INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEM

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What is geographic information system

There is no single definition for geographic information system (GIS). There are many working definitions and most of them are acceptable for understanding purpose.

A geographic information system is a computer system that incorporates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information (1).

There are three W's in geography

1. What is where?
2. Why it is there?
3. Why do I care? (Implications of above two points)

The concept that place and location can influence health is a very old and familiar idea in medicine. As far back as the time of Hippocrates (3rd century BC), physicians have observed that certain diseases seem to occur in some places and not others. Even within the human body, many diseases and organisms are known to have a predilection for, or to exclusively affect specific body organs or systems (anatomico-physiological "locations" within the human body) (2).

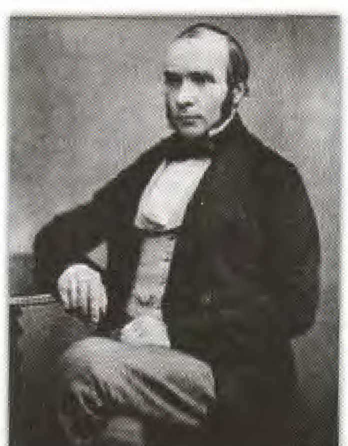
Spatial nature of epidemiological data has long been understood. In 1854, there was a cholera outbreak in Soho district of London and nearly six hundred people died from cholera in just 10 days. Dr. John Snow, a London physician and anaesthesiologist who mapped (Figure 1) the locations of water pumps and the homes of people who died of cholera, Snow was able to show that one pump, the public pump on Broad Street, was causing most of the disease. Snow suspected that infected water from the pump was the cause. He instructed the authorities to remove the handle to the pump, making it unusable; the number of new cholera cases dropped dramatically. The Broad Street pump proved to be the source of contaminated water and hence cholera, just as Snow had thought (3). Since then, epidemiology has played an increasingly important role in providing scientific evidence to support animal and human health policy development.

Spatiotemporal distribution

Distribution of disease or any phenomenon in earth surface (geographicaly) called spatial distribution. In the case of infectious diseases like influenza, Dengue and Malaria, the study of their geographic distribution frequently involves examining the diffusion of the disease through space over a given period of time (spatio-temporal mapping).

Transmission of infectious diseases is closely associated with concepts of spatial and spatio-temporal closeness of at risk individual. In the case of non-communicable diseases transmission, environmental risk factors may play important role.

The most basic GIS approach is to examine maps of disease occurrence visually to answer the question "WHAT IS WHERE" (4). This method has inherent



... mapped the locations of water pumps in Soho district of London.

weakness as this does not involve statistical testing. It needs to be followed by statistical assessment and experimental challenge of hypotheses before inferences in relation to cause and effect can be drawn. Spatial epidemiology provides the necessary tools for such statistical assessment. Although the field of spatial epidemiology has a large number of techniques, deciding which one to use can be challenging.

Spatial epidemiological analysis has three main objectives

1. Describe the spatial patterns
2. Identify disease clusters
3. Explore or predict the disease risk

To achieve these objectives in addition to the traditional attribute data describing the characteristics of the entity studied (demographic and other characteristics related to the disease), geo-referenced feature data (location information) are required.

Specific analytical objectives in three groups of analytical methods

1. Visualisation
2. Exploration
3. Modelling

First two focus solely on examining the spatial dimension of the data.

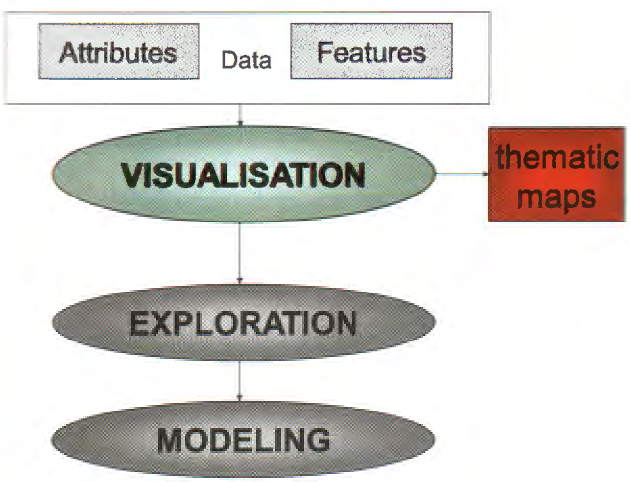


Figure 2. Framework of spatial analysis.

Visualisation is the most commonly used spatial analysis method, resulting in maps that describe spatial patterns Figure 2. Exploration of spatial data involves the use of statistical methods to determine whether observed patterns are random in space. Modelling introduces the concept of cause-effect relationships using both spatial and non-spatial data sources to explain or predict spatial patterns. It needs to be emphasised that none of these approaches allows definitive causal inferance.

Spatial visualisation

In the last two decades, we have seen an explosion of interest in disease mapping, with the recent developments in advanced spatial statistics and the increasing availability of computerized geographic information system technology. One of the first steps in any epidemiological analysis is to visualize the spatial characteristics of dataset (5).

Mapping vs Analysis of disease data

Although the mapping of disease data can be relatively straightforward, interpreting spatially referenced disease data can sometimes be challenging, particularly for non-infectious and chronic diseases For example, a researcher might map the distribution of people with schizophrenia in urban areas and find that they tend to reside in low-income, inner-city areas. At this stage, the researcher can understand how the data is distributed (patterns or clusters - mapping), but explaining "why it is there" as such is another story and requires further research (analysis).

Spatial analysis of epidemiology

Epidemiology is about the quest for knowledge in relation to disease causation, and this can be about understanding risk factors or about the effects of interventions. To determine cause and effect relationship, need to develop a theoretical hypothesis based on observed data. In most epidemiological investigations definitive causal inference is difficult, if not impossible, to obtain through analysis of epidemiological data.

Visualisation helps to:

- Identify errors
- Identify potential patterns
- Generate hypotheses about factors influencing patterns

Visualisation also serves as an excellent tool for communicating findings to the target audience.

Type of data

Data collected for the purpose of epidemiological investigations typically focus on the attributes of observations such as the disease status of individual.

Representation of spatial data depends on the map scale.

E.g. A school may be represented as a polygon in large scale (1: 10,000) and the same school becomes a point in small scale maps (1: 10,000).

Point data

E.g. Location of disease outbreaks, school survey data (Figure 3) (6).

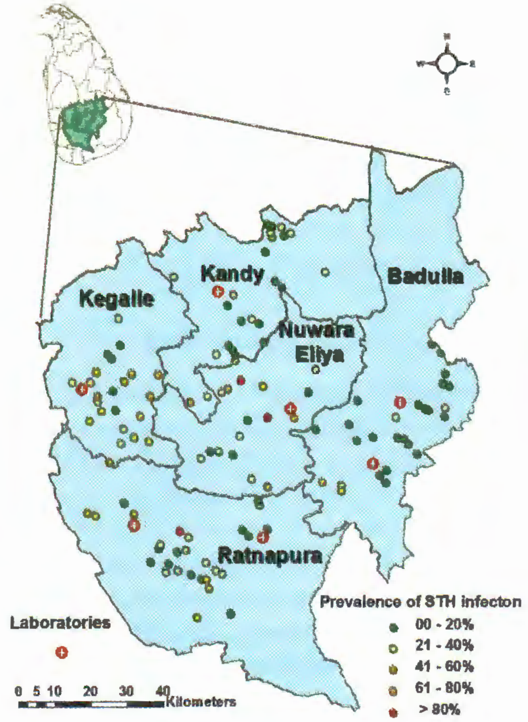


Figure 3. Geographical location of study schools and laboratories in the districts of Kandy, Kegalle, Nuwara Eliya, Badulla and Ratnapura, together with prevalence of infection with any one or more soil-transmitted helminth infection at each school (6).

Aggregated data

E.g. Disease incidence by geographic boundaries (Figure 4) (7).

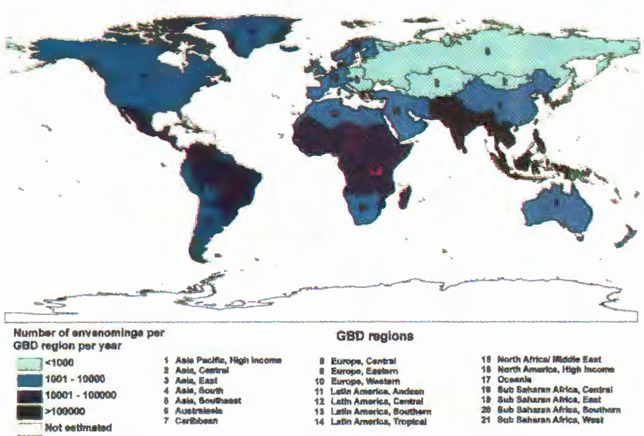


Figure 4. Regional estimates of envenomings due to snakebite (low estimate) (7).

Continuous data

E.g. Rainfall, air pollution, predicted prevalence of infection (Figure 5) (6).

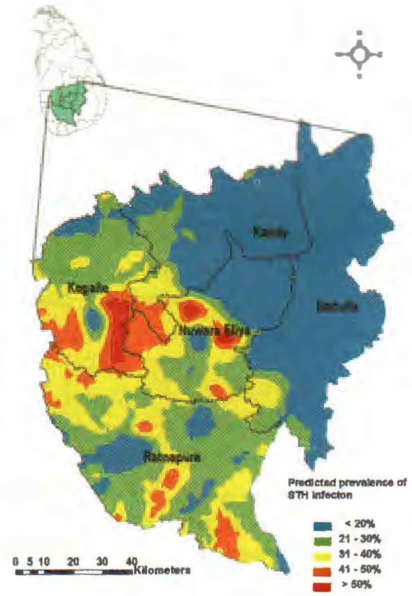


Figure 5. Predicted prevalence of infection with any one or more soil-transmitted helminth infection among children in the plantation sector in five districts of Sri Lanka (6).

Spatio-temporal analysis is concerned with cluster validation, e.g. that a detected cluster is not due to mere chance factors, and with attribution of detected clusters to the appropriate factors that played a role in their occurrence. Analysis also includes doing comparisons with other relevant patterns/clusters (in the same place at different times and in other places) and again trying to methodically explain any spotted differences or trends. Thus, in the case of the schizophrenia example mentioned above where a cluster or pattern has been detected, many questions arise (new hypotheses) that need to be addressed. For example, does the stress of urban poverty cause mental illness, or are the mentally ill forced to live in cheap housing because their illnesses prevent them from earning a stable income? Or is there a circular relationship between poverty and mental illness? Even though GIS is used widely in infectious diseases like Malaria (8), Filariasis, Helminth infections (9) and Dengue etc in other countries its use is very primitive in Sri Lanka. Most of the countries share their health related data freely and anybody can access through internet. One of such is onemap.sg maintained by Singapore government. If you need to find either Dengue clusters or Breast cancer screening centers in Singapore you are just a few clicks away.

In the west GIS is used extensively for disease prevention and control for example: Recently CDC has developed an interactive disease atlas(10). Annually 800,000 people die from cardiovascular disease in the US. Centers for disease prevention and control (CDC) is aiming at reducing Annual Heart Diseases and Stroke-Related deaths in the US by 200,000 using interactive disease Atlas which uses GIS throughout, from data collection to presentation. According to the report many of these deaths could be prevented by improving health care systems, creating healthy places to live and play and supporting healthy lifestyle choices. Hope is that by providing this data in an easy to use format (through a map) it will be clearer to see where cardiovascular disease is more prevalent and which population groups are at high risk for the problems such as hypertension, myocardial infarction and heart failure. Their goal is to help doctors, health care administrators and public health officials as well the as general public better focus health education and other preventive programs in those areas and groups and reduce the mortality (11).

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SEPSIS AND WOUND INFECTION FOLLOWING SNAKE BITE A REVIEW INCLUDING THE SRI LANKAN PERSPECTIVE

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Introduction

There are about 7 medically important venomous snakes in Sri Lanka, namely cobra, common krait, Sri Lankan krait, Russels' viper, saw-scaled viper, green-pit viper and also hump-nosed viper (1). In snake bite, as our main objectve is to manage the envenomation, identification of the snake plays a critical role due to different types of venom in different snakes. From sepsis point of view as well, it is important as local effect of some venom e.g. venom of cobra, hump-nosed vipers, is well known to cause severe tissue necrosis and subsequent wound infection. In acute management of snake bite we almost always tend to overlook the possible sepsis even after identifying the snake. Hence, anticipation of such associations would be beneficial to prevent subsequent complications.

During my tenure as the consultant microbiologist in District General Hospital, Polonnaruwa, which is a major tertiary care centre in the north central province of Sri Lanka, I could help in management of several such cases of sepsis following snake bite and I will be reporting a few of the interesting cases. The patients were from different areas of the province and were ultimately transferred to DGH Polonnaruwa for specialized care. North central province is one of the seasonal dry zones of Sri Lanka in which many types of venomous snakes are found in the human vicinity as well as in the forest areas. Majority of dwellers of the region are farmers and naturally at a higher risk for snake bites and wild animal attacks than other more urban population.

Case report 1

There was a 68 year old previously healthy female from Hingurakgoda, who presented to DGH Polonnaruwa following humped nosed viper bite on the same day. She did not show any specific symptoms or signs of envenomation but complained of pain and swelling at the bite site on the left forearm. She was put on oral cloxacillin and intravenous penicillin, which was later changed to cefotaxime while in the ward. Her initial white blood cell count was 3300/mm^3 and platelets were within the normal range.