# Geographic Information System GIS

المعهد التقني كركوك
قسم تقنيات المساحة

الحقيبة التعليمية

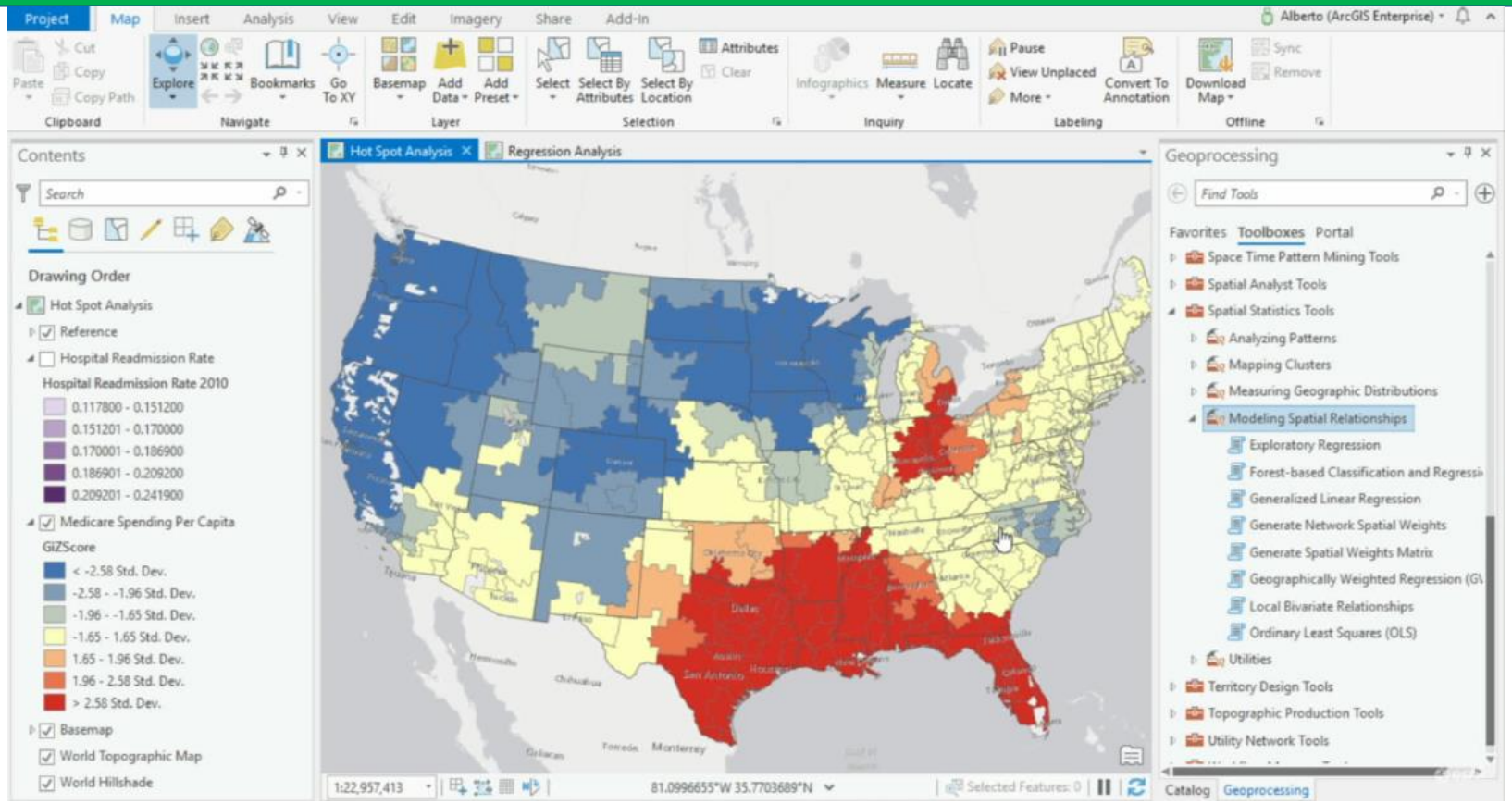
المادة

## نظم المعلومات الجغرافية/ المستوى الثاني

عدد الساعات النظري 2
عدد الساعات العملي 3

مدرس مساعد
فرمان غالب سعيد

# Geographic Information Systems



# Geographic Information Systems

❖ ***What is Geographic Information System (GIS) ?***

*'' a system of hardware, software, data, and organizational structure for collecting, storing, manipulating, and spatially analyzing "geo-referenced" data, and displaying information resulting from those processes''.*

# Geographic Information Systems

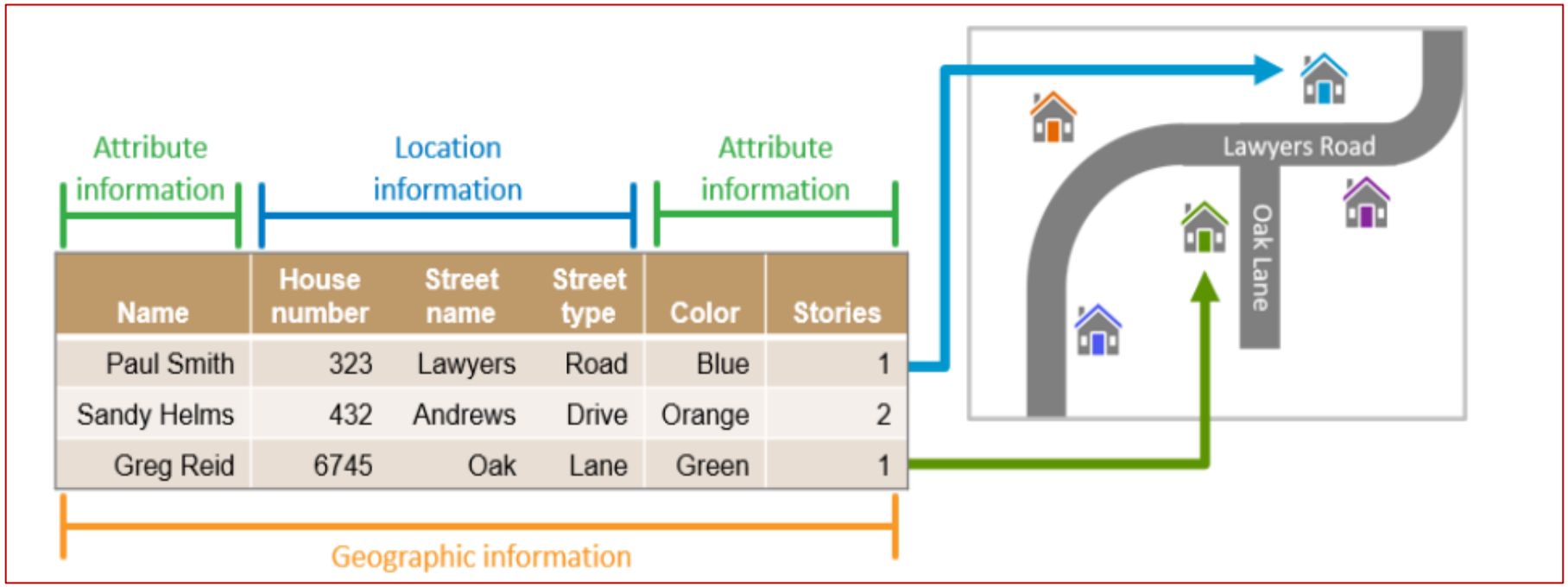
*Geographic information is made up two important elements:*

1. ***Location*** *(**geometric component** ) describes where an object resides on the earth and includes x,y coordinates, addresses, and points of interest.*

2. ***Attributes*** *(**Thematic componen**t) describe non-location information, such as ID numbers, names, and values.*

# Geographic Information

❖ ***Attribute** and **location***



# Geographic Information Systems Components

***The Five primary components of the GIS is:***

1. *Hardware*
2. *Software  ArcGIS Desktop or ArcGIS Pro*
3. *Data*
4. *People*
5. *Workflows*


*Each component contributes to the overall system, enabling the user to make smarter decisions*

# Hardware Requirements

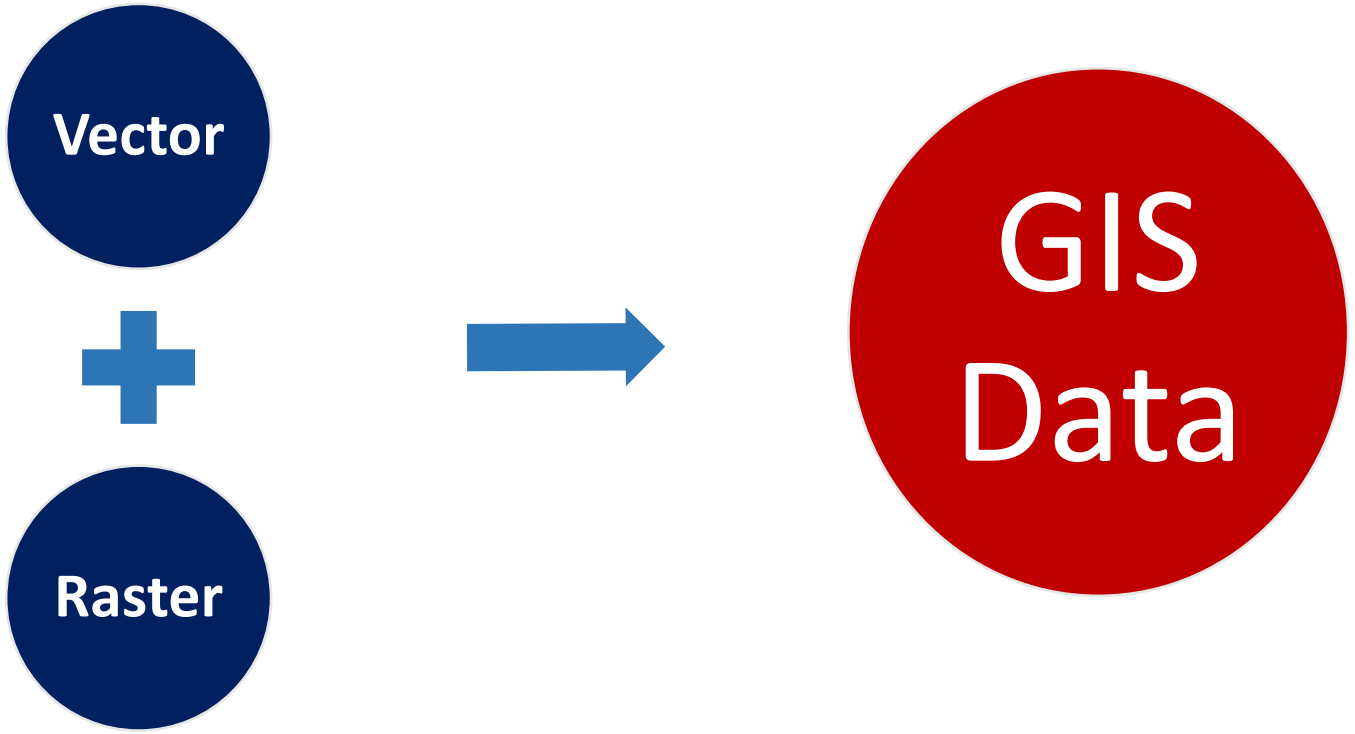
| No | Items | Requirements |
|---|---|---|
| 1 | CPU | Recommended : 4 cores,<br>Optimal : 10 cores |
| 2 | Storage | Recommended: 32 GB of free space<br>Optimal: More than 32 GB free of space on SSD |
| 3 | Memory/ RAM | recommended: 32 GB<br>Optimal: 64 GB or more |
| 4 | Dedicated Graphics memory | Recommended: 16 GB or more |
| 5 | Visualization Cache | up to 32 GB of space |
| 6 | Screen resolution | Minimum: 1024x768<br>Recommended: 1080p or higher |
| 7 | GPU | NVIDIA GPU with CUDA compute capability 5.0 minimum; 6.1 or later recommended. |
| 8 | Software | Microsoft .NET Desktop Runtime 8.0.1 |

# GIS Software

***There are as many as GIS tools and software license***

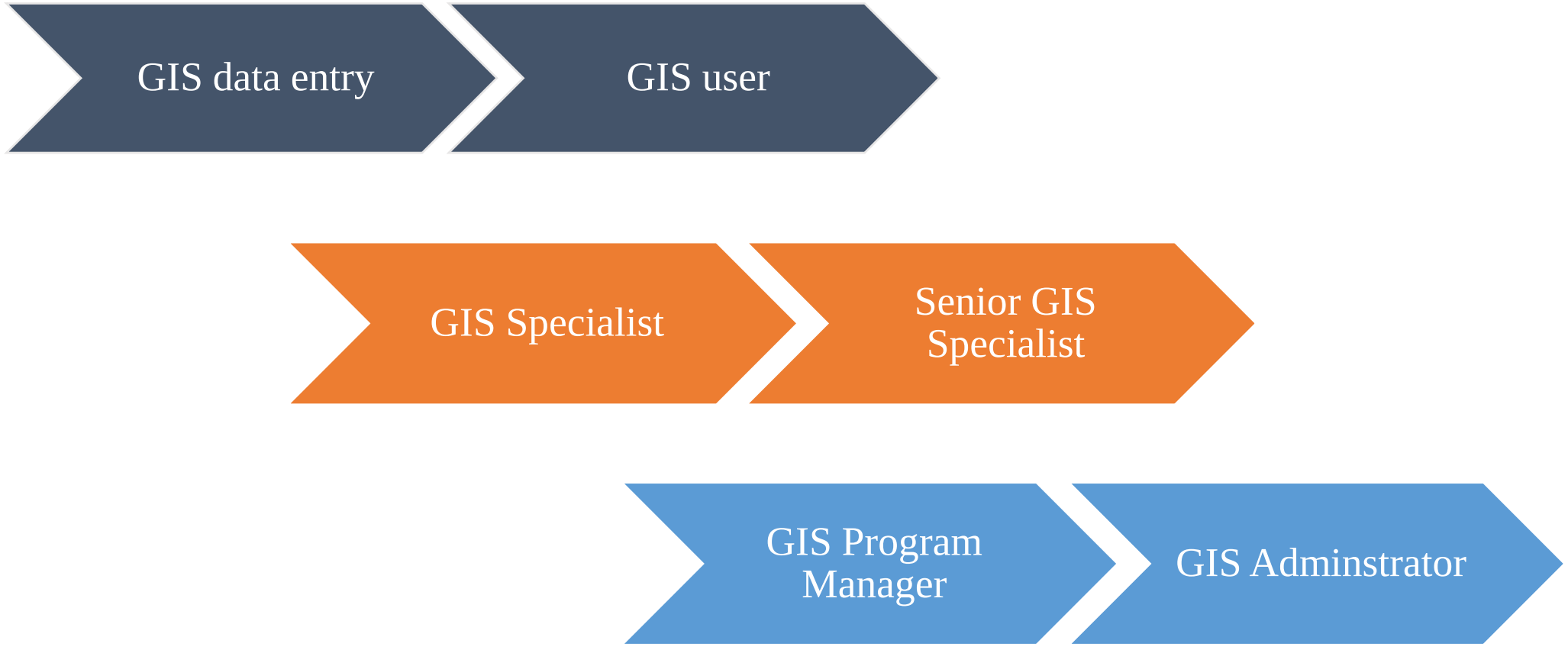
# GIS Data

***There are two types of data that are common within GIS***



# GIS - Job Titles

*There are  several GIS Job Titles in the market:*



# GIS Workflows

***Every single GIS job has workflows; here is one best workflows model to follow***

1. ***Requirements:*** What is the problem you are trying to solve

2. ***Data Collection:*** Find the data needed to complete your project

3. ***Examination:*** How the data is organized, accurate, and data sources

4. ***Analyzing :*** Geographic analysis

5. ***Decision : Making decision*** on what you get

# GIS main parts

# GIS main parts

❖ ***GIS system has four main integrated parts in one package***

1. ***Arc Map*** for analyzing and layout the results
2. ***Arc catalog*** *spatial data management and creation of GIS database*
3. ***Arc Scene*** for 3D spatial data and visualization
4. ***Arc Globe*** for visualizing the data in the globe view

# Chapter Questions

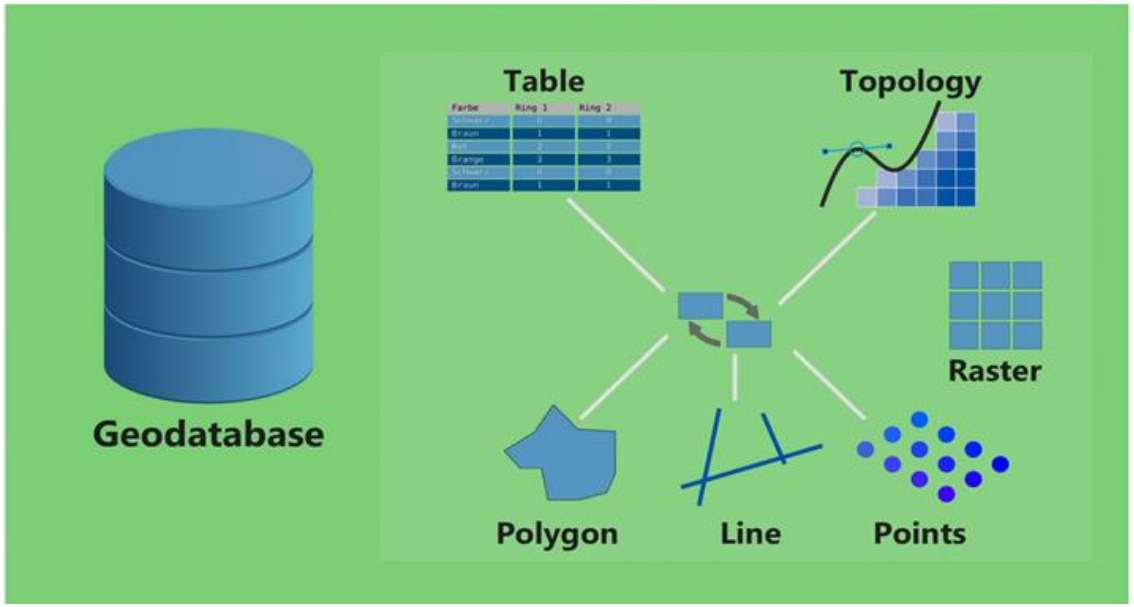
1. *List the best GIS workflows model for a project*

2. *Geographic Information Systems GIS is made up two important elements, list and explain*

3. *GIS system has four main integrated parts in one package, list and explain*

4. *Define GIS and state the five primary components of GIS*

# GIS Geodatabase



# Geodatabase

*A **Geodatabase** is an organized collection of related data that's designed for efficient storage and retrieval. In this system, data is stored in a series of relations called tables.*

❖*Various types of geographic datasets can be collected within a geodatabase, including feature classes, attribute tables, raster datasets, network datasets, topologies*

*https://support.esri.com/en-us/gis-dictionary/geodatabase*

# Geodatabase

*For example, a city might have its wastewater division, land records, transportation, and fire departments connected and using different geodatabases.*

***There are two types of single-user geodatabases:***

*A. Personal Geodatabase: It is for single users working with small to moderate GIS datasets.*

*B. File Geodatabase: It has no practical size capacity limits.*

# Geodatabase

***Some facts about File geodatabases have many benefits including:***

1. *Flexible storage and open access.*
2. *Better performance capabilities than Personal Geodatabase*
3. *The geodatabase can be compressed which helps reduce the geodatabases' size on the disk*
4. *Simplicity and efficiency.*
5. *Effective display and analysis of geographic data.*

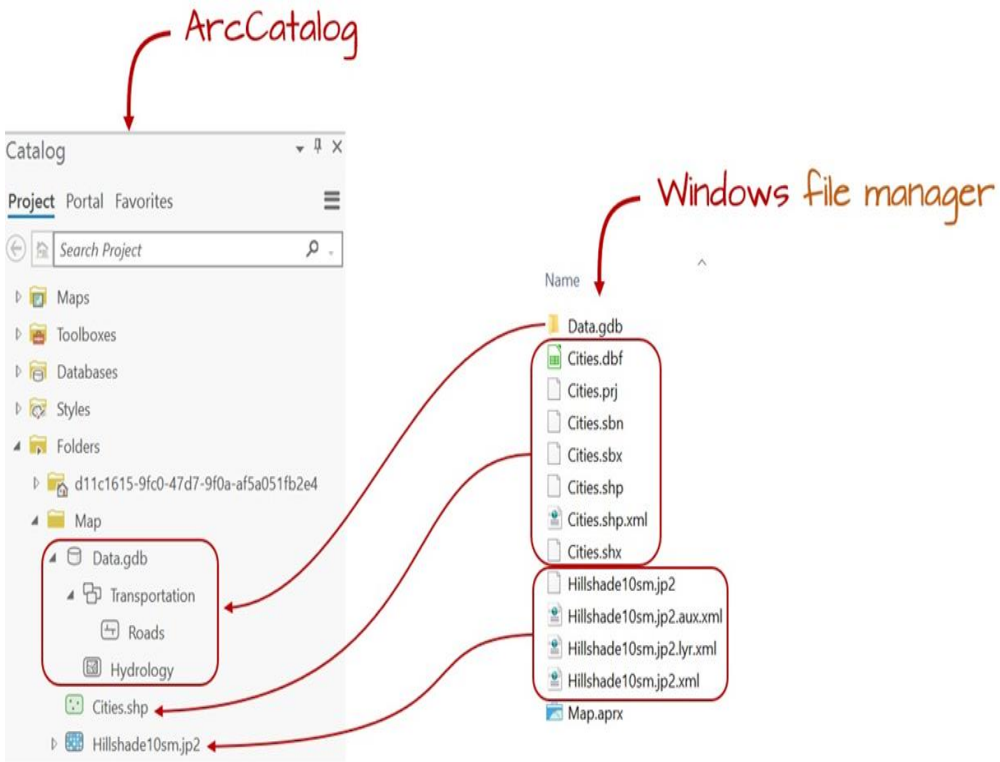
# Geodatabase Design

## *Geodatabase Design Steps :*

1. *Identify the information products that will be created and managed.*
2. *Define the tabular database structure.*
3. *Define the spatial behavior, spatial relationships and descriptive attributes.*
4. *Propose a geodatabase design.*
5. *Document the geodatabase design.*

# Shapefile

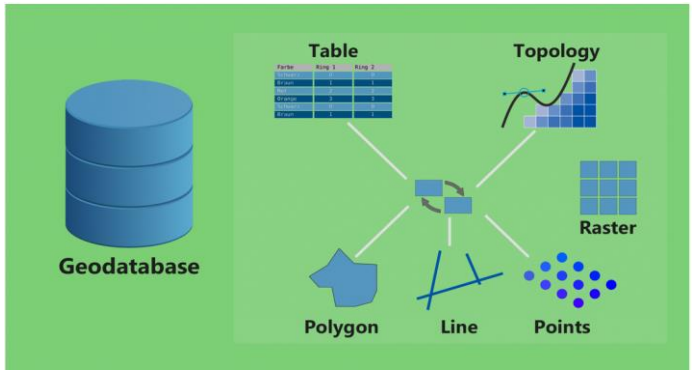
***Shapefile:*** *A vector data storage format for storing the location, shape, and attributes of geographic features. A shapefile is stored in a set of related files and contains one feature class.*

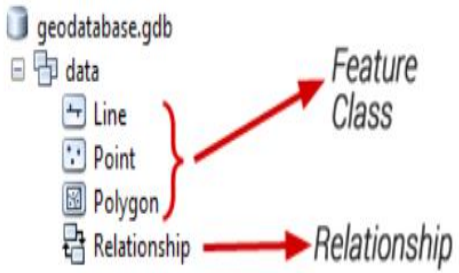


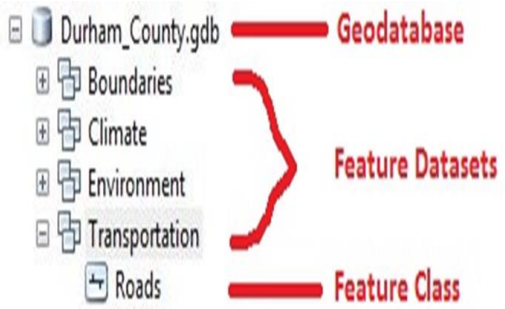
# Shapefile

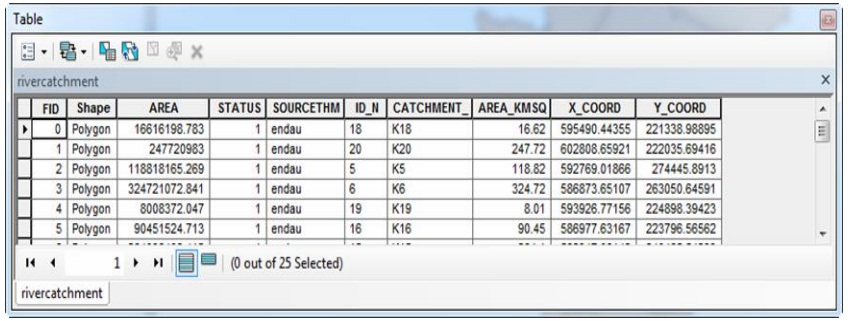
❖***Shapefiles have many limitations (disadvantages) such as:***

1. Takes up more storage space on your computer than a geodatabase
2. Do not support names in fields longer than 10 characters
3. Cannot store date and time in the same field
4. Do not support raster files
5. Do not store NULL values in a field; when a value is NULL, a shapefile will use 0 instead




| FID | Shape | AREA | STATUS | SOURCETHM | ID_N | CATCHMENT_ | AREA_KMSQ | X_COORD | Y_COORD |
|---|---|---|---|---|---|---|---|---|---|
| 0 | Polygon | 16616198.783 | 1 | endau | 18 | K18 | 16.62 | 595490.44355 | 221338.98895 |
| 1 | Polygon | 247720983 | 1 | endau | 20 | K20 | 247.72 | 602808.65921 | 222035.69416 |
| 2 | Polygon | 118818165.269 | 1 | endau | 5 | K5 | 118.82 | 592769.01866 | 274445.8913 |
| 3 | Polygon | 324721072.841 | 1 | endau | 6 | K6 | 324.72 | 586873.65107 | 263050.64591 |
| 4 | Polygon | 8008372.047 | 1 | endau | 19 | K19 | 8.01 | 593926.77156 | 224898.39423 |
| 5 | Polygon | 90451524.713 | 1 | endau | 16 | K16 | 90.45 | 586977.63167 | 223796.56562 |

- *The mandatory file extensions needed for a shapefile are .shp, .shx and .dbf. But the optional files are .prj, .xml, .sbn and .sbx.*

- *What is the function of each of these ArcGIS file types?*

- *.shp – this file stores the geometry of the feature*
- *.shx – this file stores the index of the geometry*
- *.dbf – is a standard database file used to store attribute data and object IDs.*

# Chapter Questions

1. *Define the following: Geodatabase, shapefile*

2. *State the benefits of File GIS geodatabase*

3. *Define Geodatabase and then list the Types of Geodatabase*

4. *How to design a powerful GIS geodatabase in steps*

5. *List the limitation or disadvantage of shapefile*

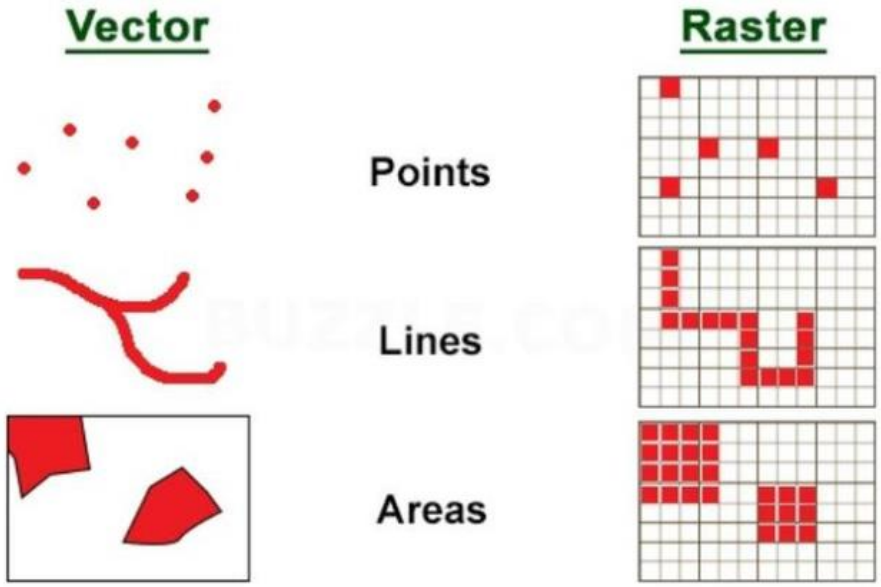
6. *List the two types of single-user geodatabases*

# Spatial Data Model

# Spatial Data Model

*There are two main spatial data model used in GIS to represent geographic features:*

1. ***Vector data Model***
2. ***Raster Data model***



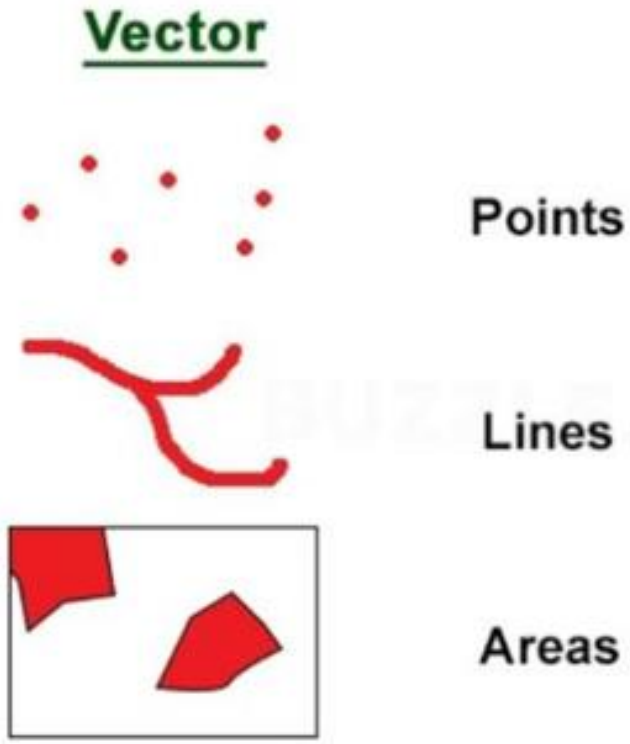
# Vector Data Model

## *Vector data model*

*A coordinate-based data model that represents geographic features as points, lines, and polygons.*

- *Each point feature is represented as a single coordinate pair, while line and polygon features are represented as ordered lists of vertices.*
- ***Attributes***

# Vector Data Model



# Vector Data Model

***There are three ways to represent the vector data model*:**

Point, Line and polygon

## *1. Point:*

- Zero Dimension
- zero area
- single (x,y) coordinate pair
- ***Ex***: tree, oil well, label location

# Vector Data Model

***2- Line:***

- Line (arc): 1 Dimension
- two (or more) connected x,y coordinates
- ***Ex:*** road, stream

---

***3- Polygon:***

- 2 Dimension
- four or more ordered and connected x,y coordinates
- first and last x,y pairs are the same
- encloses an areas
- ***Ex:*** census tracts, county, lake

# The Resource of Vector data

*There are a few resources of having vector data format:*

***1-*** *Ground surveying including:* *GPS, Total station, and laser scanner*

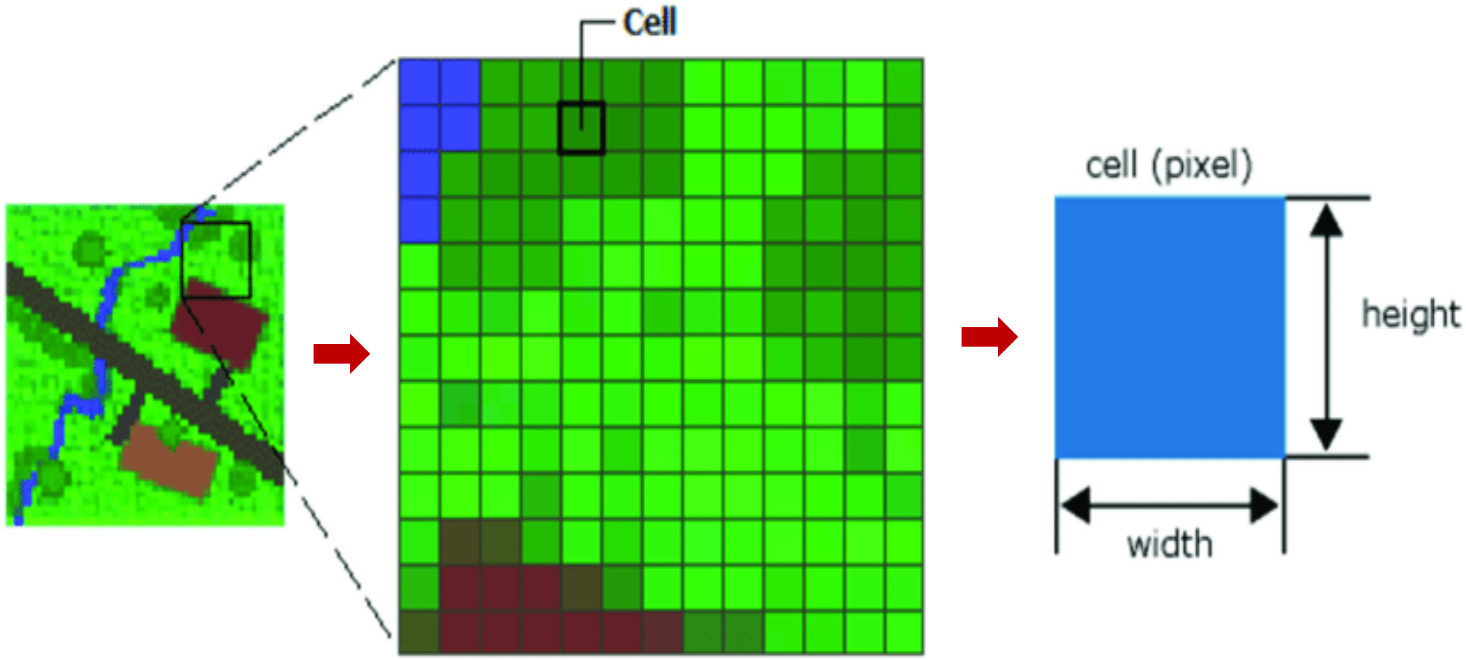
***2-*** *Raster base map*

# References

*https://support.esri.com/en-us/gis-dictionary/vector*

*https://support.esri.com/en-us/gis-dictionary/search?q=shapefile*

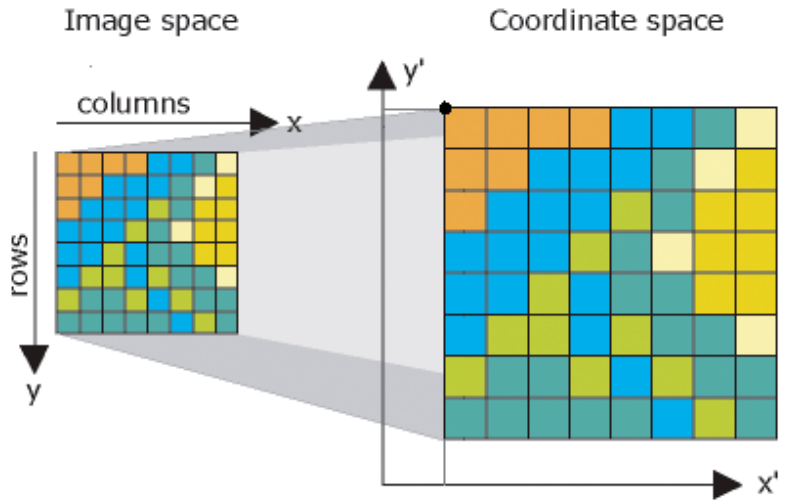
## *2- Raster Data Model*



# Raster

***Raster:*** A fundamental data structure consisting of a matrix of equally sized cells, or pixels, arranged in rows and columns, and composed of multiple bands.

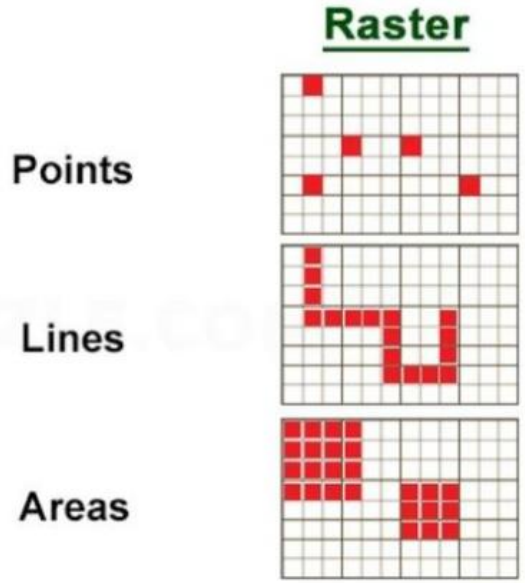
***Ex:*** digital aerial photographs and imagery from satellites



# Raster

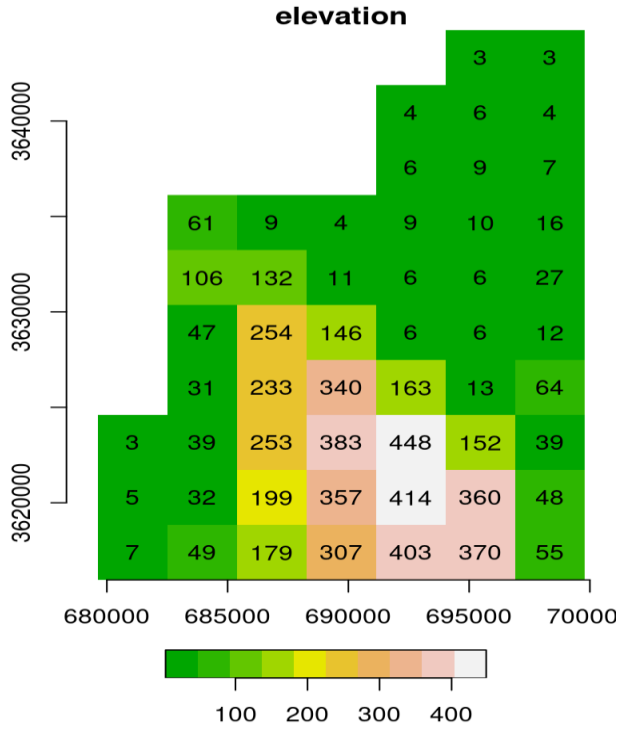
- Each location is represented as a cell. The matrix of cells, organized into rows and columns, is called a **grid**.

- ***Point*** is represented as a single pixel.
- ***Lines*** and **Areas** are represented as a series of connected cells



# Raster

Each cell represents a location on the earth's surface and contains a numeric value that represents a particular phenomenon, such as temperature, elevation and rainfall. Groups of cells that share the same coordinate value represent the same geographic feature.



# Rasters

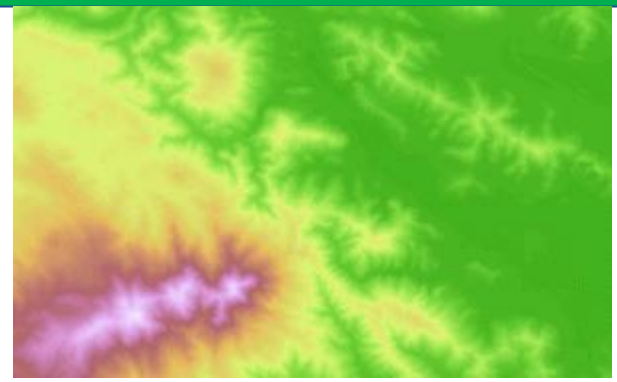
***How the Raster data is used in real life ?***

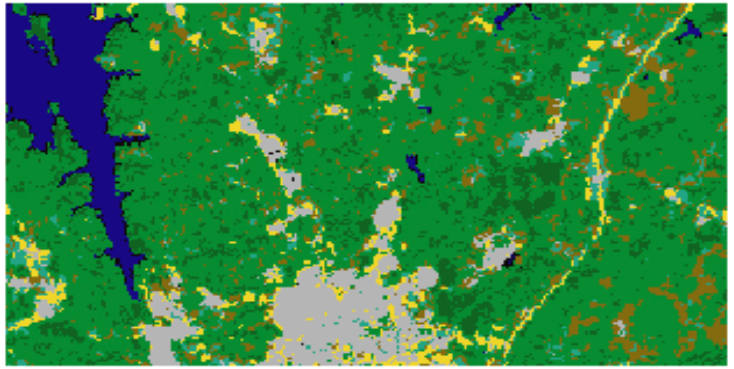
*1- Raster as Basemap*

*2- Raster as surface maps*

*3- Raster as thematic maps*

*4- Raster as attributes of a feature*




# Raster

## *Why most data is stored as a Raster format*

1. *A simple data structure*
2. *A powerful format for advanced spatial and statistical analysis*
3. *The ability to represent continuous surfaces and perform surface analysis*
4. *The ability to perform fast overlays with complex datasets*

# The resources of Raster data

❖*Raster data can be obtained using some geospatial techniques for capturing including:*

1. Remote Sensing (Ex : Satellite Imagery )
2. Aerial Photography ( Ex: *Unmanned aerial vehicles (UAVs) )*
3. Scanning ( Ex: Hardcopy of maps)

# Chapter Questions

1. *Define the following: Geodatabase, shapefile*

2. *Define Vector data model, Raster data model*

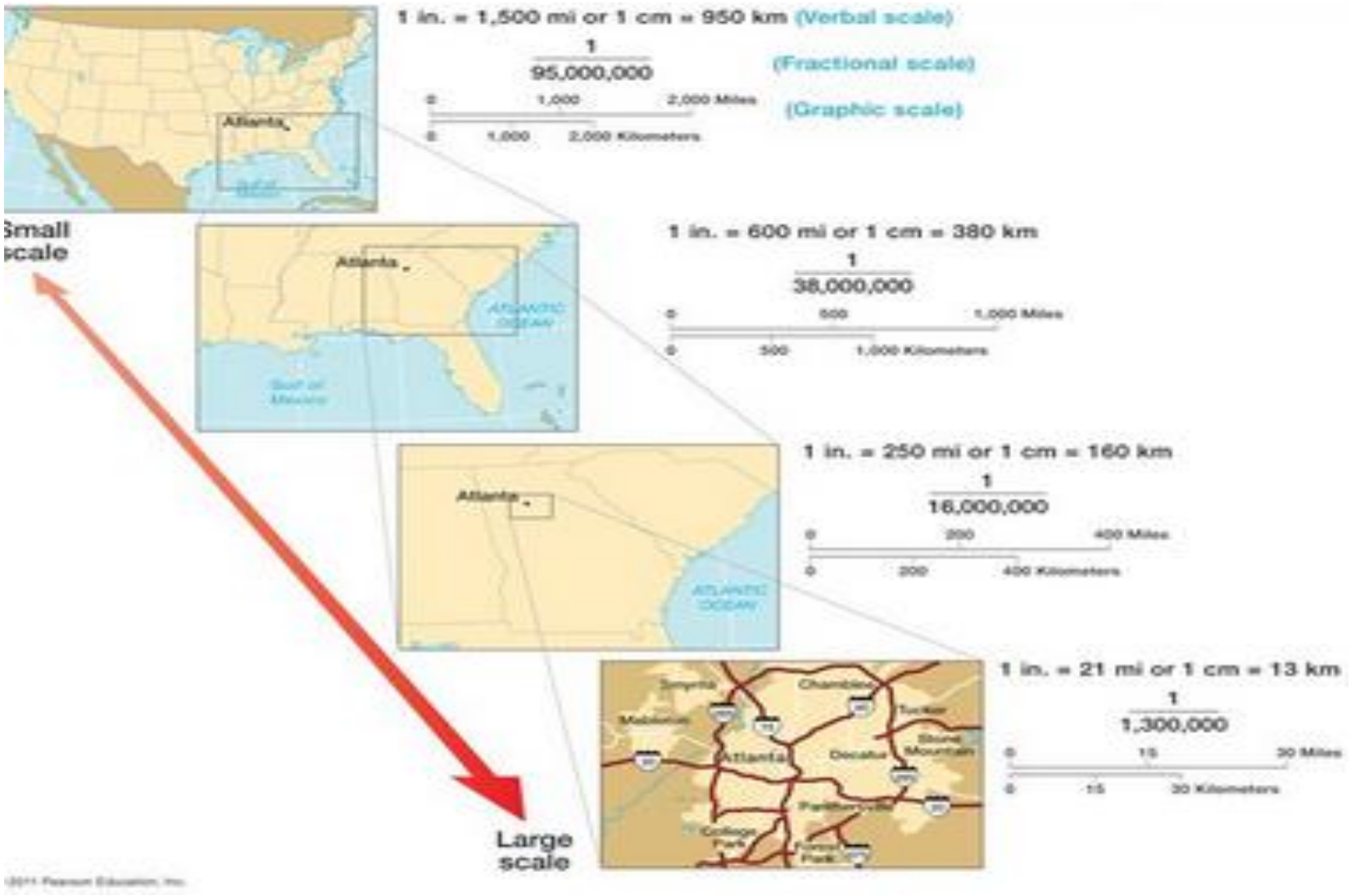
3. *Explain all vector data models types*

4. *List raster data model resources*

5. *List vector data model resources*

6. *Why most data is stored as a Raster format*

# Map Scale


1 in. = 1,500 mi or 1 cm = 950 km (Verbal scale)
1
95,000,000
(Fractional scale)
0 1,000 2,000 Miles
0 1,000 2,000 Kilometers
(Graphic scale)
Small scale
Atlanta
1 in. = 600 mi or 1 cm = 380 km
1
38,000,000
0 500 1,000 Miles
0 500 1,000 Kilometers
Atlanta
1 in. = 250 mi or 1 cm = 160 km
1
16,000,000
0 200 400 Miles
0 200 400 Kilometers
Atlanta
1 in. = 21 mi or 1 cm = 13 km
1
1,300,000
0 15 30 Miles
0 15 30 Kilometers
Atlanta
Large scale

# Map Scale

***>>> Map scale***

It refers to the relationship between distance on a map and the corresponding distance on the ground

*>>>> For example, on a 1:1000,000 scale map,*

*1 cm on the map equals to 1 km on the ground*

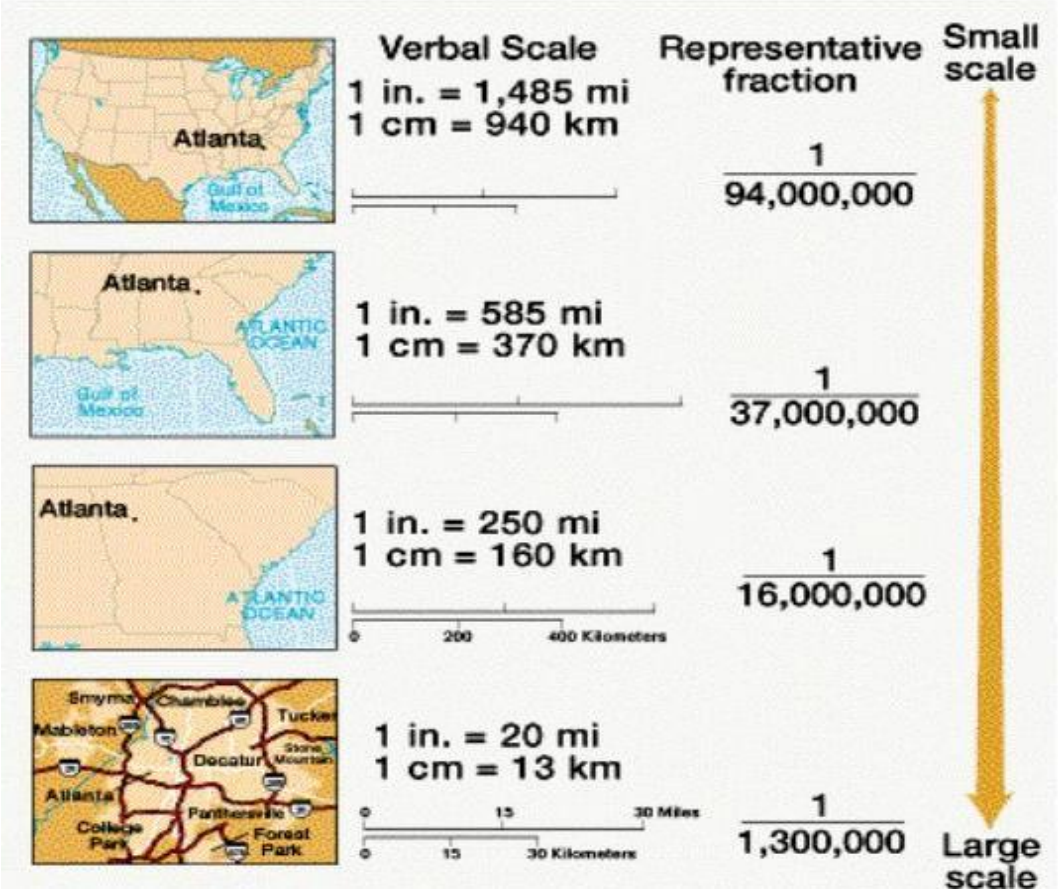
# Scale classification

| Classification | Range | Examples |
|---|---|---|
| Large Scale | 1:100- 1:100000 | Cadastral, Civil Projects |
| Medium Scale | 1:100000- 1:1000000 | Country, City map |
| Small Scale | More than 1:1000000 | World map- Atlas map |

# Types of scales

1. *Large scales:* show small portions of the Earth's surface and therefore more detailed information can be shown.

2. *Small scales:* show larger portions of the Earth's surface and display less detail



# Comparison

| Small Scale | Large Scale |
| --- | --- |
| The geographic extent shown on a small-scale map is big. | The geographic extent shown on a large scale map is small. |
| Are used to show the extent of an entire country, region, or continent | Are typically used to show neighborhoods, a localize area, small towns |
| The scale would have a much larger number to the right of the ratio. For Example, 1 : 1,000,000 | The scale would have a smaller number to the right of the ratio. For example, 1 : 1,000 |
| Less details ⟹ less accurate | More details ⟹ more accurate |

# Applications of GIS

# Applications of GIS

*Geographic Information Systems (GIS) have a wide range of applications in various industries and sectors. Here are some real-life examples of GIS applications:*

(1) Land-use planning;

(2) Natural resource mapping and management;

(3) Environmental impact assessment;

(4) Census, population distribution, and related demographic analyses;

# Applications of GIS

(5) Route selection for highways, rapid-transit systems, pipelines

(6) Displaying geographic distributions of events such as automobile accidents, fires and crimes

(7) Network analysis for vehicles

(8) Mapping for surveying and engineering purposes;

(9) infrastructure and utility mapping and management;

(10) Urban and regional planning;

# Applications of GIS

(11) Hydrology and water harvesting;

(12) Change detection;

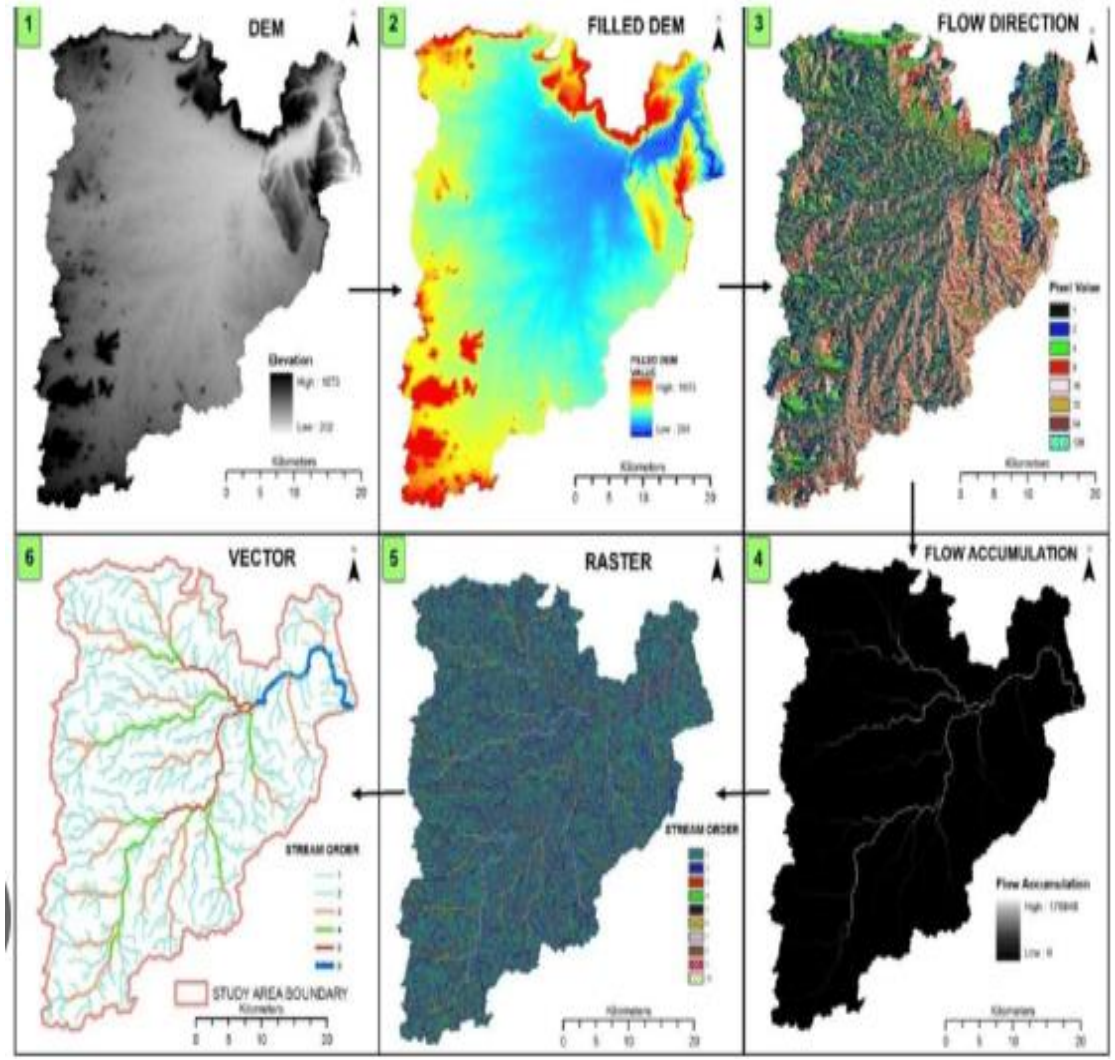
(13) Geospatial Analysis;

(14) Archaeology;

(15) Marketing

# Hydrology

- Digital Elevation Model
- Contour lines
- Slopes
- Stream orders
- Water harvesting



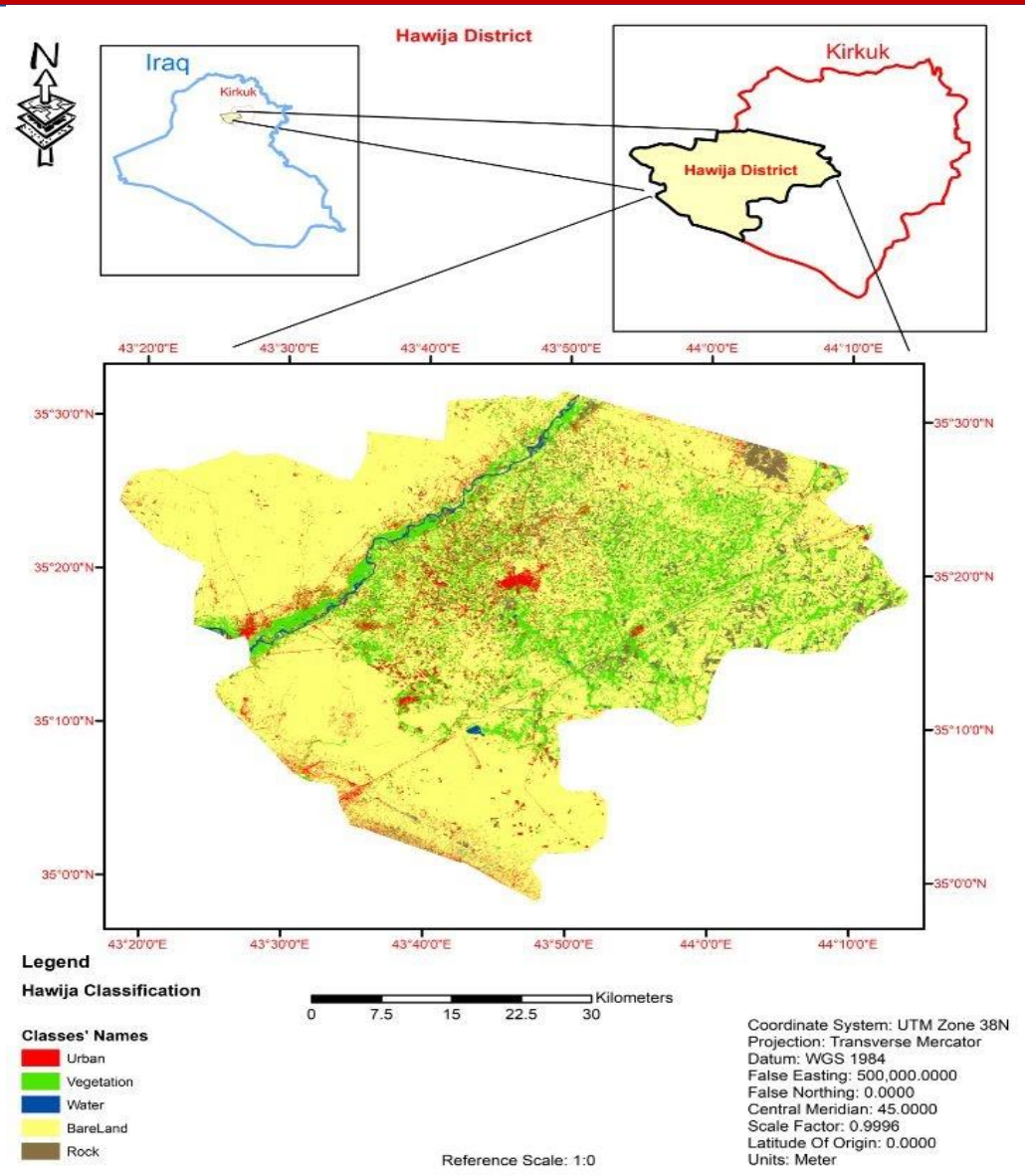
# Land Use Planning – Image classifications

❑ *Kirkuk, Hawija District - Image Classification*

Has approximately 150,000 inhabitants,

**Classifications**

- Urban Area
- Water bodies
- Vegetations
- Bare lands
- Rock



# References


1. Barry. M. and F. Bruyas. 2009. “Formulation of Land Administration Strategy in Post-
2. Conflict Somaliland.” Surveying and Land Information Science 69 (No. 1): 39.
3. Binge, M. L. 2007. “Developing a New GIS.” Point of Beginning 32 (No. 11): 42.
4. Cosworth, C. 2006. “Creating a New GIS Solution.” Point of Beginning 31 (No. 11): 16.
5. Davis, T. G. and R. Turner. 2009. “USGS Quadrangles in Google Earth.” The American
6. Surveyor 6 (No. 9): 28.
7. DeBarry, P. 2004. Watersheds: Processes, Assessment, and Management, 4th Ed. New
8. York: Wiley.

# References

1. *Define map scale, small scale, large scale*

2. *Make a comparison between large scale and small scale maps in a table*

3. *List ten applications of GIS*

# Questions