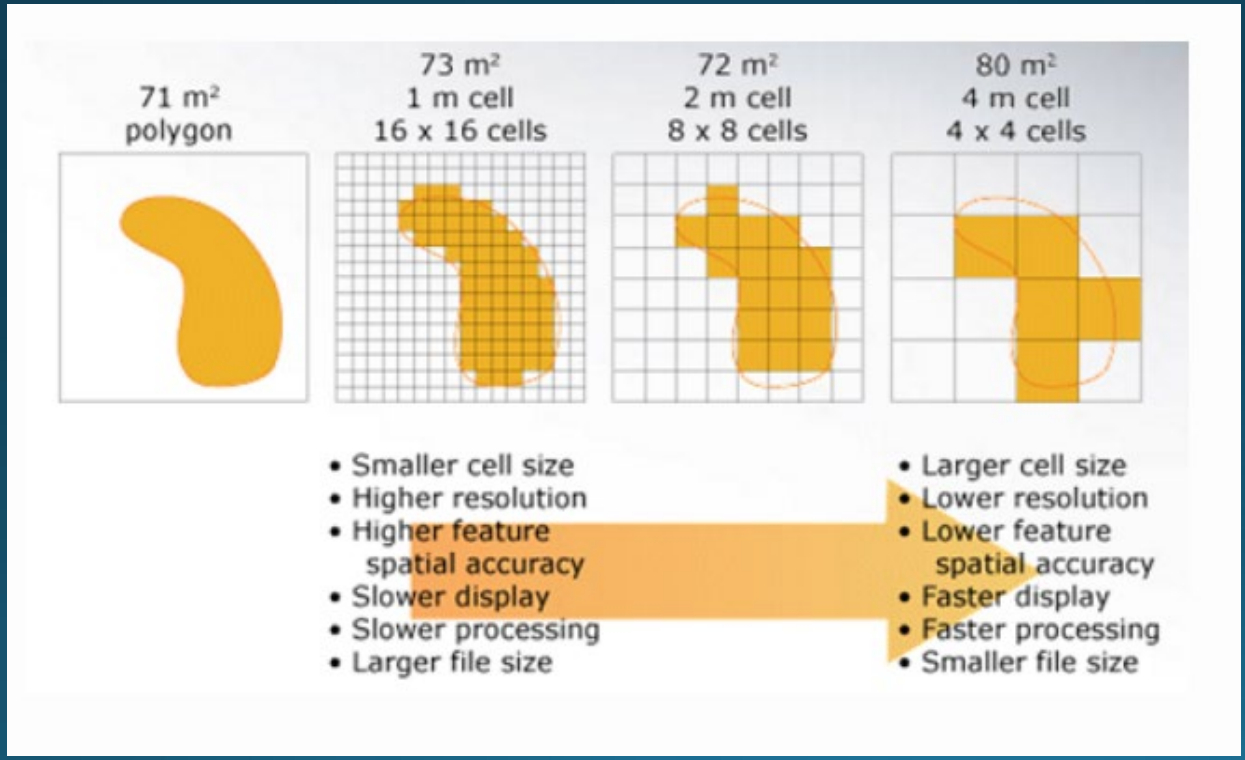


	>_Closing	Closed Forest	Open Forest	Brush/Shrubs	Open/Barren	Grassland	Annual Crop
V_Opening		1	4	10	13	14	16
Closed Forest	1	2340650700.0	147035700.0	10170000.0	940500.0	1851300.0	409500.0
Open Forest	4	290448900.0	4760739900.0	379714500.0	3848400.0	56559600.0	50959800.0
Brush/Shrubs	10	10765800.0	592208100.0	3551211900.0	9173700.0	355757400.0	289281600.0
Open/Barren	13	46800.0	1008900.0	3570300.0	63767700.0	10561500.0	8543700.0
Grassland	14	1014300.0	48394800.0	385114500.0	11777400.0	1406580300.0	112129200.0
Annual Crop	16	1112400.0	73788300.0	330057900.0	14897700.0	58254300.0	1839253500.0

	Closed Forest	Open Forest	Brush/Shrubs	Open/Barren	Grassland	Annual Crop		Total
Opening area	2505074400.0	5566579200.0	4889535300.0	107920800.0	1985937300.0	2409678900.0	##	17985297600.0
Expansions	307079100.0	883788300.0	1171880100.0	77903100.0	494789400.0	526823100.0	##	3713033700.0
Regressions	164423700.0	805839300.0	1338323400.0	44153100.0	579357000.0	570425400.0	##	3713033700.0
Net change	142655400.0	77949000.0	-166443300.0	33750000.0	-84567600.0	-43602300.0	##	0.0
Closing area	2647729800.0	5644528200.0	4723092000.0	141670800.0	1901369700.0	2366076600.0	##	17985297600.0

Raster resolution

- One of the key issues with rasters is the **resolution**
- Dimension of the area covered on the ground and represented by a single cell

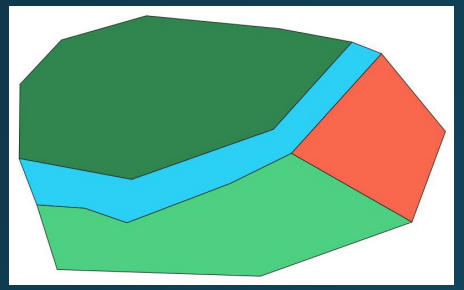


HSU, 2018

Vector analysis

- What is the average tree height within each land cover type?

Polygon layer



Point layer

Land_cover — Features Total: 4, Filtered: 4, Selected: 0

	id	LC_class	Area_km2
1	1	Forest	1.173
2	2	Water body	0.436
3	3	Urban	0.421
4	4	Grassland	0.795

Spatial join

Tree_sp — Features Total: 9, Filtered: 9, Selected: 0

	id	TSpecies	height_m	diameter_m	age_years	LC_class
1	1	Oak	8	50	40	Grassland
2	2	Maple	6	40	30	Grassland
3	3	Pine	7	45	35	Grassland
4	4	Birch	5	35	25	Grassland
5	5	Oak	10	55	45	Forest
6	6	Maple	8	45	35	Forest
7	7	Pine	9	50	40	Forest
8	8	Spruce	7	40	30	Forest
9	9	Fir	6	38	25	Forest

Attribute analysis

Statistics by category — Features Total: 2,

abc LC_class = ε abc

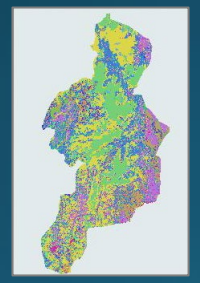
	LC_class	avg_height_m
1	Forest	8.0
2	Grassland	6.5

Raster analysis

LC 2015

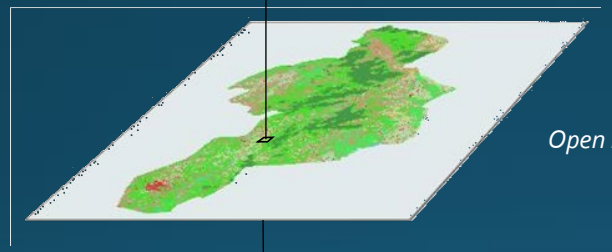
LC 2020

Land cover change map

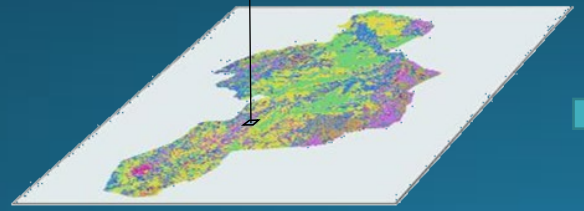


Raster algebra

Brush/Shrubs (code=10)



Open Forest (code=4)



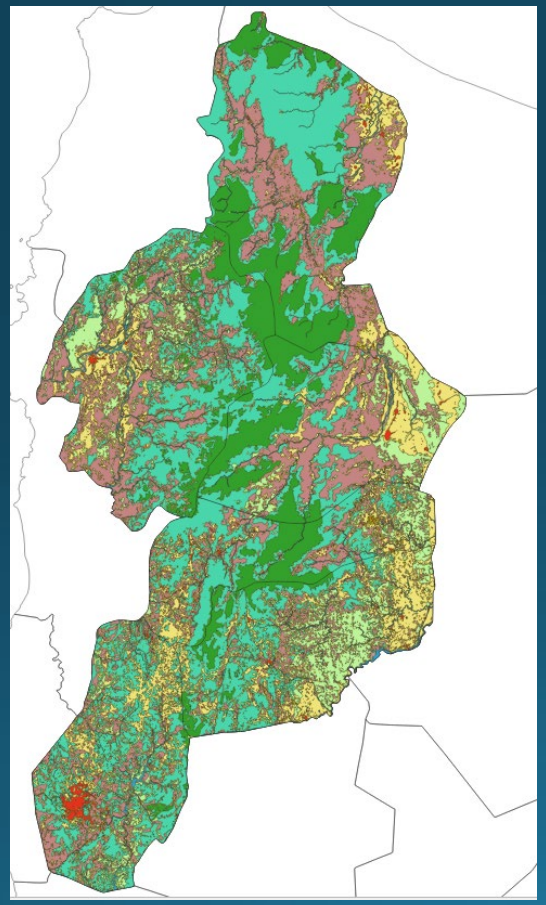
From Brush/Shrubs to Open Forest

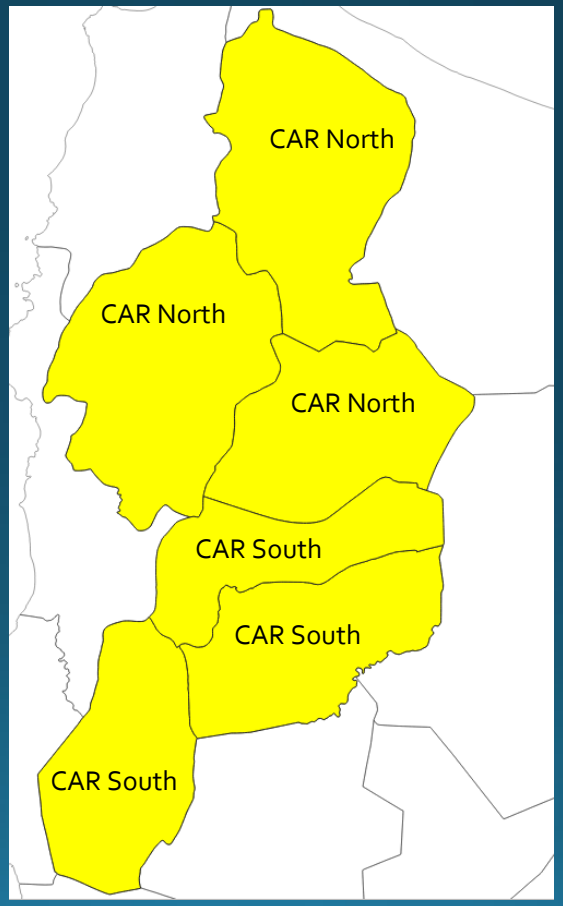
Land cover change matrix

	>_Closing	Closed Forest	Open Forest	Brush/Shrubs	Open/Barren	Grassland	Annual Crop
V_Opening		1	4	10	13	14	16
Closed Forest	**1**	2340650700.0	147035700.0	10170000.0	940500.0	1851300.0	409500.0
Open Forest	**4**	290448900.0	4760739900.0	379714500.0	3848400.0	56559600.0	50959800.0
Brush/Shrubs	**10**	10765800.0	592208100.0	3551211900.0	9173700.0	355757400.0	289281600.0
Open/Barren	**13**	46800.0	1008900.0	3570300.0	63767700.0	10561500.0	8543700.0
Grassland	**14**	1014300.0	48394800.0	385114500.0	11777400.0	1406580300.0	112129200.0
Annual Crop	**16**	1112400.0	73788300.0	330057900.0	14897700.0	58254300.0	1839253500.0

Data presentation

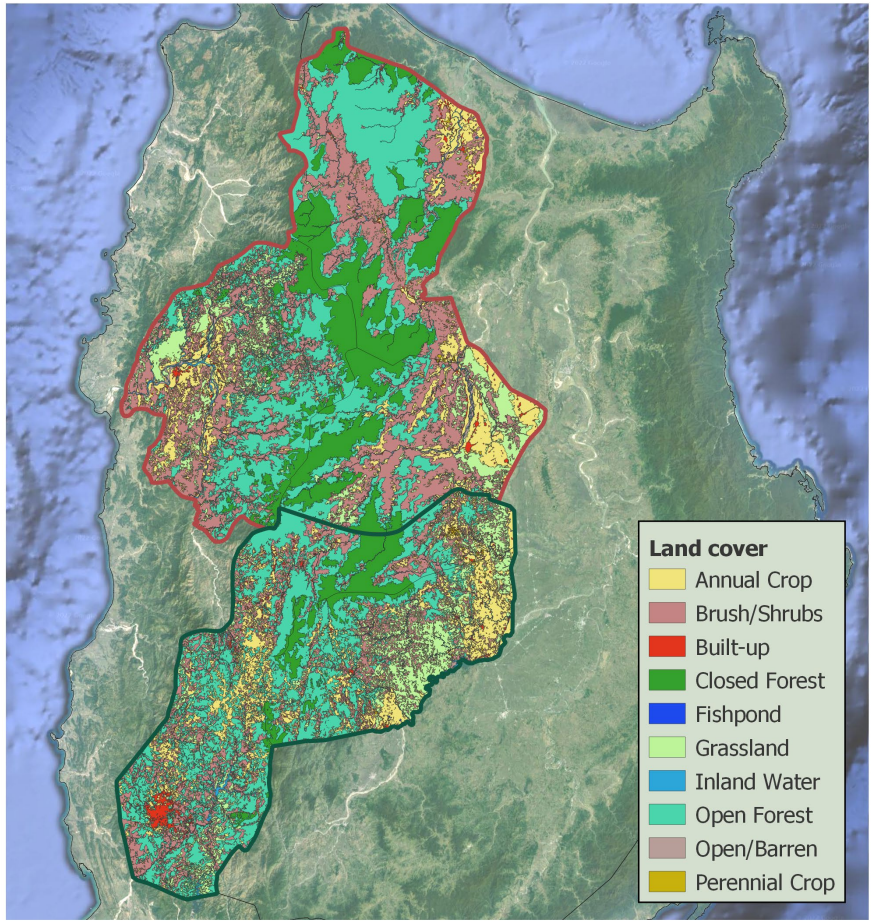
- Map with percent area of land cover classes in CAR North and South region



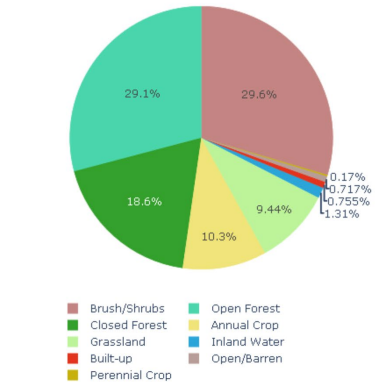


Data presentation

Land cover 2015 in the CAR region



Land cover 'CAR North'



Land cover 'CAR South'