

# GIS CHAPTER 1

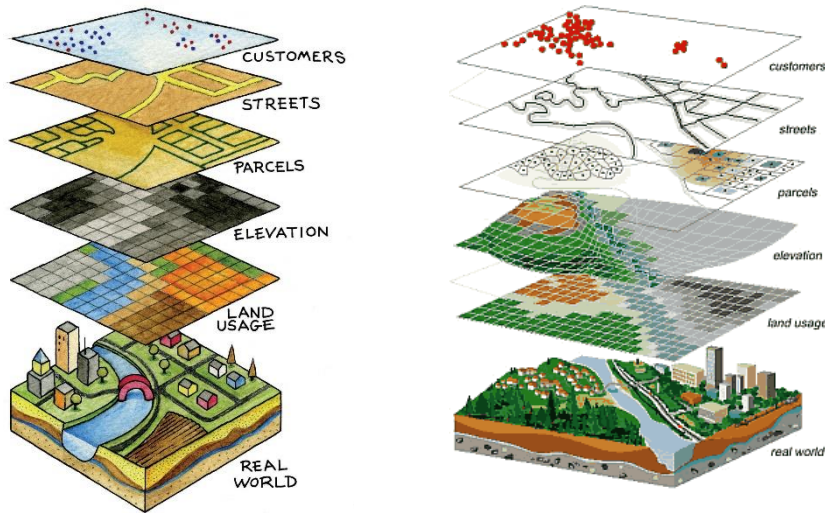
**Prepared by :  
ALY REDA**

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## What is GIS?

A Geographic Information System (GIS) is a computer system for capturing, storing, analyzing, and managing data and associated attributes, which are spatially referenced to the Earth. It provides a framework for collecting, managing, and analyzing geographic data to help users understand, analyze, and visualize spatial relationships.



## Case Study: COVID 19

Geographic Information Systems (GIS) have played a pivotal role in the global response to the COVID-19 pandemic. By combining spatial data with epidemiological and demographic information,





GIS has enabled public health officials, researchers, and decision-makers to:

## 1. Track and Visualize Disease Spread:

- **Real-time case tracking:** GIS platforms have been used to map confirmed cases, deaths, and recoveries, providing a visual understanding of the pandemic's progression.
- **Identifying hotspots:** GIS analysis has helped identify areas with high concentrations of cases, allowing for targeted interventions and resource allocation.
- **Understanding transmission patterns:** GIS has been instrumental in studying the spatial distribution of cases and identifying potential transmission pathways.

## 2. Inform Public Health Policies:

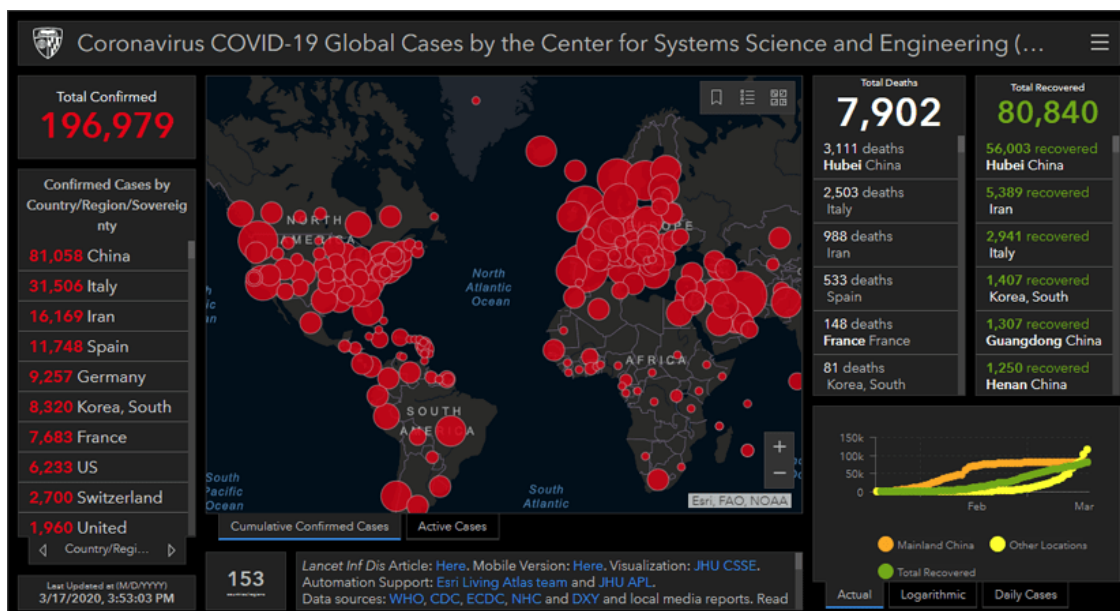
- **Risk assessment:** GIS has been used to assess the risk of COVID-19 transmission in different regions, informing decisions about social distancing measures, lockdowns, and travel restrictions.
- **Resource allocation:** GIS has helped allocate medical supplies, healthcare workers, and other resources to areas with the greatest need.
- **Contact tracing:** GIS has been used to track the movement of infected individuals and identify potential contacts, aiding in contact tracing efforts.

## 3. Support Vaccine Deployment:

- **Prioritization:** GIS has been used to identify priority populations for vaccination based on factors such as age, occupation, and underlying health conditions.
- **Vaccine distribution:** GIS has helped optimize the distribution of vaccines to ensure equitable access across different regions.
- **Monitoring vaccine efficacy:** GIS has been used to track vaccination rates and monitor the effectiveness of vaccines in reducing disease transmission.

## 4. Analyze the Impact of Interventions:

- **Evaluating policies:** GIS has been used to evaluate the effectiveness of public health interventions, such as social distancing measures and lockdowns, in reducing COVID-19 transmission.
- **Identifying gaps:** GIS has helped identify areas where interventions have been less effective, allowing for adjustments and improvements



## Geographic Information System (GIS)

**Geography:** Study of land, inhabitants and features on the earth

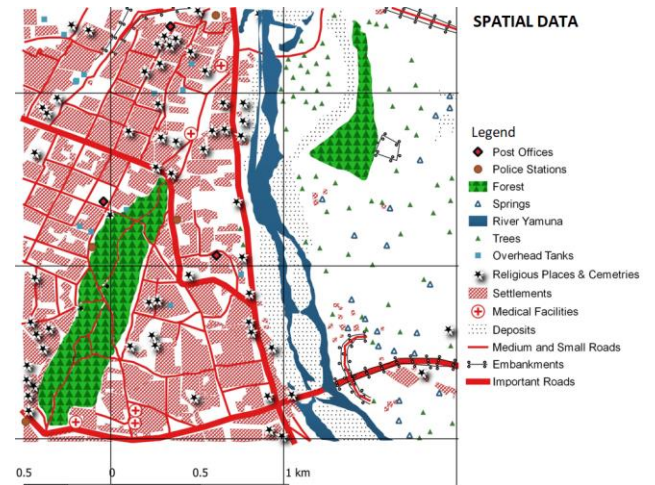
**Information:** Details of Features For example: Height of Buildings

**Systems:** technology and methods for capturing, storing and analyzing data

### Data Types:

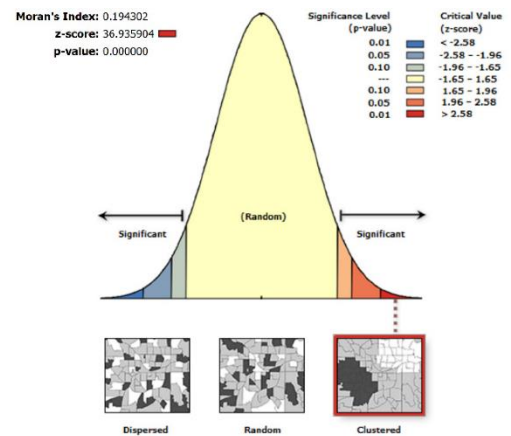
#### Spatial Data

- **Definition:** Data that has a specific location on the Earth's surface. It includes information about geographic features like points, lines, and polygons.
- **Examples:**
  - Locations of buildings, roads, and rivers
  - Boundaries of countries, states, and cities
  - Elevation data (topographic maps)
  - Satellite imagery



#### Non-Spatial Data

- **Definition:** Data that does not have a direct geographic reference. It often provides attributes or characteristics of spatial features.
- **Examples:**
  - Population density of a city
  - Land use classifications (residential, commercial, industrial)
  - Precipitation levels in a region
  - Soil types in a particular area



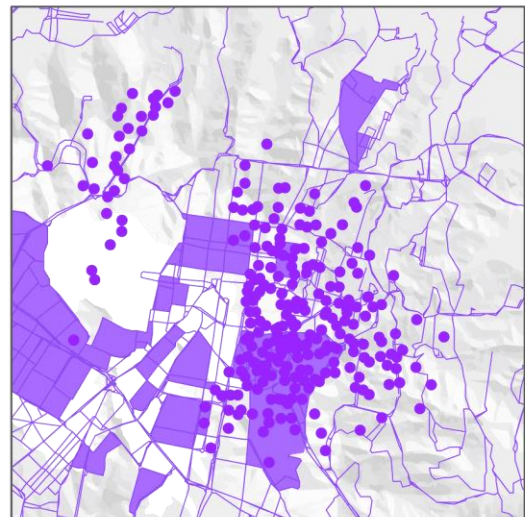
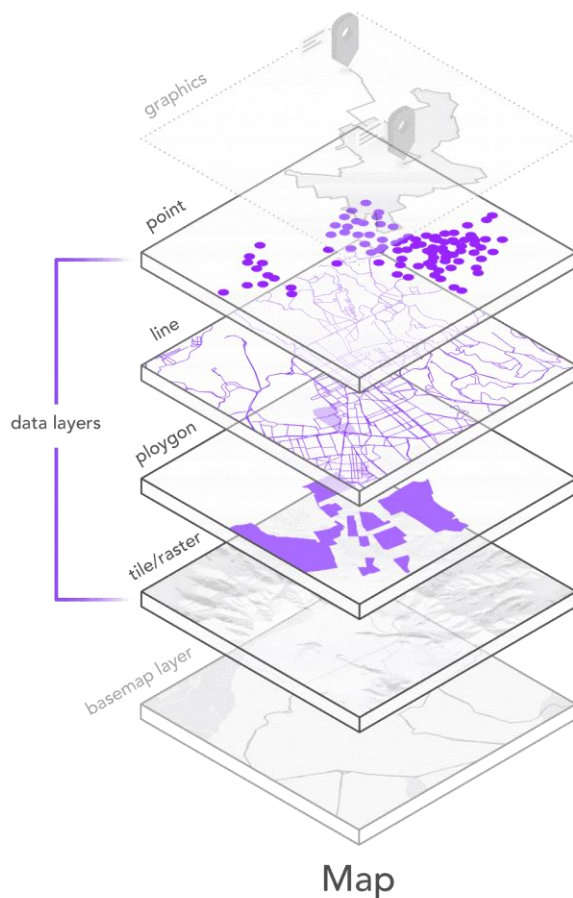
Given the z-score of 36.94, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

## Layerization in GIS

**Layerization** is a fundamental concept in Geographic Information Systems (GIS) that involves organizing spatial data into distinct layers or thematic maps. Each layer represents a specific aspect of the geographic area being studied, allowing for efficient management, analysis, and visualization of different types of data.

### Key benefits of Layerization:

- **Data organization:** Layers help to structure and organize complex spatial data, making it easier to manage and understand.
- **Analysis flexibility:** By separating data into layers, users can analyze individual components or combine them to create more comprehensive views.
- **Visualization control:** Layerization allows for selective display of data, enabling users to focus on specific features or themes.
- **Data updates:** Individual layers can be updated independently, ensuring that the GIS dataset remains current and accurate.



Map view

## Components of a Geographic Information System (GIS)

A GIS is composed of several key components that work together to capture, store, analyze, and manage spatial data. These components include:

### 1. **Hardware:**

- **Computers:** Powerful computers are essential for processing and analyzing large amounts of spatial data.
- **Data acquisition devices:** These include GPS devices, scanners, and digital cameras for collecting spatial data.
- **Storage devices:** Hard drives, solid-state drives (SSDs), and cloud storage solutions are used to store spatial data and GIS databases.

### 2. **Software:**

GIS software: Specialized software applications, such as ArcGIS, QGIS provide tools for data management, analysis, and visualization.

### 3. **Data:**

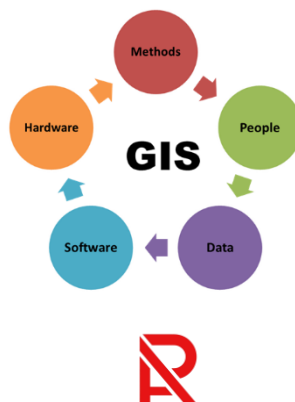
- **Spatial data:** This includes geographic features like points, lines, polygons, and rasters, which are linked to specific locations on the Earth's surface.
- **Non-spatial data:** This refers to attributes or characteristics associated with spatial features, such as population, land use, or elevation.

### 4. **People:**

- **GIS professionals:** These individuals have expertise in using GIS software and data to solve problems and make informed decisions.
- **Data collectors:** People responsible for gathering spatial and non-spatial data using various methods.
- **Data analysts:** Individuals who analyze and interpret spatial data to extract meaningful information.

### 5. **Procedures:**

- **Data acquisition:** The process of collecting spatial and non-spatial data using various methods.
- **Data management:** The organization, storage, and maintenance of spatial data.
- **Data analysis:** The application of GIS tools and techniques to analyze spatial data and extract insights.
- **Data visualization:** The creation of maps and other visual representations of spatial data.



## Functions of a Geographic Information System (GIS)

A Geographic Information System (GIS) is a powerful tool that performs various functions to analyze and manage spatial data. Here are some of the key functions of GIS:

### Data Management:

- **Data collection:** GIS can collect spatial data from various sources, including GPS devices, remote sensing imagery, and digital maps.
- **Data storage:** GIS systems store spatial data in a structured format that allows for efficient retrieval and analysis.
- **Data management:** GIS tools help manage and update spatial data over time.

### Spatial Analysis:

- **Spatial relationships:** GIS can analyze the relationships between different spatial features, such as proximity, overlap, and containment.
- **Spatial patterns:** GIS can identify patterns in spatial data, such as clustering, dispersion, and trends.
- **Spatial modeling:** GIS can be used to create models that simulate real-world processes and predict future outcomes.

### Data Visualization:

- **Map creation:** GIS can create a wide variety of maps, including thematic maps, choropleth maps, and reference maps.
- **Data visualization:** GIS can visualize spatial data in different ways, such as using symbols, colors, and textures to represent different attributes.
- **Interactive maps:** GIS can create interactive maps that allow users to explore and analyze data in real time.

## GIS Capabilities

- Spatial analytics
- Field operations
- Mapping and Visualization
- Real-time GIS
- 3d GIS
- Imagery and remote sensing
- Data collection & management



## GIS History

### GIS and the Cholera Outbreak of 1854

The 1854 cholera outbreak in London is often cited as a pivotal moment in the history of GIS. Dr. John Snow, a physician and pioneer in public health, used a map to investigate the outbreak and identify its source.

#### Snow's Map:

- **Spatial analysis:** Snow created a dot map, plotting the locations of cholera deaths in Soho, London.
- **Pattern recognition:** By examining the map, Snow noticed a cluster of deaths around a specific water pump on Broad Street.
- **Hypothesis:** Snow hypothesized that the contaminated water from this pump was the source of the outbreak.

#### Impact of Snow's Work:

- **Public health intervention:** Based on his findings, Snow convinced the local authorities to remove the pump handle, effectively stopping the spread of cholera.
- **Disease epidemiology:** Snow's work helped establish the field of epidemiology, the study of the distribution and determinants of health and disease in populations.
- **GIS applications:** His use of a map to investigate the outbreak demonstrated the power of spatial analysis in understanding and addressing public health issues.

#### Significance of this event for GIS:

- **Early adoption:** Snow's map can be considered an early example of using spatial data to investigate a public health problem.
- **Impact on GIS development:** The success of Snow's approach helped to inspire the development of GIS tools and techniques for analyzing spatial data.
- **Public health applications:** This event highlighted the importance of GIS in public health research and decision-making.



## GIS Software

Geographic Information Systems (GIS) software plays a crucial role in managing, analyzing, and visualizing spatial data. Here's a comparison of some of the most popular GIS software options:

**Esri** is one of the world's leading providers of Geographic Information System (GIS) software. Founded in 1971, Esri has played a significant role in the development and advancement of GIS technology.



### Esri products:

- **ArcGIS Pro:** The latest and most advanced GIS software in the ArcGIS suite, offering a modern interface, powerful analytical tools, and cloud integration capabilities.
- **ArcGIS Desktop:** A classic GIS platform that provides a comprehensive set of tools for data management, analysis, and visualization.
- **ArcGIS Online:** A cloud-based GIS platform that allows users to create, share, and collaborate on maps and applications.



### QGIS

- **Open-source:** A free and open-source GIS software that offers a wide range of features and is popular among the GIS community.
- **Community-driven:** QGIS benefits from a large and active community of developers and users who contribute to its development and support.



### FME

- **Data integration:** FME is primarily known for its data integration capabilities, allowing users to transform and translate data between different formats and systems.
- **Automation:** FME can automate repetitive GIS tasks, improving efficiency and productivity.



### SuperMap

- **Chinese-based:** SuperMap is a popular GIS software in China and other parts of Asia.
- **Local language support:** It offers strong support for local languages and cultural contexts.

