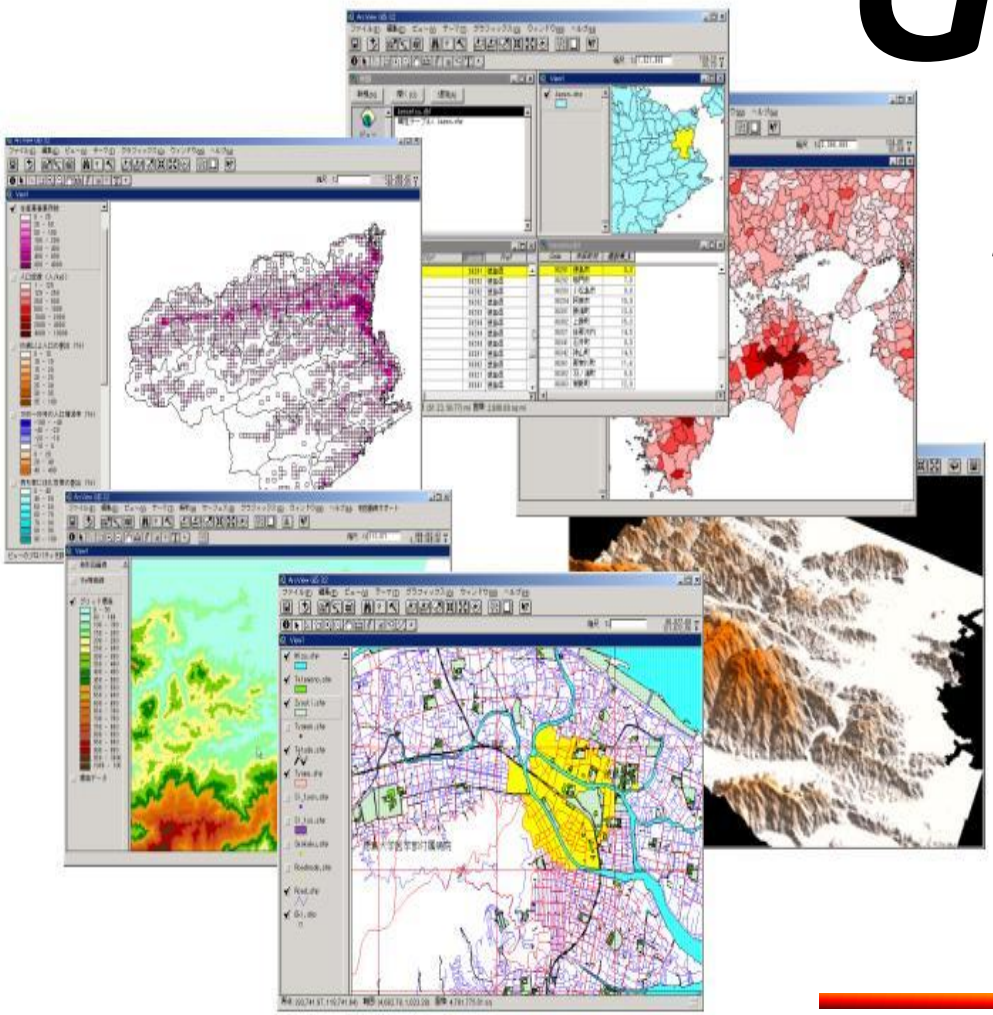
GIS and Public Health



Geographic information systems (GISs) concentrate on combining computer mapping capabilities with database management and analysis tools. GIS systems include many applications , including the transportation of people and objects, environmental sciences, urban planning, agricultural applications, and so on.

Public health is one of the most important topics that has seen an increased use of GIS. Geographical studies are playing an important role in public health and health services planning.

In general, public health differs from personal health in the following regards:

(1) it is focused on the health of populations rather than of individuals,

(2) it is focused more on prevention than on treatment,

(3) it operates in a mainly governmental (rather than private) context.[1]

These efforts fall naturally within the domain of problems requiring the use of spatial analysis as part of the solution, and GIS and other spatial analysis tools are therefore recognized as providing potentially transformational capabilities for public health efforts.

This ppt presents some history of the use of geographic information and geographic information systems in public health application areas, provides some examples showing the utilization of GIS techniques in solving specific public health problems, and finally addresses several potential issues arising from an increased use of these GIS techniques in the public health arena.

History

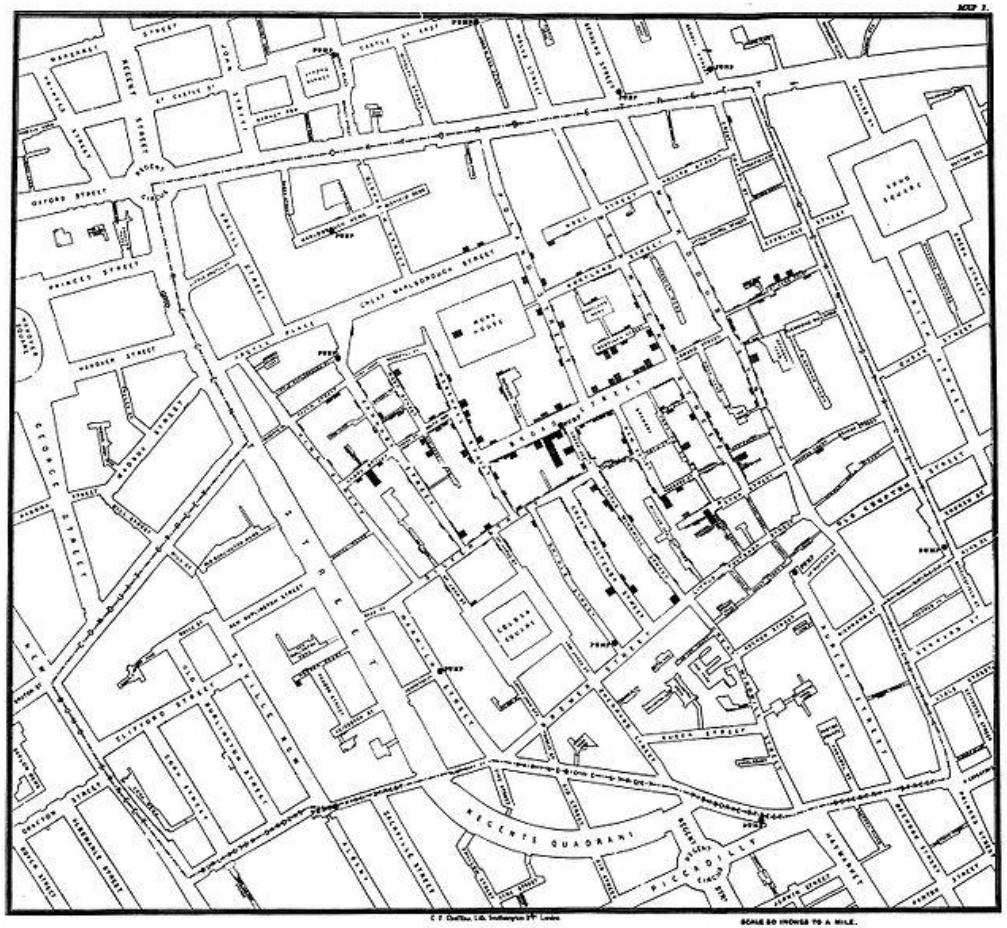
Public health efforts have been based on analysis and use of spatial data for many years. Dr. John Snow (physician), often credited as the father of epidemiology, is arguably the most famous of those examples.[2]

Dr. Snow focused on a map which overlaid cholera deaths with the locations of public water supplies . His study area was London in the mid-1850s.

Removal of the pump handle led to a rapid decline in the incidence of cholera, helping the medical community to eventually conclude that cholera was a water-borne disease.

Dr. Snow explained how a GIS could benefit public health investigations and other research. He analyzed his data, and finally showed that the relative frequency rate of cholera and its relation to local elevation as well as soil type and alkalinity. Low-lying areas, particularly those with poorly draining soil, were found to have higher incidence rates for cholera, which Dr. Snow attributed to the pools of water that tended to collect there, again showing evidence that cholera was in fact a water-borne disease (rather than one borne by 'miasma' as was commonly believed at the time.[3]

This is one of the earliest examples of geographical studies in health applications, which has become famous as "disease diffusion mapping".



Dr. Snow's map showing cholera cases in London during the epidemic of 1854.

source: http://www.google.co.jp/

GIS for public health

Today's public health problems are much larger in scope than those Dr. Snow faced, and researchers today depend on modern GIS and other computer mapping applications to assist in their analyses. For example, see the map to the slide number 9 depicting death rates from heart disease among white males above age 35 in the US between 2000 and 2004.[4]

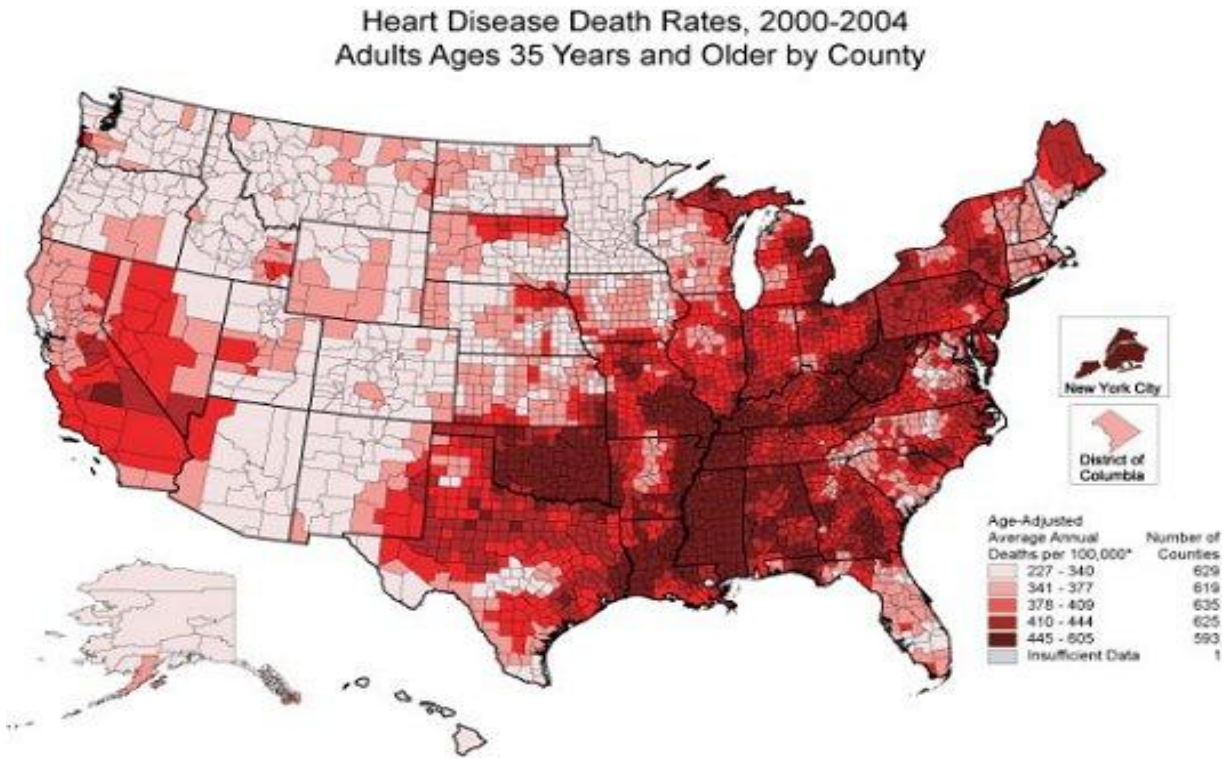
Public health informatics (PHI) is an emerging specialty which focuses on the application of information science and technology to public health practice and research.[5] *As part of that effort, a GIS – or more generally a spatial decision support system (SDSS) – offers improved geographic visualization techniques, leading to faster, better, and more robust understanding and decision-making capabilities in the public health arena.*[6]

There are different ways how GIS can support public health, health services and public health management.

GIS provides a better understanding and can drive better decisions. In fact GIS is a key for making better decisions and proper planning.

The other characteristic of GIS is that it can help its users to integrate different data from a wide variety of sources. Much public health data is still manually generated, and is therefore subject to human-generated mistakes and miscoding. For example, geographic analysis of health care data from North Carolina showed that just over 40% of the records contained errors of some sort in the geographic information (city, county, or zip code), errors that would have gone undetected without the visualizations provided by GIS.[9]

Alternately, GIS techniques have been used to show a lack of correlation between causes and effects or between different effects. For example, the distributions of both birth defects and infant mortality in Iowa were studied, and the researchers found no relationship in those data.[8]*.*



More modern disease map showing deaths from heart disease among white males in the US from 2000–2004.

Source: http://www.google.co.jp/

Issues with GIS for public health

There are also concerns or issues with use of GIS tools for public health efforts. Most grave among those is a concern for the privacy and confidentiality of individuals.[10] Public health is concerned about the health of the population as a whole, but must use data on the health of individuals to make many of those assessments. Protecting the privacy and confidentiality of those individuals is of paramount importance.

The use of GIS visualizations and related databases raises the potential to compromise those privacy standards, so some precautions are necessary to avoid pinpointing individuals based on spatial data. For example, data may need to be aggregated to cover larger areas such as a zip code or county, helping to mask individual identities. Maps can also be constructed at smaller scales so that less detail is revealed. Alternatively, key identifying features (such as the road and street network) can be left out of the maps to mask exact locations, or it may even be advisable to intentionally offset the location markers by some random amount if deemed necessary.[11]

It is well established in the literature that statistical inference based on aggregated data can lead researchers to erroneous conclusions, suggesting relationships that in fact do not exist or obscuring relationships that do in fact exist. This issue is known as the modifiable areal unit problem (MAUP). For example, New York public health officials worried that cancer clusters and causes would be misidentified after they were forced to post maps showing cancer cases by ZIP code on the internet. Their assertion was that ZIP codes were designed for a purpose unrelated to public health issues, and so use of these arbitrary boundaries might lead to inappropriate groupings and then to incorrect conclusions.[12]

Summary

GIS execution involves the creation, transformation and analysis of spatial databases including public health.

As GIS technology in public health develops, concerns about the accuracy of spatial databases have grown, and efforts have been made to develop standards for describing spatial database that enable users to search for and access data, assess the appropriateness and accuracy of the data and decide whether the spatial data can be used to answer the question the user is asking.

Public health is an application area where GIS has proven to be a reliable method for better future planning towards one of the most important object: better public health.

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