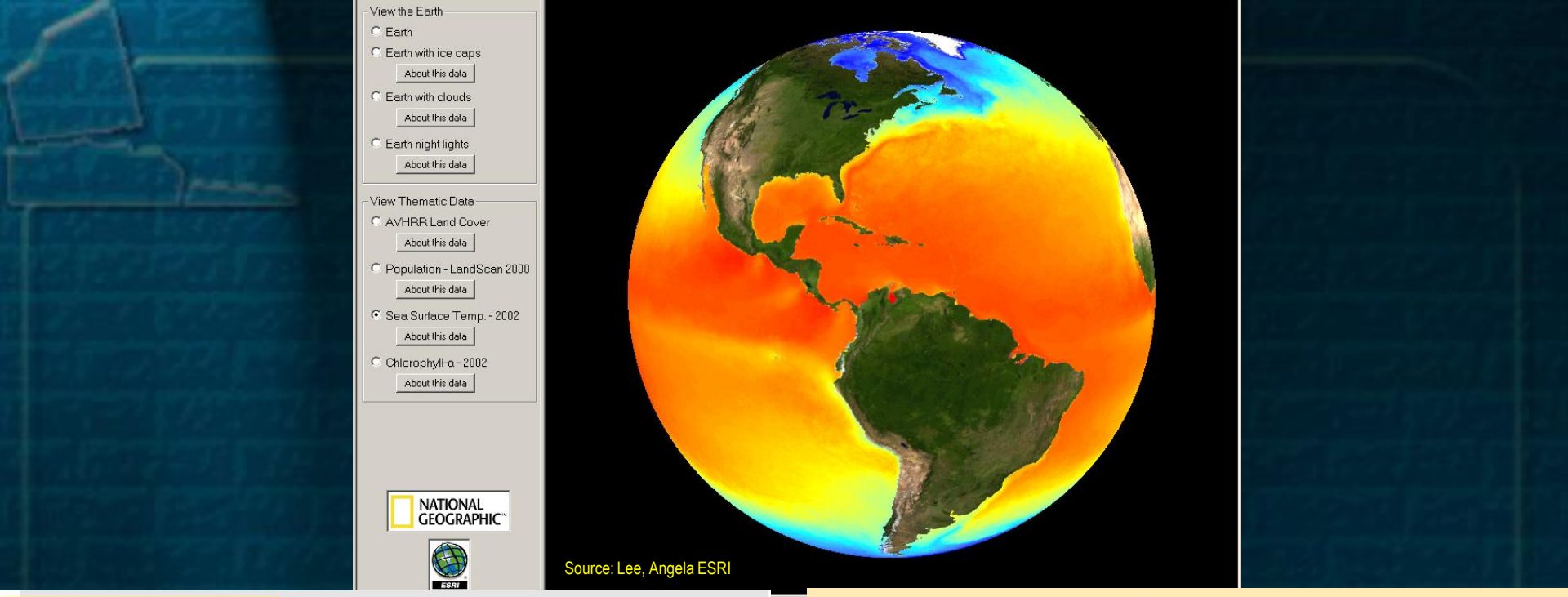
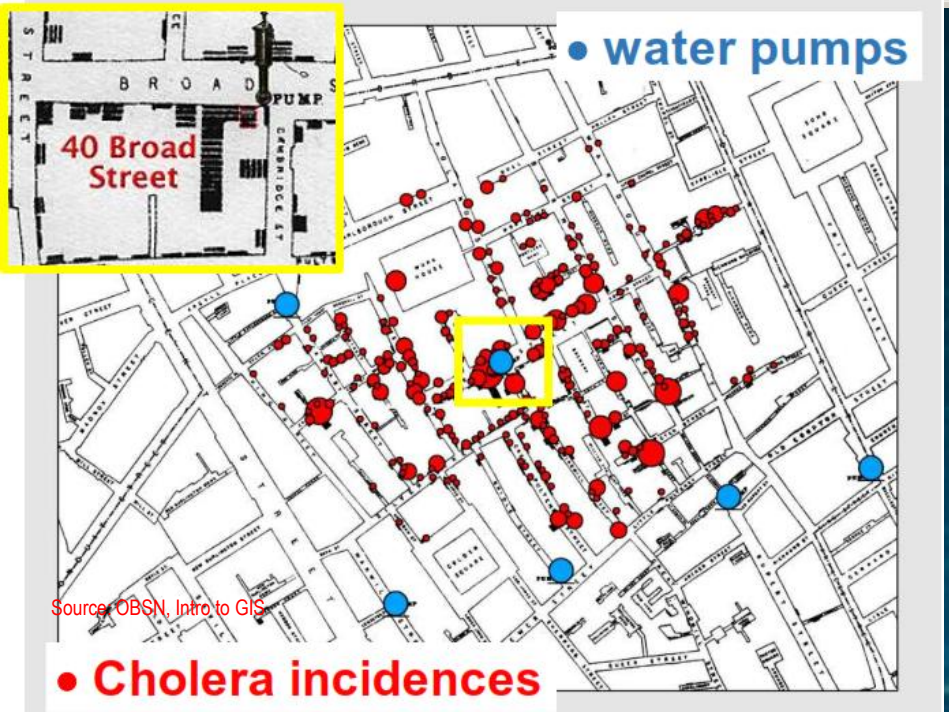
Introduction to GIS

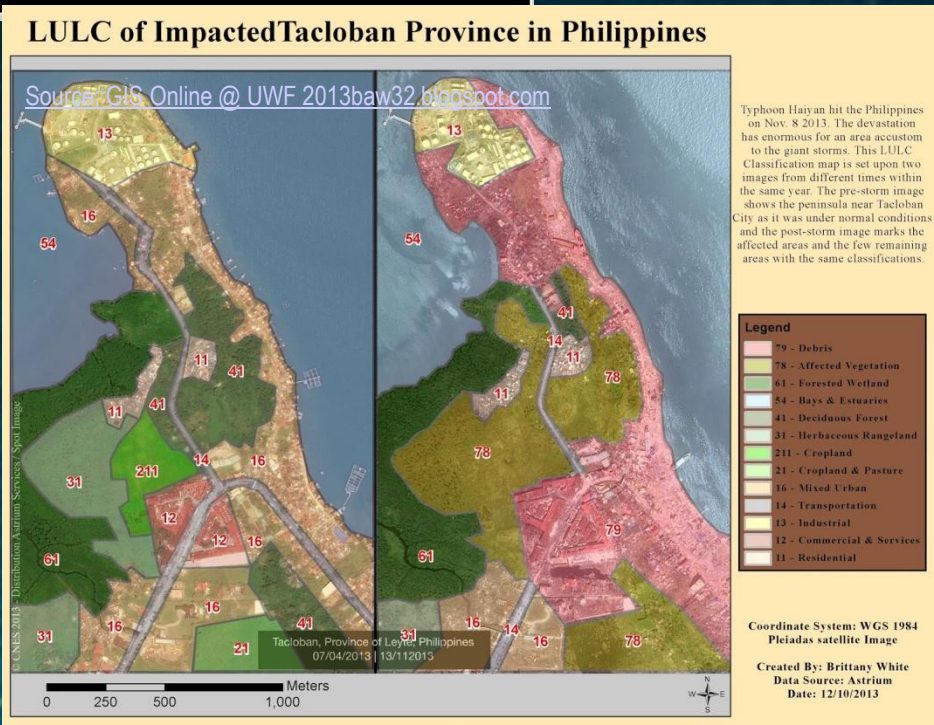
PHILIPPINE WEALTH ACCOUNTING AND VALUATION OF ECOSYSTEM SERVICES (PHIL-WAVES)

Outline

- AM
  - Lecture
    - Definition and Components
    - Applications
    - Data Models and Functions
    - Coordinate System, Projections
- PM
  - Hands-on, software familiarization


View the Earth
Earth
Earth with ice caps
About this data
Earth with clouds
About this data
Earth night lights
About this data
View Thematic Data
AVHRR Land Cover
About this data
Population - LandScan 2000
About this data
Sea Surface Temp. - 2002
About this data
Chlorophyll-a - 2002
About this data
NATIONAL GEOGRAPHIC
ESRI
Source: Lee, Angela ESRI


40 Broad Street
BROAD STREET
PUMP
• water pumps
Source: OBSN, Intro to GIS
• Cholera incidences


LULC of ImpactedTacloban Province in Philippines
Source: GIS Online @ UWF 2013baw32.blogspot.com
Typhoon Haiyan hit the Philippines on Nov. 8 2013. The devastation has enormous for an area accustom to the giant storms. This LULC Classification map is set upon two images from different times within the same year. The pre-storm image shows the peninsula near Tacloban City as it was under normal conditions and the post-storm image marks the affected areas and the few remaining areas with the same classifications.
Legend
79 - Debris
78 - Affected Vegetation
61 - Forested Wetland
54 - Bays & Estuaries
41 - Deciduous Forest
31 - Herbaceous Rangeland
211 - Cropland
21 - Cropland & Pasture
16 - Mixed Urban
14 - Transportation
13 - Industrial
12 - Commercial & Services
11 - Residential
Tacloban, Province of Leyte Philippines
07/04/2013 | 13/11/2013
Meters
0 250 500 1,000
Coordinate System: WGS 1984
Pleiadas satellite Image
Created By: Brittany White
Data Source: Astrium
Date: 12/10/2013

GIS is not just map-making

Mapping = Cartography

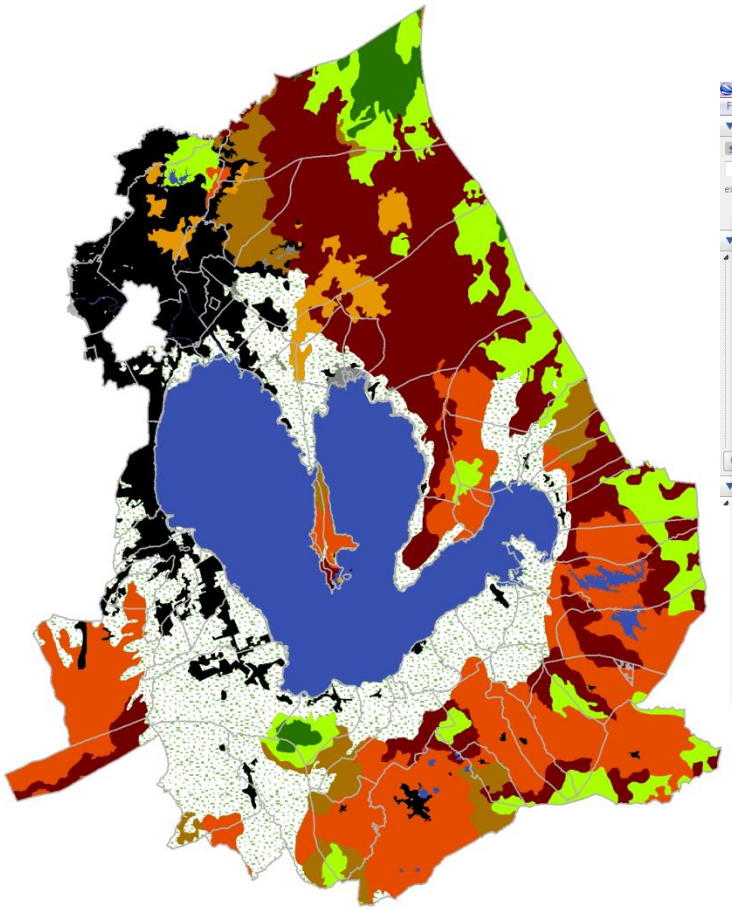
GIS = GIS

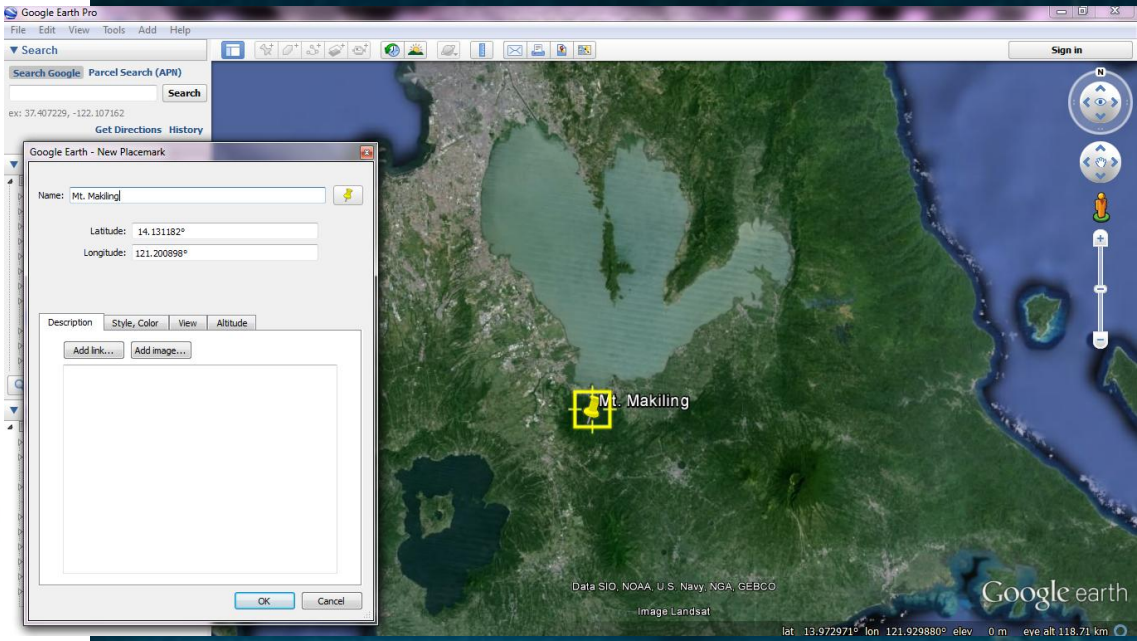
"Geographic + Information + System"

"Spatial location + Attributes/database + Hardware-software-user

GIS Components

- Geographic – Spatial, space-bound, location-based





GIS Components

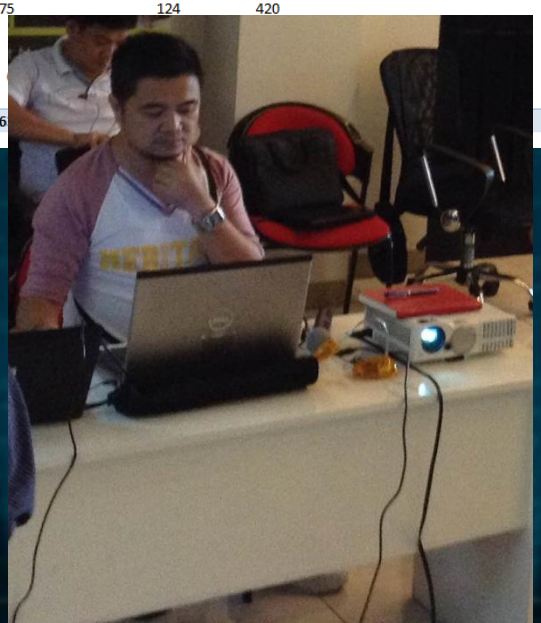
- Information System– collection of attributes, descriptive, tabular, software-based

Table

Municipal/City Boundary

FID	Shape *	PROVINCE_1	NAME2
3	Polygon	BATANGAS	Santo Tomas
4	Polygon	CAVITE	Carmona
5	Polygon	CAVITE	Gen. Mariano Alvar
6	Polygon	CAVITE	Silang
7	Polygon	CAVITE	Tagaytay City
8	Polygon	LAGUNA	Alaminos
9	Polygon	LAGUNA	Bay
10	Polygon	LAGUNA	BiÑan
11	Polygon	LAGUNA	Cabuyao
12	Polygon	LAGUNA	Calamba
13	Polygon	LAGUNA	Calauan
14	Polygon	LAGUNA	Cavinti
15	Polygon	LAGUNA	City Of Santa Rosa
16	Polygon	LAGUNA	Famy
17	Polygon	LAGUNA	Kalayaan
18	Polygon	LAGUNA	Liliw
19	Polygon	LAGUNA	Los BaÑos
20	Polygon	LAGUNA	Luisiana
21	Polygon	LAGUNA	Lumban
22	Polygon	LAGUNA	Mabitac
23	Polygon	LAGUNA	Magdalena
24	Polygon	LAGUNA	Majayjay
25	Polygon	LAGUNA	Nagcarlan
26	Polygon	LAGUNA	Paete
27	Polygon	LAGUNA	Pagsanjan
28	Polygon	LAGUNA	Pakil
29	Polygon	LAGUNA	Pangil
30	Polygon	LAGUNA	Pila
31	Polygon	LAGUNA	Rizal
32	Polygon	LAGUNA	San Pablo City
33	Polygon	LAGUNA	San Pedro
34	Polygon	LAGUNA	Santa Cruz (capital)

	A	B	C	D	E	F	G	H	I	J	K	L	M
1													
2													
3	LAND COVER	2010 (Closing)											
4	2003 (Opening)	Annual Crop	Built-up	Closed Forest	Fishpond	Grassland	Inland Water	Mangrove Forest	Marshland/Swamp	Open Forest	Open/Barren	Perennial Crop	Shrubs
5	Annual Crop	39,520	28,240	40	76	5,528	3,242	1	4	1,049	271	10,290	4,462
6	Built-up	524	46,170		0	521	520			50	57	151	191
7	Closed Forest			3,942			7			3,837			57
8	Fallow									10			16
9	Grassland	2,432	2,650			2,250	63			95	115	567	467
10	Inland Water	59	216			2	89,300		0	1	0	45	301
11	Mangrove Forest		5			0	59						30
12	Open Forest	188	229	1,275		124	420			26,220	1	2,526	8,057
13	Open/Barren	390	378									8	5
14	Perennial Crop	11,980	7,483							713	3	37,100	21,340
15	Shrubs	1,533	1,550							7,206	80	12,290	36,150
16	Wooded grassland	740	2,025							1,519	175	4,082	6,821
17	**Grand Total**	**57,365**	**88,946**	**5,26**					**4**	**40,700**	**702**	**67,059**	**77,898**
18													



GIS is an integrated collection of:

- Hardware, software, data, processes, people

Used to:

- **View/manage** information
- **Analyze spatial** relationships
- **Model spatial** scenario
- **Present** analysis or results

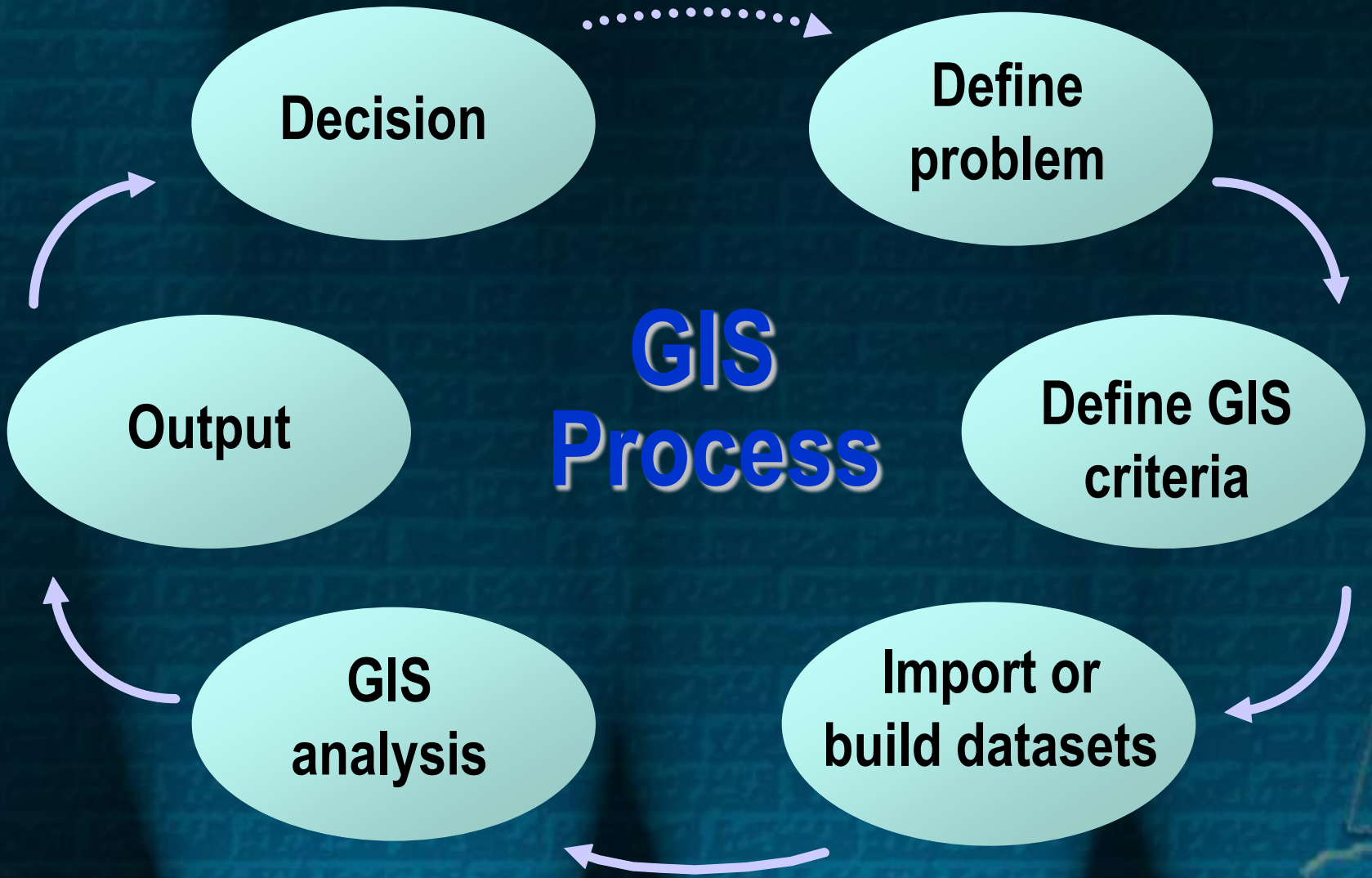
Various GIS Definitions

- A map with a database behind it.
- A virtual representation of the real world and its infrastructure.
- A consistent “as-built” of the real world, natural and manmade

Which is

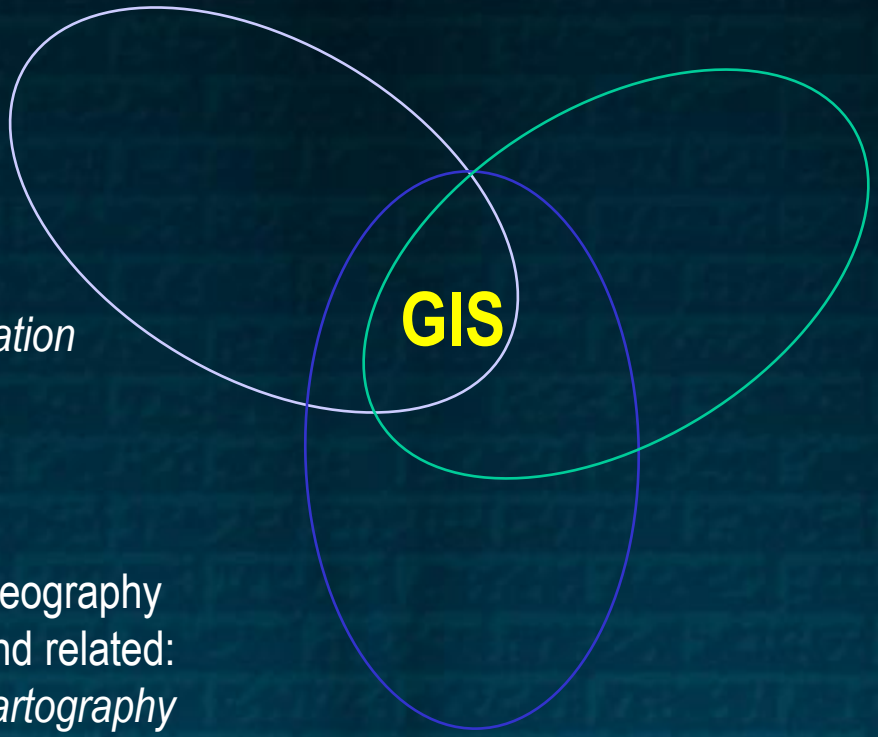
- *queried* to support *on-going operations*
- *summarized* to support *strategic decision making and policy formulation*
- *analyzed* to support *scientific inquiry*

GIS System


Define problem
Define GIS criteria
Import or build datasets
GIS analysis
Output
Decision
GIS Process

Knowledge Base for GIS

Computer Science/MIS
graphics
visualization
database
system administration
security



Application Area:
public admin.
planning
geology
mineral exploration
forestry
site selection
marketing
civil engineering
criminal justice
surveying

Geography and related:
cartography
geodesy
photogrammetry
landforms
spatial statistics.

The convergence of technological fields and traditional disciplines.

Why Learn it?

- Multi-disciplinary
- A real-world technology using real data
- Involves authentic tasks / assessments
- Promotes holistic / systematic approach
- Engages multiple ways of learning
- Encourages community connections
- Used at scales from local to global

Why Learn it?

- There are important geographic questions about changes in & their socioeconomic/political implications

Roger Tomlinson

Changing the Face of Geography (2009)

- "Climate change is a geographic problem, Solving it takes a geographic solution. "

Jack Dangermond

Founder & President, ESRI

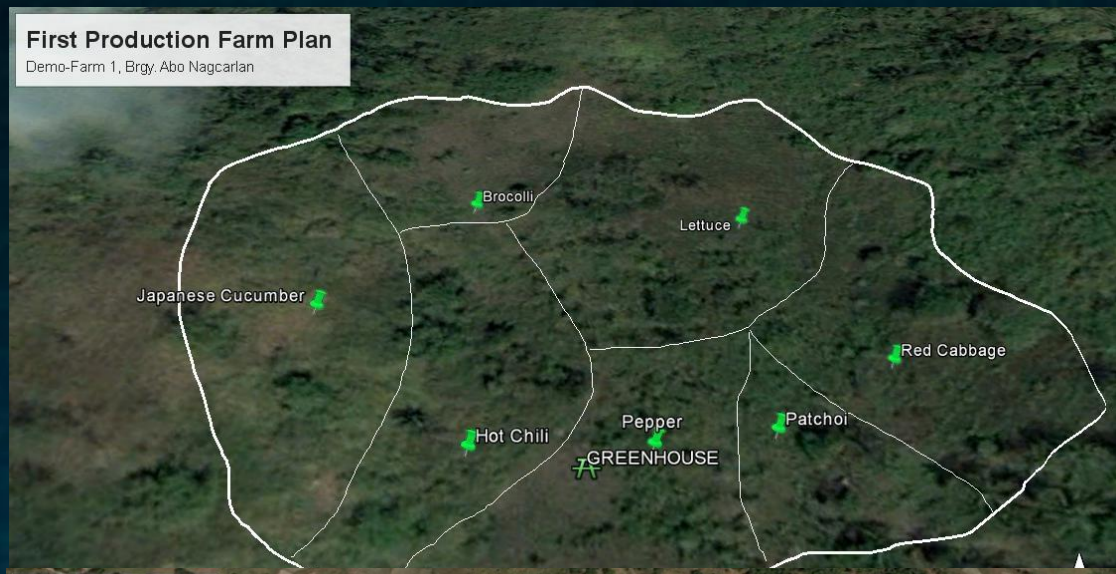
Geography matters!

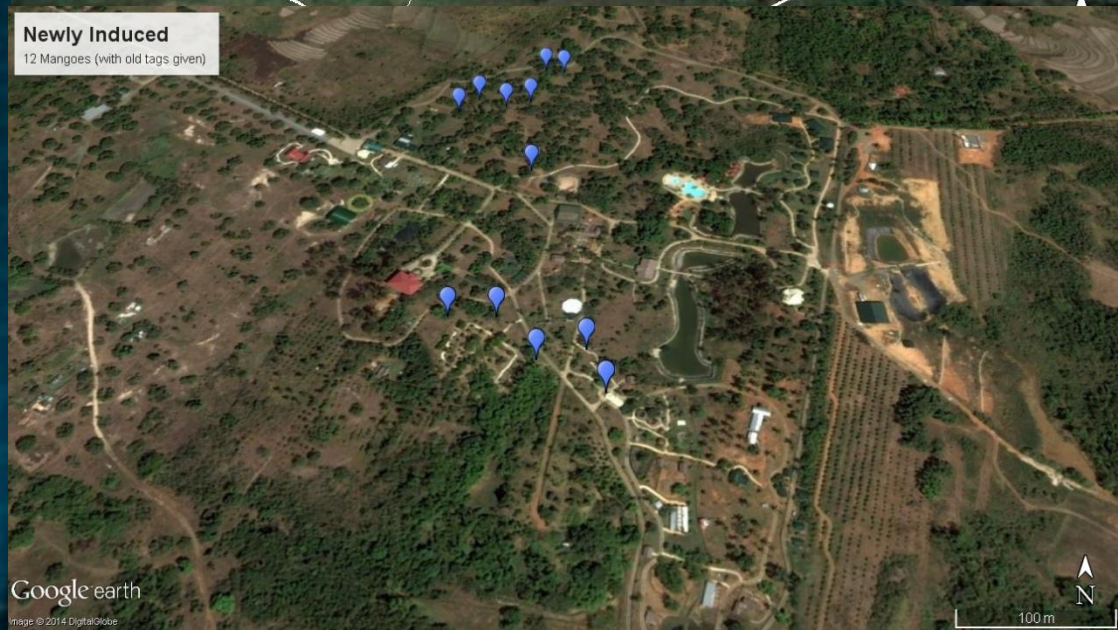
Today's challenges require geographic approach

- Climate Change
- Urban Growth
- Sustainable Agriculture
- Water Quality and Availability
- International and National Security
- Energy
- Epidemiology/Disease Tracking
- Natural Hazards

Agriculture

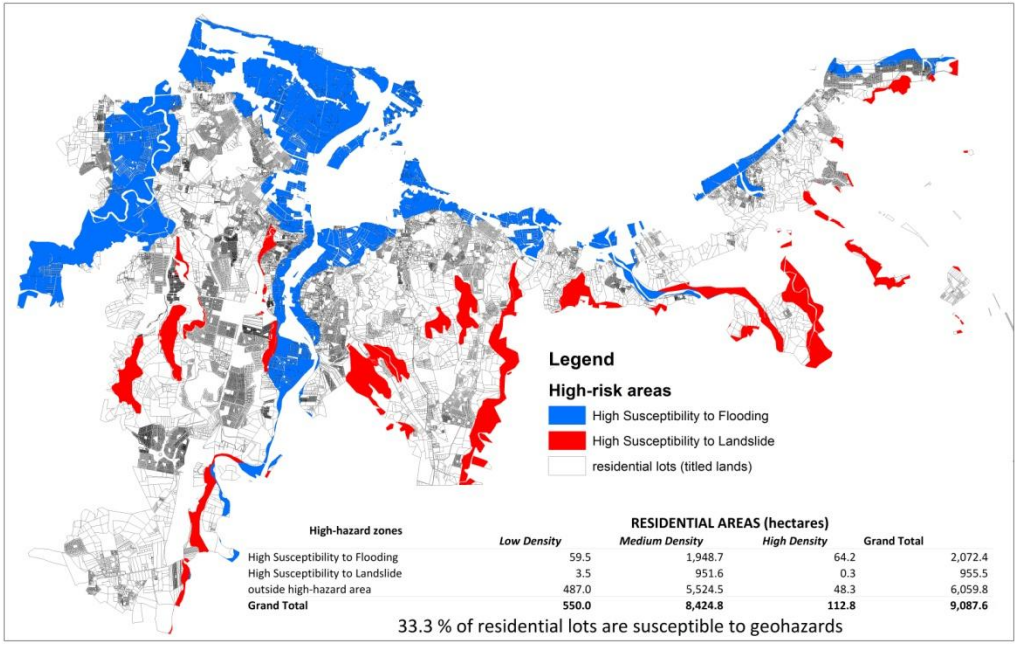
- Farm management
- Pest/Disease tracking
- Crop monitoring
- Yield prediction
- Soil analysis





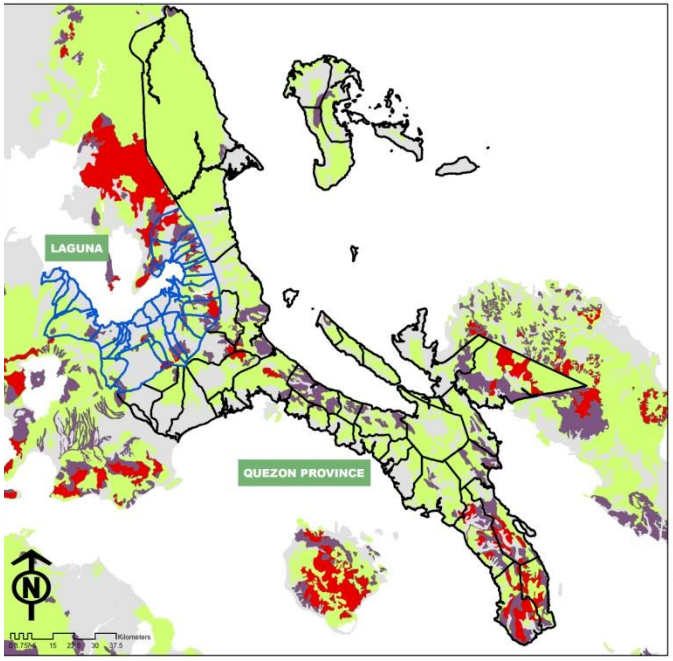
Disaster Risk Reduction and Management

- Vulnerability Assessment
- Hazard Modeling
- Easements and Relocation Schemes



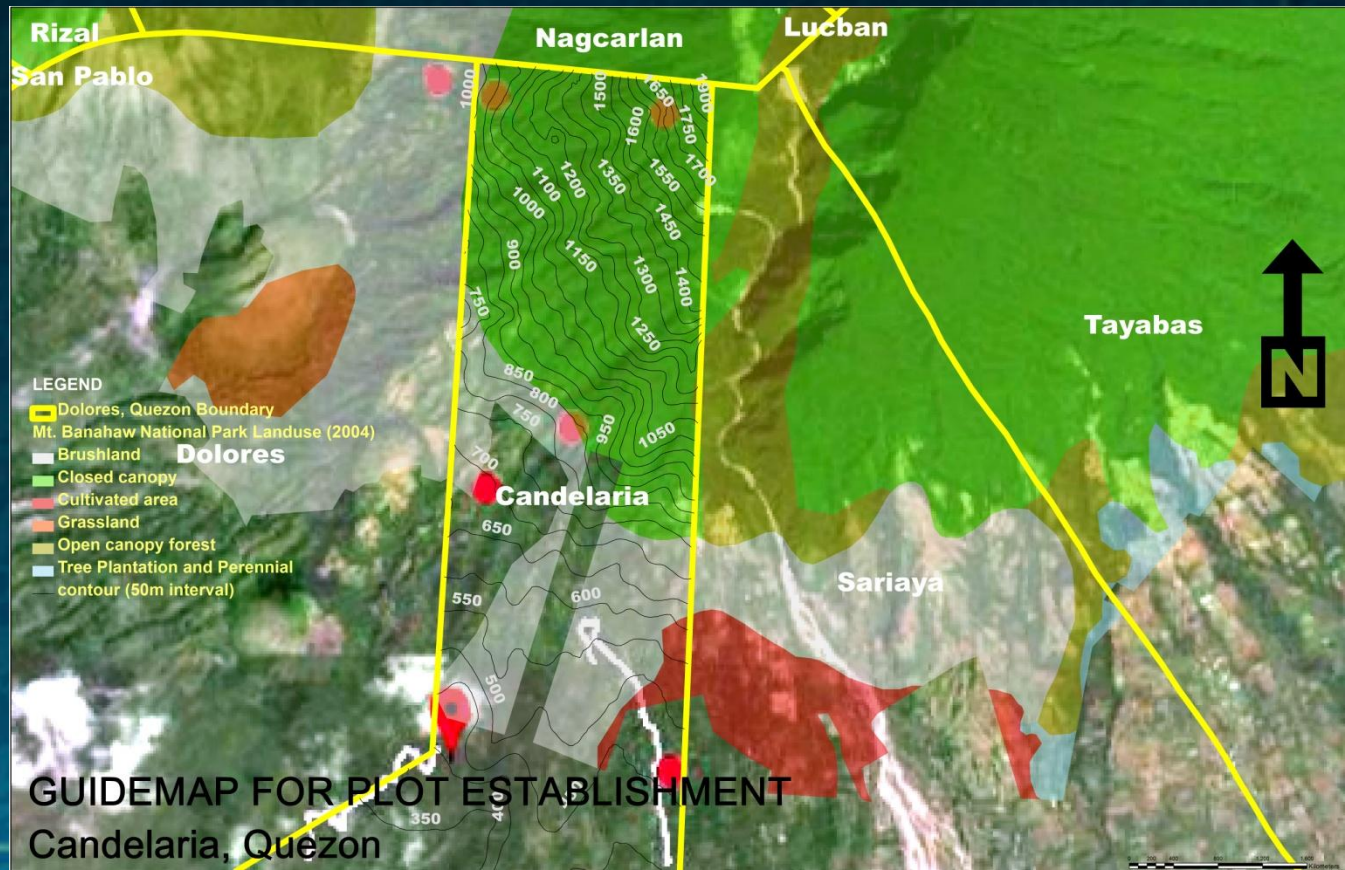
High-hazard zones	RESIDENTIAL AREAS (hectares) Low Density	Medium Density	High Density	Grand Total
High Susceptibility to Flooding	59.5	1,948.7	64.2	2,072.4
High Susceptibility to Landslide	3.5	951.6	0.3	955.5
outside high-hazard area	487.0	5,524.5	48.3	6,059.8
Grand Total	**550.0**	**8,424.8**	**112.8**	**9,087.6**

33.3 % of residential lots are susceptible to geohazards



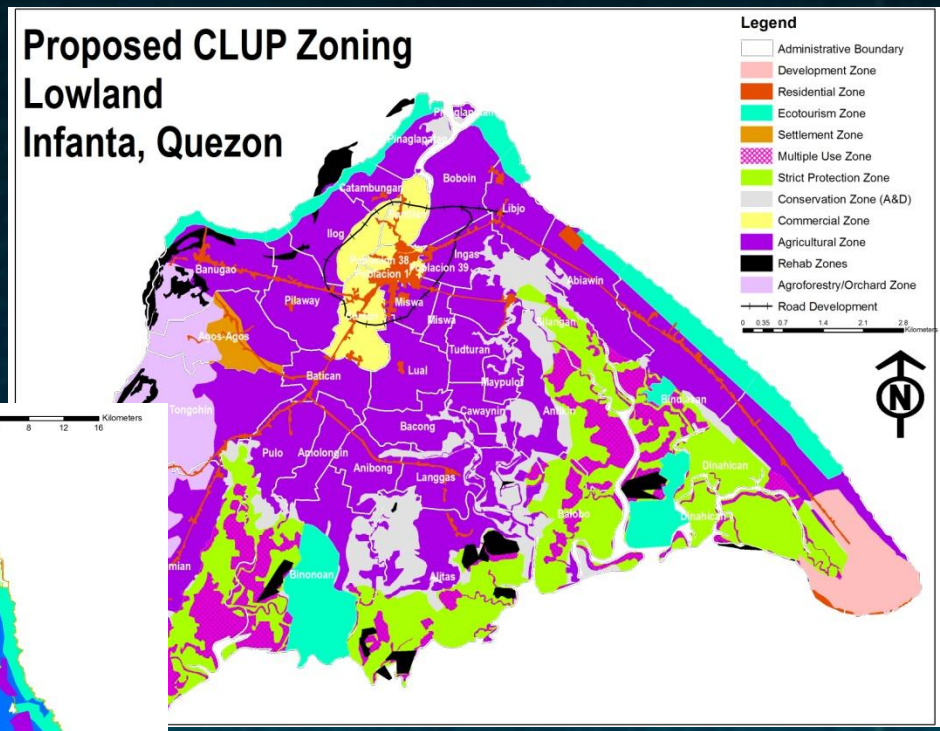
Natural Resource Management

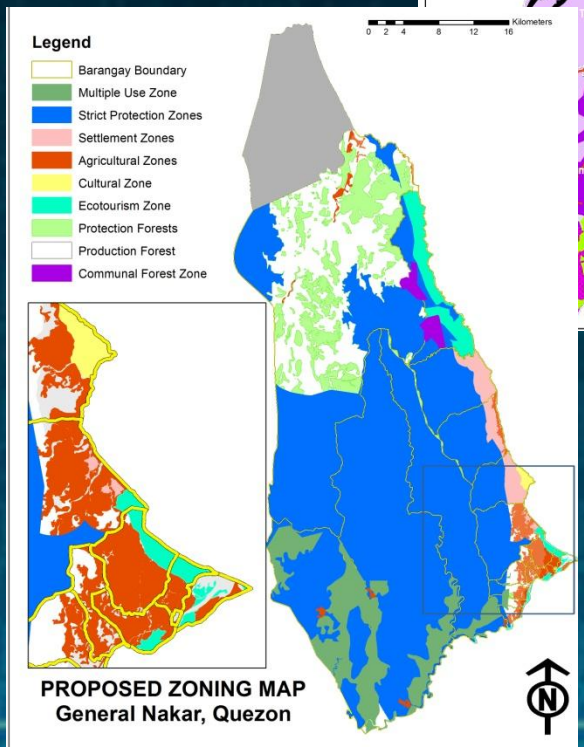
- Forestry
- Ecology
- Mining
- Fisheries
- Biodiversity Conservation



Planning and Economic Development

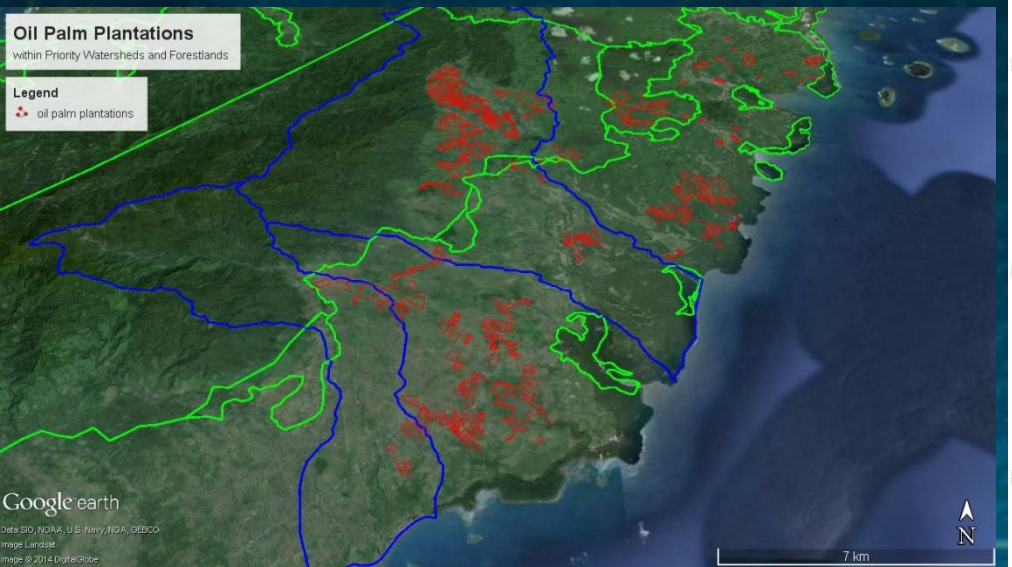
- Land Use/Zoning
- Population Forecast
- Market Analysis
- Tax Mapping
- Transportation

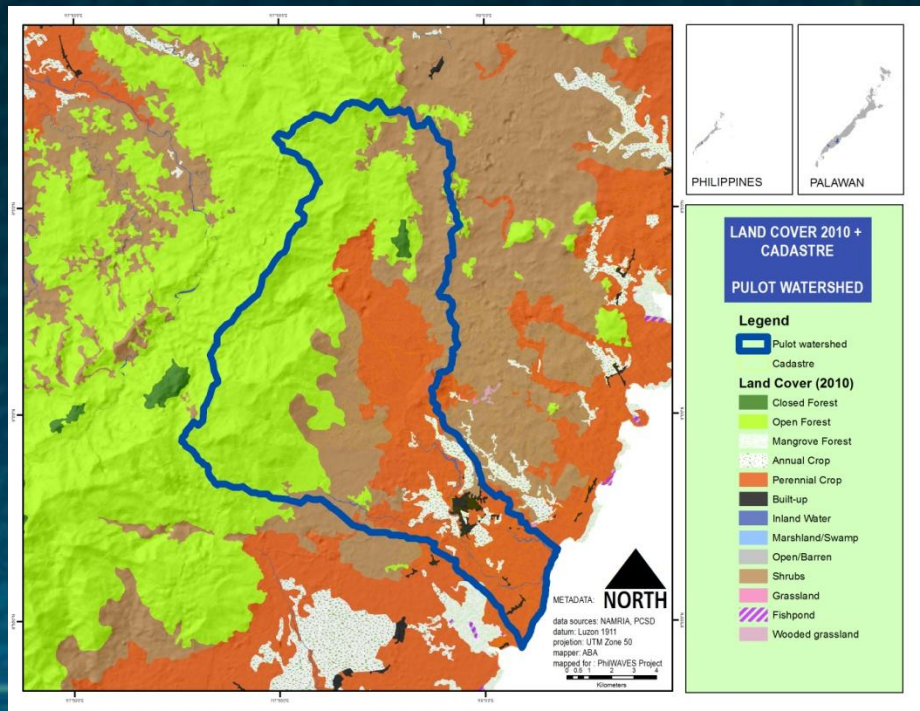




Ecosystems Services Accounting

- Ecosystem Accounts
- Opening-Closing stocks
- Economic Valuation
- Scenario Modeling





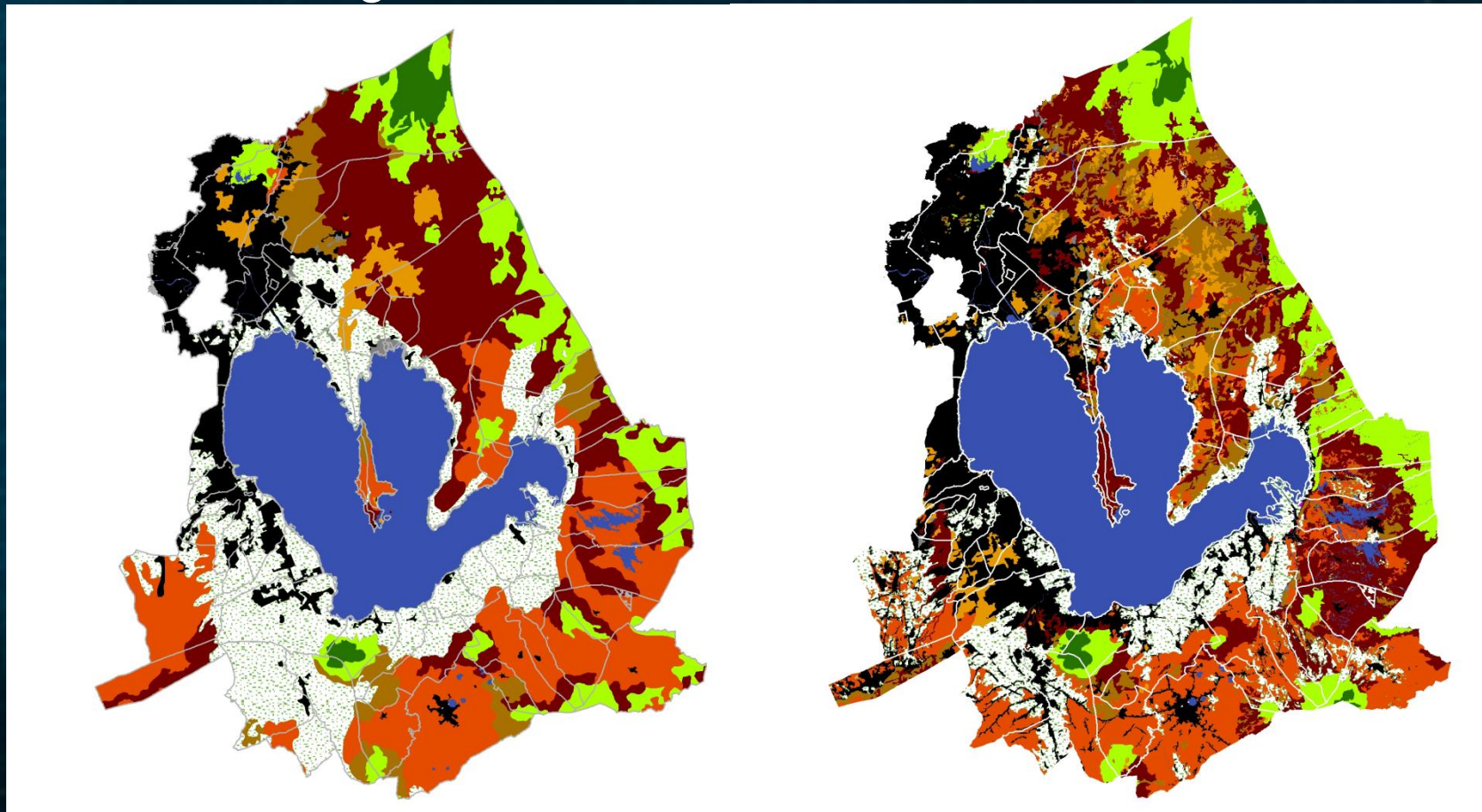
Specific Uses and Users

Uses	Users
• **CLUPs**	• government
• Tax mapping	• **LGUs**
• Crime mapping	• indigenous peoples
• Historical GIS	• communities
• Hydrology	• health orgs
• Change detection	• research
• Biodiversity	• planners
• etc.	• businesses

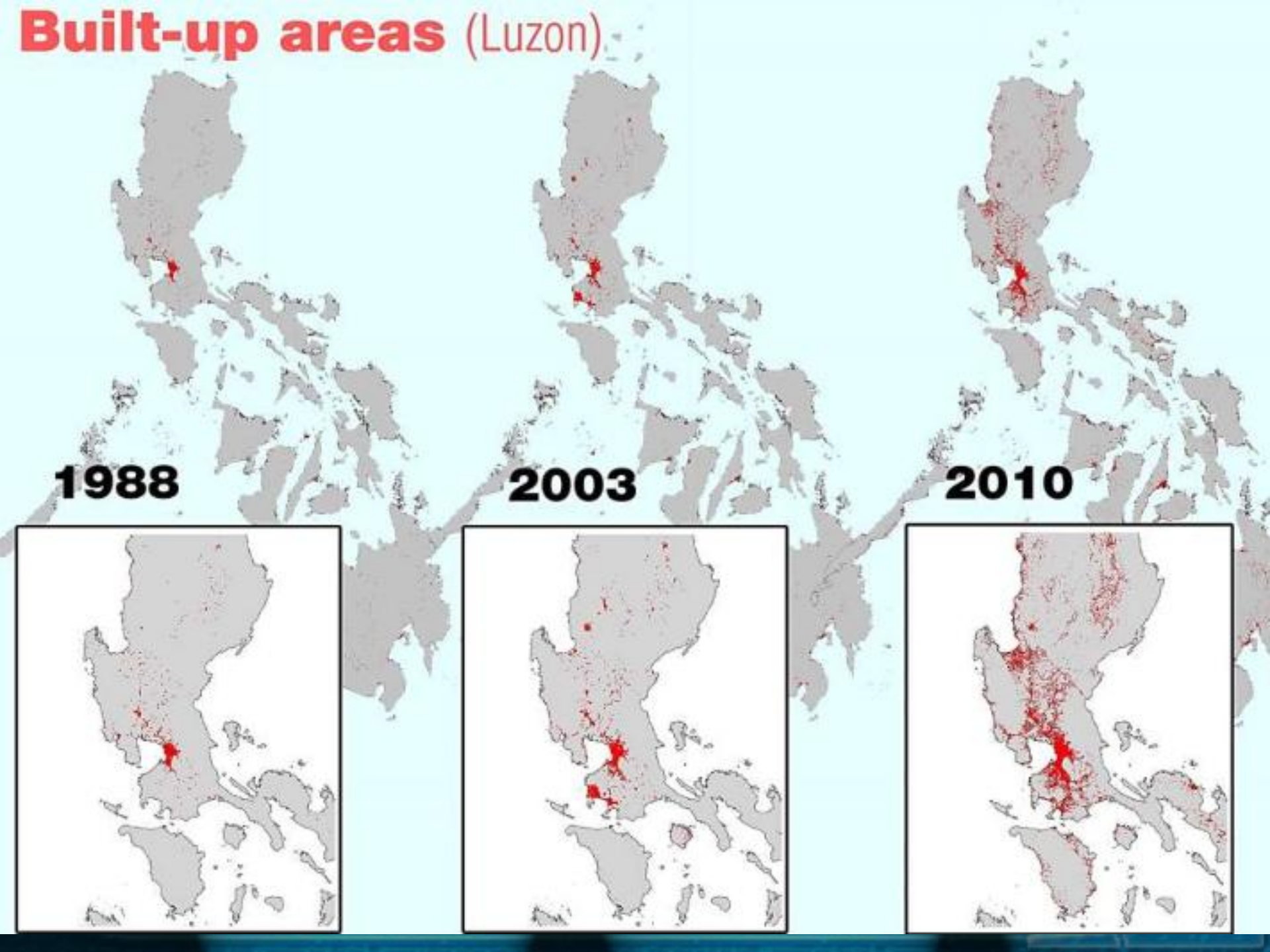
Source: OBSN, Intro to GIS

Other Sample Applications

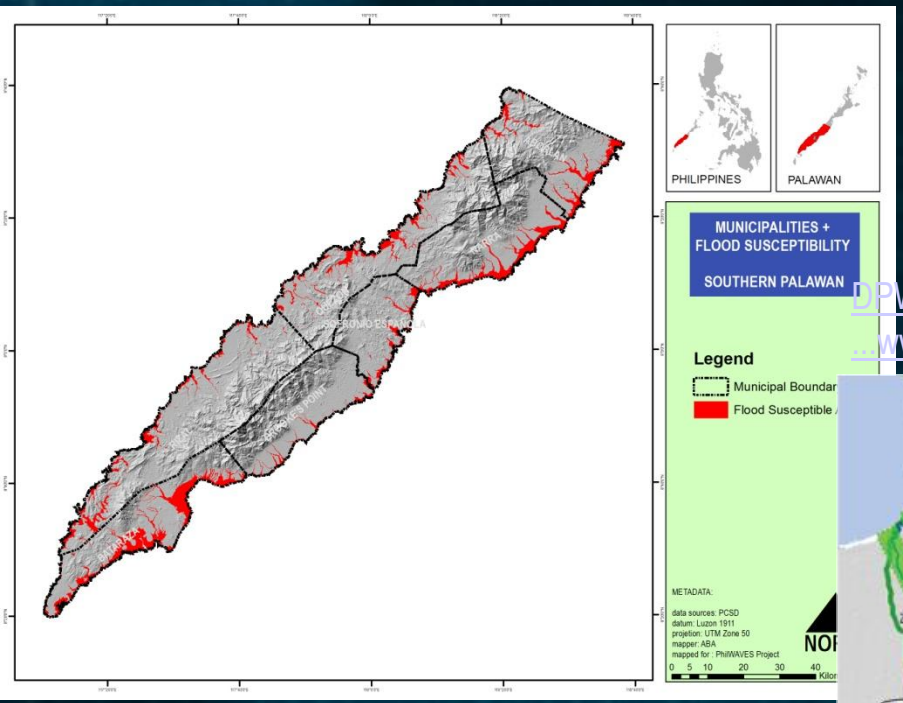
- Land-use Changes



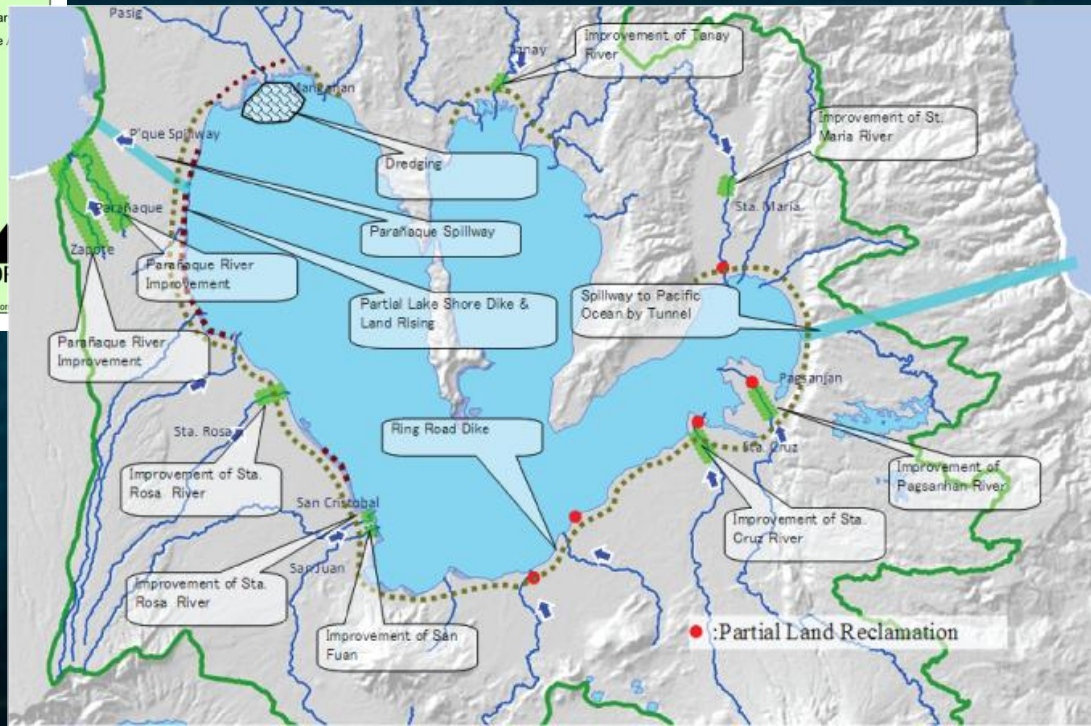
Built-up areas (Luzon)



Flood mitigation

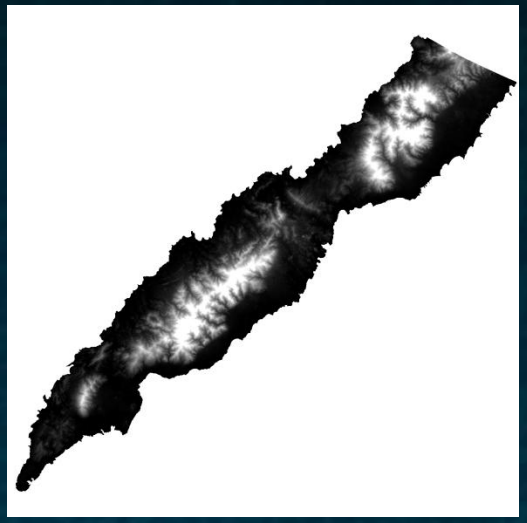


DPWH report: Flood management master plan for Metro Manila and ...www.gov.ph

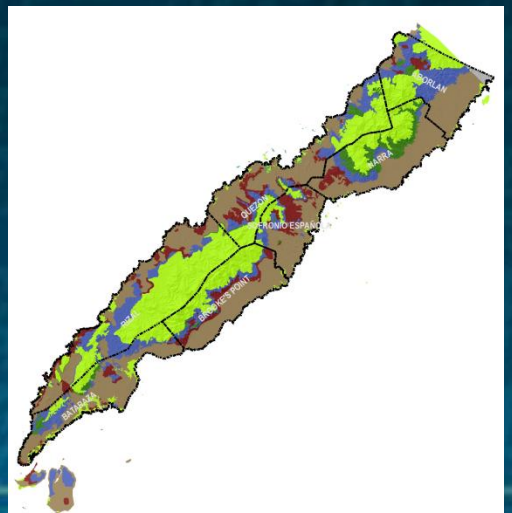


GIS Models

- Raster



- Vector



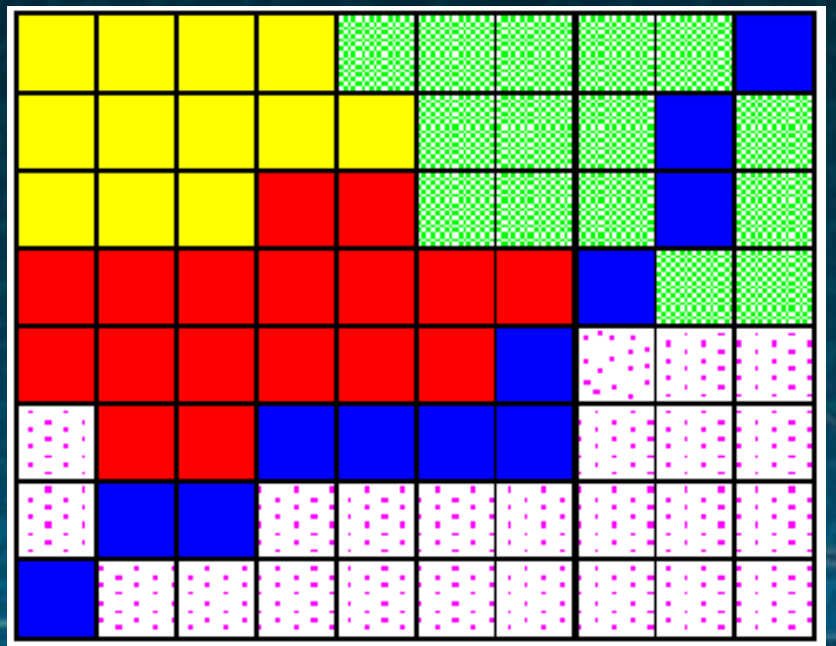
Representing Spatial Elements

Raster

Stores images as rows and columns of numbers with a Digital Value/Number (DN) for each cell.

Units as square grid cells that are uniform in size.

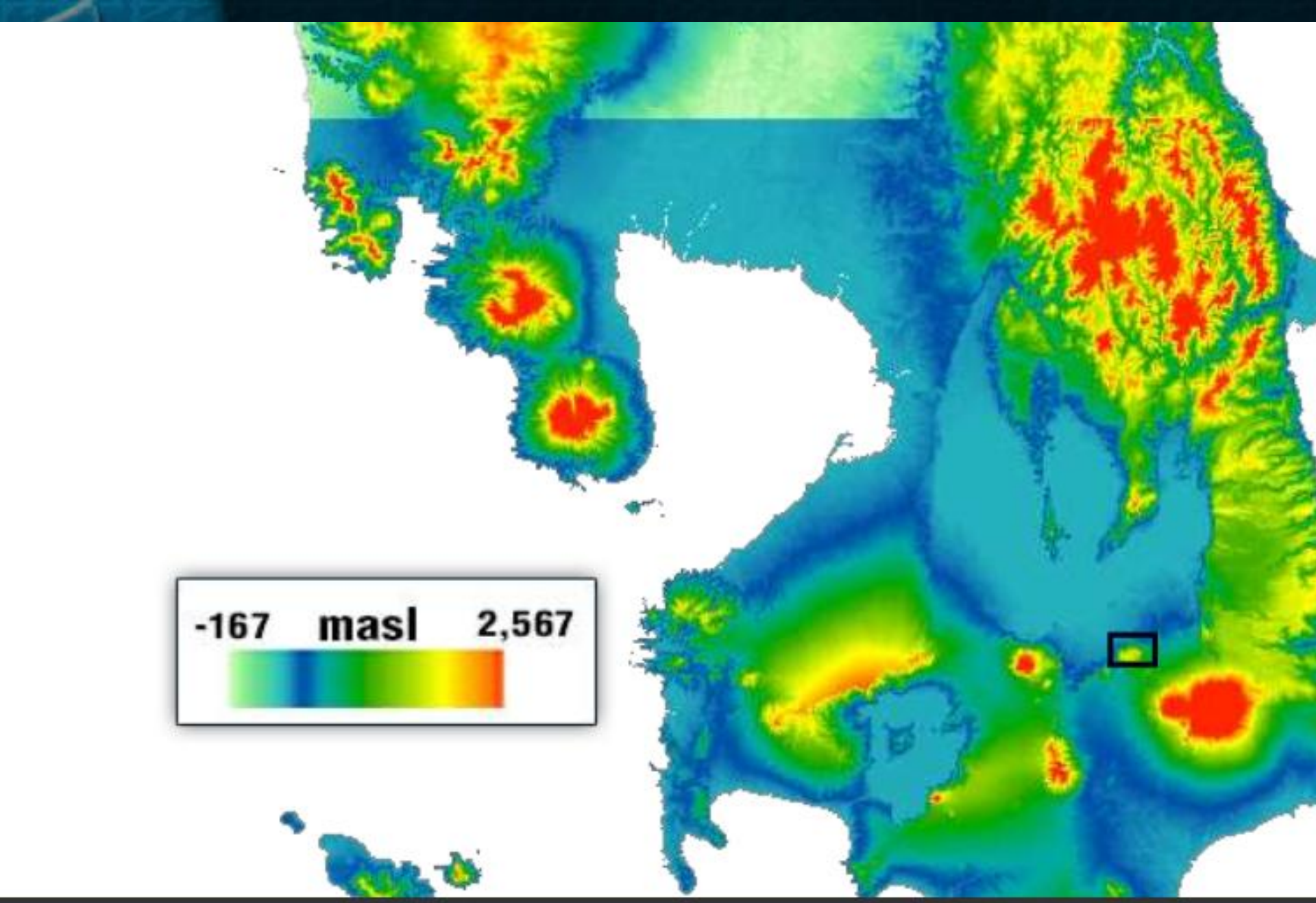
Numerous data formats (common: TIFF, GIF, ERDAS.img etc)



Examples of Raster Data

Digital Elevation Model	**ASTER** (30m) **SRTM v4** (90m)
Satellite images	Landsat, IKONOS, etc
Scanned maps	**NAMRIA** Topo map

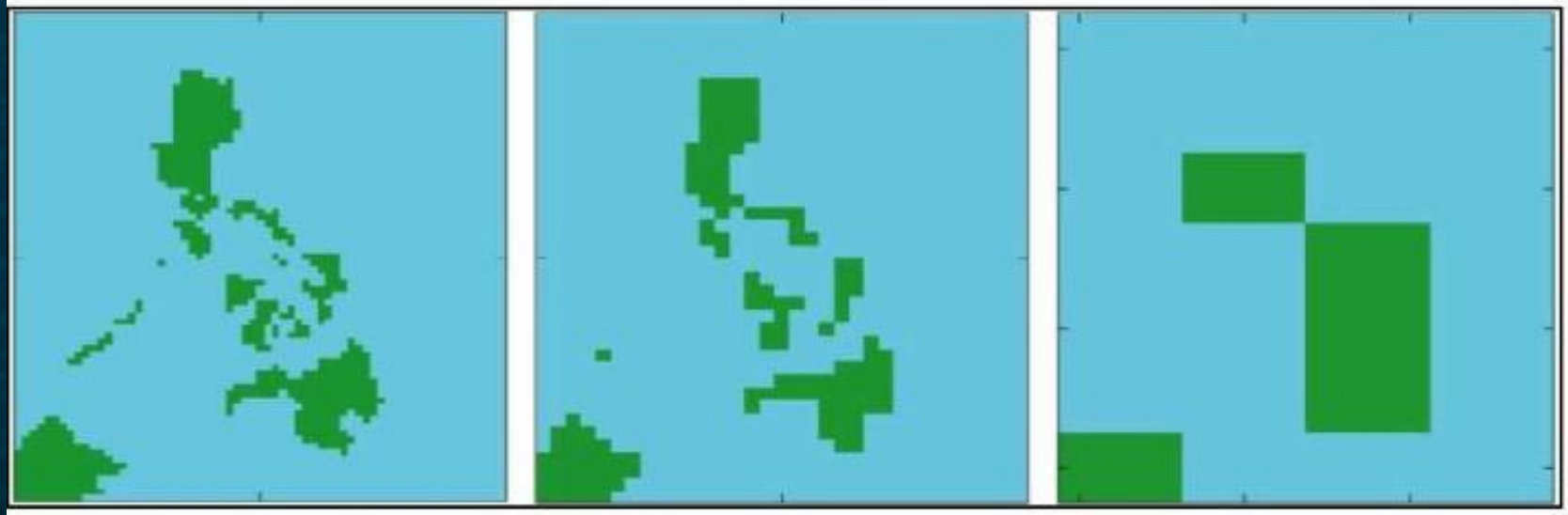
Source: OBSN, Intro to GIS



Source: OBSN, Intro to GIS

Raster Digital Elevation Model (SRTM v4

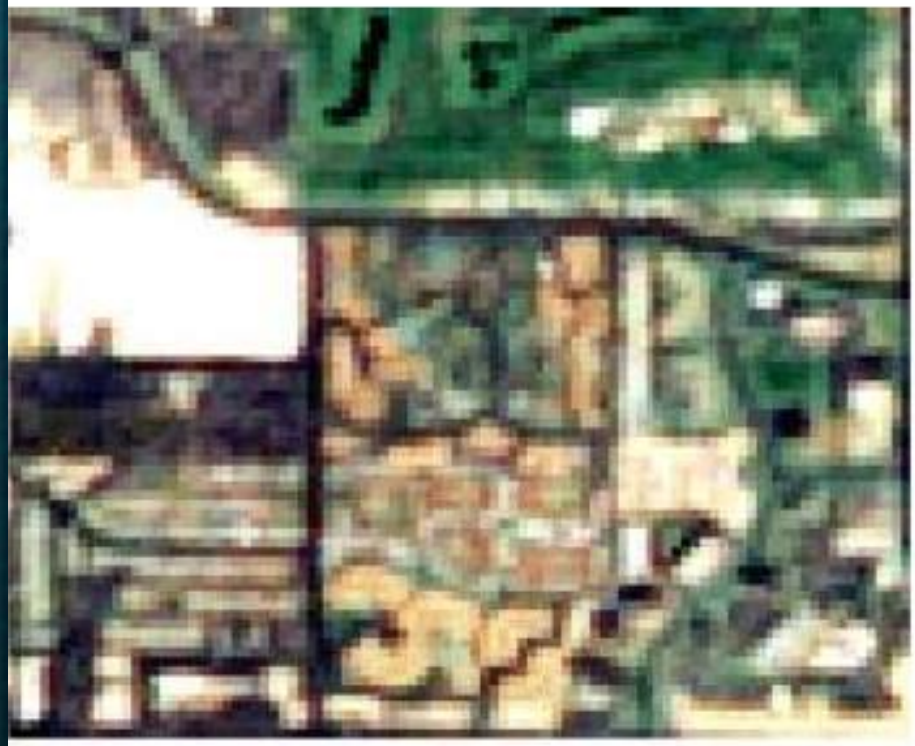
- Rasters are resolution-based



Source: Generating High Resolution Climate Change Scenarios using PRECIS, April 2004

25km 50km 300km

Source: OBSN, Intro to GIS



Scale 1:20,000
Cell size: 15 m

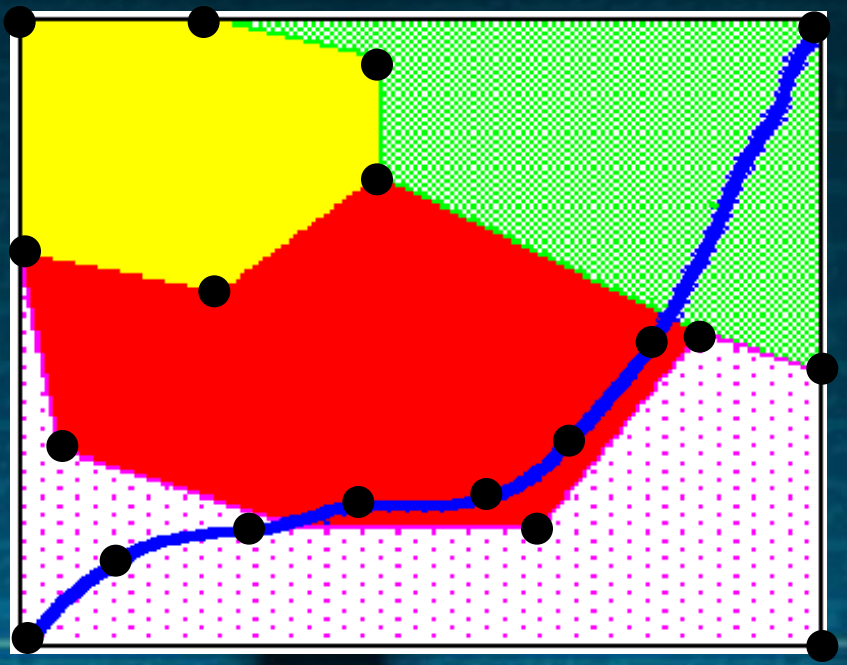
Scale 1:20,000
Cell size: 15.24 cm

Source: http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//009t00000004000000

Vector

Allows user to specify specific spatial locations and assumes that geographic space is continuous, not broken up into discrete grid squares

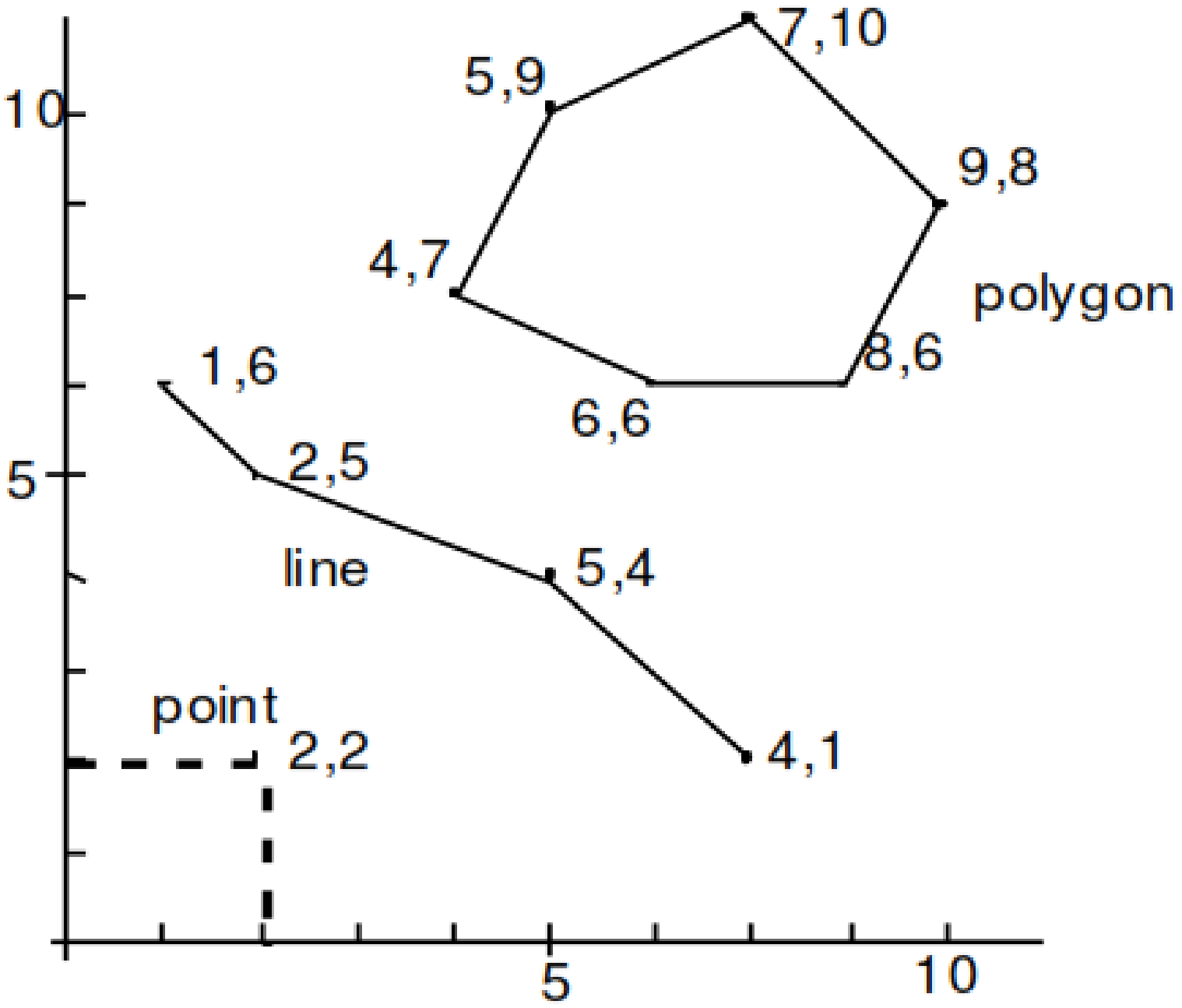
We store features as sets of X,Y coordinate pairs.



Some vector formats

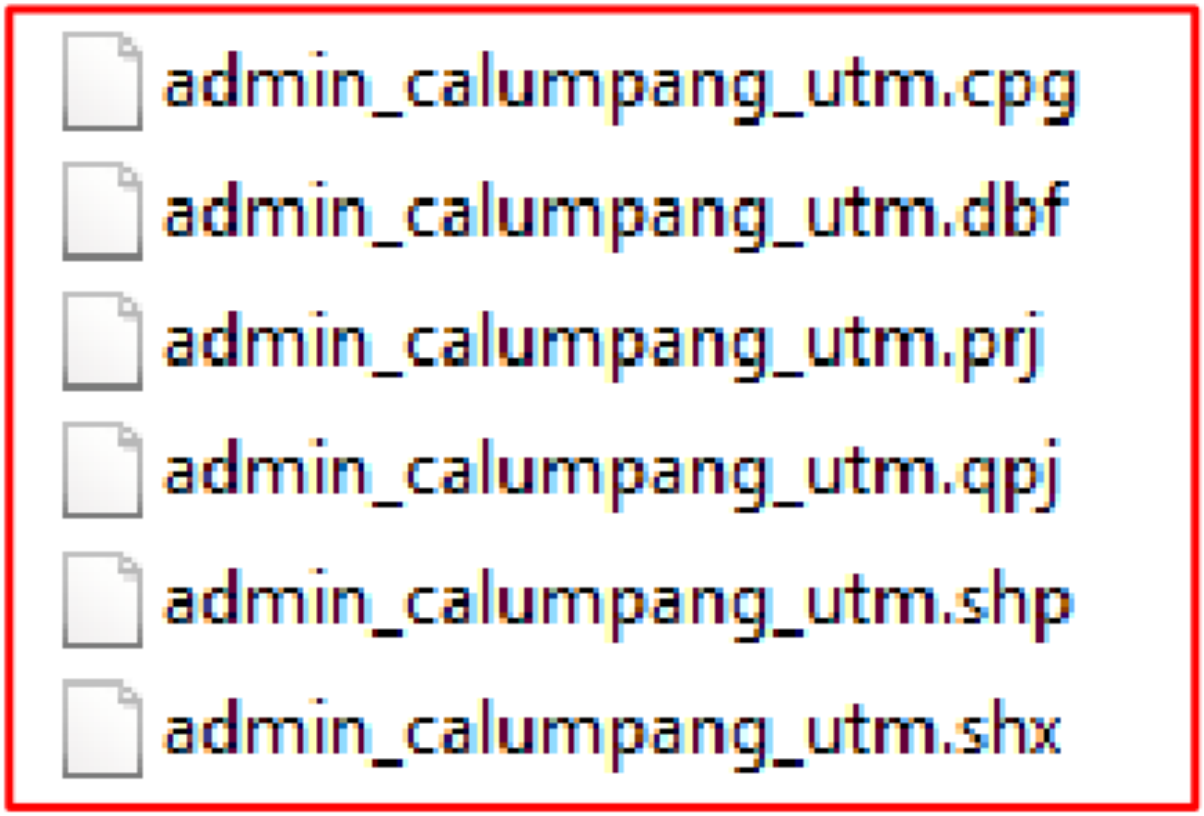
- **AutoCAD** (*.dwg*)
- Digital Line Graph (DLG) - USGS format
- .GML - by OpenGIS
- .GeoJSON
- GeoMedia - Intergraph
- ISFC - Intergraph
- MapInfo TAB format - *.TAB, *.DAT, ID and MAP files
- National Transfer Format (NTF) - UK Ordnance Survey
- Vector Product Format (VPF)
- **Keyhole Markup Language** (*.kml*) – Google Earth
- **Shapefile** (*.shp*) – hybrid vector data format

Source: OBSN, Intro to GIS



Source: OBSN, Intro to GIS

What is a shapefile?



one GIS file

Mandatory:

.dbf ***.prj*** ***.shp***

Source: OBSN, Intro to GIS

Raster vs. Vector

Raster Advantages

Easy to perform mathematical operations

Satellite information is easily incorporated

Better represents “continuous”- type data

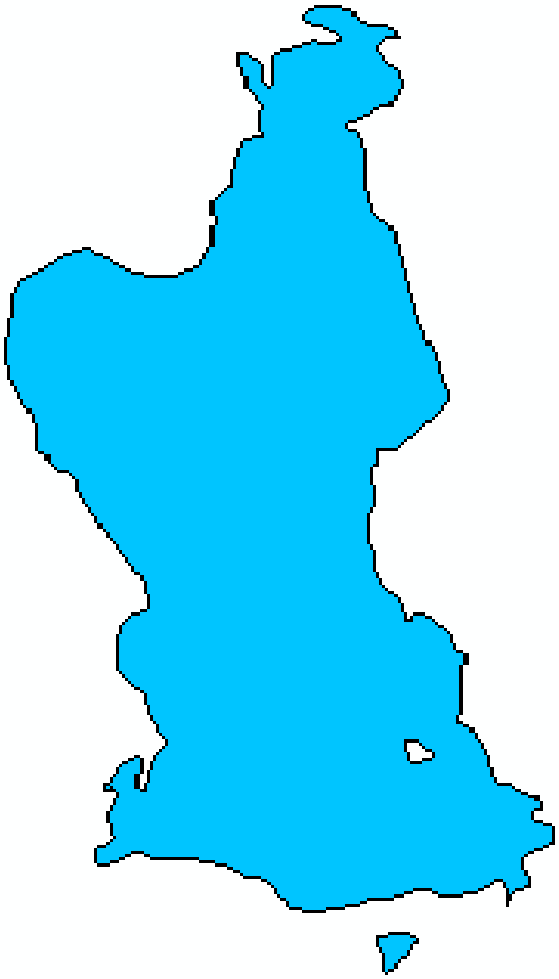
Resolution-based

Vector Advantages

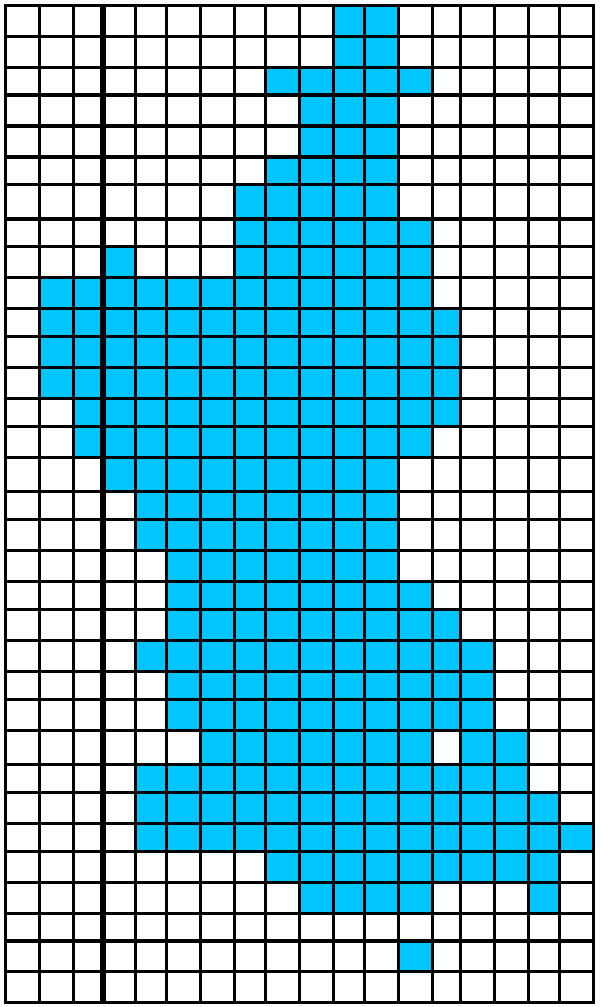
Accurate positional information that is best for storing discrete thematic features (e.g., roads, shorelines, sea-bed features, land cover)

Compact data storage requirements

Can associate unlimited numbers of attributes with specific features



Vector representation of lake polygon features. Note the detail maintained in the shoreline that defines the boundary between water and upland.

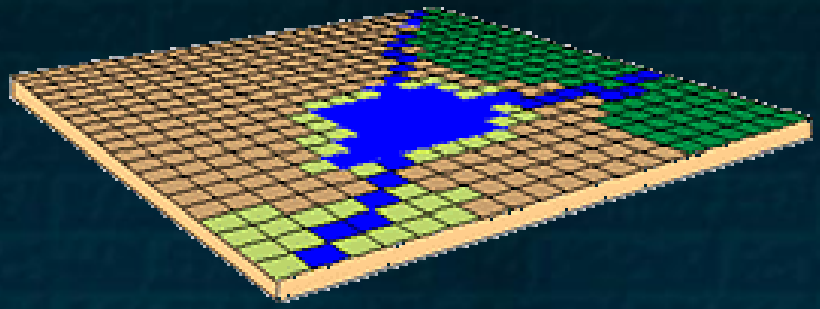


Raster representation of the same lake. With a raster data format, cells are used to encode geographic data. The entire area of each cell is assigned to a single category and boundary details are lost.

Source: OBSN, Intro to GIS

Representing Spatial Elements

- RASTER



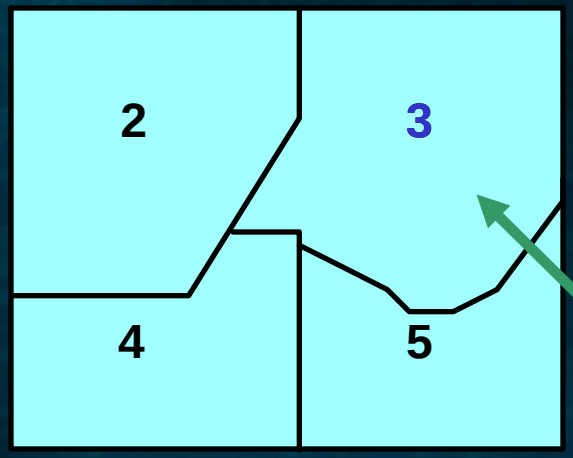
- VECTOR

- Real World

GIS Functions

GIS Storage

1 (Universe polygon)



Spatial data
(ARC functions)

Attribute data
(INFO or TABLES functions)

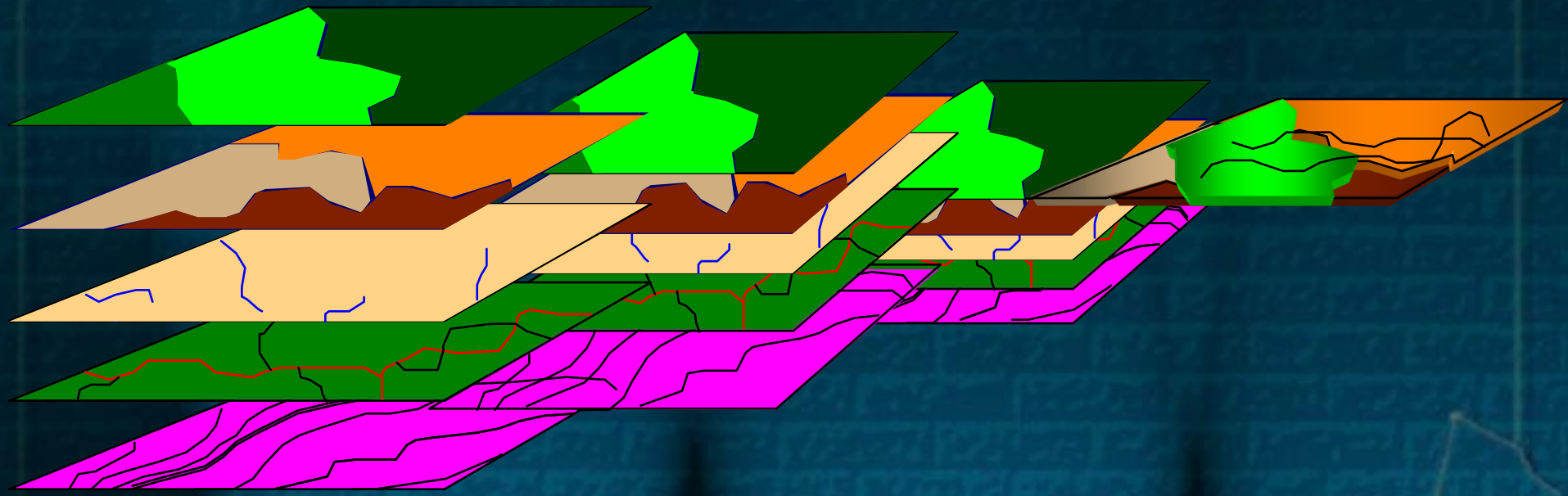
COV#	ZONE	ZIP
1		0
2	C-19	22060
3	A-4	22061
4	C-22	22060
5	A-5	22057

Spatial Data Manipulation and Analysis

- Common Manipulation
  - Rectifying
  - Reclassification
  - Map Projection changes
- Common Analysis
  - Buffering
  - Overlay
  - Interpolation

Spatial Analysis

- Overlay function creates new “layers” to solve spatial problems



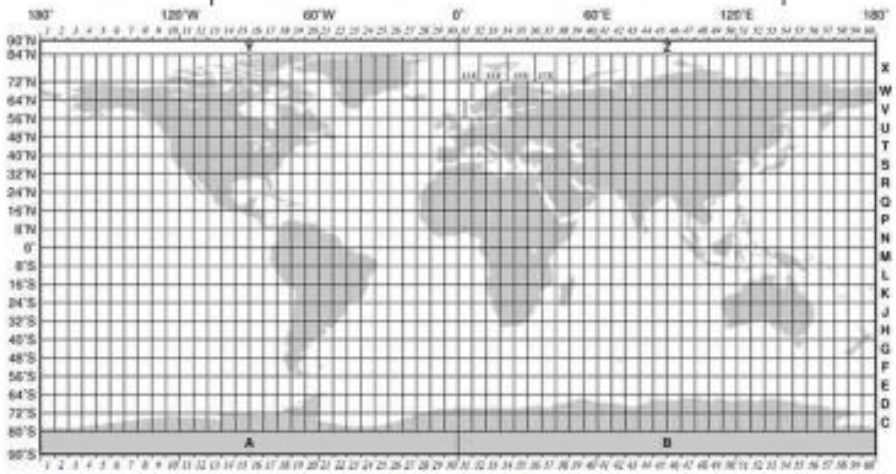
Spatial Data Output

- Tables
- 2-D Maps
- Interactive Displays
- 3-D Maps

Coordinate Systems and Projections

Geographic Coordinate Systems

Projected Coordinate Systems



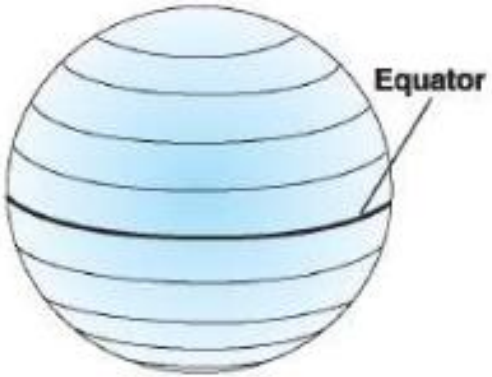
http://tabs2.gerg.tamu.edu/gmt/GMT_Docs/GMT_utm_zones.jpg

Source: OBSN, Intro to GIS

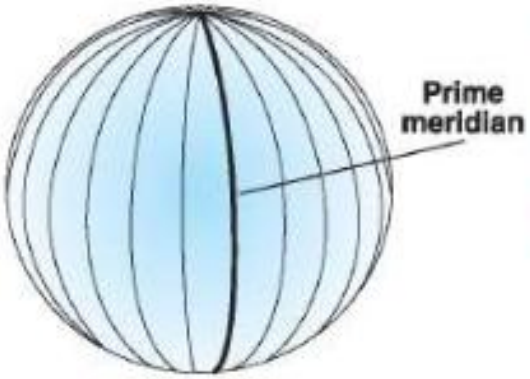
Geographic Coordinate System (GCS)

Uses 3D **spherical surface** to define locations

A point is referenced by its **longitude & latitude - measured in angular degrees!**



Parallels (Lines of latitude)



Meridians (Lines of longitude)

Source: OBSN, Intro to GIS

Commonly used CRS in the Philippines?

GCS Datum	PCS
WGS 84	***WGS 84 UTM Zone 50N (51N)***
PRS 1992	PRS 1992 - Zones I, II, III, IV, V
Luzon 1911	Luzon 1911 - Zones I, II, III, IV, V

Source: OBSN, Intro to GIS

Longitude (origin: prime meridian)

= meridian = Easting

= x values

Latitude (origin: equator)

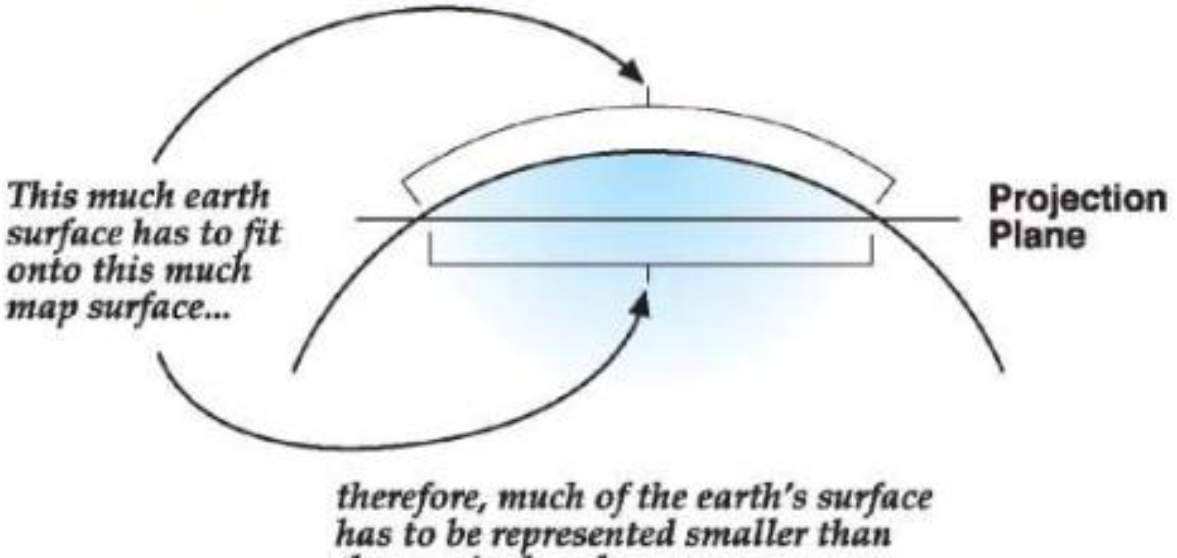
= parallels = Northing

= y values

Source: OBSN, Intro to GIS

Projected Coordinate System (PRS)

- defined on a **flat, 2-D surface** w/c has constant lengths, angles, & areas
- *PCS* is **always based on a GCS**
- *GCS* is based on a sphere or spheroid



Source: OBSN, Intro to GIS

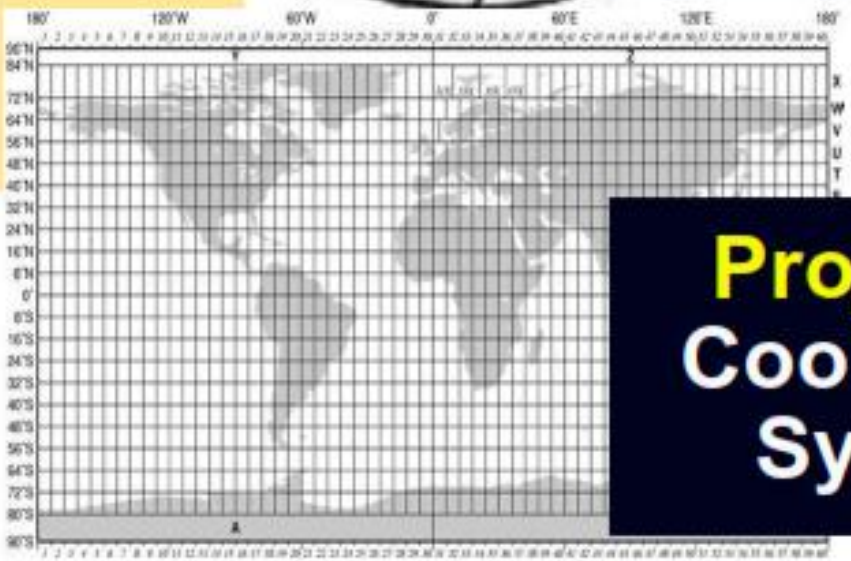
Globe / Earth

- spherical, ellipsoidal
- 3-dimensional

Geographic Coordinate System

Map

- Plane, flat surface
- 2-dimensional



http://tabs2.gerg.tamu.edu/gmt/GMT_Docs/GMT_utm_zones.jpg

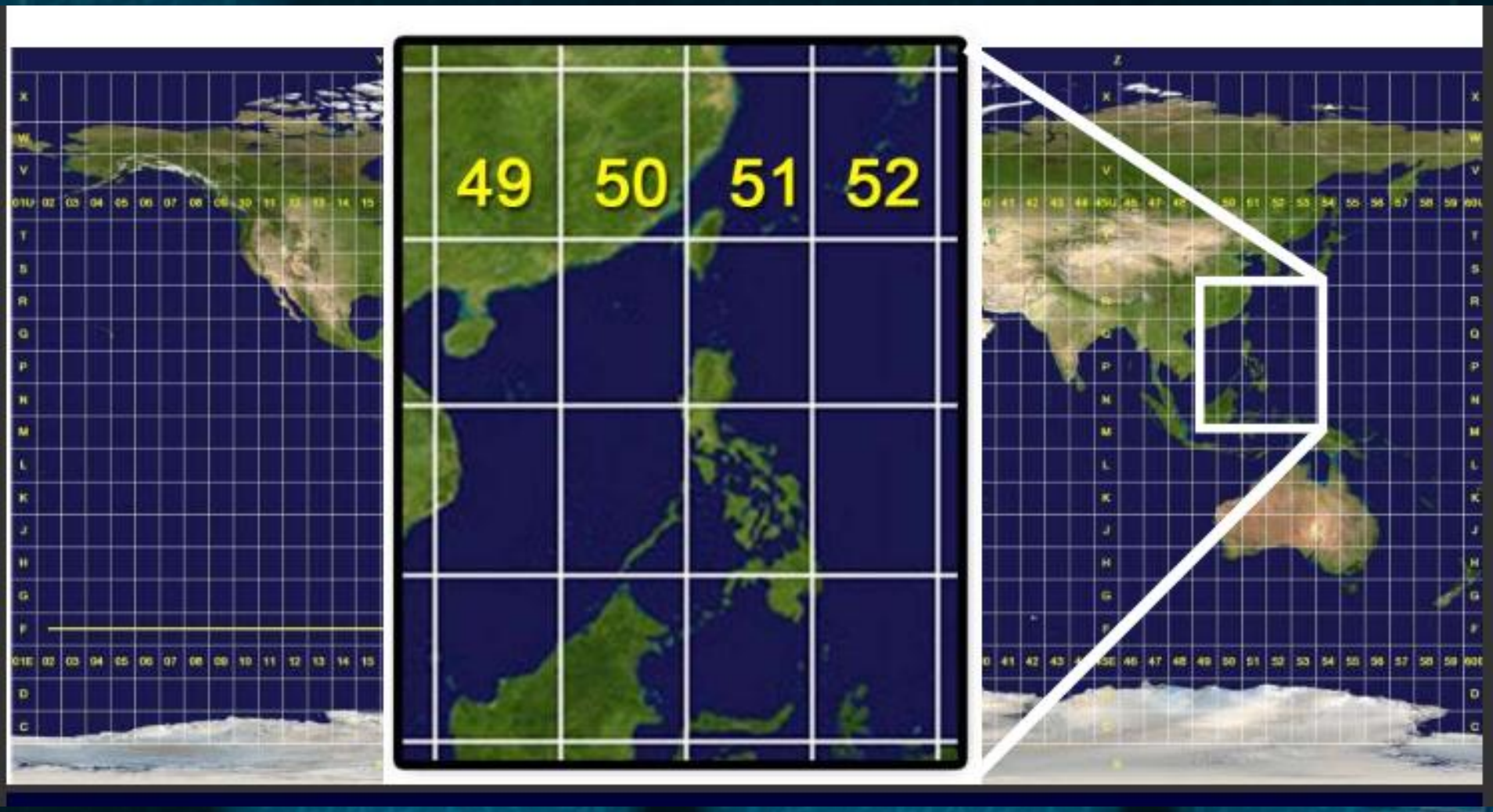
Projected Coordinate System

Source: OBSN, Intro to GIS

Universal Transverse Mercator

- **meters as unit (precise measurements)**
- Universally accepted by **many countries** by scientific community
- Based on WGS 1984
- Adopted in most RS, topo-map preps. & natural resource DBase dev't (De Mers, 2005)

- Philippines = UTM Zone 51 N (except for Palawan)



Source: OBSN, Intro to GIS

What's the CS of LLDA Office?

Geographic (WGS 1984 datum)

- Decimal Degrees - 14.644581°, 121.046187°
- Decimal Minutes - 14° 38.675'N, 121° 2.771'E
- Decimal Minutes Seconds - 14°38'40.43"N, 121° 2'46.29"E

Projected (UTM Zone 51N)

- UTM - 289572.26 m E, 1619921.13 m N

Important People

- Father of GIS – Dr. Roger Tomlinson
- Published “Mode of Communication of Cholera” (Soho Cholera Outbreak, 1854) - Dr. John Snow

- You

Short Quiz

1. T or F : GIS is synonymous to mapping
2. What GIS model to use : Political Boundaries
3. Give 2 common GCS in the Philippines
4. Give the UTM projection in the Philippines
5. True or False : UTM unit is degrees
6. Is cellphone a GIS medium?
7. T or F : 90m DEM is better then 30m DEM
8. T or F: Is GIS new?