# A review on Emerging trends, Applications and issues of Geospatial Technology in public health in Indian scenario

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**Abstract-**Integration of “Information technology”, “GIS” and “GPS” and “Remote sensing” increase the productivity and the quality of Geospatial technology ,so the spatial and non spatial information, data for analysis and decision making by providing, integrated approach and redirect to the disease control and public health and surveillance at local, regional and national levels. Smart planning in terms of emergency public health, care provision and infrastructure protection can be effectively prepared and implemented and Geospatial technology can play a key and vital role in this direction and approach. Various Spatial mapping and samples of different diseases (i.e. vector and water borne diseases) and pollution resources like water distribution lines passing through parallel or cross to the drainage and garbage sites. The availabilities and the accessibilities of health care facilities like the hospitalities, PHC, HP and were located in the GIS environment for further analysis. In this paper we tried out to explore that how Geospatial technology with GIS, GPS and RS is works as a critical tool with several applications disaster related public health issues. And Geographic Information System [GIS] related applications are emerging as powerful technological tools in integrating and analyzing data related to human health in the spatial-temporal context. Further it has also explained the trends, and the applications and the various issues in involves in public health of Geospatial Technology in Indian scenarios. Readability and Reliability of Database, its dependability and accessibility enables the major issues and challenges in India. Creating geo-databases at the micro level in public health departments and the need to relate data on census, demographics, health based, and meteorological, hydrological, environmental, and geographical aspects was emphasized.

**Keywords-** GIS, GPS, Remote sensing, Geospatial technology, Spatial Analyses Public Health Disease Control

## 1 INTRODUCTION

The application of geographic information systems (GIS) to public health practice holds great promise for improving our understanding of the ecology and causes of complex health issues and for the design and evaluation of effective population-based programs to resolve those issues. GIS has been deployed in public health practice for over 150 years, the most famous example being the use of a hand-drawn map by Dr. John Snow in London in the mid-1850’s to analyze the geographic location of deaths caused by cholera [1]. His maps which superimposed the location of cholera deaths with those of public water supplies pinpointed the Broad Street pump as the source of the cholera outbreak and resulted in the removal of the pump handle. This successful public health intervention subsequently led to a decline in the incidence of cholera. Since the 1850’s public health departments around the world have made frequent use of either hand-drawn maps or pin-maps to identify disease clusters and to focus their interventions. With the recent advent of affordable computer technology and the development of computerized software for the mapping of public health data, public health departments have increasingly begun to make routine use of computerized geographic information systems to map and analyze their public health surveillance data [2,3]. The GIS technology might also be useful to map referral services from peripheral centers providing primary care to apex hospitals providing tertiary care both in the private and public sectors.It might be helpful in identifying the nearest and appropriate places for referral, of neonates, delivering women, cases of cardiovascular emergencies and people affected by natural disasters and accidents etc. [4, 5]. Periodic mapping of the risk factors and behaviours identified in large scale sample surveys like NSS and NFHS in different population sectors and that of various disease conditions as well as disease specific and age specific mortality statistics can be considered as more advanced applications of GIS [4, 5]. Geographical Information Systems is not merely thematic mapping. All GIS users should develop the skill of building complex geo-statistical models and effectively use them as a decision support system. Agencies and organizations that have collaboration with foreign universities find it relatively easy to acquire data even up to micro level using RADARSAT through the foreign resources. Getting satellite data is not cost effective and time efficient in India. This scenario should change in the years to come [6].

### 1.1 Benefits of deploying GIS in Public health

Practice is that it can summarize a large amount of tabular data into visual maps that can be very insightful for the planning and evaluation of public programs, and for engaging the attention of policy makers and the public in the process [7,8,9]. By adding the “place” to the traditional person/time/place triad underlying public health epidemiology and surveillance, the use of GIS technology can help public health practitioners better appreciate how and where place matters in affecting the public’s health in ways that are policy and programmatically relevant. The use of GIS technology can also help enhance the “person” component of the epidemiological triad by providing a method to add measures of socio-economic status, educational attainment,ethnicity, housing quality etc. to health data sets which often contain only very sparse person-level information such as age and gender [10,11]. By linking small area neighbourhood characteristics obtained from easily available sources such as the Canadian Census to individual health records, it is possible to identify, for example, that high rates of disease are occurring in population sub-groups having certain socio-demographic characteristics such as low educational attainment, poor housing and high rates of poverty [12,13]. The use of GIS technology in public health settings can also facilitate the development of applications for the coordination of emergency response efforts (by identifying populations at high risk because of proximity to a chemical spill for example or the strategic routing of emergency response vehicles) and for the most strategic placement of health program offices and resources [14, 15].

### 1.2 GIS and PublicHealth in Indian Scenario

Looking at the Indian picture, table 1 has showed that the use of GIS in health sector remains marginal compared to other ones. In fact, the use of GIS in health studies is a recent phenomenon. Consequently, all sectors of health studies are not equally represented and application domains still remain closely linked to epidemiology and environmental health (see Map India and Map Asia Conference reports 2003-2004). Many projects are actually mushrooming on these themes. In the case of urban studies, these projects are often linked to the emerging concept of "sustainable/healthy cities"[17,18].Not much work has been done on health service location and access analysis. In the rural context, we can especially mention the work of N. Kumar (KUMAR 2004) who used the location/allocation models to examine the changing geographical access to and locational efficiency of basic public healthcare vis-à-vis private healthcare services in two districts located of Haryana. He further examines the factors that govern their geographic accessibility and locational-efficiency. Using these techniques, he demonstrates that if geographic access to Public Health Centre (PHC) has improved substantially from 1981 to 1996, there is no indication of any improvement in the locational efficiency of PHCs despite a significant increase in their number [19, 20]. In Delhi, the Directorate of Health Services decided to use a GIS to map all registered health facilities. In view of such an impressive effort, it is therefore surprising to note that the use of this tool takes the form of merely locating health facilities on a map, without any further applications or analysis. Hence, it seems that the GIS is perceived as a marketing tool rather than an analytical tool for public agencies. We hope that this is only a first step towards further applications. In fact, the infrequent use of GIS observed in urban areas going further than the mere mapping of healthcare infrastructure's locations is partially explained by the fact that many measures to evaluate health events lose their meaning with regard to intra-urban areas. In a recent paper on accessibility to primary care, M.F. Guagliardo highlights how the most popular measures on spatial accessibility to care (travel impedance to nearest provider and supply level within bordered areas) lose validity in congested urban areas (GUAGLIARDO 2004)[21,22]. More generally, in the field of public health management, one can hardly find any effective implementation of GIS technology. However, a particularly successful example of such implementation is the Spinfo Healthmap. This project was realized for Karnataka Health Systems Development Project (KHSDP). Its objective was to implement a customized GIS application, which would be an interactive spatial analytical tool enabling Health Officers to reshape, re-locate health jurisdiction for effective utilization of the health infrastructure. Compared to what has been done in Delhi, this system already contains attribute data up to the village level relative to infrastructure, personnel, supply and diseases. Such an integrated state-level health information system is a good example of application for public health management, even though we have not been able to check in the field up to what extent this system was used by the administration [23, 24].

### 1.3 Data Constraints

To start with, the GIS development that took place in recent years being largely explained by demand in terms of service location, GIS has consequently been used primarily for its spatial test abilities rather than for its modelling and analytical potential[25,26,27]. This can cause problems because these packages rarely take space into account. Now, spatial statistics do not make the same assumptions that classic statistics do. If in statistics the population is a set of individuals, its equivalent in geography is the space being studied, considered as a set of spatial units (or "mapping units")[28,29,30]. Now, using statistical analytical models requires studied populations to comply with a few basic properties rarely found when working with spatial units: these populations are supposed to be homogeneous (i.e. any subset must be a representative sample of the whole population); each individual must be independent (i.e. knowledge of a variable's value is not suppose to inform us about the value of another Variable) [31, 32, 33].

## 2 Literature Review

### 2.1 GIS, GPS, Remote Sensing and Fieldwork

The widespread use of computers has led to the development of new technologies, collectively known as geographical information sciences (GISci), for mapping and monitoring features on the surface of the Earth. Foremost for exploration and fieldwork among these technologies are: geographical information systems (GIS), which can take digital datasets and produce maps showing features of interest in matter of seconds; the global positioning system (GPS), which allows positions to be determined to ±10 m any where on the Earth's surface; and methods of observing features from a distance, such as photography or infra-red scanning, known as remote sensing. These GISci techniques complement the surveys and sampling that is at the heart of scientific exploration (Figure 1): they greatly enhance the types of fieldwork that can be carried out, reduce the amountof time needed for many tasks and improve the quality of results. A fundamental objective of most exploration is to observe and record information about the part of the world being studied, for instance by field surveys, photography, or questionnaires it is often the only source of new data about a region that will be available to you, prior to you going there to collect field data. Your GPS will tell you where you are in your study region and allows you to input your sample locations into a GIS. A GIS is a means of combining existing data and new data from fieldwork or the interpretation of remotely sensed images. GIS-generated maps greatly reduce the original amounts of data and can be designed to focus on specific themes of interest to your research [33].

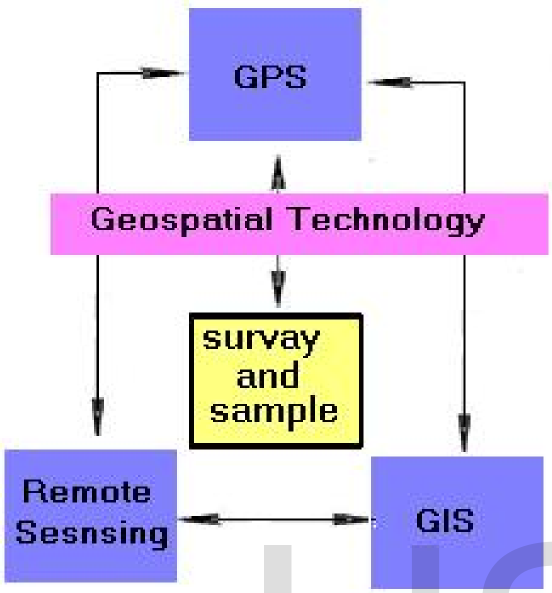



Fig 1: GIS, GPS, Remote Sensing and Fieldwork

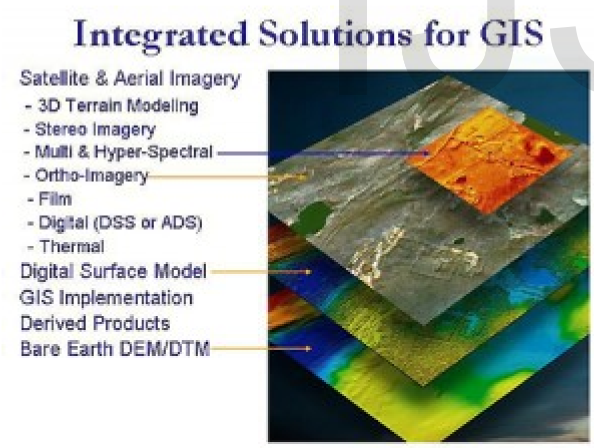



Fig 2: GIS, Integration

### 2.2 Remote Sensing and GIS applications in Diseases

#### 2.2.1 Mapping

GIS was used to map the distribution of coastal species of An. Sundaicus along the Andaman and Nicobar islands where it is the solevector of malaria, sandy soil is favorable to growth while rainfall more than 1600mm was not favorable for species to survive also, species were seen around Chilka lake, Orissa, In Andhra Pradesh, Vishakapatnam and the southwestern coast of Kerala. While An.dirus is seen in forested areas of northeastern India. It breeds in pools, unused wells, borrows pits and drains covered with foliage in deepforested areas. For validation GIS predicted areas were compared with reported distribution at micro level. In Assam, large areas on northeast were found favorable for An.dirus through GIS. In, Meghalaya deciduous forest on the eastern and western sides is favorable, while south Mizoram, Nagaland and western Tripura favorable. An.minimus has been reported along the foothills of Himalayas from Uttar Pradesh to northeast in India. The resultant map after integration of thematic maps of soil, forest cover, rainfall, temperature and altitude using GIS shows the areas favorable for An.minimus. A GIS study was initiated in Mewat in Haryana which is malaria epidemic belt of northwestern plains of India. The study Included [34].

- Delineation of malaria paradigms at macro levels.
- Identification of eco epidemiological characteristics of each paradigms /Identification of paradigms receptivity for malaria.Using Remote Sensing and GIS, the five recognizable malaria paradigms, are irrigation command, catchment/non catchment, mining, urban and flood prone areas, were mapped. Each paradigm exhibited its own ecoepidemilogical characteristics and potential for maintaining malaria transmission of varying intensity. Paradigm revealed during 1996, an epidemic year, different paradigms responded differently. Although all paradigms showed upward trend maximum amplification occurred in urban areas. During 1993 and 1998 flood prone paradigm, irrigation command area II and non catchment area continued to retain active pockets of malaria. GIS is to study and control of disease caused by hazardous chemicals and Public health management. GIS has brought geography into many academic fields of research, increasing the appreciation of geography and its tools in solving spatial problems. Health research using GIS includes demographic, political, environmental, ecological, topographical, hydrological, climactic, land use, public infrastructure, transportation, health infrastructure and epidemiological data. A GIS is an information system designed to work with data referenced by spatial / geographical coordinates (Martin, 2002; Martin 2006). In other words, GIS is both a database system with specific capabilities for spatially referenced data as well as a set of operations for working with the data. It may also be considered as a higher Representation of disease incidences data can be displayed as[34].
- Dot maps to show health event.
- Choropleth maps to display death and illness rates in geographical area.
- Diagram maps to present quantitative data within map.

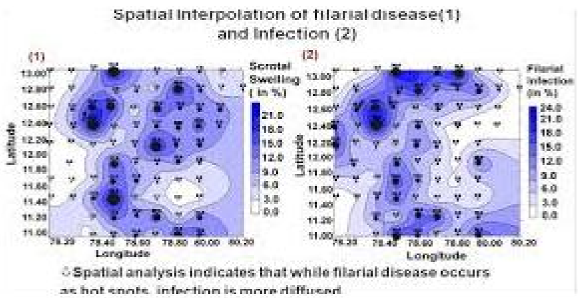
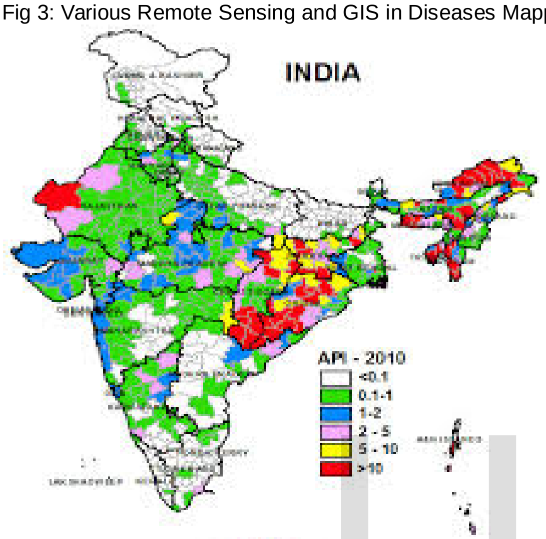



Fig 3: Various Remote Sensing and GIS in Diseases Mapping(A)



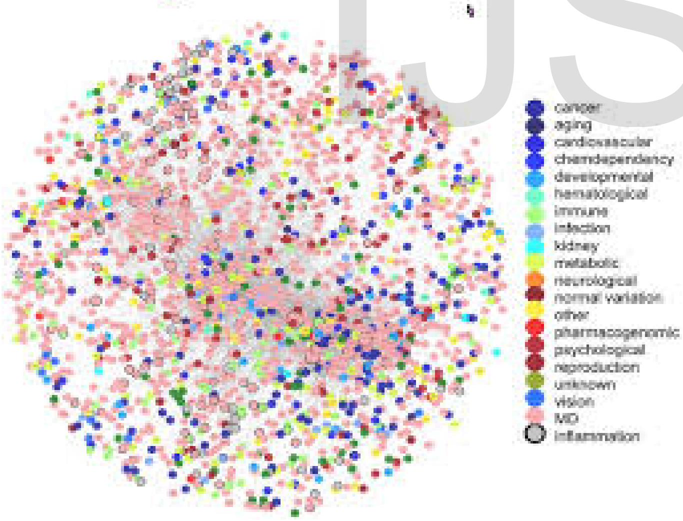




Fig 3: Various Remote Sensing and GIS in Diseases Mapping (B)

### 2.2.2 Applications of GIS in Public Health Studies

1. Identifying areas where a particular disease is prevalent.
2. Identifying vulnerable population.
3. Identify factors responsible for diseases.
4. Incidences of each disease.
5. Identify health care centers
6. To determine morbidity and mortality rates.
7. Water polluting sources
9. Diseases zonation mapping.
10. Target and plan the remedial measures [34].

### 2.2.3 Case Study at Mumbai and Jalna

#### 2.2.3.1 Study area Mumbai

Mumbai area falls between Latitude - N18°30´ to 19°20´ and Longitude - E72°45´ to 73°00´. Mumbai consists of two districts, one is the island city, made up of seven islands up to Mahim and Sion in the north and the other is suburbs which divide into two eastern and western, beyond Mahim and Sion. Mumbai area covers an area of about 437.71 Sq.Km. East to West it extends – 12 kms and North to south - 40 kms. Southern part of the city is mostly reclaimed land on Arabian Sea coast.BMC limit extends up to Mankhurd in the east, Mulund in northeast and Dahisar in northwest. Fig. 1.1 shows the study area map of the present study of ward H (E), K (E) and L, of Mumbai. Population of Mumbai about 1.19 crore people (Census, 2001) with sizeable day time floating population from nearby places like Thane, Pune, Raigad and Nasik. .Nearly 54% of the city's population lives in slums. Migration accounted for 43.7% population growth between 1991 and 2001. Population density of about 27,209 people per Sq.Km. There are about 248 spots prone to get flooded due to heavy rains of which 80-90 are chronic spots (low-lying areas) especially. Kalina, Bandra-Kurla Complex (BKC), Central Mumbai (Kamini et al., 2006)[34].

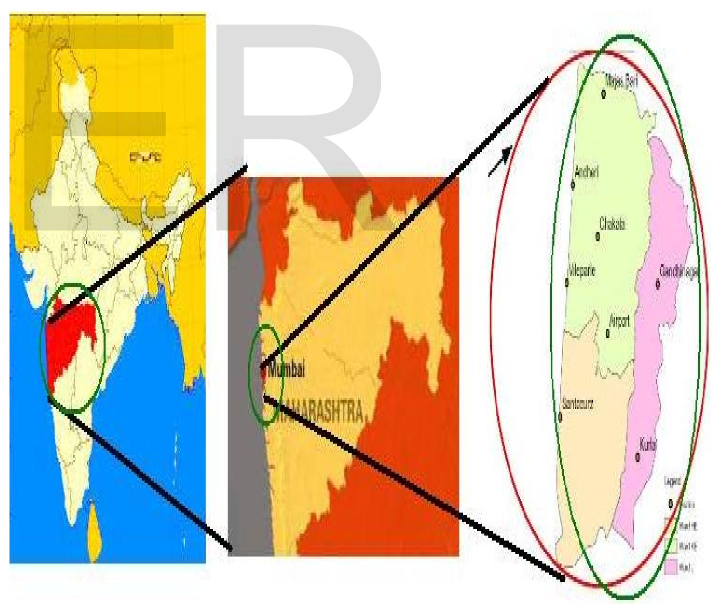



Fig 4: Map shows Study area (Mumbai city) and collection sites

#### 2.2.3.2 Study area Jalna

Jalna The container survey was conducted from June 2012 to December 2012 in the Jalna city the (N 19051' and E 076017'). During the survey, all the containers, vessels and coconut shells were examined. Larvae collection was carried out indoors and outdoors by dipping method, using pipette or dipper depending on container type and location. In this study, "indoors" refers to the interior of the building while "outdoors" refers to the outside of the building. Between June 2012 and December 2012, we collected the larvae of four species of mosquitoes in Jalna City Habitat from which collections were made included water storage tanks, plastic containers/vessels, metal vessels, ceramic vessels, tucker box, tires, coconut shell and an abandoned cement tank. We visited 12 stations, many more than once in month and collected 1893 specimens. These locations are Kanhaiya nagar, Hanuman ghat, Hamalpura, Modikhana, College road, Shri Krishana nagar, Sambhaji nagar, Ram nagar, Karwa nagar, Chaman, Railway station area and Ambad choufully. These locations cover whole the area of city, the Jalna divided in to two parts old Jalna and New Jalna. Collected larvae were preserved in 70% ethanol for identification. These larvae were identified morphologically using standard keys of S.R. Christopher 1933, P.J. Barraud 1934, and Bina Pani Das 1990[35,36,37].

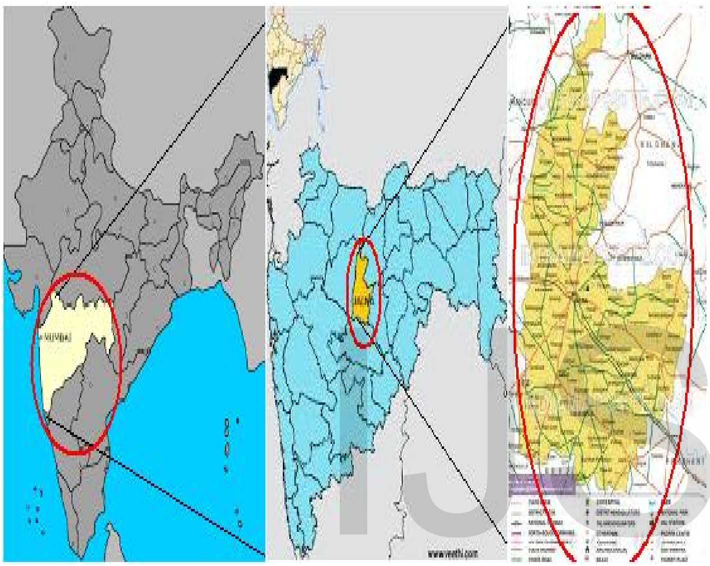



Fig 5: Map shows Study area (Jalna city) and collection sites.

## 2.4 RESULTS

A total of 1551 mosquito larvae comprising three species were collected in city during the study period. Aedes aegypti was the predominant species accounting
for n = 1551 (79.98%) of the larvae collected followed by Culex quinquefasciatus n = 230(14%),
Culex vishnui n = 1302 (5.02%), and
Aedes AEGYPTI s n = 19(1%)
(Table:1). Out of total collected larvae indoor density n = 1551 (39.04%) and outdoor n = 938(60.96%) (Table: 2). Plastic containers shows the highest number of larvae (indoors 80% and outdoor 68%) followed by clay pots and tiers, metal tins cement tank etc [38][39]. A. aegypti and Cx.quinquefasciatus breed in all the outdoor containers while A. albopictus only breed in outdoor coconut shell and some observed in tier. However only A. aegypti breed in all the containers indoor as well as outdoor. In all Cx. vishnui breed in turbid water or cement tank. The averagely high number of larvae (n = 1160) collected in the month August because of the rainfall (Table: 1)[40,41,42]. All of the twelve localities in which the Ramnagar area shows the highest number of specimens (n = 201) due to this area have the poor sanitation and slum area of the city (Table:2)[43].

Table 1. Numbers and proportions of the mosquito larvae collected in Jalna city.

| Species | Indoor | Out Door | Total |
|---|---|---|---|
| Culex Vishnui | 586 | 716 | 1302 |
| Aedes Aegypti | 07 | 12 | 19 |
| Culex Quinquefasciatus | 20 | 210 | 230 |
| Total | 613 | 938 | 1551 |

Table 2. Mosquito larvae collected in different localities in Jalna city during Jun-Dec 2012.

| S.NO | Area | Jun | July | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Railway station | 23 | 20 | 23 | 22 | 14 | 13 | 24 | 139 |
| 2 | Hanuman ghat | 20 | 19 | 27 | 18 | 24 | 24 | 17 | 149 |
| 3 | Kanhaiya nagar | 18 | 17 | 26 | 23 | 18 | 32 | 16 | 150 |
| 4 | Modikhana | 32 | 17 | 12 | 26 | 23 | 16 | 18 | 144 |
| 5 | Sambhaji Nagar | 22 | 16 | 19 | 13 | 24 | 19 | 24 | 137 |
| 6 | Karwa Nagar | 12 | 18 | 17 | 19 | 27 | 17 | 23 | 133 |
| 7 | Chaman | 24 | 23 | 23 | 23 | 18 | 23 | 17 | 151 |
| | Total | 168 | 155 | 173 | 166 | 165 | 169 | 164 | 1160 |

## 3 METHODOLOGY

Materials used were primary data tools (field visits and semi structured interviews) and Secondary data tools (Hospitals data and Epidemiology cell data, Articles, Archives) and GIS tools (Arc GIS software) and GPS, Toposheets. Each area/slum/building was linked using geographic coordinates (Latitude/Longitude). Spatial mapping and analysis done using hand held receiver GPS for collecting way. points and track points and mapped using Arc GIS software. The attributes were then layered to ascertain spatial relationship. Finally in the Geodata base have used for GIS analysis to identify the diseases prone zones and risk mapping.

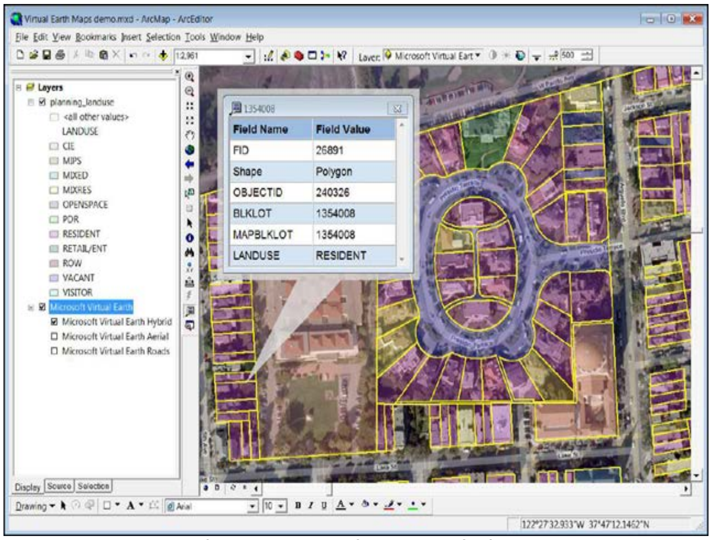



Fig 6: Arc GIS software Interfacing

## 4 CONCLUSION

Finally we concluded our study on and raise a number of public health concerns that need to be addressed. The current year rain fall in studied area was very low and so most of the people facing the complications and issues of water shortage. The dry season is normally characterized with acute water shortage when most residents usually resort into mass water storage in different containers. These containers, if not properly covered, could serve as breeding sites for disease vectors as two (Aedes aegypti and Aedes albopictus) out of the three species encountered indoors are potential vectors of deadly and life threatening diseases The overall conclusion of spatial variations in the diseases in both areas cases such as Mumbai and Jalna are mapped together depending upon the the number of availability of samples cases reported from a particular area in all the three wards. The analysis of different maps helps us to visualize the different patterns of particular disease in a specific area. the degrees of vulnerability and severity of a particular disease in a given area. Also be found, where as. The possibility of water contamination was maximum and also, subterrean taps from where the water was fetched may have been the possible cause. High risk zone for the vector borne diseases are seen in areas were open garbage dumping and improper and irregular, It has been observe that collecting all data in such a way that under one umbrella of "Geo Data Bank" could provide easy accessibility and better utility. Making links between diseases reporting system, geographic data, and registration of vital events as well as continuous updating of data were recommended to improve the overall quality of health related data



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