Application of GIS in Agriculture

The various types of mapping provided by RS required by GIS to be useful for agriculture are: •

- soil type mapping.
- crop coverage mapping.
- rivers/ distributaries mapping.
- land use mapping .
- contour mapping.
- irrigation system mapping.
- meteorological mapping

Soil type mapping
For planning of agriculture on a broad scale it is extremely important to know different types of soils, type of crops they can support and areas having the type of soil. This information if used effectively can greatly improve the agricultural output and its quality.
Some attributes of soils are: humus content, nutrient content, name etc.

Crop coverage mapping
Maps indicating crop coverage are very useful in estimating the yield of various crops. These also help in analyzing existing methods of agriculture such as crop rotation, terracing etc. In order to bring forth any improvements, it is important to study the existing trends and methodologies.

Some attributes of crops are: suitable season/ climatic conditions, water requirements, manure/ fertilizer requirements, total time for sowing reaping and harvesting etc.

Rivers/ distributaries mapping
These maps show the geographical location of the different river and distributaries systems in and around an area. Knowing his is helpful in locating nearest source of water and designing of most economical canal systems. • Attributes: name, volume, depth, width etc

Land use mapping
These maps give information about how the land is already being used. It helps in analyzing how effectively the land resources are being used and in coming up with more economical suggestions for the same in addition to keeping updated records used for various other calculations. • Attributes: kind of usage, total forest coverage, total agricultural output of an area, estimated urbanization of an area etc

Contour mapping
These maps show the elevation data of the various geographical features on the earth's surface. This information helps us in estimating important data such as the most economical laying of canals considering cost of excavation and leveling etc.

Irrigation system mapping

This kind of mapping deals with details of older or existing systems such as dams and canals. Study of this information helps in estimating how efficiently the systems work and on its basis determine the extension projects and maintenance programs.
Attributes: length of systems, efficiency details, areas served, volume of water carried, benefits etc

Meteorological mapping

Rainfall patterns, climatic conditions, seasonal changes and predictions are the areas dealt with under this kind of mapping. This is important information required by famers and agriculturists to plan the type of farming most suitable and economical. It also helps in estimating how much water is to be let out into the canal systems in accordance to the predictions of the rainfall intensities.

Identification, area estimation and monitoring:

Identification, estimation of growing stock, analysis of distribution and monitoring at regular intervals are major aspects in plantation crops. he specialized management practices make the distribution of plantation crops rather more localized in comparison to other agricultural crops.

Crop condition assessment

The physiological changes that occur in a plant due to stress may change the spectral reflectance/ remittance characteristics resulting in the detection of stress amenable to remote sensing techniques
Crop monitoring at regular intervals during the crop growth cycle is essential to take appropriate measures and to asses information on probable loss of production.

Crop yield modeling and production forecasting:

The information on production of crops before the harvest is very vital to the national food policy planning and economy of the country.
Reliable crop yield estimate is one of the most important components of crop production forecasting.

Agricultural draught assessment

Draught assessment is yet another area where in remote sensing data has been used at operational level.
The district level drought assessment and monitoring

Reflectance modeling

Physical reflectance models for crops serve the important purpose of understanding the complex interaction between solar radiation and plant canopies.
In order to obtain a reliable yield prediction, growth of crops has to be modeled by means of crop growth models.
Crop growth models describe the relation between physiological process in plants and environmental factors such as solar irradiation, temperature, water and nutrient availability.

GIS In Forestry

Satellite image based forest resource mapping and updating,
Forest change detection
Forest resource inventory
GIS database development

Forestry Benefits
Availability of baseline, Planning for afforestation, Futuristic resource planning , Sustainability of environment, Wild life conservation & development for information strategies recreation purpose.

Biodiversity
Remote Sensing Technology in biodiversity measure at landscape level gives a perspective horizontal view and helps in delivering different landscape elements and their spatial characteristics

Remote sensing forms a valuable tooling mapping and monitoring of biodiversity and provides Valuable information to
Quantify spatial patterns, Biophysical patterns,Ecological process that determine species richness and anthropogenic factors causing loss of species richness and for predicating response of species to global changes.

Forest degradation
The rapid depletion of forests made inessential to know the rate and trend of this degradation so that timely measures could betaken to prevent further loss of forest resources. • Timely and accurate information for detecting changes over a period of time is required for forest ecosystems

Forest fire
Through GIS forest fair can also determine

The GIS Applications on Emergency Services

Emergency command and rescue strongly relies on the spatial information. Staffs need to know the rescue facilities and resources available, for example, the position of the rescued, surrounding environment and rescue resources. The application of emergency system based on the GIS will greatly reinforce the accuracy and response thus winning the time for rescue. The GIS auxiliary pre-plan system can also guide the rescue. The applications of GIS in rescue will be discussed in the following sections.

Positioning of Public Emergent Events

When tackling a public emergent event, we normally need to display the corresponding address of the event on the electronic map. In order to display a stated data record (address string) on the electronic map, the system needs to assign geographic coordinates to that record, which is called address coding. The standard address database has stored standard address codes, including the coding table and total address table. When the address string is entered, the first thing to do is to split the address string. And for the successfully split string, the system undertakes matching in the address code database, and finally matches the coordinates and marks on the electronic map, thus completes the address positioning.

Surrounding Environment Searching

For general police alarm tackling interface, the police force distribution and police alarms distribution should be displayed on it by a customized period. When a police alarm comes, the system can refresh the electronic map immediately and show just the distribution status of the rescue resources nearby like patrol cars, police boxes, police force, and hospitals. Then commanding persons can dispatch relevant resources in accordance with the display information, by voice or message. The system can also analyze and give optimized and shortest route instruction for rescue.

GPS Real-time Tracking

GPS real-time tracking means utilization of vehicle GPS or handset GPS to send the positioning message to the surveillance centre by GSM wireless network. The surveillance centre, after receiving positioning coordinate information, marks the locations of mobile police force on the electronic map. GPS/GSM system consists of three parts: GPS Section (including the GPS constellation, GPS receiver), GSM communication part (including the communication controller, GSM transmission module, GSM network and the corresponding part of cable transmission) and GIS processing part (including hardware servers, software, electronic maps, databases, systems, etc.).

Video Surveillance

Video surveillance camera information is also available on the electronic map, for example, the positioning of individual camera, or its parameter. What's more, the real-time or history video record can be obtained by the interface opened. And the commanding person can control the camera by the customer end.

Emergency Response Pre-plan

Pre-plan is a pre-arrangement aiming at tackling possible emergent events. It is a critical part of emergency management system. When undertaking real-time command or rehearsal, mere way of text communication is obviously insufficient. The pre-plan system shall be visualized so that the

orders and other information can be passed down and exchanged in a lucid way. The application of GIS into the pre-plan system is a perfect solution.

Any rescue management system will involve-
Locating the sites accurately in the least permissible time
Reduces the critical time element involved in the activities
Accurate data about the resource available at the place of interest
Accessibility of information between source and destination
Correct means of alarming the resources
Real time visualization of the area of interest

GIS in Environment

It is a computer system that collects, analyzes, stores and disseminates geographic information for use by different entities to facilitate informed and smooth decision making. GIS has important uses in different fields, including in the environmental field. Below is some of the importance of GIS in environment.

1. Environmental Impact Analysis (EIA)
EIA is an important policy initiative to conserve natural resources and environment. Many human activities produce potential adverse environmental effects which include the construction and operation of highways, rail roads, pipelines, airports, radioactive waste disposal and more. Environmental impact statements are usually required to contain specific information on the magnitude and characteristics of environmental impact. The EIA can be carried out efficiently by the help of GIS, by integrating various GIS layers, assessment of natural features can be performed.

2. Disaster Management
Today a well-developed GIS systems are used to protect the environment. It has become an integrated, well developed and successful tool in disaster management and mitigation. GIS can help with risk management and analysis by displaying which areas are likely to be prone to natural or man-made disasters. When such disasters are identified, preventive measures can be developed.

3. Zoning of Landslides hazard
Landslide hazard zonation is the process of ranking different parts of an area according to the degrees of actual or potential hazard from landslides. The evaluation of landslide hazard is a complex task. It has become possible to efficiently collect, manipulate and integrate a variety of spatial data such as geological, structural, surface cover and slope characteristics of an area, which can be used for hazard zonation.

4. Determination of land cover and land use
Land cover means the feature that is covering the barren surface .Land use means the area in the surface utilized for particular use. The role of GIS technology in land use and land cover

applications is that we can determine land use/land cover changes in the different areas. Also it can detect and estimate the changes in the land use/ land cover pattern within time. It enables to find out sudden changes in land use and land cover either by natural forces or by other activities like deforestation.

5. Estimation of flood damage

GIS helps to document the need for federal disaster relief funds, when appropriate and can be utilized by insurance agencies to assist in assessing monetary value of property loss. A local government need to map flooding risk areas for evaluate the flood potential level in the surrounding area. The damage can be well estimate and can be shown using digital maps.

6. Management of Natural Resources

By the help of GIS technology the agricultural, water and forest resources can be well maintain and manage. Foresters can easily monitor forest condition. Agricultural land includes managing crop yield, monitoring crop rotation, and more. Water is one of the most essential constituents of the environment. GIS is used to analyze geographic distribution of water resources. They are interrelated, i.e. forest cover reduces the storm water runoff and tree canopy stores approximately 215,000 tons carbon. GIS is also used in afforestation.

7. Soil Mapping

Soil mapping provides resource information about an area. It helps in understanding soil suitability for various land use activities. It is essential for preventing environmental deterioration associated with misuse of land. GIS Helps to identify soil types in an area and to delineate soil boundaries. It is used for the identification and classification of soil. Soil map is widely used by the farmers in developed countries to retain soil nutrients and earn maximum yield.

8. Wetland Mapping

Wetlands contribute to a healthy environment and retain water during dry periods, thus keeping the water table high and relatively stable. During the flooding they act to reduce flood levels and to trap suspended solids and attached nutrients. GIS provide options for wetland mapping and design projects for wetland conservation quickly with the help of GIS. Integration with Remote Sensing data helps to complete wetland mapping on various scale. We can create a wetland digital data bank with spices information using GIS.

9. Irrigation management

Water availability for irrigation purposes for any area is vital for crop production in that region. It needs to be properly and efficiently managed for the proper utilization of water.

10. Identification of Volcanic Hazard

Volcanic hazard to human life and environment include hot avalanches, hot particles gas clouds, lava flows and flooding. Potential volcanic hazard zone can be recognized by the characteristic historical records of volcanic activities, it can incorporate with GIS. Thus an impact assessment study on volcanic hazards deals with economic loss and loss of lives and property in densely populated areas.

GIS in Health

Role of GIS in Public Health

Health geography Health geography is the application of geographical information, perspectives, and methods to the study of health, disease and healthcare. It is very useful and customary to divide the geography of health into two interrelated areas:
1.Geography of health and diseases
2.Geography of healthcare system

The geography of disease: Which covers the exploration, description and modeling of the spatio-temporal (space-time) incidence of disease and related environmental phenomena, the detection and analysis of disease clusters and patterns, causality analysis and the generation of new disease hypotheses?
The geography of healthcare systems Which deals with the planning, management and delivery of suitable health services (ensuring among other things adequate patient access) after determining healthcare needs of the target community and service catchment zones.

Essentials of Geographic Informatics It is possible, for example, to overlay and integrate the following data to perform different types of health-related analyses:
Population data, e.g., census and socio-economic data;
Environmental and ecological data, e.g., monitored data on pollution and vegetation (satellite pictures);
Topography, hydrology and climate data;
Land-use and public infrastructure data, e.g., schools and main drinking water supply;
Topography: the arrangement of the natural and artificial physical features of an area

Essentials of Geographic Informatics
Transportation networks (access routes) data, e.g., roads and railways;
Health infrastructure and epidemiological data, e.g., data on mortality, morbidity,
Disease distribution and healthcare facilities; and
Other data as needed to perform different types of health-related analyses.

Essentials of Geographic Informatics

As a modeling and decision support tool, GIS can help determining the geographical distribution and variation of diseases (e.g., prevalence, incidence) and associated factors, analyzing spatial and longitudinal trends, mapping populations at risk and stratifying risk factors. ▪ GIS can also assist in assessing resource allocation and accessibility (health services, schools, water points), planning and targeting interventions, including simulating (predicting) many "what-if" scenarios before implementing them, forecasting epidemics, and monitoring diseases and interventions over time.

Components of GIS A GIS is an organized collection of :
GIS for Spatial Health Information
Mapping where things are
Mapping quantities
Mapping densities
Finding what is inside
Finding what is nearby
Mapping changes

GIS to find the right site for

PHC in a village
Hospital locations
Alignment transportation network
Disease distribution
Healthcare facilities and work force
Blend client location with health data

GIS in Health planning
Assessing resource allocation and accessibility
Targeting intervention
Forecasting epidemics, and monitoring diseases (Surveillance) and intervention over time
Emergency dispatch system

4 M s of Health GIS
Mapping
Measuring
Monitoring and evaluation
Modeling

GIS in Regional and Local Planning

GIS Solutions for Urban and Regional Planning Designing and Mapping the Future of Community with GIS

GIS provides planners, surveyors, and engineers with the tools they need to design and map their neighborhoods and cities. Planners have the technical expertise, political savvy, and fiscal understanding to transform a vision of tomorrow into a strategic action plan for today, and they use GIS to facilitate the decision-making process. Planners have always been involved in developing communities everyone would want to call home. Originally, this meant designing and maintaining cities and counties through land use regulation and infrastructure support.

To date, local governments have been right sized and downsized and have had budgets drastically cut while trying to maintain service levels. Information technology, especially GIS, has proven crucial in helping local governments cope in this environment.

Benefits of using GIS in local government include the following:
Increase efficiency.
Save time.
Generate revenue.
Provide decision support.
Improve accuracy.
Manage resources.
Automate tasks.
Save money.
Increase access to government.
Enhance public participation.
Promote greater collaboration among public agencies.

“Urban and regional planning underlies the very fabric of society as we know it today. Without planning and foresight, our cities, towns, rural areas, and residential communities will not run efficiently. While communities today face many challenges, some of them, such as pollution and

traffic, can be addressed by careful and creative planning. It is the planner's job to address such problems and pro- vide viable solutions for today and the future."

GIS planning solutions can be used for

Community-based design and planning
Economic development
Smart growth
Improving the quality of life
Creating better communities for future generations
Creating livable communities
Planning services
Urban and regional planning
Brownfields redevelopment Learn more about GIS for planning at www.esri.com/planning.
Integrated Web Services and GIS for E-Government

- Government-to-business applications typically relate to economic development, land development, licensing, or permitting.
- Government-to-citizen applications provide information on government service, such as trash pickup, or streamline the public's interaction with government agencies by allowing online payment of fees or providing feedback on land use plans to officials.
- Government-to-government applications improve the amount, quality, and speed of information exchange among various levels of government and/or agencies and departments within governments.
- Better communication helps governments use resources more wisely by avoiding duplication of effort and allows agencies to work together to tackle large-scale planning problems or respond to emergencies.

GIS in Transport system

The GIS used for transport application is known as the Geographic information systems for transportation (GIS-T).
GIS-T applications are currently used broadly by transportation analysts and decision makers in different areas of transportation , planning and engineering, from infrastructure planning, design and management, traffic safety analysis, transportation impact analysis, and public transit planning and operations to intelligent transportation systems (ITS).

One critical component of GIS-T is how we can best represent transportation- related data in a GIS environment in order to facilitate and integrate the needs of various transportation applications

Existing GIS data models provide a good foundation of supporting many GIS-T applications.

Like many other fields, transportation has developed its own unique analysis methods and models. Examples include

- shortest path and routing algorithms
- spatial interaction models
- network flow problems
- facility location problems
- travel demand models, and
- Land use-transportation interaction models.

GIS-T application GIS-T APPLICATION Manage Land Records Marketing Trade Area Analysis Customer Profiling Urban Planning Risk Analysis Sales Management Site Selection Asset Management Transportation/Logistics Manage Land Records

GIS in Tourism

- GIS in tourism holds many advantages to both tourists and tourism management authorities
- Advantages for the tourists-
- Visualization of tourist sites. ie seeing what is available in the area they want to see
- Valuable information on tourist location can be embedded in the GIS- videos, photos, product brochures
- Selective information such as route planning, accommodations, cultural events, special attractions, etc
- Easily accessible information over the internet (web-based GIS)
- Interactive maps that correspond to user queries
- Advantages for development authorities
- To know where the customers are coming

- Planning like regional marketing, community infrastructure (transportation, utilities and zoning)
- Planning for new site selection
- As to know if one have the necessary space
- Utility of available resource
- Need to upgrade the transportation infrastructure to accommodate the additional traffic

Web GIS

- WebGIS is an advanced form of Geospatial Information System available on the web platform.
- The exchange of information takes place between a server and a client, where the server is a Geospatial Information System (GIS) server and the client is a web browser, mobile application and desktop application.
- The server has a unique Uniform Resource Locator (URL) so that clients can find it on the web.
- WebGIS brings GIS into the hands of the people. It reduces the need to create custom application. It provides a platform for integrating GIS with other business systems and enables cross-organizational collaboration. WebGIS allows organizations to properly manage all their geographic data.

Key elements essential to WebGIS

1. The server has a specific Uniform Resource Locator (URL) on the web so that the clients can easily access it.
2. The client depends on Hyper Text Transfer protocol (HTTP) specifications to send requests to the server.
3. The server performs the requested GIS operations and sends responses to the client via HTTP. The format of the response sent to the client can be in many formats, such as HTML, binary image, JSON (JavaScript Object Notation), XML (Extensible Markup Language).

Characteristics of WebGIS:-

1. WebGIS relying on Java, .Net, and flex can run on multiple platforms.
2. Support a large number of users simultaneously
3. WebGIS relying on HTML client supports different operating systems.
4. Better cross-platform capability.
5. However, Web GIS for mobile clients is far from being cross-platform because of the diversity in mobile OS and the incompatibility of mobile web browsers.
6. Easy to use for end users
7. Compatible with different web browsers: Google chrome, Internet explorer, Firefox, for diverse Oss (Win, Linux, Mac OS, iOs).
8. Unified system update.
9. Offers turnkey demographic datasets and imagery/map layers which allow users to access immediate context from different applications
10. Customized dashboards with the user-friendly interface

WebGIS Applications

1. Mapping /Visualization and query (attribute or spatial).
2. Collaborative collection of geospatial information
3. Geospatial analysis: measurement, optimal driving path, routing, pollution dispersion modelling, retail site selection.
4. Web GIS as a new business model and a new type of commodity. Location: specific advertising and branding based on mapping. eg Google map.
5. GIS application is an engaging and powerful tool for designing and planning government projects like flood management, forest mapping, and natural disaster.
6. WebGIS technology is used in geoscience research collaboration.
7. Web GIS in daily life: location-based service (LBS) supported by mobile web, smartphones and tablets. LBS include services to identify a location of a person or object, such as discovering the nearest ATM, restaurant, shops and hotels etc. LBS also include parcel tracking and vehicle tracking services.

The advantages of WebGIS

With the help of Internet, clients can access the geospatial information over the web regardless of the fact how far the server and client might be from each other. WebGIS introduces distinct advantages over traditional desktop GIS, including the following:

Applications:

Unlike desktop GIS, which is limited to a certain number of GIS professionals, webGIS can be used by everyone in an organisation as well as the public at large. This broad audience has diverse demands. Applications such as mapping street road, locating places to tag personal photos, tracing friends and displaying WiFi hotspots are a few examples.

Better Cross-Platform Capability:

Most of the WebGIS clients are web browsers like Internet Explorer, Google Chrome, Mozilla Firefox, Apple Safari etc. Because these web browsers are compatible with HTML and JavaScript standards, WebGIS that relies on HTML clients will typically support different operating systems such as Microsoft Windows, Linux, and Apple Mac OS.

World-Wide Reach:

The geographic data and maps can be presented to the world through WebGIS. Anybody locating anywhere in the world can access the geographical information from their computers, desktop or mobile devices. Almost all organizations open their firewalls at certain network ports to allow HTTP requests and responses to go through their local network, thus increasing accessibility for the clients.

Supports Multiple User At A Time:

In general, a traditional desktop supporting GIS application software is used by only one user at a time, while a WebGIS can be used by dozens or hundreds of users simultaneously. Thus, WebGIS provides much higher performance and scalability than single desktop GIS.

Low Cost As Averaged By The Number Of Users:

The vast majority of content on the internet is free of charge to end users, and this also applies on WebGIS. Generally, you do not need to buy software or pay to use WebGIS service. Organizations

that need to provide GIS service to individual users can also minimize their costs through WebGIS. Instead of buying and setting up desktop GIS for every user, an organization can set up just one WebGIS, and this single system can be shared by many users: from home, at work, or in the field.

User-Friendly:
Desktop GIS is intended for professional users with months of training and experience in GIS. WebGIS is intended for a broad audience, including public users who may know nothing about GIS. WebGIS is designed in such a way that navigating is as easy as using a regular website. WebGIS is specifically designed for simplicity, intuition, and convenience, making it typically much easier to use than desktop GIS.

Automatic Updates:
For desktops, GIS to be updated to a new version, the update needs to be installed on every computer. For WebGIS, one update works for all clients. This ease of maintenance makes WebGIS a good fit for delivering real-time information and taking the decisions.

Mobile GIS
Mobile GIS are an integrated technological framework for the access of geospatial data and location-based services (LBS)through mobile devices, such as Pocket PCs, Personal Digital Assistants (PDA), or smart cellular phones. With the advancement and convergence of GPS, Internet, and wireless communication technologies, mobile GIS have a great potential to play an important role in field data acquisition and validation (Pundt 2002) and emergency vehicle routing services (Derekenaris et al. 2001). The main users of mobile GIS are the field workers and consumers of location-based services,

Components of mobile GIS:
1. positioning systems,
2. mobile GIS receivers,
3. mobile GIS software,
4. data synchronization/wireless communication component,
5. geospatial data, and
6. GIS content servers.

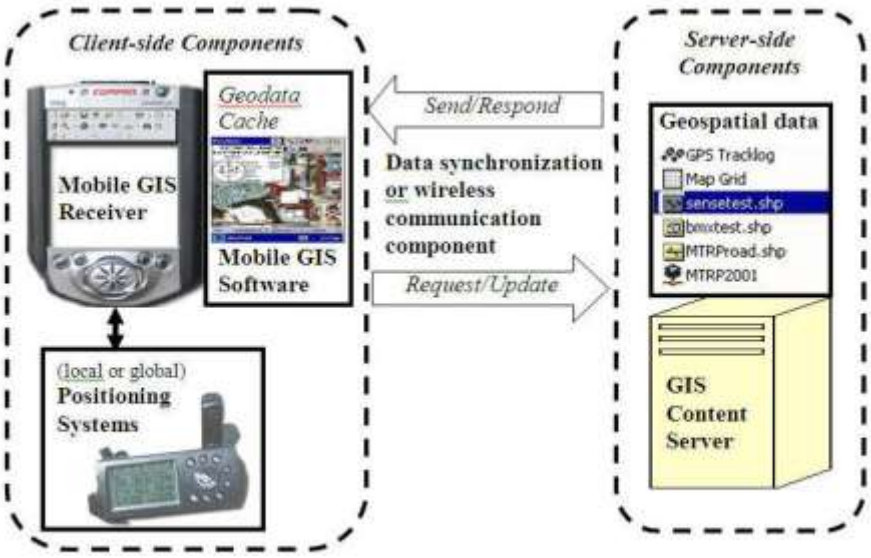

Figure 1. The architecture of mobile GIS.

Mobile GIS is taking Geographic Information Systems (GIS) out of the office and into the field. A mobile GIS allows folks out in the field to capture, store, update, manipulate, analyze, and display geospatial data and information. Mobile GIS integrates one or more of the following technologies: mobile devices (such as a PDA, tablet, or laptop computer, and in some countries mobile phones), Geographic Information System (GIS) software, the Global Positioning System (GPS), wireless communications for Internet-based GIS access. For most applications, it is an extension of desktop GIS, although increasingly users are taking mobile GIS data and uploading it directly to powerful visualization tools online such as Google Earth. Mobile GIS can allow for edits and changes to be made in the field, increasing accuracy and saving time. Many mobile GIS systems are relatively inexpensive.

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