Application of GIS in Modern Engineering

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**Abstract*: Surveillance and exchange of gathered information guides emergency response as well as long-term planning. In this paper we have discussed about the Open GIS, which can be very well utilized during different health hazards and in response to that some immediate actions can be taken up based on the available latest information in the said system. Open Source Web GIS software systems have reached a stage of maturity, sophistication, robustness and stability, and usability and user friendliness rivaling that of commercial, proprietary GIS and Web GIS server products. The Open Source Web GIS community is also actively embracing OGC (Open Geospatial Consortium) standards, including WMS (Web Map Service). WMS enables the creation of Web maps that have layers coming from multiple different remote servers/sources. Here we present one easy to implement .Web GIS server solution that is based on the Open Source Map Server. With the help of step-by-step instructions, interested readers running mainstream machines and with no prior technical experience in Web GIS or Internet map servers will be able to publish their own health maps on the Web and add to those maps additional layers retrieved from Remote WMS servers. All problems with planning and management are related to location, they are geographically referenced and require spatial analysis and presentation, an Open GIS on any compatible GIS platform will be very helpful tool for planning and decision making in emergency management. The geographical information system (GIS) is a tool used generically for any computer based capability for manipulating geographical data. The hardware and software functions of GIS include data input, data storage, data management (data manipulation, updating, changing, exchange) and data reporting (retrieval, presentation, analysis, combination, etc.).All of these actions and operations are applied to GIS as a tool that forms its database. The paper describes the types of the GIS data formats (vector, raster), database object definitions, relationships, geometric features, and the data organization structure. Some GIS applications and examples are given for better understanding of how GIS data can be used in GIS applications, with the respect to data formats, including surface elevation and slope from Digital Elevation Model data (DEM), with the applicability in water industry*.

Keywords: OGC, WMS, DEM, Vector, Raster

1. Introduction

Geographic Information Systems (GIS) is defined as "a system of computer hardware, software, and Procedures designed to support the compiling, storing, retrieving, analyzing, and display of spatially referenced data for addressing planning and management problems. In addition to these technical components, a complete GIS must also include a focus on people, organizations, and standards. A similar definition is provided by the U.S. Federal Highway Administration. Canada is a world leader in early innovations in GIS. GIS is enabling the application of smart (sustainable) development concepts and Intelligent Transportation Systems. Most transportation agencies now use GIS and Geospatial Information Systems for Transportation (GIS-T) is one of the largest users of GIS technology. The significant innovation that GIS provides is the ability to manage data spatially in layers and then overlay these layers to perform spatial analyses. Therefore, a roads layer can be integrated with a land use layer enabling a buffer analysis of the land uses within a given distance of the road. GIS added specific tools for linear data management of transportation data that has proved to be extremely successful among transportation organizations. These capabilities enable transit agencies to georeference their bus routes, stops, time points, and other features to a digital street centerline file, and keep all these data in synch.

Benefits of GIS

The following are some of the GIS's benefits:

- Integrating Geographic Information for display and analysis within the framework of a single consistent system.
- Allowing manipulation and display of geographic knowledge in new and exciting ways.
- Automating Geographic Information and transferring them from paper to digital format.
- Quick updating of information
- Integration of information by linking spatial
- And attribute data
- Spatial analysis
- Automated cartography
- Production of maps at different scales and Visualization.
- Linking location and attributes of feature(s) within the framework of one system.
- Providing the ability to manipulate and analyze Geographic Information in ways that are not possible manually.
- Automation of map making, production and updating.
- Providing a unified database that can be accessed by more than one department or agency.
- Storing Geographic Information in coincident and continuous layers

2. GIS Objectives

The main objectives of the GIS are**:**

1) To maximize the efficiency of decision making and planning
2) Provide efficient means for data distribution and handling.
3) Eradication of the duplicated data, integration of information from many sources.
4) Analysis of queries involving geographical reference data for generation of new information.
5) Update data quickly and at the minimum cost.

3. Component of GIS

The components of a GIS system intended for application in technology (hardware, software), data capture & integration, users and their requirements, and finally institutions.

4. Major application of GIS

- Urban development and planning
- Pollution studies
- Drainage programs
- Engineering and design work
- Pipeline and power-line construction
- Dam and reservoir planning
- Historical record of terrain
- Zoning classification
- Road location and highway development
- Selection of site
- Environmental impact
- Study of ecosystem
- Managing the risk regarding the use of
- natural resources
- Sustainability issues
- Managing traffic congestion
- Routing of roads
- Routing of pipelines
- Hydrologic Basin Areas
- Flow line Lengths
- Flow line Slope
- Runoff Coefficient
- Soils Types within Basins
- Land Use within Basins

4.1 GIS in the Assessment of Exposure to Air Pollution

GIS is the abbreviation for **Geographical Information System**, although it has recently been used to denote **Geographical Information Science**. GIS provides means of storing, processing and analyzing spatial data digitally. The use of GIS in exposure assessment studies has increased rapidly during recent decades. Improved accessibility to geo coded data, together with faster computers with large storage capacity, has made it feasible to conduct studies over large areas including a vast number of people. Improvements in computer capacity have also made it possible to conduct exposure modeling with increased spatial and temporal resolution. However, it is not only developments in computer science that have led to the application of GIS within this area, but also an awareness of the potential of GIS, especially in the field of epidemiology, where the need to assess the exposure of large populations or areas makes GIS ideal. Numerous GIS-based methods can be applied within this field, either as the basic concept, or in combination with other GIS-related methods. GIS can also be applied in all the different steps of exposure assessment, such as creating spatial databases of emission sources, locating population groups or areas, modeling levels of air pollutants, estimating exposure levels, locating emission sources and identifying exposure patterns. In the studies presented in this thesis, GIS has been applied for modeling concentrations of NOx, evaluating the spatial and temporal resolution of an emission database, estimating exposure to NOx and NO2, and estimating the exposure pattern from emissions of lead. These studies illustrate a variety of ways in which GIS can be used within the field of exposure assessment to provide insight into the potential of this tool.

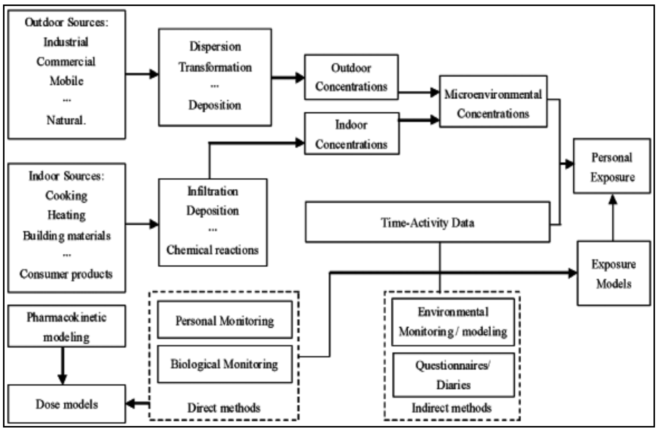

Figure 1: Air Pollution exposure

4.2 Application of GIS in traditional color coding for land uses

Land-use maps are the most common way of presenting land based data. They show land uses by rendering them in different colors. They effectively illustrate land-use concepts by graphically displaying land-uses, roads, public infrastructure, and community facilities. Planning agencies have been using one color scheme since the 1950's that has become a Defector standard. This standard is also being frequently recommended to planners across. The country. The following is a survey of this and other traditional coloring schemes. Maps generally use a different color for each of the major land-use categories. For example, It is common to render. Yellows for residential uses such as single-family and town houses.

- Browns for multi-family and high-rise residential
- Reds for retail and commercial uses
- Purples for industrial uses
- Blues for institutional and public facilities

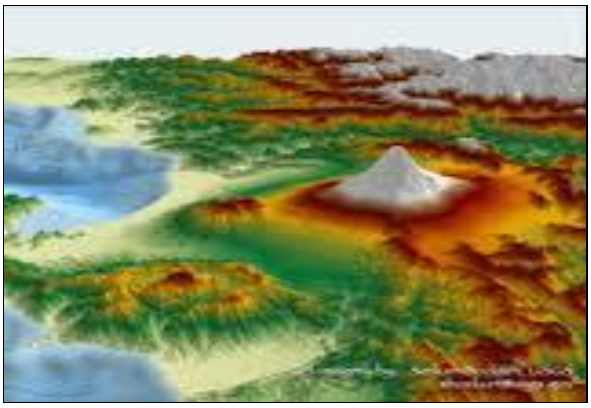

Figure 2: Colour coding in GIS

4.3 GIS for Urban and Regional Planning

The many benefits in using GIS in urban planning include

- improved mapping – better access to maps, improved map currency, more effective thematic mapping, and reduced storage cost;
- Greater efficiency in retrieval of information;
- Faster and more extensive access to the types of geographical information important to planning and the ability to explore a wider range of 'what if' scenarios;
- Improved analysis;
- Better communication to the public and staff;
- Improved quality of services, for example speedier access to information for planning application processing.

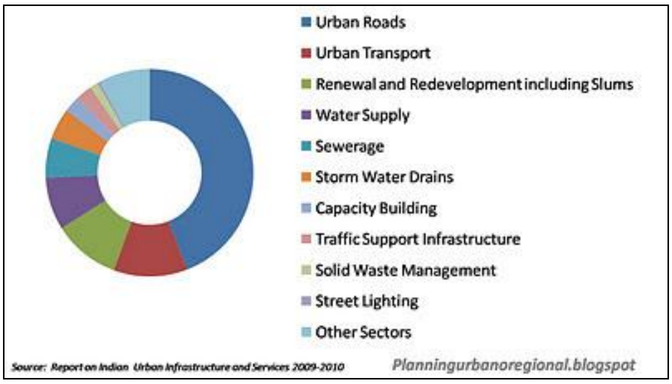

Figure 3: Orientation of Urban and Regional Planning

Planners require solutions that address day-to-day work needs while also fostering the ability to effectively predict and respond to chronic urban problems and future market fluctuation. The success of planners in combating chronic urban problems is largely determined by their ability to utilize effective tools and planning support systems that allow themto make informed decisions based on actionable intelligence.

Today, planners utilize GIS around the world in a variety of applications. The following articles illustrate how GIS is being used as a platform to help planners reach their goals of creating livable communities and improving the overall quality of life while protecting the environment and promoting economic development. GIS tools can provide the necessary planning platform for visualization, modeling, analysis, and collaboration.

4.4 Implementing Web GIS Applications using open Source Software

Internet based geographical data services involve management spatial and non-spatial (attribute) data. Geographic Information System (GIS) has come to be an indispensable tool for analyzing and managing spatial data. Data pertaining to spatial attributes can be efficiently managed using Relational Database Management System (RDBMS). The development of a Web-based system by integrating GIS and RDBMS would serve two crucial purposes. Firstly it would allow the user to operate the system without having to rapple with the underlying intricacies of GIS and RDBMS technology. Secondly, it would allow sharing of information and technical expertise among a wide range of users. In the present paper we describe the salient features of spatial database that was developed by integrating the Open Source Software (OSS) GRASS GIS and Posture Object-Relational database into a Web based client/server environment. The system described in this paper aims at providing a web-based platform for collaboration and data sharing between specialists, planning agencies, citizens, and private entities. In order to access the spatial database, the user need only have a Web browser and access to the Internet. The system can be used to readily build and manage spatial databases pertaining to landslides and is presently being adapted to suit other applications such as a Water Infrastructure Inventory System. Since the system is developed using OSS, it can be easily implemented in a distributed spatial database environment at a low overall cost. In this presentation we discuss salient features of an online system that offers public access to landslide information related to Japan .The basic framework of the system is shown in Figure 7. Further, we also present an overview of our ongoing efforts to improve the interoperability and compliance with the Open GIS Consortium (OGIS) Web Mapping Testbed (Web Mapping Testbed).

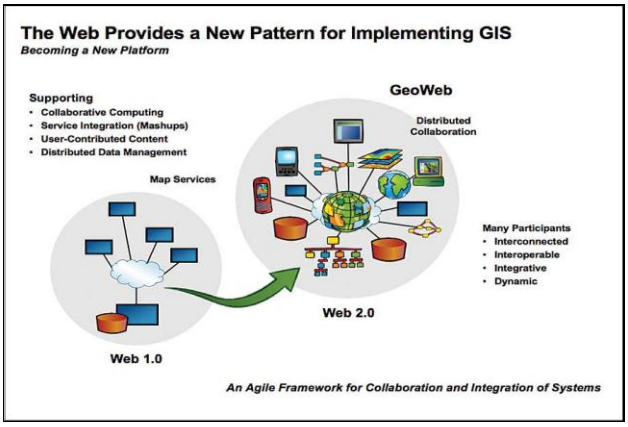

Figure 4: Implementing web GIS

4.5 Role of GIS in Water Resources Engineering

GIS provides an integrating data and modeling environment for the conduct of these activities. A GIS provides a means to collect and archive data on the environment. Measurements of location, distance, and flow by various devices are typically handled in digital formats and quickly integrated into a spatial database. Data processing, synthesis, and modeling activities can draw on these data using the GIS, and analysis results can be archived as well. The GIS spatial and attribute database can then be used to generate reports and maps, often interactively, to support decision making on which design alternatives are best and the impacts of these. Further, maps are a powerful communication medium; thus this information can be presented in public forums so that citizens concerned with planning and design choices can better understand and be more involved. Planning and design in water resources engineering typically involve the use of maps at various scales and the development of documents in map formats. For example, in a river basin study, the map scale often covers a portion of a state and includes several counties and other jurisdictions. The river drains a certain geography having topographic, geologic (including types of soils), vegetative, and hydrologic characteristics. Cities and human-built facilities are located along the river and across the basin, and transportation and pipeline networks link these together. All of these data sets must be established in a common georeference framework so that overlays of themes can be made and the coincidence of features can be identified in the planning and design phase. The GIS is applied to manage all of these data. It provides a comprehensive means for handling the data that could not be accomplished manually. The large amount of data involved requires a GIS, as there may be many thousands of features having a location, associated attributes, and relationships with other features. The GIS provides a means of capturing and archiving these data, and of browsing and reviewing the data in color-coded map formats. This data-review capability supports quality control, as errors can be more readily identified. Also, through visualization, the user can gain a better understanding of patterns and trends in the data in a manner not possible if in a river basin there are many applications of GIS, for example:

- Defining the watershed and its hydrologic and hydraulic characteristics so that models of rainfall-runoff processes can be applied to examine the impacts of land-use changes
- Mapping land-use and population demographics in support of water and wastewater demand estimation procedures Interpolating groundwater contaminant concentrations given sampled data at observation wells spaced throughout an aquifer, or estimating snowpack amounts at ungauged locations based on data obtained at gauged locations guided by factors of elevation and exposure.
- Managing public infrastructure, such as scheduling maintenance on a sewage collection system, notifying residents of water-pipe rehabilitation work, or identifying areas of potential low pressure during fire-response planning scenarios.
- Finding the coincidence of factors, such as erosion-prone areas having a certain combination of soil type, land cover, and slope.

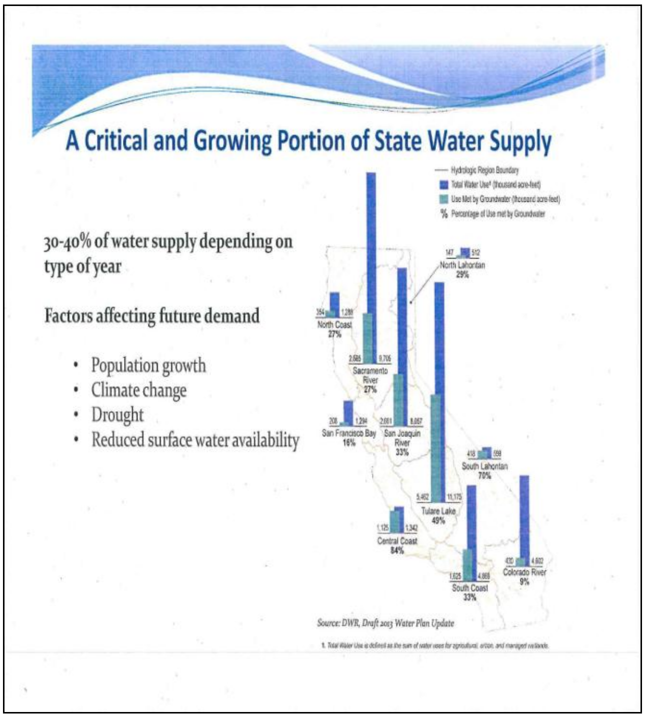

Figure 5: application of GIS on water demand

4.6 Application of GIS in Mining

The use of Geographic Information Systems (GIS) is a powerful tool and is gathering momentum in the mining industry. Of particular interest is the GIS capability to integrate communications across departments and mine sites. GIS technology must constantly evolve to meet the changing needs of the mining industry, both in Exploration and mining terms. Mining companies use GIS to actively monitor the environmental impacts that may be caused by their activities. Geologists use GIS to analyze and map soils, vegetation, surface hydrology, and groundwater. Esri and its business partners actively promote sustainable development by collaborating on many GIS applications specifically designed for environmental study. Performing advanced analysis and visualization of environmental and geologic data can be done easily and quickly using the EQuIS ArcView GIS Interface. This solution integrates several industry applications including as ArcGIS, Rockworks, EVS, and more, to produce a world-class, customizable solution for subsurface investigation and analysis.

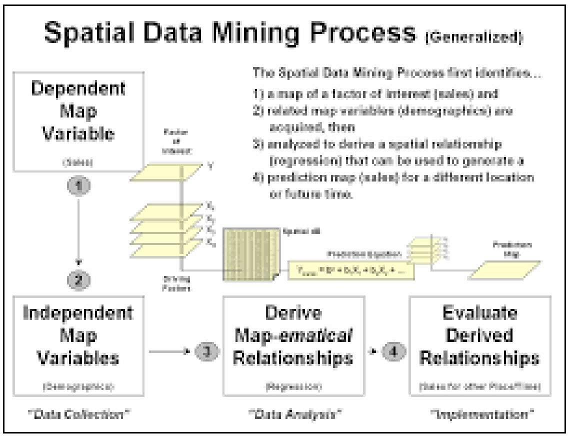

Figure 6: GIS on Mining

4.7 The application GIS on disaster management

It has become a well developed and successful tool in disaster management, as we have our location observation programmes and the requisite for hazard mitigation and monitoring rang high in the planning of new satellites.GIS allows for the combination of the different kinds of spatial data with non-spatial data, attribute data and use them as useful information in the various stages of disaster management. Various disasters like earthquakes, landslides, cyclones, tsunamis are natural hazards that kill lots of people and destroy property and infrastructure every year. The rapid increase of the population and its increase concentration, often in hazardous environment, has escalated both the frequency and severity of natural disasters. Among the tropical climate and unstable land forms, coupled with deforestation, unplanned growth propagation, on-engineered constructions which make the disaster prone areas sheer vulnerable, slow communication, poor budgetary allocation for disaster prevention, developing countries suffer more or less unceasingly by natural disaster.

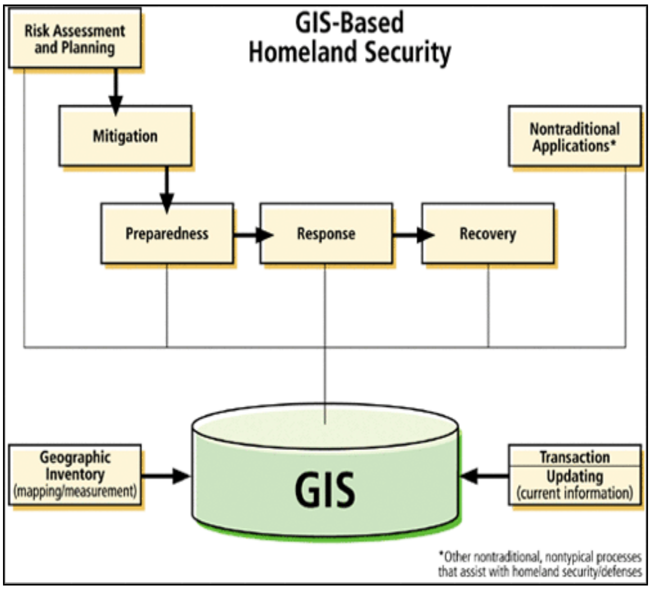

Figure 7: GIS in disaster management

4.8 Application of GIS in Transportation

A variety of applications of GIS in urban transportation planning and management have been reported. Some of these applications include: Transportation master plans and Site plans Multimodal transportation planning (e.g., travel demand forecasting) Public participation and Scenario development/visioning Asset management systems including infrastructure maintenance management. Safety management including accident analysis.Transportation system control and management (TSC-TSM) Corridor preservation/right of way. Construction management and Hazardous cargo or overweight/oversize vehicles permit routing. Environmental impacts.

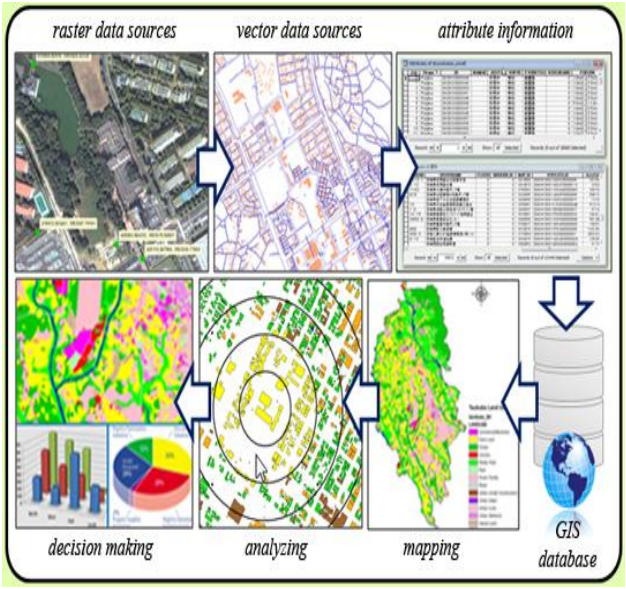

Figure 8:

4.9 GIS in Agriculture

Burrough and McDonnell (1998) has defined GIS as a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes. Application of GIS is revolutionizing planning and management in the field of agriculture. The technology that has given vast scope to the applicability of remote sensing-based analysis is 'Geographic Information System (GIS)'. GIS provides ways to overlay different 'layers' of data: the ecological conditions, the actual physiognomy and human pressure indices. Agriculture always plays an important role in economies of both developed and undeveloped countries. Here in this study, we have used satellite based earth observation data to analyze and calculate crop inventory. More accurate and reliable crop estimates helped to reduce uncertainty in the grain industry. The ability of GIS to analyze and visualize agricultural. Environments and work flows has proved to be very beneficial to those involved in the farming industry. Balancing the inputs and outputs on a farm is fundamental to its success and profitability. Spatial data are commonly in the form of layers that may depict topography or environmental elements. Nowadays, GIS technology is becoming an essential tool for combining various map and satellite information sources in models that simulate the interactions of complex natural systems. GIS can be used to produce images, not just maps, but drawings, animations, and other cartographic products. From mobile GIS in the field to the scientific analysis of production data at the farm manager's office, GIS is playing an increasing role in agriculture production throughout the world by helping farmers increase production, reduce costs, and manage their land more efficiently. While natural inputs in farming cannot be controlled, they can be better understood and managed with GIS applications such as crop yield estimates, soil amendment analyses, and erosion identification and remediation. Yang et al. (2004) has integrated remotely sensed data with an ecosystem model to estimate crop yield in north china. His paper describes a method of integrating remotely sensed data (the MODIS LAI product) with an ecosystem model (the spatial EPIC model) to estimate crop yield in North China. The traditional productivity simulations based on crop models are normally site specific. To simulate regional crop productivity, the spatial crop model is developed firstly in this study by integrating Geographical Information System (GIS) with Environmental Policy Integrated Climate (EPIC) model. (Wu Bingfng and Liu Chenglin .2000) worked on Crop Growth Monitor System with Coupling of AVHRR and VGT data.

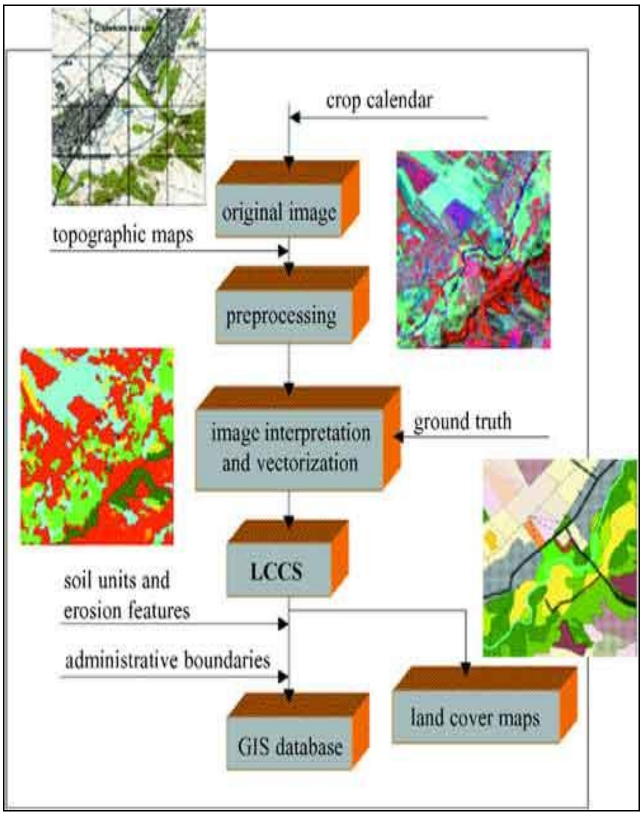

Figure 9: GIS in Agriculture

5. Conclusion

Internet based geographical data services involve management spatial and non-spatial (attribute) data. Geographic Information System (GIS) has come to be an indispensable tool for analyzing and managing spatial data. Data pertaining to spatial attributes can be efficiently managed using Relational Database Management System (RDBMS). The development of a Web-based system by integrating GIS and RDBMS would serve two crucial purposes. Firstly it would allow the user to operate the system without having to grapple with the underlying intricacies of GIS and RDBMS technology. Secondly, it would allow sharing of information and technical expertise among a wide range of users. In the present paper we describe the salient features of spatial database that was developed by integrating the Open Source Software (OSS) GRASS GIS and Posture SQL Object-Relational database into a Web based client/server environment. The system described in this paper aims at providing a web-based platform for collaboration and data sharing between specialists, planning agencies, citizens, and private entities. In order to access the spatial database, the user need only have a Web browser and access to the Internet. The system can be used to readily build and manage spatial databases pertaining to landslides and is presently being adapted to suit other applications such as a Water Infrastructure Inventory System. Since the system is developed using OSS, it can be easily implemented in a distributed spatial database environment at a low overall cost. In this presentation we discuss salient features of an online system that offers public access to landslide information related to Japan. Further, we also present an overview of our ongoing efforts to improve the interoperability and compliance with the Open GIS Consortium (OGIS) Web Mapping Testbed (Web Mapping Testbed).

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