



كلية العلوم
قسم الانظمة الطبية الذكية

Lecture: (1)

Geographic Information Systems (GIS)

Subject: GIS in Public Health

Level: Third

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Basic Concept of Geographic Information Systems (GIS)

Definition of Geographic Information Systems (GIS):

- Geographic Information Systems (GIS) are tools used for collecting, storing, analyzing, and displaying spatial data. They help in decision-making, particularly in healthcare planning and management.
- Geographic Information Science (GIScience) focuses on the study of spatial data and its applications, providing a scientific approach to geographic data processing using computational methods.

Example: GIS has been used extensively in managing the Ebola outbreak, where it helped trace the spread of the disease and guided health professionals in targeting the affected regions. In the 2014 outbreak, real-time mapping allowed quick identification of infected areas and response strategies (Perry et al., 2017).

Components of GIS in Healthcare

1. **People:** The most critical component in GIS. Skilled personnel, such as data analysts and public health professionals, interpret spatial data for informed decision-making.

Example: In the Haiti cholera outbreak, health professionals worked with GIS technicians to map and analyze disease data, guiding rapid response efforts (Haiti Ministry of Health, 2010).

2. **Data:** GIS relies on accurate and up-to-date data collected from various sources such as surveys, satellites, and sensors.

Example: Census data can be combined with healthcare data to help allocate medical resources effectively.



3. **Software**: GIS software tools such as ArcGIS and QGIS are used to visualize and analyze the spatial data.

Example: ArcGIS was used in the USA to monitor the spread of H1N1 influenza and to allocate vaccination resources based on demographic data.

4. **Hardware**: Includes computers, GPS devices, and servers used for storing and processing data.

5. **Procedures**: Methods for data collection, input, analysis, and output that ensure accuracy in GIS applications.

Types of GIS Data

1. **Vector Data**:

- **Points**: Represent specific locations, such as the locations of hospitals.
- **Lines**: Represent linear features, like roads or pipelines.
- **Polygons**: Represent areas, such as health zones or city boundaries.

2. **Raster Data**: Represents geographic features as grid cells, such as satellite images showing land cover or environmental factors.

3. **Attribute Data**: Describes the characteristics of geographic features. For example, data about patient demographics or disease statistics.

Example: Vector data is used to show the location of medical facilities (points) or the layout of road networks (lines). Raster data might represent satellite images of pollution or healthcare facility coverage, helping decision-makers understand environmental factors affecting health.



Applications of GIS in Public Health

1. Epidemiology

- **Disease Mapping:** GIS helps visualize the spread of diseases on geographical maps, identifying hotspots for interventions. For instance, during the Ebola outbreak, GIS was used to map the areas affected and guide the response teams (Perry et al., 2017).
- **Health Monitoring:** GIS tracks health trends such as vaccination rates or disease incidences, helping to identify high-risk areas.

Example: GIS mapping was used during the H1N1 outbreak in the U.S., where health officials tracked the spread of the virus and directed resources to affected regions. Real-time tracking allows for quicker action and efficient containment strategies.

2. Healthcare Planning

- **Resource Distribution:** GIS assists in determining the optimal locations for building hospitals and clinics based on population density and healthcare needs. For example, in Kenya, GIS was employed to identify the best locations for vaccination stations during the polio eradication campaign (Tshangana et al., 2015).
- **Accessibility Analysis:** By analyzing spatial data, GIS can identify underserved areas that lack sufficient healthcare services.

Example: In Canada, GIS was used to analyze the distribution of healthcare resources across rural areas. By examining the population density and available facilities, the government was able to plan more equitable healthcare access.



Benefits of GIS in Public Health

- **Enhanced Decision-Making:** GIS helps health officials make data-driven decisions about where to allocate resources, target interventions, and monitor health trends.

Example: During the SARS outbreak, GIS was used to monitor the movement of infected individuals and direct resources where they were needed most.

- **Real-Time Disease Surveillance:** GIS allows for real-time surveillance of disease outbreaks, enabling authorities to act swiftly.

Example: Real-Time Disease Surveillance: Web-based GIS platforms were used during the COVID-19 pandemic to track the spread of the virus in real time, guiding governments' response efforts.

- **Efficient Resource Management:** GIS optimizes healthcare resource management by pinpointing areas of high need and reducing waste in resource distribution.

Challenges and Limitations of GIS in Public Health

- **Data Accuracy:** The quality of GIS data is crucial. Inaccurate data may lead to misinterpretation and ineffective health interventions.
- **Cost of Implementation:** Implementing and maintaining GIS systems can be expensive, especially in low-income regions.
- **Complexity of GIS Tools:** GIS tools require trained personnel for proper usage and analysis, which may be a barrier in under-resourced areas.