HOW TO PROMOTE REMOTE SENSING - INDIAN EXPERIENCE

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ABSTRACT

Remote Sensing in India is notable for its success in implementing its promotion through the unique National Natural Resources Management System (NNRMS). The major achievements of NNRMS are: Establishment of facilities for dissemination, services and education; evolution of appropriate application methodologies dictated by user needs; national level remote sensing application projects on operational basis; development of indigenous capabilities in all areas of the technology including design and development of satellites/sensors; and encouragement to entrepreneurship. The Indian experience forms an ideal role model for all developing countries to emulate.

Key Words: Indian Remote Sensing Activities, Promotion, Experience.

INTRODUCTION

The needs of National development particularly in developing countries demand a comprehensive approach to the management of natural resources. Optimal management of natural resources on a self reliant basis requires a long term perspective and it calls for a holistic view in all resources sectors including socio-economic factors. Accurate inventory, assessment and monitoring of available resources periodically enable the planners to keep an eye on the development process and to take appropriate timely measures.

Considering the vast potentials of remote sensing technology, India has initiated a major programme on remote sensing data utilization to aid in the national development. Towards this, efforts were initiated in late 70's through a series of carefully planned end to end experiments covering various resources themes. These experiments were conducted by Department of Space with the active participation of users like Indian Council of Agricultural Research (ICAR). The successful results of these experiments provided the basis for the launching of major operational and semi-operationsal programmes on remote sensing applications in the country. The major components of the programme are to develop Space segment, Ground segment including infrastructure and interpretation facilities and development of trained manpower. Space programme in India, consistent with the stated goal of self-reliance launched activity in developing imaging sensors to conduct many experiments for different users. A variety of imaging sensors have been developed indigenously for various aircraft/spacecraft in the past two decades which include air borne - thermal scanner (10.5-12.5 microns), multispectral scanner (.5 to 3.0 microns), Bhaskara I & II slow scan vidicon (.54 to .66 and .75 to .85 microns), passive micro wave radiometers (19, 22, 31 GHz, Air borne push broom SS cameras, SLAR, Ground based radiometers, Microwave radiometer and Scatterometers. These developments had given the confidence in designing and fabricating the state-of-art sensors incorporated in the indigenously built Indian Remote Sensing Satellites (IRS).

REMOTE SENSING - A NECESSARY TOOL

For a country of India's size and population, the necessity of generating continuous and updated information on land resources and environment necessiated for the development of space based Earth Observation Systems which offer unique possibilities in their ability for synoptic and systematic acquisition of the related data and making available the same within very short turn around times to resource managers and planners. This unique facility through use of remote sensing data has gained prominence in all the resources sectors leading to long term planning of Indian Space Programme involving development of indigenous Indian Remote Sensing Satellites in series with regular improvements.

The remote sensing activity primarily started with the emphasis on national development particularly in the resources sectors of Agriculture, Land, Water and Forestry.

The Bhaskara I & II experimental satellite programmes with optical and microwave sensors in the time frame of 1976-'82, provided valuable experience and insight into a number of aspects, such as sensor system definition and development, conceptulisation and implementation of a space platform, ground based data reception, processing, data interpretation and utilization as well as matters relating to integration of the remotely sensed data with the conventional data systems for natural resources management.

With this background, Indian Space Programme leaped into a national operational satellite

based remote sensing system in the 80's to ensure generation of resource information in vital natural resources sectors such as Agriculture, Land, Water, Forestry and Geology. Thus the conceptualisation of National Natural Resources Management System (NNRMS) fructified wherein the optimal integration of remote sensing inputs with the conventional data has been realised as the most cost and time effective operational system for efficient management of India's natural resources on sustained basis.

The organised way of development and realisation of the potential of remote sensing technology through NNRMS has been justified in a country like India and has now become the fore runner in using remote sensing data virtually in all resources sectors on a need basis. This is the key factor for the success and promotion of remote sensing in India.

CRITICAL FACTORS FOR SUCCESS OF REMOTE SENSING IN INDIA

Over the last 50 years India has seen a number of organised efforts to grow and apply science and technology to national development. Today the relevance and importance of the remote social well being is well accepted by all sensing technology to national economic and sections of scientific community.

The prime factor for the success of remote sensing is its application on a need basis for natural resources management. For example India's arable land is 141 million hectares and the India's economy largely depends on agricultural production. More than 70 per cent of India's population depend on the two staple cereal crops viz., wheat and rice. The timely information on crop acreage/production estimate on these food crops before the harvest of the crop is of extreme importance for the nation to make an organised food distribution system which will aid in greater food security.

PROBLEM ORIENTED APPLICATIONS OF REMOTE SENSING

The advantages of remote sensing technology in obtaining timely and spatial information quickly over convention methods has made it easier to tackle with problem areas to yield highly significant results with problem specific solutions. The prime problem areas where the remote sensing is being employed are:

* Agricultural crop acreage and production estimation for the major crops - data on temporal condition and spatial extent.
* Agricultural drought assessment at district level for crop condition assessment
* Crop acreage for oil seed crops like ground nut and cotton
* Applications of remote sensing for cash crops like tobacco and tea
* Forest cover monitoring
* Wasteland identification
* Ground water potential zone mapping
* Agro climatic zones characterization through nation-wide land use/land cover mapping and identification of current kharif (July - October) and rabi (December - March) agricultural areas.
* Identification of potential mineralised zones
* Flood damage assessment
* Identification of potential fishing zones
* Environmental impact studies
* Snow melt run-off and forecast of inflow of water to the major reservoirs

For all the above problem areas the expected objectives and the level of information that is obtainable through remote sensing are clear while executing the tasks.

NATIONAL NECESSITY

All the issues related to natural resources affect national economy and timely solutions are needed for undertaking any rehabilitation or remedial measures. The use of conventional data would not be able to fulfil the requirements on a time and cost effective manner. On the contrary the use of remotely sensed data in conjunction with conventional data sources has been found more time and cost effective while providing reliable data base. This has been widely applied and demonstrated in all the resources problem areas in obtaining reliable data which has lead to high degree of confidence in utilization of information derived from satellite data. The experience gained over the last decade convinced all the resources managers on the validity and efficiency of remotely sensed data for the routine resources inventory and monitoring. There were several national/ regional operational application projects which have been carried out on a mission mode to meet the end goals of user departments.

ACCEPTANCE OF REMOTE SENSING - NATIONAL NATURAL RESOURCES MANAGEMENT SYSTEM (NNRMS) - SPEAR HEADING PROMOTION OF REMOTE SENSING

Realising the potential applications of remote sensing, Government of India under the aegis of Department of Space has established National Natural Resources Management System (NNRMS) which is a culmination of concerted effort of multi-disciplinary, multi-departmental venture. The realisation of National Natural Resources Management System in the country is preceeded by well organised constitution of task forces in 1983 on various resource themes headed by Secretaries to Government of India. The task

forces in the following themes were constituted: (1) Forestry (2) Agriculture (3) Water Resources (4) Urban and Regional Planning (5) Geology and Mineral Resources (6) Ocean Resources (7) Soils and Landuse (8) Cartography.

The task forces constituted have clearly addressed the conventional sources of information and the applicability of remote sensing highlighting relative advantages of satellite data either singly or in conjunction with conventional data. The infrastructure requirements, which the potential departments/ organisations need to have while adopting remote sensing technology and the associated trained manpower requirements for sustained use of remote sensing technology in India have also been addressed by the task forces.

By the year 1985 all the task forces have finalised the recommendation on the utilization of remote sensing. In order to follow the recommendations of the task forces various standing committees have been constituted in the areas of (1) Agriculture (2) Bio-resources and Environment (3) Water Resources (4) Ocean Resources (5) Geology (6) Technology and Training. All these Standing Committees consist of senior official of the relevant user departments as members. The departments undertakes various resource application projects using remote sensing techniques and are periodically reviewed by the concerned chairman of the Standing Committees. The progress made on the projects undertaken as part of the Standing Committees are conceived as Remote Sensing Application Mission (RSAM) projects with clearly defined time targets and goals.

The peer evaluation of the progress of standing committees and policy matters related to remote sesning applications in India is directed by a senior level committee called Planning Committee on NNRMS (PC-NNRMS) consisting of Secretary's of all the user departments as members. The PC-NNRMS is headed by a senior level Scientist/ Minister of State rank who inturn is responsible for providing the guidelines for the overall implementation of National Natural Resource Management System in the country under the aegis of Department of Space, Government of India.

NNRMS AND INFRASTRUCTURAL REQUIREMENTS

The implementation of NNRMS in the country calls for extensive infrastructure development for effective promotion of remote sensing in India. The various areas where the infrastructural development was necessiated are :

1. Ground segment: The satellite data reception facilities for Landsat MSS/TM, NOAA AVHRR 9 & 11, IRS 1A/1B and for ERS-1 data coupled with Telemetry, Tracking and Command support for satellite control operations. The organised data reception for all the multiple satellites and the associated data processing facilities involving pre-processing of High Density Digital Tapes (HDDTs) into Computer Compatable Tapes (CCTs) on a user friendly format.

2. Space segment: The indigenous requirement and suitability of specific spectral band widths associated with spatial resolution are the basic requirements for development of indigenous capability in design and development of imaging sensors onboard IRS-1A/1B. Consequent to the extensive end to end experiments carried out with the collaborative studies with the user departments narrowed down the immediate requirements on the suitability of a spectral band width and the associated spatial resolution of the sensors. These requirements have been specific to Indian conditions. Realising the necessity and importance a self reliant indigenous system IRS-1A and IRS-1B which are presently in orbit providing data for the entire nation in two spatial resolutions one on 73 metres (LISS I) and other with 36 metre (LISS II). The combined orbital coverage is of 10 to 11 days interval. The increased scope for obtaining cloud free data for any given season with the indigenous Indian Remote Sensing satellite data enhanced the utilization of satellite data for routine applications of resources inventory and monitoring by various user departments benefiting the nation to a great extent.

The availability of NOAA AVHRR data and LANDSAT TM providing as additional satellite sources for specific land and ocean resources applications in an operational way.

3. User Interface: The developments and promotion of remote sensing activities in India are widely documented and disseminated to all the users through NNRMS bulletins, Interface (brought out by NRSA), SAC courier and Photonirvachak (the only national journal devoted on remote sensing). In addition theme specific regional workshops organised both at national and regional levels ensure the total updating on the happenings of remote sensing data utilization. Specific examples to this are on organisation of state level workshops on the utilization of wasteland maps generated using remote sensing data and also the workshop on ground water potential zone maps at district levels. Over and above users have been provided an easy access on the information through NRSA Data Centre (NDC) facility located at NRSA, Hyderabad.

4. Facilities: In order to cater to the requirement of satellite data utilization and various levels the establishment State level Remote Sensing Applications Centres (SRACs), Regional Remote Sensing Service Centres (RRSSCs) with Digital Image Processing facilities configured around VAX 11/780 are meeting the requirements for the entire nation amply supported and guided by the major organisations like National Remote Sensing Agency, Hyderabad and Space Applications Centre, Ahmedabad. In addition considering the enormous work load on the use of remote sensing data, few

other central government departments like Geological Survey of India (GSI), Forest Survey of India (FSI), Oil and Natural Gas Commission (ONGC) have established their own remote sensing facilities for undertaking their studies.

5. Training: The increased use of remote sensing lead to the demand on the availability of trained manpower for various application areas. The training presently offered in India is at Indian Institute of Remote Sensing, Dehra Dun. The Institute provides training facilities for the resources areas in Forestry, Geology, Cartography, Soil and Agriculture, Photogrammetry and Remote Sensing, Urban and Regional Planning and aerial and satellite data processing. The training facilities are open to all the organisational/ departmental officials including academicians. In addition to inhouse training, the institute also provide Fellowships under SHARES Programme for the developing nations. Over and above specialised theme specific training programmes are also offered under the aegis of NNRMS by Geological Survey of India (GSI) and Forest Survey of India (FSI) inorder to cope the demand on training.

6. Education: With the present status of operational utilization of remote sensing it has been widely felt the necessity for introduction of remote sensing in the education curricula. As a result, University Grants Commission (UGC) and Department of Space together have evolved a remote sensing syllabus package for introduction at post-graduate level either as a part or full paper. Besides this DOS and Department of Education (DOEd) have together worked out the guidelines of the syllabus for incorporation at 10th and 11th standards. The percolation of remote sensing at the school and university level clearly demonstrates the efficacy and acceptablity of remote sensing in all sections of community.

7. Technology Development & Transfer: While the increased use of remotely sensed data either through visual interpretation or digital analysis techniques, need cost effective tools for interpretation and analysis. Towards this several visual interpretation aids have been developed indigenously and the technology has been transferred to the industry. The promotion of remote sensing enterpreneurship made way for the easy availability of remote sensing tools on a more cost effective way. In addition the development of PC based Image Processing Systems (SIPS and ISROVISION) have together broadened the applications of remotely sensed data for digital analysis.

OPERATIONAL PROJECTS

The acceptance and success of promotion of remote sensing in India is primarily due to the widespread usage of remotely sensed data for various national level operational projects. Several projects have been carried out at various levels; national, regional, local, case wise R&D studies have together provided immense impact for the policy planning viz., strategic/ tactical/technical levels. The information flow generated through satellite based sources is dual in nature both in the vertical direction right from working level to bureaucratic levels. On the other, there is an horizontal transfer of technology in specified application areas. The applications of remote sensing is mainly either diagnostic or solution specific in nature for example; the National Agricultural Drought Assessment and Forecasting during Kharif season at district level is of diagnostic in nature while providing information for strategic planning in order to take remedial measures. The various projects undertaken in India which have direct impact on national development have been shown in Table 1 clearly depicting the positive points for promotion of remote sensing.

TABLE 1

MAJOR REMOTE SENSING APPLICATION PROJECTS

Project Name	Level of information	Planning purpose	Horizontal/ Verticle	* D/S
Forest Cover Mapping	National	Strategic	Verticle	D
Wasteland Mapping	District	Technical	Horizontal	D
Landuse/ Landcover Mapping	District	Tactical	Horizontal	D
Agricultural Drought Assessment	District	Technical	Verticle	D
Ground water	District	Technical	Horizontal	S
Fishing Zones	Regional	Technical	Horizontal	S
Crop Acreages	Regional	Technical	Horizontal	S
Snow-melt	Regional	Technical	Horizontal	S
Flood damage	Regional	Tactical	Horizontal	S
Mineral targetting	Case study	R&D	TD	S
Integrated studies	District	Technical	Horizontal	S
Soil Salinity	District	Technical	Horizontal	S
Grassland mapping	Region	Tactical	Verticle	D

* D = Diagnostic S = Solution specific

INDIAN EXPERIENCE - TREND SETTER FOR DEVELOPING NATIONS:

The various need based projects undertaken using satellite based data are common to all the developing nations. The experience gained in India for effectively promoting remote sensing virtually in all resources sectors can be a trend setter for other developing nations. The Indian experience amply demonstrates to adopt the ways and means in which India has benefitted utilising the remote sensing technology for its national development while updating the information base more accurately in the desired scale of operation. The solution specific problems and associated system packages are available within Department of Space and can be accessed on a mutually agreed bilateral basis.

INDIAN EXPERTISE - OFFERINGS

With the successful launch of IRS 1A and IRS 1B which are presently in orbit operationally provide extremely good pictures of the land mass with a combined repetitivity of 11 days interval. The NRSA Data Centre (NDC) can distribute the IRS data in two spatial resolutions (73 and 36 metres) for all the needy nations with in the visibility circle with Hyderabad as centre point.

The Indian Institute of Remote Sensing which is a professional training centre in remote sensing offers training programmes for application scientists belonging to various developing nations. The course curricula comprises of three months duration to one year diploma courses.

National Remote Sensing Agency undertakes consultancy projects on various application areas using aerial and satellite data with the available expertise. The consultancy projects will be executed jointly by the users of concerned nation and Department of Space, Government of India.

With the experience gained so far for the last decade several of the application areas have been made operational through satellite/aerial remote sensing. The Department of Space, is now in a position to share with all the developing nations the operational packages on a mutually agreed basis. The operationally demonstrated packages would certanly pave way for wide spread applicability of remote sensing in all the developing nations.

The system management aspect on the lines of establishment of a national natural resources management system for any developing nation may suitably be suggested with the experience gained in India in effective promotion of remote sensing in an organised way in various resources sectors. The functionalities and the modus operandi on the reviewing mechanisms right from bureaucratic levels to working level scientists can suitably be designed with sound understanding of the issues pertinent to the nation.

THRUST AREAS - GIS

The large data base generated in various resources areas temporally is being fed into Geographical Information System in a time series mode in order to derive logical conclusions on the development and dynamics of resource areas. The information generated at various levels sectorally by various organisations need a integrated approach on consolidation and formating on to a single information base in order to develop National Resources Information System (NRIS) in conjunction with other collateral data preferably at the district level. The concept of Geographical Information System which in turn leading to National Natural Resources Information System (NRIS) with a provision of accessability, updating, retrieval etc., is the ultimate goal of NNRMS to fructify the timely information generated through remote sensing and to put in use for planning purposes at various levels.

The future remote sensing programmes of India mainly concentrate on the utilization of satellite based data in the region of middle infrared bands and microwave data through use of ERS-1 and air borne SAR data which is indigenously developed. Over and above the application of Digital Photogrammetry and Cartography and its wide spread use for urban and regional planning is intended to widen its scope through generation of ortho photos and to gain experience with the future space programmes on the utilization of stereo scopic satellite data for obtaining terrain information. India is making a serious effort to generate Digital Elevation Models (DEM) through use of Satellite stereo data in obtaining reliable terrain information.

India through its various international collaborative projects pertaining to remote sensing has made significant progress. The INDO-FRG Collaborative Programmes have widened the scope of utilization of remote sensing data in the areas of forestry, geology, oceanography, hydrology and information systems.

INDIAN EXPERIENCE - STILL NEEDS IMPETUS

Several of the application areas have been made operational through use of remote sensing data. There is also a greater variety of indigenously developed visual interpretation aids, PC based Image Processing Systems with a powerful indigenously developed image analysis packages, which have widescope for utilisation in the international market. It no doubt, calls for a aggressive marketing strategy. India having maximally benefitted through use of remote sensing data and developed various application packages can help in transfer of technology with appropriate modifications, where necessary to all the developing nations.

CONCLUSIONS

The operational utilization of remote sensing technology amply demonstrated and accepted by all the user departments in India has lead to

the establishment of National Natural Resources Management System (NNRMS) in the country. The widespread applicability coupled with efficient promotion of remote sensing technology through use of satellite data on a specific need basis and providing solutions to all the problems pertaining natural resources has been the key to success of remote sensing. The technology missions on Drinking Water, Oil Seeds Crop production and Wasteland Development which have been conceived at the national level have been fully benefitted through use of remote sensing technology amply demonstrating the promotional strength of remote sensing in India. The various application projects several of them are either diagnostic or solution specific have provided meaningful information to various levels for planning purposes viz., strategic, tactical and technical. The indigeniously developed highly sophisticated application packages, hardware, software, visual interpretation aids and ground truth equipment are commercially available and requires aggressive marketing.

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