GIS Based application for Rural Development - A Policy Warranted

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Abstract

The world is changing very fast. And the expectations of the customers are also changing exponentially. This pace of change are forcing to have phenomenal challenge to all those working in the GI industry. The boom in mobile and internet technologies continues to grow the importance of Geographic Information whilst customers demand better quality, consistency and accuracy of geographic data in the location based market. At the same time technological innovation is enabling us to collect, integrate, store, manage, manipulate, enhance and distribute this information more and more effectively in hand with a growing customer requirement for real time data update. So the challenge presented today in any field is part of a global phenomenon.

In the context of our state, deployment of such a tool is even more important since it can help plan better irrigation schemes, predict the impact of proposed highways and railway lines, help in locating the right area for new industries or housing colonies, identify locations losing plantation at alarming rate and suggest possible counter measurements, etc. Governments are increasingly seeking greater effectiveness and efficiencies in the delivery of services to the citizen. This growing agenda to reform public services have provoked a shift to be more customer and output focused. This in turn has added another dimension to the requirement for change together with some changes in funding and the need to become more commercial. The initiative set by the Departments of Space and of Science and Technology with regard to a NSDI recognises the requirement for readily accessible digital spatial information and its importance in underpinning every aspect of socio-economic activity.

Introduction

Geographic Information Technology has developed at a remarkable pace over the past two decades and will play a key role in development of nations in the 21st Century, thereupon many countries have already prepared their strategic development plans for application of GIS Technology with gigantic financing endeavors. Now time has come for all decision makers to discuss the appropriateness of GIS technology and its applications to rural development, forest management, urban development planning, land information systems and agricultural development. This will also provide a suitable solution for the use of GIS for educational infrastructure development with special emphasis on rural sector in India.

Educationists, planners, researchers, decision makers, administrators, communication professionals and officials from different departments and some reputed NGOs should be invited to discuss the role of GIS Technology and should implement the same outcome immediately for ensuring sustainable development and socio-economic and educational uplifting of the country.

Information Technology has emerged as an inevitable phenomenon influencing every walk of life of people in all sections of this society. With the ease of availability of enormous computing power and convenient access to large volume and variety of data and information, the structure and functions of all human organisations will undergo profound transformation in this century. Nations are engaged in exploiting this phenomenon for many of their socio-economic requirements. One area, which is engaging serious attention, relates to use of Information Technology in the governance systems, especially the tools and techniques for acquisition and management of data relating to Geographic Information System (GIS).

GIS in India

India maintains a pre-eminent position in the use of spatial imagery. The capabilities in the development of high-resolution satellites and extensive network of associated infrastructure have contributed to the growing interest in the application of GIS for a variety of India’s development needs. Indications are that these applications will continue to grow even more rapidly in the coming years. Since the spatial imagery is becoming easier to use and more affordable, the user base for GIS is expanding in several directions in seeking holistic solutions beyond image processing capabilities.

The Information Technology policy of Government of India adopted in 1999 emphasizes the availability of spatial data to GIS user community and industry, thereby enabling the widespread development of Spatial Decision- Support Information System Network including Web enabled GIS application services. The Indian export from GIS segment is expected to increase to US $ 150 million in the next five years from the present level of US $ 60 million. The areas which are receiving priority attention include natural resources information assessment, monitoring and management, water shed development, environmental planning, urban services and land use planning.

Most States in India and several ministries and departments of the Central and State Governments have initiated special GIS programmes relating to ground water studies, cadastral mapping, power transmission and transportation infrastructure. The integration of socio-economic data with spatial data is increasing. The institutional infrastructures have been developed across the country catering to the local, regional and national needs. Some of the institutions with sophisticated capabilities are: National Remote Sensing Agency, Hyderabad, Indian Institute of Remote Sensing, Dehradun, Space Application Centre, Ahmedabad, Regional Remote Sensing Service Centres at Bangalore, Nagpur, Jodhpur, Institute of Remote Sensing at Anna University, Chennai and Survey of India Training Institute, Hyderabad. These institutions offer a variety of training programmes relating to GIS besides undertaking or supporting large scale application projects.

At present a large number of private firms of Indian and foreign origin have been active a undertaking GIS projects. They have been particularly responsible in introducing in the country instruments, softwares and educational programmes. Central Mining Research Institute (CMRI), one of the premier laboratory of Council of Scientific and Industrial Research (CSIR) is fully equipped with latest IT related infrastructure and their Scientist are capable for undertaking any GIS related projects of India and abroad. NIC is also providing assistance to several Central, State and Local bodies in fulfilling their specific GIS requirements. In recent years most of the organisations engaged in GIS activities have felt the need for establishing control points especially in applications such as land records management, cadastral survey and hydrographic survey. For these tasks, acquisition of Global Positioning System (GPS) has been increasing. During the year July 2000-June 2001 about 50 GPS equipments have been procured by several governmental agencies in the country. Despite these noteworthy achievements in GIS in India, there are still some limiting factors that need to be addressed, such as the restrictions on the availability of high-resolution data in sensitive areas, lack of nationwide control points, absence of more convenient repository and retrieval systems and lack of standardization of map scales.

The implementation of GIS in Research Programme raised a variety of conceptual questions for both the ecological and the socio-economic sectors of this regional, integrated research programme. In addition to these basic units of research, spatial links between the two sectors and levels of data abstraction for the spatial database had to be defined. Using the theoretical background of the hierarchical system approach and valuable experiences of spatial data handling a consistent spatial information database can be created. Despite problems with data accuracy, logical consistency and completeness of data, a powerful tool for regional and local planning can be developed which can serve as a framework for a variety of planning purposes at the local and regional levels, as well as the transfer of know-how between governmental agencies and institutions using an interactive approach.

Agriculture in India

In FY 1987, field crops were planted on about 45 percent of the total land mass of India. Of this cultivated land, almost 37 million hectares were double-cropped, making the gross sown area equivalent to almost 173 million hectares. About 15 million hectares were permanent pastureland or were planted in various tree crops and groves. Approximately 108 million hectares were either developed for nonagricultural uses, forested, or unsuited for agriculture because of topography. About 29.6 million hectares of the remaining land were classified as cultivable but fallow, and 15.6 million hectares were classified as cultivable wasteland. These 45 million hectares constitute all the land left for expanding the sown area; for various reasons, however, much of it is unsuited for immediate cropping. Expansion in crop production, therefore, has to come almost entirely from increasing yields on lands already in some kind of agricultural use. Due to lack of information about the land and their nature, we are still not getting the proper return with the yield of those lands.

The Community Development Programme in India was inaugurated in 1952 to implement a systematic, integrated approach to rural development. The nation was divided into development blocks, each consisting of about 100 villages having populations of 60,000 to 70,000 people. By 1962 the entire country was covered by more than 5,000 such blocks. The key person in the program was the village-level worker, who was responsible for transmitting to about ten villages not only farming technology, but also village uplift programs such as cooperation, adult literacy, health, and sanitation. Although each block was staffed with extension workers, the villagers themselves were expected to provide the initiative and much of the needed financial and labor resources, which they were not in a position to do or inclined to do. Although progress had been made by the early 1960s, it was apparent that the program was spread too thin to bring about the hoped-for increase in agricultural production. Criticism of the program led to more specialized development projects, and some of the functions were taken up by local village bodies. There was only a negligible allocation for community development in the sixth plan, however, and the program was phased out in the early 1980s.

The Intensive Agricultural District Programme, launched in five districts in 1960 by the central government in cooperation with the United States-based Ford Foundation, used a distinctly different approach to boosting farm yields. The program operated under the premise that concentrating scarce inputs in the potentially most productive districts would increase farm-crop yield faster than would a wider but less concentrated distribution of resources in less productive districts. Among these inputs were technical staff, fertilizers, improved seeds, and credit. Under the technical guidance of American cooperative specialists, the program placed unusual emphasis on organizational structures and administrative arrangements. For the first time, modern technology was systematically introduced to Indian farmers. Within a decade, the program covered fifteen districts, 28,000 villages, and 1 million inhabitants. The Intensive Agricultural District Programme was thus a significant influence on the forthcoming Green Revolution.

Irrigation in India

Except in southeastern India, which receives most of its rain from the northeast monsoon in October and November, dryland cultivators place their hopes for a harvest on the southwest monsoon, which usually reaches India in early June and by mid-July has extended to the entire country. There are great variations in the average amount of rainfall received by the various regions--from too much for most crops in the eastern Himalayas to never enough in Rajasthan. Season-to-season variations in rainfall are also great. The consequence is bumper harvests in some seasons, crop-searing drought in others. Therefore, the importance of irrigation in India cannot be overemphasized.

Irrigation in India has been a high priority in economic development since 1951; more than 50 percent of all public expenditures on agriculture have been spent on irrigation alone. The land area under irrigation expanded from 22.6 million hectares in FY 1950 to 59 million hectares in FY 1990, an increase of 161 percent in four decades. This increase was about 33 percent of the estimated potential. The overall strategy has been to concentrate public investments in surface systems, such as large dams, long canals, and other large-scale works requiring huge outlays of capital over a period of years, and in deep-well projects that also involve large capital outlays. Shallow-well schemes and small surface-water projects, mainly ponds (called tanks in India), have been supported by government credit but were otherwise installed and operated by private entrepreneurs. Roughly 42 percent of the net irrigated area in FY 1990 was from surface water sources. Tanks, step wells, and tube wells provided another 51 percent; the rest came from other sources.

Between 1951 and 1990, nearly 1,350 large- and medium-sized irrigation works were started, and about 850 were completed. The most ambitious of these projects was the Indira Gandhi Canal, with an anticipated completion date of close to 1999. When completed, the Indira Gandhi Canal will be the world's longest irrigation canal. Beginning at the Hairke Barrage, a few kilometers below the confluence of the Sutlej and Beas rivers in western Punjab, it will run south-southwest for 650 kilometers, terminating deep in Rajasthan near Jaisalmer, close to the border with Pakistan. A dramatic change already had taken place in this hot and inhospitable wasteland by the late 1980s. As a result, desert dwellers switched from raising goats and sheep to raising wheat, and outsiders flocked in to purchase six-hectare plots for the equivalent of US$3,000.

Progress in irrigation has not been without problems. In India, arge dams and long canals are costly and also highly visible indicators of progress; the political pressure to launch such projects was frequently irresistible. But because funds and technical expertise were in short supply, many projects moved forward at a slow pace. The Indira Gandhi Canal project is a leading example. And the central government's transfer of huge amounts of water from Punjab to Haryana and Rajasthan, frequently cited as a source of grievance by Sikhs in Punjab, contributed to the civil unrest in Punjab during the 1980s and early 1990s .

Problems also have arisen as ground water supplies used for irrigation face depletion. Drawing water off from one area to irrigate another often leads to increased salinity in the supply area with resultant effects on crop production there. Some areas receiving water through irrigation are poorly managed or inadequately designed; the result often is too much water and water-logged fields incapable of production. To alleviate this problem, more emphasis is being placed on using irrigation water to spray fields rather than allowing it to flow through ditches. Furthermore, charges of corruption and mismanagement have been levied against government-operated facilities. Cases of bribery, mal-distribution of water, and carelessness are frequently raised in the media.

Another major problem has been the displacement of thousands of people, usually poor people, by large hydroelectric projects. Critics also claim that the projects are damaging to the ecology. Smaller projects and such traditional methods for irrigation as tanks and wells are seen as having less serious impact. In the late 1980s and early 1990s, the debate between large-scale versus small-scale projects came to the fore because of the US$3 billion Sardar Sarovar project on the Narmada River. Sardar Sarovar, as conceived, was one of the world's largest hydroelectric and irrigation projects. Some 37,000 hectares of land in Madhya Pradesh, Gujarat, and Maharashtra were slated to be submerged following the construction of some 3,000 dams, 75,000 kilometers of canals, and an electric power generating capacity of 1,450 megawatts of power per year. Included among the 3,000 dams was the proposed 160-meter-high Sardar Sarovar Dam. In 1985 the World Bank agreed to loan US$450 million for the project. Environmentalists in India and abroad, however, argued that the project was ecologically undesirable. In the face of this strong protest, the World Bank appointed a two-member team in 1991 to review the project. Despite a negative review of the environmental impact by the team, World Bank funding and the project continued. By 1993, however, in the face of continued international protest as well as opposition and a call for a satyagraha (passive resistance--see Glossary) by villages in the affected areas, the central government cancelled the dam project loan. Work on the Sardar Sarovar project continues, however, with funds provided by the central government and the governments of the three states involved.

Although India had the second largest irrigated area in the world, the area under assured irrigation or with at least minimal drainage is inadequate. The irrigation potential estimated to have been created by the early 1990s was about 82.8 million hectares. This amount includes the gross irrigated area plus the potential for double cropping provided by irrigation. There was a cumulative gap in irrigated land use of about 8.6 million hectares until FY 1990, by which time the gap had decreased through improved land management. Now days has come for the recycling of water and for this watershed shed management programme should be implemented properly.

Technology and Mechanization India

Despite the pervasive, large-scale use of draft animals throughout India, agricultural machinery and implements, tractors, in particular, have had an important place in increasing agricultural productivity. The stock of tractors increased from 8,600 in FY 1950 to 518,500 in FY 1982 and continued to grow rapidly throughout the 1980s . The number and sale of power tillers and combine harvesters produced and sold was small, with 4,678 tillers and 110 harvesters sold in FY 1988. There was a significant increase in the number of electric pumps and oil pump sets for irrigation during the 1980s.

The production and use of machinery are hampered by the small size of many operational holdings. However, a number of improved agricultural implements are available for tilling, seeding and fertilizer application, weeding, harvesting, and threshing. The implements include moldboard plows, disc harrows, cultivators, seed drills (more than 110,000 were sold annually in the early 1990s), and mechanical power threshers. These tools have the potential of increasing yields for all crops, but the adoption rate of improved machinery is low. The Central Institute of Agricultural Engineering at Bhopal, Madhya Pradesh, under the aegis of the Indian Council for Agricultural Research, is responsible for coordinating the manufacture and promotion of technology for small and marginal farmers. The government introduced an incentive scheme in 1990 to subsidize the cost of machinery by up to 50 percent to small and marginal farms. Additionally, farmers' agro service centers are being established to provide custom service for improved implements and machinery. The eighth plan includes a major thrust for upgrading and adopting proven technology.

In a country with a large and growing labor force, too much mechanization in the short run could create fossil fuel shortages as well as social and economic problems. There is, nevertheless, room for improvements in technology. Since FY 1983, there have been attempts to popularize improved animal-drawn agricultural implements and hand tools through demonstrations and subsidies to small and marginal farmers.

Despite these advances in mechanization, most crops in India are still sown, transplanted, weeded, and harvested through labor-intensive human work. Most grains in India are harvested by teams of Indian laborers wielding hand-forged iron sickles, binding up sheaves of grain, and carrying loads of sheaves on their heads to bullock carts to be transported to threshing floors. Teams of bullocks are then driven over the sheaves to separate the grains from the stalks, and workers toss basket loads of grain into the air to separate the grain from the chaff. Lentils, a crucial part of the Indian diet, also are harvested through labor-intensive means. Groups of laborers squat down in fields for hours at a time, ripping out lentil plants at the root by hand. Machinery available to lentil farmers has proven difficult to use, and traditional methods are preferred.

Land Utilisation

Major changes in the land use systems of any District, there is an urgent demand for adaptive environmental assessment. Semi-arid climatic conditions together with high land use pressure from intense small-scale settlements cause frequent crop failures, overgrazing and erosion damage. A spatial information system can be developed to handle the unique database demands for this study, and for further District planning purposes. Soil mapping, using GIS as a modelling tool, helped to improve existing and augment incomplete, poor or even absent data, such as a soil map on a reconnaissance level. Despite a semi-quantitative approach, modelling of the multivariate relations of risks reflects their spatial distribution clearly.

Land consolidation is the most efficient possibility for land property policy and the most generally - used application. It is an administrative procedure used to reduce the number of property plots, in order to improve the relation between ownership and land use, in the interest of economic production.

The topic which concerns the relationship between land ownership and land use, was handled with special care in different economic and political systems. The Indian Land Property policy varies state to state, which control the property market, land reforms and land allotment. Land property policy of India should be made unique and then only it will have efficiency also in the environmental and nature protection, in the extensive agriculture and the formation of environmentally-sensitive zones as well. First and last the aim of the new land consolidation concept is to define the relation between land property and land use. This consolidation makes it possible to form reasonable sized agricultural farms with the help of private farming and lease-firm and also it improves the ownership structure using national funds for supporting.

Decentralized Planning at District Level in India

A study was undertaken in the tribal-oriented and rural-based district in India to demonstrate the integration of village-level spatial and non-spatial data in GIS environment into a useful informatics tool for decentralized planning. A simple and robust tool, called 'VLIS' (Village-Level Information Systems) will assist the decision-makers to generate various eco-socio-economic views/scenarios for identifying candidate villages for rural watershed management schemes. The paper also envisages future development and usefulness of this community GIS tool for grass-root level planning.

Generation of Spatial Village Maps

District and taluka boundaries were drawn from the SOI topographical maps. These were brought in as ArcInfo coverages after following the standard procedure : digitization, geo-referencing, etc. Taluka maps, collected from the local government offices in the district, contain village boundaries with contour lines and other topographical information. These taluka maps, which do not show geographical co-ordinates, were traced, marking GCPs with respect to the SOI base map, digitized and brought to the real world coordinate system after projecting the maps (polyconic system) and carrying out the editing functions such as appending, edge-matching, etc. in Arc/Info. Each village in this map was assigned unique ids (user-defined) in a regular sequence. Thus, taluka map with village boundaries with in-built table having aerial extent, village-ids, etc., can be generated for district. The village map was opened in Arc/View for further processing.

Integration of Spatial and Non-spatial Database

The MS Excel file was converted into text format to enable to open in Arc/View. The Tables of both spatial village map and non-spatial census information were opened in Arc/View and joined together, with the help of user-defined ids, using table-join function.

Thus, an information system has been generated for the district showing the village map with its boundaries and the relevant census information containing eco-socio-economic dimensions.

VLIS tool, with a moto ‘turning data into information’, generated in the present study integrating the spatial village maps with non-spatial or tabular information can be demonstrated for its potential for grass-root level development planning taking into consideration the local needs and constraints. It has also established its usefulness to the decision-makers in the district to generate views/scenarios for decision-making at local-level. This prototype Community GIS tool will serve as a first step towards the development of Decision Support System for decentralized planning at district/sub-district level.

Future Developments

With a better database, we can provide a better service to the user organizations to assist in their own decision-making process for developmental planning. A few possible future development programmes for better service to the users for decentralized planning are :

(1) Customization: A better Graphical User Interface (GUI) could be built using GIS, as it provides very comprehensive and fast access to information, both graphically and non-graphically. This makes the system more robust in terms of its communication with a variety of users. (2) Strategic Unit for Decentralized planning: Given that all village informatics are now spatially part of a common coordinated system, a number of useful combinations can be performed. The first step in this process is to create Integrated Resource Unit (IRU). Each IRU comprises the spatial and non-spatial resource data, and can be taken as a strategic unit for assessing various decisions. Since they exhibit strong uniformity, they can all be expected to respond similarly to given intensities of human use and management strategies. Use of strategic units for treatment-oriented land use planning scheme for hilly watershed/terrain using GIS can be demonstrated in the studies carried out by Adinarayana and Rama Krishna (1995). (3) Decision Support Systems (DSS): As far as rural development planning is concerned, VLIS generated in the present study is unsophisticated but it is robust and functions with the data that are actually available with some organization.

Conclusions

The introduction of computers, micro-electronic equipment and telecommunication services have paved the way for an avalanche of information, not only for scientific research, but also for information transfer to a broader public and for planning or policy purposes. Several reasons may explain this information explosion in planning and policy-making.

- our complex society needs insight to the mechanisms and structures determining intertwined socio-economic, spatial and environmental processes;
- the high risks and costs of wrong decisions require a careful judgment of all alternative courses of action;
- the scientific progress in statistical and economic modelling has led to a clear need for more adequate data and information monitoring;
- modern computer software and hardware facilities (e.g. decision support systems) have provided the conditions for a quick and flexible treatment of data regarding all aspects of policy analysis; and
- many statistical offices have produced a great deal of data which can be usefully included in appropriate systems.

"We observe the first signs that micro-electronics, informatics and telematics may dramatically alter western societies. In many countries, prosperity is no longer exclusively created by the production and use of manufactured commodities, but increasingly by the creation and sale of services, notably information-based services" (Cordell 1985).

It is evident that a user-analyst communication is necessary for removing the above mentioned bottlenecks. It is of course important that the user or client is not disconnected from an information system, but it is equally important that an analyst is informed about the way a certain policy issue or problem is structured. The modern communication technologies provide no doubt an enormous potential, although these cannot replace the contacts between users and analysts. In several choice situations, however, interactive simulation experiments and computer graphics, designed by experts, can nowadays already directly be used by decision-makers and planners, so that policy and analysis may be brought closer together in the future.

For further development, technology will not be a limiting factor. Geographical information systems will be open and will continue to evolve to harmonise with our ever changing needs. The main challenge will continue to be in our ability to understand spatial processes, and to translate them into computer algorithms and computer environments for use by different kind of people, including decision makers! Central Mining Research Institute (CMRI) is providing GIS based support to Central/State/Public Sector by their fully equipped I.T. (Information Technology) Centre.

The overall long-term objectives of the research activity on sustainable rural development will be to:

- Analyze the underlying driving forces of regional divergences in the demographic, economic, socio-cultural, and environmental development of India by applying an integrative and truly multi-disciplinary framework.

- Develop a GIS and database with indicators that are specifically relevant for analyzing and projecting divergences between rural and urban-industrial areas in India. This GIS should assist decision makers and planners in formulating rural development policies at the regional and national levels.

- Initiate new visions for rural development in India by identifying innovative initiatives in lagging rural regions and by developing alternative development scenarios, which give special emphasis to options outside the traditional sectors of agriculture and forestry.

- Promote international cooperation in rural development research through the establishment of a network of research groups from developed countries in this area.
- Continue the existing Internet platform for research on rural development.

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