स्मृतियां Memories

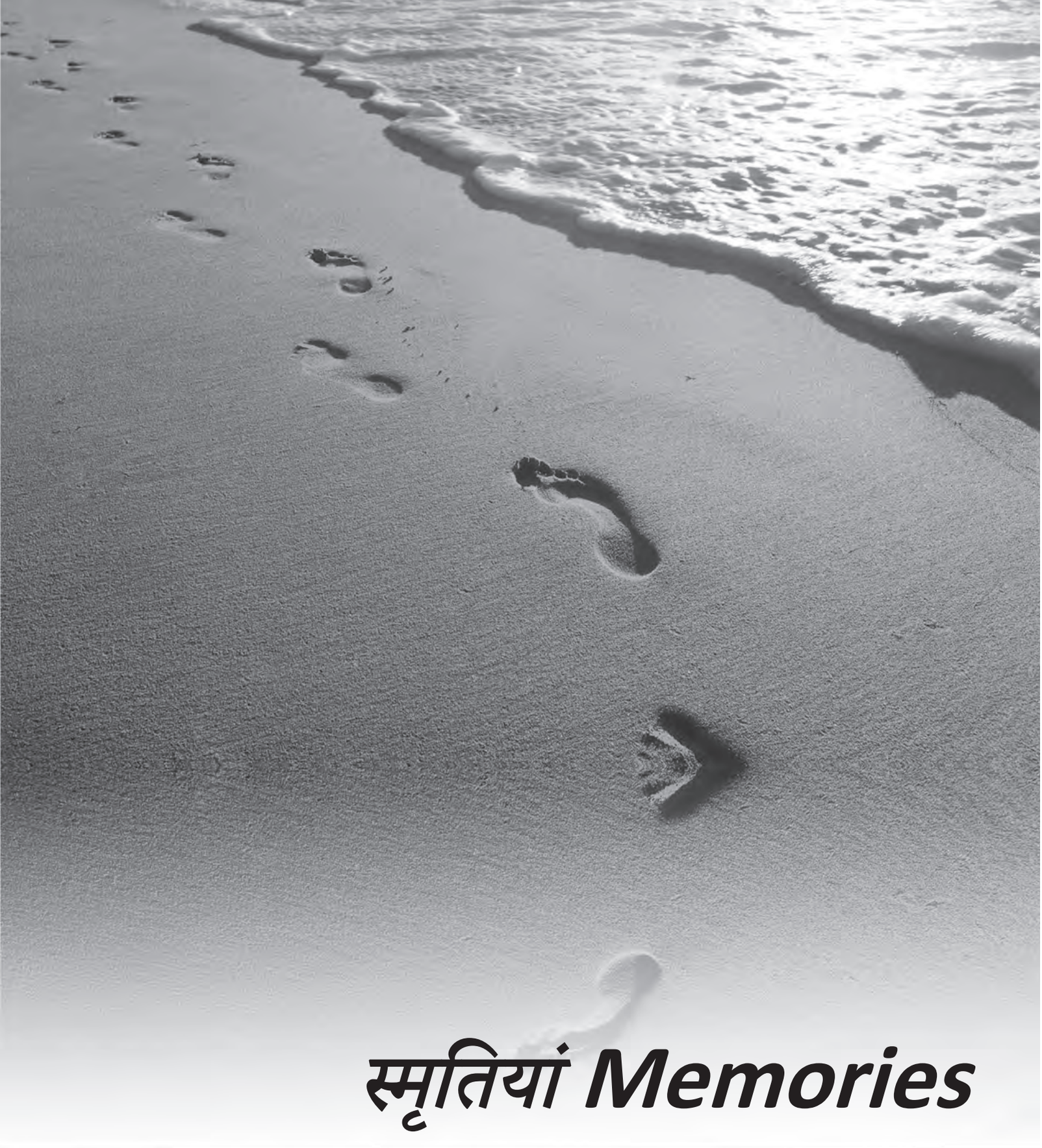
पांच दशकों के संस्मरण
Reminiscences of Five Decades

1974 - 2024

राष्ट्रीय सुदूर संवेदन केंद्र
भारतीय अंतरिक्ष अनुसंधान संगठन
अंतरिक्ष विभाग, भारत सरकार
बालानगर, हैदराबाद - 500 037

National Remote Sensing Centre
Indian Space Research Organisation
Dept. of Space, Govt. of India
Balanagar, Hyderabad - 500 037

सितंबर September, 2024



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Foreword

It is a matter of great satisfaction and pride that the National Remote Sensing Centre (NRSC) has completed 50 years of glorious service to the nation. National Remote Sensing Agency (NRSA) was established as a registered society on September 2, 1974, by the Department of Science & Technology and started functioning from hired premises in Secunderabad, Andhra Pradesh, from April 1975 with Wing Commander K. R. Rao, AVSM (retd.) as its Director. Subsequently, NRSA established its premises in Balanagar, Hyderabad in 1976. The Indian Photo-interpretation Institute (IPI) of Survey of India, Dehra Dun, under the Department of Science and Technology, was merged with NRSA in July 1976. During 1979-80, NRSA established the country's first operational satellite data reception facility at Annaram village near Shadnagar, south of Hyderabad.

NRSA was transferred from DST to the newly created Department of Space in 1980 as an autonomous centre. IPI was renamed the Indian Institute of Remote Sensing (IIRS) in 1983. On November 1, 1995, the UN-affiliated Centre for Space Science and Technology Education in Asia and the Pacific (CSSTE-AP) was established with Headquarters at IIRS. On September 1, 2008, NRSA was converted from an autonomous organization to a fully Government organization under ISRO and was renamed as National Remote Sensing Centre (NRSC). In December, 2009, the Regional Remote Sensing Service Centres (RRSSCs) located in Kolkata, Jodhpur, Nagpur, and Bengaluru were amalgamated with NRSC and renamed as Regional Remote Sensing Centres. Subsequently, IIRS was made an independent unit of ISRO on April 30, 2011.

Today, NRSC is one of the leading institutions in earth observation data acquisition, processing, archival, dissemination, and applications. During the past four decades, NRSC has developed and implemented many unique applications using images collected from the Indian remote sensing satellites and also from foreign satellite missions, many of which have been successfully institutionalized at user ministries. The impact of NRSC is visible in many vital areas of policy-making, natural resources management, and disaster support towards enhancing the quality of life across all sections of society.

I am extremely thankful for the contributions to this document from the luminaries who have contributed to building NRSA/NRSC of today. On this critical milestone of five decades of NRSA/NRSC existence, I am sure NRSC will continue to serve the society and the country in providing EO services.

September 9, 2024

Prakash Chauhan
Director, NRSC

Reminiscenes of NRSA

Wg. Cdr. K R Rao, AVSM (Retd)
Former Director
(February 1975 - January 1982)

Reminiscenses of NRSA

by

Wg. Cdr. K. R. RAO, A.V.S.M (Retd).

The initial step of introducing Remote Sensing Technology in India for applications in various fields (agriculture, hydrology, forestry, geology, landuse etc) was taken by the Department of Science and Technology, Govt. of India in 1974. I was selected to be the Director and charged with the responsibility of setting up an Institution to train Scientists and Engineers in receiving and analysing Remote Sensing data for various applications, and ultimately operationalise the Technology for efficient management of natural resources. This led to the establishment of the National Remote Sensing Agency (abbreviated to NRSA) in Hyderabad, A.P. in 1975. It operated from 4 Sardar Patel Rd, Secunderabad till permanent location was established in Balanagar, Hyderabad at the land purchased from HAL.

The NRSA consisted of Data and applications Centre at Hyderabad, a ground receiving Station to receive data from LANDSAT and Meteorological Satellites at Shadnagar (about 50 Km from Hyderabad) a Research Flight Facility in Bangalore and a Photo Interpretation Institute in Dehra Dun. An important event during this period was the signing of a Memorandum of Understanding between India and U.S.A. which enabled access to U.S. Remote Sensing and meteorological Satellites.

The System design for the entire programme was done in NRSA. A large portion of the hardware was obtained from Indian Sources and the Software was developed by NRSA.

A number of operational projects were completed

for Central and State Governments, a number of instruments were developed in house. Interaction with user agencies was always emphasised, which led to the Confidence of the Users in Remote Sensing.

Many training programmes for Indian and International personnel were conducted.

A Notable achievement was in using Remote Sensing to predict the water level in some of the dams in North India across rivers fed from melting of Snow in the Himalayan Mountains. A national forestry Map was also produced. The Research Flight Facility participated in The International MONEX project to Study the development of the Monsoon in India.

By now, Remote Sensing Technology was widely accepted as a powerful tool for planning, monitoring and managing Natural resources on an operational basis.

In 1981, the NRSA was transferred from the Dept. of Science and Technology to the Dept. of Space.

In 1982, I was selected by the United Nations Food and Agriculture Organization to Set up Remote Sensing facilities in Viet Nam and I left NRSA.

I still cherish my memories of NRSA and the enthusiastic efforts of the personnel which Contributed to the Success of NRSA.

Prof. Satish Dhawan's visit to NRSC (1983)

Visit to Shadnagar Earth Station (1975)

Visit of Minister

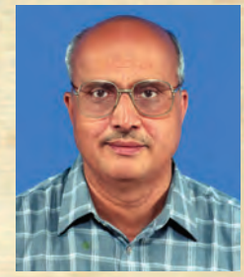
Visit of European Space Agency officials (1981)

Prof. Satish Dhawan's visit to NRSA (1981)

During recreation club programme

Journey of National Remote Sensing Agency

Prof Bulusu Lakshmana Deekshatulu
Former Director
(September 1982 - October 1996)



The seed of National Remote Sensing Agency (NRSA) was sown in 1975 in the Department of Science &Technology, Government of India and took shape of an organization under the autonomous society Act. This happened in the back drop of aerial photography of the hard rock areas around Pune and the coconut wilt disease identification in Kerala. Emphasis on satellite remote sensing technology for NRSA also arose out of the post-LANDSAT 1/2 launches during 1972 and 1973. NRSA became a national facility to carry out aerial photography and for carrying out applications using remote sensing data under the leadership of Wg Cdr K R Rao as the first Director. I joined NRSA in April 1976 from the Indian Institute of Science, Bangalore to develop the technical wing (satellite data processing). Wg Cdr K R Rao was a person with great foresight, determination and leadership abilities. He immediately acquired a piece of land from HAL Hyderabad, bought 3 aircrafts, built lab facilities for aero magnetic and photographic surveys. He developed a capable scientific team and established the Earth Station at Shadnagar (about 55 km from Hyderabad) in 1978 to receive LANDSAT satellite data. The world was already celebrating success of the first Earth Resource Satellites - LANDSAT

1/2. To push satellite remote sensing applications, he established framework for state and central government organizations and executed many turn key projects. The seed sown in 1975 had become a well-recognized institution with great future ahead. Almost at the same time, Indian Space Research Organization was developing its own satellite programs. After successful launch of Aryabhata (1975) and Bhaskara-I (1979) satellites, it was looking ahead to the most ambitious Indian Remote Sensing Satellite (IRS) programme. In December 1980, NRSA became part of Department of Space and joined the club of India's space institutions with mandate to develop and facilitate applications and promote remote sensing in State, Central and Private sectors under National Natural Resource Management Systems (NNRMS in 1982). I became the Director of NRSA in January, 1982.

NRSA enabled availability of Indian Remote Sensing Satellite data besides other foreign satellite data sets to user community in India and neighboring countries. The same expanded further as ISRO

6th Asian Conference on Remote Sensing Nov1985

launched global missions. NRSA also helped central government institutions and the States through State Remote Sensing Application Centers to institutionalize remote sensing for natural resource management, infrastructure development in rural and urban areas. Some important applications that NRSA took lead were: National forest cover mapping and monitoring, wasteland mapping, monitoring and development planning, Integrated Mission for Sustainable Development, Potential Fishing Zone delineation, Biodiversity Characterization at Landscape level and Ground water potential zoning and facilitating location of sites for drinking water in non-compliant villages etc. NRSA also took up many applications for disaster management support particularly, flood, drought, landslide, relief and rescue after earthquake and cyclone, saving millions of lives and properties. Today NRSC is connected to States, Central government and Knowledge Institutions to disseminate and transfer data/maps on real time basis. The evolution of mapping to analysis/ modeling as decision support system has been the hallmark of NRSA approach. NRSA made special efforts to take the data sets/processed information to grassroots applications and also institutions that need such information.

NRSA developed indigenously, many electronic modules tuned to different Satellites for reception. Further, it played a very important role in transferring the indigenous technologies for data reception, processing and analysis such as Drum Scanner, Multi Spectral Additive Color Viewer, Satellite Image Processing System, Antenna Control System, QPSK Demodulator/ Simulator/Bit synchronizer, etc., during the eighties/early nineties and promoted a host of Remote Sensing Application industries, besides implementing national level projects. As the technology got established, users became more conscious about the data quality. This demanded high performance computing and to meet this NRSA acquired VAX 11/780 systems against many import restrictions and regulations. NRSA also contributed significantly in developing the hardware units necessary for receiving IRS data by DIPAC, et al and also by foreign ground stations.

Indian Photo Interpretation Institute (IPI) was brought under NRSA from Survey of India in 1976. NRSA

Visit of Mr Shivraj Patil, Minister of Defence (1986)

nurtured and developed this institution to build capacity in the user departments and other stakeholders and renamed it as Indian Institute of Remote Sensing (IIRS), laying emphasis on Satellite data. The scope of this organization was enlarged by bringing in more disciplines like ecology, water resource, marine and coastal science and prominently enlarging the curriculum of remote sensing technologies including satellite remote sensing. IIRS and ITC of The Netherlands enjoyed a special relationship in the area of training, education and application development. Both have learnt from each other and grown together. IIRS and ITC exchanged faculty and had also organized many training/education programmes together. Presently they offer Joint MSc programme. IIRS got major boost in 1995, when Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), affiliated to the United Nations, was established within the campus of IIRS and I

ISRS Annual Symposium (10-Dec-1991)

was appointed as its first Director as an additional responsibility. Today IIRS is internationally recognized as a leading education & training institution. Very appropriately ISRO made it an independent Centre in 2008. This independent status increases the scope to grow as a Centre of Excellence in capacity building and research.

NRSA's contribution for implementing first ever

Release of IRS-1A first day product (1988)

forest cover mapping and monitoring; wasteland mapping, monitoring and their development, ground water potential mapping and potential fishing zone identification were the most remarkable achievements under NNRMS. These applications were subsequently institutionalized in Forest Survey of India, Ministry of Rural Development and Department of Ocean Development (now Ministry of Earth Sciences) respectively. With these projects, India emerged as a leader in remote sensing applications in all sectors, both nationally and internationally. Another important activity which happened during my tenure was to setup protocol and an institutional framework to screen remote sensing data for special and strategic applications. Both ADRIN and INCOIS are the offshoot organizations from NRSA. We also made extra-ordinary efforts in bringing the conventional survey organization like Survey of India (SOI), Geological Survey of India (GSI), Forest Survey of India (FSI), National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) in adopting remote sensing technology. It took some time to convince users on "instead of you going to the field, the field comes to your table in the form of image/map".

Over all, NRSA remained a very vibrant institution addressing the national priorities and provide application solution in the area of natural resource management, infrastructure development, disaster support and capacity building. It created its own niche with very large user base. It was known as an institution, which can deliver quality products and application solutions. It also facilitated proper dissemination of Indian Remote Sensing Satellite series data sets. The multi-disciplinary scientists and technical staff had many challenges and opportunities provided to them. Recently an integrated complex at Shadnagar came into being for providing a quick turnaround time to the data products. For me it was the most memorable and satisfying day when IRS-1A satellite data scrolled first on the computer screen in Shadnagar Earth Station. NRSA continued to receive data from IRS series of satellites.

As I retrospect, I feel NRSA should have taken a lead role on IRS data processing software development tasks and frontier research in the application areas. Brahma Prakash committee report (1980) and the sustainability model given to NRSA did not allow research to be pursued as a mandate. During my tenure, I also experienced the saddest event when our instrumented Dakota aircraft met with an accident in 1993 on the hills near Bombay and NRSA lost its most capable pilots, navigator and instrumentation engineers. The entire institution was engulfed with sadness and shock.

It was my privilege and honor to lead such a vibrant institution under the leadership of visionaries - Prof. Satish Dhawan, Prof. U. R. Rao and Dr. K. Kasturirangan.

National Seminar on IRS Mission & its Application (21-Dec-1988)

Visit of Mr K R Narayanan, Minister of Science and Technology (1987)

Journey through 'Space'

Dr D P Rao
Former Director
(November 1996 - April 2001)

It is indeed a rare opportunity to chronicle a few reminiscences of events that mattered in the success of Indian Space Program. I am happy to know that my experiences will find a place in the publication planned to commemorate the 50 years of NRSC.

Where do I begin? Most scientists/engineers of ISRO started their career in ISRO. I was a lateral entry into DOS system. With 11 years experience as an exploration geologist in the ONGC since 1960, I was inducted into IIRS, earlier known as IPI, Survey of India under S&T ministry in 1972. In the early years with ONGC, I used aerial photographs for mapping geological formations. After formal training at IPI with instructors from ITC, Netherlands, I became a professional interpreter of aerial images. IPI was merged with NRSA, also under S&T Ministry in 1976. In 1980 NRSA became part of DOS. IPI became IIRS in 1982.

My first exposure to ISRO was in June 1981, when I visited ISRO Satellite Centre, Bangalore, headed by Prof. U R Rao to get familiarized with ISRO system of working, known to be transparent with free interaction between scientists and engineers across all levels. Prof. U R Rao welcomed me with a pleasant smile. I realized that he was in a jubilant mood because of the success of just launched India's first Geo-stationary satellite, APPLE and explained how it works. Having worked all along with ground observations as a geologist, I was overwhelmed to see the orbiting satellite in the monitor. I was also instantly impressed with the working system of ISRO.

While at IPI I was fortunate to have close interaction with Prof. Satish Dhawan, Chairman, ISRO and Secretary, DOS and Prof. B L Deekshatulu, Director, NRSA in March 1983 when they visited IPI for the first time. With multiple responsibilities, as Prof. Geomorphology and Head, Coastal and Marine Resources Division, Head, Consultancy Division, In-Charge for training on MI DAS, a Digital System just installed at IPI by NRSA and also a Welfare Officer for IPI, I made a presentation to the Chairman, specifically on two issues. One on consultancy projects earning revenue and the other on the problems being faced by IPI employees for residential accommodation. The presentation was so successful that Prof. Dhawan gave instant decision to use the revenue from consultancies for internal development. Impressed with the statistics presented on accommodation problem, he took a decision to initiate construction of quarters, both at Dehra Dun and on prompting by Prof. Deekshatulu, also at Hyderabad. I had the good fortune to accompany Prof. Dhawan when he visited other Govt. institutions like Naval Hydrographic Office, Survey of India in Dehra Dun. While leaving, he invited me to visit ISRO Hqrs., in Cauvery Bhavan and other ISRO centres in Bangalore. Such an open interaction with the Chairman, ISRO for an 'SF' level scientist of IPI reassured me that I have a tremendous scope to contribute, given the work culture in ISRO/DOS. Today's IIRS is internationally known, also for hosting CSSTEAP. This remarkable change is due to the hard work and dedication of Deans, those headed IIRS, particularly Dr PS Roy and Dr VK Dhadwal.

Establishment of NNRMS in 1983 was historic, with PC-NNRMS giving guidelines. Establishment of 5 RRSSCs and encouraging states to set up State

Remote Sensing Centres with support from DOS to help the economy in utilizing natural resources was the main theme of NNRMS using the workforce of RRSSCs and State Centres. It turned out to be a unique idea, understandably proposed by Prof. Dhawan and pursued by him and his successor Chairmen. One of the 5 RRSSCs was to be located at Dehra Dun in IPI campus. During Prof. Dhawan's visit to IPI in 1983, he declared the MI DAS as the forerunner or proto-RRSSC facility for training and consultancy. The then Scientific Secretary, Shri. Y S Rajan offered to appoint me as Head, RRSSC under ISRO. I declined it politely since I was looking for a change, having been in Dehra Dun for nearly two decades. Some well wishers cautioned me the possibility of negative consequences of rejecting an offer coming from Scientific Secretary. But my understanding of the culture of DOS/ISRO by that time gave me confidence that no such thing would happen. And I was right. Later I came to know that Prof. Deekshatulu was asked to look into my wish for a change. As a consequence, I landed at NRSA Hyderabad in December 1986 on transfer from teaching at IIRS to carry out application projects at NRSA Hqrs. I was assigned to take care of Wasteland Mapping Project, the first major national level project on large scale of 1:50,000 using LANDSAT images. Dr Col L R A Narayanan was leading the project and I was to assist him. My designation in the project was Scientist 'SG'!! He told me that the Director, Prof. Deekshatulu is a task master and I will be under watch, being new to NRSA.

Visit of Smt. Vasundhara Raje Scindia, Minister of State (Independent Charge) (1999)

The period from early eighties till I superannuated in 2001, perhaps was the golden period for remote sensing applications. After the launch of LANDSAT-1, it was ripe time to reap the benefits. The launch of IRS 1A in early 1988 heralded self reliance. In the seminar held at NRSA that year, inaugurated by Prof. MGK Menon and participated by all users, Chairman, ISRO reassured that continuity of data will be maintained by IRS series. It turned out to be true, as between 1988 and 1997, IRS 1B, IRS 1C and IRS 1D, the latter two being more advanced satellites, were successfully launched and ensured data continuity. In 1996, Current Science (Vol 70, No.7) brought out an exclusive edition on IRS 1C technology and applications. Mapping of natural resources was order of the day. The availability of thematic information on natural resources was either inadequate or non-existing. Very few organizations had national coverage; they are GSI on geology and minerals, NBBS&LUP and AIS & LUS on soils and land use, CGWB on Groundwater, Survey of India for basic topographic maps and FSI for forest cover information. Restrictions on use of SOI maps and aerial photographs were a major damper for users to obtain spatial information. Further, there were no organizations to provide dynamic information on growing crops and their acreage, or rainfall run off and recharge to ground water, snow melt run off into reservoirs, damage caused by natural calamities like floods, cyclones, droughts, earthquakes, landslides/ avalanches, forest fires, to name a few. Further, information for development initiatives by various Central/state Ministries in the form required was not available in an integrated manner. For example, Ministry of Rural Development desired information for watershed development and drinking water. The concept of integrated studies was evolved way back in 1974 at IPI using aerial photos for Karimnagar District of A.P. and the methodology was adopted by Planning Commission as basis for funding district development plans as mentioned in their 6th Plan documents. Using the same concept, Integrated Mission for Sustainable Development (IMSD), a unique effort of Space Dept., provided this information by integrating information on soil, geomorphology, slope, rainfall, recharge capability and current land use obtained from satellite data and suggested land use by involving the local beneficiaries. When early results of this experiment were presented by Prof. U R Rao to Planning Commission, a question was raised why Space Dept. should do these studies; a reply was given by Shri C. Rangarajan, Member (Planning Commission), saying that no other department came forward with this idea or for undertaking such studies. The result was 175 backward districts were mapped using satellite data under IMSD and Rural Development ministry is using the information till date. Another anecdote comes to my mind about the reputation of Space Dept. When ADRIN was formed as an off shoot of NRSA under DOS, there

was a function in which Prof. U R Rao then Chairman, ISRO and Shri. Deshmukh, Secretary, Defense was to participate. Shri Deshmukh's arrival from DRDO offices in Hyderabad was delayed and on arrival he apologized for the delay and said in a lighter vein to Prof. Rao "the roads are so bad here, I wish they are maintained by Space Dept.!"

NRSA caught the attention of every organization that desired spatial solutions. Wasteland mapping provided extent of wasteland (about 20%) in the country resulting in planning for large scale afforestation. Land use/land cover mapping resulted in drawing up Agro-Climatic Zoning by Planning Commission as the maps identified underutilized areas for increasing area of agriculture. Mapping of salt affected soils resulted in identifying 2 million hectares of such soils in the country and the World Bank came forward to fund reclamation measures. Earlier, forest cover mapping on 1:1 million scale over a 7/8 year time gap helped identify areas of fast degradation that reduced India's dense forest cover to 11%, one third of international norm, and FSI was mandated to map and monitor forest cover every two years. Bhakra Beas Management Board (BBMB) was keen to know in advance the volume of water likely to accumulate in Bhakra Dam for planning on power generation and agricultural needs and the same was provided within some acceptable error margin. Similarly, under CAPE, mainly lead by SAC, Ahmadabad, advance information on crop production estimates were given for main crops like wheat , sorghum etc., to enable Agriculture ministry to take import decisions. IMSD provided necessary information for watershed development for nearly two thirds of the country and Rural Development (RD) Ministry found it as sound basis for funding watershed development projects. Rajiv Gandhi Drinking Water Technology Mission, a national project of RD Ministry made use of maps showing potential ground water zones as well as sites for recharge. Aeromagnetic surveys for GSI resulted in identifying specific areas for detailed mineral exploration. Large scale mapping using IRS 1C & 1D pan data for urban land use planning resulted in cities like Mumbai and Hyderabad to adopt this approach for spatial planning and implementation. Mapping of drought affected areas and issuing drought bulletins on early warning helped in saving crops as well as in releasing drought relief funds proportionate to drought severity. Biodiversity Characterization, a major national initiative in 1998, resulted in identification of areas potentially rich in biological diversity, which in turn helped in intensive quantitative inventorization of biodiversity. A very important and essential application is in area of disaster monitoring and assessment. Damage assessment due to floods in major rivers, forest fires in summers, occasional earthquakes affecting habitations, landslides affecting roads and bridges in hilly areas, periodic cyclones affecting coastal districts of east coast are some specific activities that needed fast and dynamic data and attention. One of the best ever service rendered by NRSA was during Super Cyclone off Odisha coast in October 1999. Every alternate day, maps identifying damage/waterlogged areas were flown to Relief Commissioner, Bhubaneswar for rescue and evacuation purpose. It was hailed as a noble service by the Chief Minister.

Felicitation to Dr D P Rao on assumption as Director (1996)

NRSA was well supported by technical areas of Data Acquisition and Data Processing and Training facilities, the multi user application projects, both at national level and local level touching practically every possible user requirement became a show case of Dept. of Space's pride. It became a cynosure of visitors from both foreign and Indian organizations. Questions were asked by many foreign dignitaries how India could achieve such a success in applications. They were told that the concept of NNRMS and its implementation at ground level has shown the success. The strength of applications scientists at NRSA grew not so easily. I had to make three presentations to Prof. U R Rao to get 75 posts sanctioned and a new application building to accommodate and it took a year of struggle. NRSA was under pressure not only to justify the large manpower and space sanctioned, but also to improve self dependency by increasing revenue. This was a challenge thrown by Secretary, DOS. When I took over as Director, NRSA in October 1996, internal revenue generation was at 45 to 50% of its total budget. By 2000, the revenue went almost to the level of non-dependency of funds from DOS. Dr K

Kasturirangan, Chairman put a halt lest NRSA should declare independence from DOS!

Visit of Mr Maumoon Abdul Gayoom, President of Maldives (2001)

On a personal note, having been intoxicated with success in applications, I thought NRSA/DOS could seize such opportunity to make its technology available to a large market outside India, particularly in Africa. Along with establishing ground stations to receive IRS data, the application area could help create data base for development. Even in India, despite several organizations developing their own Remote Sensing units, a large demand still exists for several central ministries. An organization similar to RITES to Ministry of Railways can be created under DOS/ISRO that could meet such demands.

Visit of Dr K Kasturirangan, Chairman, ISRO

The success of NRSA in DOS is due to: the work culture framed by founding fathers of Space Dept, technical and administrative support of the kind that is required to accomplish, encouragement at lower as well as upper levels, spirit of accepting challenges, the concept of recognizing merit and the drive to excel in every task to achieve the target. Working with dedication with these traits, the staff of DOS/ ISRO brought the name of "Developed Country" status in the area of Space Technology. I feel proud to be a member of Space family having been with NRSA for a while. If I have contributed anything worthwhile it is due to the all out support I had at all levels and particularly the blessings of three successive Chairmen, Prof. Satish Dhawan, Prof. U R Rao and Dr K Kasurirangan. I wish NRSC a long life with success all the way.

Dr D P Rao at CSSTEAP, Dehradun

Post retirement, an opportunity was given to me to contribute a chapter on cost benefit and economics of Remote Sensing to find a place in the report on Economics of Space Program, a task given by ISRO to Madras School of Economics. It was a tough job as it was not easy to get authentic feedback from user community, particularly on numbers. I am glad that Prof. U Sankar of MSE made a successful effort in bringing out a publication of the report by Oxford University Press titled " The Economics of Space Program – An Exploratory Analysis" in 2007.

My Sojourn to the National Remote Sensing Agency

Dr Ranganath R Navalgund
Former Director
(May 2001 - November 2005)

It was on Friday April 20, 2001, while I was attending a lecture at the Vikram Hall at Space Applications Centre (SAC), I got a message that Dr Kasturirangan, the then Chairman, ISRO wanted me to talk to him. I did it immediately. In his affectionate style, he said 'Ranganath, I like you to go over to NRSA as Officer on Special Duty (OSD) immediately, and you would take over as its Director at the end of the month. He also added, you go over to Hyderabad via Bangalore and meet the Joint Secretary, DOS to get a briefing. I joined NRSA on April 25, 2001 as the OSD. It was a strange designation for me to fathom. The same day, I had a pleasant duty of foundation-stone laying for the NRSA Guest house along with the then Director Dr D P Rao. Although, I was familiar with the activities of NRSA and also knew many colleagues personally and professionally quite well, dealing with the organisation as its Director was a different matter altogether. Getting to know activities of different areas and administration was the first task. The young Controller of Administration, an officer of the Indian Administrative Service, was very helpful in helping me to settle down. Reviving the NRSA Management Council and holding it's meetings regularly was the first task I undertook. Professional responsibility at SAC was straight forward and protected, while at NRSA, you are exposed to a large number of user agencies, their demands, providing services on time to their satisfaction etc. and also striving to meet with the expectations of the Department.

The first major activity was readying us for the reception of data from Technology Experimental Satellite providing ~1m resolution data. It was the first time, I visited SHAR Centre and watched the PSLV launch. Dr Kasturirangan came over to NRSA Shadnagar complex to witness switching-on of the camera on TES and receiving data. We were thrilled to see the quick-look data from the TES. Chairman, ISRO was pleased and addressed the gathering at the earth-station complex and we felt fulfilled. Immediately after that, he arranged a meeting with the then Prime Minister Mr Atal Bihar Vajpayee at his residence in New Delhi. We went over and showed some of the early images including that acquired over Lucknow, his birth place. It was a matter of great pride to all of us at NRSA. During my tenure at NRSA, there were two more such memorable occasions, ensuring tension free reception of data from Resourcesat-1 in October 2003 and Cartosat-1 in May 2005 in the presence of the new Chairman, ISRO. Unique set of three sensors onboard Resourcesat -1 attracted many international users and NRSA had to gear up for establishment of many international ground stations world over through ANTRIX Corporation. Newly designed and developed 7.5 m antenna helped a great deal in this effort. Cartosat-1 was equally unique, the first satellite to provide along track stereo at 2.5m resolution.

Dr R R Navalgund taking charge as Director, NRSA (1-May-2001)

Aerial Surveys for large scale mapping and disaster situations is an important pioneering activity of NRSA. This had its own problems associated with the availability of pilots, aircraft maintenance and spares, obtaining necessary clearances before flights, having enough trained people to process aerial data and associated hassles of obtaining clearance of data

acquired. One of my first tasks was to shift the aerial facility from Jeedimetla campus to the main campus for better coordination. Empowered committees were set up to scrutinise and select qualified vendors to be housed on the campus in a secure environment and for procurement of aircraft spares at a short notice. In order to get into high resolution elevation modelling, an Airborne Laser Terrain Mapper (ALTM) was procured, flown and tested. Surveys over many medium sized towns were carried out and large scale maps were prepared to facilitate preparation of developmental and master plans. As part of bilateral understanding between the Govt. of Maldives and India, aerial surveys were carried out over the many island/atolls and topographic maps were generated. This was a very complex and professionally challenging mission and it brought satisfaction to all involved. The project on Ground Control Points Library was a major effort. As part of this, zeroth and first order points were established in the country with appropriate geographic distribution. This effort has greatly helped generation of digital stereo elevation models with Cartosat data and in mapping exercises. ISO certification obtained during this period facilitated bidding for more aerial survey and consultancy projects.

Remote sensing applications grew manifold during this period with the availability of data from Resourcesat-1. Under the Rajiv Gandhi National Drinking Water mission, four more states were taken up and generation of maps was completed. In a historic function, Chief Ministers of Andhra Pradesh and Madhya Pradesh and Minister for Rural development from Govt. of India participated and received the maps from the then Chairman, ISRO. Several application projects related to updation of wasteland maps, generation of forest working plans, biodiversity characterisation at landscape level, drought monitoring, performance evaluation of irrigation commands, crop inventory continued to be carried out. A very important programme on Disaster Management Support Programme was taken up at NRSA. The programme comprised organising i) observation system of IRS satellites/international missions on opportunity basis/aerial facility ii) digital data bases of vulnerable areas including query/decision utilities, iii) virtual private satellite based communication network, and iv) establishing a Decision Support Centre as a single window to provide space based services to the country in disaster situations for monitoring and damage assessment. This was an exciting programme for NRSA to organise, execute and make an impact. I was happy to be able to contribute to this effort. Efficiency of the systems established were severely tested during the Tsunami of 2004, several flood disasters, earthquake in J&K Varunavrat landslide and damned-Pareechu lake threatening to burst any time. Employing TES and other satellites to ensure daily visit over the area of Pareechu was ensured. To assess Tsunami-affected areas, aerial surveys were conducted over the east coast of India, A&N islands and over parts of Sri Lanka as well. A Disaster Watch Group was institutionalised in NRSA. Preparation of detailed land slide hazard zonation maps for the pilgrimage routes and the north east, monitoring

Visit of Smt. Vasundhara Raje Scindia, Minister of State (Independent Charge)

cyclones and efforts made in flood forecasting were other significant efforts.

Indian Institute of Remote Sensing continued to do well in capacity building efforts by offering post graduate diploma courses. In collaboration with the ITC, Netherlands, M.Sc., courses in Geoinformatics were started. Memorandum of Understanding with the Andhra University was signed to provide possibility for our students to undertake M.Tech programmes. Support to CSSTE-AP was strengthened. A new guest house was built on the campus and effort to build a hostel for sixty inmates was initiated. Faculty was encouraged to take up improvement in their qualifications and also in research. I enjoyed going over to IIRS and Dehradun, and was always at ease in the academic environment.

NRSA had decided to close its front gate in front of the Director's office and open on the opposite side. A new Guest house was built in short time on this new front end. The old dilapidated quarters in this area were demolished, a reception facility was built and NDC exhibition foyer along with its front end office was established. It is a different matter, NDC shifted its office to the inside later. The new administrative block was readied and occupied. Library housing the high density tapes had become obsolete and was converted into a hundred-seater conference hall. Considering the heavy demand for photographic products, a huge modern photographic facility was established at NRSA in the late eighties/early nineties. However with the computing facilities becoming easily accessible and familiarity with digital data and its analysis increasing, the demand for visual products decreased. Redeployment of technical people from this facility to other activities with proper retraining became necessary. Finding alternate use for the laboratory space was also a necessity. Both were accomplished without much heart burn.

Organisation of an International Symposium of the International Society for Photogrammetry and Remote Sensing Technical Commission VII by NRSA in Dec 2002 was a major event. We also hosted the ISPRS Council meeting. More than five hundred scientists including a hundred foreigners participated. It was an excellent opportunity for NRSA/ISRO to showcase its significant contributions to space borne and aerial remote sensing. Many dignitaries including President of Germany, Prince of Bhutan and Minister of Commerce from Canada visited NRSA. Silver Jubilee celebrations were held to mark completion of 25 years of NRSA. Organisation of the meeting of the ISRO Programme and Policy Committee at the picturesque Ramoji Film city was a memorable event. Elements of ISRO's human space flight programme were first time discussed at this forum.

Visit of Crown Prince of Bhutan (2001)

NRSA had taken up the challenge of financial self sustainability very seriously at the instructions of the Department of Space. Efforts were made to increase revenue from data products, almost doubled hours of flying by aircraft and also took up many more consultancy projects. While these efforts definitely helped towards achieving self sustainability, certain other problems started cropping up. Some organisations had reservations on NRSA taking up mapping activities. This also started affecting research and development activities, since most of the emphasis started on revenue generation. DOS was also reiterating on reduction of grant-in-aid to NRSA, which was already less than what we needed. I was not comfortable with this situation. There was no reason for NRSA not to be like any other ISRO Centre. Genesis for converting NRSA into NRSC was born and a detailed justification note was prepared for further processing. I am happy, it happened in due course of time.

I enjoyed my tenure at NRSA professionally. I interacted with so many scientific organisations of the country as well as some from abroad. I learnt that providing services with a smile is as important as doing research. Nuances of managing people on day to day basis and motivating them towards a common goal were equally challenging. I used to have lunch in the canteen with every body else. I never liked having food alone in my office. Initially the staff found it strange. This provided me an opportunity to meet my colleagues from all wings of the organisation every day, know their work, their families and their difficulties. By the end of my stay, I knew everyone personally. I must put on record my appreciation

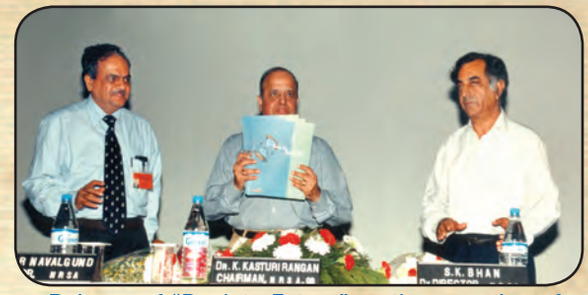
to all my colleagues from technical, non-technical and administrative areas for their understanding, cooperation and affection.

On the personal front too, I thoroughly enjoyed my

Inauguration of ISPRS TC VII International Symposium in Hyderabad (Dec 2002)

stay in Hyderabad. We had our quarter at the Banjara hills, a known posh suburb of Hyderabad. The park nearby was an excellent place for leisurely walks. My wife could do justice to her professional career at the Indo-American Cancer Hospital and Research Centre, which was at a walking distance. The then new Controller was a wonderful neighbour. I could play tennis-ball cricket with his two young children.

On June 28, 2005, I was in Bangalore to attend the Indo-US workshop on Civil Space Cooperation. During the dinner at Windsor Manor, that evening, Mr



Release of "Back to Future" on the occasion of NRSA Silver Jubilee celebrations (2002)

Madhavan Nair, the then Chairman, ISRO approached me and asked whether I would be willing to go to SAC and take over as its Director. I said 'yes' and moved to Ahmedabad and joined on July 4, 2005, although I continued to be In-Charge Director of NRSA till Dr K Radhakrishnan took over in November first week, 2005. This is in brief my sojourn to the National Remote Sensing Agency.

Down Memory Lane from NRSA to NRSC

Dr K Radhakrishnan
Former Director, NRSC
(November 2005 - August 2008)
Former Chairman, ISRO / Secretary, DOS

As the National remote Sensing Centre is celebrating Golden Jubilee, I am proudly privileged to reminisce of a long association with this national edifice. It started soon after its forerunner National Remote Sensing Agency (NRSA) merged with Department of Space (DOS), when institutional transformation of NRSA and programmatic integration with ISRO was underway in the early 1980's. Firstly, I was tasked to help NRSA to streamline its budgeting process alike the rest of ISRO/DOS and introduce Zero-Based Budgeting. Next, I got a phase of rich learning as the headquarters' representative in the project management board that oversaw augmentation of technical infrastructure at NRSA for satellite data processing. This became handy in my role to set up and steer the Regional Remote Sensing Service Centres (RRSSCs).

Integrated Mission for Sustainable Development (IMSD) was a mammoth national task undertaken in 1992 and piloted by NRSA wherein and the RRSSCs shared a major responsibility. In August 1997, I relocated to NRSA, as Mission Director of IMSD and Deputy Director (Commercialisation). IMSD was concluded logically, and I acquired a doctorate. Nevertheless, it was a rough patch of three years, and I chose to move out of ISRO in July 2000.

A pleasant turn of events in 2005 reunited me with the ISRO family, as Director of NRSA. The goodwill and mutual affection were evident after the reunion. The NRSA that I had left in 2000 had undergone phenomenal transformation, and the imprint of Dr Navalgund's leadership was visible all over. My task was to lead NRSA to the Next Level of Excellence. As the diversity and complexity of the satellites increased, NRSA had to explore technical solutions to cope and be ready to deliver data products soon after each remote sensing satellite was up in orbit. Integrated Multi-mission Ground Segment for Earth Observation Satellites' (IMGEOS) was conceived, and its architecture of IMGEOS was ready by December 2006, thanks to the inter-disciplinary team headed by Shri S. Raghunathan. One of the outcomes was the physical integration of the entire chain of activities at the Shadnagar complex. In November 2011, I came back as the Chairman ISRO to participate in the inauguration of this complex and to release satellite data products on the Web within ten minutes of the satellite passing over India.

For over a decade, NRSA had functioned as an autonomous body with frozen grants; it had to collect funds for the salaries of its employees and its sustenance. Hence, its primary mandate as the last and crucial link in satellite remote sensing

applications was constricted. An essential financial restructuring was done, and NRSA regained its status as a specialist national agency, with the ability to respond to national needs.

We still had a major handicap. The mere label of an autonomous body restricted our access to collateral data and maps from other national agencies. The only option was to restructure NRSA into a government entity. This was a seminal step and Chairman Mr Madhavan Nair found merit in it. The NRSA community, at all levels, could be taken on board as they saw that the decision was in favour of both the organization and its employees. After due approvals, NRSA became a government entity from 1 September 2008, rechristened as the National Remote Sensing Centre (NRSC) of ISRO.

A Tailpiece: Amalgamation of the five RRSSCs with the NRSA, was long-pending, and I had the parental privilege to make it happen soon after my ascend as Chairman ISRO.

Reminiscences

Dr V Jayaraman
Former Director
(September 2008 - April 2011)

When Shri G Madhavan Nair, the then Chairman, ISRO / Secretary, Department of Space asked me sometime during July 2008, about my readiness to move over from ISRO Headquarters to "NRSC" as its first Director after its conversion into a full-fledged Centre under ISRO, I did not have any hesitation to accept that offer. I knew it was a challenge. By then, my association with NRSA had spawned over 25 years starting sometime in 1982, when I first visited NRSA in its old campus in Secunderabad for initiating talks on IRS-1A ground segment. Later that association blossomed further when I was in the Earth Observation Programme Office in ISRO HQ and I fondly recall all those golden years of my close association with NRSA through its Governing Society, Governing Board and Finance Sub-committee activities for more than a decade, besides working closely with the ground segment development of IRS satellites as well as in defining the policy framework for archival and pricing. I was also part of many NNRMS user projects and missions as well as capacity building exercises carried out at NRSA and IIRS, including the prestigious United Nations' CSSTEAP activities. With experience in concurrently handling three major programmes as Director of Earth Observations Programme; Director, NNRMS-RRSSC; and Programme Director, ISRO-Geosphere Biosphere Programme (ISRO GBP), I had necessary exposure, be it in the science, technology and application domains, in dealing with the expectations of the user community, covering areas from cartography to climate, both at national and at international levels. So when I moved over to NRSC, I found that it was just a logical other side of the table. It enabled me to further understand the nuances of user interactions more closely.

Dr V Jayaraman taking charge as Director, NRSC (1-Sep-2008)

Inside NRSC's aircraft (30-Dec-2008)

Over the years, NRSA, the earlier avatar of NRSC, has served the remote sensing community in the country and abroad in a most distinguished way and has been recognised for its operational delivery of data products and services. With the conversion into a full-fledged Centre under ISRO, NRSC had a well cut responsibility to integrate fully with other ISRO Centres to develop innovative solutions and public good services to the users in a more concerted manner without compromising on efficiency and efficacy. Hence, I envisioned NRSC to strive to position itself as a globally leading knowledge institution towards developing and efficiently delivering affordable, actionable, "niche" geospatial products and services involving industry and academia; and meeting the ever growing public good, strategic and commercial needs of the nation by continuously harnessing the advances in Earth Observation science and technologies. Well, once I took over, the above became the Mission of NRSC.

Accordingly, the priorities were set in defining a mission oriented approach with definite timelines and targets for following activities

- Developing a warehouse of accessible, affordable & actionable knowledge products & services. Thus, the immediate step of reducing the prices of IRS satellites data products by 30-50% by November 2008 earmarked this intention.
- Ensuring a streamlined demand-supply chain with effective delivery mechanisms through real time, web-based services; populating free-ware tools for access to data products and services. The quick positioning of state-of-the-art portal initiatives such as BHUVAN, BHOOSAMPADA and India-WRIS exemplified this process.
- Fusing knowledge management & business process re-engineering through early operationalisation of the planned Integrated Multi-mission Ground segment for Earth Observation Satellites (IMGEOS) with efficient multi-mission data acquisition & processing mechanism for improved turn-around-time for products delivery. The quick finalization of the whole engineering drawings aiming at obtaining a Platinum rating under LEED certification and getting necessary project approval and working out a strategy to implement in record time was the hall mark of this exercise. The operationalisation of solar power plant to partially power IMGEOS was part of this Green strategy.
- Working towards NRSC-ANTRIX axis for coping with global competition & global outreach.
- Projecting NRSC as global data provider; connecting NRSC with Antarctica (Larsemann Islands) and Arctic (Svalbard) was part of this strategy.
- Optimising aerial photography/photogrammetry activities; maximizing the flying hours to the planned 750 hours and improving the turn-around-time; expanding and densifying the Ground Control Point library Phase 2 activities in a most cost effective way using PPP.
- Regenerative skills development & breeding NextGen leaders; Manpower auditing and recruiting bright youngsters (around 100 for NRSC/RRSCs together) in multi-disciplines and training the middle-managers by providing exposure to quality modules in ASCI, Hyderabad emphasized this approach.
- R&D Initiatives in newer areas like Ocean Heat Content, Interface with Academy & Industry. Initiatives in climate change adaptation, and early warning of disasters, particularly agricultural drought using newer vegetation indices like SASI.
- Bringing more focus to periodically updating the Natural Resources Census base including land use/land cover and wasteland mapping also brought many challenges.
- Launching of Space based Information Support for Decentralised Planning (SIS-DP) based on PC-NNRMS directive to generate GIS layers to enable informed decision- making by local authorities was another major initiative.
- Focused capacity building and awareness programmes, emphasizing quality of deliverables and also using EDUSAT network to improve the outreach.

Visit of Prof. Dr. Ir. Martien Molenaar, Rector, ITC (9-Feb-2009)

Apart from the above, NRSC had immediate challenges of adopting changed governmental accounting procedures from its earlier Society oriented procedures and also had to take immediate priority steps to ensure continued pension for the retirees from the NRSA! Also, operationalisation of COWAA was one more focus in tune with the other

Function to mark the occasion of conversion of NRSA to NRSC (1-Sep-2008)

Wg Cdr (Retd) Rakesh Sharma in NRSC Lecture Series (26-Feb-2009)

ISRO/DOS centres. The young Controller and his team, and the experienced PPEG ensured the whole process so smoothly that NRSC even became the first Centre to implement the 6th Pay Commission among all ISRO/DOS Centres. The merger of Regional Remote Sensing Centres (RRSSC) into NRSC posed its own problems and challenges, which were also effectively handled. The overall budget of NRSC increased three fold from the earlier annual budget of around Rs 70 crores and this, while helping NRSC launch many programmes boldly, also posed many challenges to the limited administrative/purchase/stores personnel, which were handled by them admirably.

The merger into ISRO has facilitated NRSC to effectively deal with various user departments in the Government sector as a full partner towards realising the fullest potential by expanding the public good services both from satellite and aerial platforms. Further, the amalgamation of the RRSSCs into NRSC helped in addressing the specific needs of the respective States and the region in a more focused manner. Finally, this process of Governmentalisation was a win-win situation for all the stake-holders.

Bhuvan: It was a matter of great satisfaction for me when we launched BHUVAN within a few months after NRSC became an ISRO Centre. BHUVAN was an initiative to showcase these distinctive features of Indian imaging capabilities, including the thematic information derived thereon in the geospatial domain providing 2D and 3D visualisation products and services through a web portal for easy access. Thus, BHUVAN is essentially envisaged as a window to ingress into different services, ISRO has been providing to the users. Yes, there were brickbats in the initial days and I should congratulate the young inter-centre team which withstood the tremendous societal pressure to bring out a world class product ultimately. Later, we started receiving very encouraging feedback from the users even as BHUVAN portal started adding more and more features such as map navigation, panning and adding various developers' tools incorporating the features of interoperability as per Open Geospatial Consortium (OGC) Standards. The robust and open API with rich capabilities provided by BHUVAN could be effectively utilised in wide range of applications by the users. Thus, it was a moment of glory when BHUVAN was found as one of the top-10 most popular Google searched subject in India during 2009. The crowning glory was when BHUVAN was chosen as the 'Website of the Month' by the Open Geospatial Consortium (OGC) in December 2010.

I am also happy to see that under Dr Dadhwal's leadership, BHUVAN is constantly getting updated with more and more geospatial contents and I am sure, in the coming days, it will become one of the most talked about Portal, competing with the contemporary services anywhere in the world.

The essential feature of IMGEOS is towards process re-engineering of all the related activities to have an improved near-real time data delivery mechanism in tune with the expectation of the users. It calls for a network-centric approach with a multi-tier storage system and automated processes to clear the data products within a few hours after data reception. IMGEOS aims to have a unified system addressing the needs of the new sensors in terms of varying data rates and formats, and IMGEOS

Visit of Dr K Kasturirangan, Member, Planning Commission (14-May-2010)

is expected to revolutionalise the data delivery services from NRSC in a very significant manner. Obviously, such a unified system should provide a better turn-around-time for the products benefiting the end users. We were planning to process more than 1000 data products per day, and particularly in disaster scenario, the data supply should be within a few hours. The foundation stone was laid by Shri G Madhavan Nair, then Chairman, ISRO, on May 11, 2009 and most of the construction and equipment

activities were completed within 18 months, and the facility was almost ready by the time I left NRSC in April 2011. The credit should go to the small team of CMD engineers at NRSC, who did wonders to get the project completed within the time and money.

The whole idea was an initiative by Dr K Radhakrishnan, when he was the Director, NRSA and a lot of home work has already been done by the Project team when I took over in September 2008 and my job was to get a design of the total integrated facility keeping the Green rating planned for the building and get appropriate systems procured and installed in Shadnagar, where NRSC has more than 300 acres of land. At the same time, I realised that even as NRSC is planning to have a dedicated IMGEOS activity and associated infrastructure in Shadnagar, it was essential to have a Master Plan for the whole campus, both at Balanagar and Shadnagar, looking ahead towards meeting the needs of next 20 years, including the upcoming infrastructure for National Database for Emergency Management (NDEM) and many other national and international initiatives. The Master Plan envisaged developing the total area at Shadnagar into 5 zones – Technical area, Technical support systems area, facilities area, residential area and bio-consideration area. The elevated high-bay area of the campus in the northern part has been identified for locating the antenna terminals and technical activities with the residential and other facilities located at the southern part. The redeeming feature of the Master Plan was the use of Green Technology for building the infrastructure, ensuring all environment friendly technologies. Towards this, we also planned and installed a solar power plant providing of 200 kWp, a huge effort, meeting almost 7.5% of the total energy requirement. Dr Dadhwal has added another 100 kWp to this mammoth effort,

Laying of foundation stone for Solar Power Plant at Shadnagar (25-Apr-2011)

making it really a unique achievement for NRSC. I think it is yet another major initiative by NRSC, which will also serve as a bench-mark for taking up similar such projects elsewhere in ISRO.

In the speedy execution of the above large project, I should also acknowledge here the significant support I received from ISRO Headquarters and DOS officials, particularly the Additional Secretary, DOS and Joint Secretary (Finance), who were always there to guide us in the Contract Finalisation Committee. Well, I had to retender some works more than once, but we did that to ensure transparency in all our activities. The young Controller, NRSC was also a pillar of support and advice to me in all these major initiatives. I cannot forget the continuing support and critical comments received from Head, PPEG in all the above.

Other Major Initiatives:

IRS data reception related: Launching and operationalisation of RISAT-2, Oceansat-2 and Resourcesat-2 satellite missions at NRSC were satisfying events for me as a person closely associated with those projects from Project formulation stage. The X-band SAR data reception and processing from RISAT-2 and getting a transportable terminal

Team Bhuvan with Chairman, ISRO and senior officials of NRSC (14-Aug-2010)

was a refreshing experience for NRSC though the operations handed over to the special users after the initial phase operations. NRSC established high speed communication connectivity with Svalbard, enabling the processing and dissemination of global data sets of Oceansat-2 Scatterometer data within 3 hours after data acquisition so that the data could be assimilated effectively by modellers. Significant strides were made in operationalising the CartoDEM products from Cartosat-1. NRSC continued to be in the forefront of providing upgrades for IRS data reception hardware and software, and one significant development is the setting up of a Ground station in Brazil as a cooperative venture between ISRO and INPE, Brazil, the first-ever such arrangement. I also saw to it that Resourcesat-2 data reception and processing was done flawlessly. Well, it happened even as I was laying down my office as Director, NRSC, and that also provided me a rare opportunity to address the larger ISRO community on the eve of my superannuation!!

I should also specially mention about the initiation of unmanned, remote controlled ground station at Antarctica for IRS data reception in coordination with National Centre for Antarctic and Ocean Research Centre (NCAOR) under Ministry of Earth Sciences (MoES) taken up during my period. I had detailed discussions with NCAOR and was able to send a 2-member NRSC team to Antarctica mission to start the work at the earliest opportunity in 2009. It is once again a proud moment for ISRO to have its own ground station in Antarctica.

Some of the other significant initiatives include

- The completion of the Ground Control Point (GCP) project (Phase-2) in a most cost and time effective way using the innovative Precise Point Positioning (PPP) method of data processing, covering most parts of North Eastern region, Andaman & Nicobar, Lakshadweep and Jammu & Kashmir;
- Global data availability of Oceansat-2 Scatterometer through establishing high-speed electronic connectivity between Svalbard ground station and Shadnagar;
- Procurement & Operationalisation of Large Format Digital Camera (LFDC) and Airborne Laser Terrain Modular (ALTM) for aerial services; and establishing an operational wet leasing arrangement for aerial data processing inside the Campus using industry support, just to mention only a few. The NRSC aircraft operations reached newer heights with the total flying hours touching the all-time high of 750 hours!!

I should mention about some efforts which could not yield satisfying results as well. The steps to install a small IMS data reception terminal at Papua New Guinea (PNG) was an initiative which could not be taken to logical conclusion as there were some issues on PNG side. Similarly, the efforts to procure a jet aircraft for DMSP could not fructify in spite of efforts from NRSC/DOS side.

Amalgamation of RRSSCs into NRSC: The amalgamation of the then Regional Remote Sensing Service Centres (RRSSCs) with NRSC, rechristened as Regional Remote Sensing Centres aptly reflecting them as the regional arms of NRSC, was yet another meaningful event which had to be handled with extra care and sensitivity as the professionals from those smaller outlets had hopes as well as fears as they joined the larger entity. This merger enabled NRSC to take up the ever increasing demands of the users with a more focused synergistic way.

The Users Interface Meetings resumed after a gap of few years. The data products sale crossed the 50,000 mark for the first time in the annals of NRSC's history, even as the number of hits for BHUVAN, BHOOSAMPADA and DMSP Portal showed increasing trends.

Emphasis on Applications as always: During my time, NRSC also launched major programmes such as India-Water Resources Information System (India-WRIS), Natural Resources Census (NRC) through BHOOSAMPADA portal, initiation of the National Geomorphology Mapping, Updation of Wasteland Mapping, Indian Bio-resource Information Network (IBIN), contribution to National Land Records

Inauguration of creche facility at NRSC (Jun-2009)

Modernisation Programme (NLRMP) as well as many large scale mapping and photogrammetric applications using aerial platforms, apart from continuing with various on-going application projects such as the Accelerated Irrigation Benefit programme (AIBP) under the Bharat Nirman Programme; National Drinking Water Mission; Potential Fishery Zone Mapping; Disaster Management Support Programme for flood, agricultural drought, forest fires, and land slide hazard zonation; National Urban Information System etc.

The Space based Information Support for Decentralised Planning (SIS-DP) project was yet another initiative launched at the behest of the Planning Committee of National Natural Resources Management System (PC-NNRMS). It was for creating an inventory of resources (water resources, road network, public utility, communication network, health care etc.) and disseminating them to the people at grassroots level using web-enabled information system. This was being carried out in close coordination with various State Governments for their use at district, taluk and gram panchayat level. The SIS-DP is evolved based on an approach of not imposing our prescriptions on the users based on our earlier experience of handling IMSD. In fact, this approach has spurred many users. For example, Survey of India has signed an MOU during my time to work with NRSC to develop 1:10,000 scale topo-thematic maps for the whole country. I am sure, when operational across the country, it will be yet another milestone in the long list of success stories of NNRMS.

During my period, there were also many other R&D initiatives like development of flood forecast model, early assessment of agricultural drought by use of Short-wave Angle Slope Index (SASI) using reflectance in the near and mid-Infra-Red regions; and Ocean Heat Content (OHC) using Satellite Altimetry for cyclone track and intensity prediction and the ISRO GBP activities.

Others: There were other initiatives on the human resources development front like recruitment of 65 scientists from multi-disciplinary domains and another 35 scientists appointed on Project mode under India-WRIS in RRSC, Jodhpur and mentoring scheme initiated; and training the middle management level engineers/scientists at the Administrative Staff College of India (ASCI). I used to personally participate in all the mock-up interviews of the employees to motivate them to prepare well for their DPCs. I was happy to note the significant improvement such mock-up drills brought to bear in employees' performance in DPCs. Retired employees were issued specific Identity cards making them feel part of NRSC family. For those retiring from service, a special memento was designed, depicting a satellite in orbit hovering over a golden globe with the ground station setting.

The conduct of 7th Annual Meeting of Asia Oceania Geosciences Society (AOGS) at Hyderabad International Convention Centre (HICC) in July 2010 was yet another memorable event for me. As the Chairman of Local Organising Committee, I had the privilege of seeing through the successful conduct of AOGS, which saw participation of more than 1,200 delegates from 51 countries. The unique feature of AOGS was the absence of free registration materials, free lunch and accommodation etc.! It is a matter of pride that the Conference was attended by Prof. Yuan Tseh Lee, Nobel Laureate in Chemistry, academia Sinica, Taipei and our MOS, Dr Prithiviraj Chauhan, and many senior officials conducted in typical international style, the professional conduct of the Conference was highly appreciated by all participants, particularly by Prof Harsh Gupta who was elected as President of 8th AOGS conducted in 2011 at Taipei, Taiwan.

I also remember the assembly of enthusiastic women employees from all over ISRO camping in NRSC during March 2010 for celebrating the 100th year of the Women's Day. It was a grand function with the participation of Dr Kamal Viku, the first Indian woman to travel to Antarctica and stay in the frozen continent for 16 months; and Smt Gita Aravamudan, the famous journalist with her extensive writing on gender and women's issues. It was also gratifying that NRSC women, on my suggestion, adopted a nearby village and taken on them to teach the young girls. I am happy that the same is being still continued by NRSC women!

During AOGS conference in Hyderabad (Jul-2010)

There were also a lot of infrastructure and campus improvement activities in Balanagar campus such as increasing seating capacity in auditorium, enhancing the in-campus 30-room hostel into a full furnished Guest House status, improving the Canteen facilities (like remodelling the canteen, improving washing areas, and introducing chappathi in regular meals); establishing an exclusive Executive section with its own unique settings, and providing a canopy over the open place in front of the canteen to provide a good shelter with beauty; and also improving infrastructure including laying concrete roads in Balanagar complex besides providing a good sitting arrangement for the employees and also a highly appreciated 45 feet tall Mural painting with a vast courtyard in front. There were also additions like food court, and also a crèche for NRSC women to take care of young children. The renovation of Quarters in Banjara Hills is yet another activity completed during my period. The small CMD team deserved all kudos for this achievement and it was very apt when Dr K Radhakrishnan, Chairman, ISRO specially complimented the NRSC CMD team during the inauguration of IMGEOS!!

I also should mention about the launching of the NRSC Newsletter aptly named “Pixel to People – P2P”, which provided the bridge between NRSC and the vast user community. It was well designed and was brought out regularly every 6 months!!

It was also a period when I had to live a bachelor’s life again as my family was in Bangalore. Well, it did improve my culinary skills in a way. In all, it was great experience for me and I should thank everyone in NRSC, both the administrative and technical, for all that we could accomplish in a relatively short period of just 32 months!

Resourcesat-2 first day of acquisition (28-Apr-2011)

My Reminiscences of NRSC

Dr Vinay Kumar Dadhwal
Former Director
(May 2011 - July 2016)

My formal induction to NRSA/NRSC happened through my assuming charge of Dean, Indian Institute of Remote Sensing (IIRS) in July2004. However, my entry in ISRO/DOS was 21 years earlier, when I joined the Space Applications Centre (SAC) in June 1983. In this intervening period, I had multiple interactions with scientists of the application groups of NRSA, NDC and IIRS, and was very familiar with many key staff as well as activities.

As NRSA employee my reporting officer was Dr. R.R. Navalgund, then Director, NRSA, with whom I had already worked at SAC. As Director NRSA, he was a great supporter of IIRS need for strengthening and expanding the infrastructure, educational activities (with Andhra University and ITC Netherlands) and training programs at IIRS. On his moving to the position of Director, SAC, he was succeeded by Dr. K Radhakrishnan, who enlarged my interactions with NRSA by also designating me as Deputy Director (Capacity Building) and asking me to Chair the Need Aspect Committee (NAC) of NRSC that provided me great insight into program and activities as well as procurement and replacement of many equipment and facilities.

During my stint at IIRS, I was involved in planning and supervision of (i) 40 years of its inception and collaboration with ITC, (ii) 10 years of CSSTE-AP with a function at New Delhi, and (iii) establishment of a INSAT education node at IIRS. IIRS could strengthen many of its research activities as well as infrastructure including housing, hostel, sports gymnasium, a central lecture theater as well as remodeled class rooms, a large computer laboratory, a computer server room, renovated auditorium, instrumented soil analysis and chemistry laboratory, to name a few. All this was realized under supervision of late Shri P.V. Ramaraju, whom we lost during COVID. Enhanced research activities at IIRS was in science of remote sensing (RS), quantitative models in thematic applications, microwave and hyperspectral analysis, as well as through establishing field observatories for soil erosion, hydrology and aerosols. My research interest in carbon cycle and start of a National Carbon Project (NCP) under ISRO-GBP also brought in eddy covariance flux tower instrument and data for both forests (Haldwani and Barkot) and agriculture (Meerut) to IIRS scientists and students.

During the same period, Dr. Radhakrishnan had initiated the process re-engineering for satellite data acquisition, processing, dissemination and archival through planning of Integrated Multi Mission Ground Segment for Earth Observation Satellites (IMGEOS). I was invited to participate in some of the review meetings for looking at it from application-cum-data user perspective, and could appreciate the immense scope and comprehensive nature of this transformation project. After many years, I had the privilege of inviting him as the Chairman ISRO to inaugurate this functional facility in presence of past NRSC Directors and many inter-center IMGEOS project leaders.

I moved to Hyderabad in April 2010 as Associate Director and Dr. V. Jayaraman, after a short period in Application building, arranged for my office in Director's Block where additional renovation was being done for PPEG. Although I was involved in many activities, including the application programs, I must mention two tasks assigned to me. One was to work with Head Photo-processing to realize a mural in the central courtyard on the photo-processing building. After its installation, it has become the most recognizable backdrop of many photographs with

the visitors and group events at NRSC, Balanagar campus. The second assignment was to work with GK Thomas who was appointed on superannuation to oversee the technical facilities realization of IMGEOS as well as moving the antenna and systems from interim facility at Shadnagar to the IMGEOS blocks., It is matter of satisfaction that envisaged green building IMGEOS was awarded the platinum rating of LEEDS.

I took charge as Director from Dr. V. Jayaraman in the afternoon of April 30, 2011 in the blessed presence of past Directors. My assumption of this responsibility was baptism by fire. As I travelled from home to NRSC Balanagar, received a call that a helicopter with Chief Minister of Arunachal on board has gone missing in Arunachal and ISRO should assist the authorities in searching for it using satellite data. Thus I directly reached the Decision Support Centre (DSC) and with V. Bhanumurthy oversaw multiple efforts to task satellite imaging, procure and access all relevant satellite data including microwave for this application. It was soon obvious that under cloudy weather and hilly terrain the satellite imaging capabilities were totally inadequate to meet this requirement. NRSC learnt many lessons and also became more prepared and with all teams joint working, NRSC did much better job for Kedarnath tragedy as well as Phailin and Huhdhud cyclones. Thus, my regular visits to DSC and interacting with all staff while sharing RS data with the world became a regular feature.

Shadnagar had become a hub of activities and there were many events to celebrate. This includes inauguration of IMGEOS Complex, first day reception of RISAT-1A data, visits of parliamentary committees, a string of distinguished visitors and moving the main Republic Day and Independence event from Balanagar to Shadnagar. In this period the NRSC Antarctica Ground Station also became fully functional. Shadnagar with IMGEOS functional met all the requirements of ISRO EO missions, including global near-real time acquisition of SARAL Altika and processing global data within the prescribed TAT of around 100 minutes. Its linkage with Shadnagar was fully established and I could interact with NRSC team at Antarctica. It is important to remember that realization of technical complex and its occupancy happened while many other facilities like 3-D visualization, Canteen, Guest Hose, security gate-cum-Reception building and subsequently the staff quarters and CISF quarters and barracks were also realized. Although not listed in the earlier plans, I was happy to push the development of two unique facilities, one calibration site and other atmospheric observatory adjoining it. Both are critical to long-term scientific observation of calibrating EO sensors and measuring CO_2, GHG and other minor gases.

Because of my past association with RS applications, as well as all Government agencies heavy dependence on inventory and mapping of land use, wastelands, master plans, groundwater and water quality, landslides, drought, etc. I had continuous interactions, reviews and meeting with all application teams. Here the aim was to align the activities to the future direction of earth observation. I realized that atmospheric applications would be very important in future, so a new group was created by expanding the small section with transfers from other ISRO canters as well as new recruitment. Another opportunity came our way with NRSC being assigned the nodal center for National Information System for Climates

and Environmental Sciences (NICES) and very quickly national scale terrestrial, atmospheric and ocean products were generated and made accessible for research through NICES page on BHUVAN.

As an RS scientist, it is very natural to visit google maps as well imageries and it was obvious to us that we need to transform it to meet the national needs. Here my challenge is to summarize my vivid memories of Bhuvan, its team members, the transformation from purely a GIS and satellite web visualization to a comprehensive site that allowed thematic maps to be visualized as a web service, permitted data download through NOEDA (NRSC Open EO Data Archive), thematic pages for forestry, agriculture, urban, agriculture, disaster, geomorphology and so on. I not only used to check Bhuvan access from home, check its ranking amongst all sites and regularly visit their laboratory to discuss what needs to be done. NRSC released many versions, some at events in Delhi under presence of Minister PMO. I believe that Bhuvan became nationally visible and spoken about, as well as adopted in numerous field applications. The scaling up of Bhuvan for big field data, multiple themes and use across themes, class of users and for both visualization and data source was very satisfying.

While all the excitement was happening, Dr. K. Radhakarishnan as Chairman ISRO merged the RRSC with NRSC. Visits to these centers became another very much anticipated activity. While RRSC Bengaluru had shifted to its new location under Dr. V. Jayaraman, my tenure saw RRSC Kharagpur moving to a new building in Kolkata, RRSC Dehradun merging with IIRS, new infrastructure at RRSC Nagpur as well as initiation of a new building in newly acquired land for RRSC Jodhpur. New appointments were made in RRSC also and their integration in national programs being implemented at NRSC HQ as well as providing a region-based specialization for each NRSC was also initiated. RRSC had enlarged role in SiSDP, planned for regional nodes of Bhuvan, supported WRIS web services from NRSC/Bhuvan infrastructure by moving the serves to Shadnagar.

My five years as Director NRSC passed as a breeze as I hurtled from one activity to another. The Departmental Promotion Review meetings of SF-SG at ISRO HQ and SE-SF at VSSC and ISAC, which I chaired for couple of years accounted for 6 weeks every year. My assignment at UNCOPUOS at Vienna as delegation member, later leader of delegation and in 2016 as Chair of S&T Subcommittee of UNCOPUOS accounted for 4 weeks. Thus I can only acknowledge the Deputy Directors and senior team leaders of NRSC for their truly taking the responsibility of their activity in true sense, remaining in the midst of all missions and their continuous feedback and communication, even when I was not in Hyderabad, to ensure everything runs in a timely fashion.

With the swearing in of new PM in 2014 and emphasis on expanding the foot print of RS for governance and enhanced efficiency and transparency led to identification of more than 150 projects. There were numerous meetings with Ministries in Delhi and NRSC signed nearly 50 MoU for undertaking these projects. Here let me add, just before I moved from NRSC to IIST, I could sign an MoU with USGS permitting NRSC to acquire Landsat data and process and disseminate it on reciprocal basis as USGS could download and freely use Resourcesat AWiFS data

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NRSC activities started with aerial as RFF (Research Flight Facility). NRSA had made a name for itself for undertaking both national and international projects. Aging aircrafts, challenges of hiring pilots or providing facilities under government rules, regulatory compliances and audits, and a failed attempt to augment the fleet, had made this entity functioning quite challenging. However, its leaders coped with this pressure admirably and used to have regular and long discussions with me. However, NRSC did acquire a new LIDAR and did very important projects like entire coastal strip for INCOIS, ISRO-JPL flights of AVIRIS-NG, atmospheric characterization flights for ISRO-GBP, immediate flying over coastal Andhra after cyclone, to name a few achievements. The group also helped in ortho-processing of satellite data. Aerial group were housed in a building at Jedimetla and were brought to Balanagar campus. Realizing the expanding need for aerial feature extraction, a redevelopment for aerial and outreach activities at Jedimetla was initiated. Now with new infrastructure,

it has already become another vibrant campus of NRSC.

Before I conclude my reminiscence, I must salute the entire staff of NRSC, the scientific staff, the administrative staff, the civil staff and the Director's office staff. The senior managing team including controller, Deputy Directors, Chief General Manager and Group Director PPEG. They showed immense patience to my suggestions, always exuded warmth during all interactions, excelled in their assigned and beyond activities of science and projects and made my stay at NRSC the most pleasant experience of working in ISRO. It is also an era I am proud of and feel most satisfied of my small role in this big canvas of activities. My challenge in writing this piece has not been what to write, but to convey my sense of great indebtedness to NRSC, senior leaders and all my colleagues in enriching my scientific career, in around 2000 words. I have avoided naming the individual colleagues as I would have to name all of them. In fact, I was fortunate to work with so many deputies in my tenure of 5 years, as each one in his/her unique style contributed to growth of NRSC along with every member of his team.

(Thank you all staff of NRSC and wishing you many achievements. Thank you G Behera, Dr. YVN Krishnamurthy, Dr. JR Sharma, Dr. V Raghavswamy, Dr. PG Diwakar, Dr KMM Rao, DS Jain, B Laxmi, K V. Ratnakumar, Anil Kumar, M Satyanarayana, Ms Uma Devi, V Raghu Venkataraman, Sreenivas, Dr R Nagaraja, Dr N Aparna, Dr J Ramanamurthy, Uday Raj, S Thirunavakkarasu, Ms Tripti Mathur, P. Chowdary, Shantan Kumar, …)

Reminiscences

Dr Y V N Krishna Murthy
Former Director
(July 2016 - March 2018)

As an institution celebrates its 50th anniversary, it looks back on a rich history of success and groundbreaking projects. Institutions like NRSC offer a platform that nurtures ideas and transforms them into impactful, user-centric solutions. Throughout the decades, the faces within the institute may change, but the core values established by its founders remain steadfast. I had the privilege of being part of this team NRSC, a premier institute in the country and well acclaimed globally in the domain of remote sensing and its applications.

Early 80's as a research scholar from Andhra University it was always exciting to visit erstwhile NRSA to understand advancements happening in space imaging and collaborating in applications especially using digital data sets, a new experience for everyone.

After joining ISRO as part of newly established RRSSC's, operational Indian satellite data being available it was much more challenging to introduce digitally processed data sets in user driven applications, acceptance of competing peers from NRSC, learning together to meet the national needs was memorable.

I was given the responsibility to amalgamate RRSSC's with NRSC, a balancing act. Colleagues from both sides understood mode of functioning and became a vibrant team, while meeting national needs also addressed the regional and local requirements with country wide presence. Launching of "Space based Information Support for Decentralised Planning (SIS-DP)" by ISRO a major national program to benefit local level planning and governance, responsibility given to NRSC under my leadership was a game changer, drawing mutual strengths in accomplishing a major task. First-time high-resolution Ortho corrected satellite images using Cartosat DEM, state level block adjusted with more than seven hundred stereo pairs covering mountainous terrain to coastal plains (in some states), for entire country with the participation of state remote sensing centres, a mammoth activity completed in a record time. Many experts had questions on the feasibility, but it "happened". Every state was unique on its own physiographical setup, human resources availability, a great learning experience and today we have photogrammetry experts all over the country. This has become the image base for Bhuvan the geo web portal of the country, for decentralised planning, georeferencing of cadastral maps, resource evaluation, impact assessment in temporality both in rural and urban environments. Every day was challenging with multiple scenarios, team NRSC responded aptly adhering to quick decentralised decision making and moving ahead, meeting the set quality standards, thereby benefitting the third tier of administration i.e., local level governance, in the country.

Inauguration of facility at Begumpet airport

Visit of Chairman, ISRO

Subsequently I was posted to lead IIRS, part of erstwhile NRSA. During this period, with the help of students and scientists, complex photogrammetry software was further simplified as an opensource tool to perform 3D mapping, using mobile images. During the Kedarnath floods this was used to record the infrastructure damage in 3D by local students. Today, even as hobby with mobile phone images people can make 3D models of heritage sites or any other objects of their interest. As team leaders we may visualise many such things, but realising such dreams is possible only with coherent team which responds aptly.

As Scientific Secretary of ISRO had to work closely with the colleagues of NRSC in reaching out to all the ministries of Government of India for a national workshop on use of space technology & its applications for the national development (brainchild of Prime Minister) with the participation of seniormost administrators to the probationers (present and future), who are responsible for planning and implementing programs for the benefit of people and progress of the country, along with colleagues from ISRO who develop the required technologies and applications. The concluding session was chaired by the honourable Prime Minister, who endorsed the recommendations of the secretaries and addressed the intellectual gathering on the way ahead. This has resulted in varied application projects meeting the requirements of more than fifty central government agencies and state governments, addressing socio-economic security, i.e., food, water, fodder, energy, shelter, information, infrastructure, on Sustainable Development, Disaster Risk Reduction and Governance. Majority of these projects have to be implemented by NRSC. At this juncture I was posted to NRSC as Director, another opportunity for me to work with team NRSC in successfully concluding the projects.

As Director, in record time able to do many challenging tasks, parallelly with ease, by the whole hearted support of colleagues of NRSC. We had a quick succession of Cartosat series of satellites launched by ISRO for strategic use and colleagues from NRSC Data acquisition, Data processing, Applications, civil engineering group too in establishing facilities & ground stations at user end, training the concerned, making the systems for operational use in a record time, when the country needed the most, has happened because of all teams worked in synergy, like a well knitted family, always on their toes, without any flaws, to the perfection. Something memorable to me. We had two parliamentary standing committees to address during 2017 one on estimates and the other on science & technology and environment. For the later NRSC is the nodal institute and we had to coordinate thirteen central government organizations in and around Hyderabad, host the elected members, provide necessary hospitality, plan their visits and also to NRSC Shadnagar. Strategically we have assigned young scientists from NRSC equipped with tab loaded with Bhuvan web portal highlighting the data related to the member's respective constituency. The scientist task while providing support to the members, also familiarise them in using Bhuvan, better understand the natural resources potentials of their region and opportunities for sustainable development. In the end the tab with the data and app are handed over to the MPs for their use. The members also had an opportunity to interact with the scientists who were stationed at Antarctica ground station for more than a year, and understood their work schedules in harsh weather. They were also amazed to see round the clock operations in Shadnagar, near real time support to disaster management in the country, and space applications benefiting common people. They are overwhelmed to see the quantum of work being carried out at NRSC in all sectors across the country. In the concluding remarks the chairman and the members unanimously mentioned that the scientists at NRSC and ISRO are doing great deal of work for the benefit of humanity and they felt as elected representatives they need to do more. This is

Inauguration of NRSC Outreach facility at Jeedimetla

the most satisfying moment for me as a team leader for the task delivered by the team NRSC.

Another challenging activity is establishing the C band antenna at Antarctica in the shortest time to enable data transmission through GSAT 17, with the logistics support from NCOAR. The ship supposed to bring back the team developed a technical snag, and no alternate transport was in offer. The team was worried about their return. I have assured the team to bring them back safe before fall of winter and asked them to complete the job as per schedule. I confess now, at that time I had no clue how I will bring them back. I knocked at every door and believed that when we do our job with passion and with a purpose to benefit humanity, there will be a way out. This proved right, by an unexpected ship coming to the rescue and team came back safe completing their work. This team work resulted in our own resource to transmit voluminous satellite data from Antarctica to Shadnagar. Earlier we were dependent on foreign satellites. This is another major milestone for NRSC and ISRO.

NRSC has activities ranging from user meets, workshops, training programs, outreach programs, a place of happening, lively environment, sharing knowledge and joy. World space week celebrations in 2017 was unique outreach program. We have undertaken to reach out to the maximum children in the country using the strength of regional centres of NRSC, the state remote sensing centres, NESAC, professional bodies and schools. We covered the entire country reaching out to more than five lakh students in person, competitions conducted parallelly and screened in children (more than five hundred) had an opportunity to participate in the concluding function at NRSC addressed by Chairman ISRO, Students have visited the state of art Shadnagar facilities and activities of NRSC. They were happy and excited and expressed the joy performing impromptu cultural program highlighting their regional heritage in art forms. They are future leaders of the country. For me it was only to give a direction and team NRSC responds instantaneously with their heart and soul in it and make it happen.

All the above was possible because of the unstinted support of my colleagues and their family members, including contractual employees.

At the end of the day, I am satisfied that together we could accomplish many challenging tasks and successfully explored unique opportunities. Hearty Congratulations to team NRSC on the eve of golden jubilee celebrations. Best wishes to NRSC fraternity with good health, enriching professional and personal life.

Reminiscences of NRSC

Santanu Chowdhury
Former Director
(April 2018 - December 2020)

NRSC has, since its reception, played a pioneering role in the field of Satellite Data Reception, Data Processing, Aerial Platform Utilization and Remote Sensing Applications in advancing national interest. Applications at regional level were subsequently furthered with the incorporation of five Regional Remote Sensing Centres. Bhuvan & Disaster Management services have particularly captured the needs of the community. I had the good fortune of witnessing NRSC's progress during April 2018 to December 2020. Some interesting developments that took place during the period are commissioning of tri-axis S/X band, S/Ka band and Ku band antenna systems at various stations & data products systems for Risat-2B, Risat-2BR2 and Cartosat-3 payloads, operationalization of near real time active fire alert system, use of LIDAR mobile mapping systems for 3D building models, Master Plan generation for AMRUT cities and mineral exploration studies using

spectra anomaly. An effort was made to significantly enhance the computing, storage and network security infrastructure for IMGEOS & Bhuvan, establishment of instrumentation for climate sciences and collection and analysis of atmospheric flux observations for crop and forest species. Buildings for the technical facility at Palayamkottai and Outreach facility at Jeedimetla were completed. Covid protocols were enforced from March 2020. The scientific and technical community at NRSC is highly capable and committed. In an ever-emerging technology scenario and space sector opening to private players in the country, institutions need to evolve & innovate continuously and adopt new technologies & mechanisms to stay relevant. NRSC has flourished over many decades and will remain a leader. On this occasion of Golden Jubilee Celebration, I wish NRSC community a very successful and fulfilling journey ahead.

My Reminiscences of NRSC

Dr Raj Kumar
Former Director
(January 2021 - February 2022)

The National Remote Sensing Centre (NRSC) stands as a testament to India's pioneering spirit in space technology. Thanks to the vision and dedication of my predecessors, NRSC has significantly advanced remote sensing technology over the decades, making a substantial impact on India's socio-economic development. Reflecting on NRSC's achievements, it is clear that its relentless pursuit of excellence in satellite technology and applications has not only propelled the nation to the forefront of space technology but has also significantly contributed to global scientific advancements.

Visit of Chairman, ISRO

My tenure at NRSC was a rewarding experience. Building on my background at the Space Applications Centre, I gained new insights into the centre's focus on serving government ministries and driving socioeconomic impact. I immersed myself in NRSC's mission-oriented work. NRSC serves as a critical hub for receiving satellite data from both domestic and international sources, developing and operating with cutting-edge acquisition systems. I thoroughly enjoyed gaining invaluable insights about these reception systems at different frequency ranges with experts in the Satellite Data Reception Area.

Prior to the Geospatial Data Policy, NRSC served as the sole provider of Indian and foreign satellite data. The task was immense, due to the comprehensive Remote Sensing Data Policy (RSDP), which was developed to establish transparent procedures for acquiring and distributing remote sensing satellite data from Indian and foreign satellites. To address the growing demand for high-resolution data, we, in consultation with ISRO HQ, streamlined processes and explored new avenues for faster delivery of foreign satellite data to users, pending the implementation of an open geospatial policy. These efforts were essential in building a holistic remote sensing capability.

The aircraft operations facility was a particularly intriguing aspect of NRSC. While its operations may appear straightforward to users, the complexities of maintaining and operating such a large-scale facility became evident through discussions with the dedicated scientists. Collaborating with the team, we identified opportunities to enhance remote sensing capabilities through a holistic approach, incorporating aircraft, drone, and satellite data. This led to the proposal on the acquisition of a few drones, compatible instruments, in-house data processing, and infrastructure facilities with the involvement of application scientists to undertake these projects. I am happy to learn that this initiative is now moving forward in a significant way.

Managing a high-performance data processing pipeline for near-real-time satellite data delivery was a complex challenge. I was fortunate to work with a talented team of scientists dedicated to optmizing data processing and visualization. Our collective efforts culminated in the development of Bhoonidhi Vista, a cutting-edge data visualization platform, which provides full-resolution mosaicked data visualization capability through a Web Map Service (WMS). This was officially launched by the Chairman of ISRO along with Bhuvan Lite, for a faster Bhuvan experience .

Visit of Chairman, ISRO at Shadnagar

One challenge I observed was the operational difficulties faced by NRSC management and staff due to geographical dispersion within the city and across the country, while still striving to serve the nation effectively with limited resources. However, I must commend the excellent communication facilities established, which made it easy to conduct online meetings and connect with scientists at other locations. This capability became invaluable during the challenging COVID-19 pandemic, where social distancing norms made such facilities a boon for regular meetings and one-on-one video conferencing.

NRSC's commitment to leveraging geospatial technology for societal impact is evident in its successful collaborations with government ministries and academia. By understanding and addressing critical challenges, NRSC has delivered tangible benefits, such as improved agricultural practices, effective water resource management, and enhanced rural planning through initiatives like Yuktdhara. It was highly satisfying to observe that this goal is being extremely well-served by working with ministries through a well-defined process of understanding their requirements, discussing the problems they face, and providing geospatial solutions at various spatial and temporal scales. It was heartening that during my tenure at NRSC, we were able to successfully complete many such projects.

NRSC plays a pivotal role in India's disaster management ecosystem, providing near-real-time monitoring and early warning for floods, cyclones, forest fires, landslides, and droughts, in addition to capacity building and institutionalization for stakeholders. NRSC also plays a major role in the International Disaster Charter space and Sentinel Asia.. Through the National Database for Emergency Management (NDEM), NRSC offers a comprehensive GIS-based platform for disaster response. The successful launch of NDEM underscores NRSC's commitment to enhancing disaster preparedness and resilience. NDEM Version 4.0 was also launched by the Union Home Secretary in 2021.

I must admit, it was really tough to take over the charge of NRSC during the peak of the COVID-19 pandemic, with everyone apprehensive about infections from even the slightest interactions. However, with the coordination of the Administration, Management Service Area, and a team dedicated to managing COVID-19, we were able to minimize infections, maintain meticulous weekly records of infected personnel, and ensure proper vaccination. As a result, we managed to deliver projects without any delays, despite the restrictions. Initially, due to everyone wearing face masks, it was difficult to correctly identify new faces during video conferences or outside the office. However, with the numerous tools developed by NRSC for geospatial analysis, Bhuvan services were highly utilized during this time for commodity transport, vaccination centers, and bed availability.

Given my extensive background in atmospheric and ocean sciences, NICES held special significance for me. Our initial focus was on bolstering NICES' capabilities by developing crucial essential climate variables. This involved leveraging long-term, high-quality satellite data, fostering collaborations with other ISRO centers and institutions, and prioritizing climate research. NRSC's showcase platform, BHUVAN, has significantly impacted Indian users through its innovative geospatial services and web-based analytics. The recent liberalization of India's geospatial data policy, coupled with the free availability of satellite data, has empowered individuals to visualize and analyze vast datasets, driving solutions across diverse sectors. Anticipating this surge in user demand, we proactively expanded BHUVAN's storage, computational, and network infrastructure to accommodate the increased workload.

Under the dynamic leadership of the current Director, NRSC's legacy is poised to continue inspiring ground breaking advancements in remote sensing. I am confident that the organization will deliver innovative solutions to address the complex challenges of tomorrow.

My Journey with NRSC

S K Bhan
Former Associate Director & Dean, IIRS

It is heartening to note that NRSA/NRSC is planning to commemorate the completion of 40 years of dedicated service to the nation in providing the remote sensing data and services in utilization of the data so generated. The journey so far has been very eventful and the future promises to be even more challenging in providing the solutions particularly in the areas of natural resources, environment and disaster management. Eminent position attained by the NRSC has been mainly due to the dedicated and hard working team of the qualified scientists under the able guidance of the Centre Directors.

My journey in NRSA/NRSC started in October 1976 and was one of first few scientists to join in the organization that has been barely in existence for a year and in area that was not known much and established. And with future not certain, it was going to be very challenging and risky. When I look back at that it has been not only challenging but also very rewarding and satisfying. The journey in NRSC had been very significant in show casing the achievements and laying the foundation for the future. It gives me immense pleasure and satisfaction that the hard and dedicated work put in during the initial period is bringing tremendous results and gives me very proud feeling to be part of the NRSA/NRSC. I am grateful to organization that has provided me ample opportunities for the achievements made in this journey.

Some of the great moments those are etched in my mind are:

- When we conducted Indo-US Workshop on Water Resources in 1978.
- When Indian Remote Sensing satellite IRS –1A was launched in 1988. We cannot forget the first day data that was given to us (application scientists) to explore. It was proud moment not only for us but for entire scientific community all over the world.
- When IIRS celebrated its Silver Jubilee in Feb, 1992, inaugurated by Hon'ble Vice President of India Shri K R Narayanan. Transformation of IIRS from photogrammetry and photo interpretation methods to digital methods and integration of satellite digital data shaped the growth of IIRS that made IIRS as Centre of Excellence.
- When United Nations Mission selected India and IIRS as Host Institution for establishment of Center for Space Sciences and Technology Education in Asia and Pacific in 1994-95.
- When we conducted IIRS-ITC Project National

Visit of Prof. Yashpal to IIRS

Seminar on Geoinformatics in 1998. IIRS-ITC Project (1995-1999) for creation of new Geoinformatics Facility, Staff Training, and New Course Modules and up gradation of infrastructure played a key role in development of GIS technology in India and is one of the shining examples of international cooperation between India and the Netherlands.

- When Wasteland Atlas of India was released by the Hon'ble Prime Minister of India Shri Atal Bihari Vajpayee on May22, 2000 at New Delhi.
- When we celebrated the Silver Jubilee of NRSC in Nov 2001

Visit of Mr Manik Sarkar, Chief Minister of Tripura (2001)

- When Rajiv Gandhi Drinking Water Mission was selected for Team Excellence award under ISRO Awards 2007. As leader of the team received the award from the Hon'ble Prime Minister of India Shri Manmohan Singh on August 25, 2009.

Remembering these brings to my mind all the people who have been associated with me in this journey, their efforts, support and guidance in meeting the challenges during this journey. I sincerely hope and wish that NRSC will continue to serve the nation with dedication in future also as it has done so far.

Release of "Landslide Hazard Atlas" on the occasion of NRSA Silver Jubilee celebrations (2002)

Reminiscences of My Journey with NRSC

Vinod M Bothale
Former Associate Director

My journey at NRSC began in 2012 when I took on the role of Group Director for Bhuvan, following my tenure as Director of MRSAC Nagpur from 2009 to 2012. Having been a founding member of Bhuvan since 2009, this role was particularly meaningful to me. Bhuvan was supported by a small yet dynamic team of talented and dedicated engineers and scientists. Leading this team marked a period of significant growth and achievement, providing solutions to various governance challenges faced by departments and ministries. When I assumed this position, Bhuvan was a basic geo-portal. My objective was to elevate it into a comprehensive National Geospatial Platform for governance. I am proud to say that, with the enthusiastic efforts of a vibrant team and the ongoing support from senior mentors, we not only met this goal but exceeded our expectations.

Bhuvan evolved into an essential asset for numerous governance processes, including planning and development, monitoring and evaluation, asset mapping, and decision-making. A major accomplishment was transforming Bhuvan into a dependable enterprise platform for near real-time applications, especially in disaster management. Our proactive support during crises such as the Kedarnath flash floods, Cyclones Hudhud and Phailin, and the Nepal Earthquake received widespread recognition from the media, state authorities, and disaster mitigation agencies. The impact of these experiences remains vivid and significant.

The Kedarnath disaster of 2013 was a pivotal event that highlighted the urgent need for improved monitoring of glacial lakes. The catastrophic flash floods caused unprecedented damage, underscoring the necessity for accurate information to assess the situation. Bhuvan was instrumental in providing rapid access to satellite imagery and analysis, which were crucial for understanding the causes of the flooding and the extent of the damage. We facilitated controlled crowdsourcing in the affected areas through a mobile app and launched a dedicated MANU (Mapping Neighbourhood of Uttarakhand) portal to support the state government's rehabilitation efforts. Our team's swift response and around-the-clock support during this crisis received widespread recognition from ISRO, American Geophysical blogs, and the media. The heartfelt gratitude from the affected states and disaster mitigation agencies underscored the critical importance of our work.

The experience of managing Cyclone Hudhud in 2014 is deeply ingrained in my memory. As the cyclone approached, the pressure to deliver accurate,

Launch of Bhuvan at NRSC- Hyderabad in 2009, followed by national launch in Delhi

National Skotch Platinum award: Bhuvan

near real-time data for disaster management was immense. Our team worked tirelessly around the clock, coordinating with Andhra Pradesh state government agencies to provide critical information on the cyclone's path, potential impact zones, and real-time updates through rapid mobile surveys. Within three days, we gathered data on 25,000 locations affected by the cyclone, detailing damage to vital installations, infrastructure, and crops.

The urgency and responsibility of the situation were palpable. I also managed the National Database for Emergency Management (NDEM) portal, and I recall attending meetings with the Andhra Pradesh Chief Minister twice daily—at 10 AM and 10 PM. The Chief Minister was closely monitoring the situation and rehabilitation efforts. The response to Cyclone Hudhud demonstrated the transformative power of geospatial technology in saving lives and aiding in the swift restoration of affected areas.

Expanding Reach and Capabilities: Through persistent and dedicated efforts, Bhuvan's user base grew exponentially. This expansion was fuelled by our relentless commitment to enhancing Bhuvan's content and capabilities. We processed over 3 trillion pixels to deliver high-resolution imagery, which significantly boosted user engagement. To complement these images with on-the-ground data, we evolved Bhuvan into a powerful crowdsourcing platform, gathering 4.5 million location data points and 8 million photographs. This transformation proved crucial for initiatives such as the AP Housing Corporation and the nationwide "Housing for All" program led by the Ministry of Housing and Urban Poverty Alleviation (MoHUPA).

Our journey was marked by challenges that tested our resolve and pushed us to innovate. On January 23, 2016, we faced an unprecedented influx of 250,000 location data points and photographs in a single day. This surge stretched our systems to their limits, prompting the development of advanced optimization techniques to manage the heavy traffic effectively.

PRAGATI: Serving as ISRO's representative for PRAGATI Pro-Active Governance and Timely Implementation) was an immensely valuable experience. This role involved direct engagement with the Prime Minister's Office and participation in meetings with the Hon'ble Prime Minster. The opportunity to handle high-level governance and manage interactions with the PMO provided profound insights into infrastructure and development projects. It also refined my skills in managing high-level interfaces and communicating effectively with senior officials. Through PRAGATI, we supported the review of over 300 projects during 33 meetings chaired by the Hon'ble Prime Minister.

Ground Segment Experience: During my tenure as Deputy Director (DPA) managing the Shadnagar ground segment, we achieved a remarkable milestone with seven successful missions within two years. Each new remote sensing satellite's imaging debut was a period of intense anticipation and challenge for the Data Processing team. I had the privilege of witnessing the consecutive successes of six satellites—HYSIS, RISAT-2B, RISAT-2BR1, EOS-01, Cartosat-3, and EOS-04. Unfortunately, we did not achieve success with EOS-03 due to a launch failure.

PRAGATI Meeting

The Cartosat-3 mission stands out as a particularly memorable experience. During this mission, we implemented the GRANDS system architecture, which revolutionized our capabilities. This new system enabled real-time satellite data acquisition with data rates up to 2.88 Gbps for Ka-band data and 960 Mbps for X-band data—an impressive upgrade from our previous system that supported only 640 Mbps. This enhancement was crucial for meeting the demands of future satellite missions.

While the EOS-03 mission promised even greater

challenges with its high-volume data and repetitive imaging from a geostationary orbit, the failure of the GSLV-F10 mission unfortunately interrupted these plans. Despite this setback, our efforts demonstrated significant advancements in ground segment technology and data processing capabilities.

First Day Payload Imaging: The first day of payload imaging was akin to a ceremonial event, marking a crucial milestone for remote sensing satellite missions. This day was pivotal, with teams from NRSC, as well as designers from URSC, SAC, and ADRIN, stationed at NRSC Shadnagar for a week or more. Their presence ensured thorough integration testing and fine-tuning of both software and systems. The success of the mission, particularly on the first day of imaging, relied heavily on this meticulous preparation and coordination.

Memories of RISAT-2B – First Day imaging: During the EOS-01 mission, the situation was uniquely challenging due to the COVID-19 pandemic. The virus had restricted travel and severely limited manpower availability, making in-person meetings impossible. For the first time, we had to facilitate remote access to facilities for SAC and URSC while adhering to strict IT security compliance. This added complexity to our already demanding task of setting up the ground station, systems, and software without integration support from other centers.

In this constrained environment, we built a multi-layered, highly secure IT framework without compromising ongoing operations. Despite the lack of on-site manpower, increased workload, and absence of designers from other ISRO centers, our NRSC Data Reception and Data Processing teams rose to the occasion. They delivered exceptional results, demonstrating a high degree of professionalism and quality of work.

On the first day of imaging, we broadcasted the event live to the Chairman of ISRO and the relevant ISRO centers. Despite the anxious moments and challenges, we achieved flawless success. The entire process unfolded seamlessly, with the first product generated through complete automation, all while we were engaged in a video conference with the Chairman.

Last and most important, it was always proud feeling to host a Indian tri-color in Shadnagar and Balanagar Campuses. I feel humbled and lucky to get such an honor. I also feel satisfied to get all the love & respect from juniors and guidance & encouragement from my seniors. I strongly believe that the success of an individual comes from success of the team. Today, celebrating Golden Jubilee of NRSA/NRSC is the fruit yielded from untiring efforts of Team NRSC. Best wishes.

Proud moment to host National Flag at NRSC on 26th January 2022

Reminiscences

Dr K Vinod Kumar
Former Associate Director

My journey in NRSC began way back in the year 1991 after completing my formal education in the field of science. Remote sensing technology was evolving during that time and many graduation and post-graduation courses offered by various universities did not have this technology in their curriculum. I graduated from Osmania university and they did not have Photogeology / Remote sensing in their course curriculum Most of us who had joined at that time had to learn this technology in the course of their professional career. My first assignment was geological mapping of NE states for ground water studies. This experience was memorable since it laid the foundation for my career in geological remote sensing. I realised how this technology was effective in reducing our field work. From that day till retirement spanning around 34 years I could be part of many of the important geological projects executed by NRSC. Executing these projects was challenging both on the project management level and technical aspects

With Director, NRSC

Visit of Chairman ISRO

and I am indebted to NRSC / ISRO for providing this opportunity and shaping my professional career.

The role NRSC has played in Indian Space programme is commendable and many of the government of India programmes utilize this technology for optimization and monitoring. Many of the frontier areas of remote sensing in early 90"s have become operational now especially for natural resource management and disaster. The days ahead are challenging especially with increase in user base and penetration of technology on all aspects of human life. Sensors are evolving and platforms have become multiple and users are demanding solutions at higher resolution at near real time. This requires innovation in application, processing and dissemination. I am sure team NRSC can rise to the occasion and can provide unique solutions to the user in geospatial technology. I congratulate NRSC for completing 50 golden years and wish them good luck on all their future endeavours.

My Journey with the National Remote Sensing Centre

Dandu Visweswara Raju
Former Deputy Director
(Satellite Data Acquisition Area)

Having begun my professional career with ISRO, had a challenging and rewarding experience with Satellite Technology, more specifically Spacecraft Telemetry, Telecommand & Communication systems with the associated ground segment during Nov 1968-Apr 1978.

Through direct selection process, (though deputation/ lien option was available) joined National Remote Sensing Agency (NRSA) in April 1978 and took charge of the Earth Station Division. What struck me quite odd was the absence of camaraderie, as was overwhelmingly experienced at the ISRO Centres, though the agency was headed by another former senior scientist/engineer Wg Cdr K R Rao from ISRO. Slowly but surely came to know of the working style when I was given the responsibility of getting stores inventory assessed just before leaving for the USA as a team member that took part an active role in the design/development/testing of the first-ever Indian Earth station for acquiring & processing remote sensing and meteorological data from Landsat & NOAA series of satellites.

Though NRSA was primarily vested with operationalization of resources surveys with the satellite remote sensing data complementing its aerial surveys, Wg Cdr Rao empowered his scientists/ engineers to be abreast of the technology and practices in vogue by associating them with the development of the data acquisition & processing systems at Atlanta & Houston (Clearlake City) and saving foreign exchange by getting a good discount in the overall cost of the systems. In the process, the NRSA team members have had the benefit of getting trained at vendor premises on various subsystems.

Visit of Prof Satish Dhawan, Chairman, ISRO (1981)

This enrichment & empowerment certainly helped us not only in establishing the total facility in record quick time but further savings accrued by doing on our own, though contractually the system developers were to install and commission the system.

When system augmentation was needed for Landsat 4-5 data reception & Quick-look & Real-time processing, indigenous efforts were initiated, despite reservations from the Director as he felt it was too risky and time consuming. But, the experience & exposure thus far gained helped in developing subsystems like 10m Antenna (though delayed), Servo control system, Tracking receiver, Data distribution unit, Fiber-optic links, among others, in-house which helped in lifting the morale of the staff otherwise involved only in routine operation and maintenance activities. These developmental efforts further boosted the confidence of the people in facing the Departmental Promotion Committees of ISRO/DoS.

Feed & front-end subsystem, Tracking receiver, etc., from SAC paved the way for further indigenization of Earth station subsystems. Realization of QL & Real-time, Data Processing and Analyses subsystems for the SPOT & IRS series of satellites working alongside scientists/engineers from SAC and ISAC was another major achievement.

This integration with ISRO Centres was the best thing that could have happened to NRSA as it opened new vistas like the NNRMS, RRSSCs and Remote Sensing Applications Centres in various States, thus spreading

the knowhow & utilization of remote sensing data in almost all the thematic areas of National importance.

With time, NRSA got augmented with newer aircraft & sensors for its aerial fleet; additional earth stations with back-up arrangements; additional data processing & data analysis systems; latest photo-processing equipment and other supporting infrastructure to support the ever increasing demand for quick turnaround time in disseminating the data from Landsat, SPOT, IRS-series and the microwave remote sensing satellite, ERS-1.

Alongside, the aerial remote sensing facilities got augmented with new aircraft & instrumentation and in-house developed real-time monitoring & display subsystems. Latest semi-automatic Cartography facility was inducted into the overall augmentation.

With its expertise, NRSA became focal point for DoS in meeting the demand for direct reception/processing/analysis facilities like DIPAC, KARP of MoD and those from outside India. Thus, NRSA became a global player for providing end-to-end solutions by early 2000s – from just supplying imageries, CCTs and small-scale maps in 1970s. All this advancement was made possible with NRSA becoming an integral part of ISRO-DoS five-year plans.

My direct role:

- Established data reception & quick-look real-time facilities for Landsat, NOAA, SPOT, IRS series and ERS-1 satellites.
- As IRS-1A ground system coordinator, established the complete ground system at NRSA.

Visit of Prof Satish Dhawan, Chairman, ISRO (1981)

- As ISRO coordinator for the MoD project, DIPAC, planned & finalized to the implementation stage, before retiring from the service.
- As ISRO coordinator for ERS-1 ground system, planned & executed the project to near completion stage, before retiring from service.
- Initiated several in-house developmental activities and provided opportunities to the staff for enhancing their skill levels.

Management responsibilities held:

- Chairman & Member for many committees of NRSA (maximum held).
- Completed the Normalization process for all employees in a record time.
- Assisted Director & the Controller in many sensitive issues concerning the employees.
- Counseling was given to most employees, irrespective of their disciplines in their growth.
- Maintained a harmonious bondage with the employees.

Visit of Prof U R Rao, Chairman, ISRO (1988)

General: Being frank & outspoken might have caused embarrassing situations to the higher-ups, but by and large it was a good journey with NRSA in its growing & important activities. I take this opportunity for thanking all my bosses at various stages and my colleagues for extending their whole-hearted support in the discharge of my duties & responsibilities. At the same time, I might have upset colleagues & well-wishers when I bid adieu on 31 December 1992!

I wish many more laurels to NRSC & ISRO in their pursuit for excellence …

My Journey with NRSC

S Raghunathan
Former Deputy Director
(Satellite Data Acquisition Area)

It is a challenging task to bring out the significant developments covering a period of more than three decades at an Organisation like NRSA(C) especially since it includes the formative years. I had joined NRSA on 1 March 1976 with 7.5 Year tenure at PRL / SAC. Having been associated with Prof. Pisharoty, Father of Remote Sensing in India, it was an extremely pleasurable experience to be part of NRSA and contribute towards the gigantic growth for the successful utilization of this technology and establish NRSA – ISRO – INDIA firmly as a world leader in this area in a reasonably short time frame and with relatively inexpensive expenditure.

Visit of Prof Satish Dhawan, Chairman, ISRO

It was a team of young Scientists and Engineers who were hungry to learn and apply R.S besides familiarizing User Agencies to educate and convince them to use R.S as a major supplement in their respective Organisational tasks. Establishing facilities for acquisition and processing of data with Aircrafts, Sensors and Interactive analysis systems, maintaining them in operational status including provisions for uninterrupted power systems (UPS) and diesel generators were the early tasks. Setting up of a direct reception satellite station at a faraway place (not by today's standards), and operating it to ensure repetitive coverage over desired areas and in the process face and solve the difficulties of workforce deployment at this location, ensure the operational status of all systems (some were one of a kind in the country) within the constraints of the then existing local infrastructure facilities and the Government policies.

The second decade saw a steep growth in terms of expanding facilities for reception and processing of SPOT satellites data and increased throughput of LANDSAT data. Major activity was of course getting ready for Indian R.S. Satellite program which was a resounding success and sample data being available within a very short time to the users. Evolution of Information management system towards automatic work process flow and monitoring of data processing and quality control was a great experience. Photoproducts were the main user products and one of the best facilities in the world was set up at NRSA to generate the large number of photoproducts by solving the operational issues associated with automatic photo processing and roll film recorders to meet the required high thru-put and quick turnaround times.

In parallel to above, Regional R.S. Service Centres (RRSSC), under the umbrella of National Natural Resources Management System (NNRMS), were setup towards making Data analysis facilities available to users. These Centres and the dedicated training facilities/expertise at Indian Inst. of R.S. at Dehradun and the Training Division at NRSC continuously

Visit of Mrs Margaret Alva, Minister (1990)

educated and trained the Users with short, medium and long term besides many custom designed user specific training courses. Assistance/advice to set up State R.S. Centres was also provided. Forest mapping and ground water potential mapping of the entire country at scales feasible with satellite data were path breaking milestones and have resulted in adoption of the R.S. technology as supplementary tool in most of the natural resources related Organisations in the country.

The third decade saw IRS and India maturing as a major international force and in providing reliable and repeatable state of the art data (1m) and also share the hands on experience of utilization of the data in an effective manner. Facilities were set up for users at many locations within and outside India. Indigenously developed 7.5m shaped parabolic antenna with the control system and tracking / receiver equipment were installed and supported at Users' premises. Fibre optic cable / satellite based data links from Shadnagar to Balanagar were established towards supply of urgent data products which was further developed into proposals for providing processing capabilities and transferring thru direct links to users from Shadnagar itself to minimize the delay in supply of data. I understand this system is in place now fully functional and I am really very pleased about it and compliment all those who have made it possible.

The above depict only a glimpse of the eventful 30 years spent by me at NRSA. The tremendous scope for working hard with no constraints for meaningful project proposals and the fully supportive environment consisting of young and energetic manpower besides associated support from nontechnical areas really brought the best in everyone including me.

Working in and exposure to a variety of areas which are not purely technical in nature was another aspect. Preparation of UNDP proposals for funding the manpower training in 1976 (Bendix Scanner and Analysis System) , for building the Landsat Data Processing System at Ford Aerospace in 1978 (NRSA also got reduction in system cost for providing manpower to participate in DPS development), negotiating with equipment suppliers and MoUs with NASA / NOAA and Spot Image and ESA (for ERS) were significant experiences that provided great learning opportunities about many facets of R.S. Distribution Fee concept and Scene based Acquisition fee under Spot program were unique concepts. Participating and presenting NRSA activities and sharing notes in many LANDSAT / SPOT International Ground Station Operators meet was another unique experience.

Visit of Dr K Kasturirangan, Chairman, ISRO

Use and development of new technologies and processing methodologies was possible. Use of HDTRs , Roll Film Recorders ,Optical disks , Direct recording of live satellite pass on computer disks , low cost PC based quick look system are some areas that come to my mind. Technology transfer was another area and many hardware units, equipments and systems were manufactured by Indian Industries with the knowhow provided by NRSA.

Many significant proposals and approaches could be made that fructified later on and became major activities at NRSA and elsewhere. Proposal for FSI – NFDMC was set up based on this-, Aerial Photogrammetry, Analysis and Cartography (APAC) – Digital Photogrammetry facility was set up based on this – Centralised procurement of GPSs and also PC Maintenance, Establishment of high speed Campus backbone and provision of internet to all including nontechnical areas – NRSA Purchase used to search the net and identify suppliers - , are a few cases.

Indigenous design and fabrication of 7.5m shaped parabolic antenna was a very rewarding experience. Design by ISAC and IIT Chennai, fabrication by a private Indian industry, use of close range photogrammetry and coordination by NRSA were highlights of this which resulted in achieving the

desired antenna performance and at a much lower cost.

CHSS scheme formulation and implementation, Organisational health status study of NRSA by Centre for Organisational Development, Hyderabad, and NNRMS seminar which was the first major effort to project R.S as an interdepartmental program of State and Central government were great eye openers. The image of NRSA was such that, if an activity had to be done professionally, quickly and efficiently, give it to NRSA, was the slogan.

After witnessing the launch of one of the IRS spacecraft from SHAR, I hurried to Chennai, managed to get a seat by Indian Airlines (the only airline those days) showing my ID card, going to Shadnagar next day and witnessing the successful reception of the satellite signal. Not many get such opportunities. Thank you NRSA and Dept. of Space, and the wonderful colleagues!

My Memories, as how it was working in NRSA

Dr K M M Rao
Former Deputy Director
(Data Processing Area)

It was a great time, when I carried out research and conducted experiments in aerial Remote Sensing and Image Processing during the earlier years of 1970s at Indian Institute of Science, Bangalore. Joined NRSA at 4 Sardar Patel road during May, 1976 and few months later, we moved to new campus at Balanagar. I always get a great feeling, when I recollect my working in NRSA, as I could contribute many things to develop the organization. I was asked to develop image interpretation equipment initially, though I was given the opportunity to work in image processing and data processing, as the activities were growing.

Another task was, supporting IPI, Dehra Dun for their research projects and operational activities. As remote sensing was infancy in India in 70s, IPI conducted training programs in Remote Sensing and Image Processing at local and country level.

We built image interpretation systems/equipment along with my team colleagues, as even simple systems were not available in India at that time. Designed and developed additive color viewer, image analyzer, dual densitometer, satellite image processing system, Image Scanner(Drum Scanner), photo write for generating output imageries. All these were developed in house and fabricated the prototypes in small scale industries in Balanagar, as there was no workshop to build in house. Later we produced them in large numbers to meet the user demand by transferring the technologies to industry, as we realized the importance of industry partnership, which ultimately saved foreign currency. I feel great, to recollect getting Indian Patents for number of these systems. During this phase, Remote Sensing Satellite imageries were purchased from EROS Data Center, USA and users were supplied with b/w and color photo prints, based on the user requirements. It was great experience, visiting USA during mid-1978, first time under UNDP fellowship and got trained on Landsat Satellite data, analysis, classification and filming the images and photo processing at EROS Data center, Sioux Falls, SD. Visited NASA at John Space center at Houston, Goddard Space Flight center at Greenbelt, Mary Land etc., This gave me great confidence in designing hardware and software systems later. During the second phase, we procured Multispectral Data Analysis System (PDP-11/35) and printer plotter system (PDP-11/34) to analyze the Remote Sensing data CCTs (R.S data CCTs obtained from EROS data Center). These systems were used for analysis, filming and plotting the user outputs from various applications projects. I was managing the second system, where I also processed Bhaskara Satellite data, (1 km ground resolution) with SAC

Visit of Minister

Visit of Prof Satish Dhawan, Chairman, ISRO

developed data processing software. This gave the feel of processing Indian satellite data with ISRO processing software. Seeing the need to generate precision map outputs from aerial data, I have established Aerial Photogrammetry, Analysis and Cartography Facility, as project manager. NRSA was merged with ISRO (1982) and was given the responsibility of data reception, processing and dissemination of data to Indian and outside users. During IRS-1A /1B period, I have established world class filming facility to generate outputs from CCTS of IRS data and other foreign satellite data. The facility was used extensively for supporting prints from applications projects of various users in and outside NRSA. Next phase, during IRS-1C/1D, I recollect the

Visit of Dr K Kasturirangan, Chairman, ISRO

design of large format film recorder to generate 5 meter PAN data outputs directly to preserve geometry and radiometry of the data accurately. The outputs were well appreciated by the users. Later with the help of M/s Speck Systems, which was given with the technology of small format Photowrite, we established large format filming facility. It was very challenging for me to operationalize IRS-1C/D processing software from ISRO centers like ISAC, SAC and NRSA, as Operations Director, IRS-1C/D. During 2000, simulated the images to see, how we get high resolution in across track by changing yaw bias using image processing techniques and provided inputs to IRS TES mission. I recall the excitement of one meter data from IRS-TES and challenge in processing the images, which were derived from four CCD strips. I remember, the one meter data availability, which was timely for Indian users and greatly used by some users, where I supported them to establish the processing facility in their place. I took charge of Deputy Director, Data processing during May 2002. Seen number of new satellites from ISRO, such as IRS-P5 (Cartosat-1 Stereo acquiring, IRS-P6(Resourcesat-1 Multi Resolution platform, etc.,). I have operationalized data from these satellites timely, as these data sets were well received by number of users in India and outside India. It was great challenge for me to establish number of receiving stations (International Ground Stations) in China, Germany, USA, Taiwan,etc., etc., for these satellites. As the data demand from these satellites has increased and near real time data of the global coverage was the need of the hour, established a receiving facility at Svalbard, Norway during 2004. We stablished data processing for onboard solid state recorder (OBSSR) in data processing area. I recall the memories of meeting honorable Prime Ministers (Mr. Atal Bihari Vajpayee and Mr. Manmohan Singh, the then prime ministers) and President of India, Honorable Dr. Abdul Kalam along with Chairman, ISRO to present and explain the first day products of IRS-P6 and IRS-P5 during Nov, 2003 and May 2005 respectively. As we

Visit of Mr G Madhavan Nair, Chairman, ISRO

did not have good conference halls in the campus, during mid-2000, worked out the specifications and got two conference halls built in data processing area, one to accommodate 50 people and another to accommodate 100 people with modern amenities, which was extensively used for various IRS meetings and other seminars and conferences. Felt great, when I demonstrated visualization system using IRS-1A, IRS-1C, Resourcesat-1 and TES data sets in ISRO council, which has the facility to zoom from course resolution to one meter with multiple clicks, which was the initiation for developing Bhuvan system. Got IRS processing software Ported to multicore PCs with Linux operating system to remove procurement bottle necks of workstations during Cartosat time frame. Development of medical image processing software and hardware and interfaced with number of hospitals to analyze eye images for studying various diseases and brain images for tumor analysis ,etc., This effort was also very well appreciated by Prof. Satish Dhawan and Dr. Kasturirangan, the then Chairmen, ISRO, as these applications are important for human healthcare. I encouraged student projects

in NRSA to carry out IRS software and hardware developments, as NRSA was conservative to keep manpower at a minimum level. Felt happy, when some of my colleagues got Ph.Ds under my supervision, which was different nature of work. During my period in NRSA, data media changed from CCT, Floppy, CTD (4mm tape and 8mm tape), CD ROM, DVD, DATs, Optical Tape, etc., processing speeds of computers from 1MFLOP to several hundreds of MFLOPS, computer hardware from mainframes to multicore PCs, ground resolutions changed from 1 km to sub meter resolution and I was thrilled when I experimented and got 25 cms resolution from IRS-TES. I always remember and happy about number of awards recognizing the contributions of our team like NRDC Award on 15th Aug, 1993, National Academy of Science Award for 1994-1995 etc., I moved from engineer/scientist-SC level to Deputy Director data processing area. I was also designated as operations director for IRS-1C and IRS-1D, Project Director SARPAD etc., Designing systems and establishing the facilities were always a team work.

Visit of French delegation (13-Nov-2004)

Down the Memory Lane at NRSC

A S Manjunath
Former Deputy Director
(Satellite Data Acquisition and Processing Area)

It is always pleasing to recollect the swee memories of being a part of a great institution like NRSC from its inception.

Visit of Dr K Kasturirangan (3-Jan-2008)

While working at SAC (ISRO), I had good acquaintance with Wg Cdr KR Rao (founding Director of NRSA), who offered me to join NRSA. Thus I was in the first batch of engineers to join NRSA. The early days at the leased building in SP Road was very enlightening with people like RD Sharma, Krishnan Unni, Balasubramanya, Balachandrudu, Hebbar, Maruthachalam, Venkatarathnam etc, discussing everything about earth observation. After Prof Deekshatulu joined, we had more academic interactions, daily follow up and especially, 'weekly seminars', by us on advanced topics of our choice in remote sensing. I used this opportunity to read and talk about SLAR systems, which shaped my career in microwave remote sensing. Dr Krishnan Unni had painstakingly collected lot of literature on remote sensing which was like a bible for fresh recruits. When NRSA started functioning, remote sensing was in infancy around the world. An incident I can't forget is that a Zoologist from Chennai studying crocodiles wanted a solution to track how young crocs (which can't see), go to a certain place every day? Of course, we didn't have a technology at that time. Even the computing technology was very basic. We developed an aircraft navigation system using a 1000 step programmable desk calculator. The first computer we got was a PDP 11/35 which was part of the multispectral data analysis system (MDAS) of Bendix Aerospace. Apart from operations we were also involved in maintenance of the complex systems that in turn helped us in indigenous development of several systems which were successfully transferred to industry under technology transfer agreements. These capabilities were best exploited during the last two decades for establishing ground segment for DIPAC, NTRO, DEAL, INCOIS and a large number of international agencies through Antrix.

Visit of Israel Airforce officials (1-Mar-2006)

My early studies in pattern recognition and classifiers enabled me to be a faculty (along with Dr RS Ayyangar and Dr KL Majumder) for the UN workshop on remote sensing for agriculture at Bunos Aires, Argentina.

I fondly recollect my association with Sri YS Rajan, OPN Calla, Lt Col Pant and S Chandrasekhar in the generation of first document on the development programme for microwave remote sensing, and my association with Dr George Joseph for generation of an early paper on optical sensors for remote sensing.

I was privileged to work under Prof RK Moore at University of Kansas under a UN program which enabled me to develop an X Band SLAR system. Working inside the aircraft on tarmac for installation and testing of SLAR used to be a gruelling and

Visit of Myanmar delegation (24-Apr-2007)

unique experience and I pleasantly recollect my association with Sri Rajendra Kumar, Kannan, RK Swamy, LK Ramachandran, P Sastry, Madhusudan Reddy, etc in several installations in DC-3 as well as HS-748 aircraft. Working under Prof Deekshatulu has been a great value addition. I could significantly enhance my depth of understanding while generating technical papers related to image processing, artificial intelligence, expert systems, microwave remote sensing, etc.

Visit of NRSA GB members (17-Dec-2005)

It was a nice experience to support Dr K Radhakrishnan, Director INCOIS, during the initial days for placement, procurement and acceptance of systems, etc. Further when he became the Director of NRSA his guidance greatly enabled me in managing the Data Processing Area activities. Major events that impacted NRSA during this time were, NRSA becoming NRSC, a centre of ISRO, and initiation of IMGEOS.

Further, after Dr V Jayaraman took over as Director since Sep 2008, the DPA became more active and eventful. I warmly recollect our work towards conceptualising and realising BHUVAN portal in a very short time and at the same time it won many accolades. Another outstanding achievement was establishing IMGEOS complex at Shadnagar, which has given a paradigm shift to the way NRSC meets the user needs towards exploitation of earth observation for natural resource management. Since May 2011, Dr VK Dadhwal has been leading NRSC so effectively that, with the IMGEOS having been completely established, NRSC is future ready to meet the ever increasing needs of EO users.

Release of NRSC calendar (3-Jan-2011)

I wish a great and eventful years ahead for NRSC! I thank all my colleagues who have been and are contributing to this odyssey.

Independence Day celebrations at Shadnagar (15-Aug-2011)

My Journey with N R S C

Dr Asis Bhattacharya
Former Deputy Director
(Remote Sensing and GIS Application Area)

Most people rate marriage as the most important life changing event that opens new vistas and provides a fresh outlook. I am sure it will not be an exaggeration to say that for many NRSC employees, becoming a part of this illustrious organization is as life changing as marriage, if not more. For many of us, the relation was perfectly symbiotic: even as we contributed our best to help NRSC break new ground, NRSC nurtured our talents and ambitions to bring out the best in us.

My own journey with NRSC, or rather NRSA as it was called then, began in the year 1977, when I joined Indian Institute of Remote Sensing, (more popularly addressed as IIRS), Dehradun, known as IPI (Indian Photo-Interpretation Institute) in those days. At that time, IIRS was a part of NRSC. Presently, IIRS is an independent world class Remote Sensing Training Institute under the Department of Space.

I have been passionate about teaching throughout my life and my years as a young professor at IIRS surely rate as some of my best teaching years. I hold many cherished memories of the Dehradun years: enlivening classroom interactions, field trips to remote locales, particularly in Uttarakhand and almost all other parts of India, spreading north- south from Jammu and Kashmir to Kerala, and east-west from Nagaland to Gujarat, cultural programs organized by me and the student officer trainees, so on and so forth. Dehradun was also a period of growth on the personal front for me. I got married and was blessed with two wonderful kids during this tenure.

Let me reminisce few thrilling field experiences while carrying out the ground truth data collection in Nepal for highway alignment study for the Govt. of Nepal, using Remote Sensing data like aerial photographs and satellite images. It was a very long trekking in a highly rugged terrain. At the end of the day, I had to stay in a thatched room in a very remote hilly village along with the goats of the house owner. Another such field experience when I was in a long trekking in the higher Himalayas of Himachal Pradesh for Parbati river valley hydel project study. At the end of the day, I was so tired that I fainted. However, I enjoyed those challenging tasks.

When I moved to NRSC, Hyderabad in 1985, the organization was still in its infancy. Wg Cdr K R Rao had just retired after handing over the reins to Prof. B L Deekshatulu and the first Indian Remote Sensing Satellite (IRS) had still not been launched. We were all young teams working on various ambitious projects - limited in our experience, but unlimited in our enthusiasm. My own work was in the field of geosciences and remote sensing applications, and over the years, I had the opportunity to work on numerous interesting projects in various positions of responsibility.

First launching of IRS-IA (Indian Remote Sensing Satellite) in the year 1988 was really exciting, and more exciting was to work with the first day acquired image.

NRSC crossed many signal milestones as the years went by, and today, it is among the premier scientific institutes in this country. A lot of the success NRSC has achieved, I think owes its origins to the culture of excellence that was instilled into the organization in the early years. As NRSC moves forward, it is imperative that new generations of scientists stay focused on that mantra of excellence.

I feel it may not be out of place here if I mention certain milestone projects of NRSC for which I always remain very nostalgic. I was very close to those projects and associated deeply. In fact, I initiated those projects. It is Jharia Coal Field, Jharkhand, underground coal

fire mapping and monitoring, using thermal Infra-red remote sensing data. This project was unique at that time and carried out for the first time in the country. When we used to go to the field at pre-dawn (normally for thermal remote sensing study, ground

truth is collected at pre-dawn), we observed that fire is coming out on the surface from the underground. It almost looks like a burning ghat. It was really exciting and parallel very interesting. I am grateful that NRSC recommended my name for the 'Govt of India prestigious National Mineral Award' for this coal fire research study, and to mention, I received it also. I shall relish this memory throughout my life.

I also cherished the project on 'Landslide Hazard Zonation modelling and mapping in Uttarakhand and Himachal Pradesh Himalayas', co-ordinating a big national team. We, for the first time in NRSC, conceptualised preparing an Atlas for this project. Till today, when I look at this Atlas, I recollect those fond memories of NRSC.

Rajiv Gandhi National Drinking Water Mission (RGNDWM) is also a great project of national importance, where we had a lot of up-down debates and discussions.

If I go on reeling out NRSC memories, there is no end to it. Hence, it is better to put a full stop to it.

I spent the bulk of my long professional life in Hyderabad, but it feels like that it was just yesterday that I moved from Dehradun to Hyderabad.

One of the highlights of NRSC in which I took a particular delight was the annual cultural program. As I was the President of NRSC Recreation Club, I have so many fond memories of the many dramas and other cultural programs that I organized with my enthusiastic team members. I still distinctly remember bringing my excited kids for the movie screenings that we used to have in the auditorium on the Independence and Republic Days. As a brilliant singer, my wife also performed many musical soirees in NRSC's various cultural programs.

I'll conclude by adapting a famous adage: One can take a scientist away from NRSC, but one can't take away NRSC from the scientist. Though I have superannuated and moved on in life, NRSC holds a special place in my heart.

My Journey with NRSC

Gandharba Behera
Former Deputy Director
(Remote Sensing and GIS Application Area)

It has been a long journey from 1977 to 2012 for me in nrsc. at the age of 25, immediately after my studies, i was fortunate enough to have been offered a position at NRSA to serve society by Wg Cdr K R Rao, the then Director. I chose NRSA in preference to Wipro Ltd purely based on my understanding that NRSA is a public platform as contrast to Wipro, which is a private one. I knew that my place of work in NRSA would be IIRS, Dehra Dun but my first assignment was to develop a stores classification system at Secunderabad. I would say it was probably a small contribution to NRSA but it was a reasonably good learning exercise for me that gave me an exposure to the range of items dealt in NRSA then and hence, its activities.

The first six months at IIRS, Dehradun from Sept '77 was very disappointing for me since I had no defined role though I was inducted at quite a senior level. I joined a regular training course at the Institute three months after it had started which I had to make up for during the rest of the course. In spite of this, the training posed too little a challenge leaving me with enough time to contemplate on how to integrate my managerial skills into the new science of remote sensing. This resulted in my making a dozen or so lecture notes on various topics, which were greatly appreciated by Wg Cdr K R Rao, who directed the Dean of IIRS to allow me to deliver them to the faculty there. This gave me a good boost and within a year I was an influential staff officer in the Dean's office. Then came the dynamic Col P Mishra who encouraged me further and directed me to design short courses which would give supervisory scientists and decision-makers in the state governments an understanding of the usefulness of remote sensing so as to increase participation in regular courses and better utilisation of the technology. It also resulted in IIRS bagging many consulting projects due to which our earnings became three times the annual budget.

On my promotion in 1980, Col Mishra created a new designation for me - Professor, Research, Planning & Management. It was basically his appreciation of my capacity to think out of the box and bring improvement in day-to-day usable skills, techniques and processes.

In September 1983, I was posted to ISRO headquarters to be a part of NNRMS team. Again a new place and a new job not very well defined, but basically to utilise remote sensing for natural resources management of the Nation. I had an excellent boss and guide in Shri Y S Rajan; Scientific Secretary, ISRO; Director, EOS and Secretary, NNRMS planning committee (he was three-in-one, later there were three people handling the roles). He straightway took me to Satish Dhawan, Chairman and told him that I will assist Chairman in organising his presentation to be given to a select group of Parliamentarians on NNRMS six months later. Shri Rajan was too generous to me in this

respect. Any amount of appreciation is too less to describe the goodness of Professor Dhawan. I have seen him from my low-level position looking upward from a narrow angle only for a short while developing awe and wonder as we went along. However my short association with him secured me his grace, appreciation and his remembrance. Over the six months, I was exposed more deeply to the subject of "presentation making" itself. Later I shared my

Visit of Dr Jai-Ho Oh, Korea (5-Jul-2009)

notes on this with my colleagues at the behest of Shri Rajan through a series of five lectures which became so popular that I had to deliver them repeatedly to many audiences. I keep wondering whether to call it my contribution when I was really the beneficiary.

The activities of NNRMS grew around me over the next few years when we supported the establishment of 15 state remote sensing centres. The first nation wide application project was waste-land mapping and more such projects followed later. Most of these were carried out with NRSA as the hub and state centres as the spokes. We, at NNRMS, acted as the co-ordinators and liaisons between them as well as the sponsoring ministry.

The integrated mission for sustainable development (IMSD) project was born in 1987-88 as a pilot study in Kolar district of Karnataka basically to find long term solutions to combat drought. In 1989, I moved to NRSA at my own request to take up the IMSD project as a national level demonstrative study in 18 districts spread over 13 states. This project gave my team the immense satisfaction of taking remote sensing technology to real life applications. The respective state centres were our active partners. The project required us to interface with about 25 ICAR institutes, state agriculture universities, state and district level development departments. The project provided an opportunity to prove remote sensing products as not only a vital input for preparation of grass root level development plans but for monitoring its implementation and evaluation of its impact. This culminated in Jhabua development communication programme, a satellite based community TV program for the people of Jhabua district of MP that highlighted the benefits of implementation of schemes proposed for the district based on the IMSD study. The study later was up scaled to 175 districts. Many more districts were also taken up along similar lines under DPAP and DDP.

During 1995-2004, I was in Odisha on deputation as Chief Executive, ORSAC. This was a period when I was the link between NRSC-ISRO and the state government in implementing remote sensing and satellite communication applications at the state level. GRAMSAT project which created a remote sensing based information system (database) and then provided access to people at block level using a VSAT based wide area network was implemented during my time. This communication network was also utilised for distant learning and evaluation of the state development programmes. During the 1999 super-cyclone, the use of remote sensing outputs created a much-needed faith in the state bureaucracy in remote sensing and satellite communication.

During 2005-2012, I was overseeing the disaster management and village resources programme and later as Deputy Director, I had to oversee the remote sensing application studies at the national level. I devoted much of my time in developing guidelines and documenting the same for streamlining technical processes as well as for planning and implementation of projects for achieving efficiency and excellence in application and research. In disaster management, the focus was on the timeline whereas in the village resources programme the focus was on the people's need.

Visit of Dr K Radhakrishnan, Chairman, ISRO (13-Jul-2010)

Visit of Prof Orhan Altan, President, ISPRS (6-Jan-2012)

In summary, my 35 years passed very quickly leaving for me very little time to brood over my career setbacks of which I had a few. In retrospect though these setbacks look very trivial with respect to financial loss as compared to the personal satisfaction which I got from the full freedom I had while working and the respect and affection that I received all over. The personal relationships that I developed not only with my colleagues but also with the remote sensing community with whom I interacted will stay with me always.

I must emphasise with total conviction to the young scientists that the system gives you the freedom to pursue your dream of scientific excellence and be in the amity of professionals working at the frontier of technology. In the long term, you will have the satisfaction of having served your country in an enviable area of scientific pursuit.

Visit of Indian army officials (17-Nov-2011)

Thank you NRSA, Thank you NRSC

Raghu Venkataraman
Former Deputy Director
(Aeriel Services & Digital Mapping and Outreach Area)

My most vivid memory about NRSC pertains to the many varied work opportunities that were provided to me during the 34 odd years from 1987 till my retirement from ADRIN in 2021. For this, I am grateful to all my seniors who were wonderful mentors rather than bosses. It was a privilege and an honour to have served under their leadership.

I started my career in the Programme Planning and Evaluation Division (PPED) wherein technology transfer, budget preparation and preparation of various technical/periodic reports were major activities.

Even though NRSA was just a decade old at that point in time, almost every hardware development project culminated in transfer of technology to industry for serial production and distribution to nascent remote sensing labs sprouting all over the country. It started with humble light tables and culminated in complex drum scanner digitizer systems followed by entrepreneurship development for application projects. RSI, Speck Systems Ltd and INRIMT were a few of the industries that were born in that era.

Budget making in the erstwhile NRSA was exciting because NRSA followed finance and accounting practices that were more aligned towards commercial entities rather than a government organization. Consequently, there was a lot of importance attached to generating revenue from user projects and data products to meet all the direct costs including consumables, manpower/Equipment, utilities and organizational overheads. Expenditure towards facility creation was consciously kept low to ensure that the requirement for grant in aid from Department of Space (DoS) was restricted to a bare minimum. By the middle of nineties, NRSA had nearly reached break even!!

My tenure at the NRSA Data Centre (NDC) during the nineties gave me a first-hand ringside view of two great transformations. One transformation was that we were migrating from dissemination of data products from foreign satellites like LANDSAT/SPOT to the indigenously developed IRS series of satellites from ISRO. Within a short span from 1988 to 1996, IRS data products became the mainstay for almost all application projects except a few applications which relied on NOAA data. It was also the period when IRS data was disseminated to many other countries as well. The second great transformation was the migration from photographic data products to digital media. By the year 2000 data products on CDs/DVDs had become the norm. Simultaneously digital analysis/classification had replaced visual interpretation for all application studies.

The annual User Interaction Workshops conducted by NDC were like a festival for remote sensing professionals form all the user entities in the country. They would interact with us as well as with the application's scientists from NRSC and ISRO.

The Aerial Surveys and Digital Mapping (ASDM) area was a unique national facility which could carry out activities in the entire value chain starting from raw data acquisition, data processing including terrain correction, ground surveys and 3D mapping.

My tenure in ASDM for more than a decade during 2000-2012 was a period of big disruption led by technology change towards (i) digital camera /lidar systems from Analog film-based systems, (ii) digital photogrammetry techniques from analytical systems and (iii) Airborne Kinematic GPS and differential GPS based control surveys from conventional ground surveys. These developments resulted in NRSC becoming the premier digital mapping facility in the country. Many large-scale urban mappings up to 1:1000 scale and terrain mapping projects with height contours of 1 m were carried out successfully. This period at ASDM saw the fulfilment of my childhood fascination for aero planes.

The history of NRSC during the past fifty years is truly a fascinating story of evolution and transformation with changing technologies. Consequently, my experience in various areas at NRSC was invaluable to me during my stints at ISRO HQ, Antrix Corporation Limited and ADRIN. For this I can proudly say “Thank You NRSC for all the wonderful gifts you have given me”.

A Glimpse at First National Forest Cover Mapping using Satellite Data from NRSC (A)

Dr C B S Dutt
Former Deputy Director
(Earth and Climate Sciences Area)

It was during 1970's ISRO/DOS undertook demonstration of space applications for communications, broadcasting, and remote sensing. On technology side ISRO had by then designed and built experimental satellites like Aryabhata, Bhaskara, APPLE and Rohini, and experimental Launch vehicles-SLV3 and started working on ASLV. Parallelly, ISRO had initiated many studies on using remote sensing applications through use of Earth Resources Technology Satellite (ERTS) of NASA, USA which was later renamed as Lansat-1. This gave rich opportunity and experience to the Indian scientists, including the line departments. Consistent with the rapid strides in space applications, ISRO planned for a Natural Resources Monitoring Satellite (IRS-1A) during 1980's and undertook 56 End to End experimental projects along with the users in the country. This was taken up as an early preparation towards data interpretation and experimental utilization to ensures that the users are ready by the time IRS-1A satellite was up in orbit. A few important projects relevant with respect to forestry and vegetation were: Panchamahal forest cover study, Meghalaya Jhuming and Idukki area mapping etc..The results were presented in the first National seminar of Planning Committee of National Natural Resources Management system(PC-NNRMS) in March 1983, in which many officials from ISRO, user departments/Ministries like, Geological survey Of India (GSI), Ministry Of Agriculture, Ministry of Water Resources, Ministry of Environment and Forests(MOEn&F) etc., actively took part and participated. Based on various discussions, a few resolutions were also passed on the image data utilization in specific application areas. The resolution called for establishment of a full-fledged system of NNRMS to address diverse user requirements. These included the launch of IRS-1A, formation of 9 Task forces for optimal use of satellite remote sensing data and to establish National Natural Resources Management System (NNRMS) in the country. Later some of the major study findings appeared in a special issue of International Journal of Remote Sensing (IJRS-1985), thus making India's presence in space. As preparatory initiative in this direction, ISRO/DOS initiated IRS utilization projects (IRS-UP) to ensure the readiness of Indian users for use of IRS-1A data well before the launch. Parallelly, ISRO Head Quarters also started exploring the next viable option to demonstrate operational projects using satellite data. It was during this time that a few important points were noted by ISRO, such as, "Dehradun being the seat of forestry with the presence of FRI and FSI, including the Indian Photo Interpretation Institute (IPI) offering professional training in forestry". ISRO also came across the efforts of IPI and making/ preparation of forest cover change maps using aerial photo interpretation data and Landsat MSS data for training demonstration projects. There were two study papers on Doon valley and surroundings using multidate satellite data, which appeared in the National proceedings of Environmental Conservation of Doon valley held at Dehradun, October 20-22, 1982. Dr RS Murthy, former Director, NBSS&LUP came across these from the Doon valley proceedings of 1982 that were presented as highlights in the first ever NNRMS bulletin, Volume-1, April 1983, that were being drafted. It was during that time Shri YS Rajan and Prof Satish Dhawan, former Chairman, ISRO/ Secretary, DOS found that two studies of forest cover change maps one from IPI and the other from FSI of doon valley along with few other studies were already carried out as part of an End-to-End projects that were interesting and consistent with the need of forestry studies.

Considering the above efforts, Shri YS Rajan, the then Scientific Secretary & Director EOS and Dr VR Rao, former Deputy Director, EOS, ISRO Hq. had internal discussions with Prof Satish Dhawan

the then, Chairman, ISRO/ Secretary, DOS, who envisioned to scale up such small-scale studies at National level. This spurred the emergence of scaling of similar such efforts at national level. Further, ISRO Hq invited Director, NRSC and IIRS for their immediate response on the above. Accordingly, Prof. B. L. Deekshatulu, former Director, NRSC, in consultation with Dr.NVM Unni, former Head, Forestry and Ecology division, NRSC gave strong support and feasibility to undertake a national level forest cover change assessment exercise using multidate satellite images. Immediately a proposal under the leadership of Dr. N. V.M. Unni was formulated and ISRO, DOS quickly commissioned a maiden national forest cover assessment exercise over India using 1:1million scale satellite images in 1983.

Dr. N. V. M. Unni and Dr. P. S. Roy, were designated as the lead Scientists, supported by Dr SPS Kushwaha, Dr. R. Nagaraja. Hence, a national project in forestry was scripted at ISRO. Dr. K. S. Murthy Naidu and several others from Hq and SAC also joined later in the reconciliation works. This effort enabled the interpretation of nearly 170 x 2 satellite images (two-time frames of 1972-1975 and 1981-84) and spatial data preparation with extraordinary efforts in visual interpretation technique and state wise forest cover maps with support of Cartography Section of NRSA for readiness to estimate the areas.

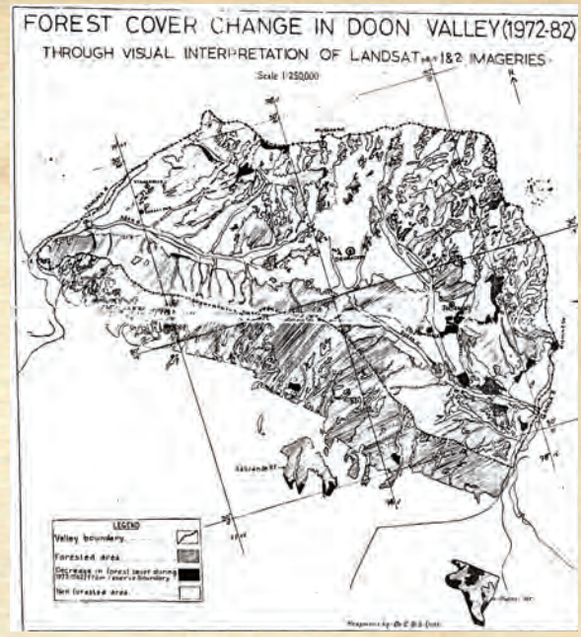
The challenge in estimating areas during the early part of 1980s was noted and there were no modern area estimators but teams were relying on dot grids of varying dot grid spacing. However, significant efforts were made while completing the state level area estimates using 1mm x 1mm dot grid spacing that involved large number of Cartographers and Draftsmen. Prior to finalizing the forest cover extent, field verification and validation in respect of all the 23 states (previously) forest cover classes were ensured through involvement of ground level forest staff from the respective state forest departments by randomly selecting few locations in a mutual consultation and ground verified by NRSC teams and SFD's. The effort of change map from 1972-1975 and 1981-1983 were also made in about 6-8 months and provided the first national level forest cover estimates and changes in 1984.

However, as per MoEn&F and FSI, the effort of NRSA, DOS was not agreeable to them and not consistent with the actual ground realities and forest classes. Some of the major issues that cropped up initially was in respect of consistency in area estimation using dot grid method, error manipulation through recounting, lack of geometry to the satellite images, border polygon counting, lack of field verification because of scale limitation in many small pockets of forest and shadow areas omission, including the forest categorization and definition differences etc. All these incidentally became contentious issues.

Consequently, at ISRO Hq., efforts were on to document the possible sources of errors and to prepare a draft, enlisting possible sources of errors. However, such of those errors were realized only after the national effort done for the first-time in this attempt. ISRO and NRSA made several efforts to convince the forest cover estimates to Ministry of Environment and Forests over at least 3-5 years through presentations and discussions. After a long resolve to this situation, both DOS/NRSA and FSI agreed to reconcile the forest cover estimates in respect of 6 states by remapping on 1:250,000 scale, that was larger than the original effort on 1:1 million. The 6 states initially selected for reconciliation were, 1. Kerala 2. Karnataka 3. Tamil Nadu 4. Himachal Pradesh 5. Gujarat 6. and West Bengal. However, due to paucity of time and technical differences only 5 states were selected, omitting Himachal Pradesh. Consequently, DOS, NRSC jointly with other ISRO Centers, initiated remapping of the 5 states using nearly same time frame data as it was done on 1:1 million scale earlier. As expected, because of the change in scale and interpretability of a minimum mappable unit, some scrub species like Proposopis juliflora, and coppiced Sal plantations were mapped under degraded or non-forest areas. Accordingly, some area changes were noticed and being a joint effort with the concerned State Forest Departments, the area estimates apparently found reconciled with the scale of mapping on 1:250,000 scale. The challenge and conflict resolution were on how the national estimate of forest cover, comprising of 23 states, could be assessed. Here in this aspect even ISRO Hq., made considerable efforts under the overall direction of Shri YS Rajan, the two NNRMS Scientists, namely, Dr CBS Dutt and Mr. P. G. Diwakar worked on several statistical models using the (5+2) 7 states (5 reconciled states area estimates and two large area states representing MP and Maharashtra) area estimates and identifying the best fit solution and applying the model coefficients suitably to rest of the 16 states which were not remapped under the reconciliation exercise. Through such statistical estimation methods, based on 7 states assessment,

the entire nation's forest cover was estimated as part of statistical probability and provided as an insight on a diagnostic manner, addressing the changes that are likely to have occurred during the time frame of 1972-75 and 1981-85. These results were also appraised to the Union Planning Commission as well as MoEn&F by ISRO/DOS teams.

Subsequently NRSA, DOS and MoEn&F could establish the suitable scale of mapping for national forest cover and assessment at 1:250,000 scale and recommended for biennial forest cover assessment as a technology that was evolved jointly by NRSA and FSI. There were several learning points that emerged during the effort of first forest cover mapping of India, led by NRSA, under the leadership of Dr.NVM Unni. Dr PS Roy and a team of Scientists could eventually formulate the first operational project using Satellite Data and also as part of ISRO's space programme. FSI, subsequent to the first efforts of NRSA and based on the procedures established, are consistently carrying out through biennial forest cover mapping of India and highlighting changes in our forest cover estimates every two years. FSI has so far brought



out 17 cycles of India's State Of forest reports and the latest being that of 2021(17 cycles). FSI have remarkably enhanced from the erstwhile 400 ha (minimum mappable area) to the present 1 ha, due to the availability of improved IRS series of high-resolution data.

Reminiscences at NRSC (2015-2020)

Barla Gopala Krishna
Former Deputy Director
(DPPA & WAA)

I joined NRSC as a Deputy Director (DD), DataProcessing, Products, Archieval and Web Applications Area (DPPA & WAA) on March 8th 2015. Though I took charge on March 8th as DD, I am not new to NRSC family. Since my joining at Space Applications Centre (SAC) in 1984, I used to come to NRSC (the then NRSA), as a data processing software development team/project member for all the IRS and Cartosat projects. Hence I am very much familier with the environment at NRSC main and Shadnagar campuses, by that time I took the charge. During my earlier visits, I used to have a lot of interactions and acquintence with the people in general (especially with Data Processing teams).

The first concern for me after knowing that I am joing NRSC, is whether I am accepted there, since I am an outsider? But at the same time I was confident, as I am already well known for my technical capabilities and ability to leading the teams for various Data Processing (DP) projects in the capacity of Project Manager (PM) and Deputy Project Director (DPD). When I joined, to my surprize there is a overwhelming reception by the area members (technical and administrative staff), which gave me a lot of encouragement and it also increased my responsibility to perform well and get some goodwill.

Apart from regular Data Processing Operations and data dissemination, the first ongoing project which I had taken with priority was CartoDEM (National DEM generation using Cartosat-1 stereo data) work. This was a joint work between SAC (development) and NRSC (operations and maintenance). It was at a maturing stage, but not getting to finishing stage. As I am aware of both the centre's working environments, I could interface well, to work together to finally produce and release the CartoDEM version-3, which was uploaded to Bhuvan portal for free download and also delivered to various centres in ISRO for their internal use. Using this experience later, global DEM for some more continents got generated and released. This project gave a good focus to NRSC interms of DEM generation capability from satellite data, its evaluation and dissemination. Even this led to creating a separate division for DEM generation.

During the first day product generation of Cartosat-2S, with Chairman ISRO

Another notable contribution is Virtual Ground Station (VGS); which is conceptualised and operationalised at NRSC to receive and supply the foreign high resolution satellite data to the users on a regular basis in a cost effective manner, without setting up a regular ground station, which is very expensive. This gave a boost in getting additional high resolution data sets to the users and getting good revenue to the centre.

Bhuvan is an important web portal serving remote sensing users with support to geospatial applications with good content base. Its popularisation with augumentation of additional themes (is a challenge) and creating precision image reference layers from very high resolution data from the available contemporary satellites, gave a good boost to the Bhuvan activities at NRSC and there was a need to expand the activies in terms of hardware and software support, which took place parallelly. There is a constant development of many new tools and applications. I provided major support and technical guidance in augumentation process, as well as high resolution reference layer creation.

Many high resolution satellites (Cartsat-2 series), medium resolution satellite RS-2A, Meteorological/ oceanogaphy satellite Scatsat-1 and experimental satellite Microsat were launched during my tenure. All these satellite missions needed a lot of focus viz., in software development, operationalisation at Shadnagar, initial phase validation, mission and sensor characterisation/ calibration and product quality improvements, from DP NRSC as a mandate. Each mission has new challenges and hence a lot of understanding is required. First day product generation and showing to Chairman and other dignitaries is the most toughest job to the team members. But we were always successful, since there is a meticulous preparation goes on to execute this task with all the contingency plans and simulations. Some days we used to spend sleepless nights to solve the problems to provide the best product to the users. I could provide the technical guidance, planning support and other logistics to the teams, wherever needed. Very efficient teams at NRSC interfacing with mission, ADRIN and SAC DP teams make the missions successful with their dedicated efforts, taking support from the higher ups and the project management.

Calibration and Validation (CALVAL) is another important activity in the entire data processing chain to generate best products from data. This is traditonally done through some reference test sites located at various places. But NRSC took up the task of development and maintenance of a CALVAL site, after doing a lot of analysis and research. Today we have developed a state of the art CALVAL site at NRSC catering to optical and SAR sensors. NRSC CALVAL activities and site availability is well known to the scientists in this field globally. Apart from site development collaboration activities were also taken up with global teams in this field during my guidance. This project also got selected for ISRO merit award.

MOU signed between Amrita & NRSC on 31-03-2017: There was lot of emphasis at NRSC for the collaboration with academia towards doing a quality research through student projects. As a focal point, I interacted with faculty of many academic institutions, universities etc., During my tenure I had signed three MOUs one at Amrita University on 31st March 2017, second MOU on academia collaboration with GRIET, Hyderabad on 22nd Feb. 2018, and the third MOU with MSETCL at RC-Nagpur for Bhuvan collaboration on 6th January 2017. These MOUs resulted in many student and faculty research projects, which were useful for algorithm development for Value Added Products (VAP) generation at DP area.

Landsat Program and other international collaboration (with Canadian Space Agency, International Ground Stations, JPL etc.) projects gave good visibility to NRSC globally. I have technically coordinated various teams at NRSC with USGS to make the

Shadnagar station as certified ground station for Landsat-8. Coordinated the data processing software implementation at IMGEOS to regularly generate the Landsat-8 products over Indian cone in an automated mode. Similar process is in place for Landsat-7 data processing. Instrumental in executing this task under a MOU in lieu of providing RS-1/2 data to USGS. Under the Landsat programme, I was deputed to Landsat Ground Segment Working Group(LGWG)#25 meeting at Thailand during 6-10, June 2016 to represent ISRO. It was really an exiting programme, meeting international scientists and disussing various DP aspects. I have presented the ISRO and NRSC activities with respect to data reception, archival and dissemination of IRS and other EO satellites. Also gave a glimpse of future Earth Observation missions of ISRO. The presentation was well received and appreciated. This paved the way for future collaborations.

ASI & ISRO merit Award at SAC, Ahmedabad, 26th Feb 2016: During this period, I was conferred with ISRO Merit award for the year 2015. Received ISRO merit award and ISRO team award (for establishment

of CALVAL facility at IMGEOS). I feel this (ISRO Award) is one of the best ways to motivate the scientists and encourage the competition in work.

I got good insight into the centre's work more by heading several technical (inter and intra central) and administrative committies. Thanks to the then Directors, Dr. V K Dadhwal, Dr. YVN Krishna Murthy and Shri. Santanu Chowdhury, who gave me somewhat free hand in my technical/administrative activities, which resulted in implementing some of the ideas I had. I tried my best to improve the working culture of people. Tried to build teams; linkages between divisions, groups and areas, which helped in more technical interactions. Due to this inter area activities are also increased, so that DP teams used to participate/help other areas in some of their applications. People are little individualistic otherwise.

The general perception of Data Processing (DP) Area was that, it only does the operational work. The same view was effecting promotions of DP scientists in DPC reviews. In fact operational work is only one part, there was lot of other research work, algorithm and software developement for VAP, geophysical product development, image simulations using Machine Learning and Deep Learning technique etc. were going on. Hence I wanted to change that general perception and publicise the activities across the divisions and ISRO centres. I think I am insrumental to achieve this to some extent. Today NRSC is known for its work at outside centres, as well as DP is known for its activities other than operations. In this reminiscence, I only highlighted some important activities, otherwise there are many more activities executed during my tenure, which brought its due recognistion to DP area within and outside NRSC.

After my superannuation in 2018, considering my outstanding work, I was appointed as 'Prof. Satish Dhawan Scientist' for two years (Oct. 2018 to Oct. 2020) at NRSC, to help DP teams in terms of technical consultancy. During this tenure I helped a team of scentists (constituted by Director, NRSC) across NRSC, including RRSSCs to develop data processing software for IRS-1A/1B/1C/1D data sets, which can operate at IMGEOS environment. Otherwise these products are getting generated outside the IMGEOS environment, which was very tedeous. This project inturn helped NRSC teams to understand the DP modeling, DP software development, which is important for the operational teams towards maintaining the SAC developed software for all IRS and Cartosat missions. Infact this knowledge is immensly useful for understanding the operational DP software at NRSC for the future satellites.

My sweet Reminiscences during my journey in NRSA/NRSC

A V V Prasad
Former Deputy Director
(Bhuvan Geoportal & Data Dissemination Area)

The major challenge in remote sensing is retaining the oldest data as safely as possible by overcoming the technological obsolesces and challenges. NRSC has valuable Remote sensing data from around 1983, i.e., Landsat 3,4,5 on words processed using FORD system and Ampex high density tape records. Need aroused to keep the data on a computer compatible DLT tapes. It is a great experience for me to Transcribe all the data on to Digital Tapes (DLTs) using the indigenously developed hard ware and software, due to the obsolesce of Ford HW and SW.

Dadalus scanner fixed on the Beachcraft aircraft of NRSA needed positional information at the instant of scanning the line on the earth to correctly locate the hot spots in Coal mines. It was a very good challenge in developing an interface unit for Inertial Navigation System (INS) Altimeter and Dedalus scanner.

Data simulators are needed before and after the launch of satellites to check the ground station. Till IRS 1C and 1D, there were simple on line generators and were transmitting for long time. But new challenges came from IRS-P5, and IRS-P6 to generate it real data, containing data compressions and RS encoding. Developing, testing and conducting test and evaluations for all the national and international ground stations is a memorable experience.

There are memorable incidents linked with IRS-P5 (Cartosat mission). When the satellite was in Ground checkout testing, and ready for shipping to SHAR for launch, we got a call from Director ISAC, Mr. Goel to bring our data reception system to evaluate payload systems, since small anomalies were noticed by ISAC ground systems. Our team studied for 40 days, day and night and qualified for all satellite modes, which has given immense confidence on IRS-P5, before launch. Our interaction with all the teams and exposure to new technologies at that time like Data compression, RS decoding etc., ground checkout procedures is a very good memory.

Swalbard station: I was very much thrilled and really feared when I was asked to go to North Pole (Svalbard) to install data reception systems at Svalbard and work along with KSAT during the night period of North Pole. Since almost all the time it is dark and our station is on the top of hill, travelling, installing and living at Svalbard is an excellent reminiscence for me, since there was nobody to help and support you. The experiences I had during that time and technologies I learned at Svalbard are very valuable.

With the experience and technology gained at Svalbard we were able to guide ECIL to establish communication ground station at Mitri station, South pole along, with NCOAR.

Time had come to move from snow glaciers at Svalbard to Sahara Desert. A full-fledged station along

with training to Algerian teams has come up from Antrix. Teaching and training the persons who didn't have good English speaking knowledge and visiting and establishing the facilities at Algeria is an excellent memory for me. I executed this project with utmost satisfaction of the customer.

ISRO is very well experienced the advantage of polar station after using Svalbard station both for data reception and telemetry and tele-commanding. During that time, NCOAR had come up with a proposal to establish a new South Pole station at Lars men hills

called Bharathi station. ISRO actively coordinated with NCPOR for establishing two stations at Bharathi, one for Remote Sensing Data reception, TTC &TTM and another for communication, video conferencing, and high speed data transfer to main land India.

Ship to Antartica: I was very much feared to go to Antarctica (South Pole) since we had to travel by Ship for 12 days from Cape Town (South Africa) and had to establish the antennas and systems within a container at very cold temperature and very limited communication to main land. But the ITBP training imparted after the regress medical tests given sufficient confidence and we were able to establish all the required functions at Bharathi station, Antarctica. Crossing 60 degree, 70 degree latitudes in the ship, experiencing the pitching and rolling of the ship and working at heavy cold and wind by wearing full woolen clothing was a remarkable experience. The day we linked Antarctica with NRSC using Video conferencing s remarkable day in my life.

Antartica Bharati station

BHUVAN: NRSC established a Geo portal BHUVAN which has immense potential and started penetrating into most of the ministerial activities. I have very good reminisces in enhancing the facilities of BHUVAN both hard ware, software and applications, with full availability of the portal and feeling the satisfaction of all the users like housing for all, MGNERAGA, GHMC, ONGC etc.,

The memories liked with Microwave and Ocean related satellites, their ground testing, operationalization and supporting international users and ground stations are unforgettable. Establishing the Microwave Calval sight is memorable.

As a chairman of Safety committee I have very excellent memories in establishing and maintaining the procedures for the safety of NRSC employees, equipment and facilities established at NRSC, Balanager Shadnager and Jeedimetla. This activity has made immense satisfaction and happiness.

Bhuvan, The National Geoportal of India, Only one of its kind

P G Diwakar
Former Deputy Director
(Remote Sensing Applications Area)

Shri Madhavan Nair, former Secretary, DOS/ Chairman, ISRO, one day asked if a web based tool can be designed, developed and deployed from ISRO, utilizing all available satellite images of ISRO". There is a background for this …….
Pl read on…….

- Dr V Jayaraman (VJ), Director, EOS, ISRO HQ had asked me to help Satyabama University to set up an operational Digital Image Processing facility and the time given was about 20 days. It was already agreed upon that Dr Kasturirangan and Shri Madhanvan Nair shall be the chief guests for the program.
- For setting up the Lab for Satyabama university, we had to configure all the necessary hardware with good processing power including an A0 size Plotter as output device. All the necessary software both for image processing and GIS. With a lot difficulty and following all necessary procedures, we could successfully set up the Lab which was inaugurated by Dr Rangan and Shri Nair. "The chief guest would press the button and a satellite image of Tamilnadu would roll out – that was the plan" And it happened exactly that way. A beautiful map of Tamilnadu came out rolling and everybody clapped and inauguration was over.
- I didn't realise that the Bhuvan was already born in Shri Nair's mind! Dr VJ and self were asked to meet Shri Nair at Chennai Airport. At the meeting he asked us one thing, the TN image that came out of the plotter was fixed in his mind, do you have similar data for all States & UTs of our country? Answer was YES. We explained the advantages of RESOURCESAT data and the three sensors "AWIFS, LISS3 and LISS4" also. Then came the question of Para 1.
- We were given just about 6 to 8 months to do the job and an 18-member team, as we proposed. Rest is history.

The focus was very clear. So much satellite data and thematic data is available, why not put them out on the public domain and let them be used by the user community in the country. The team worked hard, we had lots of tough discussions to arrive at the best system design, database design, database organization and content creation strategy, including the best possible web services. Once the tool was ready, there was an internal release done by Shri Nair to ensure proper testing of the system within the ISRO networks. That went through smoothly and we had many suggestions and feedback from our own users. We further addressed them the tools were made ready for beta release to the public usage.

The name Bhuvan was also proposed by one of the team members by actually linking the name to the movie "Lagaan" and the Hero of that movie. But the name "Bhuvan" struck the right tone as everybody liked this Sanskrit name which means "Earth".

Ultimately, the "Bhuvan – National Geoportal" was released in the public domain on the 12th August, 2009 by Shri Prithviraj Chauhan, MOS, Prime Minister's Office, as part of Remote Sensing Daya celebration in New Delhi. There was already a media buildup to this release as Bhuvan was being referred to as Indian answer to Google, even though the intension of Bhuvan was not so. Because of such a buildup, the release saw a massive user access to Bhuvan. For the beta release of Bhuvan, we had planned the infrastructure with limited number of servers to accommodate user access. For our surprise we saw crores of users accessing Bhuvan eventually jamming the networks. The first day experience of Bhuvan release can never be forgotten as we had many appreciations from those who used the data and many frustrated users giving brickbats. In ISRO we always learn it the hard way, so we took our time and went on improving the hardware and the software and over a period of time we turned out

to be the best geoportal in the country and one of its kind in the world.

If we start looking at the users of Bhuvan it goes boundless as all types of users, be it Government or Private or NGOs or even individuals, have been using the geoportal for varieties of applications. To name a few important users, I can recall many Ministries, like, Rural Development, Railways (CRIS), Urban Development, Election Commission, Culture, Home Affairs, Higher Education, Postal Dept, Ministry of Jala Shakthi, State Remote Sensing Centers (Bhuvan hosts important thematic layers for all States/UTs in the country) And the list goes on and on. The beauty of the software design is that any user requirement can be customized and within few days we can get the users onboard with their objectives and requirements embedded into the system.

There are many memories of having implemented user requirements in Bhuvan with ease and it continues even today with much more versatile tools and much bigger infrastructure to support all Bhuvan operations. One of the important user requirements was to organize "The island information system" for MHA which was done in record time and the user found it most useful for both developmental and strategic use. Similarly, the implementation of a monitoring system for MGNREGS program and the watershed monitoring (IWMP) for Rural Development ministry. Yet another example is the way we worked with Postal Department across the country to create a unique geospatial data for all 1.55 Lakh post offices in the country that highlights varieties of services and also provides location specific information. The unique near real-time online information system for Disaster Management Support Program has always helped in tracking of any major disasters in the country that got effectively used by MHA, NDMA and NDRF. The kind of disaster response system that was energized for monitoring Kedarnath and Srinagar floods are typical cases in point. Bhuvan grew in confidence to produce best results and even went ahead set up a Disaster Control Center in the AP Chief Minister's office for the Hudhud Cyclone disaster. This successful exercise became a perfect example on how Bhuvan can work with the State Govt. setup and also receive field reality data from common man through a simple Crowd-sourcing interface to provide best response to the Hudhud cyclone.

One of the memorable projects successfully hosted and implemented on Bhuvan was "Telangana Water Resources Information System" for the State Government. This is yet another unique project where all water resources were systematically organized to cater to medium and major irrigation projects. All waterbodies were geotagged and catchment boundaries were innovatively digitized using online tools of Bhuvan from the field itself. The Geofencing Applications that we built for CRIS, Ministry of Railways for people to buy online tickets was yet another unique one that a common man got benefitted. The beauty of Bhuvan and its success lies in providing the user with quick software solutions in a short time. None other than Chief Secretary of the Govt. himself took keen interest in getting this project implemented.

Every project done under Bhuvan was always unique experience and whatever I am able to remember, I am jotting down here and I only hope that I have not forgotten some important things!! In fact, the varieties of experiences that Bhuvan has gone through while providing solutions to diverse users can be compiled into a popular book for general reading. This is the only platform that is able to provide best solutions for Governance related solutions. Even today, Bhuvan geoportal is one of the sought after geoportal of the country that provides solution to any type of a situation using the available flexibility in customization of solution.

I would like write about one person who put lots of efforts in the initial stages of Bhuvan emergence……. Shri Bala of NRSC. He was with me through out and his contribution has been immense in realizing Bhuvan and taking it forward. Sadly, he is no more with us but we will always remember him for his contributions.

There are many team members whom I would like to thank and also acknowledge for their excellent efforts in making Bhuvan one of the best in the world. I feel like writing many more pages on many of our team members but this reminiscence has to be brief and simple and I want to stop at this stage.

I thank my seniors for guidance in evolving Bhuvan, The team members for the great support, entire ISRO for the encouragement. Things don't stop here, we need to support and harness Bhuvan to do much more significant applications. BEST IS YET TO COME…. WE ARE ALL WITH YOU BHUVAN, KEEP DOING GREAT SERVICE TO THE COUNTRY. It was great initiative to share ISRO data in the public domain and Bhuvan has lived up to its expectations.

My Journey with NRSC, ISRO/DOS: Reminiscenes

Dr P V N Rao
Former Deputy Director
(Remote Sensing Applications Area)

To reminisce activities of National Remote Sensing Centre (NRSC) in the past 50 years is akin to relooking at its history and celebrating the growth and landmark achievements in bringing last mile connectivity of satellite remote sensing for societal benefits. It means looking in to its origin, aims and objectives, its evolution, overcoming difficult times and developing its own culture and character while giving us, the NRSCites, an identity. Success of any institution such as NRSC lies in adopting and moving forward with the ever-changing technologies and user demands and catering to the nation's imperatives. It is heartening to see how well NRSC could precisely do that and rose to the user demands and positioned itself at the forefront of remote sensing applications.

It is not out of context to compliment and congratulate former Directors and Deputy Directors, Senior Scientists & Engineers and all other colleagues for their sustained guidance, encouragement, support, and contribution in making NRSC nation's pride at national and global levels. Likewise, NRSC is grateful to ISRO Chairmen and other peers from ISRO Head Quarters and Department of Space in benefiting from time-to-time policy directions/ guidelines, in identifying NRSC as the nodal Centre for nationwide application of remote sensing through space technology, to name a few, such as ISRO's DMSP, NADMS, NICES and in providing continuous financial and human resources support. A compilation of reminiscences of past contributors would throw light on turns and twists and events on which NRSC is made of and provides a wealth of information on its strengths and weaknesses to take benefit of and to learn from to march in to the future. This initiative of current Director of NRSC and his team to bring out reminiscences of those who contributed in the past is highly commendable.

Since joining NRSC (then NRSA) in early 1991, I remained as an applications scientist and never ceased to be surprised at the exciting but very challenging prospects of using satellite remote sensing, be it in using data from visible IR, and thermal sensors or microwave sensors across various disciplines. It is exciting and challenging because, on one hand, satellite remote sensing is essentially an inversion problem – satellite sensors capture three-dimensional dynamic earth and provide a two-dimensional image in digital numbers for an analyst to determine what is where and how. On the other hand, in 80s and 90s, it was the very early stages of remote sensing in natural resources applications with minimal awareness of its useful potential. It will not be any exaggeration in saying remote sensing went through different stages that included user curiosity, reluctance and understanding, appreciation and acceptance, adoption and utilization, increased awareness leading to more user demands. As a leading Remote Sensing Centre of ISRO/DOS, developing techniques and generating nationwide value-added products of natural resources and demonstrating to others, hand holding user organizations across the country and building capacity in remote sensing data utilization by providing training etc., are all contributing factors to excitement at NRSC. Thus, NRSC played a key role in bringing last mile connectivity through applications to remote sensing at national level in early stages. It is in this context as early as 90s, Prof. A.P.Cracknell, Chief Editor of Int. J. Rem. Sensing was at awe to see India using remote sensing for societal benefits by way of operational applications.

It gives me immense pleasure in recalling a few land mark activities I was personally involved or aware of that were in tune with the technological developments within ISRO/DOS and elsewhere. Earth observation using satellite remote sensing is fascinating as it captures God's creation in various hues and colors and lends a helping hand in several human activities. At the same time, I always viewed it as a challenge

when we try to derive information from pixels, build on it to gain knowledge, use it to find solutions. During the past five decades, space technology in general and satellite remote sensing in particular have seen rapid developments that helped moving from deriving qualitative to quantitative information, viz., natural resources mapping to geophysical parameter retrievals and to process studies. It is amazing to witness how satellite remote sensing has taken full benefit of fast paced developments in information technology, be it fast computational and storage facilities or communication networks or throwing open software applications and remote sensing data and derived geophysical databases by several national/ international data providers including ISRO for wider use. These developments enabled in processing and analysing multi-dimensional satellite data sets of large volumes and at varied spatial and time scales leading to, say for example, climate change studies. These developments in the last decade have brought a revolutionary change of analyst going to the satellite data and computational resources available on cloud from the conventional approach of an analyst struggling to develop resources at his end, which was mostly cost prohibitive and often necessitated institutional support.

In 80s and 90s, remote sensing applications at NRSC, as elsewhere, were mostly shaped on visual (analog) mapping of natural resources using false composite imagery from IRS and Landsat series of satellites at 1:250K and 1:50k scale that included nation-wide salt affected soil mapping, wasteland mapping, mapping land degraded areas, land use land cover mapping, ground water prospect mapping, forest type/cover mapping and so on. These products generated with meticulous planning and execution at national level have provided invaluable primary information and the required prioritized action, wherever required, and to use in other applications as an input. Generating such information in those early days of technology, keeping in view of the length and breadth of the country and the limited trained manpower, is truly an amazing achievement for NRSC. During the same period use of very high resolution airborne thermal IR data from Daedalus scanner for detection and monitoring Jharia coalfield fires, detection and reporting of forest fire locations and generating sea surface temperature data using NOAA AVHRR thermal IR data are noteworthy novel applications for NRSC to recollect.

Launch of Space-borne active imaging microwave systems, viz., SAR on board ERS-1 & JERS-1 satellites in early 90s have paved way for new studies in view of sensitivity of microwaves to shape, size and dielectric properties of the target on one hand and capability of providing data at variable spatial resolutions (and swath coverage), polarizations and look angles during day and night passes on the other. Taking advantage of Announcement of Opportunity projects by ESA and JAXA (NASDA in those days), NRSC pursued microwave remote sensing applications in agriculture for soil moisture estimation and crop identification and classification. For the first time, a C-band SAR temporal false color composite image (see Figure-1) generated using three images of ERS-1 SAR acquired at 35day interval during Dec 1992-Jan 1993 revealed the potential of single band/polarization SAR for change detection leading, subsequently, to demonstrating paddy acreage estimation using JERS-1 SAR data (results presented at ACRS 1994 received appreciation/award). Besides NRSC under ongoing DMS Programme started exploring the potential of all weather capability of SAR in flood mapping under cloud cover

It is heartening to note the approach of using temporal SAR data collected during the kharif paddy crop season has grown into path breaking nation-wide paddy crop acreage estimation. Availability of near all weather and day night capable ERS-1 and Radarsat-1 SAR data enabled NRSC Disaster Management

Support team demonstrated mapping and monitoring of extent of river flooding by overcoming cloud cover. In subsequent years, flood mapping using SAR data from different platforms has become operational along with kharif paddy acreage estimation. These are the two main nationwide applications that strengthened the claim for Indian Remote Sensing satellite with a SAR payload. On SAR data processing front, reporting corner reflector based external calibration of NRSC generated operational ERS-1 SAR product and an adoptive speckle filter are noteworthy. Another initiative that led to an operational status is to derive and map nation-wide surface soil moisture,

an essential climate variable and a regular product of National Information system for Climate and Environment Studies (NICES), using 25km spatial and two-day temporal resolution microwave radiometer data from AMSR-E aboard AQUA satellite.

When IRS-1D was launched on 27 Nov 1997 as a follow up to IRS-1C, it was exciting to see the richness of image texture in 5.6m panchromatic data to carryout texture analysis by segmenting and use along with the tonal variations of different land use land cover features for digital classification (published in Int. J. Rem. Sensing) using optimized texture features from Gray Level Cooccurrence Matrix

IRS-P6 (Resourcesat-1) launched on 17 Oct 2003 with three payloads of LISS-IV, LISS-III and AWiFS of similar spectral bands but different spatial/ temporal resolutions and swath coverages provided an opportunity to demonstrate new applications at the NRSC organized Workshop on `First 100 Days of Resourcesat-1'. To cite one such new application, progression of crop irrigation is mapped taking advantage of 5-day revisit capability and large area coverage of AWiFS; in subsequent years, AWiFS data paved the way for many applications across different disciplines, including wide use by the USAD for crop monitoring.

More recently, Atal Mission for Rejuvenation and Urban Transformation (AMRUT) has been carried out for mapping urban land use land cover and other infrastructure of 500 cities using very high resolution VNIR imagery at 1:4000 scale. Uniqueness to this operational project is its transparency, exclusivity and reliability in terms of i) participation of industry partners and urban local bodies, ii implementation of open GIS software for mapping, iii) centralized storage system separated from clients, and iv) implementation of Virtual Desktop Infrastructure System (VDIS) for data safety and security.

For NRSC, completing 50 years of journey is like entering its adolescence as its potential is unlimited to deliver more and serve the nation more effectively and efficiently for many more years to come with its nationwide foot print of multi-disciplinary applications including disaster risk reduction and management, generating necessary long-term databases for climate studies, capacity building and so on. I am sure, NRSC with its flexible approach and forward looking nature, would certainly address the challenges such as i) processing and analysis of continuously pouring satellite remote sensing data by developing automated techniques that include artificial intelligence – a true challenge for natural systems, ii) realizing full potential of hyperspectral visible and polarimetric SAR data for crop classification and forest biomass estimation etc., iii) exploring and exploiting huge potential of thermal remote sensing in many known and several unknown industrial and strategic applications using forthcoming high resolution thermal satellites on the horizon, iv)

developing data cubes for Indian remote sensing data at different scales, v) generating long-term ECV databases meeting required accuracy/precision and consistency for climate studies, vi) effectively partnering and mentoring the industry for maximum utilization of huge amounts of remote sensing data from multiple platforms and data providers and finally vii) transferring ready to use application tools by the user community at their door step.

While fondly recalling my association with NRSC in various capacities and programmatic activities and being fully aware of limitations in capturing countless ways in which NRSC contributed during the past 50 years, for lack of information, space and time, I conclude by thanking Director, NRSC and his team for giving me this opportunity.

I wish NRSC all the very best for coming generations.

Reminiscences Back to Future

Dr B Raghavaswamy
Former Deputy Director
(Training)

My tryst with NRSA to NRSC began from first to last day. It has been a very long and a memorable journey of 32 years. Let me begin and take it 'back to forward' - Scientific Assistant, 'C' to Senior Scientist 'G' and Deputy Director (Remote Sensing and GIS Applications & Training). Marched with a positive bent of mind determined to succeed and never looked back. "A river cuts through rock, not because of its power, but because of its persistence" - Miyamoto Musashi.

I was happy with my performance at interview. "We are selecting you with three increments" said Wg Cdr K R Rao, Director NRSA. I walked out of interview room, and sat outside on the bench, to catch my breath. "Here is your appointment letter and welcome to NRSA" said Mr. Vijayan, then Admin. officer. It was faster than it would have been in the digital times, of today. The erstwhile nostalgic administrative office building still exists on Sarojini Devi road, Secunderabad. The main office, moved little earlier to its new functional campus at Balanagar, adjacent to Hindustan aeronautics.

The thirty-two years of long professional journey began from day one till the last day of office, at Balanagar. The area was sporadically built both, inside and outside. The only transport available to reach covering a distance of 10 km, from Secunderabad railway station to Balanagar was bus numbers 30 and 31, which used to operate with limited frequency. But, it used to be an enjoyable journey with hardly any traffic on road, free from air pollution.

I reported on work in the area of land use studies division in Applications area. The room from where started working was the corner room in the ground floor of present building no 09. In one room we were five, along with the head; the only separation in the room was a green cloth, separating between him and us. It was an amazing experience to start the job, with new set of individuals, working environment and enthusiasm to carry the assigned work. The most interesting was each one of us were allotted a set of Godrej table with two drawers & two arm chair, pen stand, all prescribed according to the 'pay scale' - I still vividly remember it.

At my time from day-1, you are assigned to work in an ongoing user project in the said division in the Applications area. I was excited, to start my carrier to work in first project on, Land Cover /Land Use mapping under the Natural Resources study of Meghalaya State in NE. Region. Also was excited to go for ground truth visit to the state, again my maiden trip. The mapping was carried using Landsat data applying maximum likelihood digital classification technique on Dipix computer system. To work on the system, one had to book for allotment of date and time. Sometimes, had to wait for days, depending upon its availability, as most of the application scientists needed to work on the single console available on the Dipix system. The system was kept in the data processing building, opposite to applications building.

As part of requirement to learn newer methods and techniques, I was sent to attend the 'Terrain Applications Techniques' short course at IIT-B, Mumbai. Also, to attend course on 'Remote Sensing in Rural Development' from DSE Food and Agriculture Development Centre, West Germany. A 'General Management' Training program from ASCI, Hyderabad. The excitement knew no bounds, when I was nominated for A 'Young Scientist' Award from Andhra Pradesh Academy of Sciences.

Reminiscences at NRSC

Dr T Ravisankar
Former Deputy Director
(Bhuvan Geoportal and Web Services Area)

Experiences at NRSA / NRSC, ISRO during three and half decades at various capacities is very rich both at professional level and personal level also. Started carrier with IRS 1A satellite sensors with the development of methodologies for mapping and monitoring soils and land degradation including crop acreage estimation. Subsequently, during 1990s, with the improvements in sensors spatial and spectral resolutions of RS satellites, associated with improving methodologies to map soils and degraded lands at 1:50K.

In this decade most of the projects were carried out for central / state governments and also for private users. One such project on soybean crop acreage estimation using remote sensing data was carried out for ITC Agri Business Division in Hyderabad. Otherwise most of the national level projects like mapping salt affected soils at 1:250K were accomplished through local state govt., depart. R&D and TDP projects were also carried out.
Days are unforgettable when we were waiting entire night to receive first day products from IRS-1A/1B/1D or so to interpret images and send products to Chairman ISRO and to PMO office. Many stalwarts from different centres of ISRO were also present in NRSA campus and had interaction with them.

From 1986 onwards, rich experience was gained during ground truth collection. Unforgettable travel to fields, interaction with farmers in different soil / degraded lands/crops/land use types in different states. It was tough to get accommodation, food and tickets in trains. Tours were lasting for long days and at times cumbersome to carry field equipment, images, topographical maps and collected soil samples. We have faced unwanted situations also like minor accidents with car, late night travels etc.

During the period from 1986 to 2000 digital techniques of remote sensing data for crops, soils/ degraded lands etc., were attempted. Initially, the systems were slow and each one IRS-IA/IB or Landsat MSS /TM were taking anywhere between 15 to 24 hours for classification. The situation got improved after 1995 with the availability of desktops with image processing and GIS software.

During 2000 to 2010 decade, I was involved in fine tuning methodologies for 1:50K/25K/10K natural resources census project along with developing standards for mapping soils, land use, degraded lands, waste lands and developing SOPs. It was the decade marked by data bases preparation for entire nation on 1:50K for soils, land use, wastelands etc. The SIS-DP project and NUIS project on 1:10K with the availability of IRS - Carto/LISS-IV revolutionized mapping of various themes at village level using ortho-

rectified data and cadastral maps. During this period contributed for Soil Manual preparation by NBSSLUP, ICAR Nagpur in the form as lead author for preparing soil maps using remote sensing data.

During 2010 to 2020 decade, I was working with Ministries concerned with Agriculture, Rural Development and Member Secretary for Standing Committee on Rural Development of ISRO. This experience enabled me to execute the task of Team Lead for interaction with Ministries of Rural development, tribal Development and drinking and water sanitation from ISRO side during the Space Technology workshops for Govt Ministries. I am thankful to NRSC/ISRO for giving me an opportunity to show case the Geospatial technology for watershed Development, MGNREGA, Tribal Development and enable to address the issue of transparency and provide solutions to GOI schemes in the form of web portals. High resolution satellite data base for entire country was built.

During this phase interaction with Secretaries of DOLR, RD, Tribal Ministry etc., was challenging in terms of convincing the use of geospatial technologies in their departments. It gave experience of preparing project proposals, MOUs, SOPs/Manuals, project monitoring mechanisms and delivering the project outputs. Interaction with Ministry officials, presentation on status of projects, getting approvals and budget for the projects is all together a different level of experience. Lot of manpower from ministries were trained on respective project related web sites and apps developed for collecting field data. Awards were received from Ministries for the hard work and timely accomplishment of projects. Self also received individual excellence award from ISRO towards contributions to Space Sector. During the same period Team awards for projects like Bhuvan, SIS-DP and LULC 1:250K.

Preceding, to the above was development of Bhuvan Geoportal of ISRO was key and contributed to its development as a thematic scientist and also provided data bases developed on soils, land use, wastelands, watersheds, MGNREGA etc. Many of the apps were developed on Bhuvan like Srishti, NREGA, PDMC, etc. Attempts were made to develop on line monitoring approach for land use mapping at 1:50K. Soil Health card portal was developed for Ministry of Agriculture and farmers Welfare. From 2000 onwards participated in ISRO GBP programme and responsible for preparing carbon pool and stock map of India. During my tenure at NRSA / NRSC, I have significantly contributed towards remote sensing promotional activities in the form of delivering lectures, conducting customised training programmes, participating in seminars/symposia, conducting exhibitions etc. Most memorable one such experience is - Space Exhibition at Parliament Annex in New Delhi. Participated in NRSC user interaction meets and contributed at various levels. Lectures were delivered to Secretaries of various central/ State level Officials.

It is important to improve academic qualifications and NRSC enabled me to complete Ph.D as in- service candidate by permitting to use various technical inputs and services. I have guided M.Tech / M.Sc / Ph.D students from JNTU, PJSAUT and other Universities. It is very important to publish technical work in the form of papers in peer reviewed journals or as book chapters or present at seminars or symposia. My advice to young scientist is to keep in touch with academic and R&D centres so that they can not only help scholars or students and improve their own knowledge. Technical writing is a skill and publishing papers in national / International journals that have high impact factor is a thorough job.

NRSC has given me lot of opportunities not only on technical/ scientific front but also helped me to develop personnel, administrative, skills by putting in in technical committees - as member, Chairman etc. You have to show integrity in such roles keeping organizing values and ethos without any compromise.

Some such roles I had at NRSC are Member Secretary SC on Rural Development of ISRO, Team Lead from ISRO for Space Technology promotion in Ministries of GOI concerned Rural Development, JPC Chairman at NRSC, Member Research Advisory Council NBSSLUP, ICAR, Administrative committees at NRSC etc. One should not miss any opportunity to serve NRSC fraternity either at personal level or as a Member of social group. I served as NRSC Trustee for Viswas/ Safe and Member of BOT at ISRO HQ. Provided relief for the families who died in service through SAFE.

Tolerance, perseverance, integrity and commitment at every level in one's carrier that will fetch scientists' / engineers due awards, rewards and accolades without asking for them. Hard work with up front in knowledge update and helping management with dedication is the mantra for success. Everyone has to face ups and downs in their carrier. At times we have to fight with high ups on technical fronts, administrative and on personal issues. We should listen to Seniors advise and understand organizational expectation to swim across difficult times.

I pay my sincere gratitude and thanks to all ISRO Chairmans, Directors of NRSC, Associate Directors, Dy Directors, Group Heads /Directors and fellow S/ Es. I profusely thank staff of technical, administrative officials, stores & purchase, canteen etc., who have helped me at various stages in my carrier to accomplish tasks / projects etc. My best wishes to NRSC in the years to come on technical frontier and prosperity.

Reminiscences

Dr M V Ravi Kumar
Former Deputy Director
(Management Systems Area)

NRSC is celebrating its Golden Jubilee marking 50 glorious years of sustained contributions and services to India. This is a special occasion to rejoice and feel proud for all those who have associated with NRSC.

From my 36+ years of service, I can truly say that NRSC provides numerous opportunities and challenges for its employees that are beneficial for them to have successful careers with wide recognition and personal fulfilment. I look back with pride and satisfaction to my involvement in several initiatives and projects in NRSC.

Being a stakeholder and a contributor, I am witness to the huge digital transformation that has happened over the years in NRSC, which includes: state-of-the-art technologies roll out in RSA, establishing world class Data Centres of IMGEOS & NDEM, Bhuvan Geo-platform scale-up, migration to Unified Communications across campuses and setting up of RSA/ NRSC Private Clouds / Centralized Platforms.

NRSC has pioneered the design, development and implementation of mobile applications for field data collection and their smooth integration into Bhuvan platform. This has spawned an exponential rise in applications for several Ministries/ Departments and earned wide recognition/ appreciation for NRSC. I am proud to have played a part in this effort also.

NRSC has often tackled tough problems with innovative solutions that have led to successful first-of-its-kind operational implementations. A case in point is the establishment of secure remote access facility for Jeedimetla Outreach Campus, which was instrumental in the efficient execution of AMRUT cities geodatabase creation by outsourced firms using open-source GIS and centralized data management.

At NRSC, bright and energetic young scientists contribute significantly in all the projects. I consider myself highly fortunate to have had the unstinted support of competent hard working junior colleagues in ASD&CI Group of RSA and in the different groups of MSA. I am immensely thankful to them and wish all NRSC colleagues the very best in their careers.

I congratulate NRSC on its reaching the Golden Jubilee Celebration milestone, and pray for it to attain new heights in projects execution, research, innovation, and employee satisfaction. I hope to see NRSC achieve international recognition as an undisputed leader in remote sensing technologies and applications.

A Golden Jubilee Reflection: My Life and Times at NRSC

Dr Rajashree V Bothale
Former Deputy Director
(Earth and Climate Sciences Area)

My memory related to NRSC goes back to my tenure at RRSC, Jodhpur. I frequented NRSC to procure photo prints of satellite data and its resultant products. NRSC also served as the focal point for my SD to SE review back then. Those were the days when access to the campus was through what is now the Director's office. The entrance was marked by a bustling row of food carts, predominantly offering non-vegetarian fast food—a sight that left an indelible impression on me.

My inaugural visit to NRSC coincided with the IRS-1A symposium in 1989, an event designed to showcase the early accomplishments of IRS-1A. As a young enthusiast, everything about the symposium fascinated me deeply. However, my memories of that occasion include an unfortunate incident of food poisoning to many guests. Amidst it all, I had the privilege to witness and interact with numerous luminaries from ISRO, leaving me particularly awestruck by Dr. B L Deekshatulu, the Director at that time.

Engaging in LU/LC mapping provided a significant opportunity for me to collaborate closely with NRSC scientists. As part of the QA/QC team, I conducted regular visits to verify digital classifications. My meticulous approach to image checking often resulted in strained relations, earning me more adversaries than friends among the scientists responsible for the analysis. It was a challenging period marked by intense scrutiny and occasional friction. Nevertheless, the project proved invaluable in terms of learning and growth. It taught me valuable lessons in diligence, precision, and the importance of collaborative efforts in achieving project goals.

In 2009, the integration of RRSCs into NRSC marked a significant milestone within ISRO. One vivid memory that stands out is the celebration of International Women's Day in 2011, where I coordinated a dance drama titled "Naari Shakti" on behalf of RRSCs. This dance drama featured participation from women across all RRSCs and was a joyous endeavor that garnered appreciation from the audience. This experience ignited a passion for creative writing and directing that continued after my transition to NRSC in 2013. I composed theme song for Sports Day and written/directed dance dramas for Hindi Days and Women's Days. One of the notable contributions during this time was a heartfelt tribute to Lata Mangeshkar, likely the final dance drama I wrote and directed. These experiences not only enriched my journey within NRSC but also reinforced the power of artistic expression in fostering friendship and celebrating collective achievements.

My journey at NRSC from 2013 onward was nothing short of a roller coaster ride. I undertook roles in RSA, ECSA, MSA, and also into a new area known as ASDM & Outreach and generated many memories.

My tenure at ECSA was particularly transformative and full of events. The unwavering support and guidance from the scientists enabled me to successfully complete my PhD with four impactful publications. However, it was a proposal I wrote for Antarctica under the direction of then DD that truly altered the course of

Inauguration of Phase 1 of the NRSC Outreach Facility at Jeedimetla

my life. Never in my wildest dreams had I imagined I would one day set foot on the icy continent and spend few months there. Working in the cryosphere became a defining moment in my career and personal growth, marking a significant turning point that continues to shape my journey.

Another pivotal moment in my journey occurred when I assumed the role of General Manager for the Outreach Facility, Jeedimetla. It was a challenging task, with a small team and high expectations to meet. The inauguration of the facility by then Chairman, ISRO was a profoundly uplifting moment for me, instilling confidence that would sustain me in the years to come. His return to celebrate the facility's two-year anniversary further reinforced the significance of our work in outreach. Through this role, I gained invaluable experience in interacting with diverse groups of people and became adept at managing personnel effectively. Phase 2 of the facility was also inaugurated by the Chairman, ISRO in-spite of delays due to corona pandemic.

I especially recall the guidance and wholehearted support I received from the then Controller during his tenure at NRSC. His mentorship not only provided me with timely advice but also empowered me to navigate challenges with resilience and wisdom.

One incident that remains vivid in my memory is during the early days of the coronavirus pandemic. I had been closely monitoring the news and, after consulting with the then Director of NRSC, made the decision to allow project students to return home even before the one-day lockdown was announced. This proactive measure turned out to be a blessing, as all but five students were safely with their families when the lockdown came into effect across the country. I still recall the critical decision I made during that time was cancelling the tour of Space Exhibition bus. Looking back, I am profoundly thankful for having taken that action, which ensured the safety and well-being of everyone involved. These experiences were also a part of my learning at NRSC.

I remember the experience of creating the ISRO coffee table book, which involved contributions from all ISRO centers. This project was particularly significant for me as it coincided with my recovery from illness. Despite the challenging circumstances and tight deadlines, we managed to complete this monumental task with the collective support of all ISRO centers. The memory of the book's release by the Chairman of ISRO remains vivid in my mind to this day.

The students of outreach facility brought me immense joy and memories to cherish for life long. One of the highlights was introducing "Outreach Day", aimed at fostering the holistic development of project students. On this day, students enthusiastically participated in sports competitions, presented technical papers, and showcased their talents during the cultural evening. The event received widespread appreciation and served as a testament to the students' dedication and achievements. They still share those memories with me.

For several years, I had the privilege of hoisting the flag at NRSC. The memories of those Independence Days and Republic Days are etched deep in my heart. I began delivering speeches in three languages, including Telugu, during these ceremonies. After the flag hoisting at Jeedimetla campus, we would take students to the Shadnagar campus. It was heartwarming to see them eagerly arriving early in the morning, rushing to finish breakfast and board the bus. Spending time with them at Shadnagar was always filled with joy and friendship.

Release of P2P

My tenure at NRSC was defined by a series of challenges that pushed me to innovate and achieve. Few such tasks which I remember were revitalizing the newsletter P2P and merging and enhancing operations across Shadnagar, Balanagar, and Jeedimetla as Chairman of the canteen committee. Additionally, I played a pivotal role in bringing bilingual publications at NRSC.

One of my memories is related to organizational activities for Yuvika program and numerous events under Azadi ka Amrut Mahotsav. These initiatives hold a special place in my heart, reflecting our commitment to excellence and inclusivity. The Yuvika students have excelled tremendously, and many of them remain in contact with me. One standout student, in particular, not only pursued studies abroad but also achieved a patent at a remarkably young age. During their time in the program, there was a particular incident where I had to provide significant comfort and support to her. She remains appreciative of the encouragement and assistance offered during that time.

Upon assuming the role of DD, ECSA, I faced new targets set by the Chairman of ISRO right from my first presentation. I am delighted that I successfully completed all tasks before my retirement, including the NICES workshop, outreach efforts, and the NICES decadal plan. Launching the NICES newsletter and website just before my superannuation stands out as a highlight of my tenure as DD, ECSA, leaving a lasting imprint on my career at NRSC.

I owe a deep debt of gratitude to the entire staff of NRSC, including the CISF personnel, who not only showed me love and affection but also generously donated blood when I was critically ill. It is their collective prayers and support that pulled me through my hospitalization.

Professionally, I consider myself fortunate for the accomplishments I've achieved, but personally, the love and affection I received from everyone at NRSC mean more to me than any professional success. The kickoff of the Golden Jubilee celebrations before my retirement was a momentous occasion, and I am delighted that NRSC is marking 50 years of excellence.

I have given my utmost to this department, and in return, it has bestowed upon me recognition, comfort, and respect. As I move forward, I sincerely wish the Golden Jubilee celebrations great success, celebrating NRSC's remarkable journey and achievements.

Reminiscences

Manju Sarma
Former Deputy Director
(Data Processing Area)

The Earth Observation remote sensing ground segment is a critical part of the end-to-end science data return from Satellites. It comprises of all the ground-based elements that are used to collect, processes, calibrate, archive and disseminate the most valuable asset of the mission: The DATA.

The fifty years of journey at NRSC has witnessed a continuous growth of more than 50 times in terms of number of EO sensors, product types, data rates, users and so on. towards a reliable state of art ground segment framework to generate and disseminate EO remote sensing data for societal applications. NRSA ground station & data processing started its journey with the installation of the first 10m remote sensing antenna systems from Scientific Atlanta and Data Processing Systems from Ford Aerospace in 1979, at NRSA Shadnagar Earth Station Complex.

First decade established ground station to acquire and processes Landsat-4 and Landsat-5 MSS data, SPOT-1 and SPOT-2 data of HRV-1/2 in PLA and MLA modes from March 1983 up to 1992. Next four decades (1990's 2000's, 2010's, 2020's) of Earth Observation remote sensing witnessed development of ground segment elements (Acquisition. Processing ,Archival and Dissemination) to support numerous launches of Earth Observation missions monitoring Land and oceans from optical, microwave, hyperspectral and thermal payloads from submeter to km's resolutions . The optical payloads like IRS-1A/1B/1C/1D (LISS-I, LISS-II, LISS-III, PAN), Resourcesat-1/2/2A (AWIFS, LISS-III, LISS-IV(MX)) for land monitoring and Ocean monitoring payloads like Oceansat-1/2/3(EOS-06), Scatterometer payloads for global coverage on OSCAT, Scat-1, Scat-3, SARAL were realized to observe Ocean dynamics, tidal waves and so on. The SAR Payloads Risat-1/1A(EOS-04), Risat-2B series enabled day/night all weather Land monitoring data generation. High resolution Optical missions Cartosat-1/2/2A/2B was realized for DEM generation and cartographic applications. Sub-meter resolution data from Cartosat-2S, Cartosat-3(PAN, MX) are being acquired and processed.

Over the years from 1988 onwards, dedicated in-house hardware cards and processing software systems were developed and implemented by NRSC. In 2010 Data processing was re-engineered with state of art technologies and approaches to re-establish Integrated Multi-mission Ground segment for Earth Observation Satellites(IMGEOS) improving the quality of service in data reception and processing with reconfigurable data processing operations. Workflows are automated from payload programming to ancillary Data Processing, Data archival/retrieval from SAN for fast access and processing immediately after pass. Standard products are regularly generated with a throughput of 1000 products/day within 24 hours and disaster emergency products are delivered within One hour using Dissemination Portals.

Data Processing Infrastructure, In-house Hardware and Software Infrastructure & In-house Hardware: The first generation of computer systems (during IRS 1A/1B era) were the PDP/11 minicomputer systems, followed by second generation VAX minicomputer systems used during 1980s. From IRS-1C/1D onwards (1995/97), the demand for Value Added Data Products was on rise. In 2011 IMGEOS was augmented with high end blade servers, workstations and entire data is archived on a three-tiered SAN

storage. The use of centralized SAN storage eliminated movements of intermediate data products while also providing data - accessibility, protection, availability and scalability (up to petabytes of storage). In 2020's new technology of virtualization, object storage, dockers, containerization is established for faster, scalable and reliable data accesses over Internet and Intranet.

Ground Segment Software design, development and realization: Well designed and realized ground systems, distributing the right products at the right time to right users is the key to mission success. Few major elements are

- Telemetry and Control Ground stations : for telemetry , tracking and commanding with the spacecraft and control of spacecraft orbiting operations ,
- Payload Ground stations: for payload data receiving
- Ground Networks : for connecting multiple ground receiving & processing systems
- Payload planning control systems : for management of payload imaging operations
- Payload Data processing systems : for standard radiometric and geometric corrections
- Geophysical and value-added processing systems: for calibrated physical units' conversion at geolocation and improving, time composites.
- Calibration and quality evaluation systems: for calibration of sensor data and evaluation of quality of mission imaging operations, orbit, attitude and data.
- Dissemination systems: for satellite data products distribution to remote sensing user community.

The ground segment design, development, establishment depends on several factors which include, but are not limited to the following: Transmission RF frequencies and Data rate, Orbit and attitude specifications, Imaging Electromagnetic spectrum , Radiometric and geometric accuracy specifications , Baseband Data Handling formats , Payload data formats and on-board processing like coding , compression , Satellite Data dumping strategies across orbits and across stations and on-ground stitching of Imaging sessions , constraints and manoeuvrability , Data volumes ,Location of the ground stations, Latency requirements of data products , Geophysical products for end use applications, Cataloguing , archival of Raw data , browse , products , Dissemination and visualization of varied Data products and Standard well defined interfaces and documentation .

The various Software sub-systems which is the heart of IMGEOS are: (i) Realtime Acquisitions and Level-0 product generation (ii) Data Products Generation (DPGS) (iii) Value added Data Generation (VADS) (iv) Product Quality Control (PQC) (v) Data Quality Evaluation (DQE) (vi) Problem Resolution System (PRS), (vii)Station workflow managers software and (viii) Data processing workflow manager, (ix) Data Exchange System (DEG). (x) EMC software packages,(xi) Bhoonidhi portal, .. .

2020's is fourth generation era demonstrating handling of high-volume data (2.8 Gbps), global coverage data from satellites, Polar ground stations like Svalbard, Antarctic, Fair banks ground stations, agile image dumping from satellite, complex processing of SAR sensors, new geophysical products, Analysis Ready data with improvement of performance and Turnaround time were the key realizations. Development and Establishment of ground segment for defense users and State of art web Dissemination Platforms like Bhoonidhi to disseminate 34+ years of EO data products and first time visualize data in full resolution in Near real time.

Software Development, Reviews & Testing of ground segment elements: Development & Testing of ground segment systems is very involved process, working with multiple teams responsible for interfacing with multiple sub-systems of on-board and on-ground. Simulating the payload data, attitude/

orbit data, Interface files and generating test cases for mission scenarios needs through understating of BDH, payload, Mission, ground stations, data products and User requirements to realize a robust integrated ground segment had challenges in every mission.

First Day Imaging: The most satisfying and exciting milestone of Ground segment for a earth observation mission is the first day Real time Quick looks displays and imaging which demonstrates that all the sensors , On-board subsystems , the entire workflows , the processing software and hardware are working good as per design.

Browsing and Dissemination service: Initially Landsat browse images were made available on VHS tapes; SPOT images as 70mm films. Users came to NRSC Data Centre and screened the data. As the awareness and confidence of using remote sensing data increased, the Central and state Government users also increased from 2 digit to hundreds. The products available from the NRSC were B/W print, colour composite print, Digital versions of scenes on CCT, Exabyte or CD-ROM /DVD.

From 2011 onwards there was a paradigm shift to disseminate digital products on FTP over Internet. New User Order processing web application was realized for online ordering and Pass programming. More than 3 Lakh products/annum are being disseminated from IMGEOS through state of art BHOONIDHI Portal featuring NRT at native resolution visualizations for On-line quick analysis by users.

International Commercialization and collaborations: The Department of Space (DoS) decided to sell Indian Remote-sensing Satellite (IRS) data to the US-based Earth Operation Satellite Company (EOSAT), jointly owned by the Martin Marietta Company and Hughes Aerospace.

The international presence of IRS was not only as products but also by setting up the direct downlink and software for satellite data acquisition and processing services. IRS mission were used for collecting global coverage data through On-board SSR and by establishing 30+ ground stations globally (USA, Germany, Russia, China, Myanmar, Iran, Algeria...) by NRSC, SAC and URSC centres. NRSC has been part of many International collaborations with USGS, KSAT, NOAA, ESA, CNES, CEOS working groups, BRICS, International Charter, SENITEL ASIA, ASEAN countries for exchange of Data, exchange of software systems for acquisition and processing, evolving standards of data catalogues, data products for international web portals, Collaborative evaluation of Data quality, sharing of calibration sites for Absolute calibration records and so on ..

A Journey of Growth and Innovation: My Years at NRSC

Wing Commander
Vibhas Singh Gupta (Retd.)
Former Controller

As I reflect on my tenure as Controller of the National Remote Sensing Centre (NRSC) from October 2016 to October 2022, I'm filled with a sense of pride, accomplishment, and more than a few chuckles. Those six years were a whirlwind of activity, challenges, and triumphs that transformed not just the organization, but also myself as a leader. Buckle up, folks – we're about to take a journey through the cosmos of administrative adventures!

Fostering a Culture of Excellence (With a Side of Laughter): One of my first initiatives was introducing the monthly 'Administrative Focus' meetings. Picture this: a room full of brilliant minds, fuelled by chai and the occasional samosa, tackling administrative challenges with the fervour of mission control during a satellite launch. These gatherings became the heartbeat of our progress, a forum for open discussion, problem-solving, and the occasional witty remark that kept us all sane.

But meetings alone don't drive change – we needed systems that could keep up with our cosmic ambitions. Enter 'DARPAN,' our integrated administrative dashboard. This digital marvel became our North Star, guiding us towards efficiency and transparency. It wasn't just a tool; it was our crystal ball, minus the mystical fog and with a lot more data.

Embracing Technology (Or How I Learned to Stop Worrying and Love the Digital Revolution): Speaking of data, who could forget the implementation of PMFS (Payroll Management and Financial System)? It was like teaching an elephant to dance the salsa – challenging, sometimes frustrating, but ultimately rewarding. The successful rollout was a testament to our team's resilience, adaptability, and ability to turn coffee into code.

But my favourite tech initiative? That would be the E-Learning portal. Conceptualizing and developing this platform was a labour of love, like raising a digital child. Seeing it come to life and receive appreciation was incredibly satisfying. It's a legacy I'm particularly proud of, knowing it will continue to empower NRSC employees long after my departure, spreading knowledge faster than a satellite can orbit the Earth.

Financial Gymnastics: Balancing Books in the Time of COVID: Ah, the COVID era of 2020-21 – when "financial crunch" took on a whole new meaning, and our budget started looking slimmer than a satellite on a crash diet. This was when my role as Controller suddenly felt like being a financial contortionist in a cosmic circus.

Picture this: there I was, virtually arm-wrestling with the Department of Space authorities, trying to secure funds with the tenacity of a squirrel guarding its last acorn. Our negotiations took on an almost theatrical quality. "No, sir, we can't run NRSC on good intentions and leftover chai," I found myself explaining, while mentally calculating how many paper clips we could sell to make ends meet.

But creativity was our secret weapon. We turned the art of "doing more with less" into an Olympic sport. Suddenly, everyone at NRSC became a master of upcycling, multi-tasking, and finding innovative uses for duct tape. I'm pretty sure at one point we considered renting out our parking lot as a drive-in theatre to generate extra income (spoiler alert: we

didn't, but the brainstorming session was hilarious). In the end, through a combination of persuasive powers that would make a seasoned diplomat blush, financial acrobatics that defied gravity, and the kind of resourcefulness that would impress Jugaad champions from every Indian neighbourhood, we managed to keep NRSC not just afloat, but sailing smoothly. Who knew that balancing books could be as thrilling as a space launch? Move over, rocket science – make way for budget science!

Adventures as Chief Vigilance Officer: As Chief Vigilance Officer, I found myself at the helm of a mission as critical as any satellite launch – safeguarding the fortress of innovation that is NRSC. In an organization where cutting-edge technology and sensitive data are as common as coffee breaks, security isn't just a department; it's a way of life.

Picture this: a sprawling campus where brilliant minds conjure up ways to map our world from space, all while being guarded by the ever-vigilant CISF personnel. It was like being the custodian of a cosmic treasure trove, where every door, every computer, and every conversation could potentially hold the key to national secrets.

We turned NRSC into a veritable Fort Knox of the space world, implementing security measures that would make even James Bond raise an eyebrow in admiration. From biometric access controls that could tell a scientist from a spy faster than you can say "satellite," to cybersecurity protocols that could fend off digital intruders with the ferocity of a firewall on steroids – we left no stone unturned.

But vigilance at NRSC wasn't just about physical barriers and digital defences. We cultivated a culture of security consciousness that permeated every level of the organization. We conducted security audits with the thoroughness of a Masterchef judge inspecting a biryani. Every nook and cranny of NRSC was scrutinized, from the most high-tech labs to the humble canteen (because who knows what secrets could be hidden in a samosa, right?).

Intelligence gathering became our bread and butter. We had our ears to the ground so effectively, I sometimes joked we should rename ourselves the "Satellite and Sherlock Centre." Our network of information was so intricate, it could rival the very satellite networks we were tasked with protecting.

Through it all, we maintained a delicate balance – creating an environment secure enough to protect our nation's interests, yet open enough to foster the innovation and collaboration that NRSC is known for. It was like walking a tightrope while juggling flaming torches, but hey, who said being a Chief Vigilance Officer was going to be easy?

VIP Visits, Linguistic Leaps & POSH: Showcasing NRSC's Best: Now, let's shift gears from security to hospitality – because at NRSC, we're not just good at launching satellites; we're also stellar at launching impressive tours for our distinguished visitors!

Parliamentary Committee visits became our favorite reality show. We prepped like it was the Space Olympics, turning NRSC into a showcase so dazzling, even our satellites blushed with pride. Corridors were polished until you could see your reflection (perfect for last-minute tie adjustments), presentations were rehearsed more times than a Broadway show, and

every employee suddenly developed the poise of a seasoned tour guide.

The Committee on Official Language? Oh, they were in for a treat! We had them speaking 'Satellite' by the end of the visit. Our scientists, usually more comfortable with binary code than भाषा, transformed into linguistic acrobats. We tossed around Hindi technical terms with such flair, you'd think we were auditioning for a space-themed Bollywood musical. "अंतरक्ष से पृथ्वी का सुदूर संवेदन" rolled off our tongues as smoothly as "remote sensing from space."

And let's not forget our crowning achievement in creating a more inclusive workspace – the implementation of the POSH (Prevention of Sexual Harassment) policy. We made it crystal clear that at NRSC, the only thing we have zero tolerance for is harassment. Our workshops on this topic were so engaging, they could give TED Talks a run for their money. We fostered an environment where respect orbits around every interaction, much like our satellites orbit the Earth – consistently, unfailingly, and with great precision.

Through these initiatives, we didn't just showcase our technical prowess; we demonstrated that NRSC is a place where professionalism, linguistic diversity, and mutual respect align as perfectly as a well-planned satellite constellation.

Sustainability: Saving the Earth, One PET Bottle at a Time: Our sustainability drive was so enthusiastic, even Captain Planet would've been impressed. We didn't just reduce, reuse, and recycle – we revolutionized! Our PET bottle shredders were working harder than a teenager's jaw at a bubblegum factory.

Building a Safer, Healthier NRSC (While Dodging Wild Boars): Safety and health were always top priorities. We tackled long-standing security issues head-on, implementing 100% of the observations made by various agencies. It was no small feat, but the reduced number of new observations proved we were on the right track.

Then came the COVID-19 pandemic – a challenge none of us saw coming. Our proactive response, from issuing guidelines to coordinating with hospitals and implementing home treatment packages, showcased NRSC's ability to adapt and care for its own. I still chuckle remembering how we became expert contact tracers overnight!

On a lighter note, who would have thought that "wild boar extermination" would end up on my resume? But at Shadnagar, it was a real issue we had to address. It's these unexpected challenges that kept the job exciting!

Nurturing Growth and Well-being (With a Side of Amateur Psychology): Infrastructure development was a constant theme throughout my tenure. From setting up the Primary Health Center at Shadnagar (complete with an ambulance!) to making the Jodhpur Guest House operational, we were always expanding and improving our facilities.

But buildings alone don't make an organization. It's the people who breathe life into it. That's why I'm particularly proud of our initiatives like the master health check-ups for employees over 40 and the personal finance and managerial effectiveness training programs I conducted. Seeing the positive impact on our staff's well-being and professional growth was incredibly rewarding.

I sometimes felt like a juggler, trying to keep all the balls of technical expertise, administrative acumen, and interpersonal skills in the air at once. Our training programs became the talk of the town - or at least the talk of the office corridors! But the real fun began when I delved into organizational behavior. Suddenly, I was an amateur psychologist, analyzing others' "workplace personalities." Was that colleague's habit of humming while working a sign of contentment or a subtle form of psychological warfare? These attempts not only improved my understanding of others but also led to some hilarious self-discoveries.

Through it all, we laughed, we learned, and we grew - both as individuals and as an organization. Who knew that professional development could be so entertaining?

Juggling Regional Centers and Dancing with Directors: A Balancing Act: Imagine trying to conduct a five-ring circus while simultaneously participating

in a leadership relay race – that's pretty much what my job felt like! As Controller, I found myself playing juggler to our five Regional Remote Sensing Centres (RRSCs). Each one was like a unique flavour of ice cream in our cosmic sundae – RRSC South (Bangalore) was our spicy mango, RRSC West (Jodhpur) our desert rose pistachio, RRSC Central (Nagpur) our tangy orange, RRSC North (New Delhi) our diplomatic vanilla, and RRSC East (Kolkata) our intellectual rosogolla. Balancing their distinct dynamics was like trying to solve a Rubik's cube blindfolded – challenging, but oh so satisfying when it all clicked into place!

But wait, there's more! During my tenure, I had the privilege (or was it an extreme sport?) of working alongside four different Directors. It was like being in a professional dance competition where they kept switching your partner every few months. One director was as calm as a satellite in geostationary orbit, another as dynamic as a launch sequence. I waltzed with the outgoing ones and did the tango with the conservatives. The key was to match their rhythm while keeping the NRSC symphony playing harmoniously. Sometimes I felt like a chameleon, other times like a translator at the UN. But no matter the director's 'flavour', we always managed to stir up a delicious brew of progress and innovation.

Through it all, we proved that at NRSC, diversity isn't just about satellite data – it's about the colourful tapestry of people and ideas that make our organization truly stellar!

Leaving a Lasting Impact (And a Few Grey Hairs): As I approached the end of my tenure, I had the privilege of chairing the committee for revamping the CHSS (Contributory Health Service Scheme) for the entire Department of Space. It was a massive undertaking, but seeing our recommendations appreciated and accepted for implementation was a fitting capstone to my time at NRSC.

Of course, no reminiscence would be complete without mentioning our celebration of India's 75th anniversary of independence. Leading NRSC's activities for the Azadi Ka Amrit Mahotsav was a joy and a reminder of the important role our organization plays in the nation's progress.

In Conclusion: A Stellar Journey: As I pen down these memories, I'm struck by how quickly those six years flew by. From administrative reforms to technological innovations, from pandemic responses to wild boar challenges, every day brought something new. But what I'll cherish most are the relationships forged, the challenges overcome, and the knowledge that NRSC emerged stronger and more capable than ever.

To my colleagues and teammates who made this journey possible - thank you. Your dedication, creativity, and resilience were the real drivers of our success. Here's to the continued success of NRSC - may it continue to push the boundaries of remote sensing and geospatial technology in service of our nation!

Remember, in the vast expanse of space, it's our human connections and shared laughter that truly make the journey worthwhile. Keep reaching for the stars, NRSC – and don't forget to enjoy the view along the way!

My Journey with NRSC

Dr P P Nageswara Rao
Former Outstanding Scientist, ISRO

I am very happy to know that NRSC is com memorating the completion of 40 years in Sep tember, 2014. It is indeed a pleasant moment to recall my happy journey with NRSC. I joined the NRSA on 21st October 1978 as an Engineer/Scientific Assistant 'B' (Agronomy) with Dr R S Ayyangar, one of the senior scientists looking after the agricultural applications of remote sensing. I left NRSA on 23rd September 1980 to pursue research career at IIT-Kharagpur. I had another opportunity of coming under the NRSC-sphere of influence in December 2009, when the RRSSC-Bangalore, (now RRSC-South) along with other RRSSCs was merged with NRSC. I was on deputation to NESAC-Shillong from RRSSC-Bangalore. Before going to NESAC, I served as Head, RRSSC-B for five years from March 1998 to July 2003. Despite this on-and-off association, my career has been tremendously influenced by NRSA/NRSC, which I am briefly narrating here.

One of the pioneering research works done by me, as part of a small team of young scientists under the guidance of Dr Ayyangar with the encouragement given by then Director Wg Cdr K R Rao, was on applications of airborne scanner data for crop inventory in Mandya district of Karnataka state. Research Flight Facility (RFF) of NRSA carried out the aerial campaigns during Rabi season (February to May, 1979), the digital data products were analysed using M-DAS and I was assigned the task of plotting the spectral values. After finishing a few dozens of graph sheets, I found to my surprise that the separability of sugarcane and rice crops was much better in red (0.66-0.70 ìm) and near infrared (0.77-0.86 ìm) bands of the electromagnetic spectrum. The spectral ratios of these two bands plotted over time closely related to their phonological stages that led us to the identification of the crops. It was at this time Dr C J Tucker and his colleagues, working with ground-based spectro-radiometer at NASA GSFC, came up with similar conclusions for corn and soybean crops. Their findings were published in 1979 in the PERS, a journal of American Society of Photogrammetry & Remote Sensing. Our results were published in 1980 in "Photonirvachak"- Journal of Indian Society of Photo-interpretation & Remote sensing. Subsequently, several combinations of these two spectral bands, called vegetation indices, are related to numerous physical and biological parameters of Earth's ecosystems. I consider this as one of the significant achievements of NRSA/NRSC that laid foundation for many nation-wide application projects like agricultural drought monitoring, crop inventory and condition assessment, etc.

The spirit of team work was imbibed by us at very early stages of our career at NRSA through our projects, sports and cultural events, a glimpse of which can be seen in the photographs.

The basics of remote sensing learnt at NRSA helped me a lot in contributing to the growth of applications of the technology in agriculture, sericulture, water resources and disaster management. It has also enabled me in carrying out system studies in the EOS Programme Office at ISRO Hqrs and in discharging

my duties efficiently at the NNRMS Secretariat. While serving five years as Head of the RRSC-South during 1998-2003, we developed many large area application projects bringing self-sustenance to the Centre. NRSC's approach of doing end-to-end projects has moulded me to become the Project Director concurrently for many application projects

of ISRO viz., i) Integrated Mission for Sustainable Development (IMSD), ii) Agro climatic Planning & Information Bank (APIB), iii) a nation-wide project on using RS & GIS for fertilizer management and farm planning that was developed for Indian Farmers' Fertilizers Co-operative Ltd (IFFCO) and iv) sericulture development project in collaboration with Central Silk Board.

I owe a lot to NRSA/NRSC and ISRO from where I learnt the leadership qualities which I practiced as Director, North Eastern Space Applications Centre (NESAC), Shillong from October 2007 to November 2010. The NESAC has been shaped into a "Centre of Excellence" in the applications of satellite communication and geospatial technologies in addressing the developmental needs of north-eastern region

My Reminiscenes of NRSC

Dr J R Sharma
Former Chief General Manager
(Regional Remote Sensing Centres)

My association with NRSC, Hyderabad directly starts when RRSCs got amalgamated into NRSC in December 2009 from ISRO headquarters Bangaluru till my superannuation from NRSC in July 2015.

Hindi Workshop-2015

My reminiscences during this short period are quite vivid and profound and could only be believed, as this was a remarkable era of great leadership of the centre which shaped the organisation's achievements on one hand and personal and professional growth of every individual on the other.

In about six years with NRSC, I was associated with RC-West (as General Manager), water resources division (as Group Director), India-WRIS (as Project Director), SIS-DP and Bhuvan Panchayat portal (as Project Director) and RRSCs (as Chief General Manager) besides having additional charge for two years as Officer on special duty (OSD), Branch Secretariat, Department of Space, New Delhi. My all the colleagues in different teams gained great professional heights and popularity of their works due their commitment, enthusiasm, dedication and hard work which became cornerstone of our shared success and organisation's name particularly in the area of water resources management and decentralised planning at grass root level.

I deeply missed ex-colleagues and the team members in last about nine years of my superannuation period as many of them became good friends over the years; the series of discussions we had with the expertise and depth of subject they had; and the mentorship and leadership they provided to their junior colleagues to work in time bound projects by understanding applied user needs. The experience of working with diverse teams have made my outlook different, what I am today. Indeed, NRSC provides great platform to perform and the opportunities are limitless.

My tenure with NRSC provides pivotal moments of my professional life; fully charged with emotions and joys; many rewards & lessons learnt on the path of professional achievement and personal fulfilment (ISRO Performance Excellence Award 2015, ISRO Team Excellence Award 2015, National Geomatics Award – Technology 2015, NGRI-AHI – Hydrology life time achievement award 2014, Satish Dhawan National Award 2012, ISRO Team Excellence Awards 2010 and ISRO Merit award 2010); many discoveries particularly in India-WRIS and SIS-DP & Bhuvan panchayat portals; about the new place Hyderabad, the people I experienced; learning of human nature and the experience of wider world by two short deputations abroad – first in 2010 to Pachuka, Mexico for Mexican space agency show and second in 2011 to Seattle, USA for IEEE-US GHTC.

I am tremendously grateful to all my ex- colleagues technical, administrative and ministerial for the energy and wisdom invested, which is imprinted upon me. I cheer my fulfilling stay of NRSC/ISRO.

User interaction Meet -2015

Living and Serving Remote Sensing – My tribute to NRSC

Dr Chandra Shekhar Jha
Former Chief General Manager
(Regional Remote Sensing Centres)

At the very outset, I must tell you that my research career of last four decades has been just growing with the evolving remote sensing science and applications.

I joined PhD at the famous ecology school of Banaras Hindu University in 1984 and my supervisor, Professor J S Singh, a great name in the area of ecology research, suggested me to work on the remote sensing application on tropical deciduous forest with an integrated approach along with all natural resources (an exclusive advantage provided by remote sensing data). I must add that in those days, it was a very novel and innovative way to address the challenges of holistic management of natural resources management.

In the early nineteen eighties, the remote sensing application was not even heard by majority of Indian research community. Remote sensing in those days was mostly 1) black and white aerial photography and few available 2) Landsat images (to be acquired from EROS data Centre, NASA). Data acquisition from both the available sources were very challenging and exorbitantly costly and had several security obligations, in addition. It was only after IRS launch in 1988 that, there was a paradigm shift to the advantage of the users and stake holders. Very few books and journals dealing with remote sensing was available, that too in few libraries in India. To my advantage, my Professor guide, Prof J S Singh had executed a research project on forest inventory using aerial photographs in the Kumaun Himalayas and had very good association with Professor Satish Dhawan, the then illustrious ISRO Chairman. I may like to remind that it was Professor Dhawan's vision that the first ever national RS application project, the Nationwide wall to wall forest cover mapping took place, which we shall discuss a bit later.

Thus I was undergoing a unique thinking process, I had the hard challenges of learning the new area of research and data acquisition on one hand and the joy and excitement of an upcoming area of research in the natural resources management. Altogether, there were challenges galore – for every bit of digital image analysis, I had to arrange resources to travel to RRSC Dehradun, book the terminal time of VAX 11-780 system, well in advance (it was almost unaffordable for a UGC fellowship JRF). The operating system, VMS and the French Image processing s/w was not user friendly at all, it would take months together to be able to execute even the uncomplicated routines. However, it is important to note that the elaborate and cumbersome process of learning later proved to be a great advantage for my educational background as I was exposed to a completely new vistas of learning – new operating system, fundamentals of image processing, advanced statistical applications, abc's of computer hardware, networking and digital image processing. It is very interesting to note that command line execution mode of work will not allow any short cuts, one has to know all the details of all the processes, sub processes, their interrelationships that may impact obtaining the final results (there were no default options), else the entire process may fail eventually.

During my PhD thesis completion process, I applied (the only job application in my entire career) and got an interview call from NRSA with a condition to show PhD award at interview. Incidentally, soon, my viva voce was over and the provisional certificate was to be approved by the university research award committee. Despite of my special appeal to the then examination controller, BHU, that the provisional PhD certificate was very crucial for the interview, I could not obtain before proceeding for interview. At NRSA, I entered the interview room with a very low confidence that I shall be rejected without the PhD certificate in my hand. It was sharp 10.00 hours, I entered the interview room and to my surprise at the very entry itself, committee chairman Mr. Raghunathan mentioned that "at 9:57, BHU has

sent your provisional PhD certificate by FAX (FAX was a newly introduced means of communication those days in India), hats off to BHU for the care that they take for the wellbeing of students", and then everything was smooth and this is how I was inducted on 31 Jan 1990 in the then forestry division, NRSA.

When I joined NRSA, it was the difficult era for NRSA/DOS forestry application scientists as the post nationwide national forest mapping project reconciliations with forest survey of India and the state forest departments was not yet fully closed. The huge conflicts and controversies arisen out of the stark ground realities due to large areas of forest loss as well the limitations/inaccuracies due to poor quality images acquired for the leafless season were posing lots of challenges in reconciliation process. The large serving forester community was against the remote sensing application as it was bringing more and more transparency in the forest mapping status. It took several generations of RS application scientists to bring harmony and agreement with the community of Indian foresters.

In the last one decade, I and my entire team worked with all the scientific and communications skills to bring all the stake holders on the same page and I am very delighted to take pride that contributions of NRSC forestry has been kept at a high esteem in MOEFCC and its various institutes as well as amongst the State Forest Departments. The following brief account will explain how we brought the best possible synergy of the multi -source, multi-platform and multi sensor data towards addressing the various aspects of sustainable forest management and inventory of forest resources at the national level.

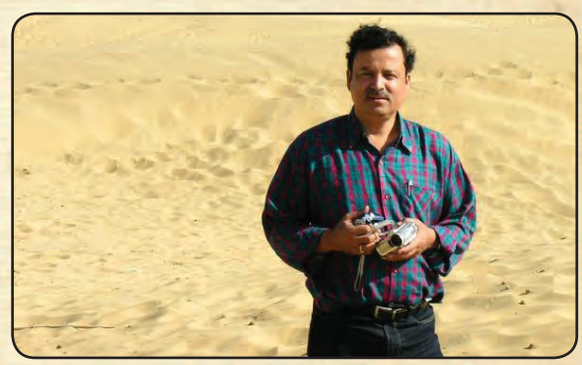
In the last decade, we had put up a goal for migrating from qualitative forestry to quantitative forestry. In order to achieve the goal, we took full advantage of the multi resolution available data and the advanced available open source software. It is worthwhile to mention that even though, lots of earth observation data is available over India but a good quality plot inventory data based on robust sampling design had been a big bottleneck. The available plot data sets generated was mostly from small plots, collected to meet the limited objectives of few projects. These analyses carried out on the mentioned data sets were very noisy and were not suitable for any model development for the quantification of forest resources at the national level.

Hence, we took the onerous task on ourselves, developed a robust sampling design at national level and worked for almost a decade dedicated for the collecting the plot data including inventory of well distributed 1 hectare plots. It also took very long to convince the ISRO management for supporting the work that leads to the generation of the intensive ground observations which may not be a high priority area for the organisation. We convinced them that only with a high quality basic ground data even at a low sampling intensity, we can demonstrate the real value and contribution towards the quantification of natural resources.

There are several anecdotes of brave and inspirational efforts that were undertaken by our team members to carry out field works in unfriendly terrain and challenging environments – lost in the dark deep forest for several hours in western ghats, chased by elephants in Assam evergreen forests; encountered several poisonous snakes, scorpions; bitten by leeches and tics; blown away with the strong water currents of hilly rivulet, to name a few.

We also utilized the hierarchical spatial and temporal and spectral resolutions of various suits of earth observation satellites, aerial digital imaging scanners, LIDAR, as well as drone data and above all the synergistic statistically balanced sampling designed plots to fulfil the national coverage with the desired scientific rigor.

To be very brief, with all the focussed multi -pronged strategies, we could, for the first time:



Field work for the Thar desert biodiversity

Generate a nationwide spatial and quantified carbon and forest biomass map with decadal trend with well described uncertainties, web enabled system for automated near real time forest and agriculture stubble fire alerts for the forest managers and citizens and automated nationwide annual forest loss map. We also developed advanced tree volume biomass models based on LIDAR and large plot inventories and also pioneered in the area of the

establishment of carbon and ET flux towers in India in the dominant forest types and worthy to mention that our Sundarbans tower was the first one in the mangrove world over.

Our team is proud to have published the decadal observations from our flux towers on the key impacts of environmental parameters on the Vegetation carbon and water cycle in different forest ecosystems, a key contribution for climate change studies. Our contributions on decadal forest cover changes in relation to forest type and biodiversity has been cited worldwide in hundreds in the very high impact journal articles.

During the last three decades of the service at NRSA/NRSC, with every passing day, we accumulated delta quantum of learning. Besides the continuous upgradation on the scientific and technical aspects, the art of working in a team and expanding the network of collaboration was the most advantageous opportunity that led the quantum jump not only in the level of scientific contribution but also winning the trust and confidence of the various stake holders in various sectors.

Visual observation from the top of the flux tower.

We also contributed significantly for the large number of high empowered committees at national level, e.g., the famous Ecosensitive Zonation Mapping, Bellary mining, Vizinjam Port compliance, etc. It is our delight to mention that we got lots of praise, recognition, awards, prizes nationally and internationally for our significant contributions. During my last two and half years of service I had the proud opportunity to serve at the regional centre (RC) headquarters. The RC teams were so well skilled and motivated that we made a distinction of working online almost every day even during the COVID pandemic. With all the motivation and cooperation, we completed several projects specific to the natural resources specific to the large physiographic regimes in which our respective RCs are situated. During this time period, we completed India's first project (generously funded by FAO) on tree level mapping using VHR data using AI. Of the several systems and DSS that we established, the most remarkable was our contributions on nationwide DSS on village level land and water management. The top level in ministry of rural development, GOI, worked with us on day to day basis in this initiative and showered lots of praise on us.

The respective NRSA/NRSC directors in their service periods extended fullest support such that we could achieve all the very high end goals. With their full encouragement, we could pool up the resources from various collaborative nodes and then only we could scale up the results at national level. I feel very lucky that I got a wonderful patronage from superiors and work execution from my highly capable, skilled and motivated team members, for whom, I am always short of words in their praise.The large number of application projects at NRSA/NRSC during 3 decades of my service took me to all the nooks and corners of India including several institutions and cities abroad, and thus made me fully familiar and comfortable with various languages and dialects, music and cultures, cuisines and ultimately made me, a better and wiser human being.

Field work for Lohari-Nagpal hydel project

I was too privileged to get the overwhelming support and respect from the collaborators and stake holders at national and international level. I am very blessed to be in an erudite family and it was always a joy to get emotional comfort, mental ease and intellectual strength from them every day before starting for office and more so, after coming back from office with the mental baggage of coming days of work.

On the auspicious occasion of Golden Jubilee, I wish NRSC Director and all the staff a great success and looking forward to large number of scientific, Technical contributions towards the well-being of the nation and humanity.

Pencil to Pixel transformation in 5 decades of evolving Geospatial ecosystem - challenges, opportunities and way forward

Uday Raj
Chief General Manager
(Regional Remote Sensing Centres)

The concept of National Natural Resources Management System (NNRMS) proposed by Prof Satish Dhawan, then Chairman, ISRO in 1984 started taking wings with the national seminar organised at NRSC and establishment of five Regional Remote Sensing Service Centres (RRSSCs) in 1986-87-time frame. It was a visionary mission to propagate Remote Sensing Technology and Its applications in the country by establishing basic digital infrastructure to acquire, process and disseminate Remote Sensing data, primarily from satellite platforms.

Apart from two major centres, NRSC and SAC, a chain of Five Regional Remote Sensing Centres (RRSSCs) were established in collaboration with the lead user agencies in the North, South, East, West and central region of the country. During this period, a major recruitment drive was taken up to recruit youngsters from across the country and concomitantly, equal number of experienced scientists from User agencies were brought in on deputation. it was a synergy of young and experienced human resource to work on the important mission of operational research in Remote Sensing & geographic Information system (RS & GIS) in the country.

I was one of the new recruits from IIT, Kharagpur in a batch of about 30 youngsters to join ISRO under the banner of National Natural Resource Management system (NNRMS) in Bangalore. We started our journey together at Bangalore and subsequently split in to small groups and relocated to Dehra Dun in North, Bangalore in South, Kharagpur in East, Jodhpur in the West and Nagpur in the central India. The young and energetic team at all the 5 RRSCs strived hard to pursue application projects and customised Software development in RS in each region of the country addressing regional and local issues.

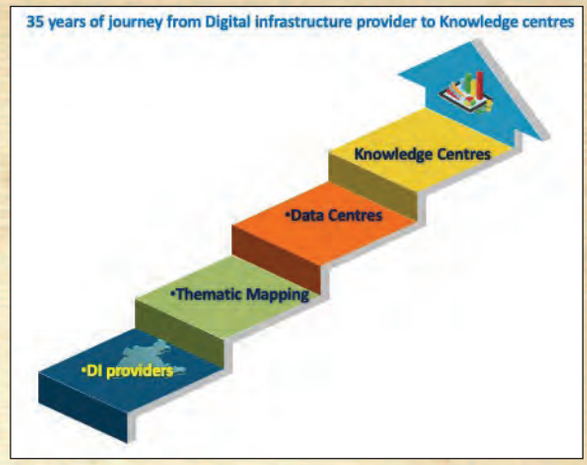
Regional Centres focus was mainly on developing digital processing techniques to process RS data. State of the art hardware and software tools were established in each Regional Centre to encourage in house and user collaborations to attempt applications in different application domains ranging from Agriculture to Archaeology, Rural to Urban planning, Forestry to Environment, water resources to disaster mitigation. It was a great opportunity for many of us to work on the latest platforms like VAX 11/780 with image processing s/w suits like VIPS from CNES, France. Initially at every centre, it was a round the clock, 24/7 working environment to test and establish the systems. our mentors and motivators were right from Chairman, ISRO, Prof Dhawan, Prof UR Rao, Dr YS Rajan and Dr Radhakrishnan. As project Scientist, direct guidance and frequent interactions with the senior leadership at ISRO has set a very high standards of work culture and bench marks in the young scientists to perform. Full freedom was given to interact, discuss with seniors, which is generally rare in an organisation. This provided the opportunity

to compete, excel and perform to the fullest potential in each one of us.

The organisational working environment and opportunities provided to all to grow and develop in to domain experts in geospatial technology was unprecedented. ISRO was in the forefront of RS technology in the country and each one of us were the brand ambassadors in the regions. In about two years' time frame, we all had travelled across the country in establishing regional centres, carrying out field works, interact with users at state level, organise workshops and seminars in user departments and academia to introduce the RS technology and its advantages. Each one of us have transformed in to scientists at core, project managers to handle projects and funds. This great opportunity has helped many of us to take up leadership roles in later part of our careers and successful individuals.

The journey of transformation of name from Regional Remote Sensing Service Centres (RRSSC) to Regional Remote Sensing Centres (RRSC) and initially, from service provider & Natural resource mapping agency to repository of Natural resources and eventually to remote sensing knowledge centres is phenomenal. The institutional memory and the opportunities provided to all the scientists is worth narrating to provide a clear picture of encouragement provided by Leadership. I was particularly fortunate to work on niche areas and emerging applications with improved resolutions of remote sensing data available and rapid technological developments. RCs are centres of ample opportunities to take a lead in perusing new areas of operational research through in house projects and in collaboration with experts from other user agencies

At Regional Centres, we always strived hard in developing new methods and SOPs in creating Value added data products, towards quantitative RS applications and development of various models, actionable RS products required for direct assimilation in to models and end use application. RRSCs are also store houses for customized software packages, Software development. Many software packages developed in house are deployed successfully in various institutions as part of many National Missions and user projects. Software developmental efforts focus on providing end-to-end solutions in Digital image processing & GIS on multiple platforms and environments. Most of the software developmental efforts fall in to 4 categories:



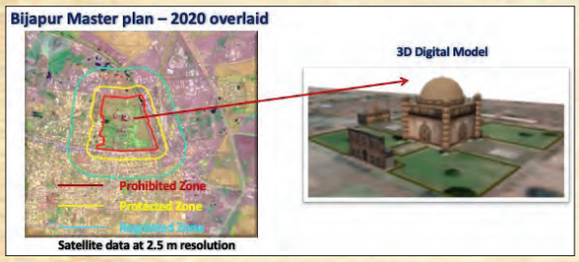
- Customization of COTS packages
- Software developed using licensed deployable libraries
- Software modules developed using freely deployable libraries
- Standalone Software packages

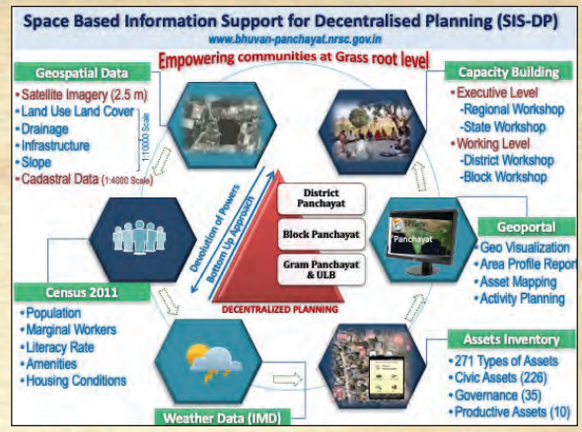
Regional Centres have successfully initiated R&D activities in the niche applications on location intelligence, location based services and mobile applications which are successfully integrated in inter-ministerial projects for G2G and G2C applications. Few of the successful projects are worth mentioning due to their unique objectives and challenges of implementations in major ministries. Many of these projects were for public good and e-governance related applications. I was the Lead for 3 ISRO Working Groups to develop products and applications for ministries viz a) Min. of Culture, b) Min. of Tourism, c) Min. of Road Transport/ NHAI. Post National meet held in vigyan Bhavan where PM of the country and senior level bureaucrats attended. Some of the most significant projects which were operational in the user ministries are mentioned below.

Project "SMARAC" Inventory & Site Management plans for Heritage sites and monuments of National Importance. For the first time, high resolution data from CartoSat and geospatial technology were used in archaeological applications as a decision support system in e-governance in collaboration with Ministry of Culture, Archaeological Survey of India, National Monument Authority and NIC. In record time, all India inventory of all the nationally important monuments and sites including 36 world heritage sites in the country is prepared and geotagged along with other important attributes. Site management plans for most of the heritage sites are prepared using high resolution data and other collateral data available with Ministry

of Culture. All the management plans are validated by the ASI circle offices online bythe G2G mobile module developed and the entire geodatabase is hosted on Bhuvan geoportal and is operational for citizen visualisation and G2G activities of ASI and Ministry officials.

The entire database is used for developing a Decision Support System (DSS) to provide No Objection Certificate to any citizen from across the country and update inventory data & prepare management plans by ASI. Customised mobile apps are developed and deployed on NIC server and BHUVAN server for free downloads by citizens and user depts. For the first time, NIC NOC Server of National Monument Authority & Bhuvan portal at NRSC are integrated to exchange web services triggered by geolocation from a G2C smartphone based mobile app to provide geospatial based solution like proximity analysis and issue of NOC to any citizen in the country. This project is qualified and included as part of "Ease of Doing Business" in the ministry of Urban affairs. The entire process chain takes 2 minutes to provide the results to citizens on the requirement of NOC which



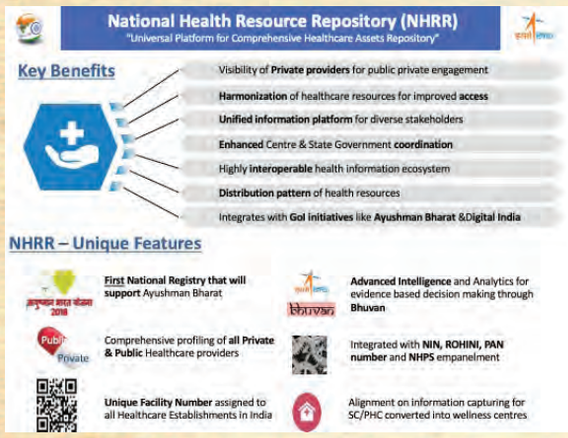


otherwise would take six months by conventional methods. Since March 2017, New Delhi and Mumbai Municipal corporations have gone fully online for issue of NOCs for building plan approvals to citizens. The challenges of accuracy of smart phone GPS, particularly in urban areas with sky scrapers, areas of thick vegetation have posed many issues and was overcome by decoding generic GPS data and using fuggy buffer zones in the management plans.

Project SISDIP: Towards effective utilization of space Technology in Decentralized planning exercise in the village panchayats at grass root level, Space based Information Support for Decentralized Planning (SISDP) project was formulated by RCs and was successfully implemented in partnership with State Remote Sensing Application Centres (SRSACs) in the country. The major outcome of this project at national level are under 6 categories (1) Geospatial Datasets (2) Socio Economic and Demographic Datasets

(3) Generation of Community Assets Inventory through Geo-tagging using mobile application (4) Meteorological Data (5) Design and Development of web enabled platform Bhuvan Panchayat Portal and (6) Capacity Building of the stake holders at various levels of planning process up to Gram Panchayat in utilization of SISDP database and Geo-Portal. The project was implemented in collaboration with Ministry of Panchayat Raj and Rural Development and National informatics (NIC). Project provided opportunities to explore cloud based geospatial applications for the first time.

Project NHRR: The National Health Resource Repository (NHRR) project implemented to create a web-based and geo-mapping enabled single platform of all public and private health facilities in India, and to create detailed data inventory on health infrastructure, human resource (specialized doctors, paramedical staff) and the availability of medical facilities in each healthcare establishment in the country. A comprehensive information technology platform equipped with data analytics techniques is developed to generate useful insights for policy makers, providers, development agencies and citizen. A standardized, secured information technology and analytics enabled repository was created for the country's healthcare resources with a unique number to all recognized healthcare establishments of public and private to strengthen evidence based decision making." The project was conceived and developed in collaboration with Directorate of health Intelligence, Ministry of health and family welfare.



With the constant encouragement and opportunities provided from time to time in my career of 32 years in ISRO/NRSC, I have many achievements to my credit and recognisation at regional, national and international forums. Visited CNES, France for a crash training on VIPS Image Processing COTS package in 1987, soon after joining ISRO. Represented India in UN/ESCAP, Bangkok on 'Committee on Managing Globalization', and Chaired fourth session of the committee in the year 2007. I have received Team Excellence Awards for executing successfully four national projects as Project Director/ Deputy Project Director 1) Rajiv Gandhi Drinking Water Mission "RGMDWM Mission" in 2008, 2) Web based Water Resources Information system "India-WRIS" national project in 2012 in collaboration with Central Water Commission, 3) National project on "Space based information support for decentralized planning - SISDP" in 2015 in collaboration with Ministry of Panchayatraj and 4) National project "Inventory and site management plans for Heritage sites and Monuments of National importance in the country - SMARAC" in 2018 in collaboration with Ministry of Culture.

Geospatial technology is fast emerging as an integral part of Information technology & digital services and location based services (LBS) as an important component of public good services, e-governance services in government sector and equally important and promising in the business & commercial world in business geographics, e-commerce domains.

Events take place everywhere & Location is a central factor for every activity ranging from Real estate to Rocket science. Value added products and maps are default visualization of data with Location info. Geotagged data with business metrics provide Business intelligent outputs for Transparency, Monitoring, Evaluation, Optimisation and Developmental planning. Some of the emerging New Business opportunities in LBS are Automatic check in at work places, Housekeeping, Security, elderly care, maintenance etc, keeping track of equipment, construction machinery, scaffolding, Precision farming, Digital advertising, hyper local visualisation & positioning, Location based business Register, Service delivery, Procurement, Licensing business & validation, Disaster management etc etc. Next decade is the decade of geospatial technology with ample opportunities to develop innovative applications in niche areas. Space technology liberalized by the government, throws up new challenges to compete and compliment industry.

My Journey with NRSA/NRSC

Dr Nagaraja Ravoori
Former Chief General Manager
(Regional Remote Sensing Centres)

I embarked on my professional career at the National Remote Sensing Centre/Agency (NRSA) on the 12th of February, 1982. Looking back, it was a time of both immense challenges and growth. What initially seemed like just another job became a profound journey through the world of geospatial applications, one that would see me contribute to national development in meaningful ways over three decades. My career intertwined with the evolution of space-based, aerial, drone, and ground-based data collection systems.

I joined NRSC (formerly NRSA) after an unexpected turn of events that led me to drop my postgraduate studies at IIT Kharagpur. During a field assignment in Kochi, Kerala, I was fortunate enough to receive an interview letter. What followed was an adventure in itself—I had lost my certificates on a train journey to Kharagpur. Fortunately, they were later discovered in a friend's hostel room in Guindy Engineering College, Chennai. With the dramatic retrieval of my, I made my way to Hyderabad for the interview, arriving just in time at 9:00 AM. I was selected for the position, and thus began my career at NRSC, where I was assigned to the Land Use Division within the Applications Group.

This unexpected opportunity could not have come at a better time. I had recently completed my Postgraduate Diploma in Remote Sensing at Guindy Engineering College in Chennai, which equipped me to dive headfirst into real-world projects. My first task was to analyze the impact of the Malprabha and Ghatprabha multipurpose reservoirs on land use changes in northern Karnataka. In those days, much of the data was extracted through visual interpretation—an intensely manual process. Digital tools were scarce; in fact, we had only one MDAS digital analysis system for the entire group, and it had to be booked in advance. Later, one more system added namely IMDAS system, but the demand was so high that I often found myself working night shifts to access the ARC/INFO GIS software.

Chaiman Vist at NRSC

Throughout my career, I had the rare privilege of working under all eight of the first directors of NRSC. My colleagues would often joke, calling me the "blue-eyed boy" of every director, a testament to the trust and responsibility I was given. I grew alongside the organization, contributing to its most critical national projects. These projects were not just about research and data—they were about solving real-world problems. They paved the way for geospatial solutions in national resource management and development, giving NRSC recognition on the global stage.

National Forest Cover Mapping: In the early 1980s, under the visionary guidance of Prof. Satish Dhawan, NRSC embarked on a mission to map India's forest cover using archived satellite data for two periods 1972-75 and 1980-82. As part of this project, I played a crucial role in interpreting the data, conducting ground validation and area estimation using primitive method -dot grid. The results of our work became the baseline for the nation's forest policies and initiated a process of biennial forest cover analysis to monitor changes—a practice that continues to shape policy today.

National Wasteland Mission: The National Wasteland Mission was one of the landmark projects of my

career. I was deeply involved in its conceptualization and design, eventually leading its execution. We created a comprehensive database across three time periods, which became a valuable resource for a range of national development programs. When the first Wasteland Atlas was released by then Prime Minister Atal Bihari Vajpayee, I knew we had made a lasting contribution to the nation. Beyond data, we transferred cutting-edge remote sensing technology to State Remote Sensing Centres, strengthening India's overall capacity for geospatial analysis.

User Interaction Meet - 2014

Land Use Land Cover Mapping: Another key project was the National Land Use-Land Cover Mapping, which used three-season satellite data to provide accurate land use statistics. For the first time, this remote sensing data was accepted as a standard for policy-making across various government agencies. This was more than just a technical achievement—it was a paradigm shift, enabling the government to make better, more informed decisions about land use and planning.

NRSC Cricket team with Director NRSC Dr K Radhakrishnan after winning the Cup

Space-Based Information Support for Decentralized Planning (SIS-DP): In the mid-2000s, I was entrusted with leading the SIS-DP project, which aimed to use satellite data to support grassroots-level planning across the country. My team and I worked on developing procedures for generating ortho products using satellite data and creating a 10K geospatial database for panchayat-level development activities. We even launched the Bhuvan Panchayat Geoportal, a tool designed to help implement e-governance across rural India.

The success of these projects—Land Use Mapping, Wasteland Mapping, and SIS-DP—helped embed Remote Sensing and GIS into India's planning systems. Our work impacted agriculture, rural development, infrastructure planning, and more. It was especially fulfilling to see our methodologies being adopted across the country, and to know that our data was playing a direct role in shaping the future.
Transition to the National Data Centre (NDC)

Best Scientist Award receiving from H'rable CM Chandrababu Naidu

In a pivotal career move, Dr. K. Radhakrishnan, then Director of NRSC, encouraged me to shift from the applications side to the National Data Centre (NDC). There, I was tasked with optimizing NRSC's products and services for a wider range of users through yearly User Interaction workshops, improving turnaround

Release of First Cycle Atlas by the Honarable PM Shri Atal Bihari Vajpayee

Release of Second cycle wasteland Atlas

times, and ensuring that our remote sensing data policies met both user needs and national security requirements. This period laid the foundation for the current geospatial policy, which has made satellite data more accessible than ever.

Leadership and Teamwork: As the Chief General Manager of Regional Centres, I was able to enhance infrastructure across our offices, particularly in Jodhpur and Kolkata, and I initiated the process of establishing a new centre in Delhi. Throughout these years, I was fortunate to have my wife, Dr. T. Anasuya, working alongside me as a colleague. We supported each other professionally and personally, and our colleagues affectionately referred to us as "Made for Each Other." Our partnership extended to the sports field, where we helped initiate cricket and badminton tournaments between organizations.

International Contributions and Recognition: My work extended beyond national borders. I had the honour of representing NRSC at various international conferences, including the UN-FAO meet in Florence, Italy, where we helped finalize global land cover standards. I also served as Secretary and Co-chair of key working groups within the International Society for Photogrammetry and Remote Sensing (ISPRS). One of my proudest moments was organizing the ISPRS TC VII Mid-Term Conference in 2002, which showcased NRSC's contributions to the global remote sensing community. My career at NRSC was deeply rewarding, and I was fortunate to receive several honours that recognized my contributions. These awards reflect not just my individual efforts but the collaborative spirit of our teams at NRSC and the pioneering work we undertook in pushing the boundaries of geospatial technology for national development

Voyage to the Establishment of Flight Facility as Centre of Excellence in Geospatial area

K Kalyanaraman
Former General Manager
(Aeriel Services and Digital Mapping)

I joined the Research Flight Facility of NRSA since its inception and was associated in its growth from a humble beginning to the present modern Centre of excellence in Geo-Spatial area and Airborne Remote Sensing.

The growth had many facets: Establishment of Facilities with the latest technologies, Growth of skilled manpower with necessary training, Execution of landmark Projects, Involvement of Private enterprise in the programs, NRSA as a focal agency for execution of Landmark ISRO Projects and above all carried out Projects abroad meeting International Standards and getting the seal of approval for the expertise developed.

The Research Flight Facility (RFF) was started in a hanger in HAL (Hindutan Aeronautics Ltd) Bangalore in 1976 where a Dakota DC 3 aircraft of NRSA was structurally modified to house Carl Zeiss Aerial camera. Several cities were photographed using the camera. A Canberra PR aircraft of Air Force was also modified to house the camera for high altitude photography. A beginning in Airborne Remote Sensing was made by the acquisition of a Bendix Multispctral Scanner. Data Processing facilities were set up in the Technical group. A HS 748 Aircraft was added to the fleet and all the 3 aircraft were modified to fly the camera and scanner. A challenging International Program (MONEX 1979) Monsoon experiment was undertaken by RFF at this stage. The aircraft collected meteorological data in East coast and west coast of India by flying into the sea. The data quality was excellent and was appreciated by the USA and USSR counterparts. Regional Aeromagnetic surveys were carried out for Geological Survey of India (GSI AMSE) (for more than 70 % of India) for ONGC (more than 70,000 line kms) & High Resolution surveys at 400 feet above GL. For AMD Hyderabad, (Department of Atomic Energy DAE) (40,000 line K.M), for Director General. Hydro Carbons (DGH) (25000 line K.M). SAC developed Hyperspectral scanner, Side looking Airborne Radar (SLAR) and various scientific payload developed by ISRO were flown in NRSA aircraft after carrying out several structural modifications.

The Bendix scanner was replaced by a Daedulus Mulitispectral Scanner. Now a modern Beechcraft Super King Air B-200 and B300 aircraft with muliti sensor housing capability were added to RFF. Expertise was built up now in Digital Topographical mapping by acquiring state of art Photogrammetry systems, GPS, GIS etc. Large scale Topographical databse was created using aerial photography and Digital Mapping for more than 100 cities in India for various State and Central Govt agencies. In order

to achieve this, several Private organisations were involved / developed in the modern photogrammetric domain. At this juncture, a Major Project of ISRO was undertaken with AS&DM as the Nodal point: Ground Control Points Library (GCPL) creation for Cartosat satellites; Under this Project, a WGS-84 datum was created using extensive GPS Surveys covering entire India. More than 10,000 image points collected spanning entire country with high accuracy. Multimedia Oracle data base created for the GCPs for the first time. The GPS Library database is being used operationally by NRSC for Cartosat data products creation. Airborne SAR developed by SAC Ahmedabad was successfully installed and flown in

Visit of Mr Prithviraj Chavan, Minister of State

NRSA aircraft. A special Radome was designed and fabricated indigenously by AS & DM., Airborne Laser Terrain Mapping (ALTM) System was selected and operationalised in ISRO with AS & DM as a Nodal Centre: Accurate ground elevation with better than 20 cms accuracy were obtained over several flood plain areas. NRSA aircraft with ALTM has carried out several Disaster Management programs. It was nodal centre for another project of ISRO, Large Scale Mapping (LSM) Project, wherein Mapping standards & Methodology were developed for large scale maps using high resolution satellite imagery. Maps prepared for more than 100 cities in the country.

Visit of Ukraine diplomatic officials (2002)

Projects Abroad :Several International Projects were carried out by taking the NRSA aircraft to the required locations, process the photographs locally / at NRSC and also carrying out GPS Survys / Digital Mapping while meeting the International Standards in Nepal, Sultanate of Oman (Muscat) , Bhutan, United Arab Emirates (Dubai) , Sri Lanka and entire country of Maldives. Each country had great challenges: Nepal, Bhutan (Hilly terrains), Muscat, Dubai (Desert), Maldives(small pieces of land in vast ocean) etc. A Geodetic Datum was established in Maldives for the first time by extensive GPS measurements. We also carried out Airborne Lidar Surveys in the areas

Visit of Russian delegation (16-Sep-2005)

affected by Tsunami in Indian coast (East & west), Sri Lanka and Maldives using NRSC aircraft.

Visit of Minister of Planning, Maldives (2002)

Looking back, it gives a great level of satisfaction and pride to note I was also part of the excellent strides in various areas and the execution of various Projects which are worth remembering.

This would not have been possible but for the excellent band of dedicated and committed young men and women at AS&DM.

My Journey with NRSC

Veerlapalli Vittal Reddy
Former Group Director
(Data Processing and Archival)

Going back in to my memory lane, I recollect three decades of my journey with NRSA (now NRSC). My service and growth in NRSA/NRSC can be broadly classified in to three phases which can be also correlated with Organisation's growth.
Phase-I: Initial/Development (1980 to 1989)
Phase-II: Fast Growth (1990 to 1999)
Phase-III: Consolidation/Stabilisation (2000 to 2009)

Phase-I: Initial/Development Period (1980 to 1989): I Joined NRSA in 1980 after taking 2 years Lien from Defence Electronics Research Laboratory(DLRL/DRDO) where I had worked earlier. My initial days in NRSA were eventful, rather tough. I was posted in Earth Station Division, headed by Mr. D.V Raju. I worked there during 1980 to 1983. Then, both Antenna & Receive System (ARS) and Data Processing Systems (DPS) were co-located at Earth Station, Shadnagar. DPS was consisting of a DEC PDP-11/55 Computer & peripherals with real time Operating System (RSX-11M), Sangamo make High Density Digital Tape Recorders(HDTRs) and an Optronix 241 mm Film Recorder, etc., Landsat-2 & 3 and Metsat data was being acquired, recorded and processed there daily. We were total about 15 engineers (both ARS & DPS together) to operate, maintain and generate Remote Sensing data products, quality check and send them to NRSA, Balanagar for supplying to users. I feel those were golden days though they were tough. There were no facilities, not even a canteen! We (4 or 5 engineers) were going to Shadnagar daily in shifts in a Matodor van starting our day (for some of us like me) as early as 4 AM (as I was staying far off in northern end of Hyderabad, Bolarum) and reach Earth Station at Shadnagar around 8 AM after having our breakfast on the way at Devi Prasad Hotel (Shadnagar) which was only source of food for us! We ourselves used to cook food for our lunch & even dinner. Most of the time, at least one DPS engineer used to stay back in night at Earth Station as both preventive & corrective maintenance of DPS sub-systems was to be carried out in-house as there was no external help from maintenance agencies like CMC, CMA, etc., those days. Then, on one fine day (rather we used to call it a black night) total DPS System was shifted to Technical Division, NRSA, Balanagar and we (most of the DPS engineers) were transferred to Technical Division, Balanagar along with DP System. We resisted this move, but could not prevent. There used to be rift between us (erstwhile Earth Station staff) and Technical Division staff for quite some time because of this.

Visit of Dr K Kasturirangan, Chairman, ISRO

Now, if we look back, things have moved in full circle and all the DP Systems have moved back to Earth Station, Shadnagar again after almost three decades!

During this phase (after the initial days at Shadnagar which I described above), in 1984, we (myself & other DPS engineers) started Hardware Development work related to IRS-1A. First indigenous Remote Sensing Satellite, IRS-1A, was planned/ scheduled for launch during late eighties. For this, we designed & developed a Frame Sync & Decom Unit (FSDU). This Hardware unit was a crucial link between HDTR & Computer. Satellite data acquired and recorded on HDTR is passed through this unit which frame

synchronises & decommutates and converts in to writable form on to the computer hard disk. My own contribution in this was design & development of Micro-processor (Intel 8748) based IRS Test Pattern Generator. My other colleagues of FSDU development team were Mr K V Ratna Kumar, Mr Francis, Mr V V S Nageswara Rao & Mr M Prasada Rao. Ten FSDU Units were fabricated & tested in-house, installed in DAS at Earth Station (Shadnagar), IRSDPS (Balanagar) and also supplied to ISAC and SAC for their use. In the same year (1984) I and Mr M Sankaran (Earth Station Division) went to Denver (Colorado), USA to perform Factory Acceptance Tests (FAT) on ten Honeywell HDTRs being procured which were required for use in recording of IRS-1A data.

Then came the great event, launch of first indigenous operational Remote Sensing Satellite, IRS-1A, on 17th March, 1988. This period was fine example of joint effort between SAC, ISAC & NRSA. H/w (FSDU) was developed by NRSA (our team) and Data acquisition & Processing S/w was developed jointly by NRSA(s/w team), ISAC & SAC. This launch of IRS-1A was an exciting event for all of us not only for NRSA but for whole ISRO/ DOS, in fact, for the whole nation (India)!

I was designated as Head, IRS DPS Section and was in-charge of IRS-1A Data Processing operations generating IRS-1A Browse (level-1) and Data Products (level-2) for which I was lucky to get a dedicated team for performing 24x7 three shift operations.

Phase-II: Fast Growth Period (1990 to 1999): During this period (in August 1991) IRS-1B was launched which was continuation of IRS-1A whose data was also processed in IRS DPS for which I was in-charge. Then, came IRS-1C launch in 1995 for which I was Dy. Operational Director and was responsible for its Data Products generation operations as Head Data Processing Division.

Then, came a very significant event - the Design & Development of Front End Hardware (FEH) Unit by our team consisting of few dedicated engineers – myself, G Satyanarayana & T Giridhar (both of them left NRSA, went to USA later), K V Ratna Kumar, S K Mythili and K S Narayana. This was quite a significant/landmark development as this used latest/ state-of-art technology - (next generation) VLSI ICs — Digital Correlators, EPLDs, Micro-Controller, FIFOs, SCSI Controller and miniaturized the unit which was fabricated to meet stringent International (FCC, USA) Standards. FEH Unit was initially developed for EOSAT Project for pre-processing IRS-1C, 1A & 1B data at International Ground Stations (IGSs). We, as a team, took it as a challenge, worked day & night and delivered the first unit in less than three months (80 days in fact) which is a significant achievement. I still remember that final day of delivery of the first FEH unit on 21st May 1995.

All of our team members were awake previous night to make the unit ready for delivery. Those moments are memorable for all our team members as Prof. Deekshatulu, then Director, NRSA has appreciated us very much for delivering a world class H/w Unit meeting the stringent dead line. We are thankful to Mr Jairam Hebbar (DD, DP at that time) who encouraged us to take up this task and supported us fully in achieving it. S/w team led by Ms Lakshmi, parallelly worked and developed the required driver s/w for the same and they have met their deadline of 1st June 1995.

This FEH unit developed for using in IRS-1A, 1B & 1C Satellites data acquisition & pre-processing, replaced both FSDU (for 1A&1B) & MFPH (for IRS-1C) used till then. FEH units were used in DAS, NRSA (Shadnagar), DPS (Balanagar), at DIPAC (Delhi) and IGS Stations like USA, Germany (for IRS-1C & P3 also) & Japan saving & earning lot of Foreign Exchange. I am also happy to mention here that for development of FEH unit we have been awarded 2nd Prize for Best Invention at All India Industrial Exhibition held at Hyderabad during the year 1998. We lost the 1st prize to none other than the great scientist Dr Abdul Kalaam & Dr Soma Raju's joint invention, Kalaam-Raju Stent.

I have personally installed FEH Units, integrated & tested with DA & DP Systems of IRS International Ground Stations (IGS) at Euromap (DAS&DPS), Germany and Kumamoto (DAS), Japan & Tokyo (DPS).

at Euromap, Neustralitz, Germany

During this period, I was heading Data Processing Division, was also Operational Director(DP&D) for IRS-P4 (Oceansat-1) and responsible for Operationalising the total IRS-P4 Data Processing chain.

As DPD DPS (H/w) SARPAD Project (1995-1998), I was responsible for Configuring Computer Systems , Procurement, Testing, Installation & Operationalisation and Warranty Maintenance of all Data Processing Systems of IRS-1C & 1D at DIPAC, Delhi.

First Front End Hardware Unit developed by DPD team, NRSA

I was also Dy. Project Director for IRS-1D (DP) and responsible for design, development of DP H/w & S/w, Procurement, Installation & Testing and readying all the Systems of DP Chain well before launch.

Phase-III: Consolidation /Stabilisation Period (2000 to 2009): During this period, I was Heading Data Processing & Archival Group, consisting of three Divisions – Design & Development Division (Mr K V Ratna Kumar as Head), Data Archival & Transcribing Division (Mr C S Kumar as Head) and Data Processing Division (Headed by Mr K S Narayana).

Another significant task performed by our Group in this period was Design & Development of Advanced Front End Hardware (AFEH) using state-of-art technology which is Augmented version of FEH. AFEH was initially designed for processing IRS-1D data in real time and also previous satellites IRS-1A, 1B & 1C data. Later, this unit was upgraded with required modifications for processing IRS-P4(Oceansat-1) data and High Bit Rate data of all IRS Satellites - IRS-P6, Cartosat-1, 2, 2A & 2B and Oceansat-2. This has become a workhorse for all IRS series Satellites' data pre-processing.

During this period, we have fabricated & tested 81 AFEH Units in-house, performed stringent QA on all


58th All India Industrial Exhibition 1998
HYDERABAD A.P.

Certificate

Joint Second Prize

AWARDED TO Shri. V. Vittal Reddy & Team

for Best Invention

EXHIBITION SOCIETY HYDERABAD

HONY. SECRETARY PRESIDENT

Certificate issued by 58th All India Industrial Exhibition held at Hyderabad

of them meeting International Standards like FCC (American) and CISPR (European). These units were used in all IRS Projects at NRSC(36 units) and also supplied to different Ground Stations in India and abroad (6- SARPAD, 6- Cartosat-2A/2B Stns. & 33-exported to International Ground Stations) saving and earning lot of precious Foreign Exchange for ISRO/ India. Here again, we took as challenge and fabricated , tested & supplied 6 AFEH Units to 5 Defence Ground Stations for use in Cartosat-2A/2B data processing in a record time of 6 weeks.

Later, during 2008-09, our group also designed & developed PCI based VHS (320 mbps) AFEH Unit for processing high bit rate RISAT data.

Apart from the above (design & developments), as Dy.Project Director (NRSA Elements) IRS-P6, established total P6 DP Chain and as Operational Director (DP Opns) Cartosat-1, post launch, operationalised total Cartosat-1 DP Chain. As DPD DPS (H/w) SARPAD Project, I was responsible for up-gradation of DP Systems for TES/IRS-P6 at DIPAC, Delhi.

As DPD (DPS H/w) MMRSGS Project, I was responsible for procurement of all DP Systems, integrating, testing & installing them at NGO Ground

Mr V Vittal Reddy receiving 2nd Best Invention Prize

Station (IRAN) and acceptance of DP Chain by NGO. I have myself carried out the Acceptance tests on DP Computer Systems & peripherals successfully at NGO (Tehran), IRAN in 2001.

Visit of Dr K Kasturirangan (24-Jan-2006)

I was Focal Point person for IGS/ANTRIX H/w Elements, responsible for procurement of DP systems, integrating and testing AFEH units with them for various International Ground Stations.

At the end of my career in NRSC(during 2008-09), I was Group Director, Data Processing & Archival, responsible for Design, Development, Fabrication & Testing of AFEH, giving maintenance support at various National & International Ground Stations. Also, responsible for Data Products Generation & Transcribing of all IRS Satellites –IRS-1A , 1B, 1C, 1D, P4, P6, Cartosat-1 & 2, OBSSR(SVALBARD) data and all (non-IRS) TM, SPOT data, etc., in NRSC. Apart from the above, I was Chairman/Member for Various Technical Committees like- IRS T&E Committees, Chandrayaan-1 ISSDC S/w Systems T&E Committee, Engineers/Technicians Selection Committees and non-technical Committees like SPC, JPC & Technical consumable Committee, etc.,

Visit of Brazil delegation (10-Aug-2007)

Finally, when I look back, whatever I contributed/ achieved in NRSC, was mainly due to my colleagues who have given me excellent support during all times without which it was not possible. Hence, I owe & express my gratitude to all of them, specially, Mr K V Ratna Kumar & Mr K S Narayana who were main pillars of my growth in NRSC. Sometimes, we used to fight rather argue seriously (not only within our group but also with other groups!) but it was all on technical issues, not for any personal reasons. We all were & all are friends forever! I have enjoyed life in NRSC and have no regrets for whatsoever.

I wish best future for NRSC, especially for my younger (ex) colleagues who are still putting their best efforts for running the organisation efficiently.

Visit of Saudi delegation (14-Aug-2008)

Life Before, During and After NRSC

Dr Naresh Chandra Gautam
Former Group Director
(Land Use, Cartography and Map Printing Group)

Being brought up in a large family, I was known to be the most mischievous and often got into trouble. One reason for my ill-behaviour was my curiosity to explore new things and learn first-hand from those experiences. Upon graduating, the same curiosities lead me to pursue my higher education and helped to sharp my carrier. While working as a lecturer at Rajasthan University and simultaneously perusing my Ph.D., titled "Urban Land Use of Bikaner Town", I received an opportunity to join National Remote Sensing Centre (formally known as NRSA) as a Scientist in early 1976. It was with great hesitation I accepted the offer, since the organization was newly formed and I was relocating from Pink City Jaipur in Rajasthan. Since then, I have called Hyderabad my home and never looked back. In 1998, a few years before my retirement, I lost my wife due to prolonged illness. This changed my life and created a gaping hole of emptiness. Nevertheless, I have several moments to cherish and reflect upon. I consider myself among the few fortunate who had an opportunity to work and grow under great leaders. At first, things did not come easily as I had to prove my ability and tenacity to deliver projects on-time and on-budget.

At a glance back, in 1991, I, along with my staff decided to adopt a uniform (which we all put on once a week) to reflect team spirit and equality. To this day, I don't believe there is any division or section within NRSC who has done such a phenomenon.

While at NRSA, there were several notable accomplishments that I recall, but the two projects that made me stand out were:

- Land Use Mapping of India
- Wastelands Mapping of India

These give the statistics and spatial distribution of Land use and Wasteland in India to reconcile the old figures. In 2000, when the "Wasteland Atlas" was presented to Prime Minister of India (Mr Atal Bihari Vajpayee), he himself congratulated the team for this feat.

For those with little knowledge on Land Use, understanding the domain and trends of change is

Dr N C Gautam receiving "Bhoovigyan Ratna Award" from Mr. Bhairon Singh Shekhawat, Vice-President of India (2002)

essential if India is to tackle the problem associated with haphazard and unconditional growth. A systematic framework is necessary to update the Land Use and Land Cover maps that are timely, relatively in-expensive, and appropriate for various states and national level needs.

Land use is captured by describing the lands purpose and a sequence of operations so that land use purposes can be achieved. Resources used may include soil, water, crop growth, and national vegetation etc., therefore combination of one land unit and one land utilization type constitutes a Land Use system.

I joined NRSC in 1976 and retired in 2001. During my twenty-five years of service, I focused on establishing honour and respect for the organization towards the end of my journey. NRSC employees arranged a memorable farewell that I cannot forget during my lifetime.

Upon retirement, I began a consulting firm named "Centre for Land Use Management" (CLUMA) and started focusing on those things I could not pursue while at NRSC including:

- Authoring books (LIS etc...)
- Imparting Management Training
- Organizing National Seminars
- Consulting services to Start-Ups

In 2002, I received the "Bhoovigyan Ratna Award" for my contribution in the field of Remote Sensing by the Vice President of India (Mr. Bhairon Singh Shekhawat). These efforts have kept me going for the past thirteen years.

I do keep in touch with most of my NRSC colleagues (a large number of them now retired) via email and often run into them at social gatherings and functions .

Before I end, I would like to take a moment to acknowledge and applaud the individual(s) whoever came up with this noble idea of Reminiscences as NRSC completes its 40 years journey.

My Journey with NRSC

Dr L Venkatratnam
Former Group Director
(Agriculture & Soils)

I joined NRSA on 1st December 1975 as a scientist (Soils) in the Applications Division after resigning as Asst. Soil Chemist, UNDP Project of Central Groundwater Board, where I have worked for over 2 years. Initially, NRSA was under Dept. of Science and Technology and later moved to Dept. of Space which catalysed the expansion even after Wg Cdr K R Rao who laid strong foundation to the organisation and Prof Deekshatulu took over as Director and continued more than a decade.

I enjoyed my time at NRSA as a scientist and got elevated to higher grades initially as we have done meritorious project work, although promotion to Scientist SG and G grades depended on various other factors. NRSA was carrying out projects related to applications of remote sensing on assessment, mapping and monitoring of natural resources like soils, forests, water resources, crops etc, managing the project work including ground truth collection, and finally submission of project reports including the maps in time to users are the main tasks of application scientists which needs interaction with administrative officials, computer scientists, data processing engineers of technical wing in NRSA as well as officers of user departments of state and central government. In the process, our scientists and engineers have become experts in project management and presentation of their work at various levels at project management meetings, user interaction seminars as well as national and international seminars, symposia and conferences.
In general, scientist's life in NRSA was good that provided vast opportunities, encouragement and freedom to do the research in addition to regular work related to projects, permission to guide M.Sc. (Agri.), M.Tech. (Remote Sensing) and PhD students registered in different Universities, attending in several seminars and presenting the scientific work in India and abroad and contribution in various scientific and other committees within Dept. of Space and other Departments pertaining to states and central government. In the process, I personally attended several seminars and conferences in India and in countries like USA, Netherlands, Canada, Kenya, Hungary, Thailand, Burkina Faso, Norway and USSR. To be an active member in scientific committees, ISRO was always lively to learn and also to gain/earn leadership qualities, which really transformed many scientists of NRSA into good leaders in their fields of interest. Thus many of our scientists are known not only in our country and even abroad for their scientific contributions.

After three month basic course at IPI (now IIRS), I was sent for another three month training in USA along with other scientists joined in NRSA, at different institutes including LARS at Purdue University mainly on digital analysis of satellite data obtainable only at Eros Data Centre, Siuex Falls, S. Dakota, in those days. After coming back from USA trip, we did a small Training Project headed by Lt Col. Narayan. Head of Applications Division using available B&W prints of Landsat-1 at 1: 1 million scale (2nd and 4th bands) along with paper print of an area in Punjab state. After about a month, we made meaningful maps on different themes like soils, geology, geomorphology, water resources, land use etc., and the project report was brought out with colorful maps. The report was sent to various user departments in the country that resulted in several requests for such maps using satellite data that paved the way for obtaining several application projects to NRSA.

I have participated in more than thirty projects at NRSA either as project scientist or as project coordinator cum scientist. In addition to mapping of natural resources of states like Nagaland, Meghalaya, Haryana etc, I also coordinated and participated variety of projects concerning land degradation from agricultural departments, pollution aspects from CPCB, as well as in IGBP related project from ISRO. I was also Project Manager for nationwide project on 'Mapping of Salt-affected Soils of India" and these maps were prepared in cooperation with ICAR and state/ central agricultural departments that were printed at NRSA.

Since its establishment, I have grown with NRSA, acquired skills, leadership qualities (awarded a silver and gold medals by Indian Society of Soil Conservation), management abilities, teaching and guiding at PG and doctoral level and got promotions from Scientist to Head, Soils Division; Head, Agriculture and Soils Division; Group Head, Agriculture & Soils Group, and finally retired as Group Director and Scientist G, Agriculture & Soils Group, in 2004. I also had a chance to conduct a couple of national seminars during my tenure and got acquainted with several scientists from different organisations in the country.

I am not sure whether many younger scientists in NRSC may know or not that I was responsible to start the Cooperative Housing Society and Cooperative Credit Society as General Secretary (elected) of NRSA Welfare Society, for which Shri D V Raju, the then Dy. Director was the Chairman. This committee was active in conducting sports and drama and other entertainments during NRSA day celebrations. Currently, I am not staying in my house in Secunderabad, but prefer to stay in my small farm house in Guntur district in midst of greenery observing the spatial/ temporal changes of spectral reflectance of the agricultural fields around my house, in different seasons of the year.

Reminiscences

A K Chakraborti
Former Group Director
(Water Resources)

Memory fades in time waves. People, date, time, place are difficult to remember. But some events remain as story and some people remain as image in the inner mind. Reflection of one such event, at the initial stage of NRSA, can be shared with the present-day young NRSC generation.

An Air-borne Remote Sensing Mission 36 years ago: NRSA was anxious to catch up national scene very fast. With assets being added: satellite receiving station at Shadnagar, digital image processing facility at Balanagar, air-borne flight facility at Begumpet airport and Indian Institute of Remote Sensing at Dehradun, in quick succession, need was to demonstrate our capability. Airborne Modular Multi-spectral Scanner (M2S) with 11 spectral bands was bought from USA under UNDP grant-in-aid. In the Governing Body meeting some time in late 1977, it was decided to put this instrument in to operational task over Kosi River. Kosi is one of the trickiest rivers in the world. It is said to have changed its course in a belt of 112 km within a period of 130 years. In the process, it has brought many thousand tonnes of sediment loads in to its flood plain. The area of airborne survey was to cover 2500 sqkm in north Bihar and 1500 sqkm in Nepal with a meager fee of Rs 2 lakhs to NRSA for survey and product delivery in-situ! Sweet NewGen, are you amused or scared?

Mission teams were formed. Dr LRA Narayan, then Head of Application Division and Prof B L Deekshatulu, then Head of Technical Division would coordinate from Hyderabad. Late A S Ramamoorthi and S Raghunathan would lead the respective teams at Patna and Birpur and report progress every day evening. On 5th January 1978, Ramamoorthi, myself and Kundalia from Application Division and Raghunathan, Mittal, C S Kumar, Ravinathan and Veerabhadra Rao from Technical Division were huddled in to our Dakota aircraft fitted with M2S scanner stationed at our Begumpet flight facility, where Wg Cdr (Retd) J Farmie (Pilot), Wg Cdr (Retd) Singha (Co-pilot), Sq Ldr (Retd) HS Mangat (navigation & operation manager) and Wg Cdr (Retd) GS Negi (navigator) greeted us inside the aircraft. We were part of an operational task and there could be no complaint about sitting arrangement around electronic gadgets and scanner, no food, huge noise of the aircraft engine, slow speed, long flight (more than 4 hours). On arrival at Patna, Ramamoorthi and I proceeded to Birpur near Nepal border by road. Our job was to brief the Kosi Project authorities, arrange red flags at points along 116 km river main as flight path for the pilots and navigators to cover the ground area of interest while flying. After 2 days of flip-flop about cloud cover and flight abort, airborne flight over Kosi was successful on 9th and 10th Jan 1978. M2S visicorder B&W prints in several spectral bands were generated by Raghunathan's team in make-shift digital processing and photo-lab in Kosi guest house at Patna. Next day, Kundalia brought the print outputs from Patna to Birpur, and following next 3 days, we three tried to visually interpret the scanner outputs by rolling ourselves on the floor of the Kosi guest house! Well, a mission was born and made successful in spite of odds in communication, logistics and first time experience. Report and maps were prepared. On the strength of it, NRSA received the repeat job order from Irrigation Dept., Govt. of Bihar for the 2nd airborne flight which took place on 31st October and 1st November 1978 to map pre and post flood change detection.

I remember this airborne RS mission in another angle. On inspiration from the then Director NRSA, Wg

Cdr (Retd) K R Rao, who was to address COSPAR at Bangalore, I made my 1st debute in international presentation (I was then 3 years in remote sensing profession) in this conference on 'Study of Kosi River Characteristics using Airborne / Space Orbital Multi-spectral Scanner Data' (see COSPAR Proc. Pergamon Press publication 1980). I remember my participation in COSPAR vividly in another context.

Visit of Smt. Vasundhara Raje Scindia, Minister of State (Independent Charge) (1999)

Prof P D Bhavsar, then Director SAC and organizer of Bangalore COSPAR was to make very special announcement in a late evening technical session. Suddenly, light was made dim in the conference hall, Prof Bhavsar appeared in the stage and made the most astounding announcement of successful launch of 'Aryabhatta' a few hours back (thus India entered the international space community); whole world had no inkling of this to happen; with lights on, unprecedented thunderous applause and standing ovation by the gathering followed.

Remembering those who pioneered application remote sensing: The then Director Wg Cdr (Retd) K R Rao had the superb management intelligence to select few at the entry level with whom he had the confidence to take NRSA to great height. Some of them who are no more with us:

A S Ramamurthi He came from Central Water Commission on deputation and later got absorbed in NRSA. As Head of Hydrology Division, a breakaway from Applications Division, he took initiative in 2 topics of his interest: snow cover in Himalayas and flood inundation mapping, where he felt that, remote sensing will have great value and early break-thru'. Rest of the water science in meteorology, oceanography, hydrology and water resources were left to Dr R K Gupta, Dr I V Muralikrishna, Dr S Thiruvengadachari and Chakraborti in his Division as he felt these topics are too dicey to digest at the moment. Dr Pavuluri Subba Rao (at-present CMD of INRIMT and Ananth Technologies) joined to assist him. Ramamurthi brought BBMB in to NRSA's fold way back in early 1978 with a pleading to pay Rs 8000/- annually to conduct experiment for 4 years to develop snow-melt runoff forecast model for Bhakra reservoir using NOAA-AVHRR data. Since 1984, this model is operational in NRSA ; a remarkable feet that an all important hydro-power producer in India uses remote sensing as end-use in sharing scarce summer water of Bhakra reservoir for power generation and irrigation water release to 5 stakeholders (Punjab, Haryana, Rajasthan, J&K and Delhi). Salute to ASR for his visionary zeal in satellite hydrology. He was an unassuming person, simple in living, content within the domain of Hydrology Division. Being diabetic, unfortunate thing happened in amputation of one of his legs. Even then, I used to hear from IIRS Dehradun that he was attending office. Ultimately, he succumbed to his injury and breathed his last just immediately after superannuation from NRSA service.

Dr N Madavan Unni He came from Physical Research Laboratory (PRL), Ahmedabad with forestry background. In fact, early research in remote sensing applications started in forestry with detection of 'forest blight' in Western Ghats by Prof Pisharoty and Dr Hariharan in PRL. Dr Unni used to take pride in working with these two great pioneers in remote sensing. In NRSA, he used to be virtual dictionary of flora and fauna, reeling Latin words of forest species at ease. He was a connoisseur of art and music. I still remember the Malayalam melody he tuned, while we were traveling from Guwahati to Shillong by car to attend NEC meeting. Dr Unni took the prime initiative for formation of NRSA Engineers & Scientists Association (NESA) and became its first President in 1982. In the mid-eighties, in line with NNRMS policy of opening door to promote remote sensing companies, Dr Unni too felt that inner call in him and took VRS. But he couldn't succeed in his single-man venture unlike other colleagues: Dr P Subba Rao (INRIMT) and T Sesha Rao (Remote Sensing Instruments) who corporatise remote sensing technology in to serious business. At the age of 59, he met with accidental death at Apollo Hospital while testing for diabetic in treadmill.

Dr R S Ayyengar A proud agronomist that he was, he obtained his formal PhD from Cornell University in USA and joined NRSA in early 1976. While we in Application Division jumped in to the bandwagon of operational remote sensing, Dr Ayyengar tried his remote sensing destiny with Mandiya rice crop experiment using airborne M2S sensor flights. The then Director had great faith in Dr Ayyengar's style and approach and allowed time for research to continue. Had he succeeded, he would have been the harbinger of 'CAPE' which SAC developed later. One quality in Dr Ayyengar was his ability to smart talking and a good presenter, which helped him to head the Training Division in NRSA at its formation stage. When the concept of RRSSCs came up, Dr Ayyengar was chosen as the First Head of RRSSC, Nagpur, in which position he continued till his untimely demise at the age of 59.

Dr R K Gupta He came from Indian Institute of Tropical Meteorology, Pune. Reception of NOAA-AVHRR data had started at Shadnagar in 1980 and he was given the responsibility to pre-processing of the data for use in snow hydrology and meteorology. A versatile researcher, he used to spend mid-night oil both at home and office to bring out quality papers for presentation in COSPAR, ISPRS, IAF conferences and in peer reviewed international journals. He had many admirers of his works in IMD and meteorological society. Longest period he spent in NRSA was in the role of heading the Training & Research Division till his superannuation in 2006. In my years at IIRS Dehradun from 1983 to 1996, Dr Gupta used to be regular guest faculty in water resources training program. A very simple living person and very frugal in money spent, I used to provoke him by asking 'what will you do with a crore of rupees worth of share held in blue chip companies'? He used to smile with a reply, 'we are from Marwari family, wealth creation is in our blood, and spending money is not in our psyche'. On retirement, Dr Gupta joined a private engineering college at Nagpur as professor and was very happy about his active educationist role. Saddest thing to befallen on Dr Gupta, while teaching in the class, he succumbed to cerebral attack and death instantaneously (he too was diabetic) at the age of 62. One month before, he came to Hyderabad for routine medical check-up and called me over phone, 'Chakraborti, I want to meet you and heartily talk to you as we used to do earlier'. Well, that did not happen!

My Experiences and Memories from NRSC

Dr B Rama Mohana Rao
Former Group Director
(Earth Resources)

I was associated with NRSC for the last 31 years till I retired in April 2008 as Group Director (ERG). My carrier started with IIRS, Dehradun (Formerly Called IPI). I joined IIRS in the year 1977 after completion of my PhD Programme in Soil Science from Pantanagar Agriculture University. Even though I was specialized in the area of pedology during my post-graduation, I was selected as soil chemist in IIRS, Dehradun. Later, I was trained in aerial photo interpretation in the area of natural resource mapping with special emphasis on soils. In the year 1979 I was called to NRSC Head Quarters for reviewing for my promotion. Dr Kasturirangan was member of the review committee and asked me questions about spatial technology and satellite based remote sensing applications which I could not respond well as I was working in the area of application of photo interpretation techniques in soils at Dehradun. Later in the year 1984, I was transferred to NRSC. Before coming to NRSC, I got the experience of working as warden of the IIRS trainees' hostel at Dehradun. As officer trainees come from different parts of the country with different food habits, satisfying them with food was a challenging job for me at the time.

After getting transferred to NRSC, Hyderabad in the year 1984, I was concentrating on satellite based remote sensing technology and participated in many National and International projects. Important projects among them are Nation Wide Mapping of Salt Affected Soils in collaboration with national organizations like NBSS & LUP, Nagpur and CSSRI, Karnal. I got the opportunities to work in many states for this project and got good experience in the area of mapping and monitoring salt affected soils. This project has resulted in providing good data base on location specific salt affected soils for India for the first time. Another important nationwide project is NATP - National Agricultural Technology Project where I got the opportunity to work as coordinator of the project. This project involves crop production systems approach in watershed management sponsored by ICAR under World Bank aid. This project has given me a lot of experience in working with different scientists of agriculture community in the country in preparing, implementation of action plans and monitoring the same in about 13 micro watersheds under different crop production systems located in different states of the country. I also felt very happy as RS&GIS techniques could be utilized for benefit of the farming community. I was also involved in other projects like IMSD and interacted with many organizations and contributed in soil mapping and the quality control aspect of the project. Another important project is nationwide mapping of land degradation, where I was involved up to the launching stage of the project before my retirement in April 2008.

One of the international projects I worked was soil mapping of Dubai. I used to wonder about the country as it has developed very well even though surrounded by sea water and desert without any productive soil and fresh water. They adopt drip irrigation and maintain avenue trees for hundreds of kilometers along the highways. We, in India, should also learn to utilize the limited resources optimally for development of the country.

Workshop on Land Resource Management
(21-Mar-1998)

My Journey with NRSC

Dr R S Dwivedi
Former Group Director
(Land Resources)

Soils are one of the most important non-renewable and finite natural resources. Ensuring food and energy security for ever growing population calls for bringing additional land otherwise lying waste under plough, and increasing the productivity of existing cultivated land. Information on the nature, extent, spatial distribution, and potential and limitations of soil resources is a pre-requisite for sustainable agriculture. Traditional soil surveys are time-consuming and cost-prohibitive apart from being labour intensive. Remote sensing offers immense potential in providing such information in a timely and cost-effective manner.

To begin with, pilot studies were taken up with Landsat-1 MSS data (standard false colour composite-FCC prints) at 1:250,000 scale for developing the methodology for reconnaissance level soil resources inventory. Simultaneously, efforts were also made to delineate salt-affected soils in a few selected areas on a pilot basis and the procedure for mapping and monitoring these soils through digital analysis of Landsat-1 MSS data was developed. These initiatives had led to the operational projects on inventory of soil resources of Andhra Pradesh and part of Uttar Pradesh; mapping of salt-affected soils of Haryana and pat of Uttar Pradesh. In these projects the nature of salt-affected soils in terms of saline, saline-alkali and alkali soils, and their spatial extent was brought out. Such information had enabled the user (Department of Agriculture, Government of Uttar Pradesh) in planning the reclamation of salt-affected soils, and subsequent launch a World bank-aided project on monitoring sodic lands.

Refinements in the level of information on soil resources, and on salt-affected soils that could be derived from space borne multispectral data were made with the availability of improved spatial, spectral and radiometric resolution data (e.g. Landsat-TM, IRS-1C/-1D LISS-III, and Resourcesat-1/-2 LISS-IV, Cartosat-1and high resolution data from commercial satellites like IKONOS-II, Quick Bird, etc.).

Pre-irrigation surveys, generation of derivative information, viz. land capability, land irrigability, suitability for a specific use; generation of land and water resources developmental plans, impact assessment of treated watersheds, performance analysis of irrigated commands, and land degradation due to shifting cultivation, tanneries, mining and aquaculture are some of the studies that were carried out subsequently. Monitoring salt-affected soils and waterlogging in major commands, namely Sharda Sahayak command in U.P., Krishnaraja Sagar in Karnataka, and Nagarjunsagar command in Andhra Pradesh are noteworthy. Detection of sub-surface waterlogging due to rising groundwater table in parts of U.P. and Mahanadi Stage-I command, Odisha using day-and- nigh time Landsat-TM thermal data, and MODIS SWIR and thermal band data, respectively is one of the innovative study.

Based on the experience gained at regional level, a national-level project on the inventory of salt-affected soils at 1:250,000 using Landsat-TM data was taken up in collaboration with the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), ICAR, Soil and Land Use Survey of India, State Remote Sensing Application Centres and other concerned organizations. For the first time, a reliable estimate of the extent and distribution of salt–affected soils was made available to planners and decision makers. Towards realizing the sustainability in agriculture

Visit of Planning Commission officials to NRSC (14-May-2010)

experiments on precision farming were conducted at the ICRISAT, CRIDA and ANGRAU agriculture farms involving paddy, pigeon pea, chickpea, and soybean and castor crops. As it is widely recognized, the changes in the land use/ land cover affect the albedo and ultimately overhead climate. Land use/ land cover dynamics in the arid ecosystems and its impact on long-term climate was studied over Thar Desert and part of Andhra Pradesh were studies under ISRO-GBP initiative. It had led to a national-level project titled "Land use and land cover dynamics and impact of human dimension in Indian river basins".

Visit of USDA officials (27-Oct-2009)

ation-wide wastelands monitoring and change analysis for entire country for two periods viz. 2005-06 and 2008-2009 using Resoiurcesat-1 LISS-III data is another major project executed for the Ministry of Rural Development. LU/LC mapping at 1:50, 000 scale from Resoiurcesat-1 LISS-III data of 2005-06 period under NRC/NRR project. So far, remote sensing-based maps were available only at 1:250,000 scale. Providing three times in-season information on spatial extent and distribution of major crops, namely, wheat and paddy that goes as an input for crop production forecasting under FASAL/ CAPE project is another important activity demonstrating the team spirit and maintaining timeliness.

Monitoring agricultural drought at national-level using NOAA-AVHRR data, and for A.P., Karnataka, Maharashtra and U.P. using Resourcesat-1/-2 AWiFS data while simultaneously striving for improvements in the methodology vis-a-vis technological developments merits mention. Lastly providing national-level information on in-season net sown area using Resourcesat-1/-2 AWiFS data since 2005 to the Ministry of Agriculture, Government of India is yet another initiative.

My Annals at NRSC

Dr Meer Mohammed Ali
Former Group Director
(Oceanography)

I initiated my adventurous odyssey to NRSA from SAC in September 1983. Even before my joining (there was a delay in getting medical fitness certificate), I informed Dr Pranav Desai, my head of the division, that I would like to go back to my home state sometime in future. He took me immediately to Prof EV Chitnis, the then Director of SAC and informed him of my desire for which he agreed. But, I could finally reach NRSC only in January 2002 when Dr AKS Gopalan and Dr RR Navalgund, the Directors of SAC and NRSA during that period, facilitated my transfer.

Dr Navalgund gave me abounding support and made me feel homely, which was very much required after coming from the SAC environment. My colleagues at the Oceanography Group, whom I have known quite well for several years personally and professionally, gave me a very warm welcome even though they knew that I would be a blockage to the administrative growth for a few of them. I enjoyed working and discussing with them very freely.

For a few years, I continued to work on ocean mixed layer dynamics (MLD) and eddies, my research topics at SAC until Dr K Radhakrishnan, the then Director, NRSA asked me, one day, how long I would like to work on MLD. Though this question, advising me to leave my favourite research topic, might have puzzled me, it gave me a new direction. I started working on tropical cyclone heat potential (TCHP) for cyclones. Dr V Jayraman, the next Director of NRSC encouraged me to work on this topic and we, jointly with National Oceanic and Atmospheric Administration (NOAA), USA, conducted a workshop on "Ocean Heat Content (OHC) for Cyclone Studies". This was the first of its kind workshop internationally.

Another new dimension in my scientific career started when Dr V K Dadhwal, the former Director, NRSC asked me to operationalise the estimation of TCHP and to keep the data and image products in Bhuvan on near real time basis. This was a challenging task, as I never worked in this direction earlier. This was a good initiative as a few research organisations started using these data. Many researchers still view the atlas on TCHP prepared during this time.

I mostly concentrated on my own research, probably paying less attention to the growth of the division or group (as some of my friends commented) and thus could not satisfy the organisation as a good leader or an able administrator. Probably, I am not capable of holding any functional designations. Excepting for this remorse, my foray at NRSC has been very comfortable, memorable and pleasant.

The other phase of my life started on 1 December 2012 after my retirement on the previous day (the portrait-sketch is a retirement gift by my colleague Mr. Biswadip). Sitting at home after working for more than 8 hours a day, most of the times, was a difficult task for me. Within a few days, I went to the National Institute of Oceanography, Goa to complete the pending work we initiated sometime back. Immediately after my return from Goa, I was fortunate to get the fellowship of Dr. Brahmaprakash Professor at NRSC. Director, NRSC has provided me with an excellent working area and I started working on the system given by PPEG. This fellowship really helped keeping me busy because of which I did not feel the pinch of retirement.

I was assigned the task of interacting and working with the scientists of RRSC-E. It is a pleasure working with such cooperative colleagues. In the initial few months itself, they could operationalise the estimation of OHC up to 700 m depth and this is one of the oceanographic products available at Bhuvan on regular basis. Our interaction is continuing and I enjoy working with them.

Though altimeter has been my favourite sensor, I started working on scatterometer in new areas like orbital velocities and wind stress estimations. As Director many times says, I am more focussed now (after retirement) and relatively more productive than while in service. Thus, my sojourn at NRSC is continuing. It is a great privilege and prestige to work in ISRO and I am proud of it. People look up to me when they come to know that I am an ISRO scientist!

My Reminiscences of NRSC

Shantan Kumar Dahagam
Former Group Director
(Construction and Maintenance Group)

As NRSA / NRSC celebrates its 50 years of journey, it is with a great sense of pride and belongingness that I share my association of 37 years and 37 days, culminating with Golden jubilee celebrations. In a way it's also my life journey …

Offer of my appointment from NRSA as Engr SB, in June 1987 came to me as a pleasant "Invitation for home coming" as I spent preceding 4 years in turbulent time in Punjab (Bachelors degree in Engineering) followed by an year in the first job at Kota, Rajasthan.

On 27.7.87, as I walked into the Admin hanger (shed), Shri. TRS Varadan, then dealing person in recruitment section, in his typical style exchanged pleasantries and lead me to CMU (Construction & Maintenance Unit) hinting that the head of the unit is like a Tiger.

Working under the first Construction Engineer of NRSA, Shri. HN Keshavan, (though apparently ferocious man), I was always at ease, thanks to Shri A R Mathur,Engineer in charge , to whom I was attached. It was a smooth beginning of my long journey.

Soon I became a blue-eyed boy of not only CMU but also to user community …I was youngest of the small team of engineers assisted by about 25 technicians to take care operations and maintenance activities of conventional AC systems/ manual monitoring. Being a bachelor, most of the time was spent in office, of course with benefit of lunch and snacks in office!! In addition to the routine activities, I am fortunate to be assigned a number of challenging tasks /projects in the very early years of my service.

Thanks to Prof. Deekshatulu, Director NRSA, Col.LRA Narayanan, then Associate Director and Controller Sri. Gopalaratnam.

As a Task team Leader in 1988, with help of two technicians and a Draughtsman, carried out site survey, preparing estimations and working out modalities for speedy acquisition of Jeedimetla campus and modification of old building therein to create facilities to establish an 'important institution'… was the first challenge. (Later came to know- ADRIN) I must remember and pay my tribute to my team and especially Mr. Samuel, the driver with Jeep who was supporting us morning 7AM to night 9 pm…about 10 months it took to make that campus ready for beneficial use

Maintaining of temperature and humidity in operational areas of DP and HDDT storage etc. was of utmost significance for me. Had many tense moments whenever slippage by duty staff resulting in a surge in wall mounted potentiometric chart recorder!! Remembering those sleepless nights in office spent rectifying a cable fault or gas leaks in central AC plant especially during post launch and day before camera opening (IRS 1A) etc..is worth which made the foundation strong.

Asia's biggest Photo processing facility- I was fortunate to be involved right from Conceptual to commissioning stage as an air-conditioning Engineer. Establishing a class 100000 clean room facility, an indigenous made overhead EOT crane, lift etc.

a big learning experience interacting with many Senior engineers in CED, DOS Hqrs .and with senior Scientists at NRSA.

Project coordination meetings during Construction stage were educative and, of course we used to have good fun as well. Occasional fights in the meetings also added flavor though on technical points, which in the process, helped realize best results.

I got married in Dec.1989 while also promoted to Engr. SC wef 1.1.1990 (normalization). Thanks to vehicle loan facility got my first new bike as well. Remember my friends making fun about my new vehicle, new designation and new wife in the new year!!

Recreation club activities and family picnics and get together was at its best. A trip to Nagarjuna Sagar with about 6- 7 Departmental buses is fresh in my mind…as also Prof. Deekshatu shaking a leg in jovial dance with NRSA families.

IIRS, Dehradun being a part of NRSA, there was a a sub unit of CMU called CMSU led by Engr SD level as Engineer in Charge. Readiness of Auditorium at IIRS for its Silver jubilee in February 1992 was another challenging task- it's my most memorable one. In additions to various tasks at Hyd-bad, I had to travel and camp at Dehra Dun for this Works completed in time and auditorium inaugurated along with Silver jubilee of IIRS.

Thanks to Prof. SK Bhan, the then Dean IIRS, who introduced me to the then Chairman ISRO/NRSA Governing body Prof UR Rao. in the lawns of Doon International. (Dinner hosted by Dean on eve of Silver Jubilee of IIRS). I was thrilled to receive the words of appreciation and warm Handshake from Prof UR Rao. With sudden increase of major civil works of during early nineties at NRSA, flow of civil engineers on deputation from CED (Civil Engineering Division) ISRO began... I was also a witness and some times victim of the cultural conflict in working style of engineers at NRSA vs those on deputation.

CMU at NRSA was split into CU (Construction Unit) and EMD (Engineering Maintenance Division) in line with similar arrangement in other Centres. I had the benefit of being in EMD and at same time involved in some major Projects as well.

Good will and encouragement by every Director and Controller from 1987 to 2024 remains for ever in my memories… A brief stint at CED, Bangalore in ISRO Hq. between 2004 to 2007 helped me develop good contacts and networking among ISRO fraternity. In 2008, again the CU and EMDs were merged into CMD in all Centres.

Thanks to Dr. Radhakrishnan, the then Director NRSA for picking me in the Study Team for development of Shadnagar campus…
Tenure under Dr.Jayaraman who steered us all through execution of major works for realization of IMGEOS and NDEM facility, Solar power plant etc. was unique in its way.
Shri. PP Chowdary, then Group Head CMG, was kind enough to give us free hand in implementation of many new initiatives. NRSC got first Platinum rated Green building certification for IMGEOS facility.

To cut the story short, undoubtedly, I am luckier than the luckiest to grow along with the growth of the Organization. Whether it is IIRS or ADRIN in Jeedimetla and later at Sikh Village, or INCOIS initially at DOD building in Balanagar to Jubilee Hills to present location Gajularamaram, I was fortunate to be involved in contributing my bit of service as an engineer.

The last leg of the long journey….
Thanks to Dr. V K Dadhwal, then Director NRSC, who has chosen me to lead the CMD team, on superannuation of Shri. PP Chowdary in 31.1.2015.

A stupendous task to lead the team…especially when you are one considered as more equal among equals. Challenges were multifold, increased requirement of Civil and building infrastructure across campuses including RCs, reduced manpower and demand for minimal turnaround time for realization.

Under dynamic leadership of Dr.YVN Krishna Murthy and able support from Controller Wg. Cdr. Vibhas Singh Gupta, CMG team became more energetic, vibrant and supported me to sail through all odds. Handled a number of VIP visits, events with ease in addition to COVID-19 pandemic situation and post pandemic normalization activities etc.

Association with Dr. D.P.Sharma, the Director, Civil Engineering. Program Office, CEPO, ISRO Hq. is another fond memory in my journey of growth. His continued guidance and encouragement helped NRSC implement new construction techniques like pre cast concrete building for ORF and realise many major works during last 10 years.

It's a mix of experienced and young energetic engineers in my Team, who were and are at their best in realizing the beautiful campuses like RC west Campus at Jodhpur, Outreach facility at Jeedimetla campus, IMGEOS facility, Housing colony at Shadnagar and above all…beautification and face-lifting our 50- year young Balanagar campus or enhancement of Solar power capacity from 300 kWp to 1600 kWp.

Its matter of pride extending services for major civil works to DIPAC in establishing Satellite Earth Station South (SESS) at Palayamkottai and to MHA, ICR-ER facility Delhi. Well, I felt honoured, when Department entrusted additional Charge of Head CMD ADRIN during first half of 2015 as per directions of DOS. Thanks to Dr.Geetha Varadan Director ADRIN, for her support.

During 2020-22, as per directions of Department, held the additional Charge of Head CMD, SCL, Chandigarh. Remincing my college days friends, it was a memorable time as my association with SCL also helped me to meet and interact some of my engineering friends in senior positions of Punjab state Government. Thanks to Shri.Surinder Singh, then Director SCL and Shri.Vikas Trikha and Team of SCL. I fondly cherish the period of working under all Directors of NRSA/NRSC and also very precious moments of interactions with visionary Chairmen of ISRO... Prof. U R Rao at Dehra Dun, Dr.Kasturi Rangan (contract labor / manpower management-Krishna Oberoi), Dr.Madhavan Nair (Shadnagar Master plan), Dr. K Radha Krishnan(IMGEOS facility), Shri Kiran Kumar(foundation for RC Jodhpur campus and his vision of ORF campus and foundation for same at Jeedimetla), Shri Sivan, (new Gate complex at Shadnagar , S/Ka antenna at Palayamkottai).

Most memorable interactions had with current Chairman Shri Somanath Sir (Inauguration of ORF building at Jeedimetla, S/Ka antenna terminal and Extension of Data Centre facility at Shadnagar and NRSC Heath Centre at Balanagar). As a moon man, he made all of us very proud lifetime. Grand celebrations of First anniversary of Chandrayan-3 (NspD 2024) at Bharat Mandapam remain life time memory, as it was beginning of my last week in office!! I fondly treasured a click with Shri.Somanath sir on this day at Delhi.

Entry of beloved Dr. Prakash Chauhan as Director NRSC in 2022 is like icing on the cake of this long journey. His vision and dynamism made a mark of its own. Jeedimetla campus is buzz ling with full activities. A new Auditorium facility, his brain child is now in place. Improvement / face lifting of Balanagar campus including Auditorium renovation and a feature wall as a memoir of the of 50 -year journey could be realized in a very short time under his leadership.
Kudos to Team CMG, NRSC. I bow in reverence to all leaders past and present at NRSC, ISRO for making this journey a Golden one for the one and only NRSA/ NRSC.

I would like to express my gratitude to NRSC and Organizing team of Golden Jubilee celebrations for giving the opportunity to express my thoughts and hearty feelings.
Jai Hind!

Reminiscenes

Koppaka Venugopala Rao
Former Group Director
(Urban Studies and Geoinformatics)

I am delighted to learn that NRSC is celebrating its Golden Jubilee, marking a significant milestone in its journey of advancing space-based geospatial applications and services for India and our neighbouring countries. Reflecting on my 30+ years of service with NRSC since the 1990s, I am grateful for the exceptional technical and research development opportunities that allowed me to contribute to national progress.

One of my most cherished memories is the development of the world-class Cartosat-1 metric stereoscopic data. This was a groundbreaking achievement, as it provided high-resolution stereoscopic data with a wide swath and ideal metric configurable base/height parameters. This innovation enabled the generation of Digital Terrain Models (DTMs) for both the entire country and globally. Notably, the creation of DTMs for the east and west coasts, covering 130,000 Sq.km in MSL vertical datum without any ground control survey, was a significant accomplishment for the INCOIS Tsunami Warning Centre and brought immense satisfaction to the NRSC team and ISRO management.

With encouragement from the Ministry of Urban Development, NRSC played a pivotal role in utilizing high-resolution satellite data for urban planning and governance. We developed major national urban missions such as the National Urban Information Systems (NUIS), Bhuvan-NUIS, and AMRUT. These initiatives led to the training of approximately 3,000 urban planners in satellite geospatial technology for planning and governance. Additionally, NRSC's work in developing standards for AMRUT and executing 1: 4,000 scale urban geospatial data for master plans demonstrated our geospatial excellence.

The cloud-based computational infrastructure, using technology developed by NRSC, showcased a new mechanism for large-scale mapping and geospatial applications. Our efforts in promoting the effective use of space technology across central government ministries and departments, through initiatives like the Bhuvan geoportal, significantly contributed to various national missions such as Pradhan Mantri Awas Yojana, NHAI, and the Island Information System.

My association with NRSC colleagues and the support from the management over the years has been immensely fulfilling and rewarding. As NRSC celebrates its Golden Jubilee, I extend my heartfelt congratulations and best wishes. I am proud of NRSC's achievements and look forward to its continued excellence as a world-class geospatial research institute, dedicated to developing technology and applications that provide grassroots solutions for common citizens

Drinking Water Problem in India Addressed Through Space Technology

Dr P Ramakista Reddy
Former Project Director
(RGNDWM project)

Dr Vikram Sarabhai, who is considered as the father of Indian Space Program said "There are some who question the relevance of space activities in a developing nation. To us, there is no ambiguity of purpose. …if we are to play a meaningful role nationally, and in the comity of nations, we must be second to none in the application of advanced technologies to the real problems of man and society."

This dream of the great visionary was made true by successfully addressing drinking water problem in the country using Space Technology. I was instrumental in developing an innovative methodology by integrating Remote Sensing, GIS and Ground Hydrogeological data for preparing the state-of art ground water prospects maps which provide integrated information on different factors that govern the movement and occurrence of ground water. Such maps are highly useful not only for selection of sites for drilling of wells near the non-covered and partially covered habitations but also for planning recharge structures to improve the sustainability of existing sources wherever required.

In India, more than 90% of rural and nearly 30% of urban drinking water schemes are dependent on ground water sources. However, the distribution of ground water is not uniform in all regions across the country, owing to spatio-temporal variations in rainfall and regional/ local differences in geology and geo-morphology. This uneven distribution coupled with indiscriminate tapping (over-exploitation) in certain zones is the main reasons leading to scarcity of drinking water in many parts of the country. In view of this a large number of habitations in the country have remained as problem villages not having sustainable drinking water sources.

In 1998, nearly 4.4 lakh habitations in the country were not having safe/sustainable drinking water sources. The Ministry of Rural Development, Govt. of India approached NRSA/DOS for addressing drinking water problem in the country. In response to the same, the 'Rajiv Gandhi National Drinking Water Mission Project' was taken up in collaboration with Central Ground Water Board, Ground Water Departments, PREDs, PHEs, Rural Water Supply Depts., of different states and other related organizations in the country.

As Project Director of this important National Mission, I was responsible for project formulation, documentation of Methodology Manual, Technical guidance, Project Co-ordination and Execution.Since, preparation of ground water prospects maps using new methodology, was a specialized job, creation of trained man power was essential. Accordingly, some senior level hydro-geologists from different centers of DOS, Central Ground Water Board, State Ground Water Depts., and other related organizations were selected and appraisal courses were conducted. Subsequently, training courses were conducted for training the working level scientists for interpretation of satellite data and preparation of maps.

Using this trained man power, the Rajiv Gandhi Drinking Water Mission Project was executed in the entire country in 3 phases, involving preparation of nearly 4000maps on 1:50000 scale. During phase-I, six (6) states namely- Karnataka, Kerala, Madhya Pradesh, Chhattisgarh, Rajasthan and Andhra Pradesh, during phase-II, Four (4) states namely- Orissa, Gujarat, Jharkhand and Himachal Pradesh, and during Phase-III program remaining states of the country were covered. Thus, this project was executed in a unique mode involving more than 100 work centers (Govt., and private organizations)

The maps prepared under this project were passed on to the concerned depts., in the respective states. Trainings/ work shops were conducted in the respective states to demonstrate the use of these maps to the field level scientists for selection of well sites and for planning recharge structures. Feed back received from the 6 states covered during phase-I program revealed that, using these maps more than 3,25,000 wells were drilled with 90% success rate. Thus, this project has demonstrated the effective use of satellite data for addressing drinking water problem at grass root level facing the country.

In the national work shop held at NRSA, attended by the top dignitaries, the HYDERABAD DECLARATION was signed stating "We the Minister of Rural Development Govt. of India, the Chief Ministers of Andhra Pradesh and Madhya Pradesh; the Ministers from the State Govts., of A.P., M.P., Rajasthan, Chattisgarh, Karnataka and Kerala, the Chairman ISRO/Secretary Dept. of Space and the Secretary Dept. of Drinking Water Supply Govt. of India participated in the National Workshop on Remote Sensing Applications for Ground Water Prospecting under Rajiv Gandhi National Drinking Water Mission (RGNDWM) Project, held on June 11, 2002; … Recognize that remote sensing based maps prepared under RGNDWM … have been the major source of information that helped immensely in locating prospective ground water zones around problem habitations in the country, … from the point of view of exploration as well as recharging of ground water… Here by we affirm that it is essential to use remote sensing applications to ground water prospecting as a part of rural drinking water projects in the country. … call for operational use of space technology applications in dealing with some of the problems at the grass root level facing the country in order to improve the quality of life."

ISRO, Dept. of Space, Govt. of India, has awarded 'Team Excellence Award' for this project team for the year 2007. This project has brought sufficient recognition to Space technology in general, NRSC/ DOS/ Participating Organizations in particular, especially to the team of scientists involved. To me it is a life time contribution.

I am highly grateful to NRSC/DOS, and the Dept. of Drinking water Supply, Ministry of Rural Development, Govt. of India for adopting the innovative methodology developed by me for preparing state of art ground water prospects maps under RGNDWM Project and selecting me as Project Director to execute this important National Mission. I thank all my colleagues of NRSC/ other DOS centers and Scientists of other participating organizations associated with this project for their co-operation and support in successful execution of this massive task.

Release of Ground Water Prospects map
(11-Jun-2002)

Some IMS Problem

J Dakshina Murti
Former Group Head
(Database Systems Group)

Anubhavadhaaraa jeevita. Series of experiences is the life. An experience could be either good or otherwise depends on time, space and person dependent. But, one has to participate in the activity to have an experience. During the course of one's own life, experiences in the career constitutes major part of life are more appropriate to mention here, which I presume. But, list of scientific papers published, description of how Software and Hardware was integrated or how I got my doctorate on the study of 'whether lord Krishna has mustaches or not' is not my intention to inspire my colleagues or present a resume to my post retirement job. Even if I tend to write great narration on systems developed during my direction, technical jargon may not be palatable to all the section of readers. Whether such systems developed were good, bad or worst was best known to their users and their usage alone were the best credentials to me. So, the environment in which systems were developed was not known to many. Hence, I would like to present few of my experiences and observations as I remember still.

Around September 1975, I joined in software division of NRSA. Soon after my reporting to duty I was asked to take a test. The test material consists of few chapters from a text book. As I was ready to face the test after a week, then the question posed to me was to explain what was in page number twenty six. That was my first experience.

There were either in-house computers or systems in and around Hyderabad to develop software to suit our requirements. The work involved in those days was line printer generated maps for the consumptions of Applications Group. The work was simple, but the ordeal of executing the software was at IIT, Madras and time allotted to execute these jobs was midnight to early morning slot. Further, frequent tours to Madras created problems in office as I was not available for discussions. This problem was slightly eased with establishing Landsat data acquisition system at Shadnagar, multispectral data analysis system, Printer plotter system and an exclusive Landsat data processing, product generating system co-located in Balanagar office.

As the progress of software scientists was measured in terms of number of programs generated rather than how many problems solved. Level1 and level2 reports were written to meet requirements of progress reports. Some programs like histogram, modified histogram, improved histogram, and new histogram were generated using in-house computer systems.

With the advent of Landsat data processing at NRSA, the archival mechanism of acquired data and its retrieval was first hit. The High Density Digital Taps were used to stack in built in cupboards of the rooms and on the ground. But soon such storage over flowed. Further, movement of tapes between data processing systems and storage created bottlenecks. But, which tape contains what, where was it, whom to contact at odd hours was the biggest problem for data processing and equally problematic for product generation. User order delays were the topic of daily discussions. Several unsolved puzzles were on how many products generated and how many products were dispatched like questions were ever cropping. As the data distribution systems were human intensive such problems were common. Correspondence was ever delayed as the typist was not made available; hence, the typing was at mercy of a typist of another division. To-day's personal computers and photo-copying machines were not in the horizon in those days. Basically, NRSA was not geared for its own data archival and data dissemination to the users at large. As usual, without any introspection of what were the requirements in this area, change of head-ship was

contemplated with anticipated miracles. I felt it was a change of body to the head to work better.\

An idle mind is devils workshop. As I was set aside without affiliation to any division or section, I felt it very convenient and comfortable working. I took it an opportunity to draft a constitution for the formation of a new facility for data distribution and browsing as NRSA Data Centre or NDC in short.

Drawing plans and professing was not an end in itself, but it needs execution too. Else, such projects would end up as systems contemplated around artificial intelligence and expert systems. Hence, meeting towards this goal, I started working on formats for metadata, the data about data as first step.

High Density Digital Tapes were catalogued using security gate passes. There were no programs to generate accession catalogues and cloud cover scores. Hence software was augmented at Shadnagar. However, accession data would never reach Balanagar or at best it may be once in a month as it was dubbed as my personal requirement and it was an extra work at Shadnagr. With such problems, a shorter version of production chain was made with data request and dispatch details. But, one had to enter data at NDC to get benefits of such programs. People refused to enter data as it was an extra work for them, moreover, they were not under my control. Nevertheless, a bait or benefit for such data entry would be reports on data requests and dispatches would be generated at any time made them realized for accepting data entry. Thus, manually compiling statistics ended. People used to take reports just before the meetings. Arguments on dispatches ended. However, a new problem emerged out that only fraction of what was generated was dispatched and rests were rejected due to poor quality.

During that time, a national seminar- National Natural Resources Management System was conducted in 1984 at NRSA with about one and half thousand delegates. As usual, committees and sub committees were formed for the event. As the seminar was nearing, reception committee was in a problem as how, when, where to service the dignitaries was not known as the information was not available at one place. I was just scheming and freelancing on how to do such jobs and collating the sequence of facts using computer systems. Simultaneously, this work was entrusted to all software scientists under green sheet culture program. As the seminar day was fast approaching, everyone equally failed in different stages of this job. As some ones permission was not required for thinking and/or scheming, my pursuits were continued. A couple of days before the event, I informed the Director that I would do this job. Director was furious and asked me how I can do when all others failed. After a day, Director, under pressure of possible failure of reception committee in attending the delegates, agreed to my request for working unofficially and also constituted a committee to investigate what I was doing and ordered for hourly progress report by the committee. The hourly disturbance nauseated me. However, I produced massive report a night before the seminar on whom, when and how delegates were coming, going, flight numbers, hotel accommodation etc. Further, deployed a terminal in front of Applications division's building for online quires by the delegates. That's it. Suddenly, I had created enemies, who failed to produce required software and typists whose overtime requirement was not desired by the seminar committee.

Visit of Dr K Kasturirangan, Chairman, ISRO

One of the biggest menaces which I faced was providing inputs for anyone who was attending a meeting or going abroad. Why, what, when, how such questions don't have a meaning. I felt that even cows were better off by eating papers and giving milk, but inputs provided to such meetings never yielded any tangible outputs. The inputs were never acknowledged. Some such meetings were Landsat working group meetings.

This inputs problem was further percolated down to training Division. Where-in, people have to deliver lectures with above inputs plus twenty copies of lecture notes for distribution. One has to do such massive effort at the cost of leaving one's own job. If one would like to manage the Training Division that a way, provide honorarium and adding some points to their annual confidential reports to people who contribute to the training programs would be in order.

Deputing to Selective training courses, seminars, conferences to the scientists enrich quality of their work and beneficial to the organization in the long run, rather than a sponsored tourism. Hence, conducting audit trial on such programs and verifying the tangible benefits accrued to the system are essential.

Around this period, Department of space made plans to launch Indian Remote Sensing Satellite. National Remote Sensing Agency was made to its testing ground. Hence, the Ground segment was formed for data reception, processing and dissemination. Thus, a project mode of working culture was set in. The project documents produced for Indian Remote Sensing Satellite program were excellent to start with. The operations scenario mentioned therein was software, hardware developed by ISRO scientists would be deployed at NRSA, and NRSA operators would be required for the operations. The requirements of data management were mentioned therein were catalogue of High-density digital tapes. Just to prove that NRSA too could design and develop systems and with my experience, I proposed an Integrated Information Management System for all satellite data at NRSA. The project felt that the system proposed should caters to Indian remote sensing satellites only, although my firm view was seamless integration of all satellite data for the past present and future satellites and their product generation at NRSA.

Visit of Smt. Vasundhara Raje Scindia, Minister of State (Independent Charge) (1999)

All through as a lone ranger, attending interface meeting at other centers with inbuilt fear haunting me on non availability of manpower, specialized software, training and desired computer. At least a dedicated terminal was not available to my proposed work. The same was informed to the Project management. Normally project management wants progress, not the problems. Hence, start express concern in every meeting. Suddenly, there was an embargo on systems from the other country; relational database software was not yet released. Hence software development was started with the terminals available with data processing systems. As the days goes by manpower was added one by one. Those were the days of Y2K problem and body shopping was rampant. With effect of this, the existing manpower started vanishing suddenly without a trace. Many software scientists were moving to work in IRS project, but, with an intension of leaving India in an appropriate time. Then, I realized that if I have to do something do it alone was the guided principle which I followed. At one stage I was alone in the office. With this type of situation, I was ready for IRS operations. On the day of IRS launch day suddenly system was not animating. My heart skipped two beats. On investigation I found that one new software entrant to my group was learning a delete command on the system. Somehow the programs executed well without any hassles from backups. The very next day, all the terminals, tables and chairs were removed from me stating that operations phase started. That was the management style of project management.

The next phase of development was to launch the Information Management System on the web or web based usage. Users should be able to place data orders and inter office communication, browsing the satellite data were some of the benefits envisaged. To enable this scenario, Internet related facilities were planned and executed in a modest way. All the employees of NRSA were given internet connections expecting that paperless office could start. However, most of them were busy browsing all types of sites. On 31st May 2001 was my exit and logoff.

I enjoyed my stay in NRSA, and thankful to my colleagues for their co-operation.

My Active Reminiscences with NRSC

Dr T Ch Malleswara Rao
Former Group Head
(Image Analysis & Interpretation)

By the grace of God, I had a chance to serve NRSA in my life. When NRSA was established in 1975 at Hyderabad, I was one of the first batch recruiters from Scientists/Engineers for computer hardware/software engineer. I joined NRSA on 18th December, 1975. At that time, our services at NRSA started from scratch where there was no proper place to sit and no systems to work. I have seen the growth of NRSA from its scratch to the present great status. Here, I am documenting some of the progressive salient recollections that took place during my service at NRSA.

Visit of European Space Agency officials (1981)

The first challenging work that I took was writing programs in FORTRAN to read LANDSAT 2 and 3 tapes, which were brought form EROS data center, on IBM 370/55 computer at IIT, Madras and IRIS 55 computer at ECIL, Hyderabad for printing the satellite data on line-printer in a particular format to get 8 to 10 gray shades form alphabets and numerals. Thus printed data was given to the Application Scientists for further mosaicking and interpretation.

My second exciting experience was participating in specifications preparation, first time participation in technical negotiations and purchasing procedures of Multispectral Data Analysis System (MDAS) and 11-channel air borne Modular Multispectral Scanner (M^2S). This was in 1976-77. I got exposed and learned many new things like preparation of technical specifications and technical negotiations procedures, etc. Seeing my active participation in discussions on MDAS software particulars, I was selected for 3 months training on MDAS encompassing hardware (PDP-11/35) maintenance and operations of MDAS at Bendix Systems, Ann Arbor, Michigan, USA. In this training I did hard work and learned MDAS operations and maintenance. In addition to this, I picked up MDAS Analysis Software Programs manual and got exposed to all the programs listings with the help of one of the software engineers in Bendix. After coming back home, this helped me greatly to develop several enhancements, filming and other analysis programs on MDAS in augmenting the enhanced capabilities of MDAS in satellite data processing and filming on Optronics-16. These developed programs were highly used in the application projects, at that time. I presented the derived results from the developed software programs through publications in journals and remote sensing seminar platforms. During the same period, I also developed several programs on Printer/Plotter system (PDP-11/04) for generating B/W maps with improved gray tones.

In 1978, again I was asked to participate in a group to establish NRSA Earth Station at Shadnagar. At that time, a contract was awarded to Ford Aerospace, Houston, Texas, USA for completing the contract in a record time of one year. Ford Aerospace requested NRSA to provide suitable software and hardware engineers (manpower) for completing the contract in stipulated time. Towards software manpower support from NRSA, I was sent to Ford Aerospace. Here, again, I had opportunity to work with engineers from Ford Aerospace and learned many new concepts

like team work participation, technical documentation standards, project management and procedures in developing large scale software packages. In this project I was given an independent responsibility to develop satellite data "disk-load-mode" package, which is the basis to generate satellite data products of LANDSAT 2 and 3. This Earth Station system was configured around PDP-11/55. Later, the same software was upgraded to accept LANSAT 4 and 5 too.

During 1983, NRSA sent me to then West Germany for 3 months under GTZ program with India. In this trip, I was asked to evaluate an Image Analysis Software, which can be used for LANDSAT data analysis. This software was developed in West Germany on PDP-11/70. During my stay in Germany, I visited France and Netherlands too as a part of getting exposed to other Image Analysis Systems and RAMTEK Image Display system, which were working at other places.

Immediately after coming from Germany, interesting and important in-house software development project work was assigned to me. This project was on augmenting and operationalization of LANDSAT-5 MSS and TM data products generation on VAX/VMS 780 coupled VAX/VMS 750 system. NRSA gave me 6 months and sufficient manpower to complete the project. This project, I could finish successfully

Visit of Prof U R Rao, Chairman, ISRO

in 5 months and documented the same. During the same period, I was also working on AVHRR visible and thermal channels data calibration and generating countywide Vegetation Index from visible bands and Sea Surface Temperatures (SSTs) over Bay of Bengal, Indian Ocean and Arabian Sea from three thermal channels. For this work I got appreciations from Prof. Dhawan when I presented my work during one of his visits to NRSA. This was in 1984/85. In mid of 1985, NRSA has procured DIPIX Image Analysis System from DIPIX Corporation, Ottawa, Canada. I was asked to go to Ottawa for conducting factory acceptance test. In the same trip, after completing factory acceptance test on DIPIX, I also visited NOAA/NESDIS, Washington, USA and got evaluated my AVHRR developmental works by one of the NESDIS scientists. Immediately after coming back to NRSA, I have corrected my AVHRR software programs as per the NESDIS scientist's comments and made ready to operational use.

By this time, in NRSA Applications area, a dire need was felt to have full time standalone software support to the ongoing multiple paid and research projects, which were utilizing data from LANDSAT, NOAA/AVHRR, SPOT and IRS. Then Director, NRSA positioned me in Application Group with two more software engineers and named this team as Application Software Division.

From then onwards, in Application area, I spent almost 20 years till I retired from NRSA. During this period I was associated with good, intellectual and hardworking 8 Scientists/Engineers who are having heterogeneous background domains and skills. Most of them have made good software contributions during their stay with me. Four of them got Ph. D. degrees under my supervision. I should say they were God given asset to me and my division. Equipment wise, our Application Software Division (ASD) started with two PC based Image Analysis Systems (IAS), initially. After some time, our division was equipped with 6 workstations purchased from sponsored project from Department of Ocean Development (DOD) for development of turnkey operational software package for generating SST maps from AVHRR thermal channels for operational usage by Oceanographic Division (OD) scientists. After interpretation of SST maps by OD scientists for identifying fish catching zones, these analyzed SST maps were weekly faxed to the fish caching centers, which are already existing all along the coast line of India, for improved fish catching on overseas. Later, this total work resulted in formation of INCOIS Organization in DOD, Hyderabad. The developed work on AVHRR Vegetation Index was resulted in two operational projects: Drought Monitoring Project and India's Forest Monitoring Project. These software packages were later shifted to NNRMS Centers and FSI respectively for operational usage. In addition to

the above big projects, ASD personnel were giving perennial software development and operational support to the ongoing applications projects.

At this stage our ASD was promoted from Division level to Group (ASG) level. In Application area, all the application scientists have given good support to us in acquiring new systems towards meeting the technology changes and their incoming paid projects and research work requirements. In Application area, as a custodian of Applications Areas IAS systems, the Image Analysis Systems architecture was modified five times. These architectures were: 1) starting from 2 PC based IAS, 2) centralized LAN connected 6 IASs systems, 3) Network connected centralized 6 workstations and positioned 24 IAS workstations in Applications Groups [each Application Group provided with 3 IAS workstations], 4) Network connected centralized 6 IAS workstations and provided PC based IAS systems to each application scientist [80 IAS systems in Application Groups] and 5) finally, augmented Application Area networked IAS systems with a centralized mass storage system NASS as Application Area centralized satellite data (raw and analyzed) storage for sharing data between applications groups. All the applications IAS systems were periodically updated with commercially available image analysis software packages and other required supporting software packages to meet the application projects and research work activities. At central facility, the systems were also augmented with high resolution color laser printers for generating quality project reports, large format scanners for digitizing maps and large format Ink-Jet Plotters for generating quality color maps.

During the last 4 years of my service, before retirement, I was also managing Geo-Informatics Section, Cartography Section and Map Record Section in addition to the existing Group and renamed as Applications Facility (AF). All AF scientists including the Cartographic Section engineers have greatly cooperated and coordinated with me in morphing Manual Cartography into Digital Cartography by renovating the cartographic premises, procuring computers with peripherals, cartographic software packages, and operationalized in a record time. As a matter of fact, with whomsoever I worked in Technical Division, Software Division and Application Area, all the Scientists/Engineers have greatly cooperated with me in my day-to-day work and I really enjoyed and learned several new aspects in the walk of my life. I should also thank all my friends from Administration, Purchase and Stores for their support in my administrative works and purchase activities. Further, I thank all my Directors and Deputy Directors for their great encouragement and support given to our group in providing required yearly budgets, constant encouragement and timely appreciations in our achievements. I always feel proud through my significant contributions and also becoming one of the bricks in the ever growing NRSC Castle.

My Journey with NRSC

Dr A Perumal
Former Group Head
(Capacity Building and Application Facilities)

I started my journey with NRSC in February 1980 at IIRS (Formerly IPI) Dehradun as Asst. Professor, Hydrogeology equivalent to Sc/Engg 'SC', after working with Ground Water Dept. Govt. of Tamil Nadu for about 6 years. I was one of the fortunate souls who were selected by Wg Cdr K R Rao, former Director of NRSA at that time under DST. Whenever he comes to IIRS, Dehradun, he used to visit individual scientist work place and ask the work progress. Once he told me "Perumal, you are a bachelor, you should work more". These were the words I cannot forget. As a faculty, I was involved in teaching on Remote Sensing Applications for Geology, Geomorphology and Hydrogeology for the serving officials of state and central Government. I had also carried out various consultation projects. During the course of my journey I have registered for my Ph.D as part time scholar with IIT, Roorkee (formerly Roorkee University) and completed. As far as my professional career is concerned though I had set back due to the normalisation I had great opportunity to work in the national projects such as Hydrogeomorphological mapping of drought affected states such as Maharashtra, Karnataka, Rajasthan, Gujarat, Tamil Nadu, etc. in 1986. Subsequently I associated with Rajiv Gandhi National Drinking Water Mission Project and completed mapping for North Eastern States in 1988 and 1989.

Visit of Chief Secretary of Orissa (1996)

After getting transferred to NRSC, formerly (NRSA) in 1990, I was associated as thematic specialist with integrated study to compact drought on long term basis using remote sensing data for 18 districts covering 13 states. Subquently the same project renamed as Integrated Mission for Sustainable Development (IMSD) as National Mission mode covering 175 districts from all the states of India. I was made as Group Head in-charge and Project Director of IMSD. It was a great honour and opportunity to work as a Project Director in such a novel National project. This project gave me a great wisdom and experience to understand the integrated approach using remote sensing data, socioeconomic information and contemporary technology established by various ICAR and other related Research organisations to apply for this project. This had greatly helped to suggest alternative suitable cropping system to improve the productivity without affecting the environment to maintain the sustainability. This was one of the new approaches to address the national issues. Later I was made Principal Scientist and coordinator to carry out the National Geomorphological Mapping in association with Geological Survey of India (GSI). The National level common legend was prepared in association with GSI and the same was adopted for the project

Inauguration of Photo Lab by Prof U R Rao, Chairman, ISRO

execution. In 2006, I was made as Group Head for Capacity Building and Application Facilities Group (CB&AFG) and retired peacefully and with honour in June 2008.

During my days with NRSC, I was associated with ISRS, a Professional body as life member and Vice-president. I was selected for ISRO award for contribution made towards the Remote Sensing Applications for Natural Resources management.

During my journey in NRSC, ISRO I really enjoyed my work and took pride of being part of ISRO, which was led by great legends like Prof Satish Dhawan, Prof U R Rao, Dr Rangan etc. I always have green memory of my contribution towards the benefit of the society using the modern tools like Remote Sensing and GIS. I had immense satisfaction to be one of the earliest bird of using RS and GIS when the technology itself was remote in the real sense. I am grateful to Almighty who had given me an opportunity to work for the humanity as a whole in the area of natural resources management especially Ground Water which was my specialised area. I am also thankful to my colleagues who loved me so much during my association in NRSC. I would like to share with you all that if you are sincere and honest in your approach and God will never let you down. This is personal experience. Thanks for one and all.

NRSA/NRSC Photo Processing Facility - Modest to the World's Best

My Journey through Incredible Assignment

N S Parandhaman
Former Group Head
(Photo Processing and Map Printing Facility)

A small makeshift Photo Lab was born in mid 1976, at the rented NRSA campus, by converting a rest room into a dark room, to generate B/W contact films and prints from ERTS images obtained from EROS Data Centre using indigenous contact printer and manual try processing. No one could have imagined then that such foundation would ultimately culminate in the establishment of World's best and largest ultra-modern PHOTO PROCESSING FACILITY later.

Aerial B/W master films, exposed in NRSA's Aircrafts pertaining to tasks, were processed and prints generated using SOI & IIRS facilities during 1976. While B/W 16mm films of Aeromagnetic surveys processed, creating improvised facilities, at different survey locations countrywide.

NRSA Campus 1977

Present NRSC Balanagar campus was then a barren land with no habitable built up area around entire foreseeable vicinity. In such a hostile environment during 1977, a temporary Photo Lab was first built, adjacent to newly installed MDAS, to process categorised B/W master films generated in Optronics scanner. Construction of Photo lab building commenced soon along with associated equipment procurement. Drum scanner films, satellite and aerial B/W films & prints generated in new PHOTO PROCESSING FACILITY by adopting manual printing and laborious tray processing. Subsequently, Durst Color Enlarger, Colenta oneshot processor, Rectifier enlarger, processing and printing aids, QC and other miscellanous equipment procured to process B/W & Color films as well as to generate all types of B/W & Color photographic films and prints using best photo films and papers available at that time and processed in cumbersome manner in Colenta processor and tedious manual tray processing.

Permanent Facility: During 1978, another Photo Lab was established at Shadnagar Earth Station to process LANDSAT B/W sheet films from Optronics Recorder & 70mm roll films from Celco Recorder, generated in MSS DPS.

Facility augmented further under INDO-FRG aid with Kodak B/W Versamat, Kodak Color RT film processors Rectifier enlarger, Log E Printer, etc. This phase also witnessed indigenous development of FCC Printer, thermostatic try processing system, densitometer, etc. specifically custom-made to suit our exclusive requirements with NRSA expertise.

Earth station site

During 1980s, major technology transition took place in the Lab operations from medium sized semi-

PROF S.Dhawan's visit

Army General's visit

automatic systems to more advanced large format automatic systems with the adaptation of Durst AF enlargers, Hope color Reversal film processor, Hostert B/W & Color Reversal RT paper, HK Contact printer, QC and miscellaneous systems, to facilitate generation all types of B/W & Color photo products with high throughput and consistent repeatable quality.

Ensuing installation of MDA B/W Fire Film & Color Fire Film Recorders in the mid eighties, master films generated in roll form were processed in continuous Roller Transport B/W film and Color Reversal/Negative film Processors respectively.

All types of photo products such as B/W & Color contact films & prints, B/W & Color enlargements in different scales, duratrans, etc. were generated using various types of equipment, which were upgraded periodically to meet users' demand.

Major Facility Augmentation: Consequent to launch of IRS-1A Satellite in 1988, demand increased manifold for assorted B/W and Color photo products namely microfiche, Browse, contact prints, enlargements, duplicate films, special products, etc. This necessitated augmentation into a larger new facility which ultimately culminated in planning, designing & establishment of a modern, sophisticated and state-of-art-technology Photo Processing Facility during 1990s under DPGFA. The Facility is designed to generate photo products with optimum quality geometric, density, color balance, density repeatability, uniformity, etc. specifications, surpassing world leaders, with highest throughput rates and shortest TAT. Facility also designed with enhanced capacity to cater to all future satellite missions, including demand from foreign users.

Uniqueness of the Facility: The facility besides, housed several unique specialized custom made photographic systems such as 40" wide B/W and Color RT film processors, 50"x50" closed-loop contact printer, 40" antistatic film cleaner, etc. to process and generate 40"x40" B/W and Color films and prints, which were procured as per NRSA's stringent equipment specifications. Similarly, 40"x40" B/W and Color films were exclusively custom made as per NRSA Specifications by reputed international Companies compatible to LF master films generation in LFFR and this gesture is unheard of. No other countries, anywhere in the world, had similar advanced systems during that time frame. This unique facility was designed with one-lakh-clean-class Air-conditioned environment especially in critical processing, printing, photo finishing and QA areas to assure ultraclean production environment outshining contemporary labs around the world.

The facility combined in-house developed novel IPC and QA techniques for efficient Process Monitoring and Control encompassing process, sensitometric, analytical and other parameters to assure foolproof quality products generation.

In addition, support facilities for Sensitometric, chemical analysis; QA, etc. were incorporated with appropriate systems and also in-house equipment development and maintenance facility to cater to Facility and organizational needs.

Technical excellence: During 1985 to 2009, big international giants like KODAK USA, ILFORD, AGFA, etc. got their new materials evaluated in NRSA lab and sought our expert opinion on their products quality, mainly because of our sophisticated Test and Evaluation Facilities as well as technical expertise.

Several Central and State Governmental organizations such as ARC, IAF, DIPAC, IMD, RRSSC, ISRO Centers, State Remote Sensing Centers such as AP, RSAC, etc. and host of private entities sought our expertise

Smt.Margret Alva, MOS visit

and also undergone training programs in NRSA. In addition training also imparted in our lab to foreign representatives from Vietnam, Algeria, etc.

The facility generated millions of satellite, aerial as well as miscellaneous types of B/W and Color photographic products in different scales and various sizes including specialised custom products and huge murals for Chandrayaan, exhibitions, etc.

Photographic technology which dominated world for more than 100 years is in the verge of getting phased

Smt Vasundara Raje, MOS visit

out due to cutting-edge digital printing technology, overwhelming giants like Kodak Company. In such a scenario to keep pace, NRSA got SFFR and LFFR developed indigenously through Technology Transfer during 1990s, for which my contribution towards development is abundant.

Laser Photo Printing Technology: Technological Innovations are fast paced closely followed by extinction of proven technologies, faster than we could imagine. Consequently during beginning of 21st century, LF Laser Color Photo Printer proved to be superior & offered viable precision printing alternative worldwide, particularly among organizations involved in satellite and aerial photographic prints generation.

As a result, NRSC procured and operationalized Large Format Durst Lambda RS Laser photographic printer to generate 50" wide Color prints in roll form seamlessly to any desired size/scale with stringent engineering quality specifications with regard to very high dimensional accuracy, MTF, CB, density range and uniformity, repeatability, throughput rates, etc. with cosmetic defects-free prints. This printer has extraordinary capability to cater to all future missions irrespective of demand and in addition can cater to all ISRO Centres. Tremendous efforts put in by me in conceiving, planning, procuring, installing and commissioning of this system in NRSC is a standing testimony.

Pioneered in creation of a new digital image library storing both scanned films data and present-day digital photos and served online to all concerned in NRSC. It was a novel concept then but later extended to other ISRO centres. Responsible for developing still and video photographic facility along with allied S/Ws, digital editing system, etc.

Map Printing Facility was added to my Group & with my planning and enormous efforts, it has undergone

Kodak USA delegate visit

paradigm technological shift with acquisition of Digital Printing Press along with associated peripheral systems to generate modern-day technical reports, maps, manuals, etc.

Contributions to major Projects: My unstinted and dedicated contributions to numerous Projects are enormous and epitome of successive successes. To start with – since 1976 my invaluable contribution & passionate involvement in Photo Processing Facility buildup in terms of planning, sourcing, procurement & commissioning during various phases is overwhelming. For all IRS and other Projects, I significantly contributed round the year in foremost key roles. DIPAC facility is a dominant example of my role in facility planning, building, procurement, commissioning, etc. flawlessly. I played key role in bringing out Satellite Image Atlas of India wherein I coordinated and executed entire activity right from data processing till offset printing activities to ensure best quality outputs. I played pioneering, crucial and innovative role in bringing out excellent quality outputs for IAC 2007 in record time and made benchmarks excelling previous international standards. I was responsible for innovating and Introducing advanced methods in T&E of new photo materials and novel process monitoring and control techniques, making standards in process quality, products specifications, systems reliability, etc. I ensured smooth ISO Certification of facility and acclaimed by external auditors as best Facility in process operation. I contributed to IMGEOS, trained PPF staff in IAS and other S/Ws, deployed them in live projects, transferred to other areas, etc. It goes on …

Foreign Assignments: NRSA/NRSC provided remarkable opportunities to all those who desired to learn and contribute to its advancement and progression and in fact sky was the limit. I was honored to be deputed under UNDP Fellowship and undergone advanced photographic training programs in USA at Staples Area Vocational Technical Institute, EROS Data Center and Rochester Institute of Technology and also expansively visited NASA Facilities, USGS Facilities, Kodak Manufacturing Labs, UNO, 3M, etc. from April 1978 to August 1978.

Foreign degates visit

Photo Facility view

I served as UN/FAO Consultant at Beijing, China during August 1982 conducted Workshops and training programs. I have participated in Factory Acceptance Tests(FAT) for MDA Fire Recorder and held technical discussions with CCRS experts during Feb 1987 in Canada; During August 1990 held technical discussions with CARL Zeiss and Hansa Luftbild experts on aerial IR Photography issues in Germany and also FAT of color enlargers at UK.

Simultaneously discussed with technical experts in KODAK, ILFORD, DUPONT & AGFA to specially manufacture large format films for indigenously developed LFFR system to generate high resolution IRS products. During 1995 and 2008, FAT conducted for Colenta Processors, AF enlargers and Durst Laser Photographic printer in USA, Austria and Italy respectively.

Gratitude: I would like to emphasize without any inhibition and with unassuming humility that NRSC Photo Processing Facility was best in the world and pinnacle of technical excellence without any parallel. Without hesitation, I communicated this to VVIPs and foreign dignitaries during their visits to PPF. I could reaffirm this due to my prolonged experience empowered with international exposures to organizations such as NASA, USGS, RIT, CCRS,

Prof. UR Rao's visit

Hansa Luftbild, KODAK, ILFORD as well as visit to other Facilities in USA, Canada, UK, Germany, Italy, Austria and China who were also in forefront of technology, courtesy NRSA/NRSC.

My contribution towards advancement of PPF and NRSC is substantial, since 1976 till superannuation, and honorably a memorable experience to cherish life long. I feel gratified for having served the world renowned facility and extremely honored to be part of strong team and with all their support able to successfully serve ambitious goals of the Organization.

I was blessed to start my career since 1974 at IISc, Bangalore under distinguished Honorable Prof. B.L.Deekshatulu; my guru, mentor, philosopher, etc., for what I am today & grateful. With his tireless timeless dedication, encouragements, motivation, scientific passion, research zeal in his

With Chairman, ISRO

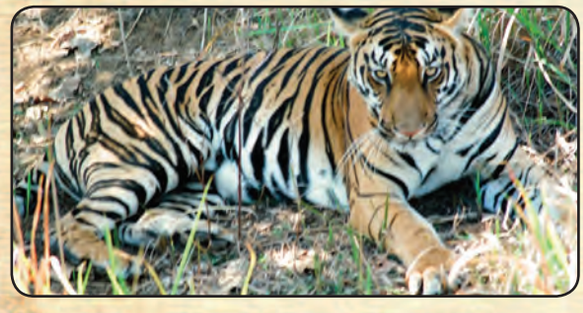
blood, innumerable innovations, simplicity, God like heart, so on…; he bestowed ability to contribute my best, for which lifelong I am indebted. Similarly during distinguished Honorable Chairman, ISRO, Dr.K.Radhakrishnan's tenure in NRSA, I contributed immensely to some landmark projects under his able, professional, inspirational, motivational and vibrant leadership.

Finally, I wish to see NRSC to be a world leader in Remote Sensing eternally, excel in its research work compared to contemporary institutions, empower ISRO to make international benchmarks in all its endeavors and make INDIA truly a global power sooner than later. I feel deeply indebted to NRSA/NRSC and longing to contribute lifelong to its betterment.

My Journey with NRSC

Dr Mahesh Chandra Porwal
Former Group Head
(Programme Planning & Evaluation Group, IIRS)

The seeds of my journey in NRSC were sown with my deputation from Forest Survey of India (former Pre Investment Survey of Forest Resources, Kolkata) to IPI (Indian Photo Interpretation Institute, Survey of India) for attending a certificate course i.e., 'O' course of 3 months duration in photogrammetry & photo interpretation during 1975. After the course, I opted for transfer to FSI Dehradun and finally joined Indian Institute of Remote Sensing (NRSC).



My actual journey in NRSC started after joining Forestry and Ecology Division, IIRS in October 1981. Since, 1981 till my superannuation on November 30, 2012, I had an opportunity to work with Head IIRS, Dean IIRS, Associate Director and Director IIRS. Out of the number of National and other R & D projects, Kanha National Park and the Biodiversity project in Meghalaya, Assam, Andaman & Nicobar Islands, U.P. Vindhyans, Delhi & Haryana were remarkable. A photo of Tiger taken in Kanha National Park using my ordinary Yashica D Camera can be seen below. During 1995, I along with 4 more colleagues of IIRS, had an opportunity for deputation to ITC, The Netherlands (pl. see photo) for attending GEO 5 course. Subsequently the 4 months GIS Course was started at IIRS. Later to this, I also attended a short course on Natural Resources management at ITC. During my 32 years at IIRS and 7 years at Forest survey of India, there has been gradual transition from photo interpretation to satellite remote sensing, Geographic information system and modelling. I also have witnessed a phenomenal growth and transition from training to education at IIRS under able leadership of various Directors. During the period I also have progressed academically, to a large extent and acquired Ph.D degree. Subsequently, I supervised Ph.D research and 7 researchers were awarded Ph.D degree under my guidance. Besides having authored a book, I have also published number of research papers in international & national peer reviewed journals, chapters in books and also co authored a book. The journey never ends and I always wish to contribute whatever way is possible even after my superannuation. I consider myself fortunate for having such an opportunity to work in IIRS – NRSC environment and will never forget my good memories at NRSC.

Reminiscences

D N Setti
Former Head
(RRSSC, Bangalore)

Sri DN Setti superannuated from geological Survey of India, in 1991 as Director in-Charge of Andhra Pradesh Operations after over 33 years of professional service in the Department.

He was on deputation to ISRO between 1986 and 1989, and served as Head, RRSSC Bangalore. He made a pioneering contribution in setting up of RRSSC Bangalore, under the joint collaboration of Department of Mines and Department of Space. These efforts include recruitment of scientific and technical personnel, provision of logistics for the centre, procurement and opertionalization of required hardware and software. He had constant interaction with the RRSSC-CMO and Heads of other RRSSC's on technical and administrative matters. Major activities during the period include

- Propagation of the application of digital image processing of satellite data for resource evaluation and to build up a trained manpower cadre, Sri Setti has organized a number of training programmes for scientists of both public sector and private sector.
- Another important aspect of RRSSC's functions is provision of digital analysis facilities to users from public and private sectors.
- Among such activities is the provision of digital analysis facility for near real time monitoring of drought, to the NRSA. RRSSC Bangalore co-ordinated the job including off loading additional work to other centers.
- RRSSC Bangalore was actively associated with 'Project Vasundhara's collaborative project on multi theme data integration for mineral targeting between the Geological Survey of India and ISRO. As a part of the project an indigenous raster based software named Indian National Geographic System (INGIS) was developed when the GIS technology was in the early stages in the country.
- RRSSC Bangalore also look a leading part in the execution of a number of applications validation projects like water spread monitoring in the reservoirs, mainly aimed for propagation of technology.

Sri Setti had the privilege of association/ acquaintance of a number of leading personalities of ISRO during his tenure in RRSSC and even before. They include luminaries like Prof. Pisharoty, Prof Dhawan, Dr U R Rao, Col. Pant and Prof Deekshatulu. Prof Pisharoty known as the father of remote sensing in India has inspired Youngsters with his wisdom and wit. He was one person who complimented the Geological Survey of India for being the foremost Department to accept the remote sensing technology in its quest for natural resources. His association with S/Sri Y S Rajan, K Krishnan Unni, Dr K Radhakrishnan and late Dr R S Ayyangar has many lasting memories.

Sri Y S Rajan, in his capacity as Scientific Secretary to the Chairman, ISRO has provided constant support and guidance in the setting up of the RRSSC's.

Sri K Krishnan Unni, who was also on deputation from the Geological Survey of India, as Director NNRMS-RRSSC, ISRO, took the responsibility of setting up and operationalizing the five RRSSC's. His commitment to the task was total, particularly his encouragement, guidance and support to all the scientific and administrative personnel. After successfully completing the job Sri

Krishnan Unni reverted back to GSI and went on to become the Director-General, Geological Survey of India.

Dr K Radhakrishnan was project Director, RRSSC in addition to his main responsibilities as Director (Budget), ISRO during this period. He was the main link with ISRO Headquarters for financial, technical administrative matters.

RRSSC's efforts at bringing the awareness of digital processing in the user communities, particularly the scientists of the State governments were yielding results and Maharashtra State Remote Sensing Applications Centre at Nagpur, under the dynamic leadership of late Dr R S Ayyangar was among the first centers in adopting digital processing in a big way.

The cooperation received from the Heads of other RRSSC's Prof. Sengupta (Kharagpur), Dr R P Dhir (Jodhpur), Dr R L Karale (Nagpur) and Dr S K Bhan (Dehradun), apart from the efforts of the central management office, Bangalore including Mrs Geeta Varadan, Manager Systems, was largely responsible for successfully operationalizing the RRSSC's. The support provided by Sri V L Swaminathan of ISRO on resolving software problems and S/Sri S Adiga and S K Bhan of NRSA in obtaining the satellite data products, flight planning of multispectral scanner surveys and other allied matters to the Geological Survey of India was prior to Sri Setti joining RRSSC and the association continued over the years.

Successful functioning of RRSSC Bangalore was not possible without the active involvement and support of the thematic specialists S/ Sri E V R Parthasaradhi, P Manavalan, B Ranganath and Udayraj, computer scientists Dr J Simhachalam, Dr Keshavaswamy, Dr Bhanu Mastan, Mr Kannan, R S Lakshmi and Mr A Ravi kumar and administrative personnel, Mr Nambudri and Mr J S Jayaram Administrative Officers and a host of others.

Looking back Sri Setti feels contended for having contributed his humble part in the propagation of the technology of digital processing in the country.

Role of NRSC in Creating Hub of Geospatial Technology based Industries in Hyderabad

S Adiga
Former Head
(NRSA Data Centre)

NRSA is responsible for the creation of a cluster of largest number of small, medium and large scale geospatial technology based service providers in Hyderabad when compared to any other city in India. This significant contribution was initiated and to a large extent implemented during the eighties by nurturing a set of entrepreneurs, some of them were our ex-colleagues from NRSA and others from outside world through the technology transfer programme for the equipment developed by NRSA.

The National Remote Sensing Agency (NRSA), now NRSC, was established with the main objective of operationalization of remote sensing and related modern technologies for management of natural resources of the country. The objective is pursued by the founder Director, NRSA and subsequent leaders by not only setting up systems to acquire and process remote sensing data, but also by developing simple, user friendly indigenous equipments and making them available to the large user community to interpret and analyze the data to generate relevant output for various applications. It is in this context that NRSA while creating major infrastructure for remote sensing data acquisition, processing, etc., also initiated efforts to develop instruments/systems/software to interpret and extract required information from the imagery. Such an initiative resulted in development of many interesting products ranging from simple light table, scale changing/enlarging equipment like plan master, optical pantograph, optical reflecting projector to complex systems like multi spectral additive colour viewer, image analyzer and drum scanner digitizer for converting digital imagery into photographic imagery. Data interpretation/analysis operations including complex ones are done today with a click of the mouse on the desktop system, but the technology along with the systems and software were not available during those days, except for the single unit of the state of the art multispectral data analysis system procured by NRSA. But such systems were expensive and needed comprehensive maintenance. Therefore it was essential to provide inexpensive data interpretation/analysis instruments to the user community for the effective utilization of remote sensing derived imagery.

It is around this time that the Department of Space, Government of India, formulated a policy of encouraging our experienced engineers/scientists to become entrepreneurs by taking technologies from DOS/ISRO. The policy created considerable interest and enthusiasm among some of our colleagues in NRSA and five of them came forward to become entrepreneurs out of whom three set up their own industry. The entrepreneurship development scheme in particular and productionisation of many technologies developed either for specific application or as a spin off technology were vigorously pursued by the then Technology Transfer Group (TTG) at ISRO HQ. I, as a Member of TTG still recall the

Visit of Mr K R Narayanan, Minister of Science and Technology (1987)

keen interest shown by the then Chairman, TTG, Mr P Sudershan in successfully implementing the entrepreneurship scheme and transfer of technologies for items developed by NRSA. In fact he would use all his persuasive skills to obtain the much needed administrative and financial approvals as well provide contract templates to ensure that the technologies were transferred as soon as development was completed. While the overall technology transfer programme was coordinated at ISRO HQ, he delegated much of the ecision making and implementation to the Centre.

In the light of the developments cited above and with continued encouragement and support of NRSA management, the PPED of NRSA could successfully transfer and productionize quite a few

Visit of Mr Shivraj Patil, Minister of Defence (1986)

technologies during beginning and mid eighties. In fact the visit to any State Remote Sensing Centre or Central Government laboratory involved in remote sensing during the nineties would be like visiting an exhibition of NRSA developed equipment. Here, besides my other colleagues, I would like to recall the effective support of Mr. V Raghu Venkataraman (currently Associate Director at ISRO HQ, Bangalore) and Mr Ramaiah, then Head, Accounts & Finance Area. Two shining examples of our entrepreneurship development scheme with successful technology transfer are M/S Remote Sensing Instruments & RSI Softech India Private Limited headed by Mr T Sesha Rao, a former Mechanical Engineer of NRSA and M/S Indian Resource Information & Management Technologies (INRIMT) headed by Dr P Subba Rao, a former Water Resources Scientist of NRSA. Today these two multifaceted industries provide variety of services based on geospatial technologies and manufacture of some subsystems for satellite/ launch vehicle programme. I know that some more engineers/scientists followed them successfully later in the creation of hub of geospatial technologies based industries in Hyderabad.

The other industries who had taken know how from NRSA during the same period such as M/s Speck Systems Limited too performed quite well in providing remote sensing based services and also as forerunners showing the path to establish similar industries in Hyderabad.

My First Innings

Seelan Santhosh Kumar
Former Head
(NRSA Data Centre)

September 30, 1977 and the number 224, the date I joined NRSA and my employee code, will always be fresh in my memory. At that time, NRSA's temporary headquarters was located in a small building in Sardar Patel Road, next to the Secunderabad YMCA, and the first building at the Balanagar campus was just being completed. A motorcycle ride to Secunderabad for lunch would barely take six or seven minutes! Until Nambiar (later Head Cook at the NRSA canteen) started a chai shop near the original main gate on the west side, we used to walk to the corner of the road for a cup of tea.

Being a part of a new organization involved with modern technology was exciting. Many young scientists and engineers were being hired and trained overseas. Wing Commander K R Rao, who established NRSA under DST, told me "we recruit scientists and develop the area - I would like you to develop groundwater applications".

This sounded great, except that I was 26 years old, and had no clue how this could be done! But the belief he had in youngsters like me was a great motivator. Prof A K Roy of IIRS (then IPI) encouraged me, and the Indo-US workshop on water resources held in NRSA in April 1978 was an eye opener.

NRSA initiated state-wide pilot projects in Tamil Nadu, Andhra Pradesh, Karnataka, etc. in the late '70s and early '80s. These were integrated projects involving several themes including groundwater. It was also the time when Wg Cdr Rao initiated the Indo-German projects. J K Sharma started working on the first ever nationwide landcover map, and Madhavan Unni started a similar effort for forest mapping. Several State Centres were being set up, and the Prime Minister of India was the Chair of the NRSA Governing Council!

Indo-US workshop, April 1978.

There was a lot of camaraderie and socializing among scientists and their families. I also recall the evenings (during our bachelor days) when Maruthachalam, Hegde, and myself used to sit by the Parade Grounds and have a Kingfisher and go for a movie in Minerva or Tivoli.

The first major challenge for me came during the early to mid-eighties. NRSA was asked to provide groundwater potential zones in Maharashtra and Karnataka quickly during the severe drought, to help select drilling sites. We assembled all available resources from within NRSA, SAC, and ISRO HQ in completing the task. When the country embarked on a mission to provide water to all villages, we were fortunate to be able to convince the authorities the potential of using remote sensing technology to carry out reconnaissance level investigations which could vastly reduce the cost and time involved in field surveys. This ultimately led to remote sensing technology being used extensively in the Rajiv Gandhi Technology Mission on Drinking Water.

It was a wonderful feeling when IRS 1A was successfully launched in 1998. I still recall the day when about forty pairs of eyes excitedly looking at the print of the first IRS scene, acquired over the Tirupathi area, as it rolled out of the Versamat printer in that little photo lab dark room!

In early 1990, I was asked to Head the NRSA Data Centre, and this turned out to be a great learning experience. Co-ordination with satellite companies,

and teams involved with data reception, production, quality control, and archival, on the one hand, and the fast growing user demand for better products and services on the other, was an interesting challenge. We still found ways to satisfy the users and also market IRS successfully. Fortunately, we had a group of very talented, and motivated young people who helped shape NDC into a viable unit.

Visit of Mr K R Narayanan, Minister of Science and Technology (1987)

When I left NRSA on January 13, 1995, to seek other opportunities for me and my family, it was a very tough decision as I was not only loyal to NRSA and DOS, but also loved my work. During my farewell speech that day in the NRSA auditorium, I mentioned that I felt like a cricketer who had completed his first innings and getting ready for the second. Later, a young woman approached me and said “you scored a century in your first and wish you will do the same in your second”. Though I missed NRSA during the initial years after my departure, my second innings indeed turned out to be greater than I dreamt, mainly due to the valuable experience gained during early part of my career.

My Journey with NRSC

Dr S Natarajan
Former Scientist/Engineer 'SG'
(Aerial Survey and Digital Mapping)

I started my journey at NRSC (then National Remote Sensing Agency) in the Technical Division way back in February 1977. In the initial period we were not aware of Remote Sensing. We were given a thick bound book in cyclostyled form (now called as xerox version) to read and assimilate. We were mostly self-trained at that time. We tried to understand and started writing small pieces of code in FORTRAN language (which is not used now). Fortunately, an Image Processing System of Bendix Corporation imported from USA was installed around July 1977. This gave us a handle to try programs in image processing using the facilities available then.

In the intervening period, as there was no general purpose computing systems available at NRSA to process the Remote Sensing Satellite data, we were deputed to Electronics Corporation of India (ECIL). We used to come to office once a week to discuss the status of the project. People in our locality thought that we were employees of ECIL. It was an interesting experience as the French Computer IRIS 55 system used to print the compilation errors in French. We had to seek the help of some of the Engineers to resolve the errors.

A momentous occasion in my career was that I was selected for the ISRO-DLR fellowship to undergo training at DLR, Oberpfaffenhofen in Germany in September 1978. I worked with their team in the development of an image processing system called DIBIAS. I had the privilege of training Engineers from Indonesian Space Organization during my stay there. The one year stay there was a great learning experience. What impressed me with the Germans is their systematic way of working. Back in India, I was one of the team members involved in developing the software to do pre-processing as well as analysis of Satellite data.

The Remote Sensing Satellite of USA called LANDSAT was the only one available at that time to process the data for the analysis of natural resources. The NRSA management took the decision to build a system in association with Hughes Corporation. The system was operationalized at Shadnagar Earth Station in June 1979. This was a milestone in the history of NRSA. Let me recount one of the interesting episodes at that time. We were in our office at Balanagar. Whenever bugs were reported we have to go to Shadnagar from our Secunderabad office. The Earth Station at Shadnagar had a tight schedule in the management of Satellite passes. There was one and half hour of gap between passes of the Satellites. This was the time available for us to resolve the bugs. We have worked as a team and completed it in within the time available to us. There were occasions where we had stayed overnight for any of the important missions.

A new course on Digital Image Processing and allied fields were introduced at Indian Institute of Remote Sensing (IIRS) at Dehra Dun in 1985. We were the people who designed the course, and executed the course for the first time. We also trained the faculty there and handed over to them. Again around 1995, when the Centre of Space Science and Technology Education for Asia Pacific Region (CSSTE-AP) under the aegis of United Nations was established in Dehra Dun, I was privileged to be one of the key members involved in the procurement of Hardware as well as in development of courseware using e-learning software tools available then.

During my tenure as Head of Programme Planning and Evaluation Division, I was responsible for the computerization of the administrative functions within NRSA. Towards this, I installed and operationalized a Local Area Network (LAN) in 1987. This may be the second such system In India at that time. A seamless

Budget Monitoring System, Project Monitoring System, Automated System for Technology Transfer, etc., were developed. I was also a member of the Committee to monitor the progress of Computerized Working of Administrative Areas (COWAA) which was operational at the various centres of ISRO.

One of the challenging projects in Aerial Services and Digital Mapping (ASDM) was the creation of Ground Control Points Library (GCPL). Being Project Manager of this Project, I was responsible for the timely generation of accurate locations of 3000 places within the country. This was to be completed before the launch of Cartosat. Manpower planning, training and timely completion was some of the important aspect of this Project as majority of the field level young people had no exposure to the technology. As per the agreement with Ministry of Defence (MOD) the survey of the land area of nearly 50 km from the coast have to be done by the personnel of MOD and the rest of the area by us. I had the problem of a Major from Army who used to wake me up around 2:00 AM to update the status and that too during the summer season of Hyderabad. As the Project was carried out throughout the length and breadth of the country different issues cropped up. When one of our teams started the operations opposite to a Mosque on a Friday afternoon in an area in Uttar Pradesh, news spread that the people in the Mosque were targeted for attack. Very soon the local people arrived and took our personnel to the Police Station. We got a call from there around 5:00 PM. They wanted to verify the credentials from the records they needed from us. I had to virtually run for a Kilometer as the Admin Office was about to be closed. I got the copies of the records and immediately faxed to them. Fortunately they received in time and released our personnel. Otherwise they would have been in lock up during the weekend and get released only on Monday. During the survey operations in Rajasthan deserts they had to go in camels for their job as cars cannot be driven there. On one afternoon we got a call from our team stationed at Karimnagar. They told us that the Police had refused to give protection to our team in that area. Immediately we asked them to leave that place and start the work in a safer place. These are some of the hazards of survey operation.

Inauguration of HRD programme (1996)

Another major project that I carried out before my superannuation is Large Scale Mapping (LSM). As Deputy Project Director, I was responsible for the operations. It was a challenging and satisfying job as it involved co-ordination with other ISRO centres as well as State Government and Private Agencies In the execution of the Project. The other notable projects were APUSP project for digital map generation of 54 towns of Andhra Pradesh, BMP Project for Bangalore on urban Utility Mapping, Kolkata Metro Development Authority (KMDA) project on urban mapping etc. It was in this period that I completed the thesis entitled “Object Oriented Geographical Information Systems (OOGIS) - A Remote Sensing Approach” and was awarded PhD degree by Jawaharlal Technological University (JNTU) under the guidance of the then Director Dr B L Deekshatulu.

Memorabilia of NRSA (NRSC)

B C Parida
Former Head
(Quality Assurance Division)

It was my proud privilege to serve National Remote Sensing Agency (NRSA) now NRSC. NRSA a pioneer organization in India in the field of Remote Sensing Activities using Satellite, Airborne and Radar ((SLAR) digital image data, providing facilities for processing, analysing the remote sensing data on image processing system for different application themes like land use, hydrology, forest, soils, agriculture, geology etc. and generating colour coded images, photos, maps of all natural resources.

I joined NRSA as an Engineer Assistant 'C' in March 1976, then an autonomous organization under department of science & technology (GOI) and was headed by Wg Cdr K R Rao as the Director. Then the technical and application group activities were combined to a rented double story building at 4, S P Road, Secundrabad. The Admin Accounts, Purchase &Store were functioning from a rented building at Punjagutta. The Research Flight Facilities (RFF) with one AVRO (HS748) and a Dakota (C-47) Aircraft was also formed at Bangalore to provide Flight facilities to get Airborne Arial Photography and Survey. Under Technical Division a Section was involved in the Aero Magnetic Survey using a small single engine BEAVER Aircraft, for mineral resources survey and mapping besides hardware R&D activities were going on by the Technical Staff at Secunderabad. The Application Scientists were engaged in familiarization of the theoretical aspects of Remote Sensing and its application in the field. Immediately after my joining, NRSA, I was directed to work as Purchase Office about three/four months and handled and processed all the Foreign Purchase Files and correspondence to accelerate the procurement of the M-DAS & m^2s system and its hardware spares, test and measuring equipment etc., from abroad. I was also responsible for the procurement off necessary tools, equipment, maps etc. needed by the Application Group Scientists. NRSA acquired a piece of land from HAL, Balanagar and Civil construction Work started on war footing in 1976. During October, 1976 a group of Hardware & Software Engineers including self and then Applications scientists from different fields were sent to M/s. BENDIX Corporation at MICHIGAN, USA for training under UNDP scholarship headed by then Technical Division Head Prof. B.L. Deekshatulu. At BENDIX, the training was imparted on Operation & Maintenance of the multi-spectral data analysis system (MDAS) Hardware & Software and on the Airborne Modular Multi-spectral Scanner (m^2s). Applications Scientists were trained at hands on operation of MDAS for processing and analysing remote sensing data for various themes. In early 1977, the Technical Building at Balanagar was made ready. The state-of-art Image Analysis system M-DAS and Airborne Scanner M^2S was received at NRSA. M-DAS installed in the Technical building at Balanagar and the M^2S was installed in the Aircraft at RFF. After some teething problem, the M-DAS system was successfully installed and operationalized.

The Technical building, besides housing the M-DAS and printer plotter (P/P) system, also provided accommodation to all Application Group Scientists in the right wing of the building. A most modern and sophisticated Photo Processing Lab came up on the left wing of the technical building.

During the early 1980's, a Satellite Ground Earth Station came up for NRSA at Shadnagar to receive the Remote Sensing satellite data from LANDSAT, TM, SPOT and later on from IRS on real time. Till then, NRSA was processing all the required remote sensing data from foreign sources. The satellite data received at Shadnagar Earth Station was recorded on High Density Tape (HDTs). The HDTs were brought to NRSA Balanagar for further processing and converting into CCT at the data conversion facilities at technical division.

From 199 till 1987 MM-Das was the only interactive Data Analysis System with a single work station, provided the image processing and analysis facilities to all Application Scientists and other users at NRSA.

In July 1986, a group of 200 engineers including self and two Software Engineers and two Application

Scientists from IIRS, Dehradun were sent to M/s. DIPIX Corporation at OTTAWA, Canada for training on the operation and maintenance of its hardware/ software and application usage of the ARIES Interactive Multi-spectral Data analysis System (IMDAS). The IMDAS was subsequently procured at the end of 1986 and was installed at the Data Analysis section in the Technical Building. The IMDAS system with its single colour work station provided the RS image Analysis work support faster than MDAS and finally replaced the MDAS.

During the first two decades, NRSA had expanded with new buildings for Applications Group, Earth Station Group, NDC, Auditorium, Map Printing and Storage Building, Canteen, Training Centre, Library, Hostel, Transport section. RFF which was at Jeedimetla also shifted to Balanagar for better operation coordination purpose, besides its manpower strength.

In 1996, I was directed to establish an independent hardware Quality Assurance division (QAD) to provide hardware quality assurance of the in-house designed and developed hardware system and module. Collected quality standards (QS), different quality tests environment test procedures from SAC, Ahmedabad, ISAC Bangalore, ECIL and RCI, Hyderabad prepared QA documents. I provided QA awareness among the technical and earth station group. R&D hardware engineers provided QA services to the in-house designed and developed hardware system subjecting them to different QA inspection and test as per QA test procedure.

During the tenure as the Chairman of the NRSA Canteen Management Committee between 1994 and 1997, I had tried to modernise the canteen operation installing a steam boiling for cooking and also our proposal for the expansion of the canteen building got approved by the ISRO HQ.

During my 22 years of services at NRSA, I could see the tremendous growth infrastructure wise and manpower wise. This was possible due to sincere, personal and professional contribution by every staff of NRSA and the efficient direction and guidance of those persons who are at the helm of all affairs.

I wish NRSC good speed and good luck.

Research & Development in Optical Instrumentation at NRSC

Y Ravindra Babu
Former Head
(Optics Division)

National Remote Sensing Agency (NRSA) was established in the year 1974 by Department of Science and Technology under the Ministry of Science & Technology, Govt. of India, for the purpose of acquisition of Remotely Sensed Data from Air borne and Space borne platforms, data processing and data dissemination to various Govt. departments for the identification, monitoring and exploitation of various natural resources.

NRSA was also entrusted the responsibility of adapting the pilot projects to develop the methodologies to prove the usefulness of the remotely sensed data for various applications with different themes in the areas of Land use and Land Development, Agriculture, Forestry, Ocean studies, water resources etc.

In seventies, Opto-mechanical scanners were in use in Air borne and Space borne platforms to acquire the remote sensing (RS) data. Multi Spectral cameras with photo films were also in use to record the remote sensing data in Space borne and Air borne platforms.

In the remote sensing program, Americans were using Landsat remote sensing Satellites and used Multi Spectral Scanner (MSS) as pay load in the initial years and produced multi spectral remote sensing data in four spectral bands, three in visible and one in near infrared regions of Electromagnetic spectrum. In the later years they introduced Thematic Mapper (TM) as payload and acquired remote sensing data in specific theme oriented spectral bands to facilitate classification of natural resources.

NRSA started using the remote sensing products (Landsat, MSS) supplied by EROS Data Center, NASA, USA in its pilot projects. Later NRSA established its own Earth Station, obtained permission to receive the data from Landsat and started producing RS products such as MSS, TM and made available to the several Govt. and other users for the study and exploitation of Natural resources.

Optical instruments were also playing a great roll in displaying the remote sensing data, whether it is in spectral band form or in additive color form. In seventies, the digital computers, digital display screens had a limitation in handling the amount of data and size. The RS data formats in Seventies made the RS data users to use optical instruments such as projectors, additive color viewers for viewing and analyzing the RS data and presenting the thematic outputs.

As the importance of remote sensing in the study of natural resources and its utility in the planning of various programs in Govt. departments and private agencies increasing, NRSA took up the development of several optical instruments to cater to the need of increasing R S users in the country and to save the foreign exchange by not importing such instruments.

The following optical instruments were developed at NRSA by the combined efforts of Optical Systems Division and Electronics Division.

1. Multi Spectral Additive Color Viewer: A four channel projection system to project simultaneously four spectral band black and white R S images illuminated by Blue/Green/Red/ White light on to a common screen to get a fused color additive image to facilitate the user to view, to analyze the content of the image, to trace the delineated thematic output and to take the photograph of the additive color output of the image, if required.
2. Optical Reflecting Projector: A projection system with a variable magnification and built into a horizontal worktable facilitating the user a convenient work platform. Useful for updating the

existing maps of different scales with the freshly acquired remote sensing data.

3. Optical Pantograph: A motor driven auto projection system projects the enlarged image of the given input at a given scale (within the range of the instrument) on to a fixed screen which is at a convenient height to the operator. Useful for updating the existing maps of different scales with the freshly acquired remote sensing data.
4. Optical Densitometer: It is a measuring instrument to measure the optical densities of photographic transparencies and hard copies.
5. Colour Photowrite: An electro optic photo write system to construct a colour image from a remotely sensed digital data.

Technology Transfer: The technology of following instruments was successfully transferred to industry for production and supply to various RS users. The industry produced good numbers of these instruments and supplied to the various user agencies in Govt. and in private.

1. Multi Spectral Additive Color Viewer
2. Optical Reflecting Projector
3. Optical Pantograph
4. Colour Photowrite

Awards: The National Research Development Corporation (NRDC), Govt. of India Enterprise, adjudged the following instruments as meritorious inventions and awarded cash prizes to the team of members who participated in the design and development.

- Optical Reflecting Projector - Meritorious Invention Award - 15th August 1986
- Colour Photowrite - Meritorious Invention Award - 15th August 1993

Optical systems became obsolete in late Eighties onwards

With the advent of high capacity digital computers, high resolution large graphic display color screens, laser & ink jet printers and the availability of dedicated software for remote sensing image processing, from late Eighties, the requirement of optical systems as output devices for remote sensing data has dwindled.

My Journey with NRSC

Thomas George Kandathil
Former Head
(Technical Support Services)

First of all let me congratulate Director, Deputy Directors, Controller and all the technical and non-technical staff of NRSC on this occasion. Also, many thanks to the committee for providing an opportunity like this to old guys like me!

Now going back in time, it was on 10th May 1978, I joined NRSA as Engineer/Scientist C, with a basic pay of Rs 780 (see the growth curve in 30 years!). Before joining NRSA, I was working at India's first Intelsat Satellite Communication Earth Station at ARVI, Pune. This station was the most advanced in technology with huge 97 ft (30m) antenna, 3KW microwave transmitters and receive amplifiers kept in liquid helium at a temperature of minus 253°C. On joining NRSA, initially it felt that I joined a very small department which was just a miniature of my parent department.

The founder/first Director of NRSA, Wg Cdr K R Rao was the project director of the satellite station ARVI. I met him for the first time during my interview at NRSA. He was a great visionary and a task master. Everybody reporting to him understood and accepted it. In his own words he came to Hyderabad with just a suitcase in hand and initiated work in a small rented building - which has now grown into the present status. By the time work on data reception station was initiated, a vibrant campus was getting established at Balanagar with Prof B L Deekshathulu as Head, Technical Division and Col L R A Narayan heading the Applications Division.

NRSA engineers at Shadnagar (1983)

Mr D V Raju, Head of earth station division, Mr M M Saxena, Mr Anil Kumar, Mr G V Ramanamurthy, Mr U D Limaye and me were the first to get inducted into the earth station project. Later, a few more batches of engineers joined in. Initially, Mr G V R Murthy and I were asked to report to Mr H N Kesavan, construction engineer for supervising the electrical and other infrastructure facility of earth station project. It was at this time I started learning and worked on project execution, techno-commercial handling and project management skills. Once the construction activity was over we were back to earth station division.

During my service, I had reported to three Deputy Directors - Mr D V Raju, Mr S Ragunathan and lastly to Mr Anil Kumar. Incidentally, Mr Anil Kumar was my senior colleague at ARVI. All of them gave me good opportunities in various projects beyond my specific area of power electronics/communications.

I was responsible for infrastructure planning and execution for IRS 1A, 1B, 1C and 1D. Later, I worked with external agency projects of KARP Delhi and Doomdooma stations for site planning, building layout preparation and all infrastructure support systems. In addition, I had the opportunity to provide technical/ planning consultation support to DIPAC, INCOIS, IIRS, ISTRAC, MMRGS, ADRIN, etc. in specific areas. I was able to contribute many innovative ideas in various projects successfully.

My experience in multi-disciplinary activity helped me in preparing the master plan and facility planning for the IMGEOS project. I am thankful to Dr K Radhakrishnan, then Director of NRSA, for giving this opportunity. Even though there were lot of apprehensions and bottle necks, this project turned out to be a real winner - platinum certification! Although I played the

role of a trigger and pushed forward, the enthusiasm and support of Dr V Jayaraman, then Director and the hard work of Mr P P Chowdhary, Mr D Santhan Kumar and their team played a key role.

The important thing for me is that I was part of the NRSC Shadnagar system which took a full circle - first life cycle. I was there when the foundation for the first Landsat station was laid and then again for IMGEOS. Even though the Shadnagar earth station campus was limited to a few acres for almost 30 years, with IMGEOS there was an instant extensive change, which occupied almost the total area of 316 acres.

What excited me the most was the multi-disciplinary areas of research within NRSA, something similar to a University. I was more interested in the study of application of remote sensing than my own area (the other side is always greener!) and tried to attend some training courses as well. I was always fascinated by the satellite imageries and maps. Due to pressure of work this remained a distant dream, but not lost hope! Now, after my retirement, I have decided to do some work/service in my dream areas. For this, a Not for Profit institute, by name Centre for Integrated Research and training (CIRT) is formed and is in the early days of growth. I hope this will give me enough self-satisfaction and turn my unrealized dreams into reality.

To conclude, I will emphasise that the success is not for an individual but it belongs to the team. I had a very energetic team reporting to me guided by Sri S Sayed Mehmood and Ms S Prema and all credits go to all of them. Sometimes, I feel that I had driven them too hard to match my expectations.

Once again wish each and every one a prosperous and exciting future.

Visit of Mr G Madhavan Nair, Chairman, ISRO to Shadnagar (11-May-2009)

My Memories of NRSA

H N Keshavan
Former CNE
(Construction and Maintenance Unit)

It was the 16th day of October 1975. "Venkatadri Express" from Bangalore declared its delayed arrival at Hyderabad around 10:30 AM. When the train roared in to the bustling Kachiguda Railway Station little did I know that I am entering into a world known only to a small community of privileged scientists in the country and the world around. And that was to be NRSA [now NRSC]. Merciless sun over the head, hot concrete pavement under the feet, milling and maddening crowd around, shrill, nasty, dusty and foul atmosphere greeted me with warm (hot) welcome to the Minaret city of Hyderabad hither to unknown to me. I had set foot on an unknown land with only a small trunk and a smaller handbag. A rickety cycle rickshaw pedaled by a skinny old man creaked in pain to put me in to the hotel which was the puller's choice. The room was semi dark due to bad ventilation. The earlier occupants had generously contributed to a thick red coat of tobacco on the floor and walls. However here and now I settled with a thin purse and a big dream - a dream of building infrastructure compatible to the birth of an amazing technology named as "REMOTE SENSING", predictably to take the scientist community by storm. A dream to translate the lifeless small patch of land near HAL to a bubbling and giggling nursery to incubate, nurture, feed and grow the "REMOTE SENSING" baby into a handsome form to conquer the world attention.

Entry to the mystery land: Mr Arunachalam, the then Admin officer was in great spirits to show and introduce me to the land that was yet to be conveyed to NRSA. But he took extraordinary pains to impress me that the land is almost his own, because he was a former employee of HAL and took liberty to graciously transfer the land then and there to me and ordered to start work forthwith. But the land continued to belong to HAL for further one month. It was a 5.4 acre (correct me if wrong) land with no fencing on any side, a big drain running along Balanagar main road, marshy, thorny and a large ditch for the rain water to stagnate for the whole year - excellent breeding place for mosquitoes and pigs, war field for dogs, surely a paradise after sunset for those interested in night life. The undulated surface of the site was covered with dense thorny bushes, boulders and ditches with rain water rivulets running in all directions.

Prof. Satish Dhawan's visit to NRSA (1981)

Challenges: I said earlier that the land was a cess pool for rain water and an open sanitation to the nearby locals. Creating an effective cross drainage system to drain out these wastes as well the subsoil water was the first challenge since the natural ground slope was inadequate for free passage. Secondly, the earth underneath was black cotton soil, which showed a dubious character of being hard when dry and butter like soft when wet. The shallow subsoil water made the soil always soft and treacherous. This posed a threat to found the heavy foundations. Treating the soil with proper techniques, strengthening to improve the bearing capacity was a challenge. Shoring, shuttering, sand piling, steel piling, etc. had to be extensively employed.

The land at hand was small, but a number of technical buildings, service buildings, roads and parking, drains, etc. were many. Hence developing a master plan to balance the demand and utility of space was itself a challenge. Acquiring a large tract of land for data reception (earth station) at Shadnagar was by itself a landmark. It was a task demanding high skill to make the tight fisted AP government officials to loosen them and tame the hostile Banjara settlement to part with their land without any bodily damage to NRSA personnel handling the case.

Administrative buildings under construction(1976)

Early days of NRSA (NRSC): In the formative years of NRSA, there was neither transport system nor a canteen. So Prof B L Deekshatulu and I shared many times the scooter to travel and also the food carried from home. Housing was also not there. All of us settled in rental accommodations. In due course, housing loans were granted. I was lucky to be almost the first recipient. Thus many of us could build our own houses in Safilguda, which was star attraction to many employees. Safilguda became like a NRSA colony. Buses and vans made their starting points from here. Canteen also came to being in the campus at a later date.

Initial setup: Face of NRSA was far different in the initial days. From 1974- 76/77 there were 3 establishments, first one was at Sarojini Devi Road, where founder Director Padmashree Wg Cdr K R Rao used to sit with a few scientists and admin staff. The second one was at Punjagutta, where Accounts, Engineering and some Applications Units were housed. Then there was one in the making at Balanagar with construction work running in furious speed. The first two offices were converted from 3/4 bedroom houses to makeshift offices. A very humble beginning isn't it?

Initially the staff strength was not big. I think it was around 150-175 till 1977-78. I was one of the early entrants. My code number was 0031, which after a year or so came down to single digit. Because of this small group, there was one to one contact with each other - one knowing the other mostly by the first name and their personal matters too. There was warmth and bonhomie all around. Connect was seamless among the entire staff irrespective of status/grade. Meetings used to be frank and friendly, exchange of ideas laced with occasional humor than the more prevalent cross arguments. There was a feeling of oneness among all.

As the time passed by, the remote sensing technology spread its wings far and wide and beyond shores. The technical support devices, infrastructure and the manpower had to be inevitably expanded. The budget, the grants, the expenditure all soared up. A beautiful little child had now grown into a strong and handsome youth. I am indeed left speechless to express my deep sense of pleasure, satisfaction and my good fortune to be an integral part of such a tall and amazing technology centre - be with it, live with it, grow with it and remain greatful till my last breadth.

Birth of CMU: All are equal in the eye of god. Some are, but, bestowed with incremental fortune than the rest. I being one such had the most benign opportunity to form and lead a construction and maintenance unit. This task started the day I reported

Expansion of Data Processing building under construction

View of DP building (18-Dec-2007)

to duty. This handpicked, cohesive, enthusiastic, young and dynamic group, selflessly, untiringly (with wrist watch removed from their hands) worked with feverish speed and tremendous dedication to create the dreamland that was to be the seat of high end technology named NRSA Campus. Each target completed one after the other on or before schedule.

With paltry piece of land, unpredictable soil underneath, incredibly short span of construction time, shortage of competent builders, compounded the complexity of the problem. It was just not a challenge to develop the land use but surely a magic. It was as though each engineer was wielding the magic wand. Thus rouse with dignity and elegance the robust and handsome buildings. Deep felt acknowledgements and accolades to all those brave engineers who struggled then and are continuing now.

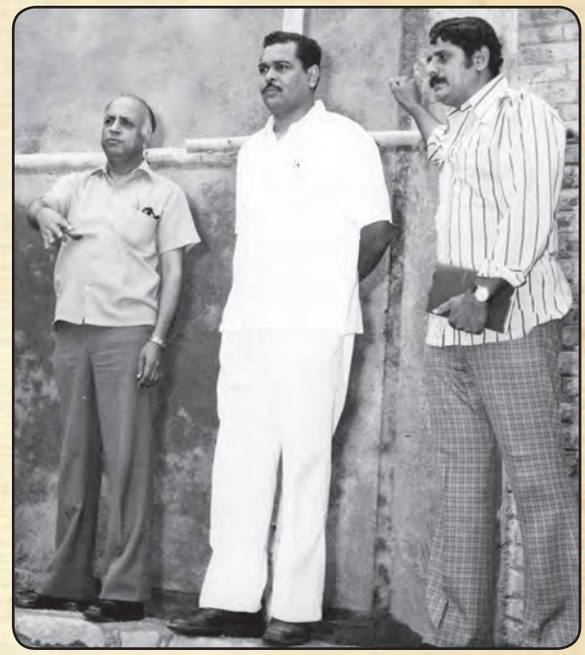
Thereafter, there were big strides in the development. Auditorium, canteen, transport sheds, housing complex, earth station and allied facilities came up one after the other in quick succession. A recreation center "The NRSA Recreation Club" and a library also started. I had the privilege to be the first Chairman of this club, which conducted interesting events and annual functions.

Some important information that I forgot to mention are:

- First Director of NRSA: Padmashree Wg Cdr K R Rao
- First ADO : Mr Arunachalam
- First Building : Technical Building (Computer Centre)
- First, NRSA was under Dept. of Science and Technology, later transferred to DOS.
- First, there was no pension scheme. It came into force after nearly 20 years

Conclusion: There may be a few omission, commission, repetition and inaccuracy in my narration. Please attribute this to my age factor and the receding memory and correct it where necessary. I joined NRSA as a father of two small kids and writing now as a grandfather of 5 children. This shows the tremendous speed of time that has elapsed in my life. Sweet memories hugging my mind haunt me constantly and I am living cherishing these memories. I hope all my colleagues share the same experience. On the 1st of Jan 1993, I had to wind up my innings and return to native place owing to personal issues. I took voluntary retirement and bid teary goodbye to all my bosom friends who are still living in my heart.

I am deeply grateful to you and NRSC to have given me the opportunity to put forth my thoughts and feelings.



NRSA Auditorium under construction

View of CMD building (2-Jan-2008)

View of Auditorium (2-Jan-2008)

My Odyssey with IIRS

Prof A K Roy
Former Head
(Geosciences, IIRS)

I remember my first association with IIRS as an Officer Trainee (Geology) for the First Diploma Course in Aerial Photo Interpretation Applications, in 1966-67. IIRS was then known as the Indian Photo-interpretation Institute (IPI) and was established under the aegis of the Survey of India in collaboration with the Dutch International Training Center (ITC). I was thrilled to get a chance to learn about a new & emerging technological tool for natural resources survey & mapping.

After successful training I went back to serving in the CGWB where I utilized the knowledge gained to map out select areas, specially the "Borunda" (Jodhpur) - Jaisalmer area in Rajasthan for a UNDP Groundwater Survey project. I was keen to apply the photo-geology technique and used it advantageously.

I joined the IPI (now IIRS) as Professor, Geology in mid-September 1970. With my background experience as Hydro-geologist, I helped introduce a course in Hydro-geology studies apart from the Geo-morphology & Geology courses which were already being conducted. Subsequently Engineering Geologic studies were also introduced.

Endeavour was always to upgrade & update the training courses from time to time. The courses also got diversified as required, for example, subsequently a short orientation course for senior Geo-scientists (2 weeks) was introduced, followed by a 5-day Awareness course for managers.

IPI was later re-named as the Indian Institute of Remote Sensing and was merged with the NRSA, Hyderabad in 1975.

With the advent of the American ERTS (LANDSAT) satellite we got scanner data and introduced "Remote Sensing Techniques for natural survey using visual & digital image processing. We also started using SPOT & Radarsat images followed by Indian IRS data. I took over as Head-Geosciences in the latter part of 1977. Around that time the Institute started further diversification of activities by adding newer Remote Sensing based training courses, holding seminars, and taking up research as well as consultancy projects.

During my service tenure I always enthused my team to take up innovative research & other projects. During Diploma courses we took up the mapping of select areas as project work, and brought up useful updated mapping as well as information about the terrain studied.

After 1975, we took up several Consultancy projects, notable ones being - a) Engineering Geologic survey in Parbati Hydel Project in Kullu district, HP, upstream of Manikaran hot-springs; b) Indo-Nepal Project on road alignment surveys in Sun-Kosi Valley, Nepal, based on Land-facet mapping; c) Landslide Hazard zonation mapping in Chamoli area, Uttarakhand. I actively participated in and guided these projects. Later we developed a research method for GIS based landslide hazard zonation.

I was involved in the integrated surveys in Karimnagar area, AP. I undertook and coordinated finalization of the IIRS-ITC project on Integrated Urban Development survey of Rohini, Delhi area using GIS based mapping.

I had developed the Hydromorphogeologic mapping approach for ground-water targeting based on landform-processes-geologic underlying materials and structural controls using Remote Sensing and ground checks. I had a memorable three decade long association with IIRS and continue to be in touch.

There has been a sea change in Remote Sensing since my time with improved scanner-sensor data, Radarsat, Interferometric data processing techniques, GPS, Internet and what-have-you. Now space in the limit perhaps!

We have now to gear ourselves to take up Lunar & Mars exploration…… God Speed!

While in IIRS (NRSA)

Prof M D Shedha
Former Scientist/Engineer 'SG'
(Forestry, IIRS)

Indian Institute of Remote Sensing(NRSC) has come long way since its establishment in 1966. I was sponsored by the Forest Survey of India(F.S.I) in1968 for one year P.G Diploma course in use and interpretation of aerial photographs for forestry. At that time, the faculty to teach basic forestry subjects and the applications of Aerial photo-interpretation technique for forest cover type mapping, Forest inventory, Forest Management Planning and allied subjects was from International Institute of Geoinformation Science and Earth Observation (Earlier The I.T.C), The Netherlands. At that time the work of Forest Cover Type Mapping and Preparation of Forest Inventory using Aerial Photo-interpretation techniques in FSI also was planned and executed under the guidance and supervision of UNDP Experts. Because of my field and laboratory experience of six years in FSI and perhaps on my performance as a trainee in IIRS, I was offered the post of Assistant Professor Forestry in IIRS which I joined on 04.03.1977. The day I joined the Forestry Division IIRS there were only two faculty members and only two trainees (1976-77 batch). The trainees were already in the forests of A.P for their field project work, where I joined them and supervised their field work. By the time we returned from field both the faculty had already left IIRS or were in the process of leaving.

Apparently there was acute shortage of faculty and the trainees. Immediate and hectic steps were taken to increase the numbers of trainees and the faculty. As a result more than ten trainees joined the next (1977-78) course. Three faculty members were recruited and got trained during the next two years.

In order to make the User Departments fully aware of the potential of Remote Sensing techniques, personal meetings and discussions were arranged with the officers of the State Forest Departments and other User Organisations and seminars were organised at regular intervals.

Towards the above goal we started undertaking the field projects of the trainees in the forests of their respective states. We also started undertaking research and consultancy projects to demonstrate the usefulness of Remote Sensing techniques in the field of Forestry. On my suggestion the subjects of Remote Sensing was included as a regular subject in the syllabus of the Indira Gandhi National Forest Academy and the State Forest Service College.

I collaborated in the Multi disciplinary survey for optimum land use planning and development and development of natural resources undertaken by IIRS in the following areas.

Karim Nagar (Andhra Pradesh), Mewat (Haryana), Sirohi (Rajasthan), Hissar (Haryana), Rohini Delhi (ITC - IIRS Research Project - Urban Forestry).

Appreciating the quality and standard of training of Remote Sensing application in the Forestry Division of IIRS, the FAO and the World Bank offered me the expert's job of organising training courses and consultancy projects on use and interpretation of Aerial Photograph and other Remote Sensing data for Forestry and Land use planning in the Tropical, Sub-tropical, Temperate and Alpine zones in Ethiopia, Iran, Bhutan and Combodia.

In the end I make an humble and important suggestion to make more and more continuous efforts so that all the Forest Departments in the country start using Remote Sensing techniques by themselves in the field of Forest Cover Type Mapping , Forest Inventories, the development of forest and Forest Management Planning. I congratulate NRSC for four decades of service and nation building.

A Bird's Eye View of Aerial Survey Facility at NRSC 1994 to 2002

K K Pappan
Former Scientist/Engineer 'SF'
(Aeriel Services and Digital Mapping)

Contrary to reports that NRSA started functioning from a rented building at Secunderabad, I would like to state that the erstwhile NRSA was commenced functioning from a Survey of India office of No.52 party located at Red Hills behind the Hyderabad Public Gardens. The Director, NRSA, the first admin person and his assistant were accommodated as guest officers at No.52 party while I was working as the Recess officer In-charge who extended courtesy to them on directive from DST, Govt. of India.

Thereafter NRSA moved its office to Secunderabad, where technical personnel were positioned. The administrative office started its functioning from another rented accommodation at Punjagutta, near the Topaz building near Mangappa island. Some SOI and HAL personnel, Director NRSA, first two employees and self are the persons who know the above stated facts.

First I salute those who worked in the airplanes, ground support systems, and dark rooms who have selflessly put in dedicated effort to evolve the Aerial survey facility as it is today.

The first air survey mission was carried out using Beaver aircraft of the Directorate of Agricultural Aviation. Aerial geophysical equipment was flown over some parts of Rajasthan. The Beaver aircraft can be taken off and landed on any level ground. The results of first airborne survey were reported to be quite encouraging. Thereafter gamma ray spectrometer, magnetic and electronic sensors were flown over some parts of Uttar Pradesh and Madhya Pradesh. These flights have demonstrated NRSA's capability for conducting Research Flights.

The Research Flight Facility (RFF) was established at Bangalore. One Dakota (DC-3) and one Canberra aircraft were procured from Indian Air Force (IAF). Aircrew were also taken on deputation from IAF. These NRSA personnel and AMD personnel have demonstrated the aerial data acquisition capability.

On a firm footing as an establishment of proven capabilities, one Avro Aircraft HS748 was procured from HAL Kanpur. As a major task at that time 1,00,000 sqkm area in Madhya Pradesh and Maharashtra were flown using airborne magnetometer for the Ministry of steel and mines.

Simultaneous to the augmentation of the aircraft fleet, sensors such as Vanob magnetometer, Modular multispectral scanner and associated equipment were also acquired. In addition aerial survey camera RMK 15/23 was procured to acquire aerial photography of the area allotted by SOI. Those days SOI was the controlling authority for aerial photography. IAF, Air survey company of India (a private company located at Dum Dum airport at Kolkata and NRSA were given aerial photography tasks by SOI. NRSA initially carried out the aerial photography of 10,000 sqkm of area in its first attempt. More importantly the thermal channel of II channel Multi spectral scanner was flown over some areas in Kutch and Kochi to acquire thermal anomaly data. At a later stage, it paved the way for underground coal-fire detection.

Aerial photography, multispectral scanner data acquisition, aeromagnetic data collection and various other sensors such as gamma ray spectrometer, etc. tasks were continued by deploying a fleet of four airplanes one Avro H748, One Canberra, Two Dakota DC-3. One DC-3 aircraft crashed during predawn survey near a hill in Prakasham District in Andhra Pradesh in the year 1977. It was a very sad day for NRSA on November 19, 1977 when the cyclone had pounded the coastal AP, specifically the Diviseema area.

The first NRSA's own aerial photography task has been carried out over 14000 sqkm area of AP coast affected by the 1977 AP cyclone. NRSA has carried out the aerial photography of the entire area and also participated in Rescue, Retrieval and Rehabilitation efforts. Thereafter NRSA has carried out aerial photography of a number of tasks for a variety of applications, some of them are

River irrigation studies: Godavari, Brahmaputra, Kosi, Narmada, Mahanadi, Hoogly, Ganga, Kaveri, Cuum, Kallar etc.

Forest mapping: Nallamalai, Dakshin Kannada, Uttar Kannada, Khammam, Adilabad, DandaKaranya

Land use mapping: Entire Kerala State, Western Ghat, Eastern Ghat, Nilgiris, Kodaikanal

Disaster Management: AP Cyclone, Paradweep port, Gujarat Earthquake, Landslide area of Niligiris, Joshimadh, Brahmaputra Flood, Kosi flood

Town and Country planning: Major towns in Tamil Nadu, AP, Kerala, Gujarat, UP, Orissa, Karnataka, etc.

Urban Planning: Mumbai, Ahmedabad, Kolkata, Chennai, Bengaluru, Hyderabad, Bhubaneswar, Delhi, Trivandrum, Kochi, Calicut etc.

EIA Studies: Kalpakkam, Idukki, Silent Valley, Sriramsagar, etc

Defence Ministry Applications: Object identification projects in Desert and Semi Desert regions by displaying warfare equipment in Rajasthan

Haystack experiment of identification of ships and associated surface water amenities
Underwater object identification using submarines diving at various depths
ITR calibration flights over Balasore
Research flights: Monex Experiment, Chlorophyll scanning, Coal fire detection, hot springs identification

Hydro Electric Projects: A number Hydro-electric projects surveys Western Ghats, Narmada

Offshore Aerial Photography: Nepal Highway project, Bhutan HE project, Muscat water supply project. Crime detection studies, Coastal AP, Nagole forest

Inland Water Transport
Ganga river Gulf of Kutch, Gulf of Khambat

Coastal Monitoring
Western Coast and Eastern Coast of India

Aerial photographic tasks using panchromatic black and white, infrared black and white, infrared colour and True colour films were carried out by NRSA. Thus NRSA was in the forefront in this field in Asiatic region.

During 1979, NRSA participated in the International Experimental project related to Monsoon codenamed as MONEX 1979. NRSA's HS-748 Avro aircraft with various sensors installed was flown to collect data pertaining to monsoon behaviour.

Commencing from 1974 and ending at 1980 NRSA has demonstrated aerial survey capabilities in data acquisition for various applications and with various sensors and media and earned an envious position in aerial survey discipline.

During the next decade ending up in 1990, NRSA has carried out aerial survey of about 9,00,000 sqkm of aerial photography and 4,30,000 sqkm of aeromagnetic surveys.

During this decade NRSA has carried out R&D projects and maiden ventures such as

- Test range calibration flights of DRDO
- Underground coal fire detection in Jharia and Ranigunj coal fields.
- Russian thermal scanner data acquisition over eastern Indian coal belts using a Russian owned volcano scanner Test flights of chlorophyll scanner designed and Developed by NRSA Scientists in FRG under the Indo –FRG Technical co operation program
- The first aerial photographic task as NRSA's own effort for an area of 14,000 sqkm of the AP cyclone effected area.
- The first offshore aerial photography of Dolal ghat - Dhankunta highway project in Nepal. The aerial film processing and printing unit were established in Kathmandu for "in-situ" processing
- To augment in-situ processing development of mobile photo processing van, aerial firm drier, contact printers, Aerial film titler, and dual densitometer were also developed by NRSA Scientists, to strengthen the aerial photographic activities.
- R&D flights for recording SST for PRL was carried

out for the selected stretches of the Arabian sea

- Aerial data acquisition ,DST sponsored environmental studies over Idukki and Silent valley areas
- AVHRR meteorological data was used for the first time to assess the cloud cover over the area selected for flying which help in reducing abortive flying
- Development of autopilot interface for association with DGCA to save gap flying
- Chlorophyll detection flight over Kochi in collaboration with CMFRI which resulted in fish school identification which greatly assisted the fishermen.
- R&D flights for water quality monitoring over Hussain Sagar lake in Hyderabad. Godavari river as a maiden ventures.
- Test flights using SLAR developed by SAC, Ahmedabad.
- Joint experimental flights using aerial camera, multispectral scanner, chlorophyll scanner, SLAR&SAR were carried out using NRSA's aircraft for SAC, ISRO.
- Thermal IR survey of western ghats as an R&D project for GSI to detect hot springs in western ghats
- Aerial data acquisition using aerial camera and M^2S on NRSA aircraft for navigational studies over Gandak & Ganga river for GFCC and IWTA
- X band Synthetic Aperture Radar survey using Cessna conquest aircraft of M/S Intera Inc. Canada flown over Ananthapur as demonstrative flights as prelude to NRSA's R&D project on SAR/SLAR
- A path breaking aerial survey task for underground coal fire detection using the thermal band of multispectral scanner over Jharia & Ranigunj coal fields. This project has demonstrated NRSA's capability in conducting predawn aerial survey capability.
- X band STRA I-SAR system of M/S Intera Inc Canada using a Cessna aircraft has carried out aerial flights over 75,000 sqkm area of A&N islands ,Godavari basin and Orissa coast for various Central Government departments. This project by NRSA has given ample scope to modernise aerial survey systems to cater to all disciplines
- During the decade ending at 1990 NRSA has carried out aerial photography for Forest Surveys, Urban Planning, Town and Country planning, Flood effected areas, and host of aerial photography multispectral data applications
- During this decade NRSA has added two Super King aircraft to the existing fleet of one Avro and two Dakota aircraft
- During the decade from 1990 to 2000 aerial survey activities were at its peak, nationally important R&D projects, and some offshore projects were undertaken. The gist is given below.
- Aerial surveys using multi sensor for object identification of Defence warfare display over desert region and semi desert region for Defence laboratory, Jodhpur. This project has revealed that certain camouflaging activities of Defence are ineffective.
- X band SLAR flights for snow hydrology studies over Kulu Manali
- X band SAR flights for data acquisition for ONGC, DST, DAE, GSI for about 75,000 sqkm area R&D flights for ALISS, DAEDULUS SCANNER ETC.
- Aerial photography and scanner survey of earthquake affected areas, flood affected areas, landslide, land slips area with a day or two of the calamity to help rescue rehabilitation and resettlement efforts.
- R&D flights for EIA of Kalpakkam, Idukki Silent Valley, Hoogly river areas to demonstrate the capabilities of NRSA to cater to such demands, specifically the effectiveness of the aerial data in tackling the environmental degradation/ preservation.
- R&D flights and aerial data acquisition of height obstacle data generation of airport and environs
- Offshore aerial photography of Oman, Bhutan &Nepal areas which confirmed NRSA'scapability to carry out such tasks away from home.
- Other R&D efforts such as near real-time path recovery of the aircraft flown using UV paper. Print generated by interfacing a strip charter to the camera console. The path recovery on-board of aircraft while flying was made possible. This strip charter was designed and developed by NRSA scientists. Indeed it is a great breakthrough to avoid gap flying later
- Yet again path recovery of the time flown by the aircraft using the aerial film without the assistance of photo print. This was made possible by assessing the yaw, pitch and roll of the aircraft by

visual examination of the margin information on the aerial film itself. This finding has saved time and cost of photo printing.

On completion of 25 years of NRSA, the aerial survey division has made great achievement through photography of 1.1 million sqkm area and completed aeromagnetic data and multispectral scanner survey of about 1,92,000 sqkm area, SAR/SLAR/Chlorophyll scanner survey of about 2,12,000 sqkm area in addition to other sensor data.

Other R&D flights as on the sensor operating are the Haystack experiment of Indian Navy which demonstrated the capability of identifying surface water crafts and their associated characters, flights for identification of terrestrial objects of a line of flight to simulate the missile targeting ground objects for DRDO. Geothermal anomaly data acquisition of R&D flights by multi sensor operations. The aerial survey group has enjoyed carrying out the jobs dedicatedly and supplied aerial data products both raw and analysed and value added to a number of central and state government departments, autonomous organizations, ULBs. Indeed it was a pleasure and privilege to work on such discipline.

My Journey with NRSC

Oruganti Satyanarayana Murthy
Former Head
(Personal & General Administration)

I am grateful to NRSC for providing me opportunity to share memories of my long association with ISRO/DOS/NRSC.

I was interviewed at Sriharikota in Jan 1973 and after selection I was posted to STEX project, Trivandrum. Though I was a native of Nellore, I was keen in joining ISRO at Trivandrum and joined on 5 Feb 1973. Prior to joining ISRO, I worked in AP State Govt. for one year and therefore took no time in getting acquited with new assignment in ISRO. I was previleged to work under the leadership of Dr A E Muthunayagam, the then Project Engineer, Sri T S Ram, PTO and Sri M Annamalai, former Director SHAR Centre. After two years in Trivandrum, I was transferred to STEX, Sriharikota in March 1975. Some memorable experiences/events in Sriharikota are:

- Enjoying open air theatre movies
- Seeing Aryabhatta satellite
- Suffered many cyclones especially, 1977
- Enjoyed the beauty of Pulicat lake full of siberian cranes

During 1978, I was selected for NRSA at Secunderabd, but posted to work at IPI (now IIRS) Dehradun which was then under NRSA and joined on 14 Feb 1978. I had spent three and half years in Dehradun. It was a good time in Dehradun for the following reasons.

- Beautiful valley city with large mountain regions at the foot hills of Himalayas
- Healthy and pleasant atmostphere
- Snow fall during winter at Shivalik regions, Mussorie, etc.
- Premier education instituions like Doon School

I enjoyed the working at IIRS, interacting with professors, trainees including foreign trainees. We used to go to Haridwar, Rishikesh, Mussorie quite frequently, which are very nearer to Dehradun, with family and friends. We also used to enjoy southern language morning show movies once in a month on Sundays. It was at Dehradun that I learnt speaking Hindi, which was compulsory to interact in shops and local people. After spending three and half years at Dehradun, I had the opportunity for a transfer to Secunderabd during May 1981. Since then, I served at NRSA, Hyderabad till August 2005. From 1981 onwards, I had also grown in my carrier along with NRSA and worked in various capacities in Adminstration under the able guidance of Prof BL Deekshatulu, Dr DP Rao, Dr RR Navalgund, former Directors and Sri R Gopalaratnam, Controller and Sri K Kalyanaraman, Sr Scientist-Conroller, apart from Sri A Vijayan, the then Head, PGA. During 1993-1997, many consultancy projects were taken up by NRSA, which resulted in recuitment of project scientists in large number. Even though those project scientists were appointed on contrct basis for the projects, consequent on their termination, many contract scientists approached court of law for redressal. All those cases were settled in court in favour of NRSA, which was a stupendous task for me. Apart from this, I had handled many court cases pertaining to contract/casual workers, which were meticulously handled by me and resulted in favour of NRSA. This pressure of court works had put me to mental stress and affected my health. Notwithstanding the above, I had discharged my duties efficiently.

Opprtunities for officers in Admin area were not

Visit of Dr K Kasturirangan, Chairman, ISRO to NRSA

available for movement to other centres till 2005, whereas officers of other centres were posted to NRSA as Head, PGA. I was the first Senior Admin Officer to move out of NRSA on promotion as Head, PGA, and posted to VSSC, Trivandrum during September 2005, as my second spell of service to Trivandrum. It was very memorable experience for me to work at VSSC, being the biggest centre of ISRO with 4500 regular employees and 2500 project traineees and apprentices. It was at VSSC that I got exposure to fulfledged Govt. functioning with strict adherence to Govt. of India rules. It was also a free flow of work at various levels of admn fuctionaries. I had the opportunity to arrange farewell function to 67 officers retired on superannuation in May 2006, which was the highest number of retireess in one month. I had also the opprtunity of conducting ICRB joinings of about 250 employees on a single day at VSSC. During this time at VSSC, I had improved my Malayalam speaking. I also had an occasion to deal with an important court case pertaining to VSSC, which was very crucial at Supreme Court of India.The veridict came in favour of VSSC. After spending two years in Trivandrum, I was again transferrred to Sriharikota as my second spell of service at SHAR during May 2007. This has given me another opportunity to work in another big centre. I was previlaged to look after logistics support of all launches, especially in looking after VVIPs and VIPs visiting the Centre for launches. During this process, I was extremely happy to visit Tirumala along with VIPS and had the Darshan of Lord Venkateswara.

During June 2009, I was again transferred to NRSC. With rich experience at senior level in two big centres like VSSC and SHAR, I was able to discharge my duties efficiently till my superannuation in September 2011. During this period, IIRS was separated from NRSC and all RRSSCs were merged with NRSC. Thus I had served ISRO/NRSC for about 39 years with full satisfaction. However I was a bit disappointed for not getting promotion as Sr. Head, PGA, even though I had spent over six years in the grade of Head, PGA. However, I had reconciled myself to erase this dissatisfaction in due course of time.

I am indebted to Almighty and pay high regards to ISRO fraternity for giving me the best in my life during my service in ISRO. I once again sincerely convey my thanks to NRSC for providing me opportunity to share my experiences in ISRO/NRSC.

During HRD training programme for NRSC staff (19-Mar-2010)

My Reminisce of Association with Bhuvana Gagana Vijayam of ISRO/NRSA

T S R K Sarma
Former Head, Accounts & IFA

I feel blessed and privileged to have association with ISRO family and in its Bhuvana Gagana Vijayam. "Ç nâtòi nômu phalamô ç dâna balamô."

I have been with the Indian Space programme since 1973. I joined the ISRO, an autonomous body at Trivandrum. Within a year our unit Static Test & Evaluation Complex was shifted to Sriharikota Range. It was a small group, headed by Project Engineer Dr AE Muthunayagam, and Principal Technical Officer Sri TS Ram and a few young scientists like Sri M Annamalai etc. I used to feel that those thoughtful, committed young Scientists can change the world and that dream became true later. About the infrastructure in office, we had facit calculating machines, compto machines and electronic typewriters. Desktop, laptop computer, even hand held calculators were not known to us. Only VSSC had large size computers. Our ledgers and pay rolls were processed on those machines. ISRO was converted into a Government body wef 1 Apr 1975.

It was an exciting time, working long hours, holidays etc. I remember that at almost any time of the day or night, we would most likely find someone at the STEX Science Centre. The project chief was Dr AE Muthunayagam, a towering personality and a great humanist. One incident I distinctly remember was a young lad who came to report for duty was refused by admin and was asked to report after a year as he was found physically underweight in the medical examination. When he approached Dr. Muthunayagam, he laughed at the situation and said "I am not able to reduce my weight despite dieting and you are not able to gain weight." He took his joining report himself instantaneously. I understand that person climbed the ladder successfully and retired from ISRO on superannuation.

I have seen two such distinguished scientists with great human values in my career one Prof. BL Deekshatulu and another Dr AE Muthunayagam.

We were housed in AC sheet roofed temporary housing colonies in SHAR initially in 1974. Offices were also AC sheet roofed sheds in Keepakam area and in STEX area. Recreation club used to be good. On entertainment front, we used to screen various films in different languages in the open air auditorium, all families used to attend and watch the films irrespective of the language of the film, English, Hindi, Bengali,Telugu, Tamil, Malayalam etc., but everyone had to take one's own steel folding chair from their home and sit on it in the open sand. Even relatives who came from other places of the country also were excited with this sort of arrangement. It was a practical Vasudaika Kutumbakam.

We established ground static testing facilities for all rockets at SHAR under the leadership of Shri M Annamalai, who dedicated his life to the development of STEX in his young age itself. Out of sheer enthusiasm, we all used to walk about 10 km behind the vehicle carrying the rocket for ground testing and used to feel as if we were taking the new bride to marriage function venue.

We all thought that SLV3 testing would be the greatest show on earth, but it was a great experiment for the successive successes reaching PSLV C23. After the initial teething troubles, we have successfully ground tested SLV and all other vehicles. That was our Bhuvana Vijayam Leading to Subsequent Gagana Vijayam.

It was in Keepakam area near the Khandelwal hanger the first satellite, Aryabhatta was exhibited to all of us, we were the lucky ones, those physically saw the final version of the satellite. After that, it was hung to a helicopter at the bottom and helicopter hovered all over the SHAR Range. The test signals was successfully received. Our joy knew no bounds.

I witnessed the misery at Diviseema-cyclone wherein lakhs of people lost their precious lives overnight due

to lack of proper weather forecasting facilities, as our weather satellite launching was in primitive stage. I am proud that our Scientists have now changed the situation.

In this time frame NRSA was set up under Dept. of Science & Technology under the able leadership of founder father Director Wg Cdr K R Rao with the slogan and caption "Samagra dristhi Sriyam AatanOtu". I salute him for his vision. We, a good number of people, shifted from ISRO to NRSA, worked at Dehradun and Hyderabad. He himself interviewed me for the job as Asst. Accounts Officer in NRSA. After a few months I resigned the job at Dehradun. When I wanted the job back, he graciously taken me in Secunderabad office and gave me the accounting responsibility of MONEX operations. Old habits die hard. After 12 years, again I went back to ISRO and returned once again to NRSA. ISRO started putting more money in remote sensing technology after it came under the umbrella of ISRO from DST. NRSA fully adopted ISRO culture. For us it was home coming in NRSA.

NRSA made a new beginning with Prof BL Deekshatulu as Director and entered into Golden era. He was a person born-great. NRSA can never be the same without his cheery presence. His enthusiasm, optimism, and caring demeanor were a constant force of encouragement for all employees. Some very smart scientists joined NRSA during his tenure and took it to new heights. They have set high expectations for the next generation scientists to own responsibility and accountability. Progress will only come if we're willing to promote ethics of hard work, a sense of responsibility, in our own lives as well. NRSA used to buy pictures from EROS Data Centre. Lateron when its own pictures were available, our clients used to say NRSA pictures are as good as EROS. Later I used to hear that NRSA pictures are better than EROS pictures. I came to know that some of the software used in NRSC are much superior to those in vogue in NASA. We used to get our pay rolls, ledger etc. processed at ECIL with the help of Sri Srikantaiah. We had our first desktop HCL Busybee personal computer in 1981 or so, installed in an AC room and used to enter that PC room leaving our shoes outside the room. Each one of us was getting half-an hour time per day to use the computer. I recollect the applications scientists working on hundreds of paid national projects and made NRSA almost self-sustaining. The projects of IMSD, watershed development, Rajiv Gandhi Drinking Water Mission, Wasteland development, etc. have brought laurels to NRSA at national level. Fruits of these projects have satisfied aspirations of the common people for drinking water in many districts in north India. Project costing was always my favourite subject. Kalyanaraman's Aerial photography costing and recovery of dues always used to keep me busy. Prof BLD's innocent smile, Dr DP Rao's musical smile, Raghunathan's smile of confidence, Hebbar's technology updation, JD Murthy's evergreen software, Col Narayan's busy schedules, Dr. Krishnan's sharpness, DV Raju's smartness, S Adiga's planning, Subedar Solomon's security, Raghu Varma's union activities, C Satyanarayan's halchal, etc. are still lingering in my memories.

I consider myself blessed that I had a very good association with late Shri M Ramayya, HA&FA. He did not simply teach certain techniques, rather he personified the excitement about work that he wanted to share with us. Another senior colleague was Shri Y Rangaiah, for me he was often a source of sage advice about how to deal with other individuals in both my professional and personal life. His instincts always revolved around being kind and fair. I miss his warmth, his friendship and his perspective very much. He was a lovely person. We've made meaningful improvements in the field of our work. All my colleagues in Finance, Sri Janardhan, Sri Varadan, to name a few, always gave me abundant cooperation and help. Opportunities to grow further in career were capped for our generation and we had to stay put for 9 years in the same grade. Even otherwise "rich gifts wax poor when givers prove unkind". Never mind, we are contented and complacent.

"Kurai ondrum illai maraimoorthy Kanna, Kurai ondrum illai Kannaa… Kannaa….. Govinda… malaiappa..." !!!

I have also contributed to the Indian space programme my bit like the squirrel has contributed during construction of Srirama Sethu. "nEnu saitam bhuvana GhOshaku verri gontuka vicchi mrosaanu". If I were to be a scientist, I would have maintained the Indian Satellites at Antarikcha after I cease to exist on earth. My passion for Indian Space programme made me to visit NASA in one of my private visits to USA to my son's home. I wish and pray that ISRO and NRSC should flourish and become Centers of excellence. People may come and people may go, but she goes on like the pious river Ganga, everyone takes a dip and goes. "Punarapi rajanee, punarapi divasaha, punarapi pakshaha, punarapi masaha, punarapyayanam, punarai varsham, thadapi namunchatyasamarsham"Thanks for remembering us on this occasion. I wish ISRO and NRSC a great success in all future missions.Om Dyauh Shantir antariksha Gwam, Shantih, Prithvi, Shantih Rapah …. Om Shanti. …

My Reminiscences and Reflections on My Stay with NRSA

Vadlamani Siva Rama Krishna
Former Head
(Purchase and Stores)

I joined NRSA in its early days and was with it for over 20 long years. In this long and fascinating period, I was a witness of its growth from a humble rented place at Secunderabad to NRSA/NRSC as we all know it today. I have written about a few incidents in my long and memorable journey with NRSA.

I did my graduation in BSc from Govt. Arts College, Rajahmundry. I worked with M/s Hindustan Shipyard Ltd, Visakhapatnam and with Hindustan Aeronautics Ltd., Sunabeda, Koraput (Orissa) before joining NRSA. I joined NRSA, as Logistics officer 'A', responsible for stores, purchase etc. I was 38 years old then. On 15th September, 1975, I resigned from HAL Koraput and left Sunabeda at about 11pm in the night in a truck with my house hold luggage and family members consisting of my wife, two daughters and a son for Hyderabad. (My elder daughter was already married by then and the couple were living in Solapur). Little did I know then, that I and my family would be spending the rest of our lives in this city and that that I would be part of a journey of the growth of NRSA from the humble fledgling organisation it was to a huge one that it is today, where it is seen as one of the leading and respected scientific communities in its field, in the country.

I reached Hyderabad after travelling about 1000 kms on the evening of 17th September, 1975 and on 18th September, I admitted my children in schools and on 22nd September, 1975, I reported to Shri Arunachalam, Senior Administrative Officer at NRSA office located opposite to Court complex, Secunderabad. I was given employee code no. 0025, which meant that I was the twenty fifth employee to be recruited into NRSA. The Senior Administrative Officer introduced me to then Director, NRSA, Wg Cdr K R Rao (Kesavamurthy Ramachandra Rao). I have started work from the same day.

Apart from the office located opposite to court complex, one more building at Punjagutta was rented, which was vacated by Managing Director, MIG complex of Hindustan Aeronautics Ltd. The building was named 'Bright house' and was once the office of the Chief Minister of AP, Shri Kasu Brahmananda Reddy. This building was modified to suit the requirements of NRSA. The present site at Balanagar, in the outskirts of Hyderabad was a 30 acre land and was obtained from Hindustan Aeronautics Ltd., Hyderabad Division. This place at Balanagar was all slushy and with a lot of bushes - jungle like. I was responsible for catering the needs of employees on all the above three locations.

I was told that NRSA was started in New Delhi at the Science and Technology Bhawan with only about 3-4 scientists. Dr Qureshi was its Director. Shri Mahalingam, Under Secretary from Department of Science and Technology was also looking after its affairs. Subsequently NRSA was shifted to Secunderabad and Wg Cdr K R Rao was appointed Director. An Ambassador car ADU 153 was purchased for Director's use and Jeep ADU 1612 for official use of employees. Complete administration and finance departments were shifted to Punjagutta office, construction division was shifted to Balanagar and purchase and stores division were operating from the Secunderabad office.

Ministry of Defence shifted one Dakota aircraft VTCGR from one of the Air Force Stations in North India to NRSA for carrying out aerial survey operations. This aircraft was positioned with Research Flight Facility division at Bangalore and various modifications were carried out on this aircraft. Since I had rapport with divisions of HAL, Bangalore, I was asked by Director, NRSA to look after the progress in respect of these modifications. For accommodating the Research Flight Facility division at Bangalore, a building was hired at 213, Double Road, Indira Nagar, Bangalore.

All formalities from DTDP-Air were transferred to DGCA. Initially this office was under the control of Associate Director of NRSA Col LRA Narayanan. Later Sq Ldr Mahendale was made in-charge of this office. An Ambassador car MEA 425 was purchased for official use of officer in charge, Bangalore. Along with Sq Ldr Mahendle, 9 more Air Force officers joined NRSA and were operating from Bangalore office. The modifications on the Dakota aircraft were supervised by these Air Force officers. Apart from supervision, the aircrew in the aircraft were travelling frequently in the southern India.

Ambassador car for use by Director, NRSA

5th April, 1977 was a sad day for NRSA. The Dakota aircraft took off at 11 am from Madras airport and crashed near Kanegiri, Podili Mandal of Prakasam district. The news of crash reached NRSA at about 12 noon through ATC Madras to ATC Begumpet. On receiving this information, Sq Ldr MK Ranganath, Mr A Vijayan, Mr S Soloman and I rushed from Secunderabad in a Jeep, with sufficient food and water, in search of the crashed plane. After reaching the borders of Prakasam district, we started enquiries at every possible spot and finally located the accident site on the midnight of 5th April 1977. All the 10 crew members of NRSA and 10 scientists from Atomic Mineral Division, Begumpet, Hyderabad were on board at the time of the accident and sadly all of them died. On 6th April 1977, we approached the District Collector of Prakasam district and other higher police officials and requested them to help the rescue team of NRSA. These officials arranged wooden planks which were converted into coffins. All the 20 bodies were identified and placed in the coffins with ice and sealed and the names of the departed were written on the coffins. Then these 20 coffins were loaded in 3 trucks and were transported to Gannavaram airport at Vijayawada on 6th night/early hours of 7th April. The trucks reached Gannavaram airport at about 5 am in the morning of 7th. We escorted the trucks to the airport, where an AN12 aircraft was ready to receive the coffins. The in-charge pilot of the aircraft wanted us to remove the ice placed in the coffins, which was removed and the bodies were wrapped in poly jute cloth and then loaded. Director NRSA, Wg Cdr K R Rao and Senior Administrative officer, Shri Ranganath accompanied the bodies in the aircraft, while we left by the jeep back to Hyderabad. The aircraft reached Begumpet airport at around 7 am and the bodies were handed over to the kith and kin of the deceased with the available markings on the coffins. Wg Cdr K R Rao, Director, NRSA also released 20 individual cheques of Rs. 1 lakh each and handed them over to the kith and kin of the deceased in a small gathering organised at Begumpet airport. Simultaneously, a claim was lodged with United India Insurance. Mr Ashok Vardhan, Divisional Manager and Mr Lakshmanan, Asst Divisional Manager of United India Insurance, visited NRSA at 10 am on the following day and issued a cheque of Rs. 20 lakhs immediately to NRSA.

A year after the accident, a few family members of the accident victims wanted to visit the accident site for the anniversary of the departed. I was deputed to reach the site and accompany the family members of the victims and help them in any manner as necessary. Those were very touching moments. I still have a very affectionate letter written to me by the mother of one of the pilots who lost his life serving NRSA.

The foundation laying ceremony for NRSA Balanagar campus was laid in the month of June/July 1976. It was a historic day and of course very memorable. We were a very few employees then with NRSA and our involvement was total and highly informal. I arranged for the purohit and brought all puja items from my house. Our sense of belonging was so strong that we felt our own house was being constructed. After the foundation laying ceremony, there was a big gale followed by heavy rain and all the shamianas were uprooted. Rain is always a good omen of the things to follow and so was it, as I saw the organisation grow, grow and grow to what it is today.

I was responsible for customs clearance of all the capital items imported by NRSA. All imported consignments like aerial camera systems from Carl-Zeiss, West Germany, computer systems like M-DAS and M²S, PDP11/70 and heavy duty paper cutting machines were all customs cleared at Bombay without payment of Customs duty by following the necessary formalities. About 98% of imported systems were cleared without payment of Customs duty. The computer systems like M-DAS and M²S were customs cleared and road hauled from Bombay to Hyderabad in special trucks. It took three days to reach Hyderabad from Bombay. I travelled with these trucks and did not allow the driver to exceed

20kmph in speed. For most of the journey, by sunset at 6 pm, the trucks would stop and we would rest in the truck itself. The onward journey would start at 7 am. The vehicles carrying the above equipment reached Balanagar campus, Hyderabad at 2am and the consignments were off loaded manually on the following day and the equipment were unpacked in the presence of the users and the civil engineering staff without any mechanical handling systems and were positioned in the respective slot and were handed over to the respective engineers for further installation processes.

Indian Photo Interpretation Institute, which is known as IPI, was located at No. 4, Kalidas Road, Dehradun and was responsible for carrying out the training in remote sensing. Similar training operations were carried out at NRSA as well as Survey of India. Hence the government thought of detaching this activity from SOI and entrusted it to IPI, Dehradun. Later IPI was renamed as IIRS. I was deputed to Dehradun for a period of two years commencing from June 1978 to May 1980. NDC (NRSA Data centre) was formed and I was made administrative in-charge of this group. When organising the centre, data products worth crores of rupees in the form of tapes, black and white photographs and colour photographs in the format of 4X, 2X and 1X were sent to users in various countries, including Pakistan, Tokyo Thailand and West Germany. At around the same time, high valued equipment was despatched to Norman earth station of Oklamaha state of US. About 80 packages of hardware were exported from Hyderabad to US by air and the equipment was insured against all risks on warehouse to warehouse basis. The equipment was packed with great care. Upon receipt, the material was unpacked, installed and switched on and the data received was extremely clear. Appreciations poured on this data centre from all over including from the then Prime Minister of India, Shri PV Narasimha Rao and from EOSAT officials. The opening of the ground station at Okhlahama was witnessed by Mr Sidharth Shankar Ray, Indian Ambassador to US, Mr Jack Milkdrel and Prof. UR Rao, Chairman ISRO, Secretary DOS.

We formed a recreation club at NRSA for employees to have some recreation during week- ends. We also started a cooperative credit society to assist the needy employees for emergency loans. As a member of this society, I was the treasurer for two times for the period 83-84 and 84-87. Today this society that was started in a small way has grown many folds and meets the needs of its members.

Those were non digital days and we were using photographic film, chemicals, CC tapes, HD tapes paper etc. These items were very sensitive and had

NRSA old aircraft Dakota DC-3

to be stored in cold storage facility with close to zero degrees centigrade temperatures. On one occasion, the cold storage facility failed and about Rs. 3-4 crores of material was stored. In view of continuous holidays for 4 days, despite alarms, nobody was able to recognise the failure of the systems. After holidays, the cold storage was examined and it was found that the temperature rose to about 9 degrees. The maintenance was under the administrative control of the controller, NRSA and supported by a scientist/ engineer from Civil Engineering Division. On the following day, during the rounds, it was observed that the system has failed and the temperature was about 9 degrees. Though the facility was to be examined on a daily basis, it did not happen due to continuous holidays. We worked on emergency basis and restored the system and fortunately there was no damage to the material. The then Director, Dy Director and Group Head were very happy and congratulated the efforts.

The photo-processing section of NRSA was on the 1st floor of photo lab buildings. Some of the equipment weighing in excess of 2 tonnes, required for processing the photo film and imagery were moved manually to the first floor and installed successfully. They were action packed days! I was a member of the technology transfer committee and the entrepreneurs who appeared for the meetings convened by the committee were assessed and the details of their services being extended to NRSA were discussed in good detail. During this time, technology for the light tables and pointers were allotted to M/s Remote Sensing Instruments; Optical reflective projector was allotted to M/s Opto-mech engineers and Photo write system was allotted to M/s Speck Systems. All these companies are successful industries today and it is a matter of great satisfaction that we contributed our bit in indigenisation. I finally retired from NRSA service on 31st August 1995 and I live with my son and grandchildren enjoying the bliss of a retired life. Anecdotes of my stay at NRSA are regular dinner table discussions at home. Though I have left NRSA some 20 years back, NRSA continues to be with me.

My Journey with NRSC

N K Lalitha
Former Senior Head
(Purchase & Stores)

I joined NRSC, then NRSA, on 21st July 1975 and my employee code number was 0012. Only handful employees were there and the tasks ahead were very huge. We all worked as one family, willingly sharing the work where there was an overload, without differentiating it as Finance, PPEG, Technical, Administration and /or Purchase & Stores. Wg Cdr K R Rao, the first Director, NRSA, late S Arunachalam, Sr Admn Officer, late M. Ramaiah, the Head, Finance and later, Prof. BL Deekshatulu, Ex-Director, inculcated in us a sense of belongingness towards the organisation.

Many major and significant activities like merging of Indian Photo-interpretation Institute (IPI) with NRSA, which is now IIRS, procurement of land for constructing our own buildings in Balanagar, Hyderabad for NRSA, procurement of land in Shadnagar for building our earth station, procurement of aircraft, issuing of a global tender for establishing the earth station, etc., were initiated during the '70s and '80s. We were all the time on our toes. There was no transport facility or canteen facility then. But, we never felt the difficulties. Usually, we would go home only around 9 pm or so, and in case we went early, that would be at 6 pm. I used to take the papers and the manual typewriter home in a jeep to complete the work at home after attending to my daughter's needs.

I still remember that the Agreement for establishing the satellite earth station with M/s Scientific Atlanta and M/s AOSI of USA was signed in the midnight in Secunderabad office.

I was in NRSC for almost 31 years. The experiences I got in NRSC later on helped me for my promotions as Head, Purchase & Stores in SDSC, SHAR, as Senior Head, P&S in VSSC, Trivandrum and subsequently as Registrar, ADRIN.

I always felt myself as part and parcel of NRSC, since I was associated with it since its inception. In fact, NRSC is my first child. A mother is always happy to see her child grow higher and higher. Likewise, I am proud that my NRSC has grown leaps and bounds in these 4 decades, and I wish all success in its future endeavors.

Employees with Wg Cdr K R Rao, Director, NRSA



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