Technical report on

Geographic Information System (GIS) and Public Health: Practice of Good Mapping

Workshop for GIS users
31Jan-2Feb & 7-9 Feb 2011

Technical Report

"Geographical Information System (GIS) and Public Health: Practice of good mapping"

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31Jan-2Feb 2011 &7-9 Feb 2011

Organized by National Institute of Epidemiology (ICMR)

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National Institute of Epidemiology (ICMR),
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Chennai – 600 077.

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ACKNOWLEDGEMENTS

We express our sincere thanks to

Message

"Geographic Information System (GIS) provides visualization and analysis of epidemiological data, thus revealing trends, dependencies and interrelationships that would be more difficult to discover in other formats." It provides an excellent means of collecting, updating, managing epidemiological and entomological surveillance and related information. GIS can be effectively utilized to identify areas where a particular disease is prevalent. The technology can be used as location planning for a newly proposed health scheme and resource management. Monitoring and evaluation can be made simple by GIS approach. GIS has long been as a valuable tool for good decision-making. GIS will have greater importance due to its abilities to integrate a wide range of data sources, from legacy systems to image data, and make complex data into easily comprehensible.

As more researchers and agencies are likely to increase their use of GIS, the demand for training, producing good quality maps, creating quality spatial data, networking and data sharing continues to grow. It is apparent that GIS data produced in our country requires streaming to avoid duplication and repetition thus producing and sharing across users is made beneficial and more cost effective. The need for the expansion of professional skills expands. Also the system needs to be reviewed periodically and made aware of the flaw for quality improvement and current requirement and also to make the users aware of new developments. Thus the present workshop is designed to fulfill the gaps between the producers, the users of GIS data in India. I hope the proposed deliberations within next three days by inviting the best available diversified resource persons within our country will fulfill the identified gaps between the users and producers of GIS data in the existing system.

I am sure that this initiative of the National Institute of Epidemiology with financial support by ICMR (HSRC) will strengthen the efforts of researchers and health planners in providing better health care through evidence based strategies.

V. Kumaraswami
Director –In- Charge
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Ayapakkam, Chennai 77.

Executive Summary

Modern tools like Remote Sensing (RS) and Geographical Information Systems (GIS) have now come in handy to address the issues on the disease surveillance, control, monitoring and evaluation. Our responsibility in the immediate future would be to provide good quality of input to these systems and adopt apt procedures in order to facilitate formulation of policy statement and preparation for strategic plans.

The National Institute of Epidemiology (NIE) with financial support from Indian Council of Medical Research (ICMR), Division of Health System Research (DHSR) organized four workshops for Geographic Information System (GIS) users. The workshops were designed to offer comprehensive guidance for those who are using GIS in public health related activity at their work place.

The workshop objectives were to develop automation of Geodatabase from a micro level, promote quality disease maps and effective usage of GIS technology in health research. The participants were from various states of our country, mainly health care providers, practitioners and researchers from Government and non Govt. Organizations, who were actively involved in health research. Experts in Epidemiology, Research Institutions, Colleges, Survey department, Census Operations, Hydrology and Disaster Management who use GIS technology extensively were identified and deliverance of a series of guest lectures were organized. Four spells, each of three days events brought together participants from different institutes as well as external educational experts (GIS) from diverse fields.

This report summarizes the proceedings of the third and fourth workshops.

Participants felt the workshop as a wonderful exposure to the world of GIS. They realized the exposure as an eye opener to strengthen the quality of geodatabase development at micro level. The expertise experiences were added as a catalyst for deeper involvement in newly emerging techniques and in addressing the improvement of public health problems.

The workshop was an opportunity for participants to conceptualize a common vision for strengthening, capacity building and to disseminate their learning to the betterment of the health.

We appreciate the participant's active involvement, encouragement and enthusiasm to have such workshops and exchange of skills to happen again.

- There is a growing user of GIS technologists in health research and also Geo community provides freely accessible GIS software's, add on modules all easy to use. There are also workshops and training programmes conducted at national and international levels using GIS. The learning process was much easy to achieve but when it comes to practice it was questionable. Without adequate data GIS technology is not useful.

Even if the data was available at macro level acquiring the data at the desired level was a cumbersome process. If micro level data was available for region like wards correlated factors at that level was not possible. As an example for disease like malaria though ward wise cases was possible but factors like breeding sites, water stagnation points etc were not available. This was true with most of the disease conditions.

It is not only with data but is same with the digital maps. Even if the digital maps were available the updated boundary maps were not readily available. If new studies emerged it would not be known to the users, unless they were published. Also for sharing data, the formulation of policies by accounting its implications is yet to be framed.

Even if the data was available at macro levels (district) for some diseases; scale, accuracy not mentioned; proper sampling methodology not applied and automation of digital data were not uniform. Hence results were not comparable even at macro level. Scholars and researchers who approach our institute for their internship, project work and thesis dissertation feel the difficulty. Action has to be initiated to set things right to use the available data to its fullest.

The published papers based on a summary of discussions about current practices in the spatial analysis of georeferenced cancer data by a panel of experts convened at the National Cancer Institute (L W Pickle 2005) adds an

additional inspiration. These points lead to us to nurturing of the workshop for current GIS. Thanks to DHSR (ICMR) for streaming out our thoughts.

- Twenty-six Government /Private organizations/ colleges/research institutes (annexure2) were approached to identify GIS users in and around Chennai city. Commonly used GIS softwares, health GIS related studies undertaken by them, published articles, GIS facilities available at their workstation, information about the workshops and their views & limitations using this technology were studied.
- Majority (80%) of the GIS users used ArcGIS, 15% used MapInfo and another 5% used EpiMap, Health Mapper, MapWindow, QGIS, OpenJUMP and GRASS GIS.
- Ninety nine percent of the institutions visited had a fully fledged GIS Lab/Cell with all facilities like scanners, colour printers, hardwares, softwares loaded with a minimum ten users and well trained and qualified personnel.
- Almost all the institution has undertaken collaborative studies related to health research and also has published several papers and reports on their work. Their published outputs and views are also taken as inputs for the workshop presentations.
- The views of the GIS users are listed in the annexure3.
- Local field experts of GIS technology in various fields like epidemiology, research / teaching institutions, survey department, census operations, hydrology, ministry of earth sciences, disaster management etc. were identified and deliverance of a series of guest lecture organized (annexure4 & 5).
- There were four workshops organized by the institute.
- The first two workshops were during 9-12th Sep'10 and13-15th Sep'10. There were 76 applications enrolled and a number of phone calls received for enrollment of the workshops.
- There were 32 participants from various states of Bihar, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu, West Bengal and from Chennai City for the first workshop (details furnished in Sep'10 Tech report).
- There were 24 participants from Andhra Pradesh, Delhi, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu and Chennai City for the second workshop (details furnished in Sep'10 Tech report).

- Salient feature of the first two workshops were some of the guests who delivered lecture were also interested in learning advancement in the techniques and were among the participants (Dr. T.P Ahluwalia, Dr.P.Venkatesan and Dr. Biju Soman).

- The latter two workshops were organized during 31st Jan'11 to 2nd Feb 2011 and 7th to 9th Feb 2011.

- There were 136 applications enrolled and a number of phone calls received for enrollment of the workshops.

- We received two mails from outside India. A scientist from Ogun state, Nigeria had stated "**he was stumbled going thro' the learning objectives** and very much interested in attending the workshop". A research scholar from Canada also wanted to participate in the workshop. Since we did not plan to have a provision to accommodate them in our protocol, we could not accommodate them.

- Momentous feature of the latter two workshops were, some of the participants were in managerial cadre like MPH coordinators, Head of departments, nodal persons, deputy superintendents, acting Country Director for various projects, Scientist E and Scientist F.

- For the workshop 31stJan to 2ndFeb 2011, there were 48 participants from states of Andhra Pradesh (Hyderabad, Secunderabad),

    Assam (Guhawati),

    Himachal Pradesh (Panchrukhi),

    Karnataka (Bangalore, Mysore, Manipal, Tumkur, Shimoga, Kodagu),

    Kerala (Ernakulam),

    Megalaya (Jaintia Hills),

    New Delhi,

    Orissa,

    Punjab/Harayana (Chandigarh),

    Rajasthan (Jodhpur),

    Tamil Nadu (Chennai, Coimbatore, Kumbakonam, Nagercoil)

    including NIE/ MAE/MPH scholars for the third workshop (annexure 6).

- The forty participants for the workshop between 7th and 9th Feb 2011 were from

Andhra Pradesh (Nellore, Secunderabad),

Punjab/Harayana (Chandigarh),

Karnataka (Bangalore, Mysore),

Kerala (Ernakulam),

Maharashtra,

Tamil Nadu (Chennai, Madurai, Theni, Villupuram),

Uttar Pradesh (Agra, Etawah),

Uttarakhand (Dehradun),

West Bengal (Kolkata)

including NIE/MAE/MPH scholars for the second workshop (annexure 7).

- In our mission of endeavour, we have completed four workshops. We had more additional features in the latter two workshops from the feedback obtained from our earlier participants
  - ➢ a demo and a hands on session on "Open source GIS- QGIS"
  - ➢ GIS ethical issues,
  - ➢ GIS: case studies
- We have lit the sparkle of GIS to spread all over the public health domain of our country and we are in success. The enclosed email from a participant is a reminder to achieve the goal in days ahead.

From: jesuraj nelson (nelsonsjri@gmail.com)
To: vasnajoshua@yahoo.com;
Date: Sat, February 12, 2011 6:19:42 PM
Cc:
Subject: Thank you

Dear Respected Madam and the organizers of NIE GIS workshop,

At the outset let me tender my warm wishes in making the NIE GIS workshop more astounding and successful. Thank you all for the good efforts taken by NIE in enhancing sensitization and GIS use in public health mapping. There is a lot to do and lot can be done. It is a field which needs to be explored in public health.

The topic chosen and the speakers were par above excellence. Given the limited time frame, they were able to make sessions more interesting. However, the disadvantage was that we could have added two more days exclusively for hands on training and group's interaction and assignments. Frankly, my knowledge was very much limited before attending the NIE GIS courses but now I feel encouraged.

Some suggestions:

1. Planning hands on education along with the workshop days. Five days would be an ideal time frame.
2. Group assignments and presentations.
3. To be having more interactive sessions and not view this merely as a technical outlier.
4. Organizing NIE GIS alumnus site so that it gives an ample window of opportunity to interact with people of other expertise and talents for both students and educationist.
5. Keeping us posted about the latest happenings in GIS related to public health.
6. More sessions on spatial epidemiology. It would be of great relevance to public health.
7. Future courses on statistical applications using GIS

Overall it was a beautiful learning experience. I wish and hope that we continue to have sessions like these organized by NIE in the years to come.

Thanking you once again,

Keep in touch

Regards

Nelson

INTRODUCTION

GEOGRAPHIC INFORMATION SYSTEM (GIS) AND PUBLIC HEALTH

The perception that location can influence health is a very old one in western medicine. As far back as the time of Hippocrates (460-370 BC), physicians observed that certain diseases tend to occur in some places. **Hippocrates** was in search of the cause of diseases. He studied about the things such as climate, water, clothing, diet, habits of eating and drinking and in turn the effect they had in caused the disease.

The Hippocratic concept of health and disease stressed the relation between human beings and his environment. The disease diffusion was spread across the geographical regions but pattern of spread was not uniform.

John Snow was a British physician and a leader in the adoption of anaesthesia and medical hygiene. He is considered to be one of the fathers of epidemiology, because of his work in tracing the source of a cholera outbreak in Soho, England, in 1854. It had already taken nearly six hundred lives when Dr John Snow, using a hand-drawn map, showed that the source of the disease was a contaminated water pump. By plotting each known cholera case on a street map of Soho district (where the outbreak took place), Snow could see that the cases occurred almost entirely
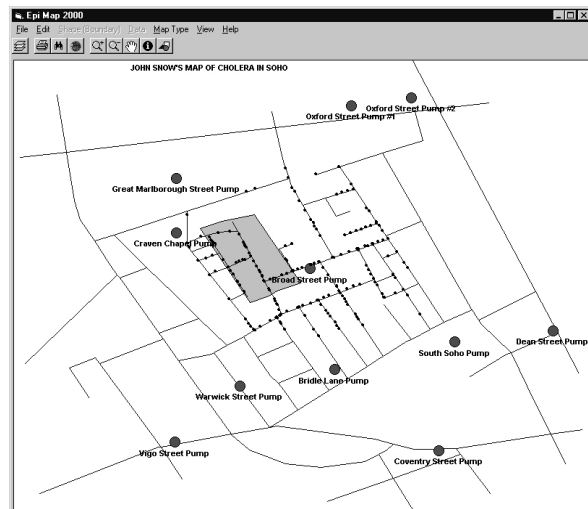
John Snow's map of Cholera deaths in London, 1840.

among those who lived near the Broad Street water pump. Snow recommended that the handle of that pump be removed, and that simple action stopped the outbreak and proved his theory that cholera was transmitted through contaminated drinking water. People's perception that cholera deaths were confined to the area around a cemetery of plague victims was removed and they were convinced that the infection was not due to the burial of plague victims.

In early 1960s Computer hardware development spurred by nuclear weapon research led to general-purpose computer "mapping" applications. The year 1962 saw the development of the world's first true operational GIS in Ottawa, Ontario, Canada by the federal Department of Forestry and Rural Development. Developed by **Dr. Roger Tomlinson**, it was called the "Canada Geographic Information System" (CGIS) and was used to store, analyze, and manipulate data collected for the Canada Land Inventory (CLI) – an effort to determine the land capability for rural Canada by mapping information about soils, agriculture, recreation, wildlife, waterfowl, forestry, and land use at a scale of 1:50,000. A rating classification factor was also added to permit analysis.

CGIS was the world's first such system and an improvement over "mapping" applications as it provided capabilities for overlay, measurement, and digitizing/scanning. It supported a national coordinate system that spanned the continent, coded lines as "arcs" having a true embedded topology, and it stored the attribute and location information in separate files. As a result of this, Tomlinson has become known as the **"Father of GIS,"** particularly for his use of overlays in promoting the spatial analysis of convergent geographic data.

"GIS provides visualization and analysis of epidemiological data, thus revealing trends, dependencies and interrelationships that would be more difficult to discover in other formats." GIS provides an excellent means of collecting, updating and managing epidemiological surveillance and related information.

The role of GIS; it can answer questions:

- Can we identify areas where a particular disease is prevalent?
- Can we get some evidence about the possible factors that are responsible for a particular disease?
- Calculates response times for interventions?

- Where to locate a new Primary Health Centre?(location planning)
- Where to provide additional resource facilities and staff? (resource allocation and management)
- Which are the areas wherein water borne diseases are prevalent?
- In which area the infant mortality is high?
- Which are the areas where the literacy rate is low?
- How many persons live within a 10 km of radius of a particular PHC?
- Who are the population affected within 100km of radius due to some natural calamity?

Few of applications of GIS in Epidemiology and public health:

- It gives health professionals quick and easy access to large volumes of data.
- Used to determine health condition of a population in an area for disease surveillance.
- Identification of high-risk groups for a certain disease condition for focused intervention.
- Monitoring, evaluation and intervention of health programmes.
- Estimates of population density for resource allocation.
- Entomological surveillance of vector-borne diseases, such as malaria, dengue.

GIS has been be used in public health for epidemiological studies. By tracking the sources of diseases and the movements of contagions; agencies can respond more effectively to outbreaks of disease by identifying at-risk populations and targeting intervention. GIS can be used to determine patterns or differences in health situations through different levels down to local level. Public health uses of GIS include tracking child immunizations, conducting health policy research, and establishing service areas that need immediate attention. Entomological surveillance of vector-borne diseases, such as malaria, dengue can be made simple with GIS technology.

Inherent in the definition of epidemiology is measurement of 'frequency', 'distribution', and studying 'determinants' of disease. All of this information requires GIS technology to comprehend quickly and take action instantly. Generally physicians and public health professionals measured health strictly in terms of indicators of ill health such as morbidity and mortality. But the practise in Epidemiology, Public Health and Medical Geography is to examine the distribution of disease and death at various geographic scales for determining whether the presence or absence of particular illness is associated with some factor(s) in the social or physical environment. In the case of infectious diseases, there is an added dimension of examining the diffusion of disease through space over a given period of time. By modeling the spatio-temporal incidence/prevalence of disease and related environmental factors, detection of disease clusters and generation of new hypothesis is possible. Although mapping of disease can be relatively straightforward, interpreting spatially referenced disease data can sometimes be challenging.

Apart from the difficulties in data acquisition, map representation, scaling, statistical analysis, and the interpretation and utility of results, the study of disease distribution may well be the most challenging and fascinating research area.

The main objectives of GIS are the management (acquisition, storage and maintenance), analysis (statistical and spatial modelling), and display (graphics and mapping) of geographic data. GIS is a valuable tool to assist in health research, health education, and planning, monitoring and evaluation of health programmes and health systems.

NEED FOR THE WORKSHOP

Healthcare providers are the most important assets to healthcare systems, to ensure high qualities of care to combat diseases. The system needs to be reviewed continuously/ periodically and make aware of the quality improvement and development goals. Geographic Information Systems (GIS) plays a vital role in strengthening the process of health care systems. GIS provides excellent means for visualizing and analysing epidemiological data revealing trends. With GIS technology, Identification of hot spots and disease clusters is simple. Monitoring and management of epidemics will be more effective by GIS tools that would otherwise be more difficult with raw or tabular form. Standardized procedures from the initial stage of data compilation and correct presentation of the data analysis would help to improve the system in full. This would make us possible to compare and contrast the results across the regions effectively.

Inappropriate and incomplete procedures would make the results invalid and misleading. Lack of quality and desired / grass route level information limits one to apply sophisticated technologies and for building complex models. This workshop provides an opportunity for the end users to improve the systems delivery to a universally accepted level. It also provides an opportunity to strengthen capacity building and networking.

Objectives of the workshop

- *Quality and promotion of a spatial data set infrastructure at a micro level*
- *Propagation of guidelines in producing good quality disease maps with specification of map accuracy.*
- *Proper usage of the map analysis.*
- *Effective usage of the GIS technology in health research.*

FREE GIS SOFTWARES RELATED TO HEALTH

EpiMap is a simple easy to use GIS program. It is developed and available to public from the Centers for Disease Control and Prevention (CDC) in collaboration with the World Health Organization (WHO). It is freely available in the public domain for researchers, public health workers etc.
[http://www.cdc.gov/epiinfo/].

HealthMapper - The HealthMapper has been designed and developed by WHO specifically for use by public health administrators working at national and district levels. The HealthMapper simplifies the collection, storage, updating, retrieval and analysis of public health data. It simplifies the use of geographic information systems and mapping and provides a user-friendly interface to spatial analysis and data management. It provides the public health user with user-friendly icon-driven functions to automatically create maps, tables and charts of their data; it can be freely down loaded at [http://software.informer.com/getfree-download-health-mapper-4.2/]

CrimeStat III is a spatial statistics program for the analysis of crime incident locations, developed by Ned Levine & Associates under the direction of Ned Levine. It was funded by grants from the National Institute of Justice. The program is Windows-based and interfaces are with most desktop GIS programs. The purpose is to provide supplemental statistical tools to aid law enforcement agencies and criminal justice researchers in their crime mapping efforts. CrimeStat is being used by many police departments around the country as well as by criminal justice and other researchers. It can be freely down loaded at http://www.icpsr.umich.edu/icpsrweb/CRIMESTAT/

GeoDa[TM], a free software program developed by Luc Anselin and The Regents of the University of Illinois and intended to serve as a user-friendly spatial analysis for non-geographic information systems (GIS) specialists. It includes functionality ranging from simple mapping to exploratory data analysis,

the visualization of global and local spatial autocorrelation, and spatial regression. It can freely downloaded at http://geodacenter.asu.edu/ .

SaTScan™ is a free software that analyzes spatial, temporal and space-time data using the spatial, temporal, or space-time scan statistics. It is designed for any of the following interrelated purposes:

- Perform geographical surveillance of disease, to detect spatial or space-time disease clusters, and to see if they are statistically significant.
- Test whether a disease is randomly distributed over space, over time or over space and time.
- Evaluate the statistical significance of disease cluster alarms.
- Perform repeated time-periodic disease surveillance for early detection of disease outbreaks.

The SaTScan™ software was developed by Martin Kulldorff together with Information Management Services Inc. Down loadable at [http://www.satscan.org/].

WinBUGS, is a software for advanced spatial analysis**.** The **Win**dow version of **BUGS** (**B**ayesian inference **U**sing **G**ibbs **S**ampling) is mainly used for the Bayesian analysis of complex statistical models using Markov chain Monte Carlo (MCMC) methods.

> The project began in 1989 in the MRC Biostatistics Unit and led initially to the 'Classic' BUGS program, and then onto the WinBUGS software developed jointly with the Imperial College School of Medicine at St Mary's, London. Development now also includes the OpenBUGS project in the University of Helsinki, Finland.

> **GeoBUGS** (BUGS for Geostatistics) has been developed by a team at the Department of Epidemiology and Public Health of Imperial College at St Mary's Hospital London. It is an add-on to WinBUGS that fits spatial models and produces a range of maps as output.

WinBUGS & GeoBUGS can be freely downloaded at

[http://www.mrc-bsu.cam.ac.uk/bugs/winbugs/contents.shtml].

COMMERCIAL SOFTWARES

ArcView/ArcGIS and various extensions

This software is developed by ESRI, Inc. and represents one of the standards in the industry. This software is used extensively by researchers but to a lesser extent by practitioners. There are other companies who provide extensions to this package such as the EpiAnalyst Extension for ArcView. These products have extensive capabilities. However their costs are generally beyond the means of public health departments.

MapInfo

This is also a commercial GIS package developed by MapInfo. This GIS product is also widely used and its cost is less compared to ESRI products; however it does have less capability as some of the ESRI products have.

OPEN SOURCE GIS SOFTWARES

GRASS GIS

Commonly referred to as GRASS, this is free Geographic Information System (GIS) software used for geospatial data management and analysis, image processing, graphics/maps production, spatial modeling, and visualization. GRASS is currently used in academic and commercial settings around the world. Also users are many governmental agencies and environmental consulting companies. GRASS is an official project of the Open Source Geospatial Foundation. It can be downloaded at [http://grass.itc.it/]

Quantum GIS (QGIS) Quantum GIS (QGIS) is a user friendly Open Source Geographic Information System licensed under the GNU General Public License.

QGIS is an official project of the Open Source Geospatial Foundation (OSGeo). It can be downloaded at [http://www.qgis.org/]

ILWIS is a user-friendly integrated software with raster processing capabilities to work on remotely sensed satellite images and vector processing capabilities for making vector maps and spatial modeling abilities. It can be downloaded from [http://www.ilwis.org/].

OpenJUMP is an open source Geographic Information System (GIS) written in the Java programming language. It is developed and maintained by a group of volunteers around the globe. OpenJUMP started as JUMP GIS designed by Vivid Solutions. It can be downloaded from [http://www.openjump.org/].

MapWindow GIS desktop application is a free, open source, standards-based standalone software package that can be used to view and edit GIS data in many file formats.

The software includes plug-ins for various geoprocessing tasks (e.g. buffer, merge, etc.), watershed delineation, accessing online data sources, and an experimental geodatabase plug-in. The attribute table editor can be used to write simple queries, and there is a complete scripting editor that allows one to write and run scripts in VB.NET and C# directly in the MapWindow program. It can be downloaded from [http://www.mapwindow.org/]

DATA LIMITATIONS

While there is a growing body of literature on the use of GIS for research and control, but there has been no review of the state of the art.

Without adequate data, GIS is not very useful. This is a problem that GIS users are facing for decades in both developed and developing nations.

Finding the funds to collect new data and converting paper maps and data into digital format continues to be problems. In many cases digital data do exist, but there are issues of confidentiality, national security, etc. which have prevented its use by researchers and health-related departments.

Data may exist in digital form but is not fully utilized due to lack of institutional sharing arrangements (government departments may not share data with one another) or because users do not know that such data do exist or because the data may have military value and is classified; Weather data (rainfall and temperature) is not usually available at the scale needed for analysis. With few weather stations in a district, parameters relevant to disease (like malaria) transmission could not be measured at all, such as wind speed and direction, which affects the vector-people interaction.

Data is too specialized or not available or incomplete. The spatial or geo-referenced data is not available at the micro level like village / taluk level. In some instances non-spatial data (attribute data) is available at the desired level but digitized maps are not readily available. In some instances the spatial scale of data is not appropriate for certain types of analyses (land cover may be appropriate for district wide analysis but not for local/village

> Providing timely and adequate data is an essential pre-requisite of evidence-based planning, which is essential to all areas of public health.

analysis because small features such as ponds and localized wetlands are not shown)

Apart from scarcity of basic data there prevails a lack of understanding of the situation. For example details on malaria risk and severity fundamental perspectives of where (distribution) why (environmental determinants) how much (transmission intensity) and when (seasonality) malaria occurs, do not exist for micro level data and at times even at macro level. This is not only with malaria but also for many more disease conditions.

Many misunderstand this concept. The accuracy of a map or dataset is depends on scale and becomes problematic when map scales are changed or when datasets are merged. For example, problems can arise when a vegetation dataset collected via satellite is combined with village level data on malaria incidence. Trying to establish a relationship between vegetation type and malaria using these two datasets can be misleading.

One way of approaching data problems is to set up a pilot program/survey. A pilot survey would have several benefits including: showing to decision makers what is possible. We have to work out problems on a small scale before launching a program nationwide to determine costs for collecting data or converting it from analog format. A good step would be to canvas all government departments/institutions for digital data. Often the forestry, mining, and/or natural resource departments are more advanced and have good GIS datasets and may be willing to collaborate and share data.

As Dr. Oppong argues "...availability of spatially referenced health data does not mean that data is suitable or even usable for GIS analysis."

Typically weather data are collected at established stations and these are not always appropriate for use in understanding diseases. There are two options if this is the case. One involves interpolating/extrapolating the data by using special

tools found in a GIS. This is not a very good solution because it tends not be very accurate, particularly if there are large variations in the data (rainfall or temperature). The second option is to add more stations. This provides more accurate data prospectively and hence takes time to accumulate the necessary data to perform analyses. A third possibility is to use indicators of weather conditions relevant to disease transmission, such as rainfall, using remotely sensed data, generally by satellite.

Data may be available only in paper form but may lack information on date, source, scale, projection, origin and author the basic information needed for digitizing. While this may seem to be a minor concern, but many maps do not have the necessary information to make them useful to a GIS environment. Though a map without a projection or scale can be scanned and adjusted or matched with other data to determine the projection/scale, this will be technically, tedious and time-consuming process. Date of map is very important. It is more important if a map shows characteristics that change relatively rapidly, such as population distribution or land cover / use. Yet another data problem that is particularly difficult to deal with involves the movement of people. While there may be some data available from the census, it is usually too old or not done frequently enough to be useful for

> **Problem in linking GIS data**
> A difficulty in linking the disease data with the GIS system that resides in the different premises and not in a flexible environment makes one handicapped.

research. The primary option is for health officers to conduct special surveys to determine the movement of people and whoever does the task, should share and if possible make it readily in usable format for researchers.

Disease reporting problems

Specifically these include: Poor recording system and non availability of required information. Repeat visits to a clinic/ hospital by the same individual in a given reporting period (gets counted as two or more cases depending on the number of visits). Out-of-date information or non-reporting of data due to technical

problems. Non availability of their locale address (geo- referencing). The local clinic does not see the value in sending data to the higher authorities for processing.

Historical maps may be digitized and made as a useful resource to compare trends and endemicity etc.

This allows for different types of surveys, undertaken in different geographic locations, at different times to be transcribed to one standard format. Then the data would be very useful at all levels.

Most government organizations are willing to share spatial data, but there are significant barriers to effective sharing. These include: Lack of awareness of existing data sets, Lack or inadequate metadata (information about data).

Lack of qualified staff

This issue is most frequently mentioned and even quoted in the literature. Growing interest in GIS technology will easily address this problem in a short span of time.

Lack of uniform policies available on accessibility, cost recovery, revenue generation, and pricing; Lack of uniform policies regarding data ownership, maintenance, and liability; Lack of incentives for sharing, Absence of tools and guidelines for sharing.

Lack of software to perform spatial analysis

The software's universally accepted are felt very expensive and beyond the reach of most of the GIS users/researchers. Yet another, more recent issue is that many GIS software do not adequately handle spatial statistics. In other words most of GIS software does not deal with spatial statistics and those who wanting to perform spatial analysis have to use another piece of software or with an add-on module such as ESRI's Extension tools like Geostatistical Analyst.

A GOOD MAP

A map can be simply defined as a graphic representation of the real world. Maps are abstraction of reality. Three elements of the maps are scale, projection, and symbolization (each element is a source of distortion)

- Scale is: real world objects "reduced" by representation or amount of reduction found in maps
- Projection: is used to portray all or part of the spherical Earth on a flat surface
- Symbols are used to represent real objects.

Spatial objects in the real world are represented as points, lines, areas, and surfaces. Maps need contrasting symbols to portray geographic differences. Map symbols can differ in size, shape, gray-tone value, texture, orientation and hue.

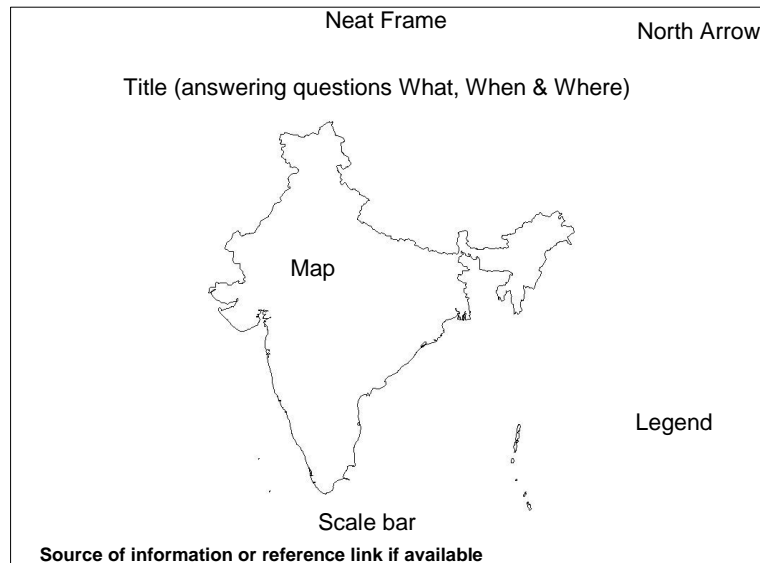Spatial entities can be represented at the nominal, ordinal, interval, and ratio levels. Shape, texture and hue are effective in showing qualitative differences. For quantitative differences size is more suited

> Maps should be designed to stand alone even when taken out of the context. A good map includes a common set of map elements.

to show variation in amount or count whereas gray-tone is preferred for portraying differences in proportion or rate or intensity and orientation for direction or movement of flow.

Map Legend is a key to all the symbols used on a map. It is like a lexicon for easy reference than one can understand the meaning of what the map represents.

A template of the necessary map elements is shown below.

Neat Frame

North Arrow

Title (answering questions What, When & Where)

Map

Legend

Scale bar

Source of information or reference link if available

Colours

Wise colour choice and colour usage enhances the appearance of a map. Selected colours should not violate generally accepted conventions. For example, individuals are accustomed to blue representing water and green for vegetation. The convention for quantitative data is that either darker or warmer colours represent higher values. For example, the historical use of reds for high rates and blues for low rates (cancer mortality maps). When data are classified into groups (classes), colours need to be assigned that works well in distinguishing between the classes.

National Science Foundation-funded research by Cynthia Brewer has produced a Web site that is particularly useful for making the colour choices for sequential (light to dark); diverging (dark to light of one

According to Cromley (2002), it is the best practice to use a single color and vary its intensity. Less intense (lighter) hues typically represent areas with low data values and more intense (darker) hues those with higher values.

colour, then light to dark of another colour); and qualitative colour schemes [http:// www.colourBrewer.org/]. The Web site also helps the map designer to choose appropriate colours for use by the colour blind (most commonly those readers who have a particular problem distinguishing red and green), printing in black and white and for displaying on a laptop computer or a projection system

Thematic maps

There are many different types of thematic maps. Two types of maps frequently used in public health research are dot-density and choropleth maps.

Dot-density mapping

Dot-density maps are the simplest way to display events. These maps use dots or other symbols to represent the number of occurrences of a given characteristic. Each dot or symbol used on the map may represent a single entity (one dot = one case) or a group (one dot = 1,000 people). Dot-density maps are useful for area comparisons. However, dot-density maps need to be interpreted with caution regarding the "symbol to data characteristic" ratio. It is also important to keep in mind that dots do not always indicate the exact location of the data.

Choropleth mapping

Choropleth maps are area maps in which polygons (e.g., census tracts, counties) are shaded, colored, or patterned according to the extent to which a given attribute (such as population size or disease rate) is associated with each polygon.

> Monmonier (1996) points out that many, many choropleth maps can be made from the same data simply by changing the class intervals. It is possible to manipulate map-readers' impressions of spatial patterns of health events simply by changing class interval.

It is well known in cartography that different ways of selection of number of classes and class breaks can radically change the information perceived from the map.

Classification is a powerful tool to express different ideas than one would like to communicate to audience. Hence it should be done with a proper care.

Most of the GIS software's provide methods of classification as

- Natural breaks
- Quantiles
- Equal intervals
- Equal area
- Standard deviation and
- User defined.

> Brewer and Pickle (2002) conducted a study and it was shown that quantile method was the best method for conveying patterns of mapped rates.

The same map may not be equally suited to all the questions. Environmental Systems Research Institute, Inc., (ESRI), a provider of GIS software, warns that "Trying to communicate too much in one map – having more than one purpose for the map – tends to blur the message and confuse the map reader. Using two or more maps, each focused on a single message, is always a better strategy"

Modeling when Spatial autocorrelation or spatial clustering exists

Tobler postulated the first law of geography as "nearby things tend to be alike." It is evident because nearby places have a common history and also environment. In disease epidemiology, the infectious disease events do not occur randomly in a geographical context but occur in clusters.

Generally spatial data exhibit positive autocorrelation such that nearby locations tend to have similar intensities. This is important because spatially correlated data cannot be

> When the spatial dependence is ignored, the ordinary least squares (OLS) estimates will be inefficient, the t and F statistics for tests of significance will not be robust, the degrees of freedom tend to be exaggerated and the R^2 measure of fit will be misleading.
>
> In other words, the statistical interpretation of the regression model will be wrong. Anselin and Griffith (1988) have shown how the results of data analyses may become invalid if spatial dependence and/or spatial heterogeneity are ignored.

regarded as independent observations. The presence of spatial dependence violates a basic assumption of many of standard statistical tests, that observations are independent.

However several techniques are available to address the problem of spatially autocorrelated data. Models have been developed for correlated spatial data. Spatial regression analysis can be performed accounting proximal and adjacent effects.

Modifiable Areal Unit Problem (MAUP)

Many spatial datasets are collected on a fine resolution (i.e. a large number of small spatial units) but, for the sake of privacy and/or size concerns, are released only after being spatially aggregated to a coarser resolution (i.e. a smaller number of larger spatial units). The main example of this process is census data which are collected from every household, but released only at the Enumeration Area or Census Tract level of spatial resolution. When values are averaged over the process of aggregation, variability in the dataset is lost and values of statistics computed at the different resolutions will be different. The aggregated data can dramatically impact analysis and make the test for associations problematic.

Spatial and Temporal mismatch

Cancer data, information on covariates and on environmental exposures typically do not "match up" in space or in time. Mismatch occurred between the cancer and air toxics data both in space (lung cancer incidence was reported at micro level; air toxics data for macro level) and in time (lung cancer incidence was reported for 2000- 2010; the air toxics data was based on emissions reported during 2009). The problem of spatial mismatch was solved by using spatial tests for association (boundary overlap) that account for the differing geographies within the randomization procedure. Temporal mismatch was problematic because latency for lung cancer is on the order of 15–20 years, and air toxics information could not be reconstructed over that time span. Thus while they found a positive geographic association between the air toxics and lung cancer
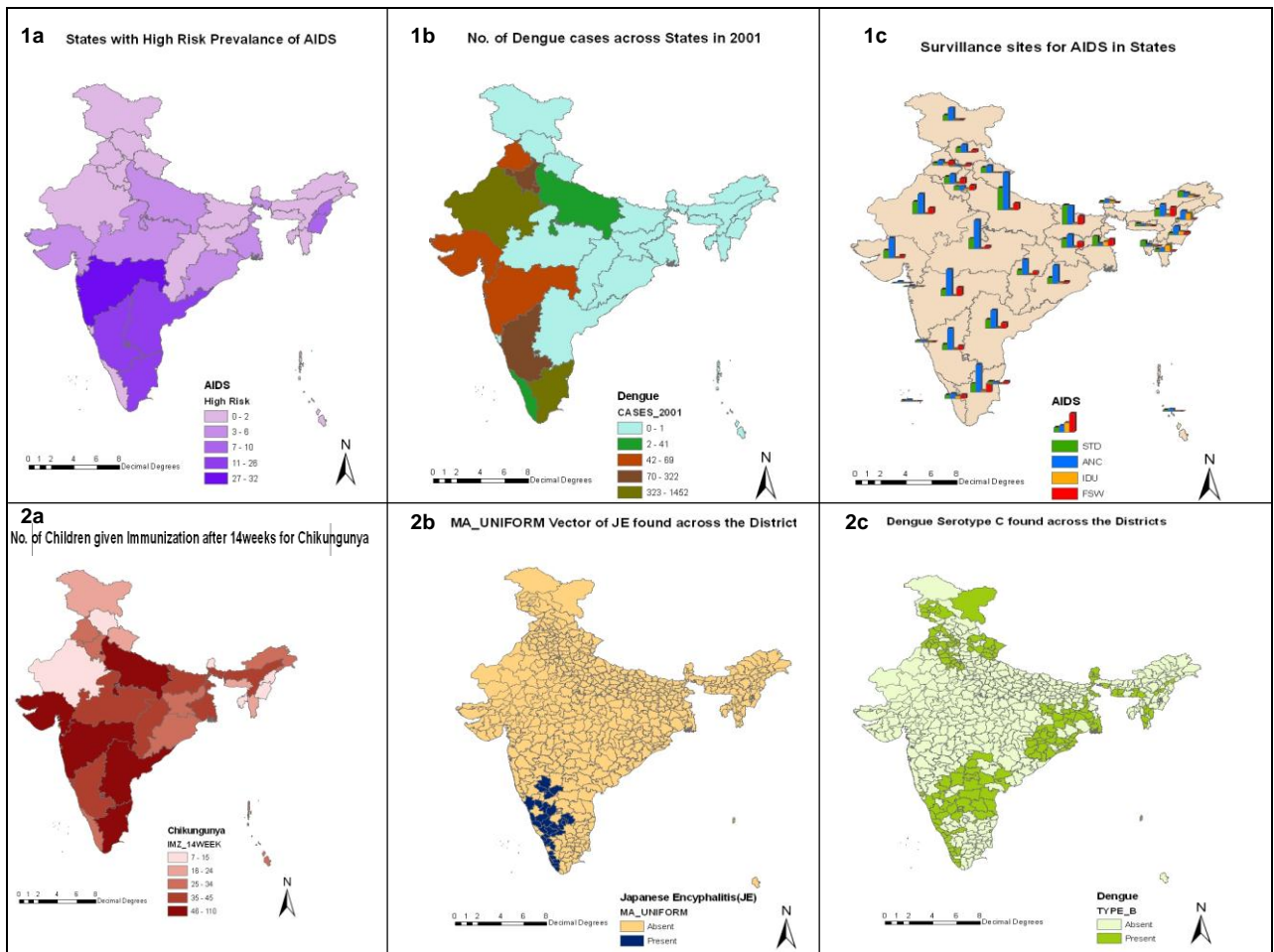
incidence, the substantial temporal mismatch means a more detailed exposure reconstruction is required before any conclusions can be reached.

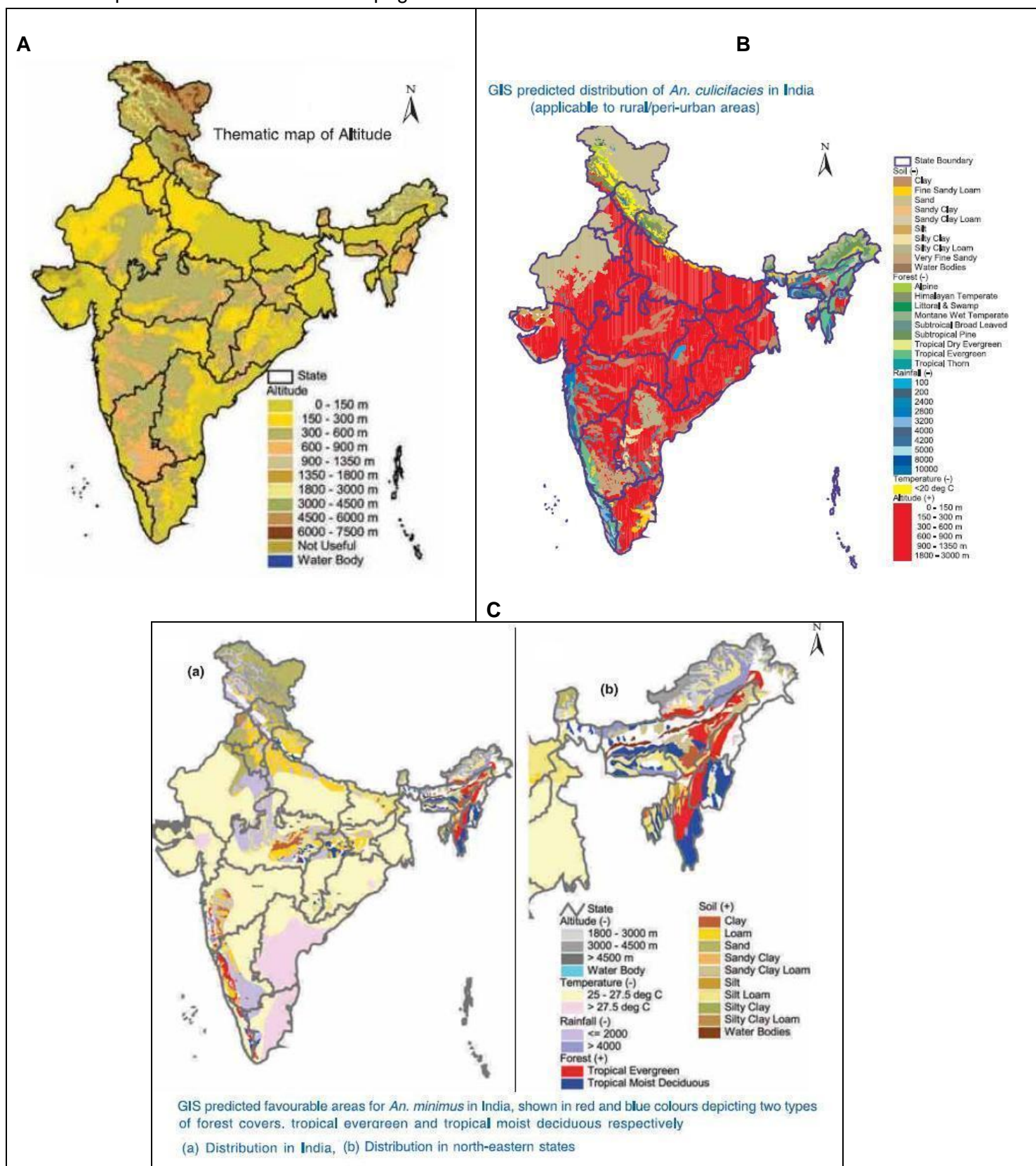## STRENGTHS, WEAKNESSES, OPPORTUNITIES, AND THREATS IN THE

PUBLIC HEALTH GIS FIELD

(Massimo Craglia and Ravi Maheswaran, "GIS in Public Health Practice" 2004)

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
Technology	Data quality	Data and technology	Confidentiality
Visualization	Analytical functions	Political agenda	Erosion of trust
Data availability	Methodology	Organizational awareness	Loss of credibility
Integration	Organizational issues	Public health GIS community	Political environment
Analytical functions	Education and training		
Body of knowledge			

Simple maps downloaded from the web page, which needs improvement

1a States with High Risk Prevalance of AIDS	1b No. of Dengue cases across States in 2001	1c Survillance sites for AIDS in States
2a No. of Children given Immunization after 14weeks for Chikungunya	2b MA_UNIFORM Vector of JE found across the District	2c Dengue Serotype C found across the Districts

- Absence of the time period to which it refers.

- Title needs improvement in clarity and can be more precise.

- In general colour choice needs improvement when considering disease conditions.

- Size of the legend [📊] not mentioned only variability is visible (1c).

- Number cases/ children depicted (1c & 2a) instead of rate /incidence or prevalence would be more meaningful for a heterogeneous population.

- Instead of presence/absence of Japanese encephalitis, some rate values would add more meaningful information.

- Map as a standalone should be self-content.

Map downloaded from the web pages

A — Thematic map of Altitude

B — GIS predicted distribution of *An. culicifacies* in India (applicable to rural/peri-urban areas)

C — GIS predicted favourable areas for *An. minimus* in India, shown in red and blue colours depicting two types of forest covers, tropical evergreen and tropical moist deciduous respectively
(a) Distribution in India, (b) Distribution in north-eastern states

- A scale bar may be used or may be mentioned 'map not to scale'
- Better colour choice would have been adopted to portray distinct variation.
- In map A & B repetition of similar colours could have been avoided.
- Apt colour for attribute -blue for water bodies (map C) could have been used.
- In legend overlapping label values could have been avoided.
- Unit of measurement of rainfall could have been mentioned.

The science behind the map to carry genuine messages is weak.

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Workshop III [31st Jan to 2nd Feb 2011]

The photos portray the inaugural function on 31st January 2011. The dignitaries in the dais seated from the right are Prof. Ramalingam, Director of Institute for Remote Sensing, Anna University; Dr. B. Nagaraju, Scientist F, National Institute of Epidemiology.

Dr. B.N. Murthy, Scientist F, National Institute of Epidemiology, gave the welcome address. The invited participants constituted a balance group of GIS users from various states right from Rajasthan in the North down to Kerala. They were health care providers / public health practitioners/Researchers and managers from Government and non Govt. Organizations / Institutions who were actively involved in health research activities.

Prof.Ramalingam spoke on Public Health Information System. He compared spatial resolution of various satellite images the IRS 1C, IKONOS, CARTOSAT2 and quickbird. He talked about rapid damage assessment of Tsunami and the response to mitigation measures using GIS technology. He also presented about a case study done in Salem district. He explained how a GIS based decision support tool for health management was created. He also demonstrated how spatial analysis of morbidity using several socio

economic variables, incidence of the diseases, location of hospital facility was mapped as multiple layers.

Dr Tune Usha spoke on the current usage terminology Geomatics comprised of GIS, GPS and Remote Sensing. She talked about fundamentals of GIS and the need for GIS. She also focused on disaster Epidemiology. She presented the methodology adopted by her for studying the coastal hazard using the four technologies namely GIS, Remote Sensing, numerical models and GPS. Method of developing a relative vulnerability index for assessing the vulnerability of buildings to coastal inundation was demonstrated.

Dr B N Nagpal talked about their journey of their success right from the year 1992 to 2010 in application of GIS technology to mapping malaria. He demonstrated a methodology in use of GIS and Remote Sensing (RS) to map Indian anophelines including six major malaria vectors associating ecological parameters (forest cover, rainfall, altitude, soil type and temperature) which mainly govern the distribution of the species. He mentioned about the studies that are in progress to find out the impact of deforestation on malaria epidemiology in districts of Assam. He spoke elaborately on mapping malaria receptivity in tribal areas of Ranchi, Jharkhand.

Dr D Ragavan talked about the problems of precision and accuracy of mapping. He emphasized about the importance of accuracy and precision of GIS data, a primary concern that needs to be addressed since the entire outcome rests on the data. He also listed the ways in which the goals can be achieved. He also discussed about different types of precision and accuracy in the generation of GIS data. He advised the GIS users to be very cautious while combining the data since the GIS systems are typically unable to warn the user if inappropriate comparisons are being made or if data are being used incorrectly.

Dr V. Selvaraj spoke about the ethical concern in using GIS technology. He mentioned that currently the GIS technology had been used widely in the public health domain. As the uses became widespread, scholars and GIS practitioners began to express concerns about the ethical implications. He discussed about the hankering of the GIS users. The assumptions that maps were impartial and value-neutral depictions were questioned. Inaccurate maps and data, intellectual property issues, and conflicts of interest were important ethical issues brought out then. There are ethical issues of GIS and data confidentiality / individual privacy. The other issues he discussed were improper use of GIS due to the lack of competence or limited knowledge about GIS technology. How maps could be used to mislead decision-makers and the public and proposed design guidelines to foster ethical practice by cartographers.

Dr S. K. Dash spoke about Remote Sensing technology. He explained the various terminologies used in RS with an example of coastal studies. He explained how the Cholera outbreaks had been linked with environmental factors. He shared his own experience in locating fish catch using variability such as Sea surface temperature and wave height. He spoke on coastal inundation maps and Phytoplankton Biomass (Derived from Chlorophyll concentration) etc. and the GIS models.

ESRI India (NIIT GIS Ltd.) is a leading GIS enterprise that endeavours to provide end-to-end GIS based solutions in India and many other countries. Mr. T.V.B Krishna Rao, Technical Coordinator of ESRI chennai, illustrated the GIS utility in Public Health related activities like Disease Surveillance, Spatial Analysis, Public Reporting, Health Informatics, Population Health, Immunization Tracking, Vital Event Registries, Animal and Food Tracking, Environmental Tracking, Strategic planning, Site Location Analysis and Outbreak Detection. He also showed how these applications and advanced geostatistical models could be performed through their product using ArcGIS.

Mr. S. Raghavendran from PIXEL Info Tech spoke about the current trends in the field of GIS with special reference to Web GIS for public health. He emphasized the importance of public health research and GIS applications in Medical Geography. He presented exhaustively the current trends and future challenges in Spatial Epidemiology.

Dr R. M. Narayanan of MGR University gave an introduction about open source GIS-QGIS. He emphasized that Open Source Software referred to software whose source code was available and that could be used, copied and distributed with or without modifications. He listed the advantages. Further, Open source software is a development method that harnesses the power of distributed peer review and transparency of process. The promise of open source is better quality, higher reliability, more flexibility, lower cost and an end to predatory vendor lock-in.

He made a live demo of the QGIS software functionalities and capabilities. He guided the participants to digitize the map of Panruti taluk in Cuddalore district, Tamil Nadu. Creation of various layers point, line and polygon were shown. Addition of attribute data and a choropleth map were illustrated. Finally a good simple map was constructed in the print layout with suitable title, direction arrow,

legend and scale bar. Participants were asked to repeat the entire steps of the demo during the hands on practice session.

Dr P. Venkatesan shared his experience on GIS based sampling methodology for the survey of health and air quality adapted in Delhi. He discussed about the advantages (probability sampling without sampling frame) in using GIS based sampling methods. He also explained how the sample of households selected was navigated and identified with the help of Global Positioning System (GPS) and the air quality modeling was built using satellite data.

Dr Vasna Joshua presented the theme of practice of good mapping. She stressed that researchers should make use of good graphic communication. She cautioned them to be more careful in presenting shape, size, value, pattern, hue or colour and direction of GIS maps. The different types of maps were shown. She spoke on small area problems. She said it should be addressed with the well-established statistical techniques.

She spoke on the situation where there were spatial and temporal mismatches. These matches were explained by an example of associating lung cancer with air toxics. She demonstrated how a good spatial statistical modelling could be

developed by using a real life data of leprosy vaccine trial data in an endemic region of Tamilnadu,South India.

Dr S. Mehendale spoke the importance of GIS and Public health. He mentioned that GIS has beyond simple mapping organizing, managing, linking, and analyzing data. He explained the GIS approach to public health investigations using a case study on Avian Flu. He listed the uses of methodology in Public health. Finally he mentioned how solutions to public health issues could be addressed through GIS.

The dignitaries and the participants of the third workshop (31[st]Jan –2nd Feb'11) are in the group photograph at the National Institute of Epidemiology.

Workshop IV [7th – 9th February 2011]

The dignitaries on the dais during the inaugural function of the fourth workshop seated from the right are Dr B. Nagaraju, Scientist F, National Institute of Epidemiology; Dr. S. Mehendale Director, NIE; Professor T. Natarajan currently chair professor & former Director of Institute for Remote Sensing, Anna University, Chennai.

The above picture portrays the section of participants in the augural function.

Dr S. Mehendale delivered the presidential address. He spoke that epidemiology provides a unifying framework for the collective public health effort. Based on the use of epidemiology, public health is empowered to make arguments for national health programs and to support the concept of health as a determinant of life options. He emphasized the tremendous potential of GIS in the field of public health.

Professor T. Natarajan gave the keynote address. He spoke about the importance of GIS in day today public health affairs. He commented that only 2.3% of the total budget expenditure for the financial year 2010-11 constitutes India's annual healthcare expenses, which he said that it still remains to be one of the lowest in the world.

The first lecture of the workshop started with Prof. Natarajan, he discussed in depth about Health GIS - prospects, problems and prescriptions. He mentioned that while new technologies have revolutionized the use of geographic information for public health practice, maps have long been a part of disease research and surveillance. He briefed about Remote Sensing technology, Digital Photogrammetric Mapping

System, Digital Elevation Models and mobile Mapping. He also mentioned about

the recent advancement in the technology like Airborne Laser Terrain mappers used in their flood assessment study of Chennai city.

Dr Tune Usha spoke that GIS era started 35,000 years ago with Cro-Magnon hunters, followed by Dr. John Snow's mapping in 1854. The current major applications of GIS are Air pollution and Control, and management of natural resources, waste water, coal mine, fire, Oil spills, and Disaster management. She talked on the topic fundamentals of GIS. She presented a methodology for studying the coastal hazard using the four technologies namely GIS, Remote Sensing, numerical models and GPS. She demonstrated the procedure to develop a relative vulnerability index for assessing the vulnerability of buildings to coastal hazards.

Dr Vasna Joshua spoke on Daniel Carr's linked micromaps & Conditioned Choropleth maps. The features and purpose of these maps were discussed and their utilities were shown. LM plots provide the reader with a tool for rapidly reviewing statistical concepts such as median, inter quartile range, upper adjacent values and outliers. The purpose of CC maps is to help researchers generate hypotheses about observed spatial patterns and move towards advanced statistical analysis. The Quality of data is the key to all maps.

Dr V. Selvaraj talked about the ethical implications of GIS. He mentioned that GIS was a highly effective information and communication technology and its universal language was the map. Some of the issues in GIS discussed are inaccurate maps and data, intellectual property issues, and conflicts of interest. Some of the other issues of GIS are data confidentiality / individual privacy, improper use of GIS due to the lack of competence or limited knowledge on GIS technology. He also discussed how maps could mislead decision-makers and the public.

Dr S. K. Dash spoke about Remote Sensing technology and its applications using coastal studies. He mentioned that many event based information like oil spills, Coastal erosion / deposition etc. could be monitored using consecutive high-resolution satellite imageries. He explained how the Cholera outbreaks had been linked with environmental factors. He shared his own experience in locating fish catch using variability such as sea surface temperature and wave height. He spoke on coastal inundation maps and Phytoplankton Biomass (derived from Chlorophyll concentration) etc. and the development of GIS models.

Mr. Ravi Kumar from ESRI spoke about the project on GIS Based Health Management Information Systems, which integrated GIS as a tool and developed a customized Geographic Information System for assisting in the delivery of health programmes in India, under the Revised National Tuberculosis Control Programme (RNTCP). He also mentioned that to achieve the goals of spatial data creation, ESRI envisaged the following Software's ArcGIS spatial analyst, ArcSDE technology, ArcGIS Server and ArcGIS Desktop applications.

Mr S. Ragavendran spoke about the current status of GIS in Public Health, new trends, the bottlenecks, the data power and the future GIS. He mentioned that GIS could be categorized as Desktop GIS, Web based GIS, Enterprise GIS and cloud GIS. He explained about interactive, near-real time and dynamic maps using swine flu. He demonstrated 3D topographic map of a municipal ward using BENTLEY software.

Dr R. M. Narayanan spoke about the recent advancements in GIS which could model the temporal and spatial patterns of hazards, environmental health problems, infectious diseases, spread of contaminants and vector and host habitats. He emphasized that various commercial GIS software are available for analyzing the epidemics, however the open source free software like Quantum GIS are equally competent enough to execute the task of mapping the health hazards. He demonstrated the QGIS software functionalities and capabilities. He digitised the map of Panruti taluk in Cuddalore district, Tamil Nadu. Hands on training on creation of various points, line and polygon layers were given. Addition of attribute data and a creation of choropleth map were demonstrated. Finally a good sample map was constructed in the print layout with suitable title, direction arrow, legend and scale bar. Participants were asked to repeat the entire steps of the demo during the hands on practice session.

Dr S. Mehendale spoke the importance of GIS and Public health. He mentioned that public health researchers were increasingly finding GIS to be an extremely valuable tool for organizing and analyzing health outcome data, estimating environmental exposures and displaying research results. He explained the GIS approach to public health investigations using a case study on Avian Flu. He

stressed that as every disease problem or health event would require different response and policy decision, information should be available that would reflect a realistic assessment of the situation at local, national and global levels.

Dr P. Venkatesan presented the GIS based sampling methodology adopted for health and air quality survey done in Delhi. He narrated that the recent advances in global position systems (GPS), geographic information systems (GIS), and remote sensing (RS) could be exploited for spatial sampling design for demographic and health surveys. He mentioned that those technologies were particularly useful when a sampling frame was not available and/or location (of household) was important for data collection (e.g., location of residence might greatly impact exposure to ambient air pollution among members of a population). He also explained the various steps involved in sampling for health surveys.

Mr. A. Elangovan talked about estimation of HIV prevalence using the GIS technology. The locations of HIV sentinel centres of Tamil Nadu were mapped using GIS. All the site-specific HIV prevalence rates were transformed into a GIS format. Using interpolation techniques estimates for non-sampled location were obtained. Thus HIV infection load was calculated for entire Tamil Nadu. He demonstrated that estimation by his method agreed with that of NACO and NFHS III.

Mr. Peeyush Gupta a participant and a GIS Associate of Disaster Mitigation and Management Center, Dehradun, shared his work experiences. He mentioned that all sciences had their portfolio of commonly used tools: astronomers use telescopes to view stars and information systems to record their characteristics, biologists use electron microscopes to visualize the structure of cell organelles and supercomputers to simulate ecological systems, and computer scientists develop new computer architectures using computer-aided design software. Geographic information scientists also have their tools, geographic information systems, which are a fundamental and integral part of pursuing geographic information science.

Dr. Vasna Joshua spoke about the theme of practice of good mapping. The basic elements of map were discussed. She discussed about the utility of different maps like dot map, dot density map, mille map, choropleth map, cartograms, poisson probability maps, Bayesian smoothing maps and map obtained thro' kulldorff's spatial scan statistics. The limitations of GIS technology were discussed due to factors like Modifiable Areal Unit Problem (MAUP). The spatial temporal modelling procedure was explained using a real life leprosy data in an endemic region of Tamil Nadu, South India.

The dignitaries and the participants of the fourth workshop (7th–9th February 2011) in the group photograph at the National Institute of Epidemiology.

Views of GIS Users
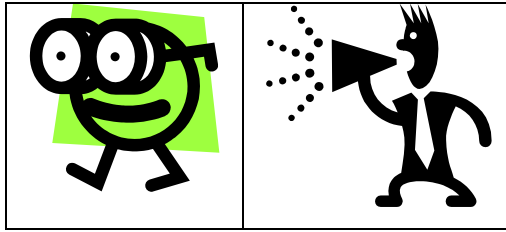
To understand the nature and requirement of GIS users in and around Chennai, we visited some of the prestigious institutions/organizations that were extensively using GIS technology and their views were personally collected.

Data and Maps

1. In Chennai, Institute of Remote Sensing (IRS), Anna University is designated as the Central Repository for all Geographic Information System applications and digitized maps developed by the Government departments, Statutory Boards and other Undertakings. This planning and development of Data Bank was initiated on 27th March 2001 [http://www.tn.gov.in/gosdb/gorders/pd/pnd-e-30.htm].

   Many of the GIS users are aware of the availability of GIS database on a single platform and Data Bank development at IRS, Anna University. Some users emphasized the need for facilitation of the initiated program and easy access to these maps and data.

   The users felt that availability of various layers (including the updated maps) and data available at Anna University could be made aware to the users through the web.

2. Micro level studies are being undertaken by different institutions/ research organizations, and students for their project work/ dissertation

work, internship work. Also some of the studies are funded by local and international agencies. It should be made mandatory that they should register their work regarding GIS (like Clinical trial registry of India). This will be useful for future approval of funding (to avoid duplication of work) and publication of the papers at state/national level. Further, online registration should be made free of cost. This online registration may contain the details of study area, map to be digitized, objectives etc of the GIS work and may be allotted with a unique identity number for further reference. This will avoid reinvestigation / duplication of micro level maps digitized by various people or agencies thus saving manpower and money.

3. Summarized data is not GIS data. Only summarized GIS data is widely available and open accessible but for GIS users it won't be of much help unless data is in the raw form, preferably at micro level.

4. In many of the instances individual's data is aggregated to district level or state level (to mask and maintain confidentiality) and hence actual variation has been nullified or hidden. For best use, GIS related data has to be stored "as it is condition".

5. Sensitive data can be masked (by shifting the origin of location) and can also be made available at micro level.

6. Sometimes data on individual health required for analyses are scattered across many sources as often it was collected by different agencies. A researcher has to spend major time and money running here and there to fulfill the formalities to acquire the required data.

7. The map scale should be mentioned explicitly in all maps for easy amendments and for error reduction.

8. The quality of health data should be improved and made transparent so that science behind the map is not lost.

9. Proper care should be exercised since many of the technical aspects are overlooked in the process of producing pretty maps.

10. Maps must be designed to communicate effectively and ensured that it suits even a person unaware of the technology.

11. Access to digital maps up to village level should be made easy.

12. Lack of availability of desired standard base maps at appropriate scales is a problem.

Documentation procedures

13. Standard procedures for documented geodata collection and automation of micro level data should be emphasized at all levels.

14. The unique identification code should start right from the state level to the smallest region like - village/town [e.g. like PLCN (permanent location code number) for village and towns used in census 2001] for identification, so that any attribute data related to the region may be easily amalgamated and analyzed without much difficulty.

15. Further if alphabets are used in the identification code it should be made case sensitive and moreover unique spelling should be adopted so that the search for the village/town is made easy for identification including with "Google earth".

16. A name change should be uniformly adopted at all levels of data storage. Similarity in the names of villages/towns/streets across different districts/states can be clearly brought out and avoided in future. Currently any person unfamiliar with a region (researchers) finds it difficult to locate or trace the place on a map.

17. Exhaustive documentation on GIS data must be available in each of GIS cell/ Lab., so that frequent change of staff members (of varying interest) and higher authorities do not affect the end users.

18. Recording systems for health and population data are often only rudimentary and hence uniform automation of geo database at all levels and different health sectors should be made mandatory.

Resources

19. All GIS Cells/ Labs should be equipped with adequately trained staff.

20. Cultivation of interest of GIS technology among younger generation should be developed. This would generate a good man power and creation of geodatabase which indeed will be useful in long run.

21. Complete understanding of the spatial statistics is the need of the hour to the GIS users.

22. All GIS users should cultivate a sound knowledge of the theory and calculations behind the software analytical modules. Otherwise it's not only just garbage-in-garbage-out but also misleads the audience (a lay person).

23. Shortage of trained manpower in using Geostatistical modeling needs strengthening.

24. Public health workers must be trained well in the technology for effective outcome of their work.

Future GIS

25. Sharing practices among all GIS users should be encouraged and motivated within the legal framework.

26. In long run all data, related to census, demographic, health, meteorological, hydrological, environmental, geographical, etc should be brought under one Umbrella of "Geo Data Bank" for easy and legal accessibility. This will have better control over utility.

27. Change of policy on the use of existing old methods is a need of the hour. We have to move with the advancement of methods and technology.

28. Large scale surveys like Census, Demographic Surveys, National Family Health Surveys etc. are done at huge intervals of time and do not cover the GIS researchers study period, hence using approximate or projected figures adds error to the result. Hence the large-scale surveys may be planned periodically.

29. Weather data (rainfall and temperature) is not usually available at the scale needed for analysis. Hence more number of weather stations must be introduced in each district.

30. The results presented/ published using complex spatial analytic techniques should be made no longer limited to scientist but also be made simple and comprehensible for public, policy makers, health planners etc.

31. In some tedious and expensive studies using GIS, it was observed that the publication of the results would create a negative impact on the policy decisions and hence kept back or suppressed. It not only leads to wastage of resources but also paves a way to more and more wasteful studies. So the GIS experts felt that as in clinical trial research studies, it was a good practice to publish the trials with null or negative results (i.e. not statistically significant or statistically significant), such practice should be adopted here also.

32. Standard GIS ethics are essential and should be propagated to the users.

33. GIS /Spatial analyst network team needs to be developed.

34. Formalities for the purchase and acquiring of Satellite Imagery like CARTOSAT consumes major study period of the researchers hence stipulated time period can be fixed openly.

35. Data collected inadequately and without proper sampling procedures depict the results for the entire country and often misled.

    Even if there are non-endemic pockets in the endemic districts, the whole district is declared as 'endemic' and often misinformed.

    Hence such maps should not be encouraged. Maps of health data should not be misinforming.

36. Statistical maps need to be developed with the help of the statisticians and cartographers with sound knowledge of the GIS technology.

37. All future GIS softwares may be developed with the spatial analytic tools and model building.

38. Maintenance and up gradation (add on modules) of standard softwares should be made cost effective.

39. The purpose of Open source GIS will be lost if it is not user friendly and Self-learning modules are not readily available with the software.

40. Expensive Geodatabase created should be utilized in full, if not at least brought to the public domain for better utility.

Feedback & Suggestions of the participants of GIS workshops

[31Jan-2Feb 2011 & 7-9 Feb 2011]

A sample feedback form is attached in Annexure12

1. Three days of workshop was a wonderful exposure to the world of GIS but five days would be an ideal time frame.
2. This workshop helped to understand the current scenario of GIS.
3. All the facilitators were so passionate and it provoked our interest on the topic.
4. Hands on education should be made exclusively for two to three days along with the workshop days with Group assignments and presentations.
5. One workshop/training only on hands on practice can be given exclusively for the participants of four workshops.
6. Some study materials can be given in advance before the workshop.
7. Stepwise user manual can be made available for the software demonstration.
8. More interactive sessions with discussion of promises and pit falls.
9. Freely downloadable software's can be given as a CD.
10. Integration of GPS and GIS practical demo using a case study would have been ideal.
11. A session on application of GIS could have been taught in a real time field.
12. Few more lectures on publication based vector surveillance using GIS would be more beneficial.
13. More personnel could have been added during the software training.
14. How best one can adopt in their day today work could have been more emphasized.
15. Future workshop on statistical applications using GIS can be organized.
16. More sessions can be added on spatial epidemiology.

17. Future workshop can be focused on GIS in other (missed) health care domains.
18. Training manuals with illustration and books must be developed containing a comprehensive set of exercises.
19. A web based GIS application along with the tutorial and a mock exercise can be launched in the NIE web page.
20. NIE should establish Central GIS laboratory.
21. Organizing NIE GIS alumnus would give an ample opportunity to interact with the expertise.
22. May be updated/ posted about the advancement in GIS related activities in public health to the workshop participants.
23. NIE being a premier institution should act as free GIS training, updating and Consultation center.

Annexure1

Public Health Information System

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Public health management needs information on various aspects like the prevalence of diseases, available health infrastructure through government and private sector, socio – economic data of the villages and the agencies working in any given area along with their spatial distribution and area of influence. The data related to Public Health covering a particular region generally is voluminous, it often becomes difficult to understand and organize the real content. In order to analysis the voluminous data GIS is used for input, storage, retrieval & analysis of complex data and display of data for depicting diseases, incidence & prevalence, planning, monitoring and evaluation of health and related data. The output is on the map of the place under study.

Using the above information System a case study was carried out for Attur, Omalur, Veerapandi and Konganapuram block of Salem district for the morbidity analysis. The location of water and Air polluting industries were mapped and the existence of fungal infection of skin in those areas were studied and analyzed and the relationships between them were identified.

A study was undertaken on the damage assessment due to Tsunami and the mitigation measures undertaken in such conditions and how the Tsunami system works with the help of the data received from transmitter buoys and prediction model.

Flood Inundation mapping for the Districts of Thiruvarur, Thanjavur, Cuddalore of TamilNadu using Radarsat -1 satellite imagery and flood damage assessment for

crop area was estimated. A study on flood risk mapping of Chennai city using ALTM data and using the digital elevation models are being studied.

FUNDAMENTALS OF GIS

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GIS – Where it all started

On the walls of caves near Lascaux, France, Cro-Magnon hunters drew pictures of the animals they hunted 35,000 years ago. Associated with the animal drawings were track lines and tallies thought to depict migration routes. These early records followed the two-element structure of modern geographic information systems: a graphic file linked to an attribute database.

Fig 1: Cave Paintings in Lascaux caves, France

The concepts of GIS are not new. The spatial overlay analysis available in the present day GIS software were practiced way back in 1854 (Fig.2) when maps showing the locations of the water pump and the incidence of cholera related death were studied.
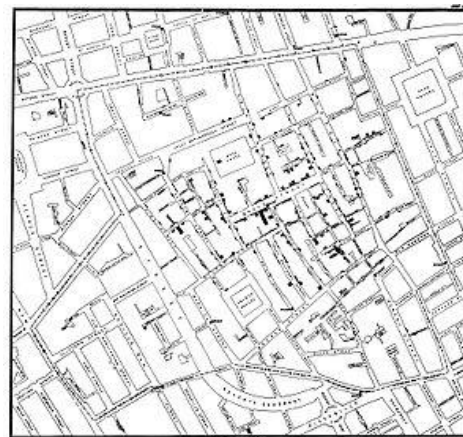
Fig.2 : Map created by Dr.John Snow to study the Cholera outbreak in 1854.

Definition of GIS

Like the field of geography, the term Geographic Information System (GIS) is hard to define. Accordingly there is no absolutely agreed upon definition of a GIS (deMers, 1997). A broadly accepted definition of GIS is the one provided by the National Centre of Geographic Information and Analysis, wherein GIS is a system of hardware, software and procedures to facilitate the management, manipulation, analysis, modelling, representation and display of georeferenced data to solve complex problems regarding planning and management of resources (NCGIA, 1990). Functions of GIS include: data entry, data display, data management, information retrieval and analysis.

Fig. 3. The concept of layers (ESRI)

Major applications of GIS

GIS is today being used in a number of fields as shown in Fig.4
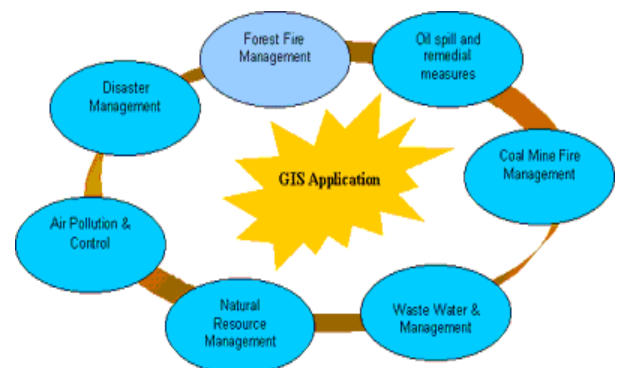
Fig.4   Applications of GIS

Use of GIS in Decision Support and Policy Making

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Geographic Information System (GIS) have been in to existence for more than 20 years, but the recent developments in software have made its use much easier for diverse fields. Geographic Information System, a computer assisted system, facilitate inputting, processing, analyzing, integrating and presenting both spatial and non-spatial information. In India, National Institute of Malaria Research was the first to conduct studies using GIS for decision support in vector borne disease control, a few important projects are mentioned here.

RS and GIS helped in estimating larval production in a lake in Delhi, which showed a good correlation with the adult density in the nearby area. Using GIS malaria receptivity of Nadiad Taluka, district Khaeda, Gujarat was mapped, the ground verification resulted in complete reconciliation of cause and effect relationship in explaining malaria epidemiology in the region. A GIS-based technique was developed to map Indian anophelines including six major malaria vectors using ecological parameters which mainly govern the distribution of the species such as forest cover, rainfall, altitude, soil type and temperature. The results were validated by reported distribution and carrying out precision field surveys. The technique can delineate the areas favourable for any species of flora and fauna, and is very useful for precision surveys. The technique is fast and can be easily duplicated in other parts of the country/world. In any disease, once the vector distribution is known species-specific control measures can be formulated in a cost-effective manner. NVBDCP formulated nation-wide malaria control strategy on the basis of GIS mapping carried out by NIMR in 2008. NVBDCP has evaluated 68 districts for decision support of formulating control strategy. The districts were categorized in four strata on the basis of API and Pf%. Villages along with the population falling in each priority were provided to

NVBDCP for designing appropriate control strategy. An attempt was made to create an information management system based on Geographic Information System (GIS) for efficient planning, implementation and evaluation of urban malaria control in Dindigul, Tamil Nadu. A click of the mouse on the respective geographic unit instantly retrieves the information attached. The areas can be zoomed into micro level over view. In addition to malaria, GIS based applications have been carried out in control of dengue in Delhi and Kala-azar in Bihar. RS & GIS based studies are in progress to find out deforestation and its impact on malaria epidemiology in districts of Assam and mapping malaria receptivity in tribal areas of district Ranchi, Jharkhand.

The GIS offers new and expanding opportunities to look into disease epidemiology because it allows choosing between options when geographic distributions are part of the problem.

Accuracy & Precision in Mapping / GIS

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Accuracy and Precision of data are a primary concern to all of us because we make decisions based on data. The maturity of GIS deployment is reflected in the importance given to this issue in the Geodata model, Data Collection, it usage and so forth. Therefore, it is pertinent that we spare some time to look in to Accuracy and Precision issues of our data.

Our goal in building a Geodatabase is to have all our data in a unified database, in a common coordinate system (where data layers will overlay exactly on each other) and at a same scale. But is it practically possible? – Yes. But is it feasible – sometimes yes and sometimes no. So what do we do? We would need to judiciously balance our data & needs to make ends meet.

To achieve this goal, we are expected to:

1.   "Integrate" all existing maps in a Digital Database using GIS

2.	Georeference all maps available in various scales and coordinate references to a common coordinate reference system eg. UTM

3.	Ensure that we follow standards of attribute coding, etc.

We have a plethora of data and a paucity of standards. We have paper maps of various scales and projections, CAD drawings, data freely available on the web in different formats, coordinate references and time stamps, survey data in spatial and non spatial tabular form, etc. So please bear in mind the following at the very beginning of your work.

1.	For what purpose are we creating the Geodatabase?

2.	What is the accuracy/precision that we need now and in the future?

3.	What is the accuracy/precision of the existing data?

4.	Can we combine maps of various scales?

5.	What is the implication of integrating data of various scales?

Through the 1990s a lot of effort was made to define the standards. We need to apply some standard to our data so that our work conforms to what people expect. Sadly, in India, we have not defined these standards. Before we look at standards, we shall take a look at some basics.

Accuracy

Accuracy is the degree to which data on a map or in a digital database matches true or accepted values. It pertains to the quality of data and the number of errors contained in a dataset or map.

In a GIS database accuracy can be of four types.

− Positional accuracy

− Attribute accuracy

− Conceptual accuracy

− Logical accuracy

Note: The level of accuracy required for various scales varies greatly. Highly accurate data can be very difficult and costly to produce and compile.

Precision

Precision refers to the level of measurement and exactness of description in a GIS database. Precise locational data may measure position to a fraction of a

meter. Precise attribute information may specify the characteristics of features in great detail.

Note: As an example, highly precise cadastral data can be very difficult and costly to collect. Carefully surveyed locations to record pipelines, cables, fire hydrants, and transformers cost Rs. 500 to Rs 2,000 per point to collect.

So when we talk about Data Quality, we actually refer to Accuracy and Precision. Be aware that people in the industry may use a variety of terms to refer to data inaccuracy and imprecision.

HIGH ACCURACY+LOW PRECISION   **LOW ACCURACY+HIGH PRECISION**
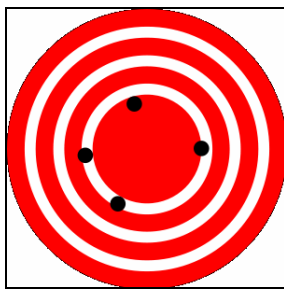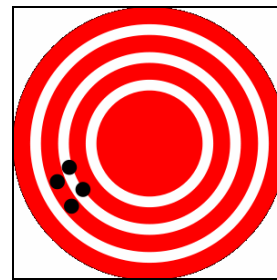
Positional Accuracy and Precision

Accuracy and precision are a function of the scale at which a map (paper or digital) was ORIGINALLY surveyed & created. There is great danger that computer based GIS systems will allow users to zoom into the data infinitely. Accuracy and precision are tied to the original map scale and do not improve even if the user zooms in. The mapping standards employed by the United States Geological Survey specify that: "requirements for meeting horizontal accuracy as 90 per cent of all measurable points must be within 1/30th of an inch for maps at a scale of 1:20,000 or larger, and 1/50thof an inch for maps at scales smaller than 1:20,000."

RF Scale	Accuracy Standard
1: 1,200	± 3.33 feet
1: 4,800	± 13.33 feet
1: 10,000	± 27.78 feet
1:100,000	± 166.67 feet

Paper Map scale was a significant contributor to the map accuracy due to the width of the pencil or pen that was used to draw the map. If a map was drawn at a scale of 1:24,000 with a pen 0.5 mm wide, each line represents a width of 12 meters. If a line represents a section line, then it is fair to say that the section line's actual location was somewhere within that 12-meter wide line representing it. If the map were drawn with the same pen at a scale of 1:1000, then the line would be only 0.5 meters wide. The accuracy of this line could be much better at a scale of 1:1,000 than at a scale of 1:24,000.

Now that many maps are drawn with computers, we can plot the maps at virtually any scale we choose. Is scale still an important factor in the accuracy of the map? The answer is, sometimes yes, sometimes no. Many digital maps are derived from aerial photography or digitized from existing paper maps. The accuracy of these digital maps is very definitely a function of the scale of the aerial photography or map. Other digital maps may show features whose locations have been determined by very accurate total Stations / GPS surveys. The accuracy of these features is largely unrelated to the scale of the map. The accuracy of any paper map, however, can be affected by its scale, even if it was generated by a computer.

Attribute Accuracy and Precision

Attribute inaccuracies may be a result of typo errors or even imprecise with insufficient information. For example the history of a patient may not mention the family history which is imprecise or it may not mention the Gender which is an inaccuracy. TO overcome these problems, a database can define domains and subtypes where default values and specific types are predefined and can be just picked up by the user while populating the database. Or even worse the ID of a non spatial data which is used to link it with a spatial data may be wrong leading to an erroneous position.

Conceptual Accuracy and Precision

Data is often abstracted and generalized into groups or categories while mapping real world phenomenon. Misclassification of information into inappropriate categories is easy. For example classifying ATMs based on visibility rather than

on the value they dispense would be misleading in a proximity analysis that is trying to identify locations for new ATMs. Still, even if correct categories are employed, data may be misclassified due to human error.

Logical Accuracy and Precision

While modeling in GIS, logical combinations of layer need to be taken together in a weighted overlay analysis, for example terrain related issues cannot be combined with proximity to power systems, etc. GIS systems are typically unable to warn the user if inappropriate comparisons are being made or if data are being used incorrectly. So GIS users need to be very cautious while combining data.

Sources of Errors

One of the most common in India is the lack of knowledge or information on the Coordinate Reference System. Data sets may have completely different coordinate systems and datum. Worse still some data sets may not have the metadata on this. Using data of differing scales and bringing the output in to a large scale is also very common. Topological correctness of data is often disturbed in digitizing and data migrations. The loss of precision while migrating data could be:

•   Migrating data from one vendor's software to another

•   Migrating data from shape file to Geodatabase

•   Migrating data from one Geodatabase to another

Metadata is a very crucial part of data when the analysis involves comparing data of various time periods and seasons, across climatic and cultural boundaries. Yes, data in GIS can also have an expiry date. So ensure you read the metadata. The density of observations over a large area of varying geological, topographical, climatic and cultural settings needs caution. The sampled data should represent all of the features proportionally.

In the absence of Metadata or Document on Data Quality

In the absence of information pertaining to the Data Quality you would need to obtain answers to the following questions.

•   In what medium was it originally produced?

•   What is the areal coverage of the data?

- To what map scale was the data digitized?

- What projection, coordinate system, and datum were used in maps?

- What was the density of observations used for its compilation?

- How accurate are positional and attribute features?

- What is the age of the data?

- Where did it come from & the reliability of the provider?

- Does the data seem logical and consistent?

- Do cartographic representations look "clean?"

- Is the data relevant to the project at hand?

- In what format is the data kept?

- How was the data checked?

Conclusion

We need to follow established standards. But do we have standards established yet? The National Map Policy in India announced on 19th May 2005, talks about standards but does not give definitive numbers on accuracy / precision. Similarly, documents available on NSDI website, at the time of this writing, does mention standards but falls short of giving us guideline values about accuracy and precision. We only can hope to have them in the near future.

Remote sensing – The Image science

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Remote sensing is an important tool for earth observations including ocean, land and atmosphere. The major advantage of remote sensing is to quantify the geophysical parameters in both spatially and temporally in different regimes. In the field of oceanography, remote sensing plays an active role to measure the

heat, phytoplankton dynamics etc. using backscatter radiances from the water column in the ocean. Unlike direct ship based measurement, remote sensing also measure the Sea surface temperature, wind speed, chlorophyll concentration etc. using proper atmospheric correction and in-situ bio-optical algorithm. Many significant features can be detected like oil spill monitoring and internal wave studies using the active sensors. Since the era of CZCS to Oceansat-2, many oceanographic sensors are in orbit and produces huge amount of datasets throughout the globe. All these sensors are placed both in the sun-synchronous orbit and polar-synchronous orbit based on different applications. Few of these application related to Indian coast is described here.

Sea Surface Temperature (SST)

As of today, the NOAA mission is very much popular and AVHRR sensor is widely used to detect the sea surface temperature within an accuracy of $\pm$0.5°K (Walton et al, 1998). Though MODIS night time SST accuracy is about to $\pm$0.3°K, observation of these changes may soon achievable and very much useful to monitor global climate change. Using sea surface temperature, the widely popular application is to identify the potential fishing zones in both tropical and sub-tropical waters. Many species based forecasts e.g. tuna forecast can be made using different biological models which can be attributed to marine fisheries in the Indian waters.

Ocean color studies

The accuracy of the phytoplankton concentration has improved in the methodology in recent days. Proper atmosphere correction and suitable bio-optical algorithm can estimate the reflectance value up to 30% while estimating the chl-a concentration in both Case-1 and Case-2 waters. Besides this the Suspended sediment and Yellow substances can be estimated up to significant accuracies. Chlorophyll-a, Photosynthetic Active Radiation (PAR), SST etc. can be used to estimate the primary production in both Open Ocean and coastal waters.

Coastal studies

Many event based information like oil spills, Coastal erosion/Deposition etc. can be monitored using consecutive high resolution satellite imageries. Synthetic Aperture Radar images will be highly useful even in cloudy days to track such disaster events. Besides satellites survey a variety of oceanic properties with near global coverage and at intervals of 1-10 days, then rapidly transmit these observations to national and International forecast centers, these data are of great operational importance. In addition, the observations contribute to long-term studies of global climate change, sea level rise and the decadal scale atmospheric and oceanographic oscillations, like ENSO in West pacific and IOD in Indian Ocean.

Other related applications (Medical Science)

Recently, Remote sensing data were used extensively to predict Cholera like water-borne infectious disease, which is an unpredictable and severe problem for developing countries. The bacterium that causes cholera, *Vibrio cholerae*, has a known association with a crustacean (i.e copepod) which lives on zooplankton. Cholera outbreaks have been linked with environmental factors, including Sea Surface Temperature, Significant wave height (Ocean height), coastal inundation maps and Phytoplankton Biomass (Derived from Chlorophyll concentration) etc. Professor Rita R. Colwell and her team at the University of Maryland, College Park, have used remote satellite imaging to track this climatologically important information and the data collected now can be used to predict outbreaks of cholera before they occur. As the Cholera epidemics have been episodic, so the

ability to predict them could be one further step towards controlling this serious, water-borne disease by providing rapid response public health measures. The climate factors shown to be associated with cholera also play a role in many other infectious diseases. So this development offers a useful model for understanding human health effects related to climate change.

The modern medical science uses remote sensing technology to monitor heath related issues from many medical instruments and sensors etc.

GIS in Health

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The area of GIS and Public Health has risen to prominence in the past two years with the recognition that health surveillance practices and health service allocations need to become more sensitive to the needs of people in local geographic areas. The collection, storage and manipulation of geographic information has undergone a revolution in recent years with the development and widespread availability of GIS software. Many health professionals can benefit from further education in this area, and with their new knowledge, they can influence the progress of health surveillance, environmental health assessment and the geographic allocation of health resources.

GIS plays a critical role in determining where and when to intervene, improving the quality of care, increasing accessibility of service, finding more cost-effective delivery modes, and preserving patient confidentiality while satisfying the needs of the research community for data accessibility. Esri has over 5,000 health care clients worldwide who are using the resource integration capabilities of GIS to create analytical and descriptive solutions. GIS has

helped the health care industry manage resources and personnel in of the same ways it has helped other consumer service enterprises.

Web GIS for Public Health

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Heraclitus, a Greek philosopher known for his doctrine of change being central to the universe rightly said that change is the only constant in this universe. No reason why this change should not be constant in the noble life saving field of medical sciences.

Public health is "the science and art of preventing disease, prolonging life and promoting health through the organized efforts and informed choices of society, organizations, public and private, communities and individuals" (1920, C.E.A. Winslow). It is concerned with threats to the overall health of a community based on population health analysis. The population in question can be as small as a handful of people or as large as all the inhabitants of several continents (for instance, in the case of a pandemic). Public health is typically divided into epidemiology, biostatistics and health services. Environmental, social, behavioral, and occupational health are other important subfields (Wikipedia). The underlying commonality in many of the above aspects of public health research is the spatial component of the factors being analyzed or monitored.

Medical geography aka health geography, is an area of medical research that incorporates geographic techniques into the study of health around the world and the spread of diseases. It also includes studies on the impact of climate and location on an individual's health as well as the distribution of health services. Medical geography is an important field because it aims to provide an understanding of health problems and improve the health of people worldwide based on the various geographic factors influencing them. Health geography is

the application of geographical information, perspectives, and methods to the study of health, disease, and health care (Wikipedia).

Thanks to the Greek doctor Hippocrates (5th-4th centuries BCE) for having studied the effect of location on one's health thus laying the foundation for the beginning of medical geography. But for Dr John Snow, a doctor in London who plotted the distribution of cholera deaths throughout London on a map and found a cluster of unusually high deaths near a water pump on Broad Street, when the cholera epidemic gripped London medical geography would not have gained significance. Since then geographic techniques have found their place in several other areas of public health research.

The ability of a GIS to add spatial perspective to any data being analyzed or monitored is the key to its application in public health research. GIS has always proved to be very useful to epidemiologists across the globe in elucidating patterns and relationships between the person, place, and time components of epidemiologist data. In addition, GIS technology has been an important tool for understanding and displaying disease or disease risk that are related directly to environmental exposure.

Medical geography has an increasing number of applications due to advancements in ICT and GIS. Besides, the spatial distribution of disease is still a large matter of importance, with GIS based maps playing a significant role in this field. Much recent attention has focused on developing GIS functionality in the Internet, Worldwide Web, and private intranets and is termed Web GIS. Web GIS is a Geographic Information System distributed across a networked computer environment to integrate, disseminate, and communicate geographic information visually on the World Wide Web over the Internet" [Gillavry, 2000]. Web GIS is also popularly called as Internet GIS. Web GIS holds the potential to make distributed geographic information (DGI) available to a very large worldwide GIS audience. On similar lines, Google Maps in the recent years has revolutionized the way in which information on several epidemics/ pandemics like swine flu, flu (Google Flu Trends) is delivered to general public with the latest addition being Google Insights for Search.

The objective of this paper is to focus on the following aspects:

- Importance of public health research,
- Current trends in the field of GIS, especially Web GIS
- GIS Applications in Medical Geography – Tools & Technologies,
- Spatial Epidemiology: Current Trends and Future Challenges

Thereby demonstrate how the convergence of advancements in ICT and Medical Geography or Health GIS could play a major role in public health research in taking it to the next level.

The Future of Human Life Expectancy: Have We Reached the Ceiling or is the Sky the Limit? Although human ability to take command of the course of life and death is controversial, after remaining fairly constant for most of human history, life expectancy has nearly doubled in the past century. However the trend towards longer life has also raised concerns about the quality of life at older ages.

GIS together with the advancements in ICT, if applied in the right manner, at the right time, for sure can help address the problems confronting the epidemiologist and the medical community in saving the human race, if not solve them completely.

No matter whether human life expectancy has reached the ceiling or sky is the limit: Let us explore ways to apply GIS to make our lives better!

An Open source GIS – Quantum GIS

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Recent advancements in GIS technologies help public health authorities to model the health & socio economic environment of the people. The residential development, age, sex, race-ethnicity of the population varies according to geographic locations. With the help of GIS it is possible to view the differences in

detail. The population distribution is perhaps the most frequently considered geographical distribution in public health and epidemiology. Activity space is another important terminology in public health since it is comprised of home based or other activity sites like work places, schools, stores, restaurants and recreational areas that are regularly visited. The activity space is important because it represent the zone where the individual are exposed to risks or resources.

Though the health event is a complex process which expose human population at risk to risk factors, many public health investigations and epidemiological studies starts with outcomes. In many of the sources the data on mortality and morbidity, the residential locations during the time of incident is reported. GIS plays a major role in mapping the cases and rates to search and manage the cluster of health events.

Incidence and prevalence of a specific disease vary geographically, where incidence is a number of new cases reported during the specific time period. However prevalence is the number of existing cases of disease at a particular point of time. Prevalence is related to incidence however influenced by the duration of the disease. A disease process which leads to mortality after onset will probably have a higher incidence than prevalence in a community. Disease mapping has made contributions to public health and epidemiology for centuries. GIS makes it easier to map large databases of health events at a higher level of spatial accuracy to link the database of surveillance systems, also other information's like environment, information about risk factors etc.

Like population, the risk factors for disease are not usually concentrated at a single point. Contaminants and biological agents of disease are present in our ecosystem. GIS have proved to be powerful tools for modeling the environmental conditions across the full ranges of geographical scales from local to global.

With the recent advancements in GIS we can model the temporal and spatial patterns of hazards, environmental health problems and infectious diseases, also model the spread of contaminants and vector and host habitats. At community level the GIS can be used to notify the people living in neighborhoods where

hazards are identified so that they can take necessary action to prevent health problems.

GIS supports in analyzing the disease clusters using the methods that don't rely on aggregated data. Area of high and low incidence can be identified by searching the individual cases to find the areas which are having high numbers of cases relative to local population. Various commercial GIS software are available for analyzing the epidemics, however the open source free software like Quantum GIS are equally competent enough to execute the task of mapping the health hazards. Hence the hands on experience in Quantum GIS software can promote us to manage/prevent the epidemics in advance.

Implication of GIS in public health

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The spread of disease is unavoidably spatial (Holmes, 1997). Infection moves from individual to individual following a network of contacts within a population through local and global (long-distance) transmission.

A very good example of this is the Severe Acute Respiratory Syndrome (SARS) or corona virus. The SARS outbreak was quiet for several months, then gave an opportunity to use spatial dependence and world travel to its advantage so as travelers acted as bridge for global transmission and generated foci of new infection at a distance. Then again, local transmission quickly brought the number of locally infected individuals to epidemic proportions resulting in a global epidemic requiring quarantine measures and travel restrictions.

GIS can enhance emergency preparedness and response locally, nationally, and globally as well.

In 1993, the WHO and UNICEF developed "The Public Health Mapping Programme" to boost efforts to eradicate guinea worm disease through the use of GIS. Guinea worm diseases affected the isolated, rural poor. GIS was used to visualize disease foci, monitor newly infected or re-infected villages, identify at-

risk populations, target cost-effective interventions, and to monitor eradication efforts.

The WHO strategy to reduce malaria includes: prompt treatment with effective drugs, effective use of insecticide-treated materials and other vector-control methods; intermittent preventive treatment in pregnancy; and emergency and epidemic preparedness and response. GIS has been used extensively to manage and enhance the federal surveillance system, and to communicate the results effectively to the public.

The area of GIS and Public Health has risen to prominence in the past decade.

Just as mapping did 150 years ago for Dr. Snow, GIS now makes it easy to translate data into useful information and to present information quickly, efficiently and effectively. Today, GIS also enables users to go beyond simply mapping data to organizing, managing, linking, and analyzing data. Furthermore, GIS engenders public participation and empowerment of a broader group of stakeholders beyond the public health arena.

A GIS Based Sampling Approach

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This paper presents a Geographical Information System (GIS) based sampling methodology for the survey on Health and Air Quality adapted in Delhi. The stratification used five factors-air quality, distance from the main highway, thermal plants, industrial sites and city centers. The sample of households was selected using a newly developed location based sampling technique. Random points were navigated with the help of Global Positioning System (GPS) to acquire the households. The satellite based indirect measures were used for air

quality modeling. The sampling methodology will be illustrated using the preliminary data collected in a survey.

GIS ethical issues

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Geographic Information Systems (GIS) are one of the most widely used information technologies in government and Research departments. GIS is increasingly becoming a standard tool for studying disease spread. Governments, militaries, commercial enterprises, and other service agencies also relay on maps. Computerized GIS, digital remote sensing, and satellite navigation systems have become indispensable tools since 90's. Application of these new technologies matured and their applications reached a peak then. By portraying real world data as maps, GIS provides unparalleled power to analyze social, economic and health data. GIS is the fastest technology that is making headway in the public now. As the uses became widespread, scholars and GIS practitioners began to express concerns about the ethical implications of their use. They question the assumption that maps are impartial and value-neutral depictions. Inaccurate maps and data, intellectual property issues, and conflicts of interest are important ethical issues brought out by them. There are ethical issues of GIS and data confidentiality/individual privacy. The other issues are improper use of GIS due to the lack of competence or limited knowledge about GIS technology. Maps can be used to mislead decision-makers and the public, and proposed design guidelines to foster ethical practice by cartographers. We discuss some of these issues and ethical implications in GIS.

GIS and Public Health: Practice of good mapping

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Maps play a vital role in Geographic Information System. A tremendous amount of information could be portrayed in a map. Too much information may blind the core theme or too little information may lose its audience. A poorly designed map fails to communicate effectively, and may in fact deliver the wrong message to the audience (Monmonier, 1993). A good map must include a common set of design elements. The map designer/researcher needs to give the scale of the map with the scale bar. According to one's needs and usefulness the small scale or large-scale map should be opted. Information about projections and coordinate systems also is one of the most important fields of geospatial metadata. Without this information it is difficult to share data across organizations. Researchers should make use of good graphic communication and careful use of shape, size, value, pattern, hue or colour and direction. A good researcher should select an appropriate type of map and also with the choice of classification method (quantile method, natural Jenk's algorithm etc.) for their application.

The existence of a spatial pattern alone in a data set cannot demonstrate nor prove a casual mechanism. The spatial analyst has a large number of tools for documenting and quantifying associations between the spatial patterns of two or more variables like cross correlograms etc. Similar to the classical correlation techniques, an existence of spatial association does not reveal causality.

Because of the need to protect patient's identity the available data are often aggregated to a sufficient extent and due to Modifiable Areal Unit Problem (MAUP) the aggregated data can dramatically impact analysis and make the test for associations problematic.

Small area problems should be well addresses with the well-established statistical techniques.

Spatial and temporal mismatch in case of the disease like lung cancer wherein the latency period involves a long time span and when examining for possible associations between air toxics and lung cancer a more detailed study is needed before any conclusion. While building predictive models if the data exhibits spatial autocorrelation then this factor needs to be addressed in the model. Otherwise the model will be misleading.

With an increased accessibility to desktop computer systems and geo-referenced health data greater care should be exercised to bring out thoughtful, meaningful and appropriate applications.

Health GIS - prospects, problems and prescriptions

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Prospects:

GIS is slowly gaining acceptability levels on all fields of public administration. But unfortunately, the full potential of GIS, especially in Health GIS is get to gain the momentum It is seen the domains technological components of GIS which contribute to the successful utility of GIS data base for Health management on undergoing rapid changes.

Such as higher resolution base map, powerful software for efficient analysis more powerful Sharing of data through cloud computing/location based services and better cartographic output for easier assimilation of collusion.

Such rapid changes in the technology ……… constantly provide inputs for more efficient management of health data to derive faster. Economical and efficient ……….. for the Health management of the nation for progress we must change but more change is not progress.

Problems:

Problems which are after unmetered are briefly given below:

The availability of health related data and its reliability (Type of data, area coverage when collected, whether periodically updated whether tabular health data are geo referenced. If so at what scale whether data collected is in public domain willing to share or put it in the public domain? Whether standardized unique identification code for project area has been followed whether GIS data has been customized to the needs of heal. Primary data collected in raw form valuable: some researchers need such data. Data updation interval – is it satisfactory? Handling of health data - to arrive at conclusion, whether statistical principles were followed? Whether policy decisions are taken based upon decisions derived from GIS data base after analysis.

Whether policy /decision - matters are made aware of the power of GIS.

Prescription:

Every problem is to the seen as an opportunity for every problem there is a solution senator ion multiple solutions.

The crony is GIS itself is capable of providing prescriptions because it is programmed that every GIS provides prescription in the form of decision support system.

Meeting of minds and Raising of Required Resources will help to reach the goal provided there is a WILL.

GIS mapping using HIV sentinel surveillance

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Sentinel surveillance was expected to provide information on entry of HIV into the country at various points over a period of time. Since there is no reliable information available for HIV estimates, data available through sentinel surveillance is being used to estimate the HIV load at the national level from year to year by making several assumptions. There are 68 sentinel surveillance centres in Tamil Nadu. Blood samples (around 27,000) have been collected from

these centres and tested for HIV positivity. These HIV prevalence rate were plotted in the GIS map and tried to study the pattern of HIV distribution among various districts of Tamil Nadu and to see any pattern is emerging with the national highways. The analysis shows that prevalence values are higher for the centers closer to the National Highways. Generally places on the East Coast of Tamil Nadu have very low prevalence values for HIV. The observed pattern of relationship with the national highways suggests that the epidemic is mainly restricted and follows the pattern of national highways.

Linked Micromap Plots and Conditioned Choropleth maps with application to Public Health data

Dr. Vasna Joshua

Technical Officer, NIE, Chennai 77.

A wide variety of maps have been used to display health related data. Carr et al (2000) has developed templates for displaying geospatially-indexed estimates: linked micromap (LM) plots and conditioned choropleth (CC) maps.

Linked Micromaps (LM) provides a template in which multivariate estimates are associated with each spatially indexed study unit. The primary purpose of LM plots is the communication of geospatially indexed statistical summaries.

Conditioned Choropleth Maps (CC) provides a template that shows the connection between a dependent variable (as represented in a classed choropleth map) and two explanatory variables. The purpose of CC maps is to help researchers generate sharper hypotheses about observed spatial patterns.

The above-mentioned innovative approach will be explained using Infant Mortality rates (IMR) of India.

Annexure2

List of Institutions/Organization/colleges/ government institutions where in GIS used /users were identified.

- Regional census Office, III Floor Rajaji Bhawan, Besant Nagar, Chennai.

- National Informatic Centre (NIC), I Floor Rajaji Bhawan, Besant Nagar, Chennai.

- University of Madras, Department of Geography, Chepauk, Chennai - 600005.

- Indian Institute of Technology Madras, Environmental & Water Resources Engineering Division, Chennai 600036

- Regional meteorological Centre, College road, Chennai-600006

- Loyola College, Unit of Environmental Health and Biotechnology, Chennai-600034.

- Tamilnadu Water Supply and Drainage Board, Kamarajar Salai, Chennai-600005.

- National Institute of Malaria Research Centre, Chennai-600077.

- Corporation of Chennai, Geomatics Division, Ripon building, Chennai-600003.

- Directorate of Public Health and Preventive Medicine, 359 Teynampet, Chennai 600 006.

- National Rural Health Mission, Chennai- 600006.

- Survey of India, Block III, Electronics Complex, Thiru-vi-ka Industrial Estate,Guindy, Chennai 600032.

- Christian Medical College, Dept of Bio-statistics, Vellore

- Institute of Remote Sensing, Anna University, chennai-600025.

- Centre of water resources, Anna University, Chennai-600025.

- Ocean Engineering, Anna University, Chennai-600025.

- Centre for climate Change & Adaptation Research, Anna University, Chennai-600025

- MS Swaminathan Research Foundation, 3rd cross road, Tharamani, Chennai 600 013.

- Vellore Institute of Technology (VIT), Environmental, Water Resources & Transport Engg. Division, Vellore 632014.

- Vellore Institute of Technology (VIT), Centre for Disaster Mitigation & Management, Vellore 632014.

- CHAD (Community Health and Development), CMC, Vellore

- SRM University, Civil engineering dept, Kattankulathur, Kancheepuram district.

- The Centre for Research in Medical Entomology, Chennai 77.

- NIOT, Govt. of India, Ministry of Earth Sciences,
  ICMAM Project Directorate, IIIrd Floor, Pallikaranai,
  Chennai 600100.

- JIPMER (Jawaharlal Institute of Medical Education Research),
  Institution of National Importance Dhanvantri Nagar,
  Puducherry 605006, India.

- Vector Control research Centre (VCRC)
  Medical Complex, Indira Nagar,
  Puducherry – 605006.

Annexure3

Advertisement

ICMR (DHSR) sponsored workshop for GIS users

"Geographic Information System (GIS) and Public Health: Practice of a good mapping" – 31stJan-2nd Feb 2011 & 7-8th Feb 2011.

National Institute of Epidemiology (NIE), Chennai is organizing two workshops on 31stJan-2nd Feb 2011 & 7-8th Feb 2011 at NIE. The workshop is designed to offer comprehensive guidance of those who are using Geographic Information system (GIS) for public health related activity in their work place. The learning objectives are -

1. Quality and promotion of a spatial data set infrastructure at a micro level
2. Propagation of guidelines in producing good quality disease maps with specification of map accuracy.
3. Proper usage of the map analysis and
4. Effective usage of the GIS technology in health research.

Eligibility:

Health care providers/ public health practitioners / Researchers from Government and non Govt. Organizations / Institutions actively involved in health research.

Application Deadline: December 30, 2011.

Workshop Coordinators: Dr. Vasna Joshua & Mr. A.Elangovan, NIE.

Application forms should be submitted through proper channel or with 'no objection certificate' from the present employee and may be sent by post (marked as "Application for the workshop for GIS users") or thro' email

The Director/ Coordinator
National Institute of Epidemiology,
R127, Third Avenue,
Tamil Nadu Housing Board Colony,
Ayapakkam, Chennai -600 077, India.
E-mail at gisnie2010@gmail.com

Fifteen participants per batch will be selected from various states and the selected participants will be informed within 10 days. ICMR employees should be nominated by their respective Heads of Department and TA & DA claims made at their respective institutes. For other participants, shortest II AC train fair & DA will be given as per ICMR rules.

Limited accommodation facility is available at our hostel. Those who need accommodation should indicate their option in the application form. It will be on first come, first served basis.

Note: **Participants who have already attended the workshop in Sep' 2010 are not eligible. Those who had applied earlier but not participated are requested to submit a fresh filled in application.**

Support:

Division of Health System Research (DHSR),

Indian Council of Medical Research,

Dept. of Health Research, Ministry of Health & Family Welfare,

Ansari Nagar,

New Delhi 110-029, India

Contact Details:

The Director / Coordinator

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Fax no: 26820464 / 26820355

Email: gisnie2010@gmail.com

APPLICATION FORM FOR THE WORKSHOP FOR GIS USERS

"Geographic Information System (GIS) and Public health: Practice of a good mapping"
31Jan- 2nd February 2011 & 7- 9th February 2011

1.	Name of the applicant: (in Capital)		
2.	Age		**3. Sex** Male/Female
4.	Educational Qualification		
5.	Designation		
6.	Name of the Institutes/ Organization (working) with complete address		
7.	Area of Research/ Teaching/Working		
8.	GIS Software used ArcGIS/ MapInfo/ Health Mapper/ ATALS GIS/ Geoda/ GRASS GIS/ EPIMAP/ *SAS GIS/ any other specify*		
9.	Any published / unpublished work done in GIS to be attached (Word / pdf etc.)		
10.	Date of preference	i) 31 Jan - 2nd Feb 2011 ii) 7- 9th Feb 2011	
11.	Address for correspondence Phone / Mobile No. Email:		
12	Whether applied thro' proper channel / with no objection certificate	**Yes /No**	
13	Accommodation required	**Yes /No**	
	Date: Place:	**Signature**	

Annexure4

Workshop III (31st Jan– 2nd Feb'11)

S.No	Facilitators	Topic	III workshop
1.	Prof. M.Ramalingam, **Director, IRS**, Anna University. Chennai- 25	"Public Health Information System"	31.1.2011
2.	Dr. Tune Usha, **Scientist E,** **NIOT campus,** Pallikaranai, chennai 100	Fundamentals of GIS	31.1.2011
3.	Dr. B. N. Nagapal, **Scientist E,** National Institute of Malaria Research, New Delhi.	Use of GIS in decision Support and policy making	31.1.2011
4.	Mr. D. Ragavan, M.Sc., M.Tech. Geoexploration, IIT Bombay **Head of Operations,** Indian Geoinformatics Centre, Chennai	Accuracy & Precision in Mapping / GIS	31.1.2011
5.	Dr. V.Selvaraj, **Technical Officer A**, National Institute of Epidemiology, Chennai 77	GIS ethical issues	31.1.2011
6.	Dr. S.K. Dash **Scientist C,** Integrated Coastal and Marine Area Management Project Directorate, Ministry of Earth Sciences, NIOT campus, Pallikaranai, chennai 100	Remote Sensing- The image science	1.2.2011
7.	Mr. T.V.B Krishna Rao **Sr. Regional Technical Coordinator** ESRI (NIIT GIS) 71, Uthamar Gandhi Salai Nungambakkam Chennai 34	GIS a decision tool for public health related activity	1.2.2011
8.	Mr. S. Ragavendran, **Manager Technical - GIS** PIXEL SOFTEK PVT. LTD., Chennai- 6	Web based GIS for Public Health	1.2.2011
9.	Dr. R.M. Narayanan **Asst. Professor** Dr.MGR Educational and Research Institute E.V.R. Periyar Salai (NH4 Highway), Maduravoyal, Chennai - 600 095,	An Open Source GIS – Quantum GIS Demo	1.2.2011
10.	Dr. Sanjay Mehendale **Director** National Institute of Epidemiology, Chennai 77	Implication of GIS in Public Health	2.2.2011

11. Dr. P. Venkatesan **Scientist E** Tuberculosis Research Centre, Chennai -31	GIS based sampling methods for Health Surveys	2.2.2011
12. Dr. V.Selvaraj, **Technical Officer A**, National Institute of Epidemiology, Chennai 77	GIS case studies	2.2.2011
13. Dr. Vasna Joshua, **Technical Officer A**, National Institute of Epidemiology, Chennai 77	GIS and Public Health: Practice of good mapping	2.2.2011

Annexure5

Workshop IV (7th – 9th Feb'11)

S.No	Facilitators	Topic	IV workshop
1.	Prof. T. Natarajan **Former Director of IRS** **Currently Chair Professor** Anna University, Chennai 25.	Health GIS - prospects, problems and prescriptions	7.2.2011
2.	Dr. Tune Usha, **Scientist E,** **NIOT campus,** Pallikaranai, chennai 100	Fundamentals of GIS	7.2.2011
3.	Dr. V.Selvaraj, **Technical Officer A**, National Institute of Epidemiology, Chennai 77	GIS ethical issues	7.2.2011
4.	Dr. Vasna Joshua, **Technical Officer A**, National Institute of Epidemiology, Chennai 77	Linked Micromaps & Conditional choropleth maps	7.2.2011
5.	Dr. S.K. Dash **Scientist C,** Integrated Coastal and Marine Area Management Project Directorate, Ministry of Earth Sciences, NIOT campus, Pallikaranai, chennai 100	Remote Sensing- The image science	8.2.2011
6.	Mr.Ravi Kumar Veeramani **ESRI (NIIT GIS)** 71, Uthamar Gandhi Salai Nungambakkam Chennai 34	GIS a decision tool for public health related activity	8.2.2011
7.	Mr. S. Ragavendran, **Manager Technical - GIS** PIXEL SOFTEK PVT. LTD., Chennai- 6	Web based GIS for Public Health	8.2.2011
8.	Dr. R.M. Narayanan **Asst. Professor** Dr.MGR Educational and Research Institute E.V.R. Periyar Salai (NH4 Highway), Maduravoyal, Chennai - 600 095,	An Open Source GIS – Quantum GIS Demo	8.2.2011
9.	Dr. Sanjay Mehendale **Director** National Institute of Epidemiology, Chennai 77	Implication of GIS in Public Health	9.2.2011
10.	Dr. P. Venkatesan **Scientist E** Tuberculosis Research Centre, Chennai -31	GIS based sampling methods for Health Surveys	9.2.2011
11.	Mr. Elangovan, **Scientist E**, National Institute of Epidemiology, Chennai 77	GIS mapping using HIV sentinel surveillance	9.2.2011

12. Dr. Vasna Joshua, **Technical Officer A**, National Institute of Epidemiology, Chennai 77	GIS and Public Health: Practice of good mapping	9.2.2011
13. Dr. V.Selvaraj, **Technical Officer A**, National Institute of Epidemiology, Chennai 77	GIS case studies	9.2.2011

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Annexure8

National Institute of Epidemiology (ICMR)

ICMR (DHSR) sponsored workshop for GIS users

"Geographic Information System (GIS) and Public Health: Practice of a good mapping" – 31st Jan - 2nd Feb 2011

AGENDA FOR INAUGURAL - on 31st January 2011

Time	Activity	Speaker
9:30 - 9:40 am	Welcome address	Dr. B. N Murthy
9:40 – 9:50 am	Presenting Bouquet/memento to the Dignitaries	
9:50 – 10:05 am	Presidential Address	Dr B.Nagaraju
10:05 – 10:20 am	Key note address	Prof. M. Ramalingam
10:20 – 10:30 a.m	Vote of thanks	Dr. Vasna Joshua

Annexure9

National Institute of Epidemiology (ICMR)

ICMR (DHSR) sponsored workshop for GIS users

"Geographic Information System (GIS) and Public Health: Practice of a good mapping" – 7th– 9th Feb 2011

AGENDA FOR INAUGURAL - on 7th February 2011

Time	Activity	Speaker
9:30 - 9:40 am	Welcome address	Mr. A. Elangovan
9:40 – 9:50 am	Presenting Bouquet/memento to the Dignitaries	
9:50 – 10:05 am	Presidential Address	Dr. S. Mehendale
10:05 – 10:20 am	Key note address	Prof. T. Natarajan
10:20 – 10:30 am	Vote of thanks	Dr. Vasna Joshua

III Workshop Schedule

DAY 1   31.1.2011

Time	Topic	Faculty
09:00-09:30	*Registration*	
09:30-10:30	*Welcome & Inaugural session*	
10:30-11:00	*Tea*	
11:00-12:00	Lecture 1: Public Health Information System	Prof. M. Ramalingam
12:00-13:00	Lecture 2: Fundamentals of GIS	Dr. Tune Usha
13:00-14:00	*Lunch*	
14:00-15:00	Lecture 3: Use of GIS in decision support and policy making	Dr B N Nagpal
15:00-15:30	*Tea*	
15:30-16:30	Lecture 4: Accuracy and Precision in mapping/GIS	Mr. D. Ragavan
16:30-17:30	Lecture 5: GIS ethical issues	Dr. V. Selvaraj

DAY 2   1.2.2011

Time	Topic	Faculty
09:30-10:30	Lecture 6: GIS and Remote Sensing	Dr .S. K. Dash
10:30-11:00	*Tea*	
11:00-12:00	Lecture 7: GIS a decision tool for public health related activity	Dr. Krishna Rao
12:00-13:00	Lecture 8: Web based GIS for Public Health	Mr. S. Raghavendran
13:00-14:00	*Lunch*	
14:00-15:00	Lecture 9: An Open Source GIS – Quantum GIS Demo	Dr. R.M. Narayanan
15:00-15:30	*Tea*	
15:30-16:30	Lecture 10: Hands on training QGIS	Dr. R.M. Narayanan
16:30-17:30	Lecture 11: Hands on training QGIS	Dr. R.M. Narayanan

DAY 3   2.2.2011

Time	Topic	Faculty
09:30-10:30	Lecture 12: Implication of GIS in Public Health	Dr. S. Mehendale
10:30-11:00	*Tea*	
11:00-12:00	Lecture 13: GIS based sampling methods for sample surveys	Dr. P. Venkatesan
12:00-13:00	Lecture 14: GIS: Practice of Good mapping	Dr. Vasna Joshua
13:00-14:00	*Lunch*	
14:00-15:00	Lecture 15: GIS case study	Dr. V. Selvaraj
15:00-15:30	*Tea*	
15:30-17:00	Feedbacks & closing section:	

Workshop IV Schedule

DAY 1   7.2.2011

Time	Topic	Faculty
09:00-09:30	*Registration*	
09:30-10:30	*Welcome & Inaugural session*	
10:30-11:00	*Tea*	
11:00-12:00	Lecture 1: Health GIS - prospects, problems and prescriptions	Prof. T. Natarajan
12:00-13:00	Lecture 2: Fundamentals of GIS	Dr. Tune Usha
13:00-14:00	*Lunch*	
14:00-15:00	Lecture 3: Linked micromaps & conditional choropleth maps	Dr. Vasna Joshua
15:00-15:30	*Tea*	
15:30-16:30	Lecture 4: GIS ethical issues	Dr. V. Selvaraj
16:30-17:30	Lecture 5: GIS: case studies	Dr. V. Selvaraj

DAY 2   8.2.2011

Time	Topic	Faculty
09:30-10:30	Lecture 6: GIS and Remote Sensing	Dr .S. K. Dash
10:30-11:00	*Tea*	
11:00-12:00	Lecture 7: GIS a decision tool for public health related activity	ESRI (NIIT GIS)
12:00-13:00	Lecture 8: Web based GIS for Public Health	Mr. S. Raghavendran
13:00-14:00	*Lunch*	
14:00-15:00	Lecture 9: An Open Source GIS – Quantum GIS Demo	Dr. R.M. Narayanan
15:00-15:30	*Tea*	
15:30-16:30	Lecture 10: Hands on training QGIS	
16:30-17:30	Lecture 11: Hands on training QGIS	

DAY 3   9.2.2011

Time	Topic	Faculty
09:30-10:30	Lecture 12: Implication of GIS in Public Health	Dr. S. Emendable
10:30-11:00	*Tea*	
11:00-12:00	Lecture 13: GIS based sampling methods for sample surveys	Dr. P. Venkatesan
12:00-13:00	Lecture 14: Estimation of HIV infection using GIS	Mr. A. Elangovan
13:00-14:00	*Lunch*	
14:00-15:00	Lecture 15: GIS: Practice of Good mapping	Dr. Vasna Joshua
15:00-15:30	*Tea*	
15:30-17:00	Feedbacks & closing section:	

Feedback Form

"GIS &Public Health: Practice of good mapping"- September 2010
WORKSHOP FEED BACK FORM
Please take a moment to complete this **feedback form**. Your comments will assist us in improving our future workshops.   * **This information is kept confidential** *
PARTICIPANT INFORMATION

Name (Optional):   Date:

EVALUATION						
SCALE: 1- STRONGLY AGREE; 2 – AGREE; 3 – NEUTRAL; 4 –DISAGREE; 5 – STRONGLY DISAGREE						

	1	2	3	4	5	Comments
1. The **workshop** organization was good.	☐	☐	☐	☐	☐	
2. The **workshop** was informative.	☐	☐	☐	☐	☐	
3. The **workshop** facilities were satisfactory.	☐	☐	☐	☐	☐	
4. The **workshop** time slot for each presentation was adequate.	☐	☐	☐	☐	☐	
5. The presenter answered to questions was appropriate and in a satisfactory manner.	☐	☐	☐	☐	☐	
6. Guest lectures were good and useful.	☐	☐	☐	☐	☐	

7. Please tell us in one or two lines, what you liked best about the presentation.

8. Please tell us in one or two lines, what you did not like and that needs improvement about the presentation

9. Would you recommend this workshop to a colleague/friend?	Yes	☐		No	☐	

10. Can you name one GIS software easy to learn and use.

11. What is your opinion about the open source GIS software?

12. Can you specify (at least three points) the difficulties you faced in the application of GIS technology and its limitations (related to data, software, personnel.....)

    a.

    b.

    c.