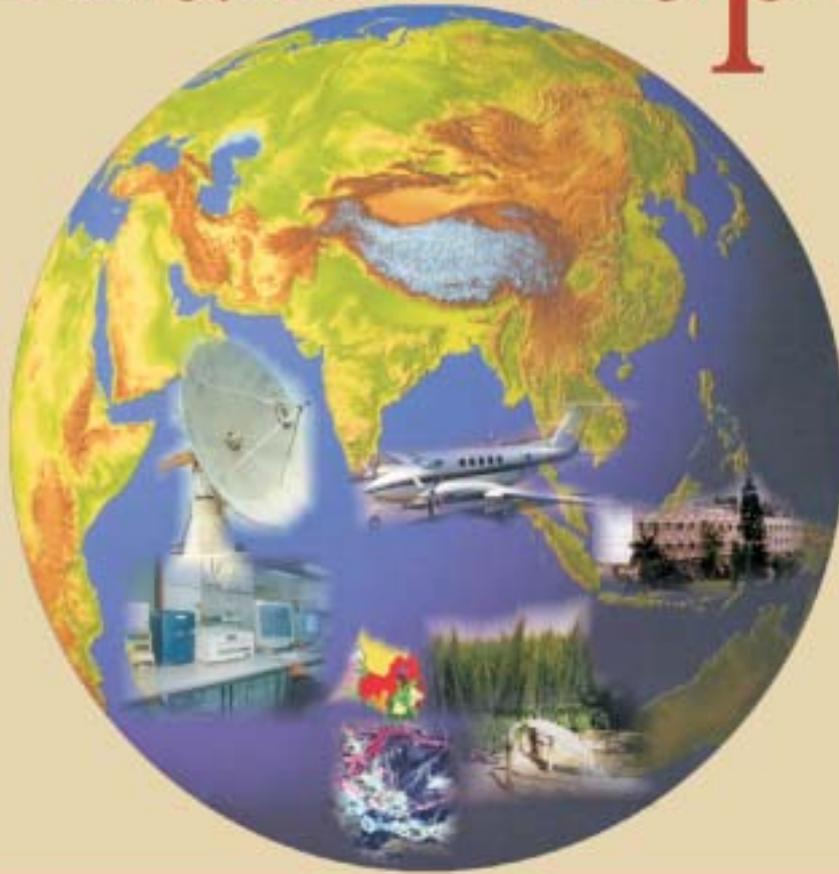


वार्षिक रिपोर्ट Annual Report



2004-2005

नेशनल रिमोट सेन्सिंग एजेन्सी
national remote sensing agency



*.....providing high-quality
remote sensing data,
indigenous capacity and
application services to
facilitate enhanced utilisation
of Remote Sensing in
resource management and
disaster mitigation.....*



Back cover: Khed Brahma was the first area in India to be viewed by Cartosat-1. Bordering Gujarat and Rajasthan, this region is surrounded by hills, seen clearly in a 3-D perspective view generated from stereo data from Cartosat-1.

Composition

Members

President

Minister of State in Govt. of India (GOI) dealing with Dept. of Space (DOS)

Shri Satyabrata Mookherjee

Hon'ble Minister of State for Statistics & Programme Implementation, Planning, Atomic Energy and Space

Shri Prithviraj Chavan (from Sept 4, 2004)

Minister of State (MoS), Prime Minister's Office (PMO)

Vice-President

Secretary to GOI, DOS

Shri G. Madhavan Nair

Members

Secretary to GOI, Dept. of Science and Technology (DST)

Prof. V.S. Ramamurthy

Secretary to GOI, Ministry of Defence (MoD)

Shri Ajay Prasad

Shri Ajai Vikram Singh (from Jul 1, 2004)

Three Eminent Scientists

Dr. P. Rama Rao

Dr. Brahma Prakash Distinguished Prof., International Advanced Research Centre for Metallurgy and New Material (ARCI), Hyderabad

Dr. R. Natarajan

Former Chairman, All India Council for Technical Education (AICTE), New Delhi

Shri Chandi Prasad Bhatt

Social Worker, Dasholi Gram Swarajya Mandal, Chamoli, Uttaranchal

Additional Secretary and Internal Financial Advisor, DOS

Shri S. K. Das

Ms. Veena Sreeram Rao (from Jan 6, 2005)

Member (Finance), Space Commission and Ex-officio Secretary (Finance) to GOI, DOS

Dr. S.S Meenakshisundaram

Shri S.K. Das (from Dec 9, 2004)

Director, Earth Observations System (EOS), DOS

Dr. V. Jayaraman

Director, NRSA

Dr. R. R. Navalgund

The Society of NRSA 2004-2005

The Governing Body of NRSA 2004-2005

Composition	Members
Chairman Secretary to Govt. of India (GOI), Dept. of Space (DOS)	Shri G. Madhavan Nair
Members	
Secretary to GOI, Dept. of Science and Technology (DST)	Dr. V. S. Ramamurthy
Secretary to GOI, Ministry of Defence (MoD)	Shri Ajay Prasad Shri Ajai Vikram Singh (from Jul 1, 2004)
Three Eminent Scientists	Dr. P. Rama Rao Dr. Brahma Prakash Distinguished Prof., International Advanced Research Centre for Metallurgy and New Material (ARCI), Hyderabad
	Dr. R. Natarajan Former Chairman, All India Council for Technical Education (AICTE), New Delhi
	Shri Chandi Prasad Bhatt Social Worker, Dasholi Gram Swarajya Mandal, Chamoli, Uttaranchal
Additional Secretary and Internal Financial Advisor, DOS	Shri S. K. Das Ms. Veena Sreeram Rao (from Jan 6, 2005)
Joint Secretary (Finance), DOS	Dr. R.G. Nadadur Shri P. Mukherjee (from Dec 10, 2004)
Director, Earth Observations System (EOS), DOS	Dr. V. Jayaraman
Director, NRSA	Dr. R. R. Navalgund

technology and operations

Highlights 2004-05

- * Digital browse & payload programming integrated with data ordering
- * Large Format Direct Photo-writing operationalised for IRS-P6
- * Software developed for image masking for QuickBird & IKONOS; AOI based products of high-resolution data
- * Data Archival and Acquisition Policy project completed
- * Over 19,000 satellite data products supplied
- * IRS-P6 data products announced to users
- * Readiness for IRS-P5
- * Technology of PC-based Servo Control System and PC-based Direct Archival and Quick Look System transferred to industries
- * Aircraft utilization - 588 hours
- * Installation and acceptance of ALTM-DC
- * Aerial tasks - pole-to-pole survey for electrical network mapping for KMDA; municipal GIS solution for BMP; aerial photography, digital mapping over cities; aeromagnetic survey over Indo-Gangetic plains
- * International
 - * Alaska, Norman, Neustralitz and Beijing upgraded for IRS-P6
 - * New IRS-P4 acquisition station at Rutgers University, USA
 - * Thematic mapping of Dubai and Hatta
 - * Post-tsunami ALTM-DC survey, aerial photography over Sri Lanka and Maldives
 - * Digital mapping of Maldives; training conducted for officials

resource assessment and monitoring

- * Rajiv Gandhi National Drinking Water Mission - mapping for 8 states
- * Snowmelt runoff forecast for Sutlej basin at Bhakra reservoir
- * National Wastelands Inventory and Updation Project
- * Integrated Resource Information System for Desertic Areas - land & water resources development action plans generated
- * Biodiversity characterisation for E-Ghats and Central India
- * National Agricultural Technology Project - Atlas for Gambhir watershed released
- * Utilization of high resolution data for tree inventory
- * Inputs for environmental studies for hydropower plant at Myanmar
- * Irrigation water management, river engineering studies
- * Participation in ISRO-GBP land campaign-II on aerosols

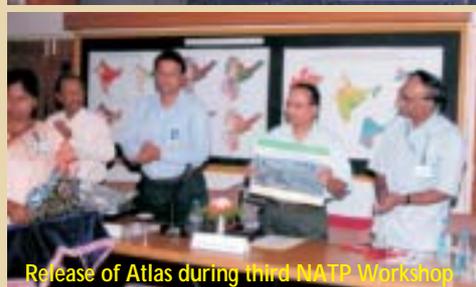
disaster support

- * Monthly Disaster Watch Reports from Decision Support Centre (DSC) for Disaster Management
- * Fast-track and detailed damage assessment after tsunami
- * Monitoring Pareechu lake blockade
- * Near-real-time flood monitoring, inundation area assessment for 9 states; 60 maps disseminated
- * Drought monitoring for 14 states; state-wise monthly summary report for entire country
- * Forest fire monitoring

training & education

- * 436 officers/scientists trained in RS, GIS and allied areas
- * CSSTEAP - Faculty/infrastructure support by IIRS; trained 21 participants
- * Technology development and R&D studies on various data reception, processing and application themes

ISO for NRSA



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annual report

National Remote Sensing Agency in 2004-2005

1. Executive Summary

The country's first remote sensing Earth Station has completed 25 years of its establishment. Starting with a single antenna that received Landsat data, NRSA's earth station at Shadnagar has seen several major milestones. Today, the earth station is a multi-mission system with 3 antenna that cater for as many as 8 satellites, both Indian and foreign. NRSA has also set-up a network of ground stations across the globe that caters for data from Indian Remote Sensing satellites (Fig.1).

Another highlight of this year has been the fact that NRSA is now ISO-compliant. With this, NRSA joins ranks with leading space agencies of the world in the area of remote sensing.

The Data Processing Facility supports archival, processing, product generation and dissemination of data from IRS-1C/1D/P3/P4/P6, ERS, NOAA and Terra/Aqua. Major workcentres handling heavy data volumes have been upgraded with Gigabit network connectivity. The digital browse service and payload programming facility have been integrated with data ordering facility. e-IIMS, based on web technology, is operational for all the satellites. As per the Data Archival and Acquisition Policy, historic data of all satellites

in NRSA's archives has been transcribed onto durable high-density digital media.

Data quality evaluation and quality control activities have played a significant role by providing timely and necessary feedback to mission for all issues related to all data products, particularly Resourcesat-1, whose products were announced to the users. Over 19,000 data products have been disseminated to Indian and foreign users/organisations, with the IRS forming the major chunk.

Resourcesat-1 products, especially LISS-IV MX, have been successful in capturing the imagination of remote sensing data users, as seen from the large numbers that have been supplied. While the distribution of high-resolution data from IKONOS and QuickBird satellites has doubled, data use from the central and state sectors has also shown an upward trend when compared to last year. As many as 49 new private users have joined NRSA's user base this year.

Programming support is being given for all the International Ground Stations for IRS satellites. The Alaska, Norman, Neustralitz and Beijing stations have been upgraded to support IRS-P6 operations. A new IRS-P4 acquisition station has been operationalised at Rutgers University, USA.

Fig.1 NRSA – The Activity Spectrum



The ground systems for reception, processing and product generation are being upgraded for the future missions like Cartosat-1/2 and RISAT. Facility build-up and system readiness has been completed for Cartosat-1, which is scheduled for launch in May 2005.

The devastating tsunami of December 26th last year left widespread damage in its wake. NRSA immediately responded to the news, and the disaster mechanism was operationalised. A rapid assessment of the damage was made for the affected areas within few hours and disseminated through computer networks to the agencies concerned. The data was hosted on the website to allow access to all concerned, including decision makers, scientists, media and public. This enabled rapid decisions in identification of critical damage and assistance.

The International Charter for Space and Major Disasters was also activated. Later, a detailed assessment was done on various categories of damage, their exact geo-location and comprehensive information associated with the damage. High-resolution data from aerial digital camera as well as from satellites was utilized for damage assessment. This enabled decisions of longstanding nature, especially in regard to offers of rehabilitation assistance and future preparedness against disasters.

All the major flood events in the country were mapped during 2004, covering Assam, Orissa, West Bengal, Punjab, Haryana and Bihar. The damage assessment was reached to the organisations concerned in near real-time, for which NRSA was appreciated by the Ministry of Home Affairs and Govt. of Assam.

The National Agricultural Drought Assessment and Monitoring System (NADAMS) provided information on agricultural conditions at district/sub-district level on a biweekly/monthly basis through Kharif season for 14 states of the country. In addition to state-wise reports, monthly summary reports for entire country and sub-district level report for Karnataka and Andhra Pradesh were also issued.

NRSA was requested to identify and investigate the status of Pareechu lake, which was suspected to have caused landslides and flash floods in Himachal Pradesh. Information on the water-spread area of the lake on different dates was provided to the Ministry of Home Affairs, the Sutlej Jal Vidyut Nigam Ltd. and Govt. of Himachal Pradesh on the same day the inquiry

was received. Besides these, disaster events like landslides and forest fires were also monitored and analysed.

The drinking water mission has successfully demonstrated the application of space technology for addressing the key issue of providing potable water to the masses in the country. While eight states have already been covered, work is nearing completion in Gujarat and Orissa.

Under the National Wastelands Inventory and Updation Project (NWIUP), the wasteland atlas is being updated in terms of identification and delineation of new areas under wastelands, and identifying areas where reclamation programme has been implemented.

Land and water resources development action plans have been generated for selected blocks in four states as part of a study on Integrated Resource Information System for Desertic Areas (IRIS-DA).

Phase-II of the Biodiversity Characterization Project is in progress for the Eastern Ghats and Central India. Prototype studies have been completed in 11 test sites in different states under the Natural Resources (NR) Census Programme.

National Agricultural Technology Project (NATP) aims at developing the technologies that would help improve income of farmers and also address issues specific to production system. An Atlas prepared under 'Rainfed Nutritious Cereals Production Systems for Soybean Production' in Gambhir watershed of M.P, was released. Crop Acreage Production Estimation (CAPE) and studies on precision farming have been done. The potential of high-resolution data for tree count in urban areas has been carried out for Hyderabad.

Snowmelt runoff forecast in Sutlej Basin has been done for Bhakra Beas Management Board. Merged data of LISS-III and LISS-IV sensors was utilized to provide the physical and environmental setting of the proposed Tamanthi hydropower project at Myanmar, as well as for 8 such sites in Arunachal Pradesh and Himachal Pradesh.

The multi-resolution capability of Resourcesat-1 is being used to provide irrigation utilization both at command and basin level to provide near-real time information for effective

irrigation water utilization. High resolution satellite data of the order of few a meters captured the existing irrigation infrastructure and helped in monitoring the progress of new irrigation potential created under Government-aided programs.

Under the Command Area Development (CAD) program, NRSA had completed the task of evaluating the performance of 13 irrigation commands aggregating to 3.2 million hectares of cultivable command area spread over five states. To reach the benefit of these evaluation studies to the respective states, a series of workshops were organized in all the five states.

In the area of ocean studies, estimation of sub-surface temperature profiles has been done using Artificial Neural Networks (ANN). Combining spectral responses of SWIR and visible bands of IRS-P6 LISS-3, it has been possible to distinguish salt pans at different stages of crystallization in Kutchchh and the aquaculture fields in Coringa. NRSA is participating in the IGBP Land Aerosol Campaign by way of operating the instruments for monitoring aerosol optical depth, near-surface aerosol size and mass distribution and black carbon aerosol concentration.

Apart from satellite data services, NRSA also has a strong aerial remote sensing activity for large scale mapping applications including aerial photography and digital mapping, infrastructure planning, scanner surveys, aeromagnetic surveys, cadastral mapping, etc. Two aircraft with modern navigational aids supported by dedicated human resources take care of all the analysis and processing requirements.

This year, the utilization of the two aircraft was significantly higher on account of international aerial survey tasks. Among other tasks carried out this year was a pole-to-pole survey for electrical network mapping. A customized municipal GIS solution for stand-alone application and web browser based application has been developed.

Among the international assignments, thematic mapping of Dubai and Hatta regions has been done. Post-tsunami, ALTM-DC survey and aerial photography were done over the affected areas of Sri Lanka and the islands of Maldives for the Ministry of External Affairs, New Delhi. As a part of the project on digital mapping of Maldives, training was conducted for Maldivian officials.

Capacity building through training activities is one of the key areas of focus. The Indian Institute of Remote Sensing (IIRS) at Dehradun imparts training, education and awareness for various cross-sections of people. A total of 436 Indian and foreign participants were trained at IIRS/NRSA Headquarters. As part of HRD activities, 172 employees at various levels were trained for both technical as well as soft skills.

NRSA has developed two technologies - PC-based Servo Control System and PC-based Direct Archival and Quick Look System. The know-how of these two technologies has been transferred to two private industries for commercial production. With these, a total of 32 technologies developed by NRSA so far, have been transferred to the industry.

Strong outreach programmes have helped promote the technology of remote sensing, while also creating awareness about the Indian earth observation programme. Exhibitions and workshops were held in different places in India. Specific training/demonstration of technology are being done for users. Support has been provided to the Research Sponsored (RESPOND) Programme for universities.

With the completion of second phase of IIRS-ITC, The Netherlands collaboration, research collaboration in these common areas of interest is being explored. IIRS/NRSA is providing faculty and infrastructure support to the UN-affiliated Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP).

2. Governing Body and Society Meetings

2.1 Governing Body Meeting

Thirty-third meeting of NRSA Governing Body was held on November 30, 2004. The following decisions were taken in the meeting:

- (a) Approval of Accounts and Annual Report of NRSA for 2003-2004.
- (b) Approval of Plan of Action and Budget for RE 2004-2005 and BE 2005-2006.

2.2 Society Meeting

Twenty-ninth meeting of NRSA Society was held on November 30, 2004. Shri Prithviraj Chavan, Minister of State (MoS), Prime Minister's Office (PMO), and President, NRSA Society, presided over the meeting. The Annual Report and audited accounts for the year 2003-2004 were approved.

3. Satellite Data Services

3.1 Data Acquisition and Archival

3.1.1 Data Reception

NRSA's earth station has completed 25 years of its establishment. Set up in 1979, the data reception started with a single antenna that received Landsat data. Today, NRSA's earth station is a multi-mission system with 3 antenna that cater for as many as 8 satellites. Data acquisition is being done regularly from Indian Remote Sensing Satellites IRS-1C/1D/P3/P4/P6 and USA's Terra/Aqua and NOAA. ERS data is being acquired against specific user request.

Multi-mission data reception

- * IRS-1C/1D/P3/P4/P6
- * Terra/Aqua
- * NOAA
- * ERS

Data archival efficiency has been more than 98% for all the missions. Data are recorded onto digital media by the archival and quick look browse systems. The browse data along with ancillary data is being

transmitted over the Spacenet from Earth Station facility at Shadnagar to the browsing facility at Balanagar, Hyderabad. The data stored on the browse archival system is available for users on Internet for viewing and data selection.

3.1.2 New Developments at Earth Station

A new version of Tracking Controller Unit (TCU) with multi-mission compatibility was developed and commissioned for operations. All old version TCUs which were based on Discrete Components Technology, are being systematically replaced with this new version at Shadnagar as well as at other IRS earth stations. A digitally controlled programmable phase shifter working at 8 GHz was incorporated in place of the old mechanized stretch line phase shifter in one of the terminals at Shadnagar. All the stations will soon be equipped with this indigenous equipment. The Terminal-I and Terminal-II receive chains have been augmented for IRS-P5 payload and Standard Positioning System (SPS) data reception.

The Data Serializer System (DSS) is a PC-based system to serialize data at high speeds for the purpose of reception chain testing and for Level-0 processing evaluation. Data available as a disk file is serialized into synchronous serial format. DSS has been designed for Cartosat-1 configuration but can be used for other missions

as well. This unit is being used regularly for testing systems at the earth station. Data Path Controller, which is a high-speed cross-point switch, replaces the manual patching and aids in automation of data reception by providing suitable connectivity between the bit-synchronizers and the data archival systems. This unit is used to route serial digital data and its clock to various real-time archival systems. The unit is configurable through keypad/LCD interface. General Purpose Interface Bus (GPIB) control is provided for remote control. This unit, which has been developed in house, has solved the problems of manual errors.

The Time Code Translator (TCT) is an in-house developed Very Large Scale Integration (VLSI) based system for use with Data Archival and Quick Look Browse (DAQLB) system for the purpose of time stamping. The system accepts modulated Inter Range Instrumentation Group (IRIG-A) input and provides Binary Coded Decimal (BCD) time information to computer through two different interfaces. These have now replaced the imported units at the earth station as well as those at all IRS International Ground Stations.

Developments in data reception chain

- * Multi-mission TCU commissioned
- * Digitally controlled programmable phase shifter incorporated
- * Data Path Controller to aid in automation of data reception
- * In-house developed TCT replaces imported units at Shadnagar as well as at IGS
- * Readiness for IRS-P5
- * Terminal-I & II receive chains augmented
- * DSS designed
- * S-Band SPS Direct Archival System developed and deployed

The S-Band Standard Positioning System (SPS) Direct Archival System has been developed for acquiring the SPS data available in S-band chain at 16 Kbps data rate. The raw data is ingested in real-time to system disk. The system consists of a PC and in-house developed data acquisition card, and has been deployed for Cartosat-1 SPS data archival chain.

3.2 Data Processing

The data processing facility supports data archival, processing, product generation and dissemination of data from IRS-1C/1D/P3/P4/P6, ERS, NOAA and Terra/Aqua. Support is also provided for all IRS missions for data quality

Developments in data processing chain

- * Digital browse & payload programming integrated with data ordering
- * Large Format Direct Photo-writing System operationalised for IRS-P6
- * Software developed for
 - * Image masking for QuickBird and IKONOS
 - * AOI based products of high-resolution data
 - * Image Display Utility
- * Full India AWiFS mosaic and tile-based L-III coverage of entire country
- * DAAP project completed
- * IRS-P6 data products announced to users
- * Readiness for IRS-P5 data processing - design & development of software for data decryption & decompression

evaluation. Interferometric Synthetic Aperture Radar (InSAR) Digital Elevation Models (DEMs) are being generated. All major workcentres handling large data volumes have been upgraded with Gigabit (GB) network connectivity. The digital browse service and payload programming facility are integrated with data ordering facility. Web-based Integrated Information Management System (e-IIMS) is operational for all the satellites.

As a new element in the Data Processing chain, operational systems and procedures were worked out for correcting the Auxillary Data Information File (ADIF) and updating the image browse co-ordinates. Evaluation and quality checking procedures have also been subjected to quality assurance auditing under ISO-9001:2000 program and some recommendations are being implemented. Large Format Direct Photo-writing System has been established and operationalised to meet the requirements of IRS-P6 data products.

Special products generation software is being used for supplying user-defined customized products. Among the software developed are the image masking software that has been extended for QuickBird and IKONOS, software for handling Area-of-Interest (AOI) based bundled products of high-resolution data, and an Image Display Utility with online image processing tools for satellite data users. Full India AWiFS mosaic at 50 m resolution and tile-based LISS-III coverage of the entire country at 25 m resolution has been prepared.

New procedures have been worked out to improve product quality especially for merged and photo products. Ground Control Points (GCP) from the GCP Library

are being used to improve location accuracy. LISS-3 and LISS-4 mono products have been generated with GCPL and accuracies were found to be 20 m and 4 m respectively. A preliminary design of a 3-tier system model for secured accessing of GCPL database over network has been developed and tested for IRS-P6 product generation.

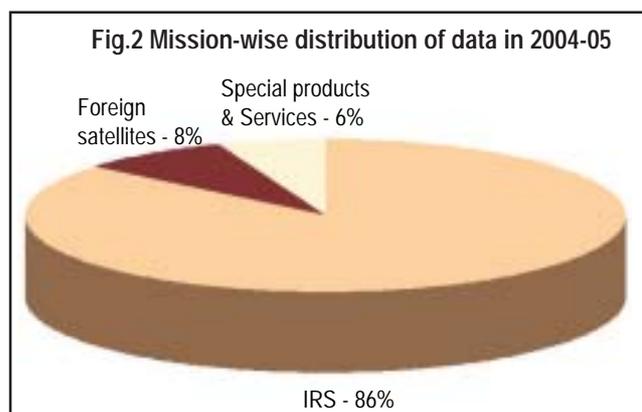
As per the Data Archival and Acquisition Policy (DAAP), historic data of all satellites in NRSA's archives has been transcribed onto durable high-density digital media like DLTs and CDs. OCM/NOAA data are being made available through ISDN to important users like IIT, INCOIS, SAC etc.

The photo processing facility is equipped with specialized/custom-made modern processors, printers, enlargers, printing and processing aids and other equipment for processing, printing and generating various types of satellite and aerial photo products. A digital image library has been built with the recent and archived imageries. Interactive image enhancement is being carried out for best radiometry quality of all photoproducts.

Data quality evaluation and quality control activities have played a significant role by providing timely and necessary feedback to the mission for all issues related to Resourcesat-1 data products, which were announced to the users during the annual User Interaction Workshop during February 2005. An e-brochure on Resourcesat-1 has been hosted on NRSA's website.

3.3 Data Dissemination

A total of 19,067 data products valued at Rs. 3468 Lakhs were disseminated to Indian and foreign users/organisations. IRS data formed the major chunk of the distributed data (Fig.2).

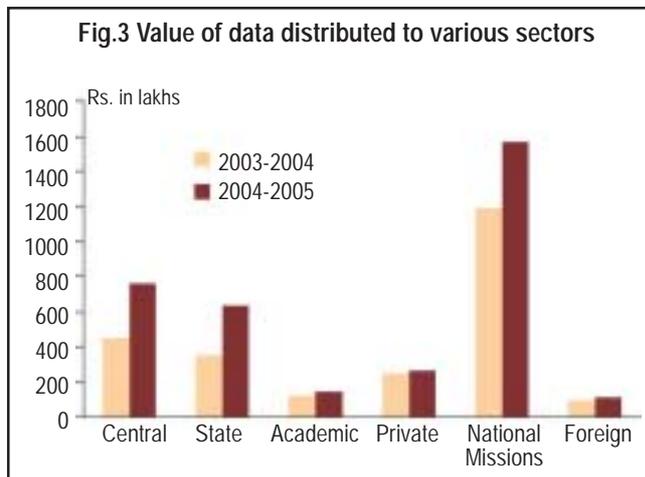


Data being distributed

- * IRS-1A/1B/1C/1D/P3/P4/P6
- * Terra/Aqua
- * LANDSAT
- * SPOT
- * NOAA
- * ERS
- * IKONOS
- * RADARSAT
- * ENVISAT
- * QuickBird

The potential of Resourcesat-1 has been recognized for multifarious applications by the remote sensing community. Of all its sensors, the LISS-IV multispectral data has been supplied in large numbers, which has been possible because of an extensive archive built by systematic coverage of the entire country. Distribution of high-resolution data from

IKONOS and QuickBird satellites has doubled. Requirement of remote sensing data from the central and state sectors has increased by 67% and 81% respectively when compared to last year (Fig.3). As many as 49 new private users have joined NRSA's user base this year.



Browse data are available on NRSA's website. Data in Geotiff (GIS-compatible) format is available. The demand for high-resolution data has increased, especially for geomatic applications.

Under the Remote Sensing Data Policy of the Government, NRSA is the national acquisition/distribution agency for all satellite data within India. NRSA also distributes data from IKONOS, RADARSAT, ENVISAT and QuickBird satellites. Distributors for IRS data are appointed in USA, Iran, Bangladesh, Sri Lanka and Singapore.

3.4 Support to other ground stations

Pass programming is being done for all Indian and International Ground Stations (IGS) for IRS satellites. The IGS are being upgraded to support IRS-P6 operations. Alaska, Norman,

Neustralitz and Beijing have already been upgraded, while Iran, Algeria and Dubai are in pipeline. Eight Advanced Front End Hardware (AFEH) units (Fig.4) have been supplied to various ground stations. The Level-0 and data processing systems to cater for IRS-P6 are being established at Russia.



Fig.4 Advanced Front End Hardware

Over 15 international ground stations, including a mobile station are now receiving IRS-1C/1D data. IRS-P3 data is also being received at Germany and Spain.

A new IRS-P4 acquisition station has been operationalised at Rutgers University, USA, bringing the total number of P4-enabled stations to four, including Korea, Germany and one in USA.

3.5 Readiness for New Missions

The ground systems for reception, processing and product generation are being upgraded for the future missions like Cartosat-1/2 and RISAT.

Facility build-up and system readiness has been completed for Cartosat-1, which is scheduled for launch in May 2005. The Data Archival and Quick-Look Browse (DAQLB) systems have been upgraded. New procedures have been worked out for quality verification and the facility has been established. The PC-based data logging system is being upgraded to cater for Cartosat-1. For Cartosat-2, software requirements have been finalized. Technical support for evolving the ground segment to support RISAT mission data processing at NRSA has been done.

A separate Data Processing Facility has been established to cater for Cartosat-1. Depending on user requirement, the data product can be corrected to various levels of accuracy by applying radiometric and geometric corrections. The Ground Control Point Library (GCPL) will be used for precision correction for

Cartosat-1 launched

Cartosat-1, India's first satellite dedicated for cartographic applications, has been launched on May 5th, 2005 from Satish Dhawan Space Centre (SDSC), Sriharikota. Cartosat-1 has two cameras - a fore and an aft panchromatic (PAN) camera, with a spatial resolution of 2.5 m and swath of 30 km.

The data quality was evaluated and the specifications were found to be as defined by the mission. The satellite has been declared operational and the data products are being made available to the users.

high location accuracy. The User Order Processing System (UOPS), which facilitates data browsing, selection and ordering from the user site, was implemented during the IRS-P6 mission. The same functionality is being extended for IRS-P5 data users.

4. Remote Sensing Applications

4.1 Natural Disasters

The Disaster Management Support Programme of the Department of Space is designed to consolidate the efforts towards providing data which will aid in timely action for disaster relief as well as build up a strong base for operational disaster management activities involving other organisations.

The Disaster Watch Team (DWT) of the Decision Support Centre (DSC) for Disaster Management has kept a constant watch on the natural disasters. Disaster reports are being generated every month. The information on these disasters

is compiled from various websites maintained by government organisations involved in monitoring these disasters viz. the Indian Meteorological Department (IMD), the National Disaster Management (NDM) of the Ministry of Home Affairs, the news media and various other websites.

4.1.1 Tsunami Damage Assessment

On December 26, 2004, an earthquake of magnitude 9.0 on Richter scale occurred off the west coast of Sumatra. This earthquake triggered a devastating tsunami that killed thousands of people across different countries including India. Tamil Nadu, Andhra Pradesh and the Union territory Andaman & Nicobar islands were the worst affected, while Kerala and the Pondicherry also suffered.

NRSA immediately responded to the news. Actions were initiated to check the coverage of various IRS satellites over the affected areas. The PAN cameras of IRS-1C/1D and the LISS-4 of IRS-P6 were tilted to procure data of the affected areas. A rapid assessment of the damage was made within few hours and disseminated through computer networks to the agencies concerned. The data was hosted on the website to allow open access to all concerned, including decision makers, scientists, media and public. This enabled speedy decisions of identification of critical damage and offers for assistance. **Fig.5** shows IRS-P6 AWiFS pre and post-tsunami images of Trinkat island which is a part of the A&N islands. The LISS-4 MX sensor of IRS-P6 captures part of Chennai city in **Fig.6**.

As the tsunami had caused extensive damage to the neighboring countries, the satellite data covering Sri Lanka and Maldives was also procured and analysed and the information was furnished on NRSA website. The International Charter for Space and Major Disasters was activated. The data made available by various international space agencies on Charter web site was also analysed.

Later, a detailed assessment was done on various categories of damage, their exact geo-location and comprehensive information associated with the damage. High-resolution aerial

Fig.5 Pre and post-tsunami images of Trinkat island

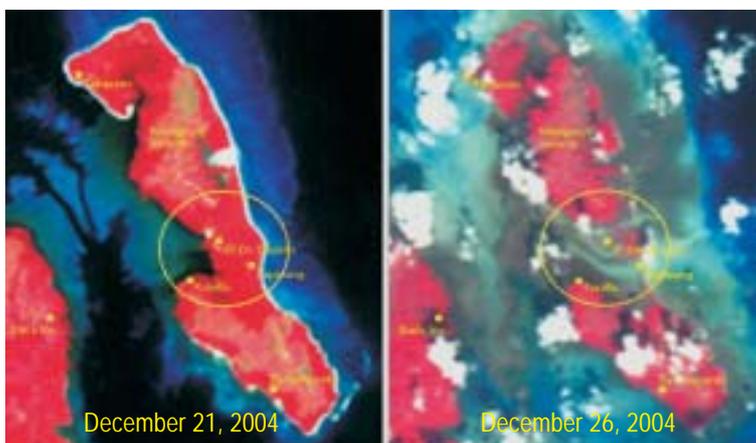


Fig.6 Pre and post-tsunami images of part of Chennai



digital camera data was procured over selected affected areas in Tamil Nadu, Kerala, Andhra Pradesh and A&N islands. ENVISAT, RADARSAT and SPOT data were also utilized for damage assessment. This enabled decisions of longstanding nature, especially with regard to offers of rehabilitation assistance and future preparedness.

4.1.2 Near-real-time Flood Monitoring and Inundated Area Assessment

All the major flood events in the country during 2004 have been mapped, covering Assam, Orissa, West Bengal, Punjab, Haryana and Bihar. A constant watch was kept on the flood situation in the country through water level information from Central Water Commission (CWC), ground reports from State departments, news media, etc. The information collected was compiled and Disaster Watch Reports were generated on daily basis.

Support during disasters

- * Flood/tsunami damage assessment
- * Drought monitoring
- * Lake blockade monitoring
- * Landslide hazard zonation
- * Forest fire mapping

Satellite data from IRS, Terra/Aqua and RADARSAT was analysed within 5 hours after receiving the data and flood

inundation maps at different scales (1:1,000,000, 1:500,000 and 1:250,000) along with district-wise flood inundated area statistics were furnished to the Director, NDM Control Room; Chairman, CWC, New Delhi; the Relief Commissioners; the State Remote Sensing Centers of respective states and the North Eastern Space Applications Center (NESAC) for further dissemination to the officials concerned.

During 2004, a total of 60 flood maps have been prepared and disseminated. Information on

flood extent in different districts of Tripura, Meghalaya and Arunachal Pradesh were also furnished. Appreciation was received from Ministry of Home Affairs and Govt. of Assam on the work carried out by NRSA during the floods.

In order to create a common platform to share various experiences and issues related to flood disaster management and available technologies so as to

bridge the existing gap areas for better management, a workshop was organized in June 2004. Participants from ITC, The Netherlands, Ministry of Home Affairs, CWC, IMD, Department of Space, State Remote Sensing Centers, Relief Commissioners of W.B, A.P and Assam attended.

4.1.3 Drought Assessment and Monitoring (MoA/DAC)

National Agricultural Drought Assessment and Monitoring System (NADAMS) has been providing near real-time information on agricultural conditions at district/sub-district level on a biweekly/monthly basis through Kharif season (June to October) in terms of bulletins and detailed reports for 14 States (A.P, Bihar, Chattisgarh, Gujarat, Haryana, Jharkhand, Karnataka, Maharashtra, M.P, Orissa, Rajasthan, T.N, Uttaranchal and U.P) in the country. In addition to state-wise reports, monthly state-wise summary report for entire country and at the sub-district level report for Karnataka and Andhra Pradesh were also issued.

NRSA organized a Regional Workshop on 'Agricultural Drought Monitoring and Assessment System using Space Technology' during May 2004 at the request of the United Nations Economic and Social Commission for Asia and Pacific (UN ESCAP), Bangkok. The workshop was attended by representatives from 10 countries of the region. Drought monitoring mechanisms and user feedback, and regional cooperative mechanism were discussed.

4.1.4 Landslide Hazard Zonation

Landslides near Gangotri and Joshimath during August 2004 were monitored. The database generated under the Landslide Hazard Zonation project had indicated the areas as high hazard zones, and management practices like soil conservation, retention wall with drill holes,

slope modification etc. had been suggested for the same. A brief report has been submitted, highlighting the factors contributing to this landslide.

4.1.5 Monitoring Pareechu Lake

During last week of July 2005, a landslide and formation of a lake over Pareechu river in Tibet was reported and NRSA was requested to identify and investigate the location and the formation of this lake. It was confirmed that the lake had formed only recently, and also that there is a natural depression in that place where water could accumulate during monsoon. A blockade was observed in the stream course in the eastern fringe of the newly formed lake. Information on the water-spread area of the lake on different dates was provided to the Ministry of Home Affairs, the Sutlej Jal Vidyut Nigam Ltd. and Govt. of Himachal Pradesh on the same day the inquiry was received. Status of the lake was monitored on daily basis during August and September using data from IRS, RADARSAT and other high-resolution satellites.

Fig.7 shows the river as seen through LISS-4 sensor of IRS-P6. The blockade of the river (seen on August 11 image) caused the formation of the lake. 60 satellite data sets were analysed. Very little change was observed in the water-spread area during October and November. Ministry of Home Affairs appreciated the efforts of NRSA.

studies have been carried out earlier, the need for a national daily fire monitoring system was not met.

As part of the Disaster Management Support Programme, the INFFRAS (Indian Forest Fire Response and Assessment System) has been established for to facilitate forest fire monitoring and management. The system leverages the capability of the MODIS sensors aboard the Terra/Aqua platforms as well as the Defense Meteorological Satellite Programme (DMSP) satellites for near real-time daily active fire detection. The AWiFS and LISS-III sensors provide data for burnt area and recovery assessment. User can request information and products over the Internet.

INFFRAS is designed to meet the user requirement at three levels - Pre-fire - preparatory planning for fire control; During fire - near real-time active fire detection and monitoring; Post-fire - damage and recovery assessment and mitigation planning. The system has been operational on a trial basis in the fire season of 2005 and will be fully operational for the 2006 fire season. Several areas were covered in response to user requests.

Daily fire occurrence during February to May from MODIS data was provided to the park authorities at Tadoba-Andhari Tiger Reserve.

Fig.7 Monitoring lake blockade



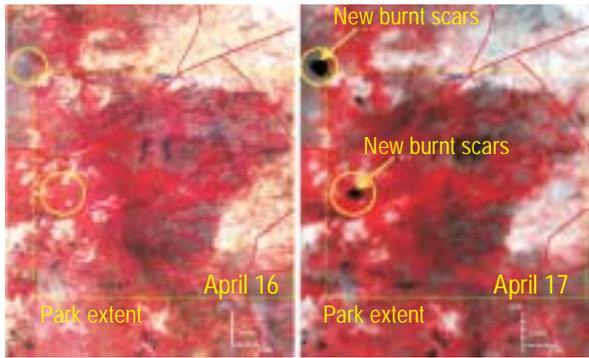
4.1.6 Forest Fire Monitoring

Indian forest ecosystems, especially deciduous forests and grasslands are prone to fires every year. The size and accessibility of the forested areas constrain the efficiency of the routine fire alert systems. Satellite remote sensing provides useful inputs for fire detection, monitoring and mitigation. While several

Near real time burnt area assessment was done for Bandhavgarh National Park with IRS WiFS/ AWiFS data (**Fig.8**).

Uttaranchal Forest Department was provided with near real-time daily active fire locations. Efforts are underway to provide near real time daily burnt area assessment and also provide archived fire location data.

Fig.8 Near real time burnt area assessment



4.2 Rajiv Gandhi National Drinking Water Mission

The drinking water mission has successfully demonstrated the application of space technology for addressing the key issue of providing potable water to the masses in the country, while also touching upon other essential aspects like involvement of user departments, transfer of technology, manpower development, capacity building and private participation. Eight states viz. Andhra Pradesh, Chattisgarh, Karnataka, Kerala, Madhya Pradesh, Rajasthan, Jharkhand and Himachal Pradesh have already been covered. Work is nearing completion in Gujarat and Orissa.

4.3 National Wastelands Inventory and Updation Project

The wasteland atlas is being updated in terms of the spatial information, identification and delineation of new areas under wastelands, and identification of areas where reclamation programme has been implemented. 32 workcentres including other DOS centres, Central Arid Zone Research Institute (CAZRI), Center of Studies in Resources Engineering (CSRE), Birla Institute of Technology and some entrepreneurs are involved in this endeavor. The project is nearing completion and the final maps and GIS database is ready.

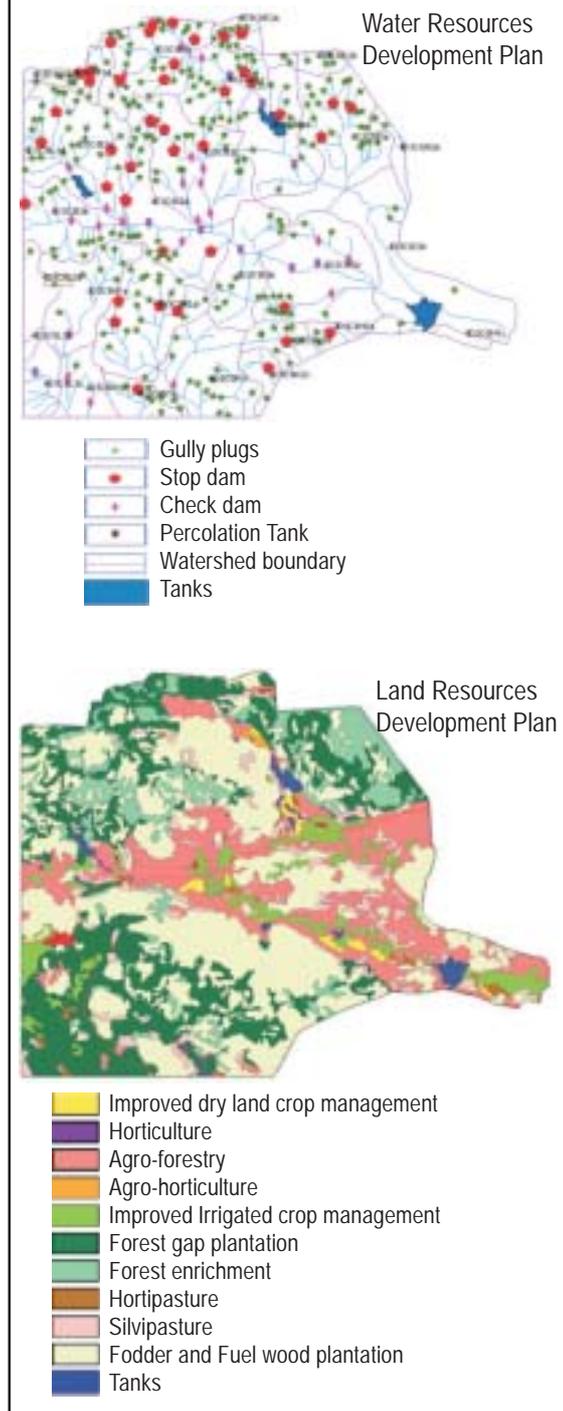
4.4 Integrated Resource Information System for Desertic Areas (IRIS-DA)

Funded by the Ministry of Rural Development, the study aims at creating a natural resources database for desertic areas on 1:50,000 scale through conjunctive use of satellite and conventional data. Optimal land and water resources management utilization plans will be generated to aid the state and district-level officials in planning and implementation of

developmental programmes for a geographical area of 76,257 sq. km (83 blocks in 18 districts) in parts of Haryana, Rajasthan, Gujarat and Karnataka.

As of now, land resources development action plans have been generated for a total of 79 blocks while water resources development action plans have been generated for 50 blocks (Fig.9).

Fig.9 Development plans for desertic areas



4.5 Biodiversity Characterization

Phase-II of the Biodiversity Characterization Project is in progress for the Eastern Ghats and Central India, covering West Bengal, Madhya Pradesh, Andhra Pradesh, Uttar Pradesh

	Coverage (sq.km)
Eastern Ghats & East Coast	4,52,550
Central India	6,64,982
Total coverage in Phase II	11,17,532

Vindhya, Jharkhand, Chattisgarh, Tamil Nadu and Orissa. Species identification, vegetation and land cover type mapping, and phytosociological data collection is in progress.

4.6 Natural Resources (NR) Census

The primary aim of NR census is to provide a periodic assessment/report on the state of natural resources. Prototype studies have been completed in 11 test sites in different states.

4.7 National Agricultural Technology Projects

The National Agricultural Technology Project aims at developing the technologies that would help improve income of farmers and also address issues specific to production system. The project envisages:

- Resource inventory at regional/micro-watershed level
- Identification of critical areas
- Development of action plans
- Implementation of action plans
- Monitoring the progress of implementation/ impact assessment

Under the umbrella of NATP, NRSA has been the lead center for agro-ecosystem research for two major projects on Rainfed Rice Production Systems (RRPS) and Rainfed Nutritious Cereals Production Systems (RNPS). At the Annual Workshop of the project, 32 delegates from other collaborating centers viz. CRIDA, NBSS&LUP, CSWCRTI etc., met at NRSA during June 2004. Status of the two projects, including implementation of action plans in the micro watersheds were presented, and the important achievements were highlighted. An overview of the NATP programmes taken up by ICAR was done. An Atlas prepared under RNPS for Soybean Production System in Gambhir watershed of M.P, was released.

Under the recently completed NATP project at IIRS, various approaches of crop modeling viz.,

single date spectral, spectral crop growth profile and deterministic biomass production model have been investigated for yield estimation of wheat in western U.P. Incorporation of MODIS observations into above deterministic biomass production model provides wheat yield estimates for approximately 60% of the cases within 95% confidence levels of official estimates. Empirical and semi-empirical approach were also evaluated for retrieval of crop parameter using remote sensing inputs and the results have been encouraging. Information on regional scale actual water use and water use efficiency of wheat were also derived to identify specific biophysical constraints to wheat productivity.

4.8 Agriculture and Soils

4.8.1 Crop Acreage Production Estimation

In A.P, about 70% of the normal rice cropped area was covered by the end of first fortnight of September 2004 due to the delayed monsoon and consequent low release of canal water for irrigation, as per the estimate of the Department of Agriculture (DOA), Govt. of A.P. During the same period, cotton crop exceeded by about 20% of the normal acreage of the state.

4.8.2 DEM for Estimating Runoff and Soil Loss

A case study has been conducted to study the accuracy of DEM generated from IRS-1C PAN stereo data and its influence on the estimation of runoff as well as soil loss in a micro-watershed in Zaheerabad mandal of Medak district, A.P. A DEM has been generated from stereo pair from IRS-1C PAN as well as from aerial photographs. The DEM generated from aerial photographs provide better appreciation of terrain elevation and features as compared to the one generated from PAN stereo images.

To estimate soil loss, an event-based mixed/hybrid model developed and calibrated for Indian conditions was used. DEMs derived from aerial photographs and PAN stereo images were processed to generate hydrological DEM. The amount of runoff accumulated at the outlet of the watershed was compared with the *in-situ* observed values of runoff. The results indicate that the variations in slope as computed from aerial and PAN DEMs don't seem to have a great impact on runoff computation. The observation is supported by the fact that the predicted runoff is in very close agreement with the measured runoff. Similarly, the sediments

accumulated at the watershed outlet were computed using aerial and PAN-derived DEM. It was inferred that the values for runoff as well as sediment loss computed using PAN DEM as input are relatively lower than those of PAN-derived DEM.

4.8.3 Precision Farming

A synergy of precision farming with other technologies like remotely-sensed images coupled with GPS and GIS offers a powerful tools for arriving at farm management decisions at within field level to optimize crop production based on the potentials and limitations of the available resources. To explore the potential of remote sensing in providing spatial and temporal information on soils and crops as input to precision farming technology, field experiments were initiated in collaboration with other organisations for cultivation under irrigated conditions, rain-fed controlled and rain-fed farmers' conditions.

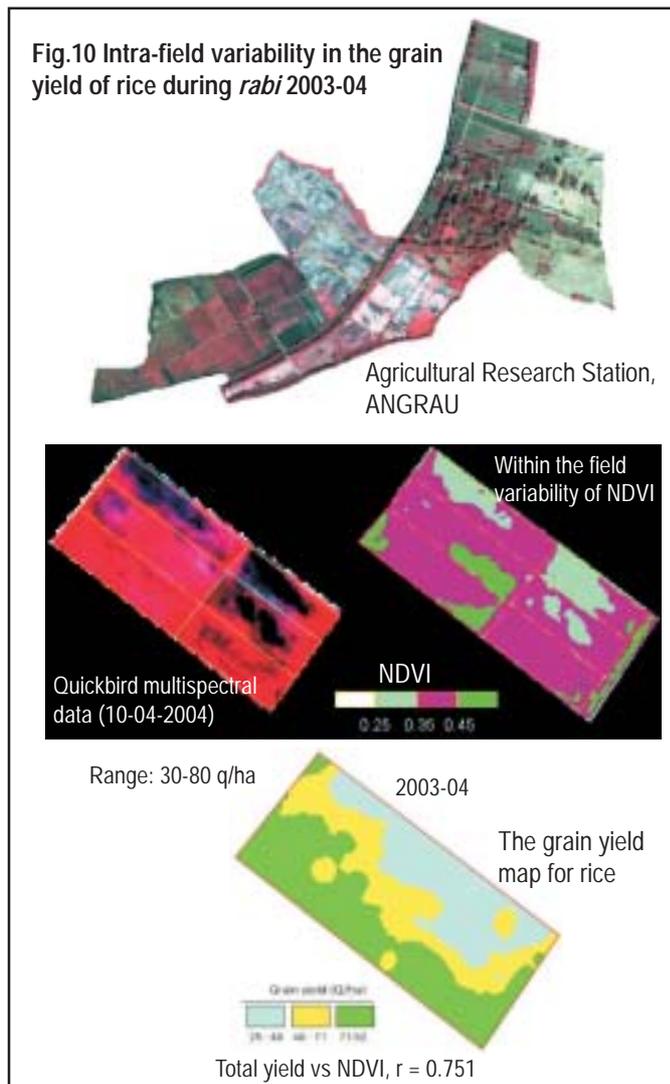
At Acharya NG Ranga Agricultural University (ANGRAU) Research farm, the study was taken up to assess the variability in soil fertility and yield of paddy using *in situ* observations and high resolution multispectral data. Paddy crop was taken during *Kharif* and *Rabi* seasons of 2002-03 and 2003-04. Variability in crop yield and soil properties has been studied by (i) recording crop yield from well-defined grids, and (ii) relating the ranges of Normalized Difference Vegetation Index (NDVI) values of spaceborne multi-spectral data with the soil nitrogen and crop yield. To relate the spectral characteristics of crop with grain yield, IKONOS and QuickBird images coinciding with the peak vegetative development stage were analysed.

The variability in the grain yield of paddy has been studied using yield data obtained from grid sampling. As seen from the grain yield map, the yield varies from 25-92 quintals per ha (q/ha) during the 2002-03 *rabi* season, with major portion of the field having grain yield range of 48-71 q/ha. A small portion in the eastern corner of the field exhibits poor yield (25-48 q/ha). A comparison of the yield map with that of NDVI image reveals some correspondence between the areas within the field with low NDVI

and poor yield. Similar exercise was repeated during the next *rabi* cropping season of 2003-04. NDVI image of the field and grain yield map (Fig.10) indicates the prevalence of poor crop yield in major portion of the field. There is a good relationship ($r > 0.72$) between the NDVI and grain yield.

The spatial distribution of soil nitrogen before transplanting of paddy in 2002-03 cropping season and after harvest of the crop was studied. The total soil nitrogen in the field ranged from 45-90 kg/ha during the pre-transplantation stage and from 35-62 kg/ha after the harvesting of the crop during the year 2002-03. It was also evident from the soil nitrogen variability map that there was a well-defined gradient from northwest to southeast.

Although there is wide variation in the nitrogen level before planting the paddy crop, the scenario during post-harvest period is more or less uniform with major part of the field



showing poor residual N (< 48 kg/ha). The grain yield is also low in the areas where soil nitrogen is low. The study points to the potential of fine resolution satellite data in providing information on intra-field variability in crop yield and as important data source for precision agriculture.

4.9 Geosciences

4.9.1 Hazard and Risk Assessment for Tsunami Tidal Inundation in Car Nicobar

India is gearing up for a Tsunami Early Warning System by 2007. Hence it is essential that a prioritisation of coastal areas be done for tsunami hazard and risk for effective evacuation and rehabilitation. Earth observation systems, both space and air-borne, provide some of the critical input towards such studies. The primary requirement of hazard zonation is accurate Digital Elevation Model (DEM) with high resolution. Airborne sources, especially ALTM and aerial photographs, are a good source for such information with synoptic and temporal capability. The coastal geomorphology, which is another critical input for hazard zonation, is obtained from space-based sensors with resolutions. Land use/land cover is also a key input from the space for risk assessment and monitoring. Integration of all these parameters with other parameters like bathymetry etc. provides the necessary datasets for developing hazard and risk assessment scenario for a particular event.

A collaborative study has been done by the RS&GIS Applications area and the Aerial Services and Digital Mapping group in order to demarcate the areas along the low-lying coast, which have a threat perception from possible tsunamis. The

study area covers the south-east part of Car Nicobar island, covering areas which were severely affected by the December 2004 tsunami. High-resolution airborne digital camera data with 75 cm resolution, DEM with 1 m resolution and high resolution satellite data were the inputs for the study.

Hazard map was prepared by integrating various thematic units in a spatial model and by categorising into different hazard levels. The pre and post-inundation satellite-derived inundation condition was used to understand the maximum tidal ingress levels. The maximum level derived from this method was around 5 m (Fig.11). The aerial data was acquired during high tide (1 m). The local geomorphological features, especially the shape of the coastline,

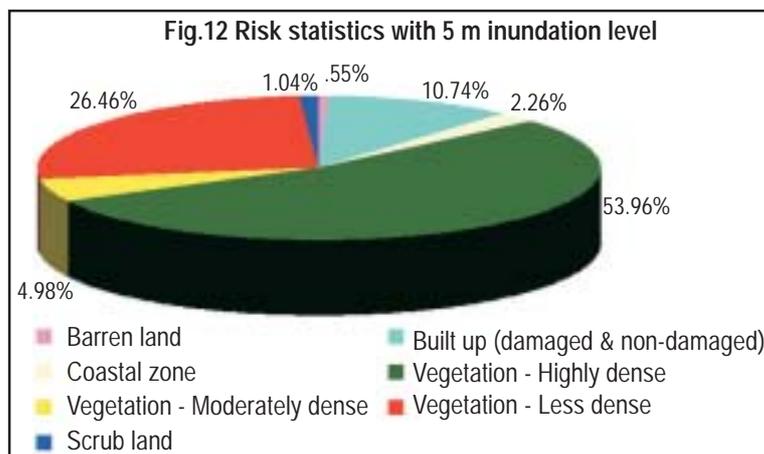
Fig.11 DEM of Car Nicobar island

Background is an aerial image; blue color indicates tidal inundation at 5 m tidal surge



were considered for this hazard zonation, along with the high resolution DEM.

The coastline can be categorised into two major zones based on morphology - a rocky promontory coast in the south and gentle coastal plain in the west. It is this gentle coastal plain which has seen the maximum damage. Two levels of hazard have been demarcated for a tsunami of magnitude of the December tsunami, and with the epicenter near Indonesia.



In order to know the risk at different inundation levels, risk maps were prepared by integrating land use map with 2 m, 3 m, 4 m and 5 m inundation level maps with its statistics (Fig.12). The major sea level boundary changes were seen in eastern segment of the coast where the terrain is gently sloping flat land covered by soft sediments. In the southern

segment of the coast where exposed rock cliffs are seen with higher slopes, no major changes are seen in the coastland boundary. This indicates probably the changes are more of tidal inundation and coastal erosion rather than subsidence.

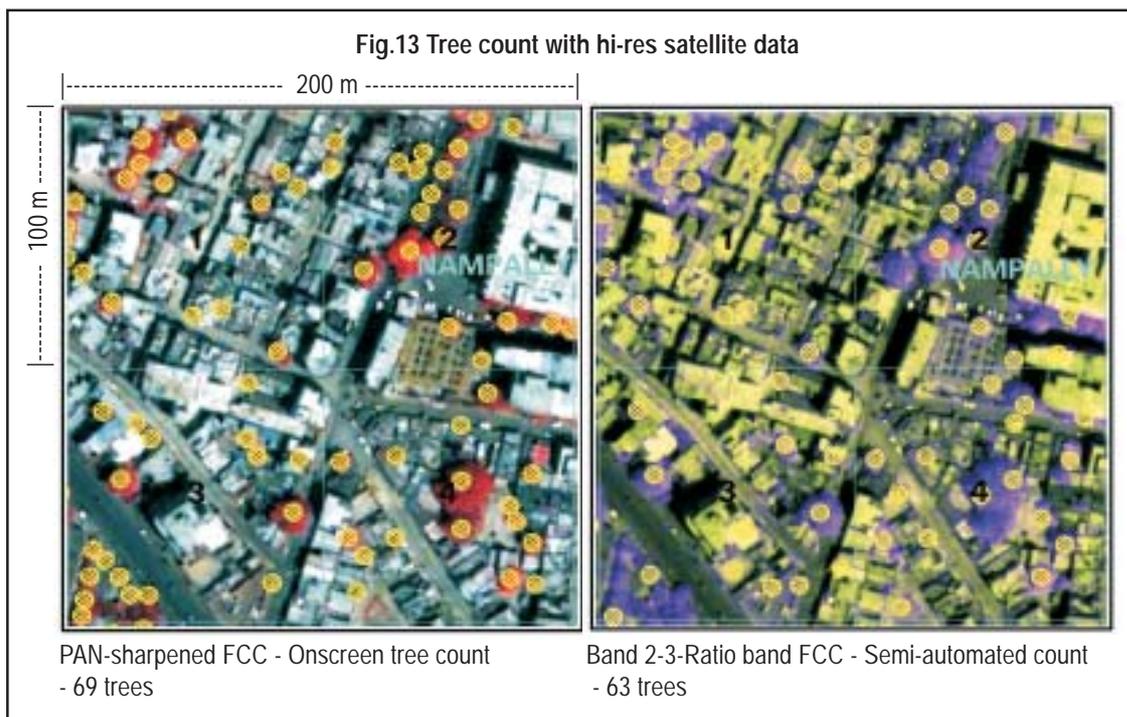
4.10 Land Use and Urban Studies

4.10.1 High-resolution Data for Tree Inventory

Trees, besides forming an important vegetation cover of the cultural landscape in urban areas, also help in mitigating pollution and improving the micro-climatic conditions, while aiding in enhancing the ground water. Generally, the trees in cities are planted under urban forestry, horticulture or under social forestry plantation programmes. A study on the tree count has been carried out for the Municipal Corporation of Hyderabad using high resolution PAN sharpened (0.60 cm) multispectral data (2.5 m) from QuickBird satellite.

technique was applied for selection of grids (100 x 100m) for field verification. A total of 175 grids at 90% confidence level with a standard error around 6% were selected. The total number of tree count is around 5 lakhs. Other ancillary information like tree height, colony name and names of the trees were also collected. Tree cover maps on 1:5,000 scale and a GIS database, containing information on wards and localities, have been generated.

The results of Sanathnagar area in Hyderabad (Fig.13) show an increase in tree count (10 to 20%) when compared to pre-field interpretation. In satellite data, the avenue plantations with canopy size of 40 cm have not been depicted properly. In organic plantation, overlapping of tree crowns is not separable in many cases, which lead to underestimation of the numbers. The study demonstrated the use of high-resolution data in tree inventory and the data is expected to help the corporation in taking up plantation in deficient areas.



The total corporation area of 172 sq.km is divided into 35 wards and 250 localities. For the purpose of tree count, the study area was subdivided into three groups - trees in residential locality, trees along major roads and trees in parks/gardens (as clusters). In the first round, the trees were counted using a semi-automated method. Then, the unclassified trees were interpreted visually. Random sampling

4.11 Water Resources

4.11.1 Snowmelt Runoff Forecast in Sutlej Basin at Bhakra Reservoir

The snow cover in Sutlej basin is regularly monitored using NOAA/AVHRR satellite data. Snowmelt runoff forecast of inflows during April-May-June 2004 into Bhakra reservoir was

issued as 18 lakh cusec-days to Bhakra Beas Management Board. The actual measured inflows were 17 lakh cusec-days.

4.11.2 Inputs for Environmental Studies for Proposed Hydropower Plant

The merged data of LISS-3 and LISS-4 sensors was utilized to provide the physical and environmental setting of the hydropower site for National Hydroelectric Power Corporation (NHPC). Submergence area analysis corresponding to the Full Reservoir Level (FRL) was carried out to estimate areal extents of various land use/land cover categories including phenological types of forest cover and its density classes. Infrastructure details such as roads and bridges and human settlements etc. were also mapped.

This information was used in initial environmental assessment of the Tamanthi hydropower project in Myanmar. Proximity analysis was also carried out to assess the impact of the project on existing National Parks and Wild Life Sanctuaries. Thus the satellite based study has provided insight into the land use - land cover pattern and their spatial extents within both submergence area at FRL and its buffer area around FRL (Fig.14).

In a similar study, satellite data has identified broad land use categories, the area under each of them and in immediate surroundings in respect of 8 proposed hydropower sites in

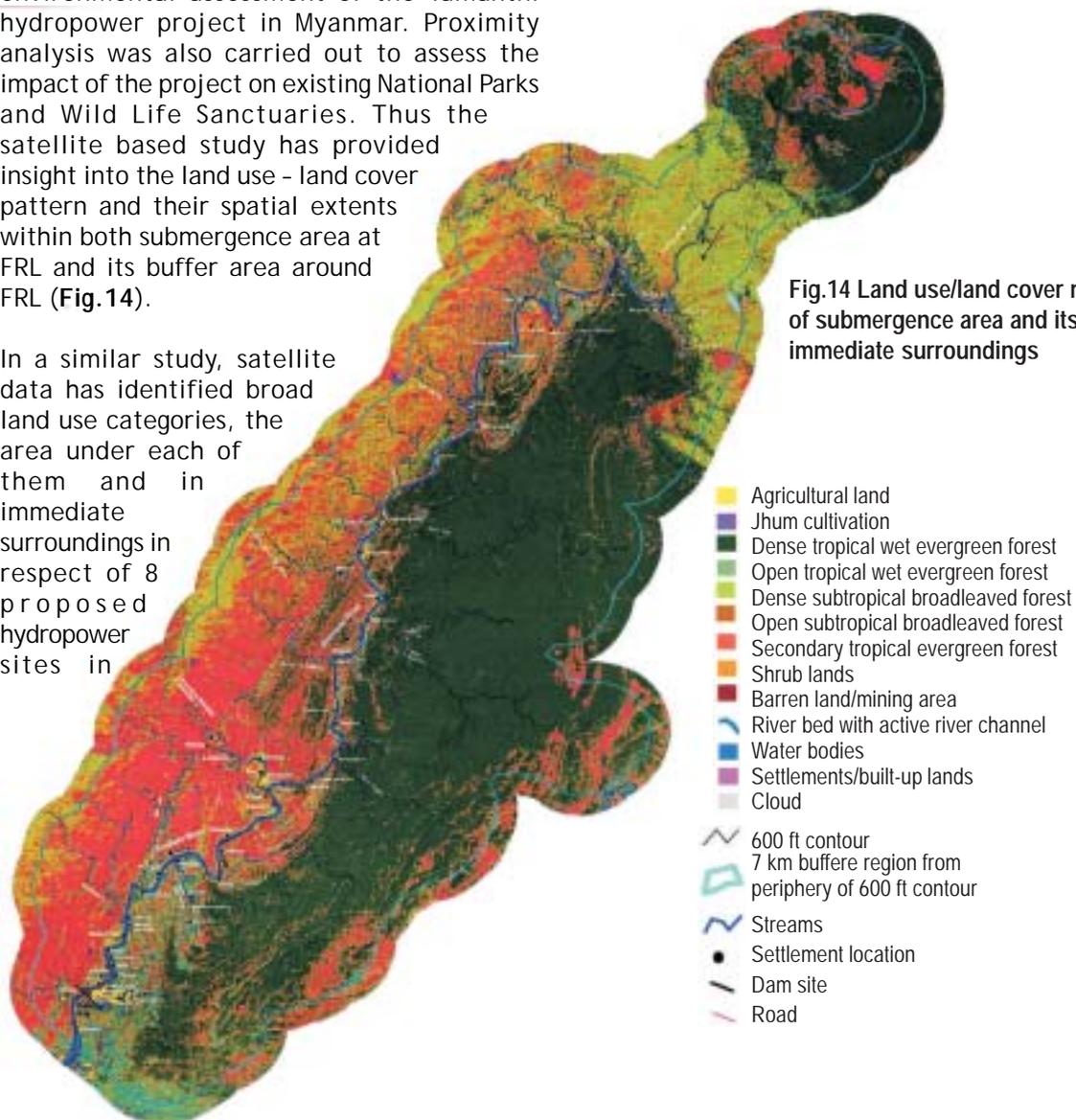
Arunachal Pradesh and Himachal Pradesh.

4.11.3 Sedimentation Survey of Reservoirs

Sedimentation survey using satellite remote sensing data has been completed for two reservoirs - Sriramsagar in Andhra Pradesh and Ujjani in Maharashtra. The project was completed in two phases, following which the officers/engineers from the collaborating agency, the Central Water and Power Research Station (CWPRS), Pune were trained.

4.11.4 River Bank Erosion Mapping (CWC)

Bank erosion mapping was undertaken for Brahmaputra river. IRS LISS-III data of 1996 and 2002 was used to map the extent of erosion at 1:50,000 scale. About 40 erosion maps and 80 photo prints were sent to the user.



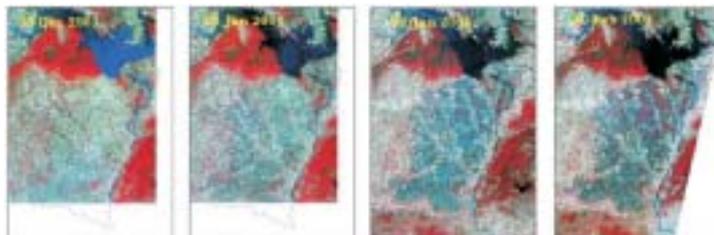
4.11.5 Assessment of Irrigation Potential

High resolution satellite data of the order of few a meters provides excellent opportunity to capture the existing irrigation infrastructure and to monitor the progress of new irrigation potential created under programs such as the Accelerated Irrigation Benefit Program (AIBP), a Central Loan Assistance Program launched in 1996-97 by the Government of India. For this, a pilot project sponsored by the CWC and Planning Commission is being taken up. The study also aims at speeding up the implementation of ongoing irrigation/multi-purpose projects, starting with the Upper Krishna project command area in Karnataka and Teesta barrage command area in West Bengal.

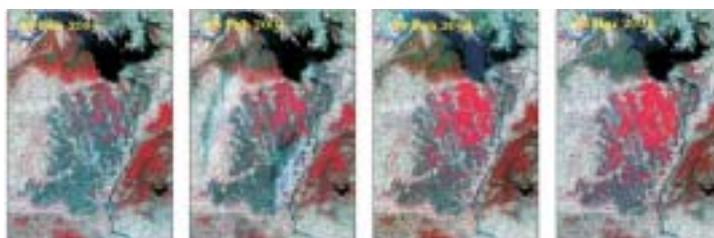
4.11.6 Irrigation Utilization

Resourcesat-1, with its multi-resolution capability, is being used to provide irrigation utilization both at command and basin level to provide near-real time information for effective irrigation water utilization. A study carried out in Hirakud project command area in Orissa clearly brought out the usefulness of its five-day revisit capability in monitoring the progression of rice crop acreage (Fig. 15).

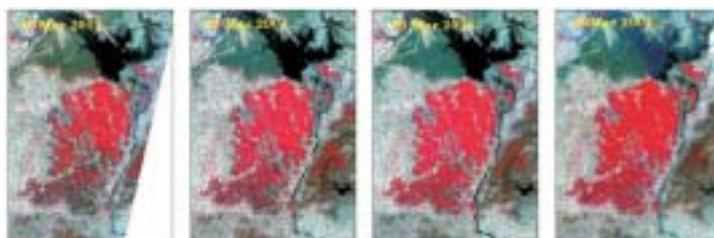
Fig.15 Multi-date AWiFS data showing progression of irrigated crop area in Hirakud command during Rabi 2003-04



Prior to irrigation Irrigation supplies initiated Field preparation/rice transplantation



Rice transplantation/spectral emergence/active tillering



Spectral emergence/active tillering/heading

From the progression of rice crop acreage, emergence pattern has been derived and was used to identify the variability in rice transplantation period across the command area. This information assists in rescheduling of water supplies in accordance with the changes in demand and also provides scope for an improved and optimal water allocation plan considering actual demand scenario.

In another study, an attempt is being made to understand the trends in water utilisation vis-a-vis the changing hydrological scenarios, inventory and change detection of surface water resources and agricultural crop lands in parts of Krishna river basin.

4.11.7 Workshops on Performance Evaluation of Irrigation Projects

The Command Area Development (CAD) Program sponsored by the Ministry of Water Resources, Govt. of India was initiated in 1974-75 with the objective of bridging the gap between the creation and utilization of irrigation potential and for optimizing the productivity and production from irrigated land on a sustainable basis. In order to make quick and reliable evaluation of impact of CAD program on irrigation projects, NRSA completed the task of evaluating the performance of 13 irrigation commands aggregating to 3.2 million hectares of cultivable command area of spread over five states.

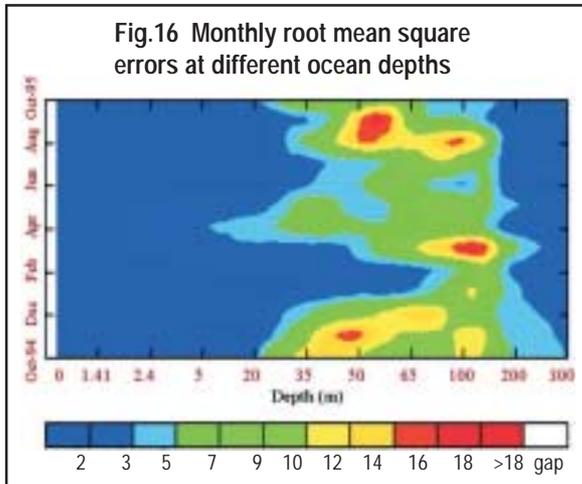
To reach the benefit of these evaluation studies to the respective states, a series of workshops were organized in each of the five states of Andhra Pradesh, Rajasthan, Maharashtra, West Bengal and Assam. These interactive workshops facilitated the command area officials to deliberate and discuss the results and observations of each of the project and to provide suggestions and feedback.

4.12 Ocean

4.12.1 Estimation of Sub-surface Temperature Profiles using ANN

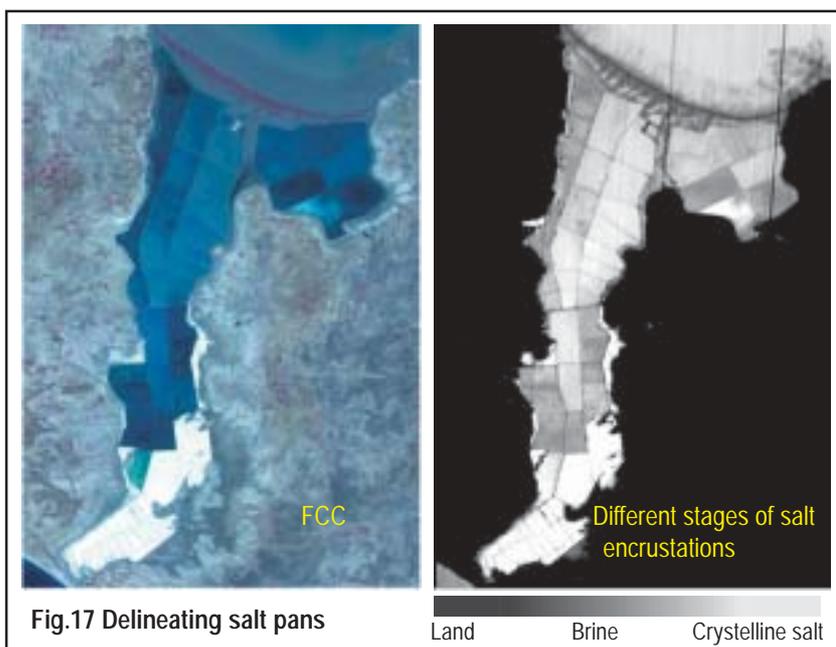
Sub-surface ocean temperature profiles have been estimated from surface parameters using Artificial Neural Network (ANN) approach. The Root Mean Square (RMS) error

of all the estimated temperatures for all the depths is 0.584°C , with R value of 0.99. The monthly RMS deviation between the estimated and in-situ profiles is shown in Fig.16. The maximum monthly RMS errors of the order of 1.8°C are located near the Mixed Layer Depth (MLD) regions.



4.12.2 Delineation of Salt Pans

Visible band remote sensing has limitations for coastal zone mapping due to the closeness in the spectral and spatial properties of the coastal features like salt pans, beach sands, aquaculture plots and fly ash dump. Combining spectral responses of Short Wave Infrared (SWIR) and visible bands of IRS-P6 LISS-3, it has been possible to distinguish salt pans at different stages of crystallization in Kutchchh



(Fig.17) and aquaculture fields in Coringa (Fig.18).

4.13 ISRO Geosphere Biosphere Programme

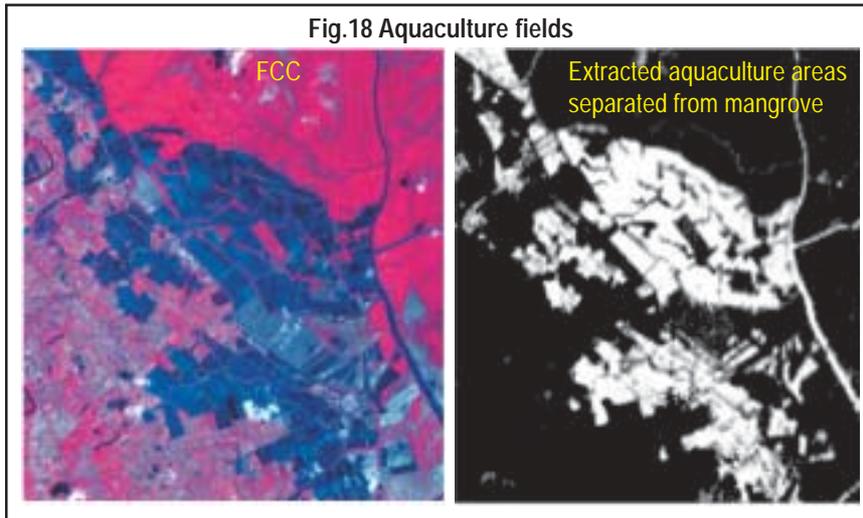
4.13.1 ISRO-GBP Land Campaign-II on Aerosols

The primary objectives of the Land Aerosol Campaign are to characterize the atmospheric aerosols during the winter period and to identify the possibilities of transport and transformation across west to eastern Indian region. This would also help in understanding the dynamics of fog formation during winter and the possible role of atmospheric aerosols.

The ISRO-GBP had undertaken a mobile pilot land aerosol campaign covering 15,000 km road length in southern India. As a follow up of this pilot campaign, ISRO-GBP is now mapping the northern corridor from west to east of India, covering entire Indo-Gangetic plains through continuous measurements of aerosols from December 1st to 31st, 2004.

The Land Aerosol Campaign is simultaneously being conducted in 8 specified locations. This campaign is complemented through vertical measurements of atmospheric boundary layer through Micro Pulse Lidar (MPL) and tethered balloon. In addition, NRSA's aircraft also would be making observations through on-board mounting of some atmospheric measuring instruments from various altitudinal levels up to 10 km in the troposphere. There are 28 national institutions participating in this national endeavour.

A Land Aerosol Campaign project on such a large scale is being carried out for the first time in the country. The NRSA team is operating the instruments for monitoring aerosol optical depth, near-surface aerosol size and mass distribution and black carbon aerosol concentration at Allahabad. Analysis of satellite data for land surface processes will also be done.



5.2 Aerial Survey and Digital Mapping Tasks

This year, the utilization of the two SKA - B200 aircraft was significantly higher at 588 hours, mainly on account of international aerial survey tasks (Fig.19).

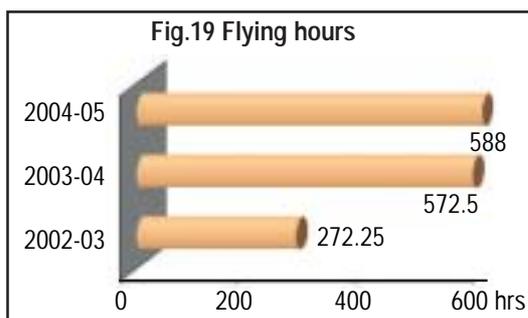
A number of aerial survey as well as range calibration/sensor validation tasks were carried out during the year. A pole-to-pole

5. Aerial Services and Digital Mapping

5.1 Facilities

The unique aerial remote sensing facility at NRSA has been offering a range of value-added services to users for over two decades, including aerial photography and digital mapping, infrastructure planning, scanner surveys, aeromagnetic surveys, large scale base map and topographic and cadastral mapping, etc.

Two aircraft with modern navigational aids, aerial cameras and sensors and trained human resources carry out these activities. Facilities like photo processing lab, analytical/digital photogrammetric systems, GIS systems, survey systems like GPS, etc., supported by dedicated human resources take care of all the analysis and processing requirements. Augmentation like FMC magazine, GYRO stabilized mount etc., are being planned to meet the international flying standards. Installation and acceptance of Airborne Laser Terrain Mapper - Digital Camera (ALTM-DC) system has been done after calibration tasks over 4 different terrains. Site preparation for ALTM-DC calibration was carried out at Hyderabad airport and Shadnagar.



survey for electrical network mapping was done for West Bengal State Electricity Board in collaboration with Kolkata Metropolitan Development Authority. GPS field survey was done for all categories of EHV, HV & LV (both overhead and underground feeders) starting from 400 KV to 230 volts in Howrah, Biddhannagar and 24 Paraganas (south) distribution circles. GPS and GIS techniques were adopted for collection of location and their attributes of 6 lakh poles in these circles covering 63 electric supply units to facilitate development of power GIS applications.

A customized municipal GIS solution for stand alone application and web browser based application has been developed for the Revenue, Engineering, Health and Horticulture Departments of the Bangalore Mahanagar Palike. CAD data also has been converted to GIS database and field maps have been supplied at 1:500 scale. Some of the tasks taken up and completed this year as well as ongoing assignments are detailed in the table.

5.3 International Assignments

Thematic mapping of Dubai and Hatta regions was taken up this year for Global Scan Technologies, Dubai and successfully executed. Post-tsunami, ALTM-DC survey and aerial photography were done over the affected areas of Sri Lanka and the islands of Maldives for the Ministry of External Affairs, New Delhi.

As a part of the project on Digital Mapping of Maldives, monumentation and GPS surveys over pre-signalized points and reference/base stations has been completed. GPS survey for selected islands has also been completed. In-

depth training has been conducted for Maldivian officials.

5.4 Generation of Aerial Photo Products

As many as 47,938 B&W prints and diapositives were generated from aerial surveys, mainly for the tasks of TCPO (Phase-III), Maldives, Mumbai, Visakhapatnam and Karnataka. 9713 frames of aerial photographs have been scanned using two precision photogrammetric scanners.

5.5 GPS Surveys/Kinematic GPS Operations

Calibration targets have been established at Shadnagar by surveying the boundaries and fixing the targets at regular intervals and finding the coordinates by GPS survey. GPS reference station has been operated for NWDA project. GPS surveys have been done over Hampi for RRRSC, Bangalore, and over Uttarkashi for Disaster Management Support project. GPS survey and data processing has been done for

- * Hyderabad airport runway
- * Test sites Chirala, Yellapur, Kesamudram and Hyderabad-urban
- * Belgaum, Nasik, Porbandar and Surat for Cartosat-2 project
- * Three towns for APUSP, Kolkata, Agartala, Guwahati and 7 towns of LSM project

* Four target areas for ALTM-DC validation for about 100 sq. km. comprising of 68 points

5.6 Current Assignments

While many tasks were taken up and executed this year, these are some of the other projects that have been awarded and are being done:

- Consultancy work for aerial photography of project and reservoir area for National Thermal Power Corporation, Noida
- Aerial digital camera operations and processing for tsunami task for Disaster Management Support Project, Dept. of Space
- Aerial flying over Abujmad area (2400 sq. km) of Chattisgarh for Commissioner, Land Records, Govt. of Chattisgarh
- Aerial flying over Ahmedabad and Chennai on 1:6000 scale for Survey of India, Dehradun

6. Training

Creating trained manpower for optimum utilization of remote sensing technology as well as building awareness about allied areas is one of the key areas of focus.

The Indian Institute of Remote Sensing (IIRS) at Dehradun, Uttaranchal imparts training,

Sl.	Task	Project/User
Aerial survey tasks		
1.	B&W aerial photography over Mumbai on 1: 6000 scale	Survey of India, Dehradun
2.	B&W aerial photography over Vizag on 1: 6000 scale	Aerial photography, photogrammetric mapping for Vizag Municipal Corporation
3.	B&W aerial photography for 2 of the 16 towns on 1:8000 scale in Karnataka	Aerial photography of 16 towns in Karnataka for KRSAC
4.	ALTM-DC survey over Inchampally-Nagarjunasagar, Inchampally-Kinnerasani	National Water Development Authority, Hyderabad
5.	ALTM-DC survey over tsunami-affected areas of coastal AP, TN, Kerala and Pondicherry and A&N islands	Ministry of External Affairs, New Delhi
6.	Aeromagnetic survey over Indo-Gangetic plains comprising of about 7,000 line km at 500 ft altitude totaling to 12,000 line km so far	Aeromagnetic survey over Indo-Gangetic plains of about 40,000 line kms for Directorate General of Hydrocarbons (DGH)
Digital mapping tasks		
7.	Bangalore city and surroundings on 1:5000, 1:10,000 & 1:20,000 scale covering 1424 sq.km	Bangalore Development Authority (BDA), Bangalore
8.	Base map at 1:5000 scale for 11 towns in A.P. using high resolution satellite data	Andhra Pradesh Urban Services for the Poor (APUSP), Govt. of A.P
9.	Mapping for 16 towns covering 1200 sq.km (12 towns with hi-res mono data and 4 towns with hi-res stereo data)	Large Scale Mapping (LSM) project
Range calibration / sensor validation tasks		
10.	SAR sensor validation tasks comprising of 97:25 hrs over Ahmedabad, Nagpur, Bhubaneshwar, Patna & Guwahati	Validation of SAR sensor by Space Application Centre (SAC), Ahmedabad
11.	Range calibration tasks of 37:40 hrs	Defense Research and Development Organization

People trained during 2004-05

M.Tech/M.Sc.	38
PG Diploma	21
CSSTEAP course	21
3-4 month courses	87
Short-term/user-defined	269

students and trainees to government officials and decision-makers. It is a unique organization in the entire South-East Asia, fully equipped with sophisticated systems for Image Processing, GIS, Geoinformatics, Digital Photogrammetry, etc.

Long and short-term training in various application disciplines, Digital Image Processing, GIS (Geoinformatics), Digital Photogrammetry, etc. are being imparted, leading to Certificate, PG Diploma, M.Sc. and M.Tech degrees. 14 students of the M.Tech. Course on RS and GIS (2002-2004 batch) were awarded degrees by Andhra University during September 2004.

IIRS is recognized by UNESCO as a training center in capacity building for disaster reduction program. The Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), affiliated to the United Nations, has arrangements with IIRS as host institution for conducting programs related to Remote Sensing and GIS (PG Course in RS and GIS and also international short course every year). Faculty and infrastructure support is provided to the CSSTEAP, which is located in IIRS campus.

On the request of Geoinformatics and Space Technology Development Agency (GISTDA), Bangkok, a special course was organized on 'Geoinformatics Applications in Disaster Mitigation and Sustainable Natural Resource Development' for 11 of their officials.

Short-term courses ranging from four to twelve weeks on remote sensing and its applications, image processing and GIS are offered by the Training Group at NRSA, Hyderabad.

This year, a total of 436 Indian and foreign participants were trained at IIRS (301) and at NRSA Headquarters (135) at Hyderabad, including 21 participants of the CSSTEAP course.

7. Technology Development and R&D

NRSA has developed two technologies - PC-based Servo Control System (PCSCS) and PC-

education and awareness for various cross-sections of people - right from

based Direct Archival and Quick Look System (PCDAQLS).

The PCSCS has been developed for remote sensing satellite tracking stations. The main advantage of this system is improved reliability with reduced hardware, besides being user-friendly (Fig.20). The PCDAQLS not only performs data recording function but also carries out the processing functions as required. This makes the effective cost of the recording system negligible as it replaces expensive High-Density Digital Tape Recorder (HDTR).

Fig.20 PC-based Servo Control System



The know-how of these two technologies has been transferred to two private industries for commercial production. With these, a total of 32 technologies developed by NRSA so far, have been transferred to the industry.

R&D is being carried out on following areas:

- Image processing techniques for very high resolution satellite imagery
- Reduction of onboard data transmission rate for LISS-4 multi-spectral imagery from Resourcesat-1
- Selection of spectral band for Resourcesat-1 LISS-4 Mono operations
- Multispectral quality enhancement by compensating for Modulation Transfer Function (MTF) of LISS-4 imagery

8. Outreach Programme

NRSA has a strong outreach programme that seeks to promote the technology of remote sensing, while also creating awareness about the Indian earth observation programme, its capabilities and potentials. An awareness programme on remote sensing was organized for the students and teachers of a Kendriya Vidyalaya in Bhubaneswar (Fig.21). Several exhibitions and workshops were held in different places in India .



Fig.21 Awareness programme for school children

The 15th User Interaction Meet, which focused on the latest developments in data products, services and applications, was attended by 300 participants from a vast section of users. A permanent exhibition at NRSA campus gives a picture of the space activities in India and about NRSA. Advertisements have been released in technical magazines. Specific training/ demonstration of technology are being done for users. In order to encourage the use of remote sensing data in research and for other new areas, data is being provided to the academic users at a discount.

9. ISO Achieved

Internal audits and external ISO certification team audit were completed. NRSA Quality Management System was standardized successfully to meet the requirements of ISO 9001:2000 standards. This has been verified by Standardization, Testing and Quality Control (STQC), New Delhi. NRSA has achieved the ISO 9001:2000 certificate (Fig.22).

10. Academic Sensitization

The Research Sponsored (RESPOND) Programme of the Department of Space encourages quality research in fields considered relevant to the country's space programme. Financial support is provided to universities and academic institutions for conducting research and development activities related to Space Sciences, Space Technology and Space Applications in India. 11 such projects that are going on in universities all over India, are supported by NRSA. The progress of these projects was reviewed.

11. Events/Seminars/Workshops

- * April 2004
- * NRSA-ISRO-ITC Research Workshop

- * May 2004
- * UN-ESCAP Workshop on Agricultural Drought Monitoring and Assessment System using Space Technology
- * June 2004
- * Flood Disaster Management - Space Inputs
- * IIIrd Annual NATP Workshop
- * August 2004
- * 7th ISRO Policy and Programme Council (IPPC) Meeting organised by NRSA
- * September 2004
- * Parliamentary Standing Committee on Science and Technology, Environment and Forests visited NRSA
- * October 2004
- * One year of Resourcesat-1 in orbit
- * November 2004
- * End-of-Study Workshop for Performance Evaluation of 13 CAD Projects for A.P state
- * February 2005
- * 15th User Interaction Workshop

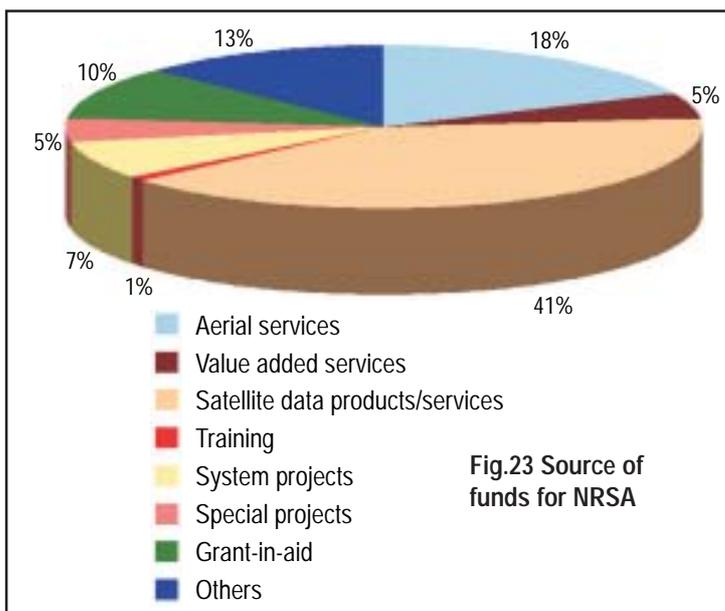
12. International Collaboration

12.1 IIRS-ITC Collaboration

The second phase of collaboration between IIRS and ITC, The Netherlands has concluded. The association was a fruitful one in terms of

Fig.22





15. General

15.1 Personnel

Manpower of the organisation including IIRS, Dehradun, was 933 (as against the sanctioned strength of 1074) as on March 31, 2005, with 620 technical and 313 non-technical employees. The policies of Government of India on reservations in services for SC, ST OBC categories as applicable to Department of Space are followed in NRSA. Liaison Officers monitor the above reservations. In NRSA, we have 130 employees belonging to SC category, 29 employees to ST and 43 employees to OBC categories. 110 apprentices were trained in technical and commercial trades.

As part of HRD activities, 172 employees at various levels were trained for both technical as well as soft skills such as management and personality development, including a 3-day programme for the members of NRSA Employee Union. A new concept of learning a subject, called 'Learn with a Colleague', has been started, where the teacher is one of our colleagues, a step towards making NRSA a learning organization.

Independence Day, Republic Day, National Science Day, National Safety Day, Vigilance Awareness Week and Safety Week were observed at NRSA. Popular lectures on various topics were also arranged.

15.2 Official Language Implementation

More than 90% of NRSA employees possess a working knowledge of Hindi. In-house training

program for Hindi shorthand and typewriting on computers is being organized. NRSA website also includes a link in Hindi. NRSA also extends support to ADRIN for implementation of Official Language. One scientist passed Hindi Prabodh examination with distinction.

Rajbhasha Samaroh-2004 was celebrated at NRSA during September 2004, with several competitions for the employees like essay writing, elocution, typing and also cultural programme. ISM-V5, A multilingual network-based software was inaugurated on Hindi Diwas, enabling all the computers

connected over NRSA's Intranet to work in 12 Indian languages. This software also allows word processing as well as web-page development. Fourth issue of NRSA house journal Samvaad was released. NRSA's weekly e-magazine Guruvaar Bulletin is issued regularly on intranet. A special Hindi workshop was organized exclusively for officers and staff working in transport section, with participation from ADRIN.

15.3 Awards/Honors for NRSA

- Dr. K. Srinivas, Manager, Database Systems, has been elected Fellow of Royal Statistical Society, UK and also the Fellow of Institution of Electronics and Telecommunication Engineers (IETE), India.
- Dr. R.K Gupta, Group Director, Training & Educational Activities has been inducted as Fellow of Indian National Academy of Engineering (INAE).
- Shri K. Neelakantan, Scientist with Land Use & Urban Studies Division, received 2nd Best Poster Paper at the ISRS Annual Symposium at Jaipur.
- Dr. N. R. Patel, Scientist with Agriculture & Soils Division of IIRS has been awarded ISRS-SPECK Award 2004 for best oral paper presented at the ISRS Annual Symposium at Jaipur
- Ms. SVL Bhavani, Scientist with Land Use & Urban Studies Division, received the Consolation Award for her poster paper at the ISRS Annual Symposium at Jaipur.

- Dr. Suresh Kumar, Scientist with Agriculture & Soils Division of IIRS received the Consolation Award for his poster paper at the ISRS Annual Symposium at Jaipur.

15.4 Selected list of Publications and Reports

Publications

1. R.K Gupta, D. Vijayan, T.S Prasad and P.M Bala Manikavelu, "Assessing limits of classification accuracy attainable through maximum likelihood method in Remote Sensing", Asian Journal of Water, Environment and Pollution, Vol.1, No. 1&2, 99-108, 2004
2. A. Senthil Kumar, A.S Manjunath and K.M.M Rao, "Role of Advance image processing techniques for very high resolution satellite imagery", Journal of Spacecraft Technology, vol. 15 (1), pp. 53-57, 2005
3. R.S Dwivedi, K. Sreenivas and K.V Ramana, "Comparison of classifiers of remote sensing data for land-use/land-cover mapping", Current Science 86 (2): 328-335, 2004.
4. S.P Wani, Piara Singh, R.S Dwivedi, R.R Navalgund and A. Ramakrishna, "Measurable biophysical indicators for assessing impact of integrated natural resources management technologies at ecoregion scale", Shiferaw, B., Freeman, H.A, and Swinton, S. (eds.) NR Management in Agriculture: Methods for Assessing Economic and Environmental Impacts. CABI Publishing, 2004.
5. R.S Dwivedi, K. Sreenivas, and K.V Ramana, "Detection of waterlogging using spaceborne multispectral measurements", Current Science, 2004.
6. P.V Narasimharao and M.V.R Sessa Sai, "Clouds over land in ENVISAT ASAR C-Band image", International Journal of Remote Sensing, 2004.
7. M.M Ali, D. Swain and R. Weller, "Estimation of ocean sub-surface thermal structure from surface parameters: A neural network approach", Geophysical Research Letters, Vol. 31, 120308, 2004.
8. V. Ramaswamy, P.S Rao, K.H Rao, Swe Thwin, N. Srinivasa Rao and V. Raiker, "Tidal influence on suspended sediment distribution and dispersal in the northern Andaman Sea and Gulf of Martaban", Marine Geology, Volume 208, Issue 1, 2004.

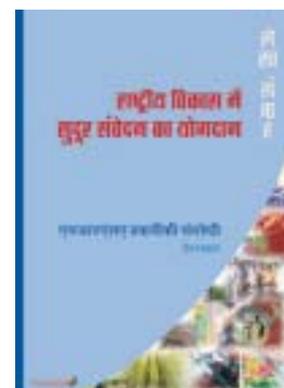
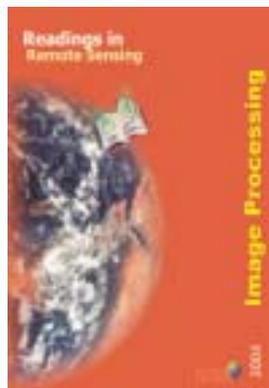
Reports

1. Assessment of waterlogging and soil salinity and/or alkalinity in Krishnarajasagar command area of Karnataka.

2. Evaluation of airborne SAR data for deriving information on natural resources.
3. Quantification of soil loss
4. Integrated Natural Resource Management using Remote Sensing and Geographic Information System techniques - Reports for Rewari, Mahendergarh, Jhjar, Hisar, Fatehabad, Sirsa districts (Haryana) and Dawanagere, Bellary, Raichur districts (Karnataka).

15.5 Outreach

1. Early Results of Resourcesat-1
2. Readings in Remote Sensing - Image Processing issue
3. NRSA Lecture Series
4. updates@nrna - NRSA's quarterly newsletter
5. Samvaad - 4th issue of NRSA's House Journal in Hindi
6. Interface - A quarterly bulletin from NRSA Data Centre
7. Guruvaar Bulletin - Weekly Hindi magazine on NRSA's Intranet
8. Contact - Newsletter from IIRS





భారతదేశంలోని అంతర్జాతీయ అంతరిక్ష కార్యకర్తలకు
అనుబంధంగా, అంతర్జాతీయ అంతరిక్ష కార్యకర్తలకు
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