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Application of GIS and Associated Technologies for Resource Mapping and Planning

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Geographic Information System or GIS is so versatile that it is difficult either to define or to imagine or even to visualize it. By the end of the 1970s the term GIS had emerged in recognition both of common technological requirements and of the opportunity to built the system that could potentially satisfy all of various applications. Nevertheless, GIS is information about geography, i.e. information tied to some specific set of locations on the earth surface, including the zones immediately adjacent to the surface and subsurface, ocean and atmosphere. 'Spatial' is often used synonymously with or even in preference to 'geographical' in the context, although in principle it might be taken to include information that is tied to frames other than the earth surface, such as the human body (as in medical imaging) or a building as in architectural drawings.

The modern GIS has the utility of the maps by replacing it with a large number of mapped 'coverages', each with an interrelated theme. These coverages can be automatically analyzed and the themes are combined to give meaningful answers for decision makers. The GIS is gradually changing the way we do think with maps, the way we think about geographic Information, even the way in which the geographic data is collected and compiled. The task, which was impossible with the traditional maps, is now commonplace. To answer such question requires access to the geographical information, which is characterized by its multidimensional nature (x, y, z coordinates and time), its large volume and high processing cost. Even to answer apparently simple questions needs that data from several sources must be integrated into consistent form and be analyzed.

Many planning department and other national organizations such as Survey of India, NRSC and National Atlas and Thematic Mapping Organisation have a long history of using topographical maps and remotely sensed imageries for preparing base maps for spatial planning. The methodologies of designs in such projects are invariably worked out on the basis of requirements projected by the resource users. The multidisciplinary approach to planning is often effected by non-availability of reliable, systematic and accurate data to all those involved in spatial planning. A number of planning organizations have developed need based GIS to assist in analyzing and making suitable projections. Non-availability of accurate and consistent spatial data base is, however, proving to be the biggest constraint. There also appears to be hesitation in standardization the database content on account of subjectivity in the requirement of data.

Geospatial information, including maps and images, are vital to support decision making at various level and implementation of action plans. With the availability of space borne imagery, Global Positioning System (GPS) data and Geographic Information System (GIS) technology, users are now able to process maps –both individually and along with tabular data and crunch them together to provide a new perception- the spatial visualization of information.

Space based images has the characteristic to cover vast areas and have larger information quality as well as multi-spectral and repeat observations ability, thus, it is suitable for regional and global environment monitoring. The application of satellite images not only used for mapping but to monitor temporal changes in the environment as well. Further, global positioning system is one of the recent and important advances positioning technique. Its effectiveness and high positioning accuracy, the system has been widely applied in many different fields

Geographic information system now has become a tool to integrate different sources to help users to manage earth's resources and environment. It assists decision makers to formulate the best policy for the development and the use of earth's resources. Vast amount of geographical information that was originally scattered in different organizations like maps, photos, statistics, detailed list etc could be integrated in GIS environment.

The science of surveying and mapping encompasses a broad range of disciplines including Surveying & Mapping, Remote Sensing (RS), GIS and GPS. The technology of digital image processing, the global positioning system and GIS are being used to integrate, processed and analyzed the spatial data for sustainable development of the natural resources. The digital data (e.g. High resolution images, scanned aerial photographs, scanned maps and digital orthophotos) are currently available for this purpose. GIS is powerful system for decision-making tool is now in the hand of cartographers. Beginning with a computerized topographic map as its base, a GIS overlays and integrate graphic and textual information from separate databases. The end result is a customized and reliable tool that can support decision making and problem solving and provides almost instantaneous answers to complex questions.

In view of the present day requirement, Survey of India (SOI) plans to provide digital topographical databases for entire country on 1:50,000 scale initially, in a years time. Topographical data/maps in digital and analogue form on WGS 84 (World Geodetic System 84) is made available for general public without any restriction (existing topographical maps of SOI are on Everest datum). The department uses the state-of-the-art technology in glossarial data

acquisition, management and dissemination. Airborne Laser Terrain Mapping (ALTM), GPS, Electronic Distance Measuring (EDM) instruments, digital photogrammetry, modern printing technology and computer hardware/ software are being used in map-making process. High-resolution satellite imagery viz. SPOT, Ikonos, Quickbird data etc are being used for updating of topographical maps. All these data sets would be useful in developing Spatial Data Infrastructure that will better facilitate the availability and access to spatial data for all level including Government sectors, Commercial sectors, Academia and citizens in general.

Images & GIS

The technology of the geoinformatics is now becoming user friendly. The sophistication of new data gathering technologies and geographic information system (GIS) technologies is increasing in developing spatial data applications. In the present scenario, we may identify various technologies where its products and services are directly representing its application in sustainable development. These are like navigation and positioning, high resolution sensing, image analysis, GIS, data visualization, database management, geospatial data and its infrastructure and user application and solutions.

High Resolution Images

Airborne remote sensing has been characterized extremely flexible and broad range of high-resolution data enabling mapping at scales of better than 1:1000; black-and-white and color photography, mono and stereo; high-resolution multi-spectral and radar digital imagery. Alternatively, satellite remote sensing has exhibited resolutions typically 10 m or better, enabling mapping of up to 1:50 000 scale. ALTM technology is being used for preparing large-scale maps. SOI has recently acquired digital data through ALTM technology and prepared a line map.

Image Analysis

Image analysis technologies are undergoing a number of changes. The major trend will be to see the expansion of image analysis technology from the exclusive domain of the highly educated remote sensing professional to the desktop of significant numbers of new professional and other users, as a result of a number of contributing factors. First, the continued drop in the price of PC hardware combined with a substantial increase in power, memory, storage capabilities and graphics speed makes sophisticated image analysis feasible for the first time on the desktop. Also, the planned launch of high-resolution commercial satellites will bring image analysis technology into many new markets including infrastructure, property management, health and insurance.

Geographic Information Systems

Geographic information systems deal with the storage, management, retrieval, conversion, analysis, modeling and display of spatially related data in a systematic way. GIS software is potentially applicable in nearly any situation that calls for decisions involving a spatial component. In other words, GIS can be a useful tool in situations as diverse as area to determining the environmental impact. It is impossible to list all the possible applications of GIS, as they are practically limitless. As computer power grows, enabling the use of more complex models and the more efficient incorporation of a time component in analysis, the more this will

be true. Advances in computer software and hardware, increased familiarity with the power and applicability of GIS and its related technologies, and a greater breadth of accessible data have driven the growth in demand for GIS and will continue to do so in the future. Throughout the knowledge-based economy, both software and hardware have become much more powerful and simple to use while becoming less expensive. Clients in all markets are now comfortable with computers and have access to the necessary equipment to run even complex GIS packages. Furthermore, not only has a greater range of geospatial data become more readily available but also non-traditional data such as those found in the social sciences.

Data Visualization

Geospatial-related data visualization technologies are tools that facilitate the understanding of complex data sets, models and issues that have a spatial component. They include everything from their simplest form -- paper maps -- to a wide range of computer hardware and software. While these represent a broad spectrum of complexity, these media are linked by their purpose of presenting geospatial data from different perspectives. Recently, however, data visualization has been driven by advances in modern computer and display technology.

As geographic information systems become more flexible, powerful and sophisticated and more closely integrated with modeling software, the interface between the GIS and the user needs to become more interactive and complex. There is also a push for the broader application of data visualization technologies in non-traditional areas.

Database Management

Data Base Management System (DBMS) are specialized pieces of software that provide functionality for storing, updating and retrieving information and generally provide mechanisms for maintaining the integrity of stored information, managing security and user access, recovering information after the system fails, and accessing database functionality from within an application written in a third-generation language such as COBOL, C or JAVA.

Great advances have been made in the area of DBMS over the past decade. Early systems were hierarchical in nature, but relational systems have become the standard recently. With the emergence of object-oriented programming languages, object-oriented systems are becoming increasingly important to data storage. Constant developments in areas such as structured query languages, most recently SQL3, have been a driving force in these changes and are fuelling a shift away from purely relational systems.

Geospatial Data and its Infrastructure

The characteristics of the geospatial data set are changing. First and foremost, in order to meet users demands effectively, the capacity for the real-time collection, synthesis and access must exist; data currency is essential. The data should be scale less, seamless, without artificial boundaries, and linked to a time component that has become critical to many applications, for example, traffic flow management, routing and delivery, and tidal and marine traffic. Moreover,

as technologies become more advanced, geospatial information will be both more readily available and in greater demand.

There will also be a growing trend toward the collection and integration of non-traditional data using secondary reference systems like voting, culture and housing patterns, gender, sales and industry. Furthermore, as technologies and applications become more globally used, geospatial data will spread to and originate from non-traditional sources such as the voluntary sector, health councils, communities and peoples. However, regardless of what data are collected by whom, unless they are easily and readily accessible, their value diminishes; hence the importance of an exceptional geospatial data infrastructure. Furthermore, a well-developed national information infrastructure, enabling the dissemination and sharing of valuable, geographically referenced information, and with an ever-increasing audience of businesses, entrepreneurs, students and researchers, and communities, is widely accepted as an essential asset for any country to maintain and to advance its social and economic well being. As such, geospatial data and the infrastructure in which they are organized can be considered to be a technology in its own right within the rubric of this Technology.

User Applications and Solutions

While technologies such as GPS and GIS have matured during the 1990s, increasing attention has been focused on the development of user applications and solutions. This technology segment can be defined as software/hardware solution bundles developed specifically to solve a geospatial information user's problem. The critical challenge in this area is for the technology supplier to gain an in-depth understanding of the user's business environment so that the solution is optimized to address the user's key business issues. Built on top of the core technologies, user applications/solutions are developed using combinations of database management, object-oriented programming and systems integration tools and techniques. Clearly, geospatial data and GIS were considered to be extremely important technologies for addressing solutions in a number of applications.

India, over the years, has generated a rich base of information through systematic data collection in the form of topographical surveys, geological surveys, soil surveys, cadastral surveys, various national resource innovative programmes and the use of remote sensing images. Further with the availability of digital topographic databases, high-resolution imageries and sophisticated techniques of data collection using GPS and tidal station, the accuracy of information content of these spatial data sets or map is very high. With the growing awareness for Information Technology among users, an initiative was taken by Department of Science & Technology in the form of National Spatial Data Infrastructure (NSDI).

Conclusion

Images, GPS and GIS were considered to be extremely important technologies for addressing solutions of various users. The technology of surveying and mapping is knowledge-based and having no bounds or limits at this time and having the possibility to evolve in numerous directions, including resource mapping and planning. The technology advancement will determine the direction and strength of this evolution over the next few years. As such, it is

very difficult to describe how the technology will look at any time in the future with any degree of certainty.

Increasingly, state and local economic development activities are coming to rely as much on GIS technology as are environmental and natural resource concerns. These problems would be challenging enough, but they are complicated by the inefficiencies of traditional government planning processes. As authorities admit, "traditional planning is fractured, takes decades to implement, and often spawns lawsuits between developers and environmentalists." With population growing at skyrocketing rates, these were conditions different counties could no longer tolerate. Increasingly, national, state, regional and municipal social and economic development activities are coming to rely on GIS technology. In order to have an economically viable approach, GIS capabilities are also being deployed in an effort to improve health, enhance emergency preparedness, and save lives.

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