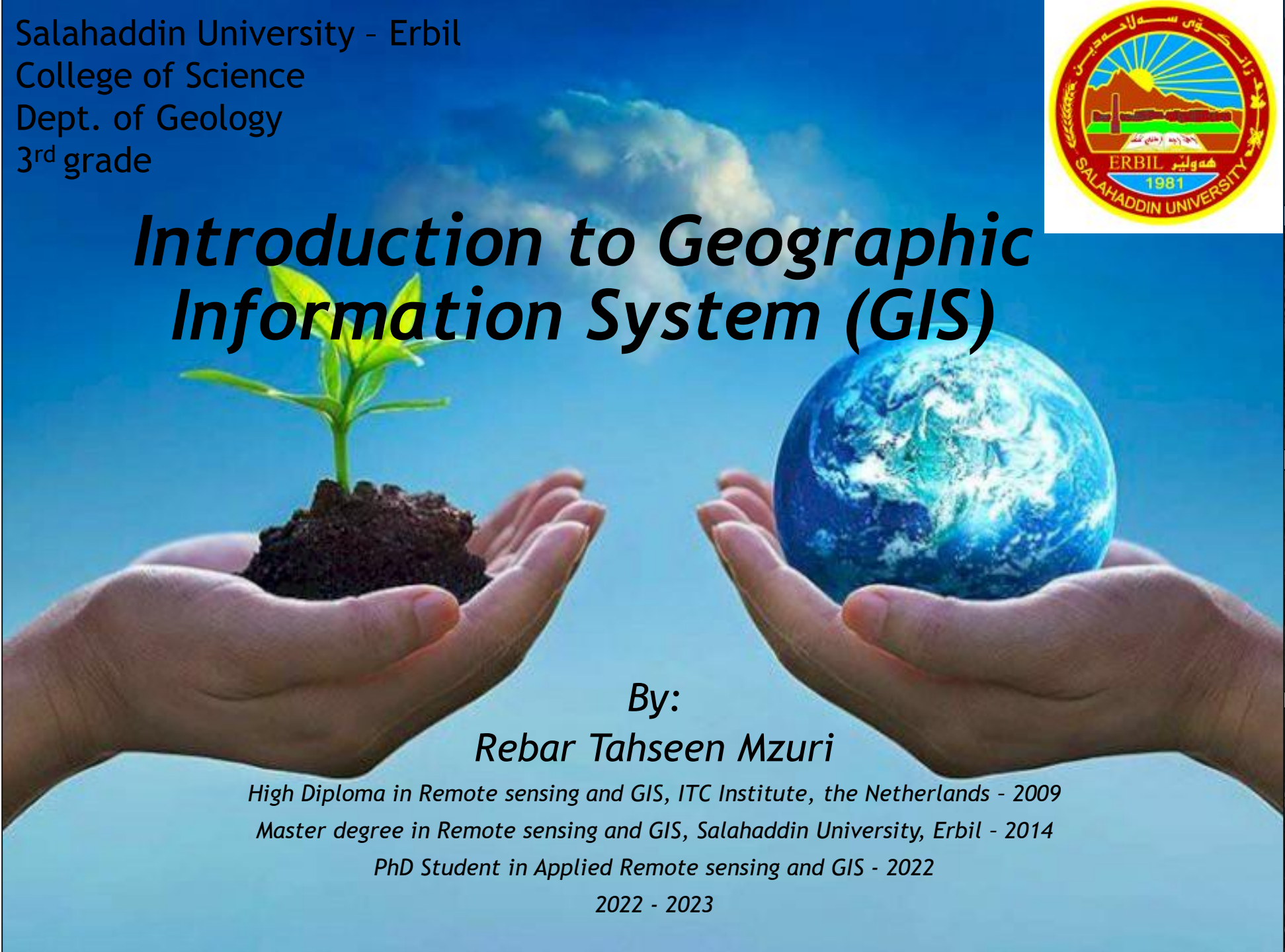
Salahaddin University – Erbil
College of Science
Dept. of Geology
3rd grade

Introduction to Geographic Information System (GIS)



By:

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High Diploma in Remote sensing and GIS, ITC Institute, the Netherlands - 2009

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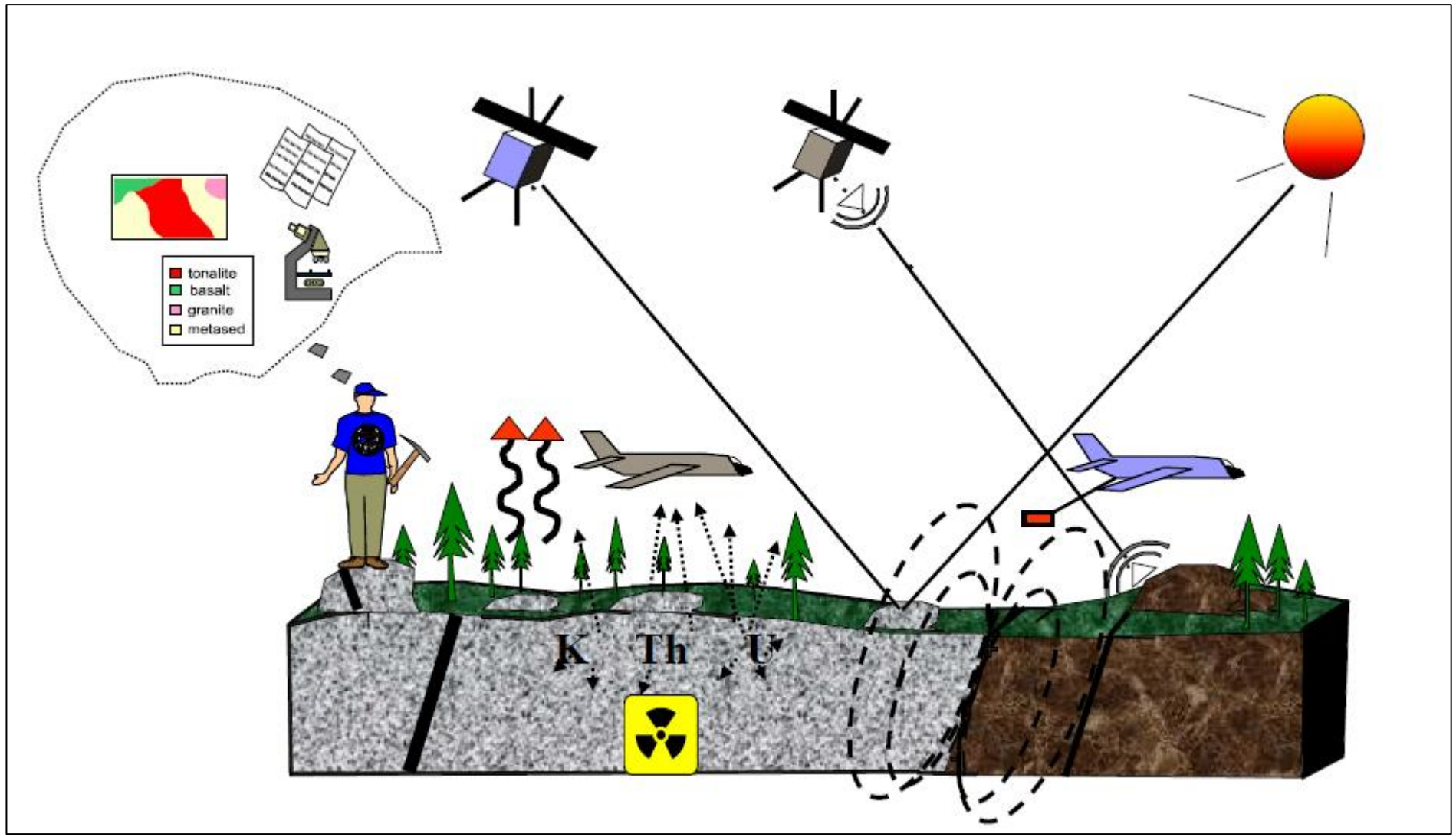
PhD Student in Applied Remote sensing and GIS - 2022

2022 - 2023

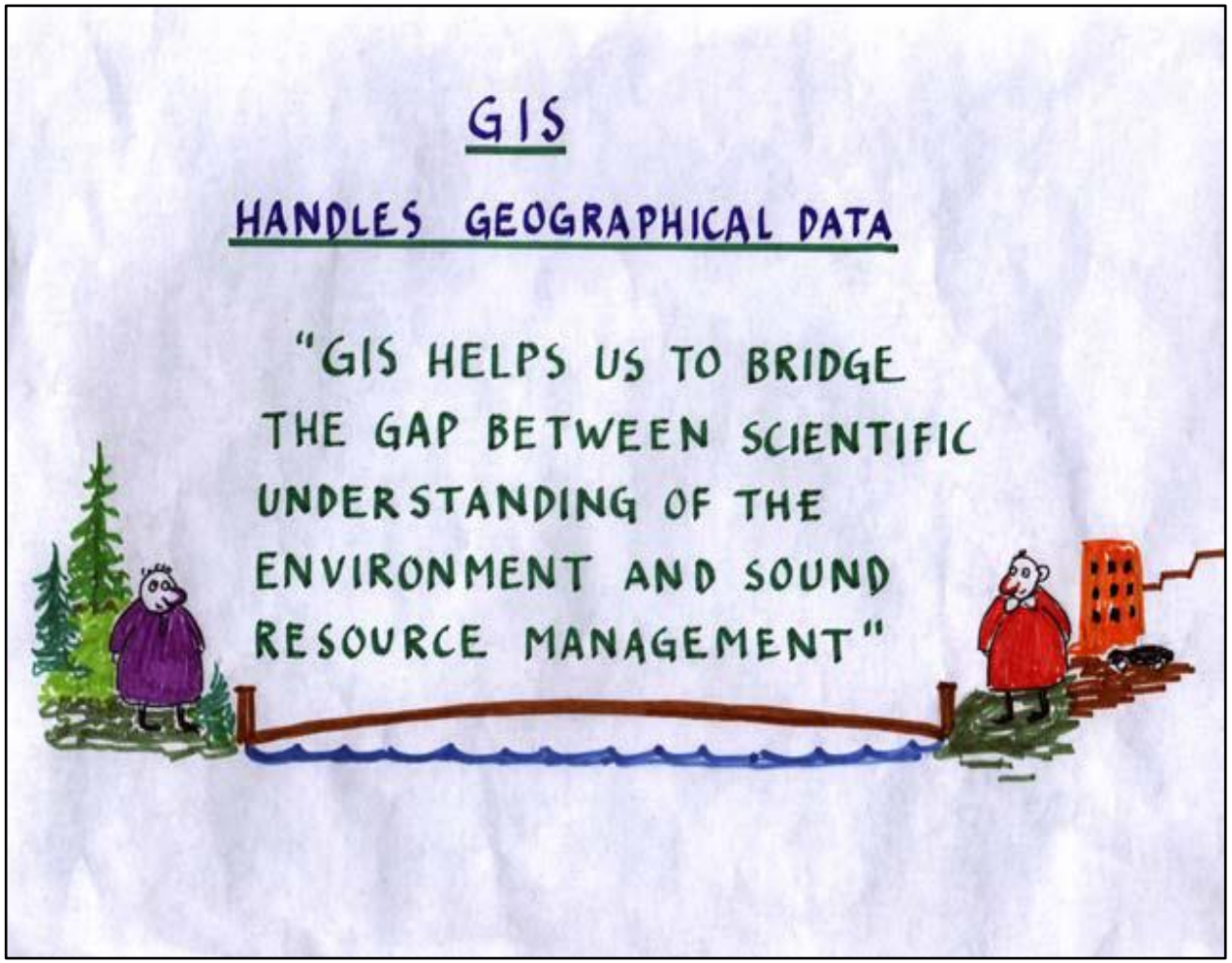
Why GIS in Earth Sciences?

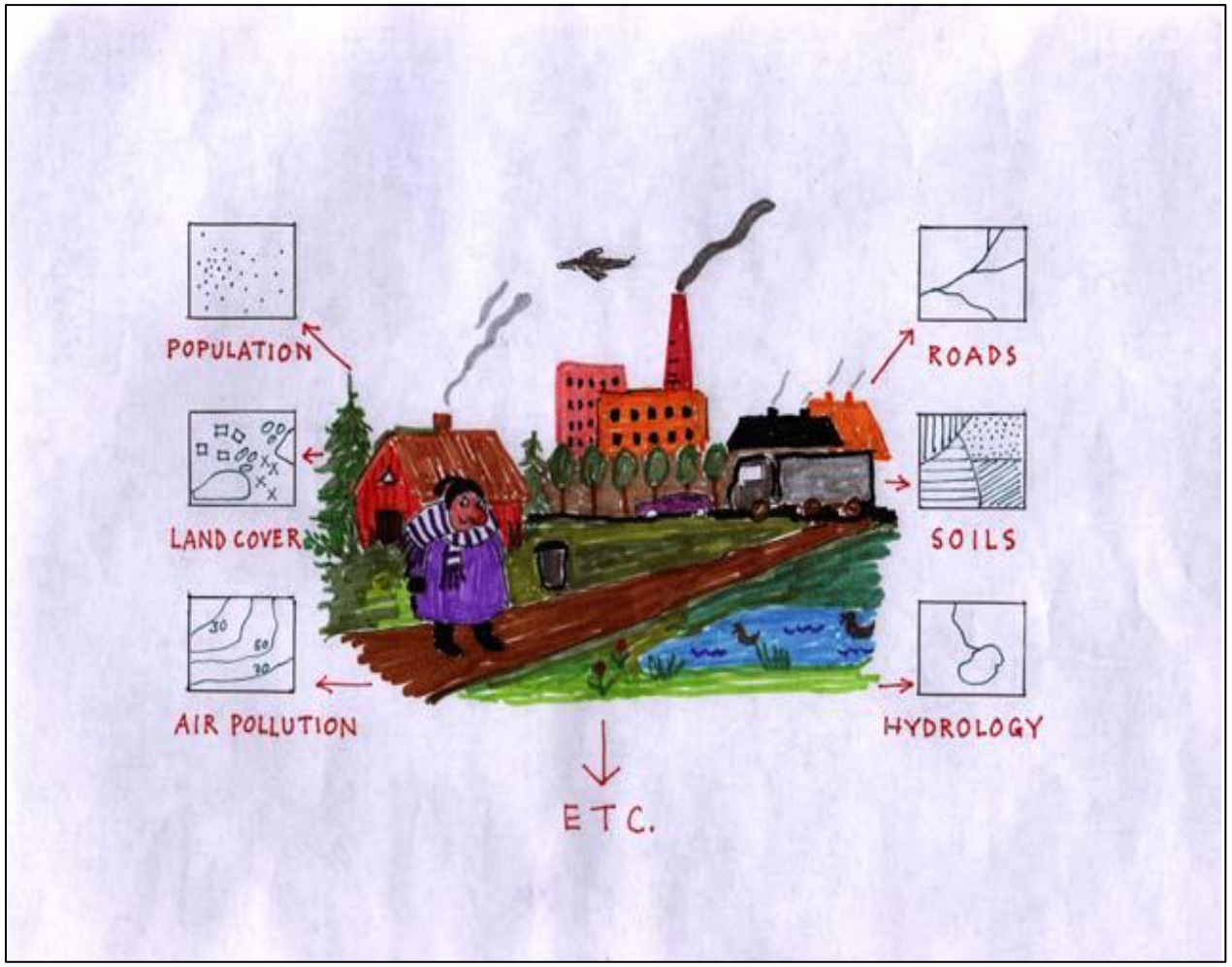
- Functions for the efficient input, management, integration, analysis and dissemination of heterogeneous spatial data sets.
- Effective query and search functionality.
- Functions for spatial analysis and models (e.g. predictive models on mineral potential; hazard and vulnerability mapping etc.)
- A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. By relating seemingly unrelated data, GIS can help individuals and organizations better understand spatial patterns and relationships.

Modern situation in Earth Sciences



What is a GIS?


GIS
HANDLES GEOGRAPHICAL DATA
"GIS HELPS US TO BRIDGE THE GAP BETWEEN SCIENTIFIC UNDERSTANDING OF THE ENVIRONMENT AND SOUND RESOURCE MANAGEMENT"


POPULATION
ROADS
LAND COVER
SOILS
AIR POLLUTION
HYDROLOGY
ETC.

What is a GIS? (cont'd)

- GIS is a system that handles geographical information or geographical data. As such, it is a tool that helps bridging the gap between different disciplines, e.g. scientific understanding of the environment and sound resource management.
- It also provides the tools for using different types of information together to solve different problems. But the most important feature with the GIS is that it handles information in a digital format.
- In the past, such information was mainly in paper map format but now computers are used to handle it instead. From the computerized databases, information can be retrieved quickly and easily, as both maps and/or tables.

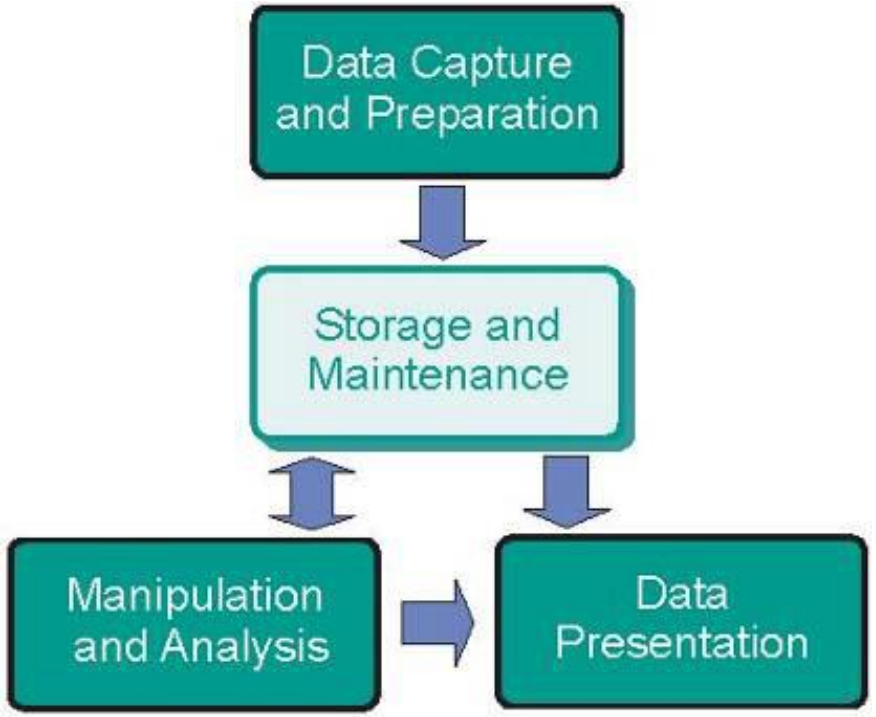
What is a GIS? (cont'd)

- a GIS usually contains:

➢a computer-based system,

➢allow data entry, analysis, presentation

➢of geographically referenced data



GIS functional components

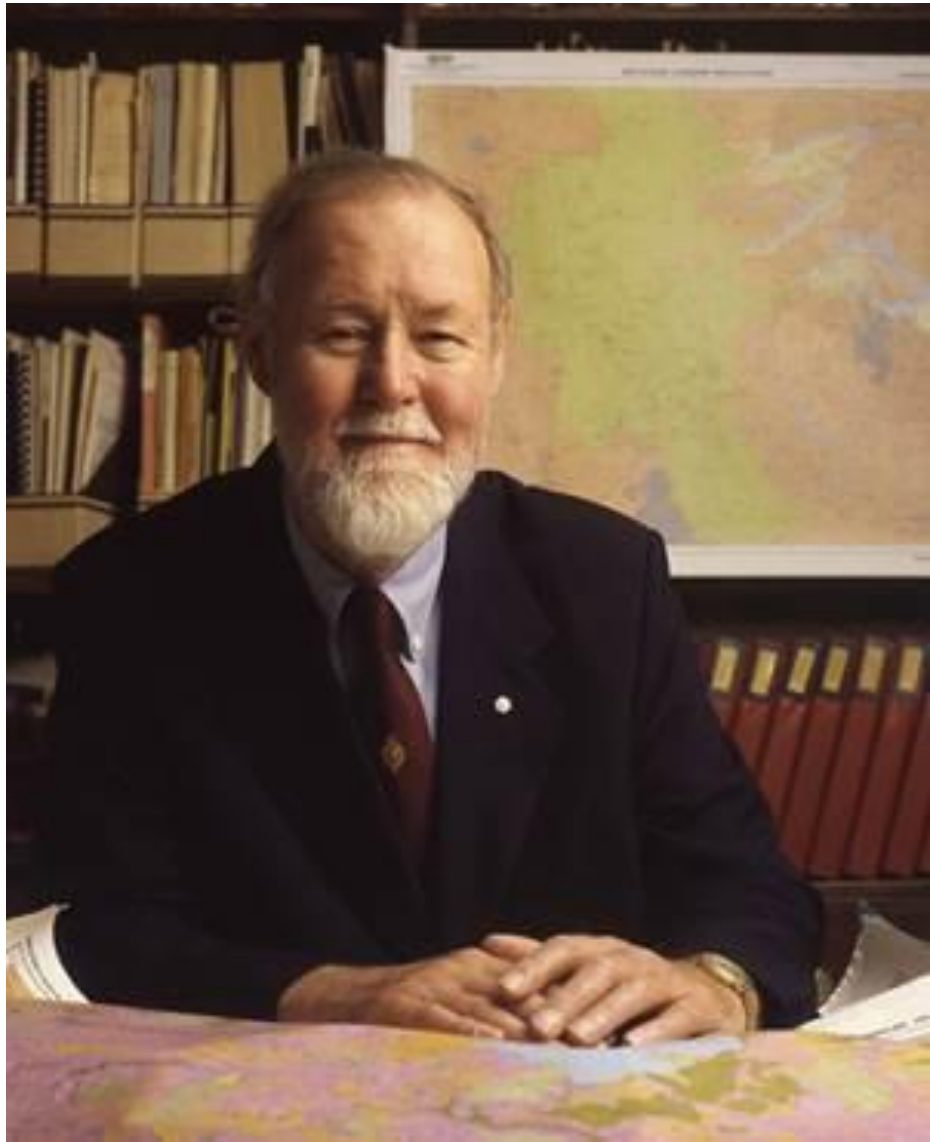
What is a GIS? (cont'd)

Who is the father of GIS?

- It was a serendipitous meeting on an airplane that launched what is now a global industry valued at over $270 billion dollars annually. Onboard a flight in 1961, ***Roger Tomlinson*** met Lee Pratt, the recently named head of the Canada Land Inventory who had been tasked with developing a land map covering one million square miles in order to manage agricultural land, forests, wildlife, and identify land suitable for tourism.
- ***Tomlinson*** proposed a solution using computerized spatial data and thus modern GIS was born. In the more than fifty years since, GIS has grown into a technology that can be applied in almost all disciplines needing to understand patterns across space and time. Tomlinson went on to coin the term “geographic information systems” and it’s his contributions to geographic information systems (GIS) that earned him the nickname, “Father of GIS”. Roger Tomlinson died on February 9, 2014, at the age of 80.

Who is the father of GIS?

- **Roger F. Tomlinson**, (17 November 1933 – 7 February 2014)
- was an English geographer and the primary originator of modern computerized geographic information systems (GIS) and has been acknowledged as the "father of GIS.



- Dr. Tomlinson was a native of Newmarket (England) and prior to attending university, he served in the Royal Air Force from 1951–1954 as a pilot and flying officer.

- After his military service, Dr. Tomlinson attended the University of Nottingham and Acadia University for two separate undergraduate degrees in geography and geology, respectively.

Data vs. Information

1. **Data:**
- Representations useable in processing / by computers

2. **Information:**
- Interpretation of data by human being

3. Prefix **Geo-** or **Geo-spatial**:
- with a reference to a position on earth

Data quality - metadata

- Metadata = data about the data
- Metadata helps in knowing:

- to know where data came from
- what intentions were
- use restriction
- quality
- Satellite image source
- etc....

Metadata Example:

- **Metadata for great zab river.**
- **Description:** all flowing water

Bodies of great zab river.

Files included:

Greatzabriver_dbf

Greatzabriver_shp

Greatzabriver_shx

Datum: WGS 1984, UTM, zone 38 N

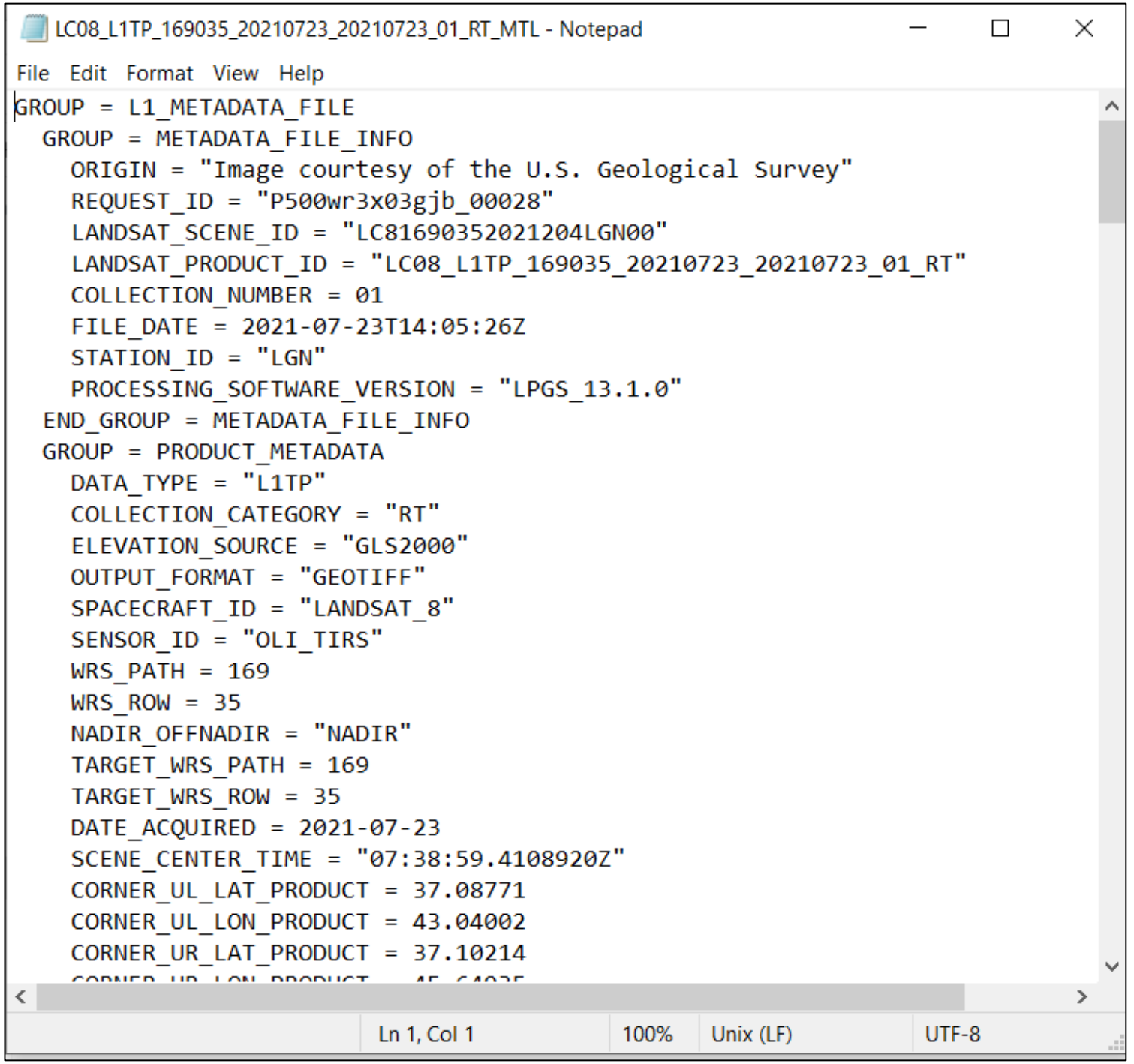
Ref system: geographical long & lat

Source: digitized by ….

Sharing information: this overlay must not be shared with or used by other organizations except dept. of Geology.

Contacts: college of science, dept. of Geology

Rebar Mzuri



The real world and Models

- Model: representation of a small part of the real world
- contains only relevant data (or what we think is relevant)
- often has to simplify or generalize real world.

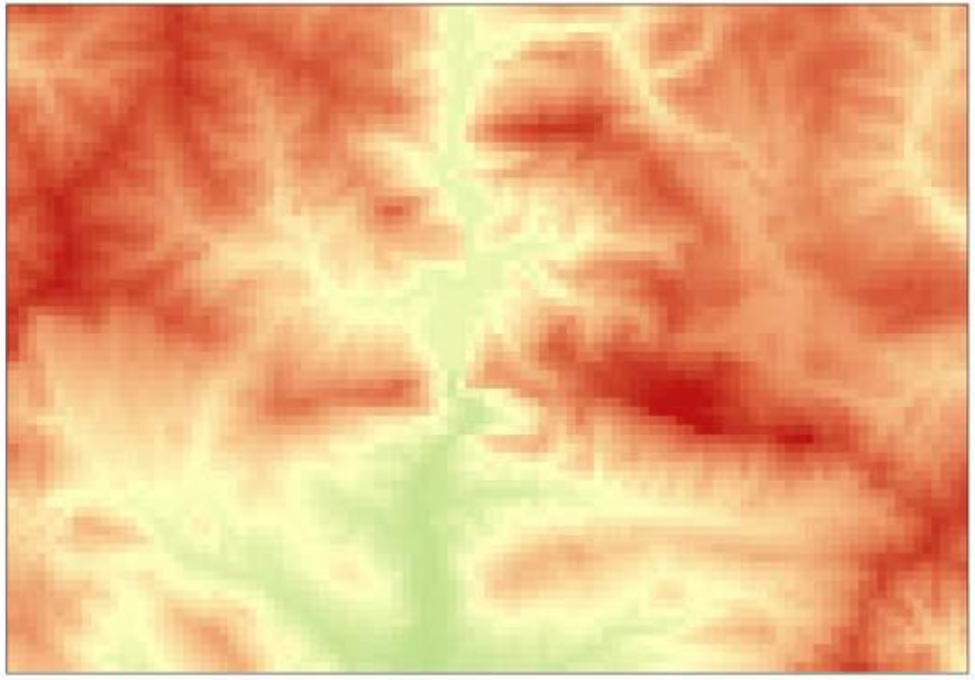
Types of Models:

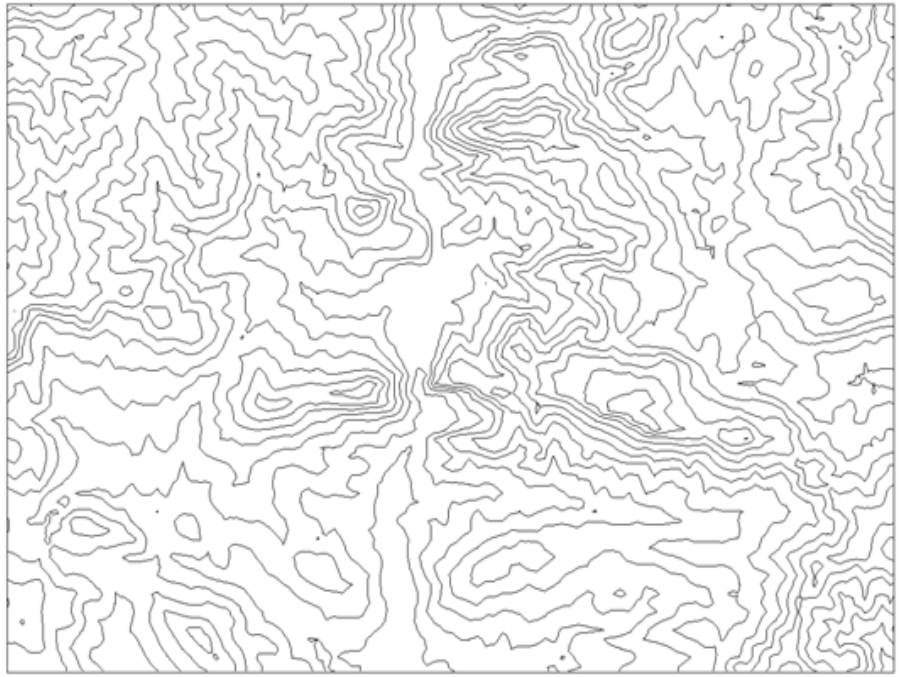
1. Static model: “frozen” representation of a real-world phenomenon at one point in time

2. Dynamic model: model that can deal with changes in past and/or future

Raster and Vector Models

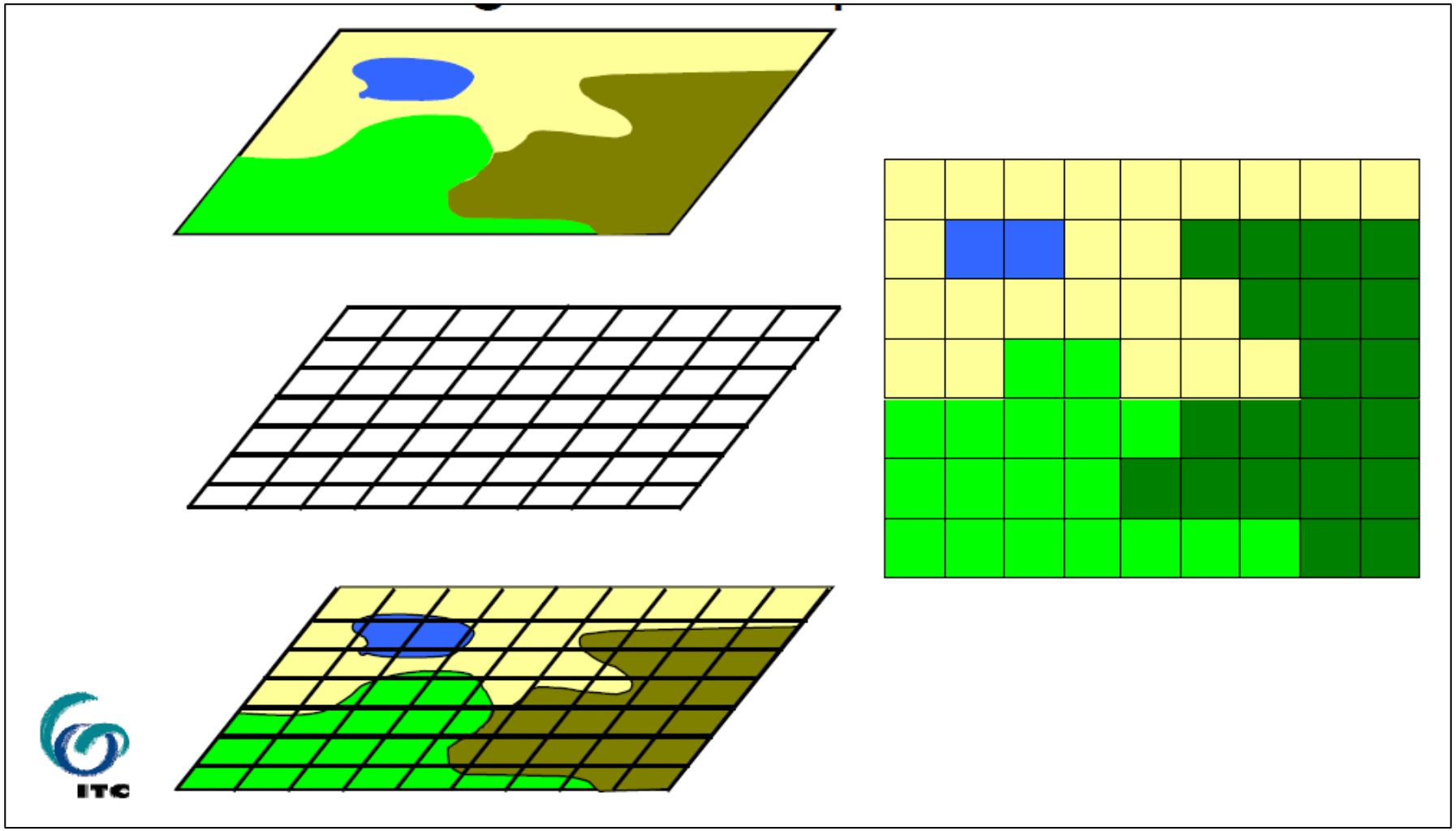
- **Raster Representation:** stores images as rows and columns (grid, image) of numbers with a Digital Value/Number (DN) for each cell. Numerous data formats (common: TIFF, GIF, ERDAS.img etc)
- **Vector Representation:** allows user to specify specific spatial locations and assumes that geographic space is continuous, not broken up into discrete grid squares.(point, line, polygon)



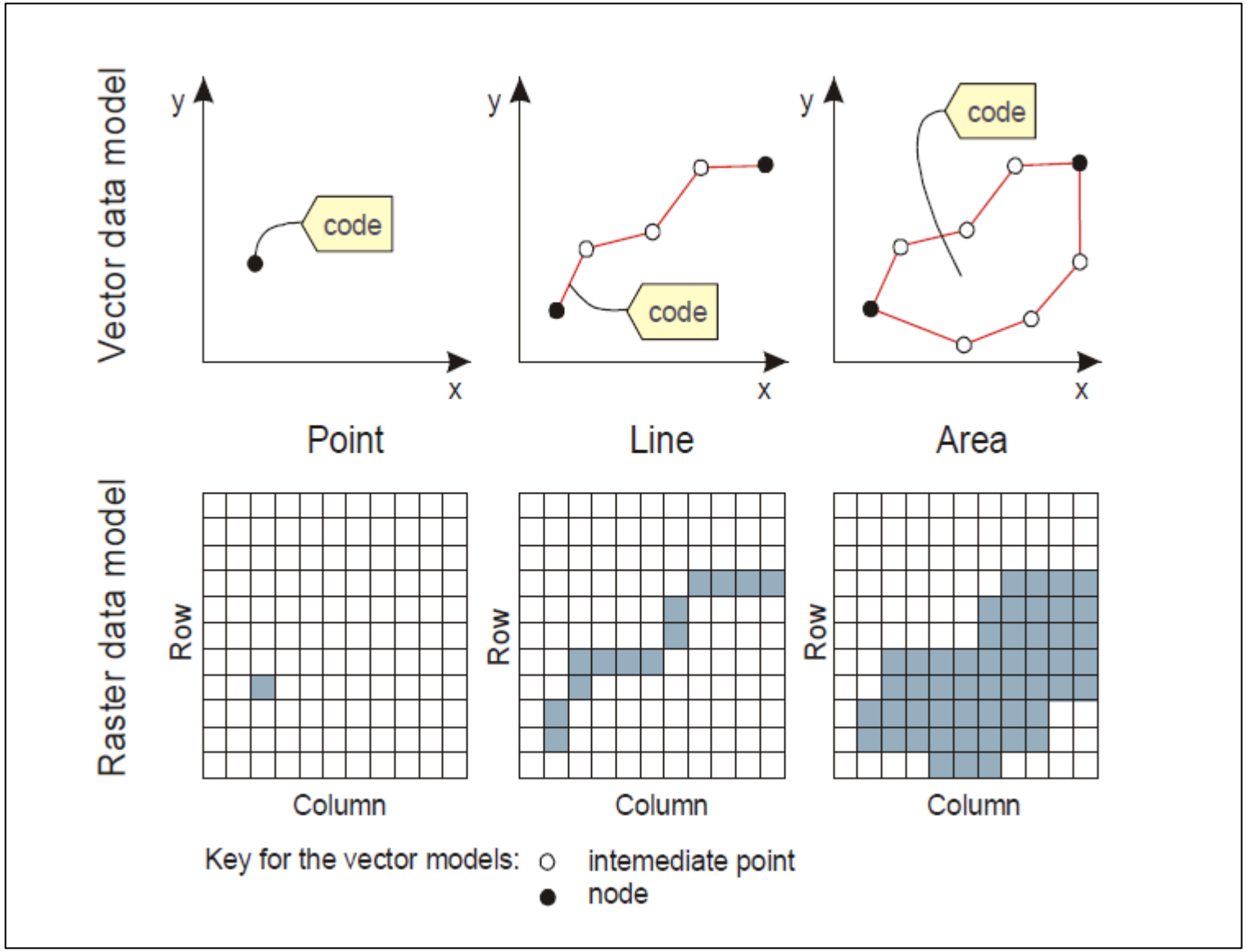


Raster and Vector Models (cont'd)

Rasterizing vector maps



Raster and Vector Models (cont'd)

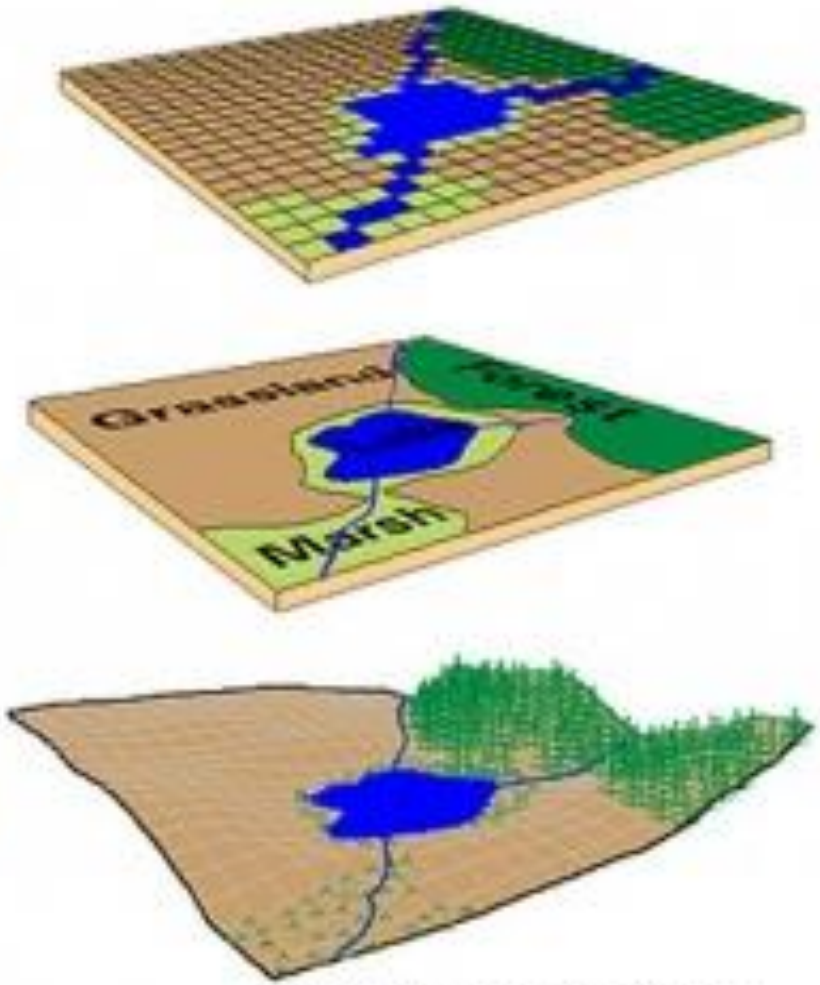


Raster and Vector Models (cont'd)

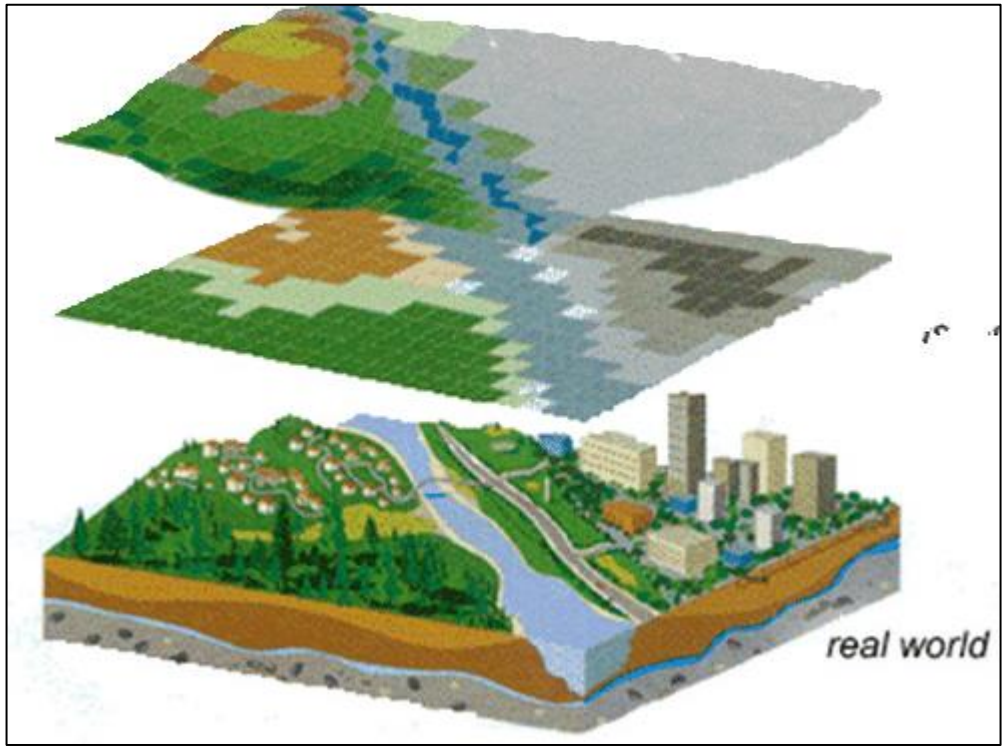
Raster representation	*Vector representation*
advantages	
• simple data structure • simple implementation of overlays • efficient for image processing	• efficient representation of topology • adapts well to scale changes • allows representing networks • allows easy association with attribute data
disadvantages	
• less compact data structure • difficulties in representing topology • cell boundaries independent of feature boundaries	• complex data structure • overlay more difficult to implement • inefficient for image processing • more update-intensive

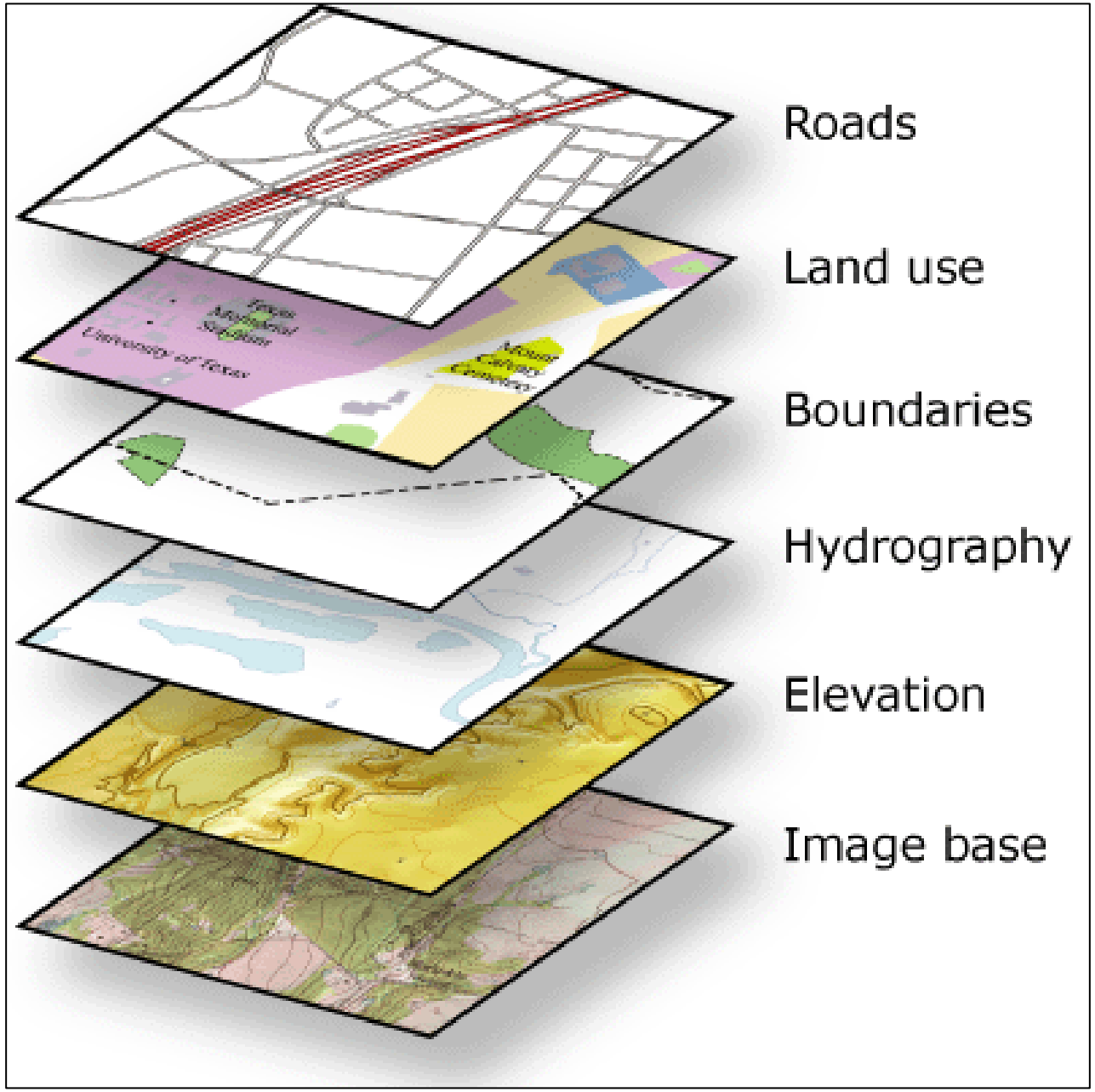
Raster and Vector Models (cont'd)

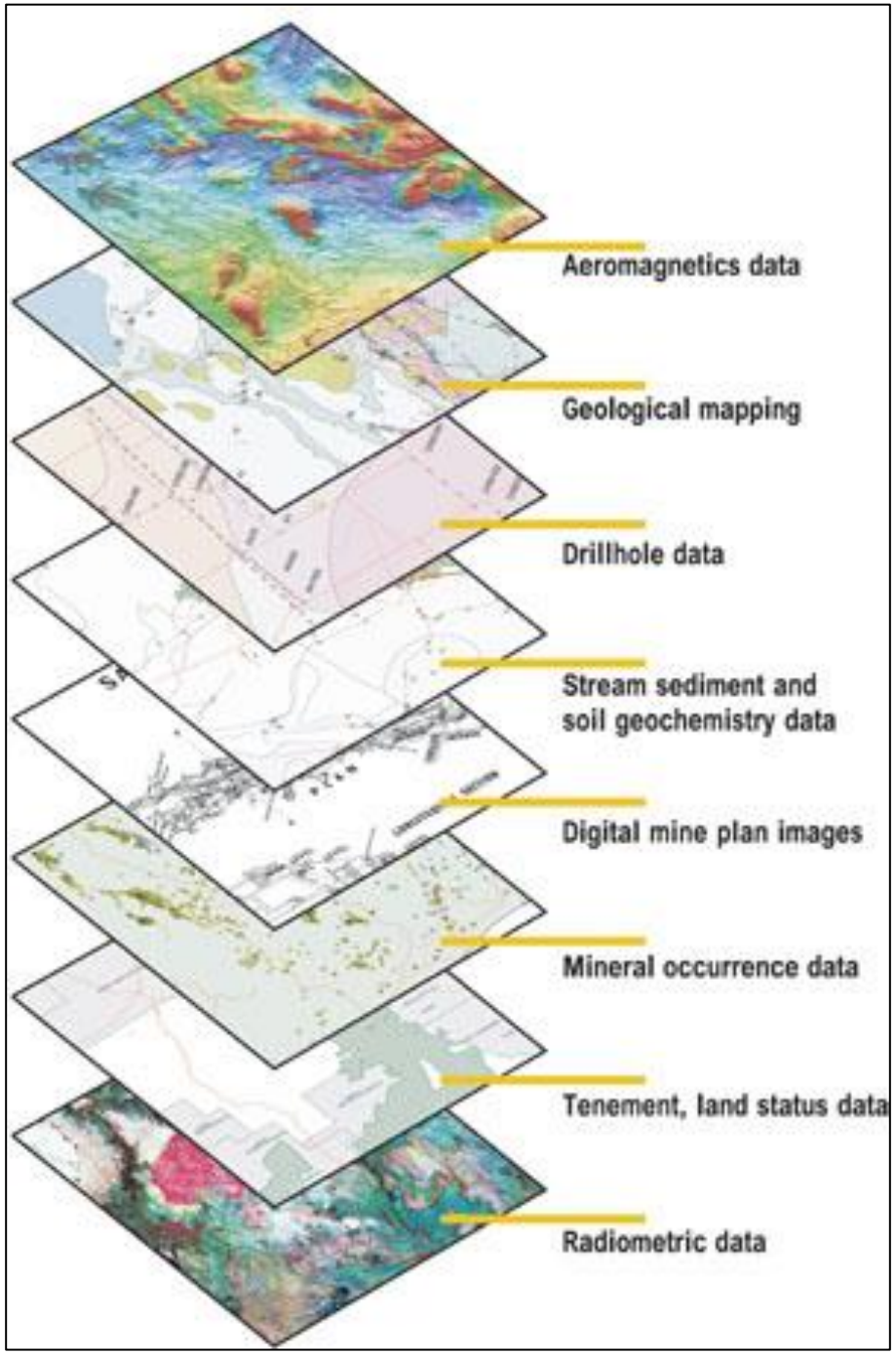
- RASTER →
- VECTOR →
- Real World →



Source: Defense Mapping School
National Imagery and Mapping Agency




Roads
Land use
Boundaries
Hydrography
Elevation
Image base


Aeromagnetics data
Geological mapping
Drillhole data
Stream sediment and soil geochemistry data
Digital mine plan images
Mineral occurrence data
Tenement, land status data
Radiometric data

Vector structure

VECTOR GIS

GEOMETRICAL OBJECTS ARE REPRESENTED AS

- POINTS
- LINES
- POLYGONS

ATTRIBUTES CAN BE LINKED TO THESE

LINE { ARC, CHAIN, STRING, LINK, POLYLINE

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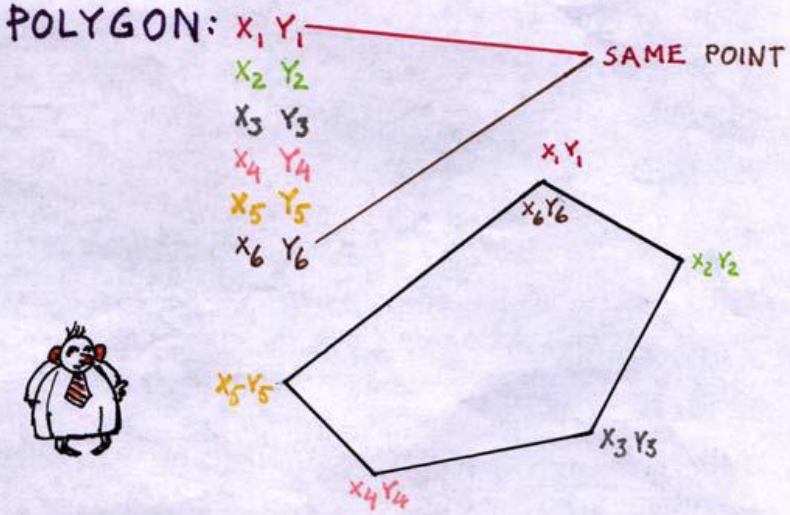
THE GEOMETRICAL DATA ARE STORED AS COORDINATES, E.G.

POINT: X Y

LINE: $X_1\ Y_1$ – START NODE
$X_2\ Y_2$ – VERTEX
$X_3\ Y_3$ – STOP NODE

POLYGON: $X_1\ Y_1$
$X_2\ Y_2$
$X_3\ Y_3$
$X_4\ Y_4$
$X_5\ Y_5$
$X_6\ Y_6$



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