VILLAGE INFORMATION SYSTEM (VIS) Development of Village Economy through Space Technology

Kiran Jalem* and A.K. Singh**

Abstract

Paradox prominently persists in Jharkhand in terms of resource base and regional/socio-economic development and natural resource management. Peace and freedom, though, are not necessarily outcome of economic development, it is a must to have the affordability to the minimum level of basic needs like food, shelter, health, education, and decent living conditions in the marginalized/underdeveloped regions/societies.

Village Information System (VIS) is an interdisciplinary approach with Remote Sensing, GIS and GPS technologies conceptualized to bring about the development in such regions through creating/updating, disseminating information related to resources and aspects of development. VIS, a GIS based customized information system, aims to integrate various datasets at micro-level (village, panchayat & block). This project is being carried out for Namkum block of Ranchi district in Jharkhand on pilot basis which will later on be implemented to the entire state. The objectives include the Geospatial technology based thematic mapping on various natural resources viz. Geology, Geomorphology, Soils, Landuse/Landcover and Forest type & density as well as Socio-Economic profile consisting of amenities/infrastructure like healthcare, schools, roads, power, drinking water, etc., to help meet the above stated goals in the villages of Jharkhand.

The project also attempts to integrate and generate comprehensive information including Computerization of Land Records (Land Records Information System) to develop various development action plans which addresses issues like Land Utilization, Rural Development and Poverty Alleviation, Tribal Development, Natural Resource

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Management & Utilization, Wasteland, Watershed Prioritization, Infrastructure Planning finally leading to the overall Regional Development. The information will be made available and accessible to the people ranging from the policy makers, administrators, plan executors, researcher and academicians, NGOs to the villagers and other people concerned.

This study is being carried out using Indian Remote Sensing Satellite data (LISS-III and LISS - IV) and Quick Bird Data of 2004-05, Census 1991 and 2001 Data and Primary Survey Data on Household, Village Information, Health Information and Education Information Survey.

Introduction

Paradox prominently persists in Jharkhand in terms of resource base and regional/socio-economic development and natural resource management. Peace and freedom, though, are not necessarily outcome of economic development, it is a must to have the affordability to the minimum level of basic needs like food, shelter, health, education, and decent living conditions in the marginalized/underdeveloped regions/societies. Jharkhand is one of the largest producers of mineral resources of the country spreading over majority of the districts with a paradox to be among the bottom lying states in terms of development till now. It has got the vast resources in flora and fauna or biodiversity too. In terms of human reserve the state is rich, which can be converted into quality human resources through proper efforts and intervention. The other endowments, like scenic beauty, all over the state with a vast potential for tourism are also unutilized or underutilized. The figures indicate that a considerable portion of the land is under agricultural wastelands that have to be beneficially utilized for rural development.

The state has also received the special development plans as hill and tribal region (as Chotanagpur Plateau prior to the Jharkhand State). Yet the development indicators indicate the poor results of the plan efforts. To uplift the State in terms of development, the development of rural areas is a prerequisite. Since the rural areas are regionally heterogeneous at micro-level, it is necessary to have local specific plans and programmes. For any kind of development plan or programme the most required aspect is availability of reliable real-time database/information at easy access to the policy/decision makers, administrators, executors and the people converned. It may also motivate the participation of the villagers in local/village level decision making and development activities with understanding about their settlement locations, resources and environment or village ecology with an input of indigenous/local expertise or

technology. Therefore, it is necessary to design and develop a comprehensive and systematic database to attain the goal in sustainable manner. Therefore, this work is oriented towards creating and providing information on all resources related to land, water, forests, minerals, soils, agriculture and human and socio-economic development, infrastructure and facilities, etc. The integration of these sets of information would fill the data gaps to some extent in planning process and development efforts. This is an endeavour by geo-spatial technology like Remote Sensing, GIS, GPS, etc, and application projects for the development of the state.

The Need

Urban population is increasing in India at an alarming rate, but urban development trend is affected by shortage of resources and environmental problems. Hence optimum use of natural resources like water, which forms the part of basic amenities in urban settlement, is the need of the hour. Jharkhand state has blessed with abundance Natural resources like Minerals, Rivers, Forests etc, but its improper management is acting as a hindrance for development. Especially the capital "Ranchi" lacks either the proper assessment or development or Management of basic infrastructure facilities. The present condition of utility services in the state capital needs Preparation of Landuse map, Management & updation of other Utility services.

Development of any settlement rural or urban can be broadly categorized into 4 phases:

- Pre-planning phase
- Planning and implementation phase.
- Monitoring and Evaluation phase.
- Re-planning for existing and future development phase

Planning, Development and management at settlement, village or urban level, need information not only for the initial stage but on regular interval so that the whole process of planning can be systematized in terms of data sources, data collection, storage, processing, updating, retrieval and meaningful efficient use, which acts as the basic information required for the urban utility services.

This project "Village Information System" on completion will address to all the above issues and will help in Updation, Analysis, Development, Assessment, Management and Retrieval of data related to above mentioned urban utility services.

Village Information System (VIS) is an interdisciplinary approach with Remote Sensing, GIS and GPS technologies conceptualized to bring about the development in

such regions through creating/updating, disseminating information related to resources and aspects of development. VIS, a GIS based customized information system, aims to integrate various datasets at micro-level (village, panchayat & block). This project is being carried out for Namkum block of Ranchi district in Jharkhand on pilot basis which will later on be implemented to the entire state. The objectives include the Geospatial technology based thematic mapping on various natural resources viz. Geology, Geomorphology, Soils, Landuse/Landcover and Forest type & density as well as Socio-Economic profile consisting of amenities/infrastructure like healthcare, schools, roads, power, drinking water, etc., to help meet the above stated goals in the villages of Jharkhand.

The project also attempts to integrate and generate comprehensive information including Computerization of Land Records (Land Records Information System) to develop various development action plans which addresses issues like Land Utilization, Rural Development and Poverty Alleviation, Tribal Development, Natural Resource Management & Utilization, Wasteland, Watershed Prioritization, Infrastructure Planning finally leading to the overall Regional Development. The information will be made available and accessible to the people ranging from the policy makers, administrators, plan executors, researcher and academicians, NGOs to the villagers and other people concerned.

The other dimension of this project is to take the utility and fruits of this geospatial technology to the door steps of even the remote villagers through printed maps and also through the network accessible at Info-Kiosks or Village Resource/Information Centers (VRCs) connected by VSAT. In nutshell, it will be of immense help in proper and effective development intervention in the same paradigm of 'bottom up approach' in regional development.

Objectives

The main objectives of VIS are:

1. To generate and integrate information on various natural and human resources
2. Integration of thematic information in GIS environment to draw up area-specific and location-specific action plans like Land Resources Development Action Plan, Water Resources Development Action Plan, Watershed Prioritization, etc.
3. To disseminate these information to the policy makers, administrators, plan executors, villagers and people concerned

4. To customize user-based softwares for browsing and query
5. Training and transfer of technology to various users/departments

Data Base

Spatial/Maps:

Since there are many aspects involved in VIS, different materials and methods have been used. The materials used for this project are Survey Of India toposheets, latest Remote Sensing Data (LISS-III, LISS-IV, IKONOS and Quickbird) of 2004-2005. Theme wise data sources have been given below:

Geology:

1. Quadrangle Geological Map of Geological Survey of India.
2. IRS P-6 LISS -IV data to modify the Litho Units

Geomorphology:

IRS P-6 LISS -IV data to interpret and delineate the geographic units (Valley Fill, Valley Slope, Plateau (Weathered & Dissected), Tors & Domes, Denudational Hills, etc.

Landuse/Landcover:

IRS LISS-III and LISS-IV

Soil:

IRS P-6 LISS -IV data to map Soil Series

Slope:

SOI Toposheet (1:50000)

Drainage:

IRS P6 LISS IV data

Forest Resource Assessment (FRA)

IRS P-6 LISS -IV

Computerization of Land Records (Land Information System or LIS)

1. Revenue or Khasra Maps collected from the Block or District Nazarath Office,
2. Quick Bird Satellite Data

Attribute Data

1. Census of India, 2001- Village Directory and /PCA
2. District and Block Offices (Document II, Anganbari Centers, BPL, etc)
3. Primary Survey based on questionnaire for Village Information, Education Information, Health Information, and Household Information

The other thematic, tabular and textual secondary and ancillary information have also been obtained supplemented by the field survey and ground truthing.

Methodology

Different methods have been followed for generating different themes in this project. The methods are following (the methodology and approach have been shown in the flow charts given subsequently):

1. **Village Boundary Mapping:** Boundary map acquired from the Census of India and confirmed with the Block about the present boundary, since it falls partly in the urban area now. The paper maps were scanned, georeferenced, digitized, village-codes assigned and socio-economic data attached for thematic mapping.
2. **Landuse/Land Cover Mapping:** Landuse/Landcover mapping of Namkum Block was carried out using IRS LISS-III and LISS-IV Satellite Image. Visual interpretation techniques and adequate ground verifications was considered to identify various Landuse/Landcover classes. Major emphasis was given to delineate the landuse classes such as agricultural, fallow land (kharif, rabi, double cropping seasons), agricultural plantations, forest, wasteland, built-up land, quarrying sites and water bodies.
3. **Soil Mapping:** Soil resource mapping of Namkum Block on 1:25000 scale was carried out by using LISS-IV satellite data. Soil series were mapped occurring on different physiographic units. The detailed morphological, properties of the soil were studied in the filed and physio-chemical analysis was carried out in the laboratory. The soil samples were classified as per the soil taxonomy.
4. **Geology:** Geological mapping of Namkum was done using Quadrangle Geological map of Geological Survey of India and litho units were modified/updated on the basis of IRS P-6 LISS-IV data and limited field checks.
5. **Geomorphology:** IRS P6 LIS-IV data supported with limited field checks were used for interpretation and delineation of geomorphic units of Namkum Block.

6. **Forest Mapping:** Forest type and Forest cover mapping of the Namkum Block was carried out by using LISS-IV data. Both Forest Type and Forest Cover were mapped using onscreen visual interpretation techniques. Sample plots were laid out in the forest for community ecosystem analysis with adequate field checks.
7. **Slope:** Maps were prepared based on contour spacing of consecutive elevation.
8. **Drainage:** Drainage were demarcated based on Survey Of India Toposheets and updated by IRS P6 LISS IV data and limited field checks.

   Socio-Economic Profile: Village wise socio-economic thematic maps have been prepared based on data availability from the Census of India (2001) that includes Social Composition, Sex Ratio, Literacy Workers Classification, where as Health Facilities, Educational Facilities, Safe-Drinking Water Facilities, Post and Telegraph Facilities, Power Supply, etc. were collected from the primary survey on village information, health information, educational information and household information. A detailed village level primary survey is carried out to collect the latest socio-economic data for household, village, school and health related information. In addition, latest information regarding hand-pumps by their working conditions from the Public Health Engineering Department and school information from Jharkhand Education Project Council (JEPC) have also been collected and mapped.
9. **Water Resource Development Plan:** Water Resource Development Action Plan has been prepared on the basis of integration of information on geology, geomorphology, hydrological characteristics, surface water availability, drainage, land use and current status of ground water exploitation keeping in view of both immediate and long term needs of water in the area.
10. **Land Resources Development Action Plan:** Land Resources Development Action Plans has been prepared based on the integration of land use, geomorphology, soils, ground water, rainfall, socio-economic data and irrigation facilities available in Namkum area.

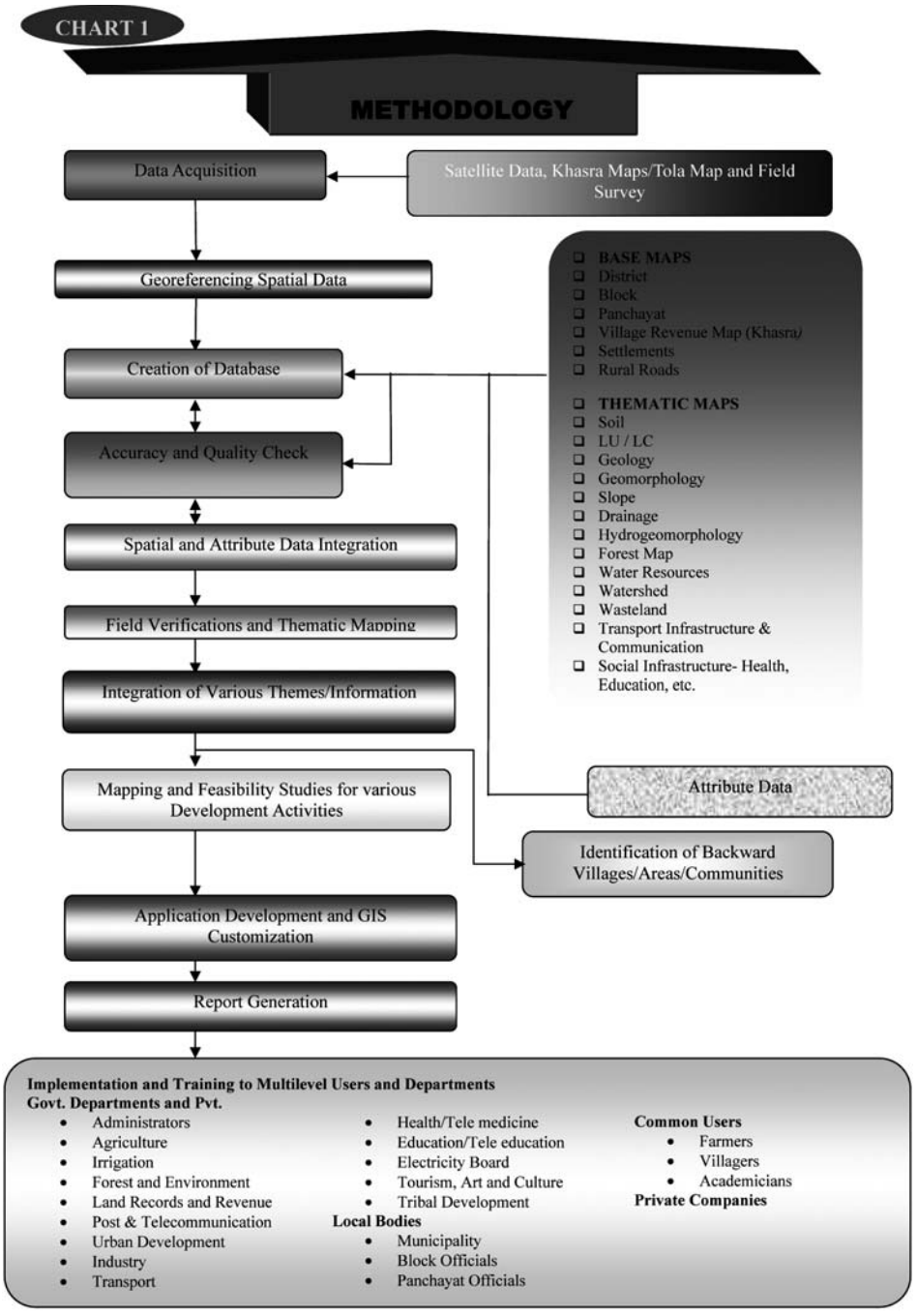


CHART 1
METHODOLOGY
Data Acquisition
Satellite Data, Khasra Maps/Tola Map and Field Survey
Georeferencing Spatial Data
Creation of Database
Accuracy and Quality Check
Spatial and Attribute Data Integration
Field Verifications and Thematic Mapping
Integration of Various Themes/Information
Mapping and Feasibility Studies for various Development Activities
Application Development and GIS Customization
Report Generation
BASE MAPS
District
Block
Panchayat
Village Revenue Map (Khasra)
Settlements
Rural Roads
THEMATIC MAPS
Soil
LU / LC
Geology
Geomorphology
Slope
Drainage
Hydrogeomorphology
Forest Map
Water Resources
Watershed
Wasteland
Transport Infrastructure & Communication
Social Infrastructure- Health, Education, etc.
Attribute Data
Identification of Backward Villages/Areas/Communities
Implementation and Training to Multilevel Users and Departments
Govt. Departments and Pvt.
Administrators
Agriculture
Irrigation
Forest and Environment
Land Records and Revenue
Post & Telecommunication
Urban Development
Industry
Transport
Health/Tele medicine
Education/Tele education
Electricity Board
Tourism, Art and Culture
Tribal Development
Local Bodies
Municipality
Block Officials
Panchayat Officials
Common Users
Farmers
Villagers
Academicians
Private Companies

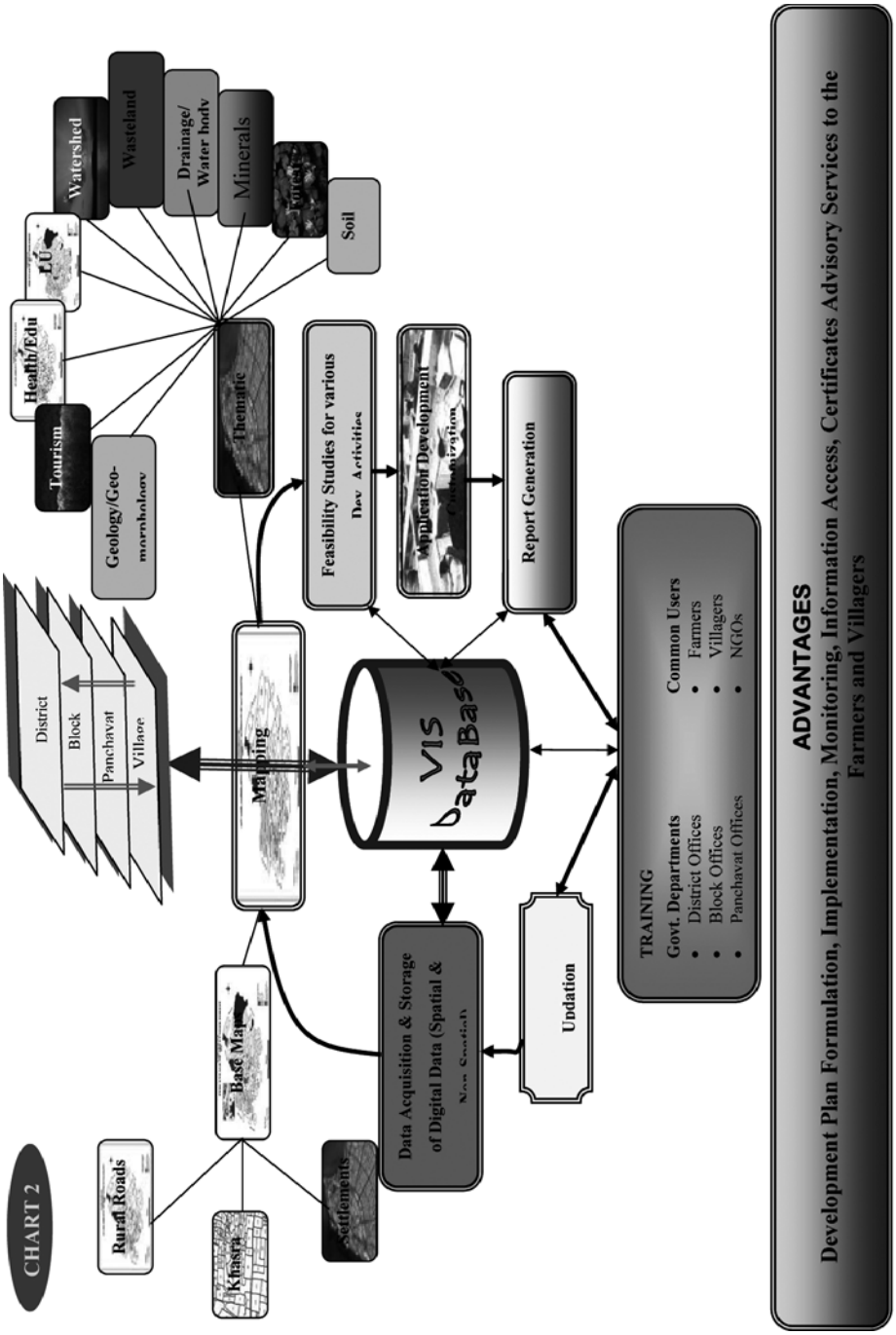
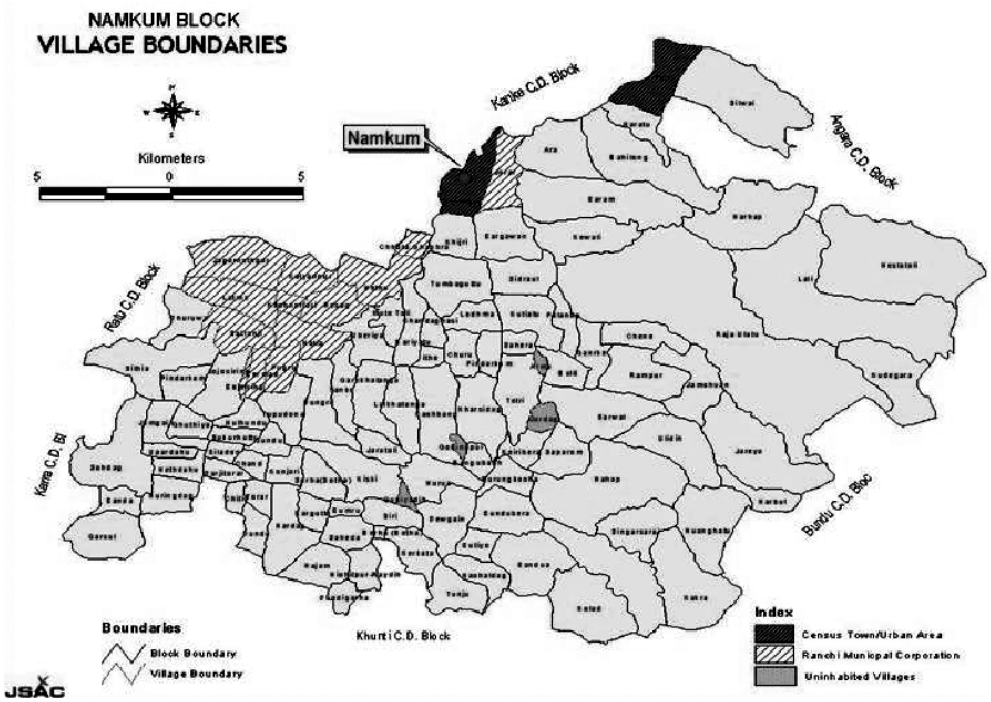


CHART 2
Rural Roads
Khasra
Base Map
Settlements
Data Acquisition & Storage of Digital Data (Spatial & Non Spatial)
Updation
District
Block
Panchayat
Village
Mapping
VIS DataBase
Geology/Geo-morphology
Tourism
Health/Edu
EU
Watershed
Wasteland
Drainage/ Water bdy
Minerals
Forest
Soil
Thematic
Feasibility Studies for various Dev. Activities
Application Development & Customization
Report Generation
TRAINING
Govt. Departments
• District Offices
• Block Offices
• Panchayat Offices
Common Users
• Farmers
• Villagers
• NGOs
ADVANTAGES
Development Plan Formulation, Implementation, Monitoring, Information Access, Certificates Advisory Services to the Farmers and Villagers

The Pilot Area: Namkum Block (Ranchi District, Jharkhand)

Namkum Block of Ranchi has been taken as a pilot block. It is roughly located between 85o13'33" N and 85o14'4" N and 23o10'0" E and 85o23'31" E. It falls partially under the Ranchi city. Part of Namkum village has developed as an urban centre along with Tati, a Census Town (CT). The Ranchi Municipal Corporation boundary has also been now extended. The Namkum Block has been surrounded by the Kanke block in the north, Angara in the north, north-east, Ratu in the west north-west, Karra in the west, Khunti in the south Bundu in he south south-east and Sonahatu in the east. The average annual rainfall is 1293 mm.



A large part in the block is under the cantonment area. It has also got a number of industrial units varying from small to large notable among them is Usha Martin, Vaxpol India, High Tension Insulator Factory, Daewoo Motors, along with the Software Technology Park of India, etc.

The Census of India, 2001 suggests that there are 21156 households with a population of 114397 in the Namkum block out of which only 9.2 per cent population resides in the urban area (table 1). The Scheduled Tribes (ST) are the largest constituents of the total population in the block with 63.2 per cent share followed by the Others (31.8 per cent) and the Scheduled Castes (SC) with only 5.0 per cent share. The main community, ST, is primarily rural as only 7.6 per cent resides in the

urban localities. The sex-ratio is little above the national average for all (940), which is better in the rural areas (951).

Table 2: Socio-Economic Profile of Namkum Block, Part II

Indicators		Total	Rural	Urban
Main Workers	Total	65.8	64.3	87.8
	Male	75.2	73.7	90.6
	Female	49.5	49.2	65.1
Cultivators	Total	46.2	49.9	6.8
	Male	40.4	44.7	4.6
	Female	61.7	62.5	31.4
Agricultural Labour	Total	4.7	5.0	0.7
	Male	4.2	4.6	0.5
	Female	6.0	6.1	3.6
Household Industry	Total	3.2	3.2	2.3
	Male	2.6	2.7	1.8
	Female	4.7	4.6	8.2
Others	Total	45.9	41.8	90.1
	Male	52.8	48.0	93.1
	Female	27.6	26.8	56.7
Non-Primary Sector	Total	49.1	45.1	92.5
	Male	55.4	50.7	94.9
	Female	32.2	31.4	64.9
Non-Workers	Total	63.0	61.8	74.4
	Male	54.3	53.9	58.1
	Female	72.2	70.2	93.8

Source: Census of India, 2001

There is diversity in the economic activities blending the modern traditional and conventional occupations with the modern hi-tech white and blue collar jobs. For example half of the population is engaged with the agricultural and allied primary activities and half of the population is involved with the secondary sector like household industry and manufacturing industry other than household industry, construction and building, and tertiary sector like trade and commerce, transport and communications and other services.

A sizable population is engaged as main workers in the block (65.8 per cent). Out of the total main workers little above half of the population has the occupation related to agriculture, where 46.2 per cent are cultivators and 4.7 per cent are still agricultural labours. In both cases, percentage of females goes higher than males indicating their positions in the society. The data also shows the significant percentage of female workers

as the agricultural labourers. Surprisingly household industry registers only 3.2 per cent workers in the block. Diversifications has taken place in the block as 45.9 per cent main workers are engaged in Other activities (incl. construction, trade and commerce and other services) and 49.1 per cent workers are engaged in the non-primary sectors. Thus, still half of the workers are engaged in the agricultural and allied activities constituting the primary sector in the block.

There are significant variations across the villages of Namkum block in the above indicators. As a block partially falling in the Ranchi Urban Area, there is much contrast over the space. Even the population density is widely variable in the block.

Project Team

The following team has been involved in the project right from the project formulation to the database creation, survey, database integration, thematic mapping and the preparation of action plan maps and application development:

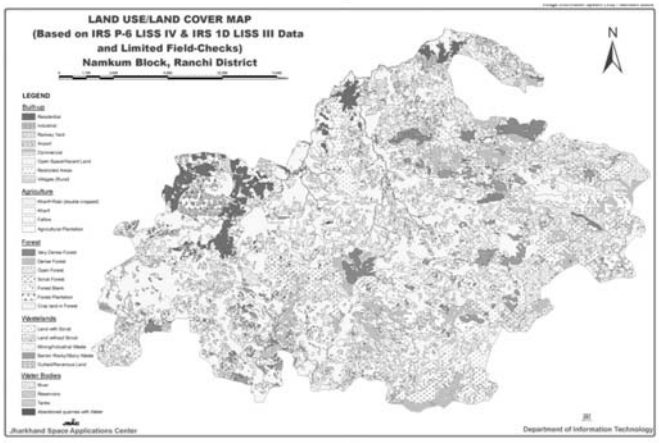
- JSAC, Dept. of IT, Govt. of Jharkhand - Scientific Team

Outcome And Discussion

The following maps and data have been generated under this project:

Village Boundary, DEM, Roads and Railways, Soil, Landuse and Landcover, Slope, Drainage, Geology, Geomorphology, Watershed, Wasteland, Forest, Land Information System (LIS) or computerization and updation of land records, Demographic information like social composition, sex ratio, literacy, occupational structure, educational facilities, health facilities, communication facilities, safe drinking water facilities, electricity connections, Action Plan Maps like Water Resource Development Action Plan and Land Resource Development Action Plan. More maps, reports and data integration are also in progress especially based on the data collected through primary survey. Important

Map 1.

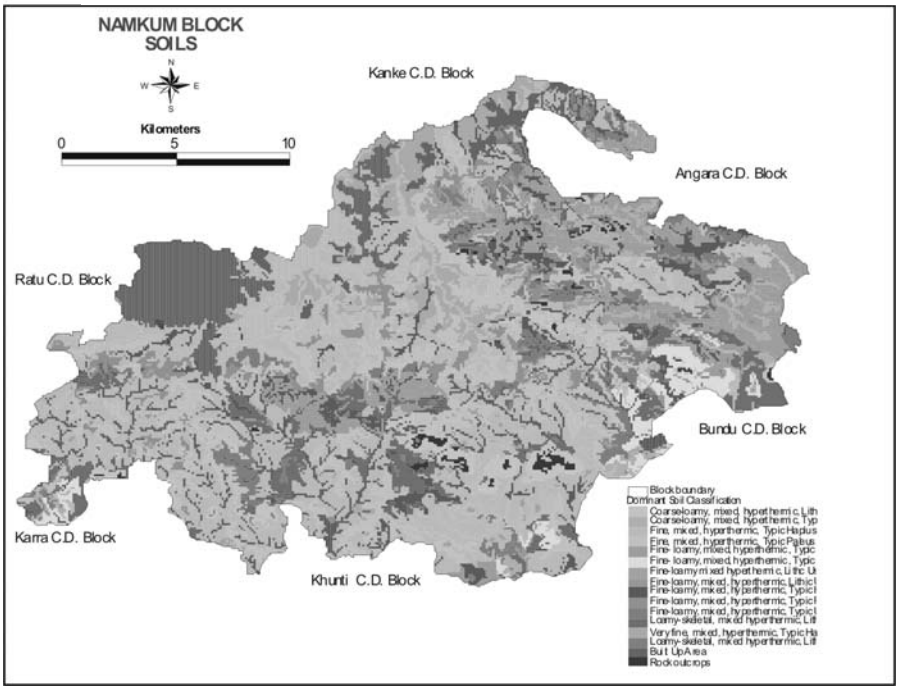


among them is the mapping of tolas with houses, roads, amenities, and service centres based on the layout sketch from the field survey and the quick bird satellite data. Subsequently this will be integrated with the household level information for each individual. Similarly other features like road, school, health centre, wells, handpumps will also be integrated with the associated data collected from the field work and the respective departments.

Landuse/Landcover: Landuse/landcover (Map 1) is an essential component of VIS, which will be used as a basic unit in conjunction with other natural resources as well as socio-economic data for Land and Water Resource Development Action Plan.

Soil: The soil database (Map 2) is created and interpreted as per the user needs like Soil Irrigability Classification, Soil Site Suitability for different crops, Soil Fertility Status, Soil Erosion Status, and Land Capability Classification. This information is used for preparing the detailed Land Resource Development Plan on sustainable basis.

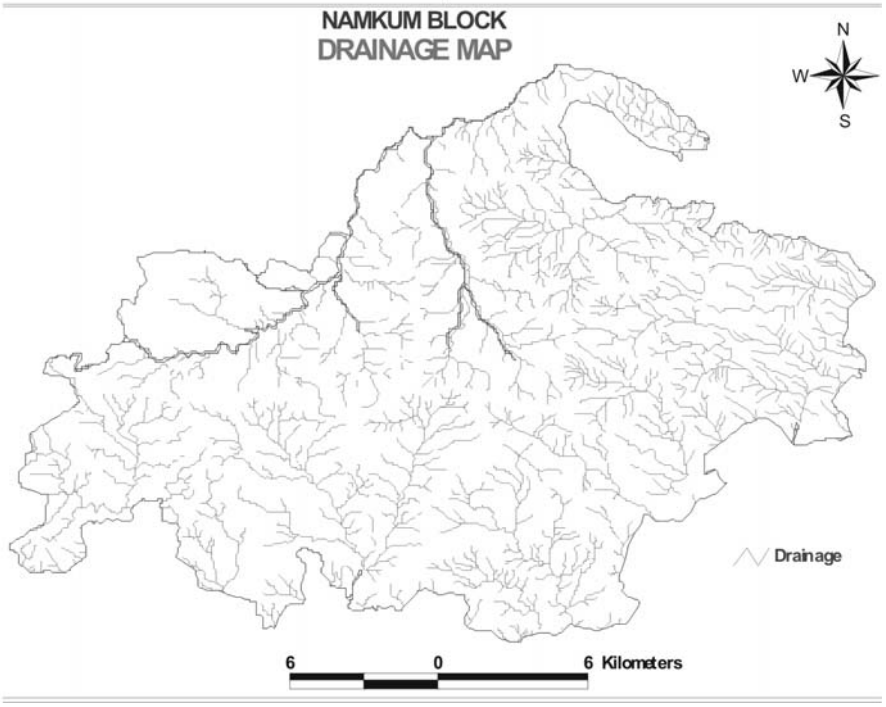
Map 2.



Geology: It is observed that the area is predominantly composed of granite Gneiss and Granite rocks. Various geological units/features were mapped and integrated with

geomorphology/ hydrology of the region to finalize Ground Water Prospects zones there by contributing as one of the major components in preparation of Land & Water Resources Development Action Plan.

Map 3.



Geomorphology: Geomorphologically, area has been classified into Valley Fill, Valley Slope, Plateau (weathered and dissected), Tors & Domes, Denudational Hills, etc. These geomorphic units were used as the base ground water zonation for Water Resource Development Action Plan.

Forest: The resultant maps showing Dense Forest Blanks, Open Forest, Scrub Forest, etc. being used for deriving Land Resources Development Action Plan.

Drainage: The Subarnarekha is the main river passing through the block, which originates south of village Nagri, 15 km west and south- west of Ranchi town. It contains treacherous quick sand, which is dangerous to cross. The name means streak of gold and gold is found in its bed in minute quantities. The other important drainages of the block

are Sapahi Nadi, Raru Nadi, Kocha Nadi and Kanchi Nadi. Mostly, perennial rivers are effluent in nature in which ground water seeps continuously. The drainage map of Namkum block has been shown in Map 3.

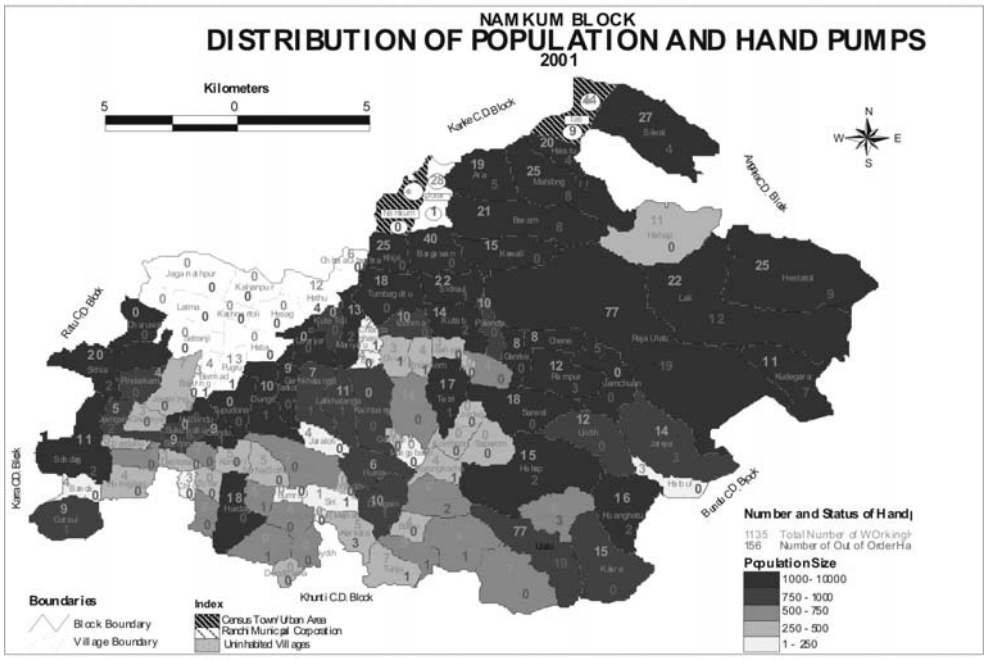
Fig 1.

Slope: The study area is basically part pf Chhotanagpur plateau but locally characterized by flat to undulating terrain with some high rising hills in North- West and Southern part of the block. The general slope of the terrain is towards south and southeast. The altitude from mean sea level varies from 360 m in valley portions to as high as 750 m on hill tops.

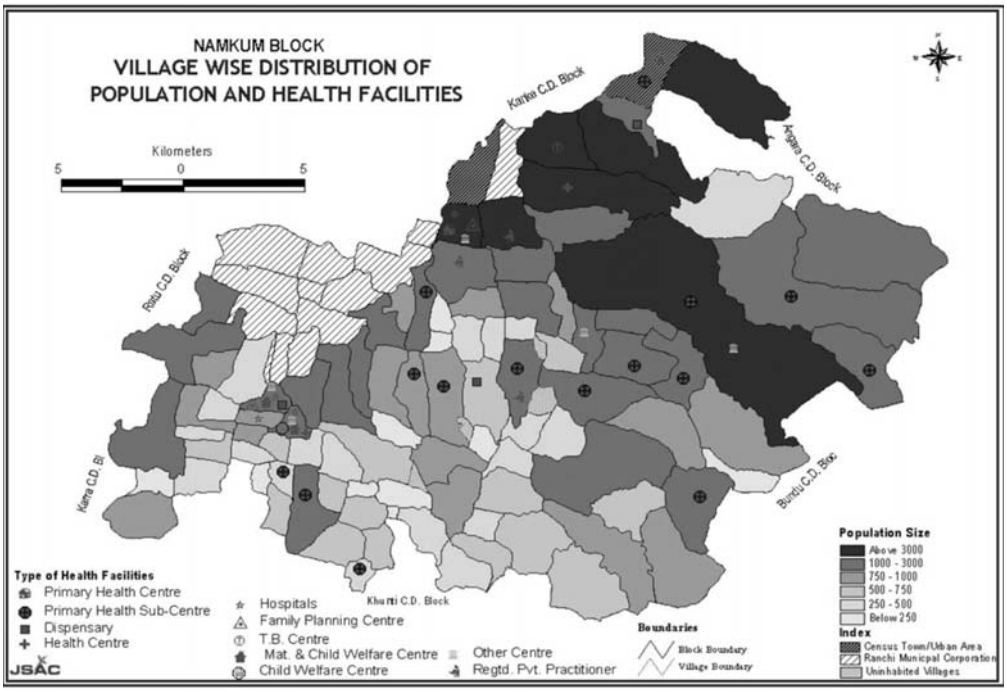
Computerisation of Land Records (Land Information System or LIS): It has been a great effort to mechanize the maintenance and updation of land related information and better land management, land base and land use planning, agriculture planning, infrastructure planning (roads, drainages, canals etc.), planning developmental schemes to eradicate rural poverty and improve village income, minimization of land disputes, etc. Map showing village boundaries shown in Figure 1.

Socio-Economic Data Survey for the Effective Planning: Any kind of plan or programme aims directly or indirectly to the well-being of society. And the information

Map 4.



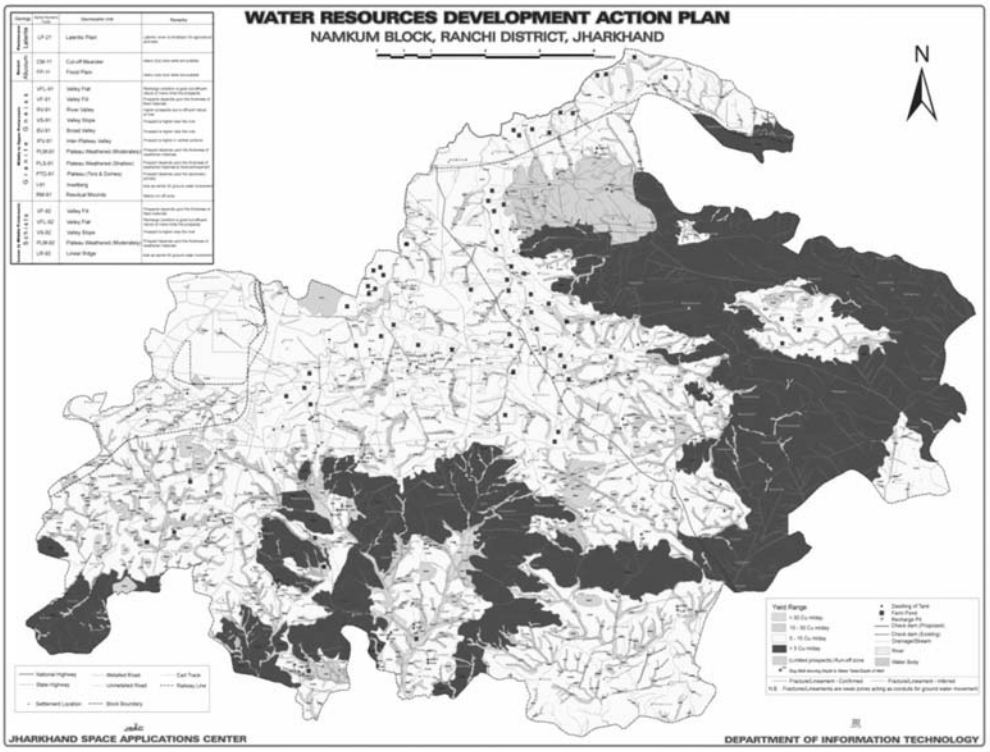
Map 5.



is a must for better and meaningful planning. Moreover, socio-economic background is also an inevitable component in policy making. One of the major activities and achievements is the latest data collection on tola wise village information, health information, educational information and household information for entire Namkum Block. The survey covers 327 tolas in 93 revenue villages covering 20,861 households and 108,489 populations. It covers the 27 government health centres and nine private health centres and clinics, and 136 government and private educational institutions in the rural areas of Namkum block. It gives useful information regarding the infrastructure, amenities and facilities in the tolas and villages, unserved areas, community wise housing condition, poverty, literacy and educational levels, economic infrastructure and activities, safe drinking water, etc. The analysis and translation in map is in progress (Map 4 & 5).

Water Resource Development Plan: The map (Map 6) shows different geomorphic units and its ground water prospects based on field survey, well data and existing literature. Different water harvesting structures like check dams, desilting of tanks,

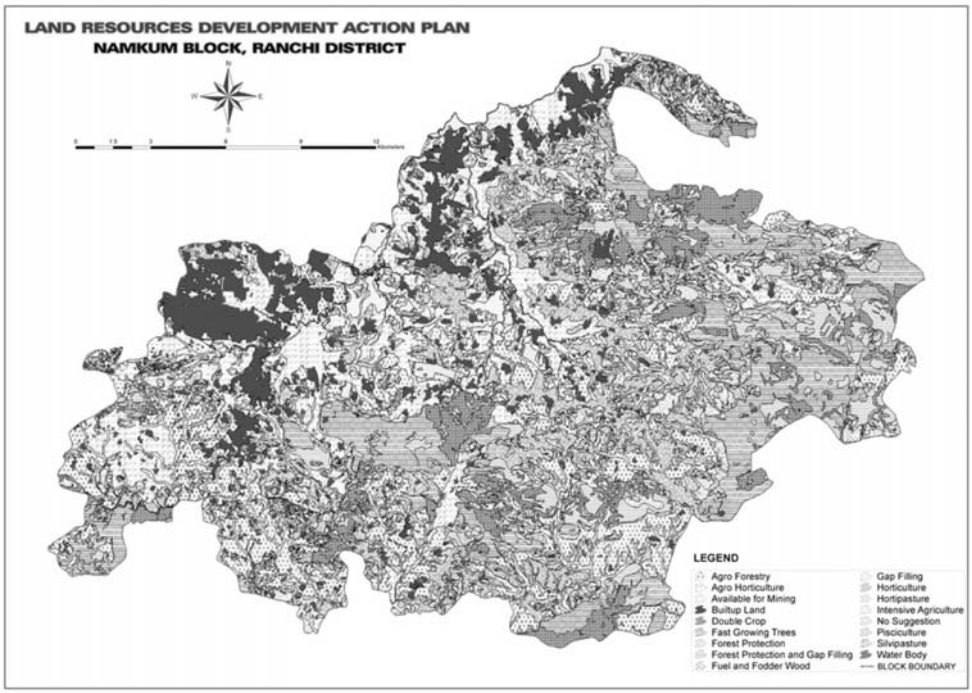
Map 6.



percolation tanks, farm ponds, etc., have been proposed for exploitation and sustainable development of ground water as well as surface water.

Land Resources Development Action Plan: Recommendations are made for land resources management on long term sustainable basis (Map 7). Measures are suggested for better return from the land by proposing sites for agro-horticulture and also new crop varieties with proper crop rotations. Allied agricultural activities recommended includes conversion of single cropped area into double cropped area by exploiting ground water, as well as increasing area under oil seeds, pulses, vegetables and fruit crops with emphasis on dairying, fishing and bee-keeping. The management of forest land is also proposed by way of protection and improvement in crown cover and afforestation in forest blank areas.

Map 7.



Limitations And Future Scope

Limitations

1. Data Unavailability
2. Data Inaccessibility
3. Resources

Future Scope

1. It will have complete coverage of Individuals, Households, Tolas, Villages, Blocks, Districts and State in the process of balanced regional development and well-being. VIS will help in leading to the real development, decentralization, self-governance and ensured public participation towards the destination of Gram-Swaraj. Through VIS, every remotest area in the state will be covered.
2. The household level information will be integrated with household map drawn with the help of Quickbird data and layout maps of tolas. Similarly information regarding tolas/villages, health and educational centres will be integrated with the collected attribute data.

3. The project is expected to help in e-governance in the State.
4. The information technology will be at the doorstep of every villager of Jharkhand with very simplified visual understanding. The information generated under this project will be of immense help for the planners and bureaucrats as well.
5. The priority villages (relatively backward) will be identified on the basis of certain parameters condensed in a single Village Development Index (VDI) to bring into the mainstream of development.
6. The VIS will benefit the government departments (administrative, agriculture, irrigation, forest & environment, land records and revenue, post & telecommunication, urban development, industry, transport, health, education, electricity board, tourism, art and culture, tribal development), local bodies (municipality, block officials, panchayat officials), common users (farmers, villagers and academicians), NGOs and private companies.
7. It will be available on the Internet/Public domain for universal accessibility through customized software to disseminate all the information on intra and internet.

Conclusions

Thus the VIS has made attempts towards providing information on various development and management scenarios to decision-makers and the public for the integrated balanced and sustainable development of resources at the Village, Panchayat, Block, District and the State Level. The project attempts to generate and integrate comprehensive information on priority areas like Land Utilization, Tribal Development, Natural Resource Management and Utilization, Wasteland, Rural Development, Infrastructure and Amenities, Poverty Alleviation, Overall Development, e-Governance and other aspects to meet the goal of overall development of the State through grassroot. It has been an inter-disciplinary approach to generate and integrate necessary information for the multi-dimensional development in the Block and State.

References

1. AISLUS. 1970. Soil Survey Manual, IARI, New Delhi., pp
2. Application of GIS for Land use /cover change and analysis in a mountainous terrain S Ghosh, A C Sen, U, Rana K-S-Rao, IC Saxena, Journal of Indian Society of Remote Sensing, vol, 24:3, 193
3. Avery, T.E. 1977. *Interpretation of Aerial Photographs*, Third Edition, Burgess Publishing Company, Minneapolis.
4. Botkin, D.B., Estes, J.E., Mcdonald, R.M. and Wilson, M.V., 1984. Studying the Earth's vegetation from the space. Bioscience, 34: 508.
5. Brahmabhatt, V. S., Dalwadi, G. B., Chhabra, S. B., Ray, S. S. , and Dadhwal, V. K. 2000. Land use/ land cover change mapping in Mahi Canal command area, Gujrat, using multitemportal satellite data. Journal of Indian Society of Remote Sensing, 28, pp. 221-232.
6. Brahmbhatt 2000, Landuse, land cover change mapping in Mahi canal command tree Gujarat using multi-temporal satellite data , Journal of Indian Society of Remote Sensing, vol 28, 4, pp 221-232
7. BS Bisht, BP Kothari, 2001, Land-cover change analysis of Garua-Ganga watershed using GIS RS techniques, Journal of Indian

Society of Remote Sensing, vol, 29:3, pp 137-42
8. Champion, H.G. and Seth S. K., 1968. *A revised Survey of the Forest Types of India*, Manager of Publication, Government of India, New Delhi, p 404.
9. Daniel, D. and Shenan, I. 1987. A preliminary assessment of Landsat TM imagery for mapping vegetation and sediment distribution in Walsh estuary. *International Journal of Remote Sensing* 8(7): 1101-1108.
10. Eswaran, H. J (1989). Soil Taxonomy and agrotechnology transfer.p 9-28. In: Soils for development (Ed. Van Cleemput et al. Proceedings Symp., 25st anniversary of ITC for PG Soil Scientists, Stqate Univ., Ghent (Belgium). ITC Ghent, Publ. Series 1. p. 107.
11. Eswaran, H., Kimble, J., Cook, T. and Mausbach M (1987). World Benchmark Soils Project of SMSS. Soil survey and land evaluation 7: 111-122.
12. FAO (1993). Agroecological assessments for national planning: the example of Kenya, FAO Soils Bulletin 67, Rome 19993.
13. Ghose, S., Sen, K .K., Rana U., Rao, K S. and Saxena K. G. 1996. Application of GIS for land use / land cover change analysis in a mountainous terrain. Journal of Indian Society of Remote Sensing, 24, (3) pp. 193-202.
14. Hall, R.J., Dams, R.V. and Lyseng, L.N., 1991. Forest cut cover mapping from SPOT satellite data. *International Journal of Remote Sensing* 12(11): 2193-2204.
15. Jakson, M. L. (1967). *Soil Chemical Analysis*. Prentice Hall, New York
16. Jakson, M. L. (1973). *Soil Chemical Analysis*. Prentice Hall, New York.
17. Klingbiel, A.A. and Montogomery, P.H. 1961. Land Capability Classification. Agric. Handbook, 210 SCA, USDA, Wasshington D.C.
18. Kuchler, A.W., 1988. The classification of vegetation. *In vegetation mapping*. eds, A.W. Kuchler and I.S. Zonneveld, Kluwer Academic Publishers, London.
19. Land use land cover Mapping and change detection in parts of Eastern Ghats of /- Tamilnadu using Remote Sensing, GIS, Journal of Indian Society of RemoteSensing, vol 31:4,pp251-260
20. Land use / Land cover change analysis change in Mumbai - Navi Mumbai cities and its effects on the drainage basin & -catchments using GIS, Journal of Indian Society of Remote Sensing, vol : 26 1 & 2, ppl-6
21. Lillesand, T.M. and R.W. Kiefer. 1987. *Remote Sensing and Image Interpretation*. Second Edition. John Wiley & Sons, New York.
22. Lokesha, N., Gopalkrishna, G. S., Honne Gowada H.and. Gupta A. K. 2005. Delineation of ground water potential zones in a hard rock terrain Mysore district, Karnataka using IRS data and GIS techniques. Journal of Indian Society of Remote Sensing, 33, (3) pp. 405-412.
23. Londhe, S.L. 1998. Study of spectral reflectance properties in specially associated red and black soils of Saptadhara Watershed, Nagpur district. M.Sc. (Agric.) Thesis (Unpub.)
24. Minakshi, Churasia & Sharma P K , 1994, Land use land cover mapping and change detection using satellite data, A Case study of Ludhiana district Punjab, Journal of Indian Society of Remote Sensing, vol, 21 & 22, pp 115- 1 22
25. Prasad, N., Goyal, S.P., Roy, P.S. and Singh, S., 1994. Changes in wild ass (Equushemionus khur) habitat conditions in Little Runn of Kutch, Gujarat from a remote sensing perspective. *International Journal of Remote Sensing*, 15 (10): 3155-3164.
26. R.K. Jaiswal, A. Saxena, Sanmitra Mukherjeepp 123:128 Approach of RS techniques for Landuse and Land Cover
27. Robinson, A.H., R.D. Sale, and J.L. Morrison. 1978. *Elements of Cartography*, Fourth Edition. John Wiley & Sons, New York.
28. Roy, P.S. (1999). Forests resource assessment, prospects and issues, *GIS Development*, 3(5).
29. Roy, P.S., Saxena, K.G., Pant, D.N. and Kotwal, P.C. 1986. Analysis of vegetation using remote sensing in Kanha National Park. *Proceedings Seminar-cum-workshop on Wildlife Habitat Evolution Using Remote Sensing Techniques*, 22-23 oct. 1986, Dehradun, p 6-12.
30. Saxena, R.K., Verma, K.S., Chary, G.R., Srivastava Rajeev and Barthwal, A.K. 2000. IRS 1C data application inwatershed characterization and management. International Journal of Remote Sensing, 21, pp. 3197-3208.
31. Sehgal, J. L. Saxena, R. K. and Vadivelu, S. (1989) *Field Manual- Soil Resource Mapping of different states in India*. Tech. Bull., 13, NBSS Publ.
32. Talukdar, G.T. 2002. *Geospatial Modeling of Land Dynamic Processes in Shifting Cultivation Induced Landscapes of Meghalaya*. D.Phil thesis, University of Pune.
33. Tisdale, S. L. Nelson W. L., Beaton J. D. and Havlin J. L. (1993). *Soil fertility and fertilizers*, fifth edition, Prentice Hall Publ. 634 pp
34. Tucker, C.J., Gatlin, J.A. and Schneider, S.R., 1984. Monitoring vegetation in the Nile Delta with NOAA-6 and NOAA-7 AVHRR imagery. *Photogrammetric Engineering and Remote Sensing*, 50: 647-651.
35. Walsh, S.J., 1980. Coniferous tree species mapping using Landsat data. *Remote Sensing of Environment* 9: 11-26.
36. William, D.L. and Nelson, R.F. 1986. Use of remotely sensed data for assessing forest stand conditions in Eastern United States. *IEEE Trans. Geosci. Remote Sensing* E-24: 130-138.