Ch-6-Application of GIS

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Introduction

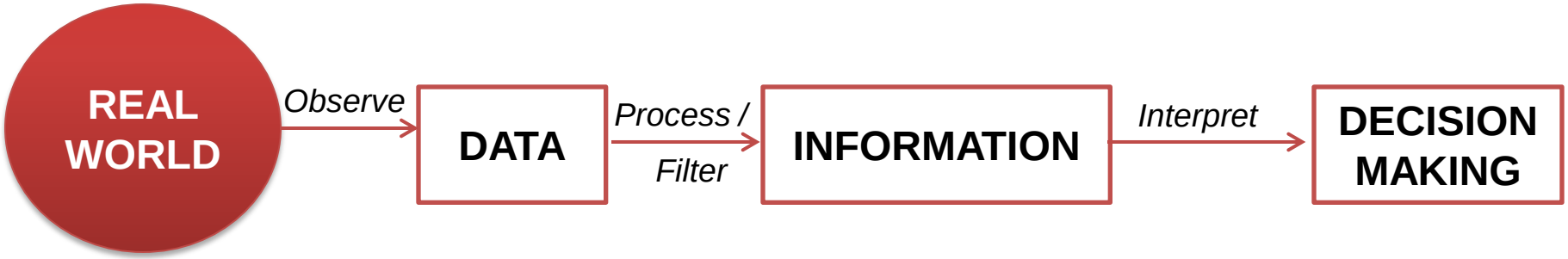
- GIS and geospatial technologies are used routinely in fields as diverse as business and marketing, emergency management, environmental planning, geo-intelligence and security, risk assessment, urban planning and utilities management, to name just a few.
- Studies suggest that industries such as telecommunications, utilities, transportation, education and scientific research constitute some of the largest consumers of this technology, and there is great capacity for growth.
- The value of GIS is realized through its application in numerous daily tasks such as:-

- GIS in Mapping
- Telecom and Network services
- Accident analysis and Hot Spot Analysis
- Urban Planning
- Transportation Planning
- Environmental Impact Analysis
- Agricultural Applications
- Disaster Management and Mitigation
- Landslide Hazard Zonation using GIS
- Determine land use/land cover changes
- Navigation (routing and scheduling)
- Flood damage estimation
- Natural Resources Management
- GIS Solutions in Banking Sector:
- Soil Mapping
- GIS based Digital Taxation
- Land Information System
- Surveying:
- Wetland Mapping
- GIS Applications in Geology
- Detection of Coal Mine
- Assets Management and Maintenance
- GIS for Planning and Community Development
- GIS in Dairy Industry
- Tourism Information System
- Irrigation water management

- Fire equipment response distance analysis
- Worldwide Earthquake Information System
- Volcanic Hazard Identification
- Energy Use Tracking and Planning
- GIS for Fisheries and Ocean Industries
- Monitor Rangeland Resources:
- Deforestation
- Space Utilization
- Space Utilization
- Reservoir Site Selection
- Forest Fire Hazard Zone Mapping
- Disaster and Business Continuity Planning
- Utilities
- Lease Property and Management
- Development of Public Infrastructure Facilities
- GIS for Drainage Problems in Tea Plantation Areas
- Collection of Information about Geographic Features
- GIS for Public Health
- Location Identification
- Knowledge Based System for Defense Purpose
- Pipeline Route Selection

- Producing Mailing Labels for abutter Notification
- Site Suitability for Waste Treatment Plan
- Geologic Mapping
- Environment
- Infrastructure Development:
- Coastal Development and Management
- Crime Analysis
- River Crossing Site Selection for Bridges
- Land Use Changes Associated with Open Cast Strip Mining
- Economic Development:
- School Student Walking Distance Analysis
- Locating Underground Pipes and Cables
- Coastal Vegetation Mapping and Conservation
- Regional Planning
- GIS for Land Administration
- Snow Cover Mapping and Runoff Prediction:
- GIS for Wildlife Management

Geospatial focus areas where GIS and remote sensing play a key role in career development



Decision making through GIS

GIS and remote sensing play great role in various Sectors such as:-

- Natural Resources Management
- Disaster Management & Mitigation
- Health
- Education
- Business GIS
- Electoral process
- Environment
- Military Applications
- Infrastructure –Power, Telecom, Transport etc.
- Urban Planning etc…

Natural Resources Management

-Resource assessment

-Change detection

-Suitability analysis

-Scenario study

-Impact assessment etc…

Natural Resources Management Applications

- ✓Water Resources assessment
- ✓Land-use planning
- ✓Soil erosion potential evaluation
- ✓Watershed planning
- ✓Vegetation mapping
- ✓Ecosystem analysis
- ✓Conservation planning
- ✓Risk assessment
- ✓Coastal zone management and hazard mapping

Disaster Management & Mitigation

- Earthquakes
- Drought
- Fire
- Flood & Cyclones
- Landslides & Erosion
- Volcano etc.

Managing Disasters -Why GIS?

Better Decisions and Informed Action!

- Action
- Decisions
- Model
- Analyze
- Measure
- Historically Largely Applied
- Individual Systems

Providing Many Benefits

- Understanding
- Efficiency
- Cost Savings
- Improved Analysis
- Effective Planning
- Better Decision Making
- Better
  - –Communication
  - –Collaboration
  - –Coordination

GIS Provides:

•Data analysis on the disastrous phenomena (for e.g. landslides, floods, earthquakes etc.), their location, frequency, magnitude etc.

•Risk potential assessment & monitoring

•Post-disaster damage assessment

•Data analysis & prediction on the disastrous events which might take place: topography, geology, geomorphology, soils, hydrology, land use, vegetation and so on.

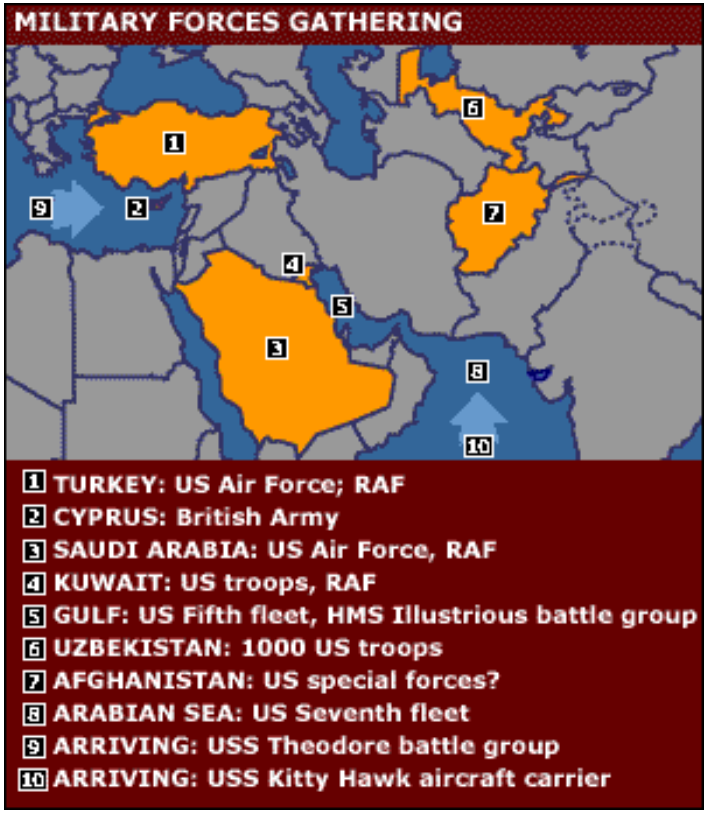
• Data on element that might be destroyed if the event takes place: infrastructure, settlement, population, socio economic data and so on.

Common Objectives:

- Protection of life and property.
- Provide critical and timely information.
- Provide the appropriate and timely response.
- Provide for basic life support needs.
- Provide for expedited recovery.
- Seek improvements and expand capacity.

Military / Defence Applications

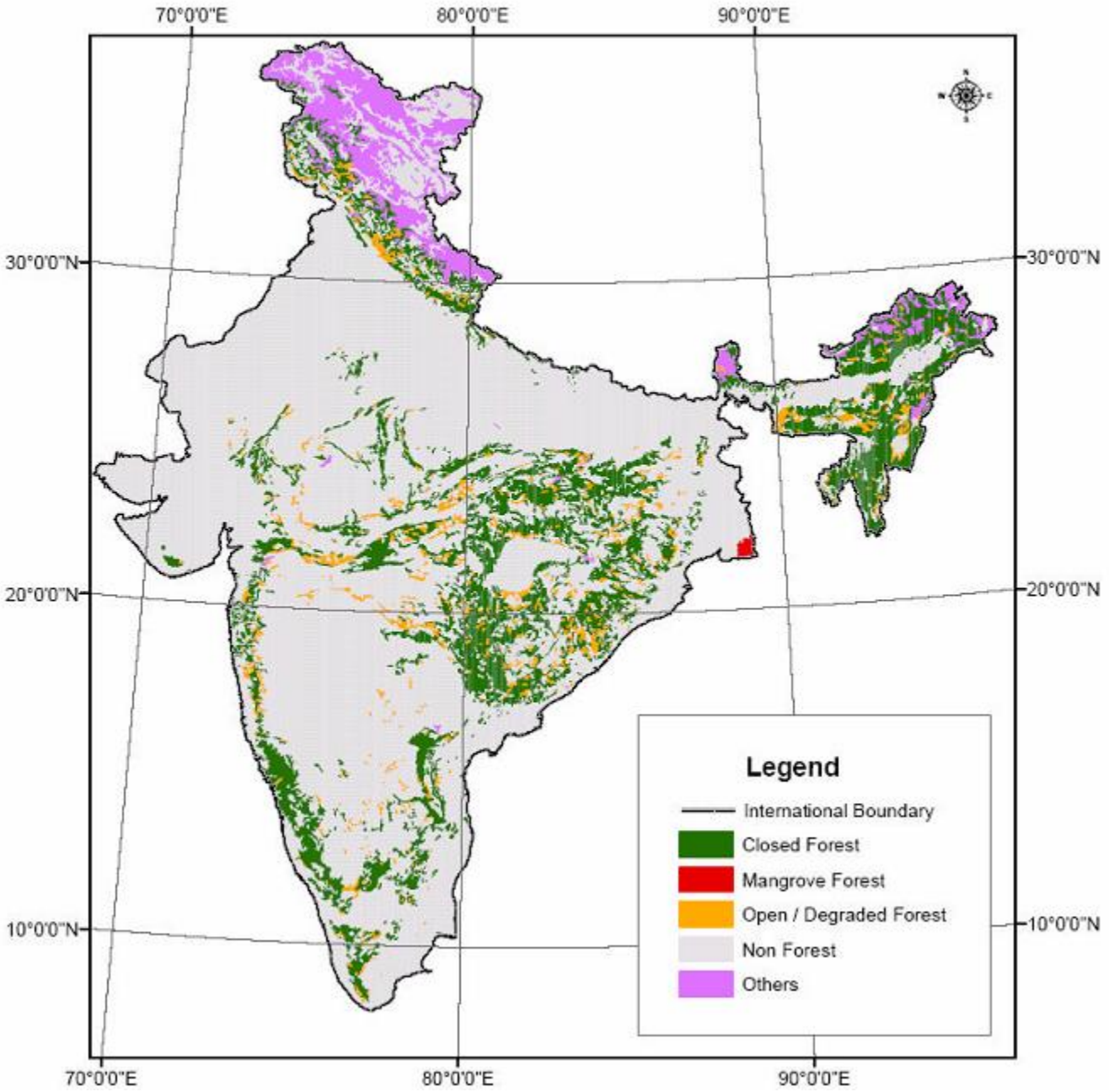
- Conventional use of paper maps is continued
- Need to exploit GIS to exploit that Digital Geographic Information
- GIS is particularly helpful in two areas of defence: *command and control and production.*



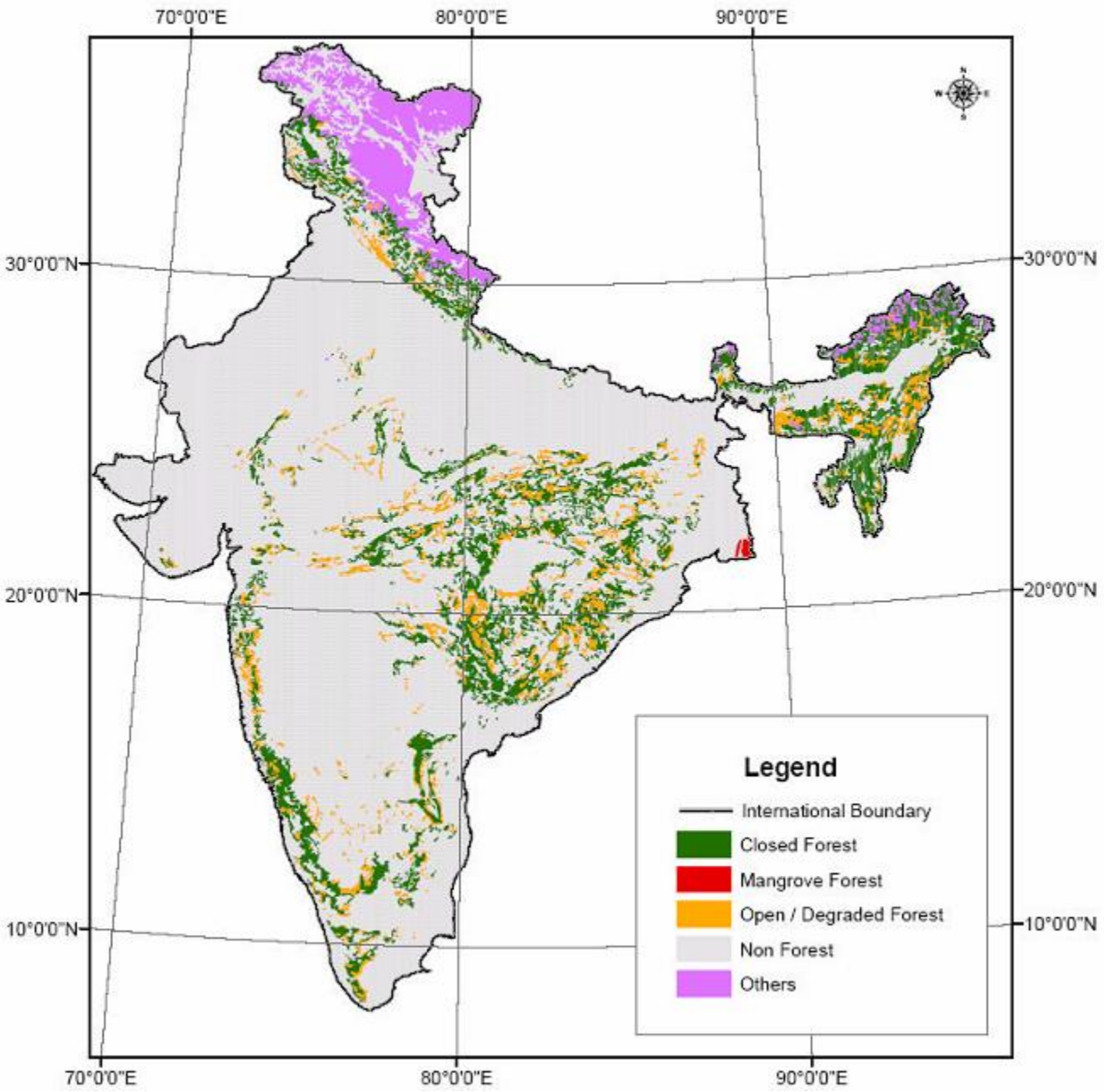
Forestry

- Forest Management Information System
- Forest resource mapping & monitoring
- Encroachment investigation
- Forest fire assessment

Forest Cover in India in 1972-75



Forest Cover in India in 1980-82



Agriculture

- ✓Crop water requirement prediction
- ✓Crop acreage & yield estimation
- ✓Crop condition assessment
- ✓Soil moisture evaluation
- ✓Suitability mapping

Business GIS

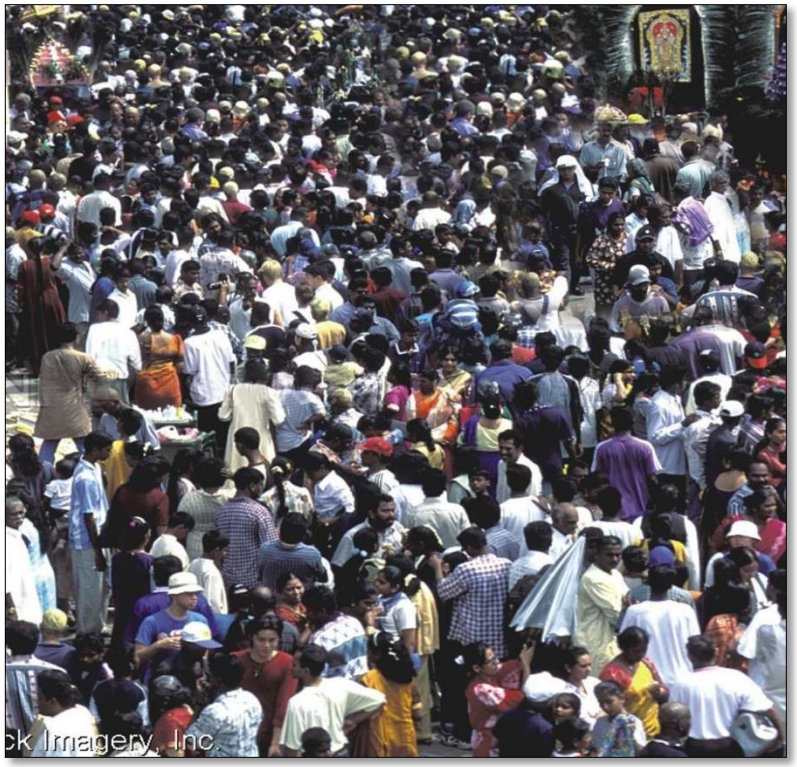
- Supply Chain Management
- Marketing
- Site Selection
- Consumer Management
- Logistics
- Intelligent Routing
- Demographic Analysis

Precisely GIS can be used for -

- For detection of potential market.
- For detection of dealer / distributor network.
- Zoning by market growth.
- For strategy planning in case of market analysis for launch of products

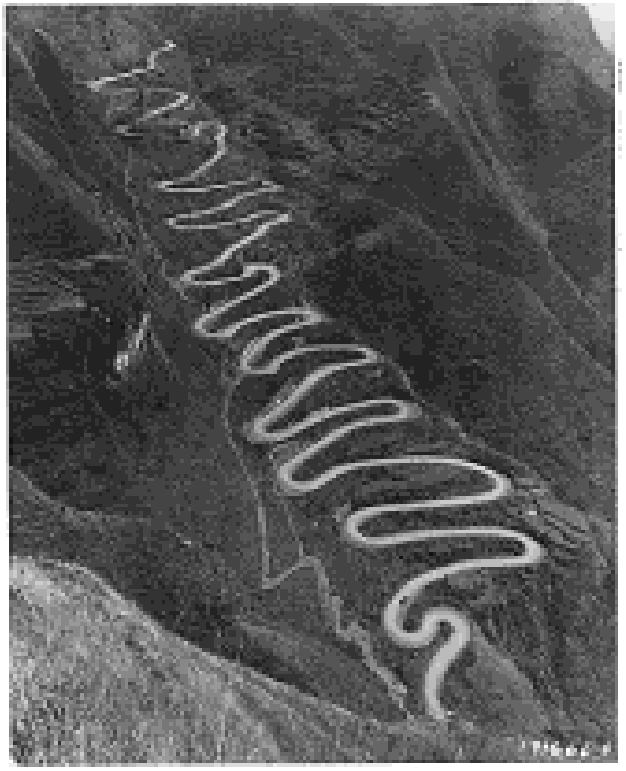
Urban Planning & Development

- ✓ Urban sprawl analysis
- ✓ Cadastral mapping & land management
- ✓ Land use / land cover mapping & analysis
- ✓ Site selection



Transportation

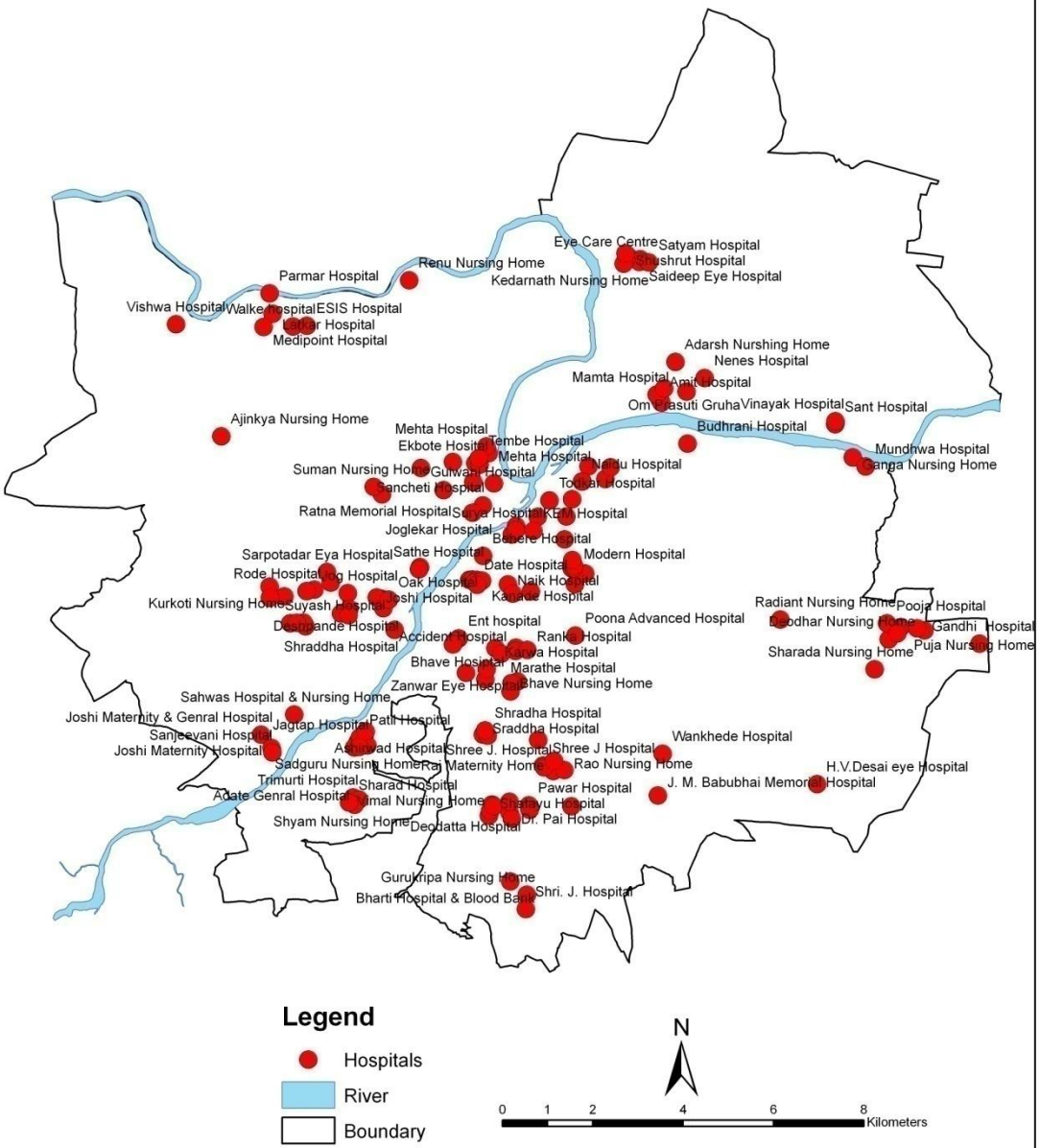
- ✓Route planning for road & rail
- ✓Road network updating
- ✓Logistics management
- Analysis of highway crash data
- Intelligent crash location
- Traffic planning tools
- Route selection and evaluation



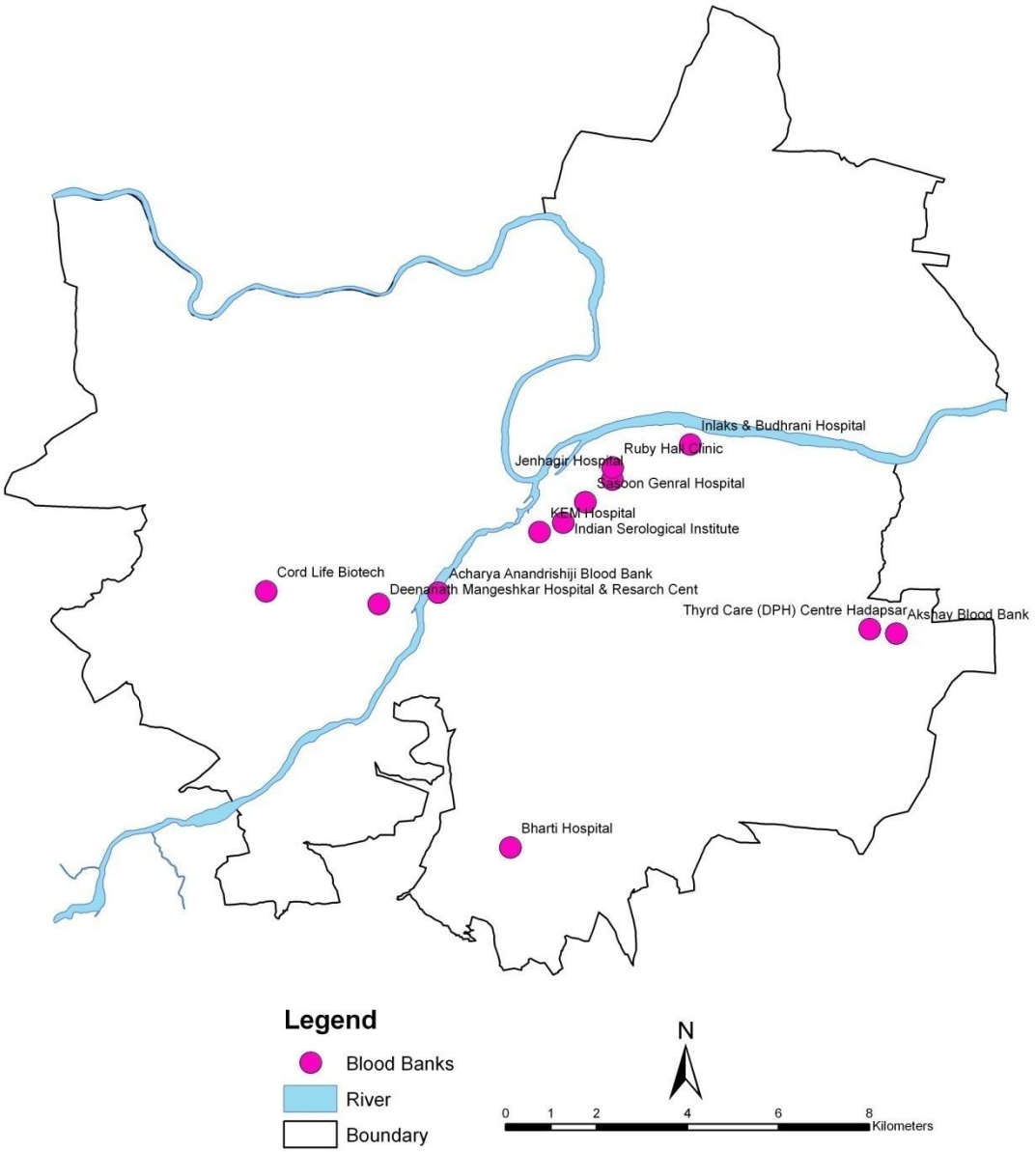
Emergency Response Planning

Time taken to reach the site from fire station

HOSPITALS OF PUNE CITY

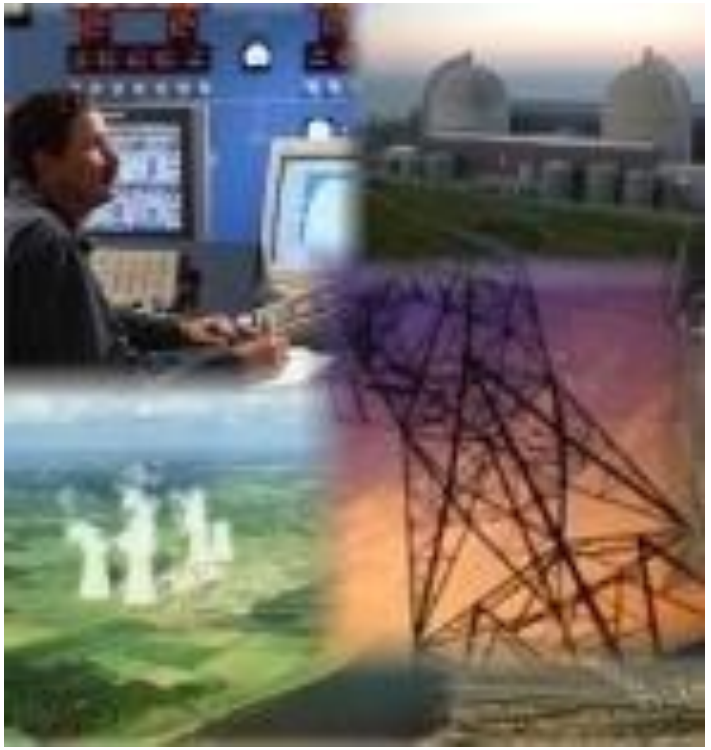


BLOOD BANKS OF PUNE CITY



Utility Management

Creation of digital maps and asset maps of Electricity, Gas, Telecom, Power, Water Utilities etc. linking them to the relevant databases and developing systems for providing decision support information.



Implementing a GIS in Environmental health

Existing GIS within Health and Human Service Agencies

- Public health departments around the world have embraced GIS as a tool for collecting and analyzing data, evaluating health programs, and communicating results (internally, to policy makers, and to the public).
- WHO, the European Centre for Disease Prevention and Control (ECDC), CDC, US Environmental Protection Agency (EPA), all 50 US state health departments, hundreds of US local health departments (LHDs), and the majority of accredited schools of public health in the United States all use Esri GIS software

- Public health organizations use GIS on a daily basis to:
  - ✓ analyze the spread of infectious and chronic diseases,
  - ✓ promote and encourage healthy behaviors,
  - ✓ protect the public against environmental hazards (as discussed throughout this paper),
  - ✓ prevent injuries (e.g., analyzing traffic injuries by location),
  - ✓ respond to disasters and assist communities in recovery (e.g., situational awareness, identifying vulnerable populations), and
  - ✓ ensure the quality and accessibility of health services as well as many other programs and services.

- Many leading public health organizations have endorsed the use of GIS in public health practice and research.
- ***CDC says,*** "GIS plays an important part in health promotion and protection."
- ***WHO says, GIS :-***
  - ✓ Is "highly suitable for analyzing epidemiological data, revealing trends and interrelationships that would be more difficult to discover in tabular format"
  - ✓ "Allows policy makers to easily visualize problems in relation to existing health and social services and the natural environment and so more effectively target resources"
  - ✓ Is an "ideal platform for the convergence of disease-specific information and their analyses in relation to population settlements, surrounding social and health services and the natural environment"

Programmatic Areas and GIS

Outdoor Air Quality

- Improving the accuracy of air pollution health impact assessments with GIS
- Examining residential proximity to heavy-traffic roadways and associated adverse health outcomes
- Estimating at what distances the impact of direct traffic emissions on ambient particulate matter concentrations are significant
- Developing semiautomated GIS approaches to estimation of daily air pollution concentrations (e.g., using kriging)
- Using land use-based regression (LUR) and GIS-based estimation to estimate exposure to pollutants (over the traditional area-average approach)
- Using GIS to develop web-based carpooling programs

Water Quality

- Using GIS to track violations, health advisories, boil water orders, and reported illnesses that may be related to drinking water
- Using GIS-based spatial analysis and statistical analysis to determine clustering of cholera
- Using Web-based maps to display oil spill information, coliform levels for beaches, well-water quality data, etc.
- Spatially locating residences and pipes (e.g., vinyl lined)
- Monitoring naturally occurring contaminants in public drinking water (such as arsenic and nitrates)

- Developing GIS data models to determine arsenic contamination (safe and vulnerable areas) as well as where to focus intervention campaigns
- Examining relationships between arsenic levels in water and various cancers
- Assigning cases to corresponding water supply zones using point in polygon techniques
- Producing attack rate maps based on water districts
- Producing color-coded, GIS-based consumption advisory maps providing location-specific information on the amount of methylmercury in fish

Toxics and Waste

- Applying thematic mapping and analysis (e.g., buffering) to identify locations where potentially noxious land uses may be having a disparate adverse impact on minority and low-income populations
- Achieving community buy-in for the enactment of public health regulations to control waste, junkyard, and recycling facilities
- Using mobile GIS/GPS technologies to conduct surveillance (exposure assessment) for radiation, asbestos particles, radio frequency exposure, etc.)

- Finding associations between maternal residence near agricultural pesticide applications and autism spectrum disorders among children
- Modeling plumes (smoke, dust, asbestos, PCBs, and other pollutants)
- Comparing mapped reports of respiratory problems with plume locations
- Testing the efficacy of aerial spraying of mosquito adulticide in reducing incidence of West Nile virus
- Using GIS-based methods to recruit participants for prospective pesticide exposure studies, thereby increasing efficiency and enhancing accuracy
- Solid waste management(landfill and container sitting….,??)

Healthy Homes and Healthy Communities

- Assessing the size and dimensions of green spaces and their respective distances from the population of potential users
- Using GIS to expand policy makers' awareness of the proximity of environmental hazards to schools
- Examining environmental conditions (criteria pollutants, pollens, mold spores, and pyrethrin pesticides) and respiratory problems (especially asthma)
- Using GIS in asthma surveillance, such as the relationship between asthma hospitalizations by ZIP Code™ and environmental factors
- Using GIS portals to track rats and rat complaints

- Using exploratory spatial data analysis to assess the extent of lead poisoning clustering and examine the geographic distribution of lead poisoning rates throughout a jurisdiction
- Examining the geographic distribution of important lead poisoning risk factors and prioritizing lead poisoning prevention programs (e.g., through GIS data linkages to cadastral records)
- Detecting radon hot spots and producing national radon risk maps
- Using GIS in disaster preparedness drills (mass vaccination, stockpile location and logistics, geographic emergency notification)
- Using GIS–CAD integration and robots to monitor indoor environments

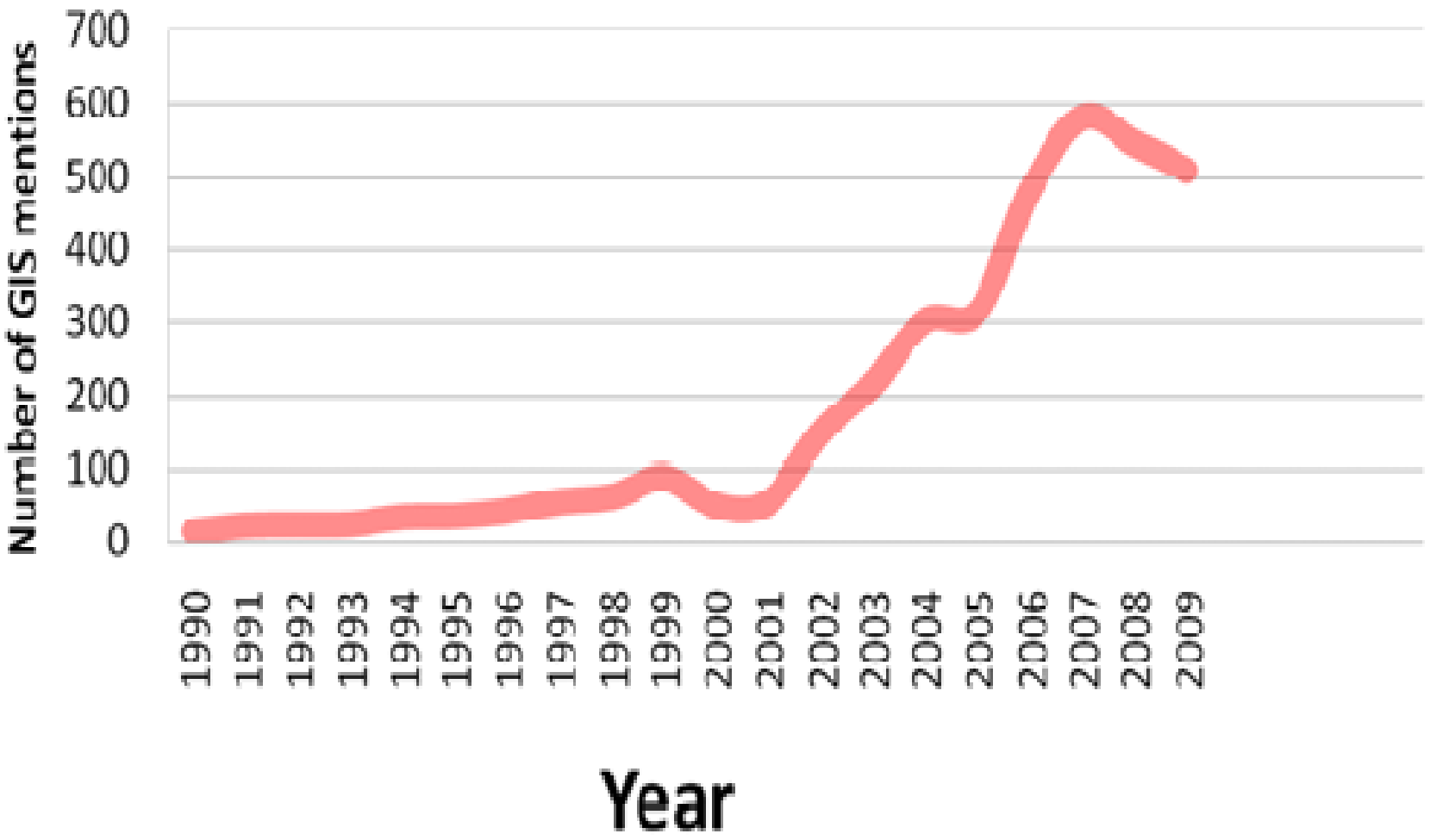
Infrastructure and Surveillance

- GIS-based models to estimate exposure to pesticides
- Environmental Public Health Tracking portals
- West Nile virus surveillance systems
- GIS-based well inspection systems
- Spatiotemporal analysis of the relationship between vector-borne disease dissemination and environmental variables
- Other GIS-based inspection systems

Global Environmental Health

- Mapping the burden of diseases
- Investigating cholera epidemics
- Detecting regions of higher incidence of diarrhea and other water-borne diseases
- Measuring distances from households to water sources
- Analyzing travel time for obtaining clean water
- Analyzing the spatial distribution of standard morbidity rates per area

GIS in Peer-Reviewed Health Publications[5]



Legal and Ethical Issues in GIS

The following guidance should be considered prior to using geospatial technologies for data collection and use.

Reflecting on and maximizing the benefits

- Be clear how the data collected or the mapping undertaken using geospatial technologies will specifically address or concretely inform policy, programming or advocacy needs within the local context.
- Assess the benefits of using geospatial technologies for data collection in the context of pre-existing information sources and/or the viability and resource implications of alternative data collection mechanisms.

- Collect evidence wherever available identifying the explicit benefits of the technologies and the appropriateness of the data collection method.
- Collect only data that is necessary. To the greatest extent possible, reflect and plan for the data collection within strategic planning processes.
- If third party data or consultancy expertise is to be used, ensure that a non-disclosure agreement is included in the procurement process and that experts are briefed on any relevant, organizational ethical procedures and requirements pertaining to privacy.
- *Ensure that there are sufficient numbers of qualified staff and/or time and resources to produce meaningful and timely information.*

Ensuring privacy and security

- **Acquire consent where relevant and feasible.**
  - ✓ If the project is likely to capture personally identifiable data then, wherever possible and feasible, informed consent should be obtained in advance.
  - ✓ If this is not possible, information on the project should, at a minimum, be provided on the organization's or office's webpage and/or the landing page on social media.
- **When receiving secondary data, take into account data providers' expectations regarding the privacy of data.**
  - ✓ Care should be taken in the use of this secondary data, reflecting on the context in which the data was collected, the nature of the population whose data is being analysed, the information used, the likelihood of identification of individuals and the degree to which expectations of privacy can be met.

- **De-identify personal data (incl. visual data) to the greatest extent possible and as soon as possible.**
  - ✓ Disaggregate geographical clusters to the strict minimum needed, adopt the weakest possible visible resolution (i.e. maximum useful distance for visual data), remove identifying information and/or obscure visual details, while maintaining the usefulness and meaningfulness of the data for programme, policy and decision-making purposes.
- **Consider using geomasking techniques to mitigate against re-identification of individuals in data sets produced.**
  - Discuss the value of geomasking for your project with the geospatial experts involved.
- **Review visual data as soon as possible to ensure** that identifying information is not shared nor made public

- **Build in privacy by design.**
- **Consider the privacy policies of third-party geospatial data providers (such as social media services).**
- When using third-party data, consideration should be given to the privacy policies of the organization and their implications including (where relevant):
  - ✓ Safe transmission mechanisms for data (e.g. encryption used at all times when data is being sent from one party to the other)
  - ✓ Whether there are clear conditions evidencing respect for individuals' rights relating to their data.

- This could include consent arrangements for non-operational use of data, notification of potential sharing of data (including information about with whom it may be shared), right to removal of personal data from data sets, etc.
- When deciding (a) whether to use the third-party data and (b) whether it is feasible or appropriate to create an MoU to ensure privacy and security in the transfer and receipt of data or analysis.
- **If deciding to proceed with a partnership to accept geospatial data from third parties, then measures should clearly be taken to publicly acknowledge the nature of any partnership and the safety measures taken to protect the privacy of those whose data has been used.**

- **Carefully consider the risks, benefits and alternatives if the potential partner is incorporated or subject to the legislation in a country with broad surveillance powers** and a history of (a) gross violations of individual privacy and/or (b) interrupting national access to media channels including social media. In other words, consider the reach of the relevant government in terms of access to or blockage of use of technologies.
- **Establish an agreement/MoU with service providers or volunteer organizations clarifying arrangements for** data sharing and personal identity protection arrangements, including what procedures to follow if community consent is needed

Understanding data risks and limitations

- **Understand potential limitations in the data.**
- Limitations of the data could include: data gaps, who is included or excluded from the data (pertaining to accessibility of technologies, devices and profiles and demographics of participants), merging of incompatible databases/data sets, inclusion of outdated data, etc.
- Any limitation of geospatial data (whether collected directly or indirectly through a third party) should be understood.
- Discussions should be had with data providers and data experts on these limitations.

- **Consider the possibility of discrimination against disadvantaged groups that are collectively associated with particular geographical areas**.
  - ✓ Correlations between particular populations in light
  - ✓ of factors such as their geography and the relationship between location, poverty, gender and race may result in geographical trends and predictive models that discriminate against certain persons in relation to their access to services and their opportunities.
  - ✓ Where discrimination is a possibility, the use of geospatial technologies and data should be reconsidered and/or any resulting decision making should be carefully triangulated with other data sources

Thank You

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