JAN – JUNE '95

SPACE india

INDIAN SPACE RESEARCH ORGANISATION

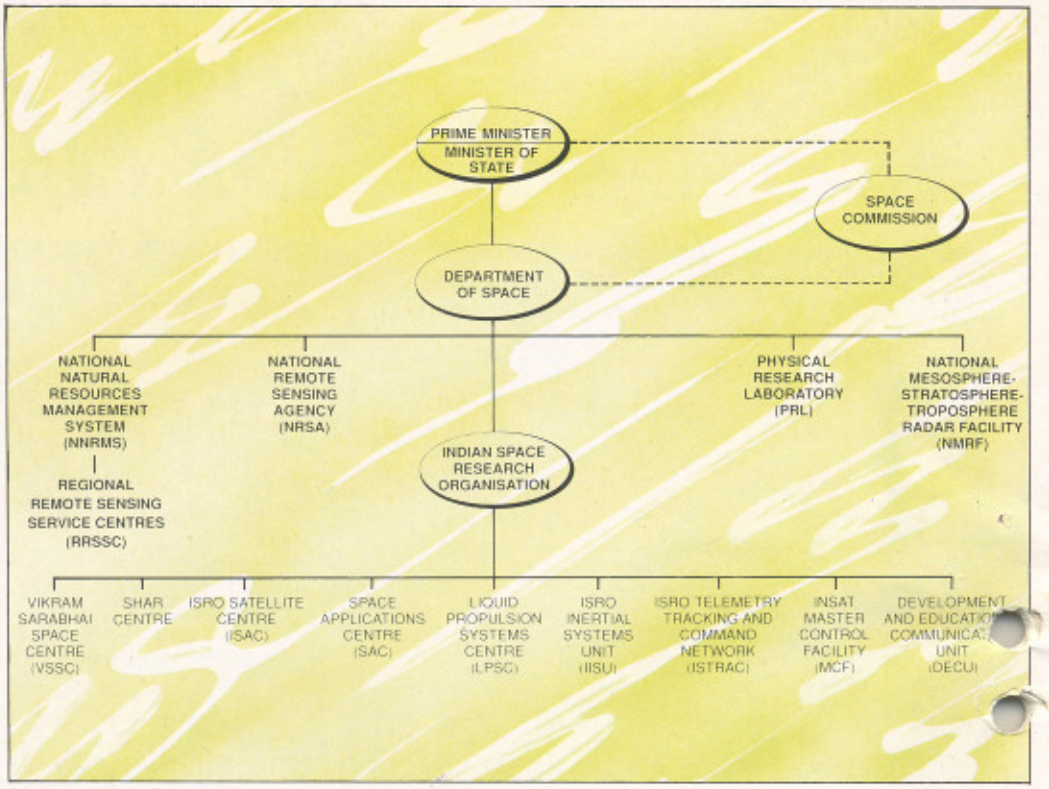
The Indian Space Programme

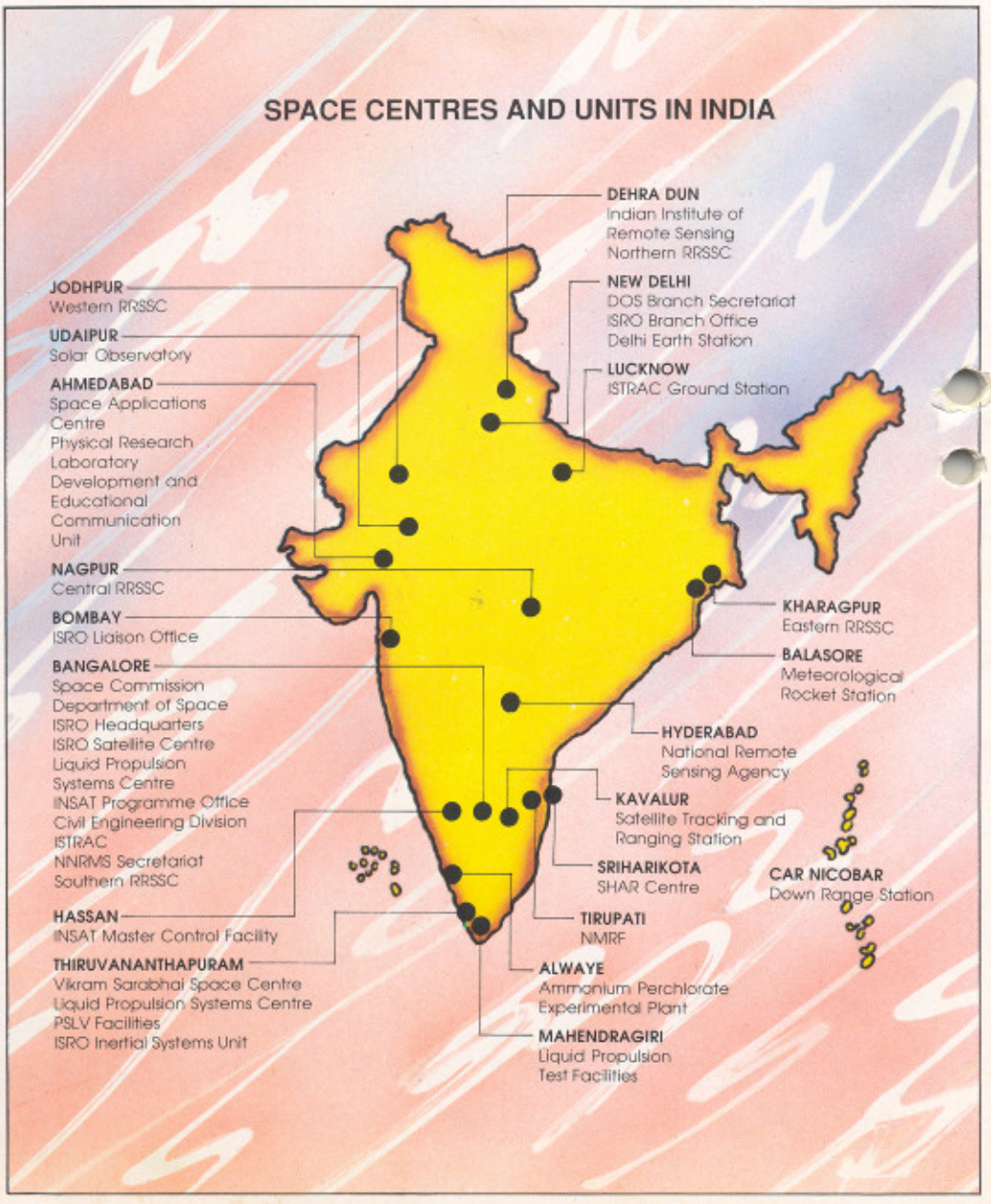
The setting up of the Thumba Equatorial Rocket Launching Station(TERLS) in 1963 marked the begining of the Indian Space Programme. The Space Commission and the Department of Space (DOS) were established by the Government of India in 1972 to promote unified development and application of space science and technology for identified national objectives.

The Indian Space Programme is directed towards the goal of self-reliant use of space technology for national development, its main thrusts being: (a) satellite communications for various applications, (b) satellite remote sensing for resources survey and management, environmental monitoring and meteorological services and (c) development and operationalisation of indigenous satellite and launch vehicles for providing these space services.

The Indian Space Research Organisation (ISRO) is the research and development wing of DOS and is responsible for the execution of the national space programme. ISRO also provides support to universities and other academic institutions in the country for research and development projects relevant to the country's space programme.

Both the DOS and ISRO Headquarters are located at Bangalore. The development activities are carried out at the Centres and Units spread over the country. □





FRONT COVER
India as seen by IRS

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EDITORS
S.Krishnamurthy
Manoranjan Rao

EDITORIAL ASSISTANCE
S.K. Dutta

PRODUCTION ASSISTANCE
B. Chandrasekhar

Jan — June '95

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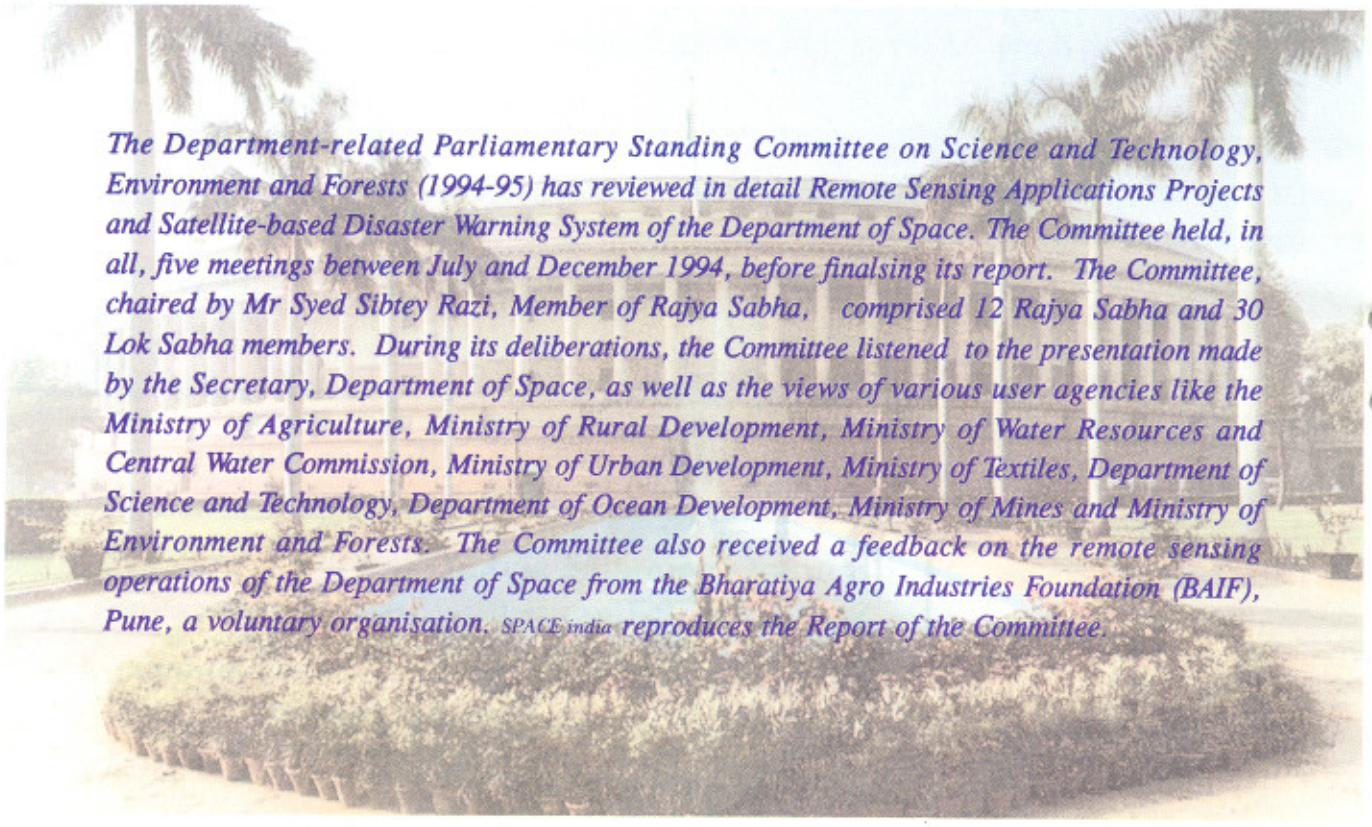
Parliamentary Committee Reviews Remote Sensing Programme



The Department-related Parliamentary Standing Committee on Science and Technology, Environment and Forests (1994-95) has reviewed in detail Remote Sensing Applications Projects and Satellite-based Disaster Warning System of the Department of Space. The Committee held, in all, five meetings between July and December 1994, before finalsing its report. The Committee, chaired by Mr Syed Sibtey Razi, Member of Rajya Sabha, comprised 12 Rajya Sabha and 30 Lok Sabha members. During its deliberations, the Committee listened to the presentation made by the Secretary, Department of Space, as well as the views of various user agencies like the Ministry of Agriculture, Ministry of Rural Development, Ministry of Water Resources and Central Water Commission, Ministry of Urban Development, Ministry of Textiles, Department of Science and Technology, Department of Ocean Development, Ministry of Mines and Ministry of Environment and Forests. The Committee also received a feedback on the remote sensing operations of the Department of Space from the Bharatiya Agro Industries Foundation (BAIF), Pune, a voluntary organisation. SPACE india reproduces the Report of the Committee.

General Background

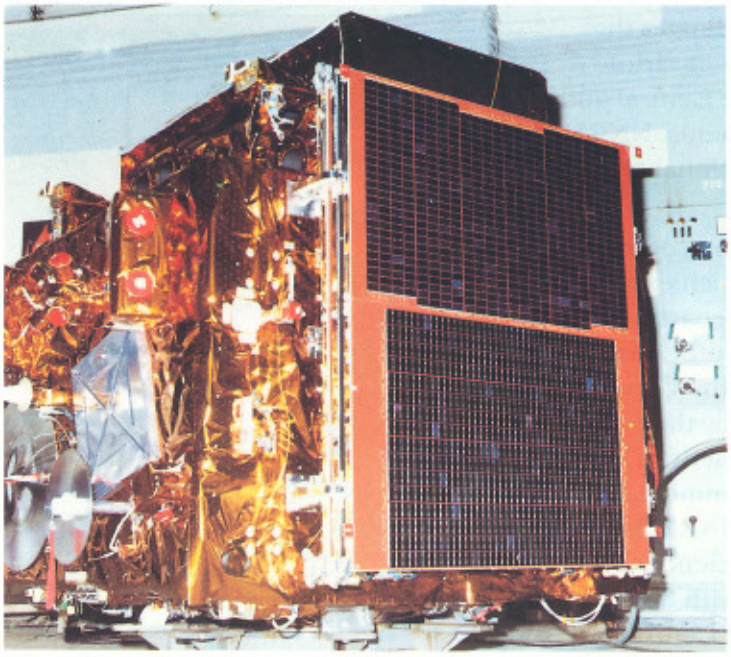
Remote sensing implies sensing things which are at a distance and detecting and measuring some of their properties without actually coming into contact with them. The phrase "remote sensing" is now commonly used to describe sensing various aspects of the earth system through detectors placed on satellites, aircraft or balloons. Through remote sensing one can know about forest cover, vegetation index, soil moisture content, geological aspects, mineralogical conditions of soil, forecast crop yields, detect crop diseases, detect environmental pollution, predict optimal locations for drilling for underground water and so on. It can add to our knowledge of changes in climatic conditions, provide accurate and timely information with regard to snow-cover conditions in watershed areas and thereby help in making forecasts about the volume of snow-melt run-off, delineate patterns of urbanization and present a clear picture about the status of environment, etc. Through application of remote sensing, and related new mapping techniques surveys can be made more accurate and meaningful.

2. Space-based remote sensing is the process of obtaining information about the earth largely from instruments on board an earth observation satellite. Remote sensing satellites have extended the sweep and scope of our observational powers. Detectors carried on remote sensing satellites relay an immense amount of data which must be used wisely and efficiently. Though the data generated by these satellites are important, it must be stressed that to get a complete and meaningful picture, this has to be used in association with data obtained with aircraft/balloon based remote sensing, data obtained on the ground and other information of an economic, sociological, census and statistical nature.

3. Remote sensing is a very valuable tool for a country like India of vast geographical dimensions and diversity. There is no other way in which one can obtain so much relevant

information on a rapid, repetitive, real-time basis.

4. The remote sensing programme was initiated in India in the year 1970 when aerial surveys were conducted using a Hasselblad camera to obtain IR imagery to study coconut wilt disease in Kerala. Indian Space Scientists also took advantage of the 'LANDSAT System' which was made available by the United States, and developed ground stations and analysis capabilities to make full use of data from these satellites. Before venturing on our own operational remote sensing satellite system, like Indian Remote Sensing Satellite (IRS), Indian Space Research Organisation (ISRO) embarked on two experimental remote sensing missions viz., Bhaskara-I and II during 1975 - 1982. Having gained experience from these missions, the satellite-based remote sensing system was established in the country with the launch of the first operational Indian Remote Sensing Satellite IRS-IA on March 17, 1988, which was followed by the successful launch of IRS-IB on August 29, 1991. These satellites are now providing unique opportunities to use remote sensing data for monitoring and measurement of our natural resources and environment. From the viewpoint of the functioning of the hardware e.g. satellites, detectors and ground systems, these have been working to absolute perfection and to prescribed specifications. At present remote sensing data are being used for several applications such as: agricultural crop acreage and yield estimatation; drought monitoring and assessment; flood mapping and damaging assessment; landuse/landcover mapping for agro-climatic zone planning; wasteland management; water resources management; ocean/marine resources survey and management; urban planning; mineral prospecting; forest resources survey and management, etc.



Indian Remote Sensing Satellite (IRS-1B)

5. In order to know about the coordination mechanisms which exist between the Department of Space (DOS) and the major user Ministries/ Departments at the Centre and in the States and to know whether the remote sensing data are being found useful by the user agencies, the committee took up the examination of the remote sensing operations of the Department of Space, and invited user Ministries to present a feedback on the data supplied to them. The examination of the remote sensing activities of the Department of Space was undertaken by the committee on the basis of the Annual Report of the Department of Space for the year 1993-94.

6. In his presentation, the Secretary, Department of space informed the committee about the status of various remote sensing application projects and gave his viewpoint as to how the remote sensing data were being utilised by the various agencies. The Committee was informed that IRS-IA & IB are today supplying important data which are being utilised under the National Natural Resources Management System (NNRMS). This System was set up to facilitate optimal utilisation of the country's natural resources by preparing a proper and systematic inventory of the availability of resources. This will help in reducing regional imbalances through effective planning and promote long term sustainable development. Data obtained from IRS Satellites are used for several applications by various agencies of the Central Government; and of the State Governments which have set up their Remote Sensing Centres. At present there are 22 states which have set up their own Remote Sensing Centres. There are also a number of applications of remote sensing data which are currently being used by private entrepreneurs and voluntary agencies. The Department of Space , as the nodal agency for

NNRMS, coordinates the activities between various agencies of the Central and the State Governments. NNRMS has become operational to a large extent.

7. As regards the coordination mechanism which exists between the Department of Space and the other user Departments, the Committee was informed by the Secretary of the Department of Space that a Planning Committee of NNRMS (PC-NNRMS), chaired by Member (Science), Planning Commission, with Secretaries of the concerned Central Government Departments as members, coordinates and guides this effort at the national level. Six Standing Committees in various major areas of applications, namely Agriculture & Soils, Bio-Resources, Oceanography, Geology, Technology & Training and Water Resources, chaired by the secretaries of the concerned Central Ministries/ Departments, provide necessary guidance and direction for ensuring effective use of remote sensing techniques in the

Composition of Standing Committee

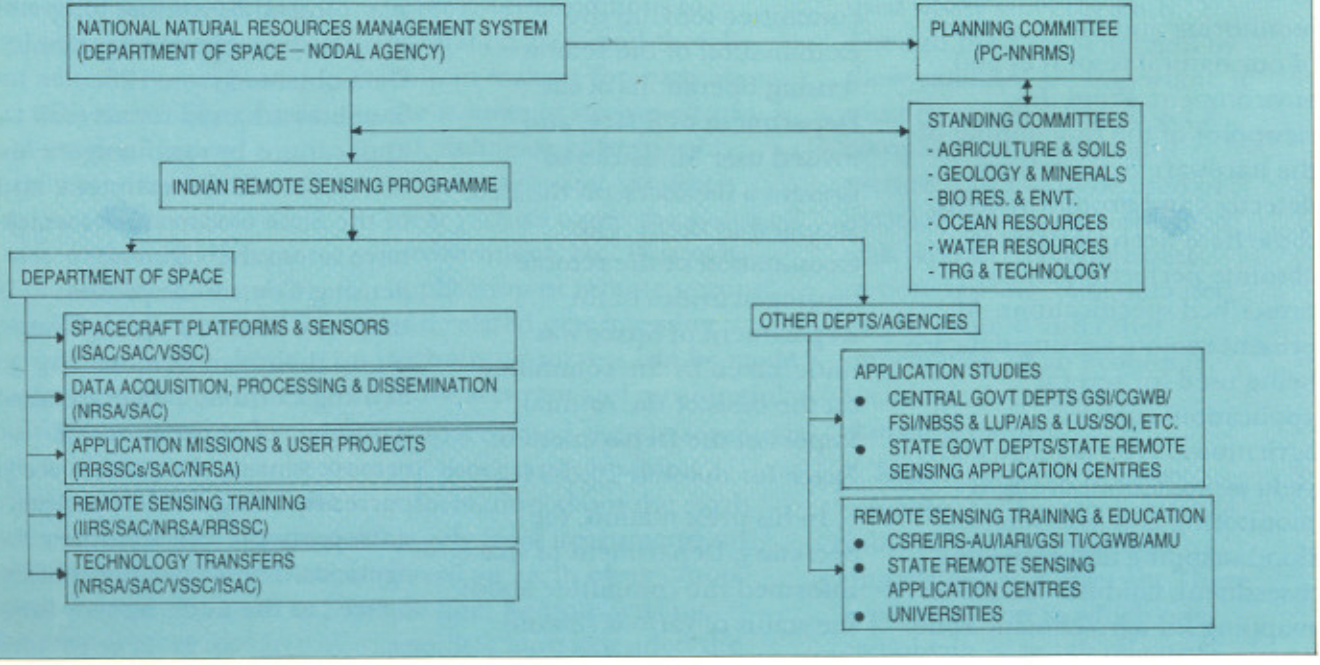
RAJYA SABHA

1. Shri Syed Sibtey Razi
2. Dr. M. Aram
3. Shri Ajit P.K. Jogi
4. Dr. Murli Manohar Joshi
5. Shri Suresh Kalmadi
6. Shri K. Rahman Khan
7. Prof. M.G.K. Menon
8. Shri Suresh Pachouri
9. Shri N. Giri Prasad
10. Shri W. Kulabidhu Singh
11. Dr. Ranbir Singh
12. Shri Ram Gopal Yadav

LOK SABHA

13. Shri E. Ahamed
14. Shri P.C. Chacko
15. Shrimati Bhavna Chikhalia
16. Shri Jitendra Nath Das
17. Shri Sharad Dighe
18. Shrimati Saroj Dubey
19. Shri Oscar Fernandes
20. Shri Shankarrao D. Kale
21. Shri P. Kumarasamy
22. Shrimati Mahendra Kumari
23. Shri Pramothes Mukherjee
24. Shri M.V.V.S. Murthy
25. Shri Harpal Panwar
26. Shri Balraj Pasi
27. Shri Bhim Singh Patel
28. Shri Chandresh Patel
29. Shri Vijay Naval Patil
30. Prof. Radhika Ranjan Pramanik
31. Shrimati Vasundhara Raje
32. Shri Rama Chandra Rath
33. Shri M.G. Reddy
34. Pt. Vishwanath Sharma
35. Shri Brij Bhushan Sharan Singh
36. Shri Harchand Singh
37. Shri Ram Prasad Singh
38. Shri K.G. Shivappa
39. Shri Bapusaheb Thite
40. Kumari Sushila Tiriya
41. Kumari Frida Topno
42. Shri Ram Kirpal Yadav

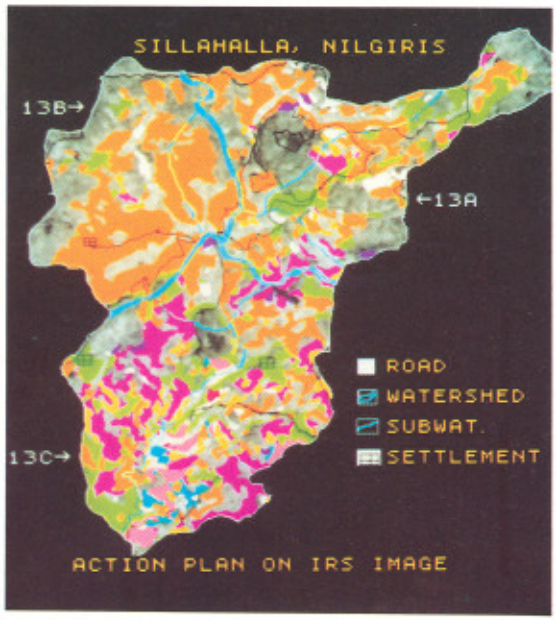
OVERVIEW OF NNRMS AND ITS ELEMENTS



respective areas. These Committees meet regularly and review various projects undertaken under NNRMS, in coordination with State Remote Sensing Centres and Central/ State user agencies/cells.

8. The Committee was also told that the Department of Space is also coordinating activities relating to imparting training and education in the areas of remote sensing; for this there exists a Standing Committee on Technology & Training under NNRMS. The Indian Institute of Remote Sensing, Dehra Dun, National Remote Sensing Agency, Hyderabad, Space Applications Centre, Ahmedabad, Regional Remote Sensing Service Centres and other user organisations are conducting training programmes at various levels. So far, about 4,000 scientists from user Departments have been trained in remote sensing. Remote Sensing has also been included in some educational curriculum. Specific training programmes are also arranged for project scientists.

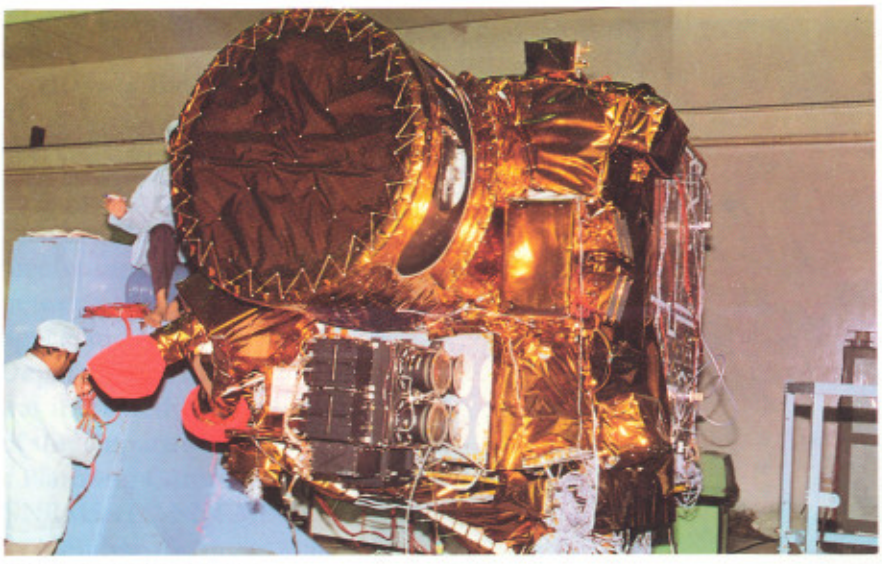
9. Under NNRMS a major mission called Integrated Mission for Sustainable Development (IMSD) is also being executed by the Department of Space with the active participation of the States, concerned Departments/agencies of the Central Government and the Planning Commission. Under this Mission, 157 districts have been identified, which cover nearly 45% of India's geographical area. The implementation of the action plan initiated under IMSD will contribute to the overall sustainable development of the country, as the Mission addresses most of the problems concerning water and soil conservation and better management of land resources.



Land use pattern in Nilgiri district, Tamil Nadu

Further, the programme that has been initiated to establish a spatial information system at various levels under the Natural Resources Information System (NRIS) would lead to the availability of uptodate resource information for decision making at different levels. The IMSD approach involves integration of thematic information on various natural resources derived from satellite data, and integrating it with other relevant ancillary information, meteorological and socio-economic data, in a Geographic Information System (GIS) environment, to arrive at locale specific prescriptions for development. The locale-specific action plans, as informed to the Committee, would include recommendations, on water harvesting, soil conservation, afforestation, agro-forestry choice of crop and rotation, agro-horticulture, fuel wood and fodder development, land-use planning sand-dune stabilisation, mining and other related conservation measures, etc.

10. The Committee was also apprised by the Secretary of the future plans of the Department of Space with regard to remote sensing. The Committee was informed that the second generation remote sensing satellites IRS-IC & IRS-ID are expected to be launched during the year 1994-95 and 1996-97 respectively, which would cater to various user requirements such as continuity of data, improved spatial resolution of better than 10 metre, enhanced spectral coverage, revisit capabilities and stereo viewing. Highlighting the special characteristics of IRS-IC and ID satellites, the committee was informed by the Secretary of the Department of Space that the United States of America has entered into agreements with India to receive data from IRS-IC & ID. Presently, India has an agreement with the US to market the IRS products. After the failure of their satellite LANDSAT-6, IRS-IC and ID will be the key satellites which the US will use. This puts IRS-IC and ID at a global level, and as a preliminary step, IRS-IB is already operating for a ground station in the US. Secretary, Department of Space also informed the Committee that with the successful launch of the PSLV, India has the capability not only to build and use remote sensing satellites of



IRS-1C under integration

the IRS class but also capabilities to launch them.

11. Besides the presentation made by the Secretary of the Department of Space, the Committee also heard the representatives of the Ministry of Agriculture, Ministry of Rural Development, Ministry of Water Resources and Central Water Commission, Ministry of Urban Development, Ministry of Textiles, Department of Science & Technology, Department of Ocean Development, Ministry of Mines and Ministry of Environment & Forests. The Committee also invited a representative from the Bharatiya Agro-Industries Foundation (BAIF) Pune, a voluntary organisation to find out as to how the voluntary organisations are making use of the remote sensing data obtained from the Department of Space. The committee heard the Secretary of the Department of Space again on the Points arising out of the discussion which the Committee had held with the representatives of the Central Ministries/Departments and the representative of the voluntary organisation.

12. The Committee heard at length some of the user Ministries/Departments on various aspects of the application of remote sensing techniques in their areas of jurisdiction and in order to ascertain the relevance of data being supplied by the Department of Space to them. It was thus able to ascertain the varied use for which the data generated through remote sensing are put to by the various Ministries/Departments including a voluntary organisation. A summary of the details provided by them together with the views of the Committee is given below.

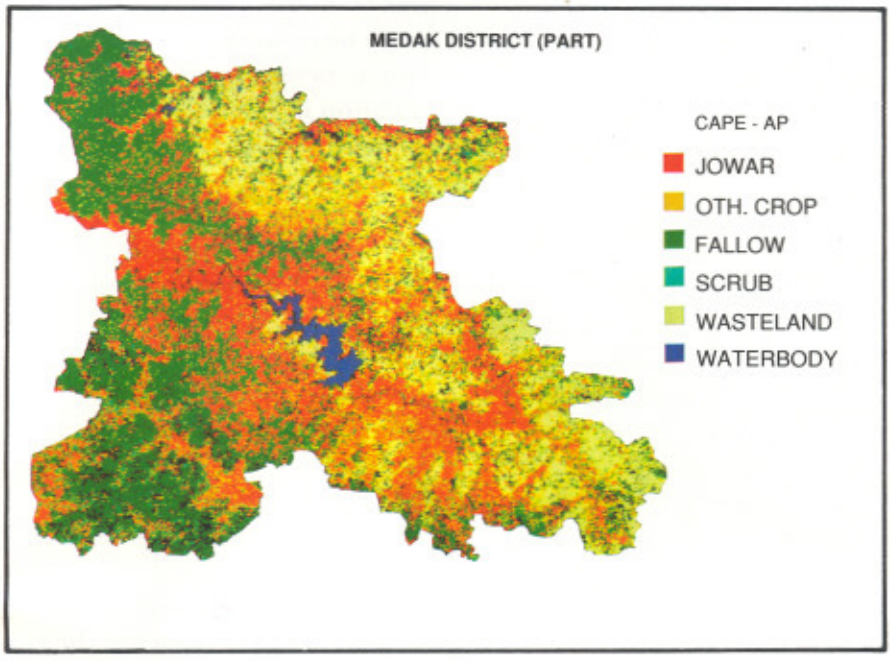
Ministry of Agriculture and Co-operation

13. The Ministry of Agriculture is one of the major user Ministries/Departments of the IRS data. The Department of Space informed the committee that three important operational application projects viz., (i) crop acreage and production estimation (CAPE), (ii) National Agricultural Drought Assessment and Monitoring System (NADAMS) and (iii) Mapping of Saline/ Alkaline soils, were being carried out with the assistance and co-operation of the Department of Agriculture and Co-operation in the Ministry of Agriculture.

Crop Acreage and Production Estimation

14. Remote sensing estimates on area under cultivation and production of foodgrains such as wheat, rice, sorghum and oil seeds (like groundnut, mustard) for regions/districts identified jointly by the Ministry of Agriculture and Department of Space are generated every season. This project is carried out in close cooperation with users from the States and with funding support from the Ministry of Agriculture. Production figures are provided one month in advance of the harvest. They meet the accuracy criterion of 90/90 (90% accuracy on 90% occasions) for single crop dominated regions. For wheat and rice, regions covering 85% production of the country are being covered under this project.

15. When the Secretary, Ministry of Agriculture was asked by the Committee about the usefulness of crop production estimates being provided by the Department of Space, based on remote sensing, he submitted that the Ministry did not find remote sensing technology to be particularly relevant, particularly in the regions where practice of mixed-cropping was in vogue. In states such as Punjab, Haryana and UP (Western parts) where there was a continuous stretch of the same crop, the remote sensing estimates were found to be quite accurate. But where farmers took two or more crops together, remote sensing technology was not of much help in arriving at crop production estimation.



Satellite imagery identifying jowar crop in Medak district, A.P.

16. When this fact was brought to the notice of the Secretary Department of Space, he informed the Committee that for heterogenous multi-cropped regions covering 25-30% of cropped areas in the country, a methodology was being developed to improve accuracy through better sampling techniques and use of high resolution data which would be available in the near future from the IRS-IC satellite onwards. IRS-IC would provide data with 23m resolution in multispectral bands including short wave infra-red along with data from an additional camera viz., Wide Field Sensor with 5 day repetitivity; this would further improve the accuracy of crop acreage estimation and yield forecasts for dryland/ multicropped/small field regions.

17. The Committee notes with satisfaction that the Department of Space has already 73 initiated steps for improving the accuracy of crop acreage and production estimates by incorporating more sophisticated facilities in the IRS-IC which is going to be operational soon. It is only by carrying out such experimental studies, in association with user departments, that one can arrive at solutions that are relevant for dealing with the real situation and felt needs of our country. In this, lies the strength and self-reliance of our space programme. In contrast, if one were to be wholly dependent on what is available from elsewhere in the world that would be for very large areas covered by single crops which is very different from the Indian agricultural pattern. The committee feels that there is a need to improve the accuracy of data for heterogenous/multi-cropped regions and also to check on absolute accuracy of figures arrived at both by remote sensing and conventional methods. A joint effort in this regard is called for on the part of the Ministry of Agriculture and the Department of Space.

National Agricultural Drought Assessment and Monitoring System (NADAMS)

18. The Department of Space informed that, since 1986, Normalised Difference Vegetation Index (NDVI) information is being generated for the entire country at 1 km resolution. This information is being used for assessment and monitoring of agricultural drought conditions at district level in 11 states, and it is provided to the Department of Agriculture and Co-operation on a regular basis. Currently, sub-district level (tehsil/block/ mandal) assessment of drought conditions is also being done in Karnataka, Tamil Nadu, Andhra Pradesh and Orissa. It is proposed to extend this programme, in due course, to cover all the drought-prone states. The feedback on the information on drought assessment, received from the district collectors/officials has been encouraging; and based on the feedback, information on storage levels of reservoirs, fuel/fodder availability, likely impact of drought on agricultural production, etc., is being included in the drought assessment reports. Weekly district-wise rainfall summary from the India Meteorological Department (IMD) is used in the National Agricultural Drought Assessment and Monitoring System (NADAMS). Comparative evaluation of Vegetation Index (VI) based drought assessment with regard to rainfall and aridity anomaly has been conducted. IMD issues short-term forecasts (upto 72 hrs.) and long term seasonal forecasts, which are too general to be used for drought monitoring. However, the medium range forecasts of 7-10 days duration issued by the National Centre for Medium Range Weather Forecasting (NCMRWF) could be used to predict vegetation response. These forecasts are presently

experimental. An Expert Committee consisting of IMD and National Remote Sensing Agency (NRSA)/DOS representatives has discussed twice, in 1993, about the integration of IMD inputs with NADAMS. As part of R&D studies, using the data-base on Vegetation Index generated under this project, biomass estimation and vegetation dynamics at regional scale have been taken up.

19. The Secretary, Ministry of Agriculture told the committee that the application of remote sensing technology in drought monitoring, and assessment based on Vegetation Index (VI) of an area, was also not without its limitations. VI of a particular area certainly gave an idea about the extent of greenery, which helps to determine the status of drought in that area. Since such a methodology involved comparison with the data of last year, an accurate assessment became impossible if that year happened to be abnormal. If it was either less or more than last year, one really was not able to know about the position in the current year. IMD, no doubt, was doing weather forecasting which was of a general nature; and it was not a sub-division level forecast. In view of this, the Secretary, Ministry of Agriculture, suggested that there was a need to establish a linkage between the forecast made by IMD, the actual data of rainfall and the VI during a particular period, and my combining all these indicators some kind of model could be developed for the future. The Committee feels that the suggestions made by the Secretary, Ministry of Agriculture need to be examined with a view to building a more 73 fool-proof model.

Mapping of Saline/ Alkaline Soils

20. The Committee was informed that mapping of saline/alkaline soils in the states of Punjab, Haryana, Gujarat, West Bengal, Bihar, Orissa, Maharashtra, Kerala, Karnataka, Tamil Nadu, Rajasthan, Uttar Pradesh, Madhya Pradesh, Andaman & Nicobar Islands and Andhra Pradesh had been completed. Maps for most of these States have been reconciled with National Bureau of Soil Survey and Landuse Planning (NBSS & LUP), Nagpur; and the rest is in progress. Mapping of salt affected soil on 1:50,000 scale has been proposed in Uttar Pradesh, Haryana and Tamil Nadu. Soil mapping on 1:1 million scale of the entire country, using 1:250,000 scale satellite imagery and extensive ground information, is under way at the NBSS & LUP, Nagpur. This will also lead to the preparation of state level soil maps at 1:250,000 scale. The committee hopes that this work would be expedited and maps would be available to all the agencies which are dealing with the development of the saline and alkaline soils.

Identification of Potential Fishing Zones

21. Information of features such as water colour, turbidity, sea state, flotsam and jetsam, wave size and direction, wind patterns and climatic conditions has direct influence on fishing strategies. Timely forecast of potential fishing areas can help in maximising the gains and optimising the efforts and time put in by the fishing fleets. The advent of remote sensing satellites, with their capability to cover large spatial areas over oceans on a repetitive basis, can prove to be of substantial economic benefit, particularly for a nation like India having a large coastline and extensive Exclusive Economic Zone. Although direct spotting of fish schools is not possible from satellites, indirect methods of identifying potential fishing zones have been found to be feasible. The Department of Space has initiated efforts to utilise space-borne remote sensing on an operational basis to aid the fishing operation on the Indian coast.

22. Presently, the fisheries forecasts are being made on the basis of the sea surface temperature (SST), with the help of which zones are delineated where there is temperature gradient. The PFZ information consisting of latitude and longitude positions, bearing in degrees, distance in kilometre from the coast depth in metre and validity period with reference to particular fishing centre are disseminated on a near real time basis. The forecasts are normally valid for a period of 3-5 days. Presently, the fisheries forecasts are disseminated by FAX/Telex to state Fisheries departments and concerned fishermen associations. It is put up on the notice boards in vernacular language for the convenience of fisherman. Local newspapers also publish it. It is also being broadcast through the All India Radio. It has been observed that, by and large, the notified grounds, as per the fishery forecast, are found to yield better catches of pelagic fishes (increase in catch per unit effort to the extent of 2 to 3 times) compared to unnotified grounds. It has çalso been observed that there is significant increase in catch per unit effort to demersal varieties of fishes in the in-shore areas.

LANDUSE / LAND COVER MAP

(PART OF EAST GODAVARI DISTRICT)

1:125,000

Km 2.5 0 2.5 Km

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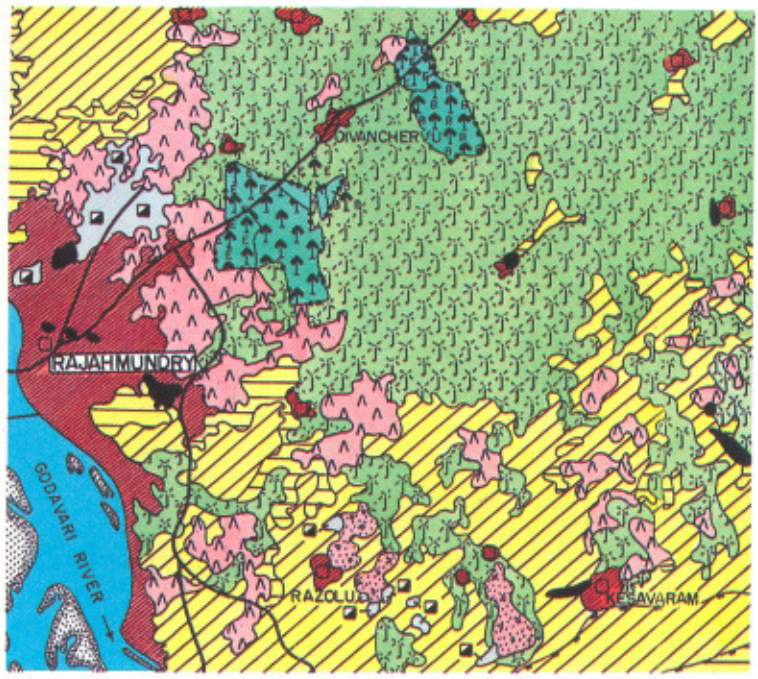


REFERENCE

LEVEL - I	LEVEL - II	LEVEL - III
1. BUILT-UP LAND	1.1 Built-up land	
2. AGRICULTURAL LAND	2.1 Crop land	
	2.2 Fallow	
	2.3 Plantation	
3. FOREST	3.1 Forest plantation	3.1.1 Eucalyptus
		3.1.2 Bamboo
		3.1.3 Mixed
4. WASTE LANDS	4.1 Land with/with out scrub	
	4.2 Barren rocky/Stony waste/Sheet rock area	
5. WATER BODIES	5.1 River, Stream	
	5.2 Tank, Canal	
6. OTHERS	6.1 Quarry	

SOURCE : VISUAL INTERPRETATION OF SYNERGISTIC FCC'S OF ERS-1 SAR 8 IRS LISS-II DATA (1992).

23. The Secretary, Ministry of Agriculture agreed that the information of PFZs generated by the Department of Space through remote sensing had been found to be useful. The efficiency of the system to bring the information to the fishermen, however, needs to be improved. In actual practice, benefit of this information was being cornered by the fishing trawlers; and small scale fishermen remained unaware of it.

24. When the attention of the Secretary, Ministry of Agriculture was drawn to the fact that the Department of Space had informed the Committee that the information was being broadcast through All India Radio in some states, he replied:

"Our feed-back so far is not very encouraging. But technology is there. It is a question how we can put the technology to use. It is also our short-coming. The issue is how to use it."

25. The Committee notes that feedback received from the Ministry of Agriculture in this regard was different from the one received from the Department of Space. As

regards data relating to PFZ not being available to small fishermen the Department of Space contended that the question did not arise because the information provided through the PFZ charts was mostly valid beyond ten km. from the coast; these areas are exploited by those with trawlers, whereas traditional fishermen are confined within ten km. On the basis of this information supplied by the Department of Space, the Committee finds that the satellite-based PFZ charts facilitate mainly the commercial fishing operations which are being carried out by fisheries departments and fishermen's associations who have necessary where-withal to fish beyond ten km. The PFZ maps presently appear to have limited use or no use for small fishermen who generally fish within ten km.

26. The Committee notes the view expressed by the Secretary, Ministry of Agriculture that the Department of Space should see to it that satellite-based data regarding PFZs should be such as to benefit small fishermen also instead of being utilised largely by the fishing trawlers. It also devolves on the state fisheries departments and the local administration to make necessary arrangements to disseminate the information in a suitable way. The Committee accordingly recommends that the Ministry of Agriculture should coordinate with state fishery departments to take necessary steps to ensure that the satellite-based information generated by the Department of Space reaches the small fishermen living even in remote villages.

27. In view of the fact that PFZ charts prepared by the Department of Space have limited use for the small fishermen, as it is basically valid beyond ten km. the committee feels that the Department of Space should make efforts to integrate more oceanographic parameters than are being presently made use of, to make fisheries forecast more effective for near-shore waters.

Ministry of Rural Development

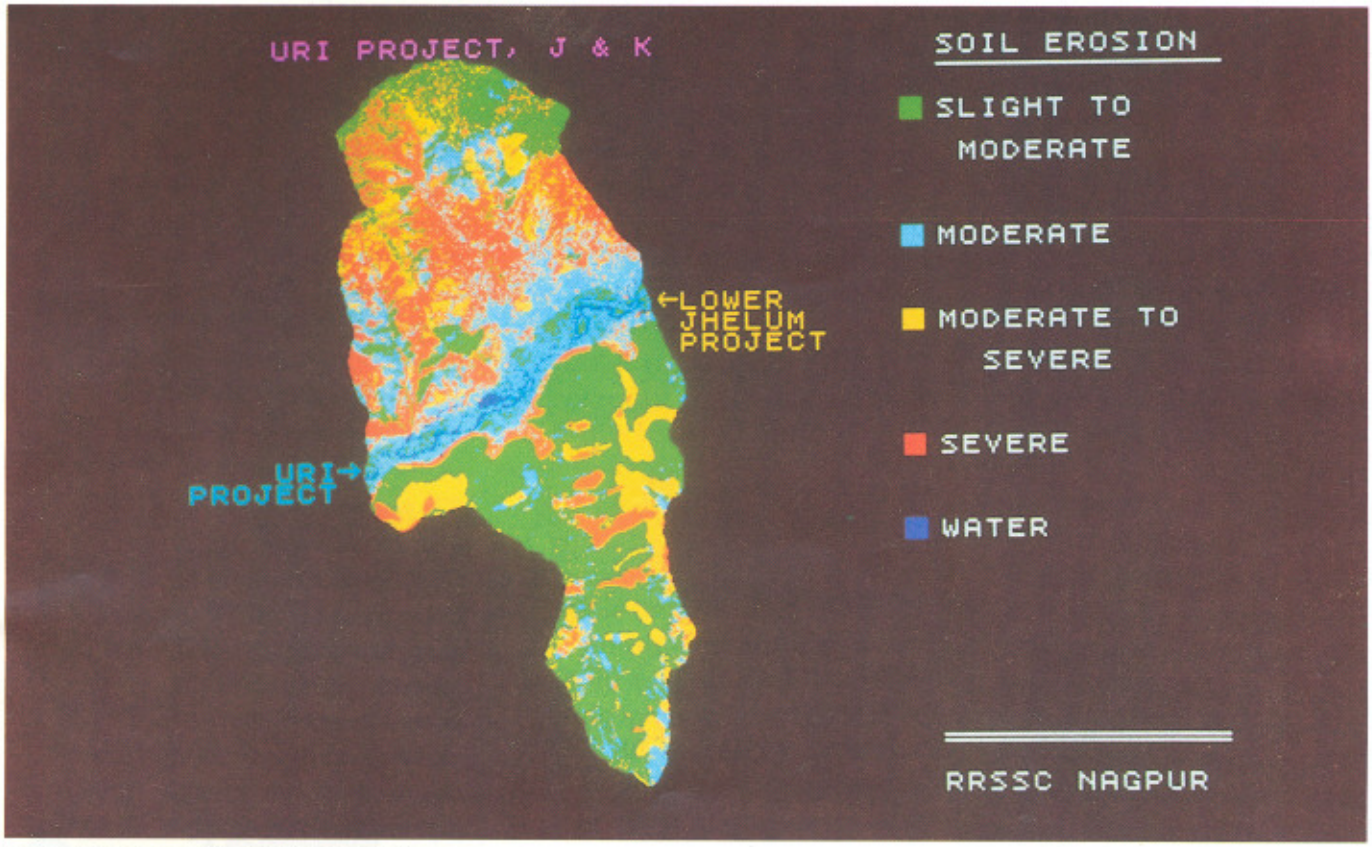
Wasteland Mapping

28. About 16% of India's land area is considered as wasteland due to various reasons including salinity of soils caused by excessive use of fertilisers and improper irrigation procedures, degradation due to the prolonged agricultural usage, deforestation, desertic condition, snowcover, barren rocky and steep slopy areas, etc. The use of remote sensing for mapping wasteland in the country was started in 1985. The Department of Space had prepared wasteland maps for the entire country on 1 : 1 million scale in that year using LANDSAT data; and about eight wasteland categories were identified and mapped in that study. From this mapping activity, it was estimated that the total wasteland in the country was 53.3 million hectares. Subsequently, towards the reclamation of the extensive wasteland tracts of the country, Government launched a programme to green 5 million hectares every year. Although this was a gigantic task, a pre-requisite for this was to identify wasteland rapidly on a sufficiently detailed scale (1:50,000), showing village boundaries. As the Department of Space had already mapped the wastelands on 1:1 million scale, it was assigned the task of preparing detailed wasteland maps of the country on 1:50,000 scale using satellite remote sensing data.

29. The Committee was informed that the wasteland mapping on 1:50,000 scale had been taken up in different phases. A total of 237 districts had been mapped for wastelands, and this included 146 districts having more than 15 per cent of the geographical area under wastelands, and 91 districts having 5-15% of geographical area under wastelands. 13 wasteland categories were mapped on 1:50,000 scale and this included gullied and/or ravinous land, upland with or without scrub, waterlogged and marshy land, land affected by salinity/alkalinity, coastal/inland, shifting cultivation area, underutilised/degraded notified forest land, degraded pastures/grazing land, degraded land under plantation crop, sands (coastal and desertic), mining/industrial wastelands, barren rocky/stony waste/sheet rock area, sloping area and snow covered and/or glacial area.

30. The final maps were handed over to the National Wasteland Development Board (NWDB) and also to District Magistrates, District Development Officers, Chief Planning Officers, Divisional Forest Officers, Sub-divisional officers, Tahsildars and other concerned department officials for further follow-up action for reclamation. Since the amount of work involved had been enormous, as many as 18 different work centres distributed all over the country were involved in the task.

31. The Committee was informed that under the wasteland mapping project, being carried out with funding by NWDB, mapping had been completed so far for 237 districts. The mapping of the remaining 192 districts in the country was proposed to be



Mapping of soil erosion using IRS data

taken up and would be completed in 2 years' time from the date of approval of the project.

32. Apart from the mapping of wasteland categories, the Department of Space has also taken up projects on a pilot-scale at the behest of National Afforestation and Eco-development Board (NAEB), for wasteland reclamation using Geographic Information System (GIS) techniques, where different resource maps and socio-economic data are integrated to suggest plans for wasteland development. Pilot scale projects have been completed in 10 districts by the Department of Space and 5 other scientific and technical institutions in the country. The districts covered are Durgapur, Purulia, Bellary, Sundargarh, Nasik, Madurai, Gurgaon, Alwar, Kheda and Almora.

33. As for the feedback, the Committee was apprised in detail by the representatives of the Ministry of Rural Development about the usefulness of the wasteland maps prepared by the Department of Space. The Committee was told that the District Rural Development Agency (DRDA), responsible for implementing the Integrated Wasteland and Development Scheme, was making use of the data supplied through remote Sensing while preparing the wasteland development plans. This data was used in conjunction with the traditional data available in the field. When asked about the extent of wasteland in the country, the Committee was informed that the data provided by the Department of Space were different from those obtained through surveys conducted by departments other than the Department of Wasteland Development. These were being harmonised or reconciled by inter-Departmental consultation. The main emphasis of the Ministry was to see that the limited resources available with the NWDB were used for actual implementation of the schemes for the development of wastelands.

34. The Committee inquired about the manner and extent to which the remote sensing data were being utilised by the Department while planning for the wasteland development, and wanted to know if the Department was finding the data adequate. The representative of the Ministry informed that the Integrated Wasteland Development Plan was prepared at the district level through a multi-disciplinary team by making use of the remote sensing data provided by the Department of Space. The knowledge and requirement of local people was also taken into account. As regards the adequacy of the remote sensing data, the representative of the Department submitted that the process of reconciling the data

on waste lands received from different sources was on. Referring to the work done by the Department of Space for the preparation of Natural Resources Management System-based plan for the District of Chandrapur, the representative of the Department described remote sensing as "a very powerful and important tool" which could be used effectively in area development schemes.

35. The Committee observes that the wasteland maps prepared on the basis of remote-sensing data have been found to be very useful in planning for the wasteland development and commends the work done by the Department of Space for the preparation of Natural Resources Management System - based plan for the district of Chandrapur and hopes that the encouraging results of this plan would guide the planning efforts at the national level also.

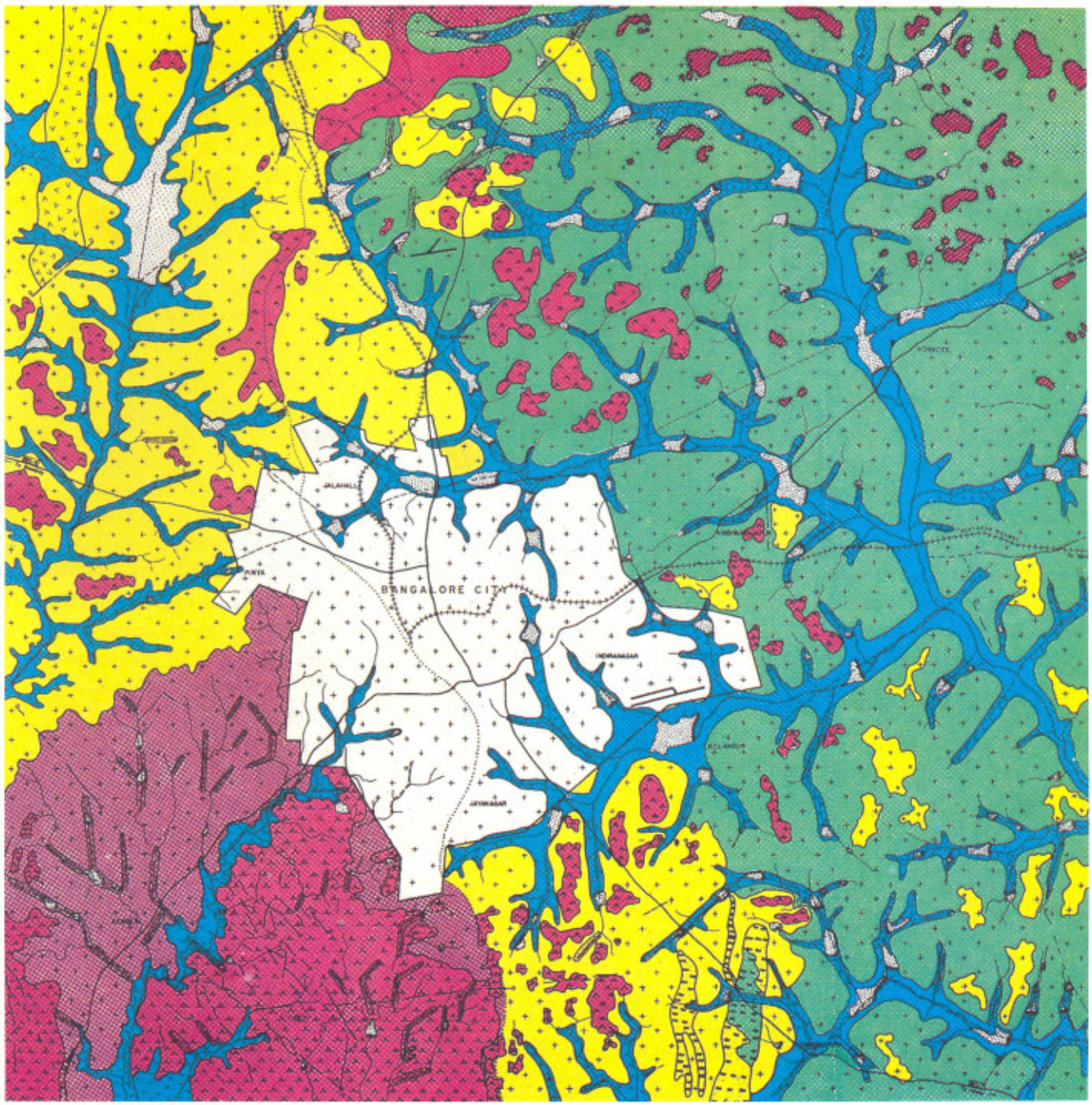
Ground Water Targeting

36. Presence of ground water can be indirectly deduced by studying such factors as lithology (rock type), landforms, associated geological structural features, soil, landuse/cover, etc. and remote sensing data provides information on these factors. Ground water targetting was among the early highly successful applications of satellite remote sensing in India from the time of setting up of the National Natural Resources Management System. Early successes were in Gujarat, Maharashtra, Uttar Pradesh and Madhya Pradesh including difficult hard rock terrains. Recognising this established potential of remote sensing technology for ground water studies, the preparation of hydro-geomorphological maps, indicating the potentials of ground water, was taken up under the National Drinking Water Mission. The mission had the primary objective of providing drinking water to all villages. While the Department of Rural Development was identified as the nodal agency to carry out the mission, the Department of Space was entrusted with the responsibility of preparation of hydro-geomorphological maps (ground water prospect zone maps) by using remote sensing data, which forms one of the important components for locating borewells. For the first time, the hydro-geomorphological maps, along with details legends indicating ground water prospects in terms of probability of ground water occurrence, was mapped on a 1:250,000 scale for the entire country. Copies of these maps were submitted to the concerned State/Central Government Departments, such as Ground Water Department, Public Health Engineering Department/Central Ground Water Board, National Geophysical Research Institute for further hydro-geological and geophysical investigations and for selecting suitable sites for borewells. It was observed that when ground water prospect zone maps, prepared using remote sensing methods, were used along with the conventional (hydro-geological and gepphysical) methods the success rate of locating borewells with good yield was as high as about 90% as against 45-55% achieved using only conventional methods. With the increased rate of success achieved in drilling the borewells using remote sensing technique in conjunction with the conventional methods, there were considerable savings in terms of time, money and labour. The entire exercise showed that the ground water potential zone maps, prepared on the basis of remote sensing data, were very useful in narrowing down the target areas for ground water exploration. In addition, mapping of hydro-geomorphological features on 1:50,000 scale using IRS data was also done for identified problem villages in the country.

37. Apart from mapping the ground water prospect zones, remote sensing data have also been found useful in locating sites/areas for check dams, anicuts, sub-surface dikes, percolation/recharge tanks and inverted wells, etc., which are essential for maximizing the ground water recharge. Studies are also being carried out to assess the suitability of sites identified for setting up major chemical industries, in order to avoid pollutants entering the ground water sources.

38. When the committee wanted to know as to why all the states could not fully utilise the data generated by the Department of Space, the representative of the Ministry informed that all states did not possess capabilities for utilising this data. For example, many of the states in the North-East were not in a position to utilise the remote sensing data in this regard, largely because they did not have well organised ground water departments. The Committee was further informed that this data was in a sophisticated form and further that this data alone did not serve the purpose. This data had to be utilised along with conventional sources of geophysical and hydrological data.

39. In the light of the feed-back received from the Ministry of



Ground water potential zone map of Bangalore City and surroundings.

Very Good

Good potential, depending upon tne thickness.

Nil.

Poor to Moderate, depending upon the depth of weathering & intensity of fracturing.

Moderate to good, depnding upon the depth of weathering and intensity of fracturing.

Poor to moderate.

Nil, Poor to moderate Potential along narrow valleys, faults & fractures.

Nil (Except along Fractures / Faults).

Poor (Moderate potential along the narrow valleys, Fractures / Faults).

Poor to moderate potential, depending upon the depth of weathering

Moderate to good, depending upon the depth of weathering.

Poor potential within the dyke rock But good potential on the upstream side of the dyke.

Good to Very good depending upon the intensity of Fracturing/Faulting.

Good.

Rural Development, the Committee feels happy over the fact that the data obtained through remote sensing has been found to be very useful in identifying and locating the ground water in many states, particularly those suffering from arid conditions with a success rate of as high as 90%. The Committee, however, notes that a number of states were not capable of utilising this valuable data due to lack of infra-structural facilities required for this purpose. It, therefore, recommends that efforts should be made at the central and at the state level to fully utilise the remote sensing data on ground water targetting, generated by the Department of Space. The Department of Space should also impart training to the personnel working in the Rural Development Departments or other such departments which are concerned with providing water to the people at the state level. The Committee strongly recommends that the remote sensing inputs provided by the Department of Space should be integrated very closely with the Rajiv Gandhi Drinking Water Mission by the Ministry of Rural Development. Presently, the remote sensing technology is being applied in preparing geomorphological maps indicating the probability of occurrence of ground water at a particular place. It does not, however, give any idea about the quantity of water; in the absence of this it is not possible to know as to how long a particular source would last. In view of this, the Committee feels that apart from indicating potential ground water zones, efforts should also be made for measuring the size and age of ground water reservoirs so that it gives an idea as to how long the source located is going to last and also if it has any recharge value. For this radio isotope techniques using beryllium-10, carbon-14, and tritium would be valuable; the Department of Atomic Energy which has capabilities in this area should be brought into support this programme.

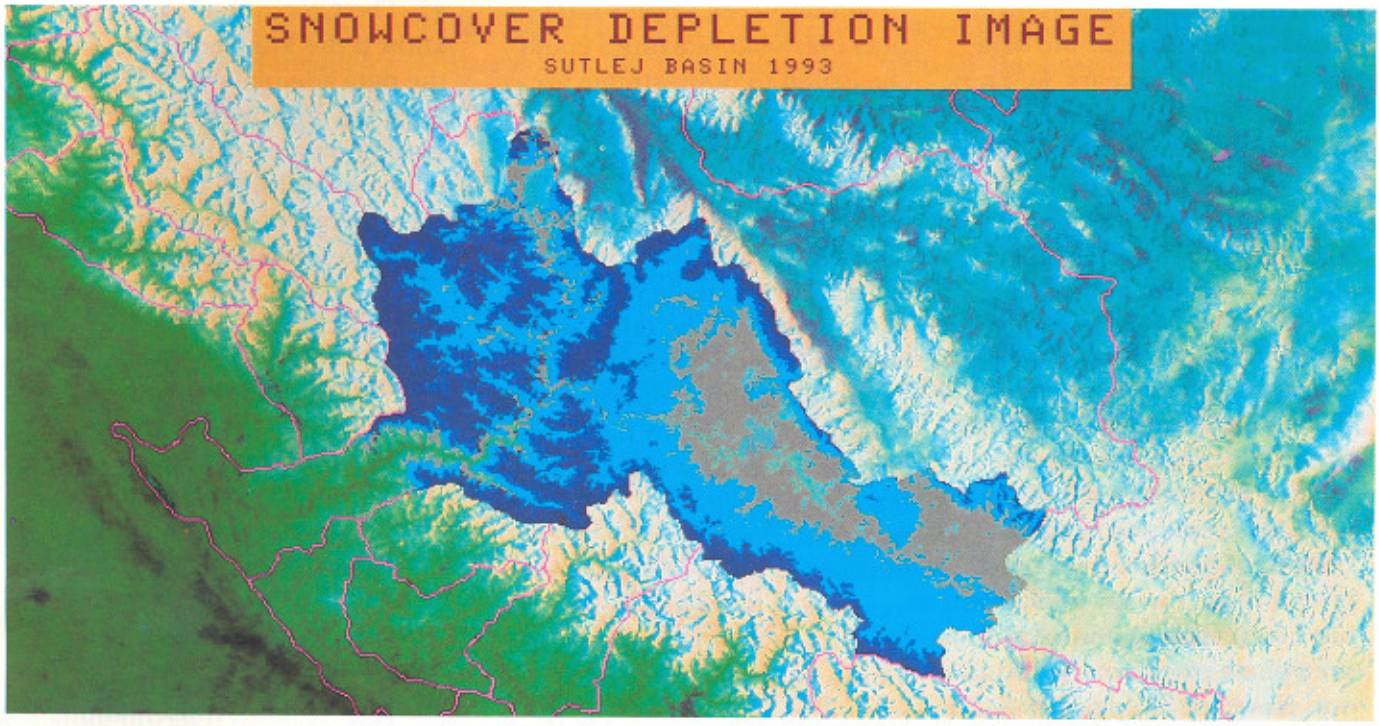
Ministry of Water Resources

40. The Department of Space undertake flood mapping and flood damage assessment, snow mapping and command area studies with the help of space imageries; the main users for these are the Central Water Commission, Flood Control Boards, State Irrigation Departments, etc. The Department of Space has been doing near real-time flood mapping and assessment of crop damage due to floods since 1987. Flood maps have been prepared on 1:25,000 scale for larger floods and on 1:50,000 scale for detailed assessment of crop damage. Using multidate satellite data, difference waves of floods that occurred in the Kosi River basin have been mapped, and flood risk zones delineated. Flood maps were prepared in near real- time using visible infra-red and microwave sensors (on IRS LANDSAT and ERS-1 SAR) covering Assam, Bihar, Jammu & Kashmir, Punjab and West Bengal. Information on marooned villages and length of roads submerged was also estimated. Flood damage information system is being developed for Marigaon district in Assam for assessing flood damages, together with ground information. During 1993, flood damages at mouza level for Marigaon district were estimated.

41. The Committee was informed that the Department of Space had also done snow-mapping with a view to delineating features of the Snow-covered area, and estimation of snow melt run-off. Snow melt run-off estimated had been done for the Bhakra-Beas catchment both on short-term (seasonal) and long term (whole season) basis. These estimations were found to be within ± 5 % of actual run-off.

42. The Committee was apprised of the use of satellite data for predicting the amount of snow-melt run-off into the rivers. A major part of the northern side of the country is covered by snow. Remote sensing plays an important role in predicting the snow-melt run-off because most of the snow-covered areas are inaccessible, and the use of traditional instruments to measure the actual snowfall is very difficult. Through the space imageries the area covered by snow in different months can be delineated. How much melting of snow takes place in that area can also be ascertained. Snow-cover information through satellite imageries, coupled with the corresponding quantitative analysis is having a very good application in the area of snowfall and snow forecast. This will also be useful in the area of hydel power generation, micro-hydel and mini-hydel schemes which are coming up in the northern parts of the country.

43. When the Committee asked if it was possible to measure the amount of snow in a particular area with the help of remote sensing data, and also if the total mass of snow was actually increasing or decreasing, the committee was told that remote sensing data in this regard relate mostly to the area covered by snow and not on its



depth and density. Information regarding density of snow was being obtained from some stations located at different places but because of inaccessibility of snow covered area, information and depth and density was not available for most of the parts. For measuring the amount of snow more stations need to be put at high altitude, though snow surveys were being conducted for which terms go to specific areas periodically. It is possible to have unmanned instrumented stations to measure snow fall, snow depth and density, with the data being relayed to satellites passing overhead which can command these stations; and these satellites can be queried to obtain the needed data. R&D efforts are in progress to include run-off from permanent glaciers to improve accuracy. Based on remote sensing data, an Atlas of Glaciers in Himalayas had been prepared. It has been possible to identify the spatial extent of different glaciers and also the ablations zone.

44. Besides, command area studies had also been undertaken with the help of remote sensing data for monitoring of crops/irrigation status in command areas. The Committee sought to know from the Ministry of Water Resources and the Central Water Commission about the use of remote sensing data by them and how far these were found useful by them in regard to command area development, flood mapping, and snow cover mapping, etc. The Committee also invited suggestions for making the data obtained through remote sensing more effective and useful for these purposes.

45. The Committee was informed that the data generated by the Department of Space through remote sensing were not being used for command area development *per se*, but efforts were on to use the data for improving the irrigation and water management, and the operation of water management facilities, etc., in different command areas. The data enabled one to identify area which did not get enough water. Normally, while the head reaches got enough water, the tail reaches did not get even the required quantity of water. One had to ensure that the tail reaches in a command area also got adequate water. The process of getting information physically from all areas and then managing the water system was a costly affair both in terms of time and money. Since remote sensing data is available almost every eleven days from satellites, operating at current IRS altitudes, enough information is available about areas not getting water: this facilitates the issuing of instructions to improve the situation. Elaborating on flood management and disaster management and the use of remote sensing data for these operations, the Secretary, Ministry of Water Resources said:

"In the case of flood management and disaster management on a real-time basis, we intend to use the remote sensing data for

preparing maps of flood-prone zones. If we can scan the data for the last 10-25 years, we know at what frequency different areas are getting flooded. This information will be useful for taking loss-preventive measures like constructing temporary shelters, raised platforms, etc."

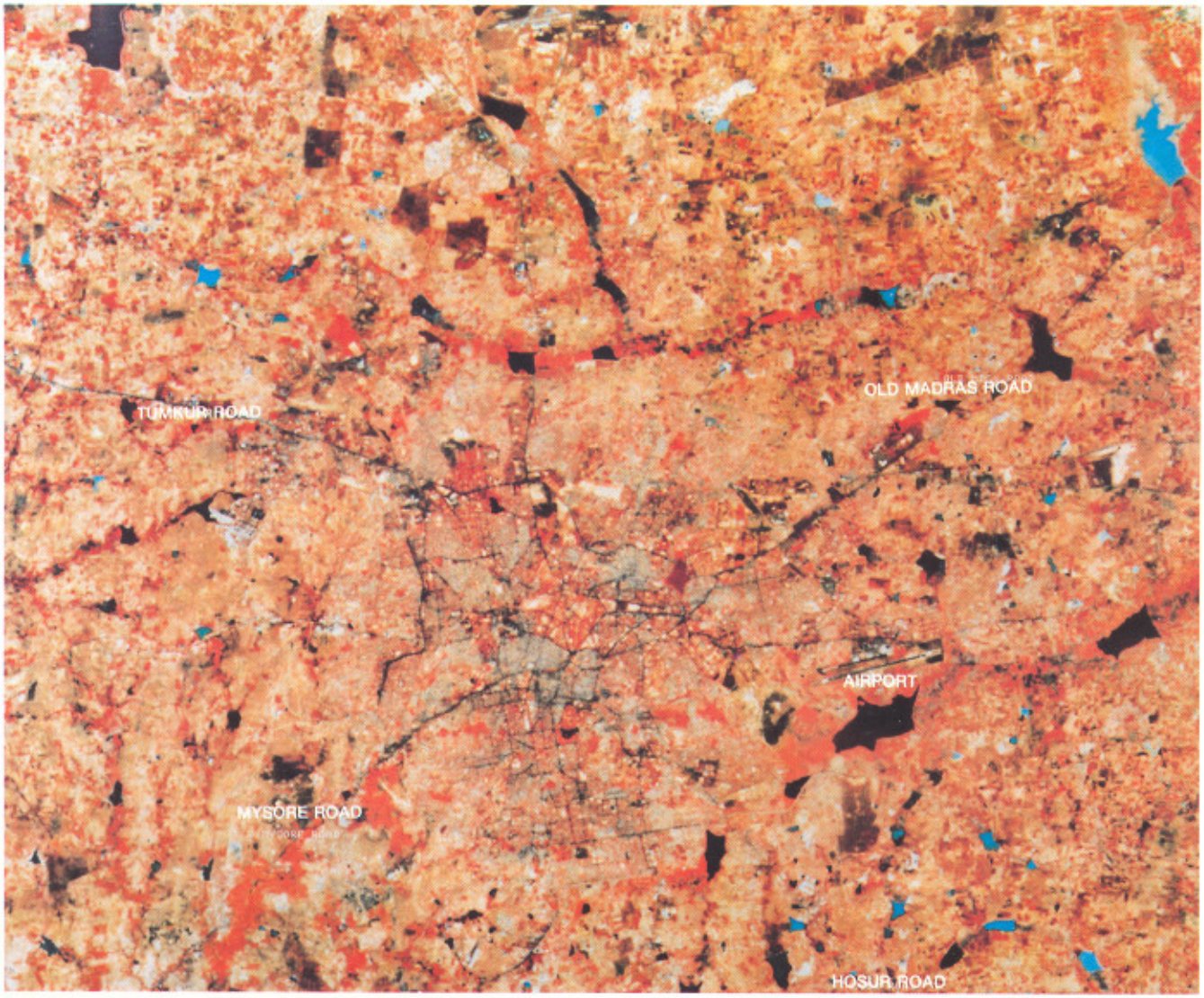
To a query regarding the possibility of predicting flash floods, it was explained to the Committee that the remote sensing technology could not be used for prediction of floods because this technique could give only the density of clouds but how much of it would precipitate could not be found out. However, an idea about how much area was prone to flood could be gathered adequately. However, if a flash flood occurred while a satellite was overhead, warnings could be issued to down-stream areas.

46. The Committee was further informed that satellite imageries provided an idea about the trend of migration of rivers; and if any such trend was observed, adequate preventive measures could be taken with a view to avoiding possible loss to human life and property. Such exercise had already been done for the rivers Kosi and Ganga at Farakka. As regards sedimentation, satellite imageries, particularly of water reservoirs, helped to determine the rate of sedimentation. One of the finest laboratories to use such remote sensing data, the Committee was told, was set up under the Central Ground Water Board (CGWB).

47. The Committee wanted to know if the Ministry had found the data adequate or there was a need for improving the remote sensing data on various aspects of its functioning. The Secretary of the Ministry of Water Resources replied:

"In the flood maps prepared, we do not have the cloud penetrating capacity. For this, we have to use the French satellite. In the monsoon period, when there is a cloud-cover, to have a real, effective, flood management capability, we need the cloud penetrating capacity. To that extent, improvement is required.

"Regarding water conservation, it is difficult to say as to how far the remote sensing technique helps. One help is, you can have



Bangalore and its surroundings as seen by IRS

geographical information system (GIS) for a particular basin on a watershed through the remote sensing satellite imageries."

As regards water-logging the Secretary of the Ministry of Water Resources said:

"We are, particularly, in the Ministry of Water Resources, concerned with the amount of water-logging that takes place in the flood-prone areas. At the moment, we are not having any technique which can tell us about the amount of water-logging because of rise in water table."

48. The Committee notes with satisfaction that the data made available through the space imageries are being utilized for flood-mapping and damage assessment, snow-cover mapping, ground-water targetting, etc. The Committee, however, feels that technique of remote sensing needs to be improved with a view to acquiring such capabilities as cloud penetrating capacity (for which microwave sensing capabilities would be needed on the satellites), flood prediction, measuring of snow density and water-logging , etc. Though the Committee has been assured that the remote sensing satellites to be launched in coming years would, to a great extent, generate improved and more accurate data, the committee feels that more research needs to be done for improving the understanding of the complicated data that would be made available through future satellites. For this personnel in the user Departments are required to be given proper training.

Ministry of Urban Development

49. The Department of Space informed the Committee that, in addition to aerial remote sensing surveys being regularly carried out for urban cities by National Remote Sensing Agency (NRSA), multidate data from Remote Sensing Satellites are being operationally used to map urban sprawl and landuse. Satellite data have been used to map 12 major cities with over one million population, and studies in respect of current landuse and trends of their urban growth have been carried out. Besides, Geographical Information System (GIS) based studies have been undertaken for integrating resource information with socio-economic and demographic data to arrive at urban development plans. In this context, the Department of Space referred to three specific examples of utilization, namely:
(i) the notification issued by the Bombay Metropolitan Development Authority that remote sensing based inputs were to be used for clearance of the developmental planning subsequent to the study on urban stability zones;
(ii) planning of the National Capital Region; and
(iii) alignment of Ring Road in Bangalore city. It was also explained by the Department that with the availability of IRS-IC satellite, 6m resolution data with stereo-viewing capability would be available which would help in the preparation of maps with sharper features. As regards contour mapping, the point made by the Department was that the same would be possible mostly through availability of stereo-data and the high resolution (better than 6 metre) with stereo-viewing capability. The committee was also apprised by the Department of the fact that pursuant to the objectives of nation-wide mapping for landuse cover for agro-climatic zones on 1:25,000 scale, all the districts in the country have been mapped; and similarly, under the project 'Urban Studies', urban sprawl maps for Madras, Hyderabad, Nagpur, Calcutta and Bombay have been prepared.

50. In his presentation made before the Committee, the Secretary, Ministry of Urban Development underlined the importance of urban planning in the context of rural-urban migration and increasing population, and growing urban agglomerations; and focused on the efficacy of remote sensing as an instrument for urban planning. He emphasised that in view of the current nature of urban spread, it was very important to have accurate maps on urban sprawl, landuse and coverage in order to find out the infrastructure developing in these towns; and in the area of mapping the role of the Department of Space could not be minimised. Citing an example, he stated that when the Ministry wanted to prepare the Master Plan of Delhi in 1951, it took them almost 10 years to have a map because, for collecting necessary data the whole exercise had to be undertaken manually and people engaged in the task had to go to different areas. This is in contrast to what is possible today. The Secretary, however, clarified that the satellite imagery being provided as of now to them cannot be put to extensive use for the reason that it does not have the kind of resolution needed for detailed urban planning. No doubt, for regional planning such as in Singrauli area, or to see the extent of urban sprawl in Bombay in order to find out how the urban area is developing, satellite data have been used. Similarly, in National Capital Region, remote sensing data provided by the Department of Space has

been used. In view of the constraints imposed by the existing limited capability in resolution, the Ministry of Urban Development is using aerial photography which helps them in detailed planning; but the aerial photography is far too expensive. Therefore, what the Ministry is hoping for is that the Department of Space would be able to provide the needed resolution with higher capabilities in the next one or two years when IRS-IC and ID become operational. The Ministry intends to use aerial photography as well as remote sensing data because the former is extremely useful in certain areas and the latter will help it in covering large number of towns. With that end in view, the Ministry has decided to sustain the efforts of the Department of Space. A sum of Rs. 5 crores given to the Ministry by the Planning Commission for taking up development of 25 towns on pilot basis has been given to the National Remote Sensing Applications Centre. Another reason for the Ministry to have close liaison with the Department of Space is that the latter has assured that with the help of new technology which is proposed to be inducted, contour mapping too will be made available to the Ministry. This implies that what used to be done in a time of a decade for preparation of Master Plan or what used to be done by aerial photography would be better achieved with the efforts of the Department of Space when the IRS-IC and ID go into the orbit. The Secretary of the Ministry, expressed the hope that the satellite data made available through IRS-IC and ID in near future would enable the Ministry of Urban Development to undertake urban planning of larger areas, and urban mapping of atleast 25 towns quite expeditiously which have been identified for development on pilot basis.

51. The Committee wanted to know whether it was not a fact that distinct pattern of imbalances in big cities was emerging and whether the increasing pressures of growing population did not render the whole concept of Master Plan for such cities inconsequential. The Secretary, agreed that the needs of the growing population coupled with other factors put tremendous pressure on the efficacy of Master Plans and the result was indeed haphazard and mushroom growth, particularly of slum areas. In this context, he submitted that the satellite data being provided to the Ministry at present by the Department of Space was not of much help in locating the haphazard growth of cities and towns, particularly slums. At the same time, he expressed the hope that with improved satellite imagery of higher spatial resolution in the near future, and with the power of remote sensing for repetitive mapping the Ministry would be able to get relevant data on the basis of which plans could be worked out which would be dynamic in nature, and would detect imbalances so as to make possible corrective measures.

52. The Committee notes that at a time when the population of the country is tremendously increasing and extra pressures are building up on the cities and towns, urban planning assumes great importance. This can become a success only through mapping of these areas on a regular basis, so as to be able to check unplanned growth particularly in the proliferation of slums, encroachments on public land and damage to environment. And in this, the role of the Department of Space is very crucial, Remote sensing techniques have to be upgraded with the needs of time. The proposed launch of IRS-IC and ID by the Department would definitely help in making available necessary data and imageries of higher resolution needed for sound urban planning. The Committee feels that however perfect and reliable data may be, it is of little use unless the Departments/Agencies involved in the efforts show seriousness of purpose and make optimum utilization of such data in an effective manner. The role of local bodies in this context is very important and it has to be ensured that necessary data reach them, as also the other grass root level agencies/ bodies. The task of urban planning is, no doubt, a mammoth one but a coordinated effort between the Central Government and the State Governments through effective use of information obtained through remote sensing can ensure some amount of success on this vital front. The committee further feels that the Department of Space might consider the feasibility of attaining resolutions of 1 km not for generalised remote sensing but of specific areas such as urban growth centres; and for this panchromatic imagery is not called for. This may be looked into.

Ministry of Textiles

53. The Committee was informed by the Department of Space (DOS) that the Cotton Acreage and Production Estimation using remote sensing data was initiated in

1990 at the behest of Ministry of Textiles; and that the Department of Space has carried out satellite data analysis for the years 1990, 1991, 1992 and 1993. The cotton acreage and production estimates for 17 selected districts were made and sent by the Department of Space to the Cotton Advisory Board, Ministry of Textiles and Department of Agriculture and Co-operation (DAC). As per the existing structural mechanism, an Inter-Departmental Working Group, with members from the Ministry of Textiles, Directorate of Economics and Statistics of the DAC, the Indian Council of Agricultural Research (ICAR) and DOS oversees the whole project in this area. In the meeting held in July 1992 this group had recommended extension of the projects to 44 cotton growing districts.

54. The Secretary of the Department of Space submitted that, during the year 1992-93, cotton acreage estimation was undertaken in respect of the States of Punjab, Haryana, Maharashtra, Andhra Pradesh, Madhya Pradesh and Gujarat; and the total number of districts covered was 15. In these 6 States, the Department has been able to get, from remote sensing, the data relating to the yield based on the acreage; and for the last three years the Department has been providing information to the Ministry of Textiles only, on Cotton acreage for the area under cotton cultivation. The information is being regularly supplied to the Ministry by DOS but no feedback from the Ministry as regards the adequacy or the precision or the timeliness thereof has been received back, except that the data was being used by the Ministry for certain types of planning programmes. The Department of Space, however, was not in a position to determine the purpose for which the data was being used. The Ministry of Textiles nonetheless accepted the data for the year 1992-93 provided by the Department, and conveyed that it was good.

55. The Committee, was however, surprised to find that the Ministry of Textiles took a somewhat unusual stand when it was examined on the subject in as much as that the Secretary of the Ministry took the view that the subject of Cotton Acreage and Production Estimation fell within the purview of the Ministry of Agriculture. When the Committee told him that the Project on Cotton Acreage and Production Estimation was undertaken by the Department of Space at the instance of the Ministry of Textiles which had ever since been receiving remote sensed data from the Department of Space, the Secretary, Ministry of Textiles stated that the assessment of area under cotton and its production stands formally allocated to the Ministry of Agriculture and the Ministry of Textiles has been involved in this just on an informal basis. The establishment of the Cotton Advisory Board is an administrative arrangement evolved by his Ministry with which the Ministry çof Agriculture is not associated at all. Even the project on Cotton Acreage and Production Estimation should have been handled by the Ministry of Agriculture and it is just because the events so developed that the Ministry of Textiles had to deal with this Project.

56. In April, 1990 the Cabinet Committee on Export Strategy had emphasised the need to give better attention to production estimates of cotton; pursuant to this, a meeting was convened by the Ministry of Textiles inviting the representatives of the Ministry of Agriculture and Department of Space. In that meeting, the issue as to how better production estimates in respect of cotton could be had well in advance for purposes of planning Export Strategy was discussed threadbare. It was in the meeting held in June 1990 that the Department of Space gave a proposal for remote sensing application to assess the area and productivity which was to cover in the experimental phase 17 districts in 6 States. There are 9 cotton producing States covering 44 districts; but 50% of the production of cotton comes from 17 districts in 6 States which were taken up initially in the experimental phase. Based on the proposal of the Department of Space, a budgetary provision for launching the project was made for the year 1991-92, but the proposal was not admitted in the Budget. Then, in the month of March 1991, the Department of Space was requested to recast the proposal. The Department of Space came out with a much enlarged project of Rs.4 crores; and since this was too big a sum for the Ministry to invest, it was decided to approach the Common Fund for Commodities. Since the funding under this Fund could be only on regional basis, involving a number of countries in the region, the proposal remained a non-starter. However, further discussions took place, and in August 1992, the Department of Space submitted a third proposal involving an amount of Rs.79 lakhs which would cover all the districts over a period of three years. The investments was supposed to be Rs. 21 lakhs in the first year and Rs. 29 lakhs each in the second and third years. The Ministry of Textiles,

however, did not pursue this proposal with seriousness as a result of which nothing came out of it. The Department of Space, however, continued to work on the Project. The Department of Space decided from a research point of view to invest Rs.21 lakhs from their Budget, and started the project. Based on the performance of IRS-1A and 1B satellites, the Department of Space offered to make available updated figures at an interval of every 11 days. According to the Secretary, Ministry of Textiles, the experience of his Ministry is that the data supplied by the Department of Space is more on area whereas the Ministry is more interested in having the data on production of cotton. The Department of Space, no doubt, gives production figures with reference to 4 parameters namely, vegetation index; data on rain supplied by the Meteorological Department; soil condition; and extent of moisture in the Soil. What is, however, important is that, in order to have correct production figures, knowledge about the area and the crop condition, variety of cotton grown and yield is very necessary. Yield in any case will have to be worked out on a decentralised basis. The Secretary of the Ministry of Textiles, in the course of his submissions, made a point that having regard to these variables, the conversion of area figures into possible production figures has not been very satisfactory and the Department of Space, being conscious of this, asked for five year time-frame to build up their data-base and to make their models more reliable and acceptable. The Department of Space has three more years to evolve a reliable base for conversion of area figures into production figures and one reason for that Department to continue with the project is that IRS-1C scheduled to be launched in near future will have an infra-red band which gives accurate information on moisture stress. The Ministry of Textiles, as a user Ministry, believes that the Department of Space could develop capabilities in this area. It has, however, been impressed clearly on the Department that the Ministry needs information for all the 44 districts in 9 States and, therefore, the entire ground has to be covered. Secondly, the Department should develop its data-base first, start converting area figures into production estimates and then approach the Ministry with the production figures; and lastly, the Ministry would take it up after IRS-1C becomes operational. Therefore, in view of this, the Ministry of Textiles has practically done little with regard to the initiatives of Department of Space, so much so that the Ministry has had no correspondence with them nor for that matter in their reports have been analysed with any seriousness or continuity of purpose. The reason for the lack of interest on the part of the Ministry on this account, according to the Secretary, is that Ministry finds it very difficult to invest Rs. 50-60 lakhs just to collect area figures. Despite this, the Ministry would be very happy to be the client of the Department of Space if it improves its technology and capabilities and would be satisfied only when it has conversion capabilities from area to production.

57. Replying to a query from the Committee, Secretary, Ministry of Textiles, clarified that the Department of Space had made available production figures, but the same were not accurate as they were based on vegetation index which varies from place to place. Besides, the Department did not give different details in terms of per hectare yield, seed-rate, climatic factors and varieties grown. To another question, as regards the extent of variation between figures of production estimates given by the Department of Space and the ones arrived at by the Ministry, the representatives of the Ministry provided a statement giving comparative figures for the year 1991-92, 1992-93 and 1993-94.

58. The Committee expresses its displeasure over the stand taken by the Ministry of Textiles on the Crop Acreage and Production Estimation Project undertaken by the Department of Space. The Ministry seems to be dragging its feet, being totally oblivious of the fact that it was at its initiative that the Department of Space came into the picture, and that even though it had no technique then in its armoury to make 100% accurate forecast about cotton production in the country, it took in hand the project clearly impressing upon the Ministry that yield modelling would require some R&D efforts because of the complex relationship between green biomass and yield of cotton. The requisite funds also don't seem to have been made available to the Department of Space by the Ministry of Textiles; but notwithstanding this, the Department of Space went ahead with the project from its own resources, and since 1990 the Department has been making available data as regards crop acreage and production estimation to the Ministry of Textiles. The Ministry of Textiles on its part, not only has not been funding the project, has neither been analysing that data nor giving any feedback to the Department

of Space. The Committee feels that for a national effort of this nature greater patience and coordination on the part of the user Departments/agencies concerned is needed; but unfortunately in this case the cooperation extended by the Ministry of Textiles was far from satisfactory. There seems to have been quite extensive correspondence on the subject between the Ministry of Textiles and the Department of Space on the subject during the period 1990-92 and the former should have been aware of the difficulties inherent in production estimation of cotton which were clearly identified by the later.

59. The Committee was informed by the Department of Space that the project covered 17 districts for which cotton acreage and production estimates based on trend analysis of historical data during 1990 to 1993 were provided to the Ministry of Textiles. The Department of Space is making efforts to evaluate remote sensing based estimates with presently available data from Cotton Advisory Board. The Department of Space has nevertheless emphasised that cotton production estimation is a complicated exercise, as cotton is an indeterminate crop with prolonged phenological events and without distinctive vegetative and reproductive phases. At present, DOS (along with Agricultural Universities) is using the acreage estimates from satellite data to work out the yield estimates through trend analysis of historical data. R&D efforts are also underway to integrate temporal profiles of vegetation indices derived from satellite data with agro-meteorological models to estimate the potential yield and also for identification of varieties of cotton crops. In-season crop condition assessment (occurrence of pests, diseases, etc.) is being integrated with the empirical models to refine the yield figures.

60. The Committee trusts that in view of the wide field Vegetation Sensor to be provided by IRS-1C and 1D there will be quite useful crop yield estimation; and the problems now being faced in making accurate production estimation of cotton too will be minimised to a considerable extent. The Committee also hopes that the Ministry of Textiles would cooperate with the Department of Space in realising the objectiveness of the project.

Department of Science and Technology

61. The Committee wanted to know from the Secretary of the Department of Science and Technology as to what were the areas within its mandate where remote sensing data were being extensively used, and what useful information was given by the Department of Space under the Disaster Warning System. The Secretary emphasised at the very outset that it was paramount to have the capabilities to interpret the remote sensing data, the effective use of which lay in integrating it with conventional data. He explained that the Disaster Warning and Indian Topographic Survey are the two significant areas where the role of the remote sensing is very crucial. The life-line of the whole cyclone warning system is INSAT, which with the help of high power radars, provides necessary information on the origin and tracks of cyclones. The essential components of cyclone warning are detecting and centering, tracking, structure and intensity and movement. As submitted by the Department of Space, prior to the launch of the INSAT series of satellites, there had been practically no warning system in the country for major disasters like cyclones; and today INSAT-based Disaster Warning System for cyclone monitoring is an operational system. It is a system developed jointly by the India Meteorological Department and the Department of Space, which uses the VHRR and communication capability of INSAT and is a unique indigenous design not tried elsewhere in the world. The advantages of this system are its high reliability against adverse weather, broadcast of warning directly to remote coastal locations and minimum handling delay. The transmission of warnings is done in local language and broadcasts are frequent. It was pointed out by the Secretary of the Department of Science and Technology that New Delhi has been recognised as a regional specialised Meteorological Centre on tropical cyclones. Under this system, the India Meteorological Department has to provide information on cyclones around the Bay of Bengal to neighbouring countries including Pakistan. Not only this, there are other distinct meteorological applications of INSAT in weather observation such as cloudy area location, cloud movement and wind speed, high rainfall zones, turbulence and thunderstorm locations. INSAT, in any case, is a mode of communication for Disaster Warning and Meteorological Data Dissemination for which Very Small Aperture Terminals have been used.

62. Some of the Committee Members wanted to know whether it was possible to make forecast about other natural calamities such as earthquakes, cloud bursts and landslides. The Secretary of the Department of Science and Technology clarified that there were many features which could not be detected by Remote Sensing and the INSAT based system was essentially for warning in respect of cyclones; this had great importance because of the geo-destruction potential of the cyclones. The Secretary, however, added that his Department had undertaken National Coordinated Programme on landslides whereunder some intensive test areas, mostly in the Himalayan region, have been selected. Under this Programme, which started only two years ago, 11 R&D Projects are going on and a lot of reports and documents have been brought out. Remote sensing is being utilised as an important data input. However, because landslide is a very small phenomenon on the ground, high resolution data is needed. Elaborating further on this point, he stated that the IRS Satellite is currently providing a resolution of 35 metres, but with the launching of IRS-1C, the resolution of 6 metres will be made available. He, however, emphasised that still the IRS-1C data will have to be complemented by conventional means.

63. A point was made as to whether the Department had examined the feasibility of having linkages with educational institutions such as engineering colleges which could be used to analyse the data so that the interests of the particular region could be served. The Secretary concurred with the view saying that the universities and the laboratories were always treated by the Department as its constituencies.

64. The Department also submitted exhaustive data on the extent of remote sensing technology being used by the Survey Of India (SOI) which is basically responsible for producing topographical maps on scale 1:250,000, 1:50,000 and 1:25,000. The Survey of India is exploiting different capabilities of remotely sensed data such as repeatability of data, multi-disciplinary use of data and easy availability of data for inaccessible areas in map making/map revision; and satellite imagery could help in adding real-time information (both geometric and thematic) to the existing topographic map base. The Survey of India has used SPOT, LANDSAT and IRS imageries of different resolutions. The result of all this is that image maps superimposed with text and linear information are available in a very short time and are highly useful for proper understanding of the terrain for various planning purposes.

65. On being asked as to what specific improvements the Department of Science and Technology would like to be effected in remote sensing inputs, the Secretary of the Department suggested that water vapour channel which is not available at present may be incorporated in the INSAT. This would help IMD to study air wind movements, in addition to cloud movements. In other words, when there is no cloud it would be possible to determine the wind movement pattern on the basis of water vapour channel. Water vapour could be a good tracer. Improvement in resolution was another essential requirement which the Department would look forward to. Besides, increase in the perodicity of satellite repeat cycle is also needed to cope with certain problems such as in the area of monitoring floods. The Department would also like to see some upgradation in the data processing capabilities at various State remote sensing centres so that the data was accessible to the local academic sectors. Another area which demanded attention was the pricing structure for the data products; and the paramount need was to fix a different price for data products for academic and university people vis-a-vis others. Clarifying a point about detection possibilities from remote sensing of tectonic movements, the Secretary referred to a technique currently being used whereby synthetic aperture radar and some kind of interference methodology is brought into operation to detect the stress pattern on the ground like the photo-elastic effect. Under this technique, microwaves are used to enhance the effect by using synthetic aperture principle and the interference pattern is monitored. Amplifying this point the Department of Space submitted that the prediction of earthquake occurrence directly through satellite remote sensing is not possible presently. However, scientific studies have been initiated in India and elsewhere for earthquake prediction, using advanced technologies such as synthetic aperture radar interferometry and use of sophisticated, sensitive sensors to measure micromovements of continental plates, electromagnetic disturbances, etc., that have a bearing on earthquake occurrences. It is feasible to use satellite data for mapping earthquake prone areas with respect to geology, geomorphology and structural features, which when integrated

appropriately with collateral data such as past seismic activity, gravity anomalies and *in situ* micro-seismic observations will help in better understanding of earthquake prone areas.

66. The Committee has noted with satisfaction that remote sensing provides very potent tools in disaster warning management system. It has also proved very helpful to the Survey of India. The Committee would like the Department of Space to look into the possibility of a dedicated remote sensing satellite for cartography. The use of remote sensing inputs, particularly in areas which are very rugged and inaccessible, is all the more necessary. The Department of Science and Technology has made some useful suggestions for upgradation of remote sensing technology, particularly in the area of resolution; and the Committee hopes that the Department of Space would seriously examine them, though the Committee believes that with the induction of new technology in the planned launch of IRS-1C and 1D the requirements of the Department of Science and Technology will be considerably met. The Committee would also like the Department of Space to seriously examine the feasibility of bringing other natural calamities within the ambit of disaster warning system so that larger number of people are benefited and the system does not remain confined only to the area of cyclones.

Department of Ocean Development

67. The Committee wanted to know as to how the Department of Ocean Development (DOD) was using Remote Sensing Technology in environmental marine survey, collection of oceanographic data and identification of Potential Fishing Zones (PFZs). The Secretary of the Department, at the very outset, submitted that the IRS Satellites operating at present are merely land satellites which provide data only in respect of land; and what the Department needs is an ocean viewing satellite. The Department took up the matter with the Planning Commission, and is now working closely with the Department of Space in that direction. The Department of Space is currently seized of the matter, and as conveyed to the Committee by the Space Department itself, studies on Oceansat have been completed. Five sensors, viz., Ocean Colour Monitor, Scatterometer, Altimeter, Thermal Infra-red Sensor and Passive Microwave Radiometer have been prioritised. While DOD is planning to fund the development of these payloads, DOS has initiated preparatory actions towards spacecraft development. Oceansat is proposed to be launched in 1998-99. Besides, the Modular Opto-electronic Scanner (MOS) onboard the IRS-P3 satellite planned to be launched using PSLV-D3 vehicle, will also be available for the Ocean colour studies.

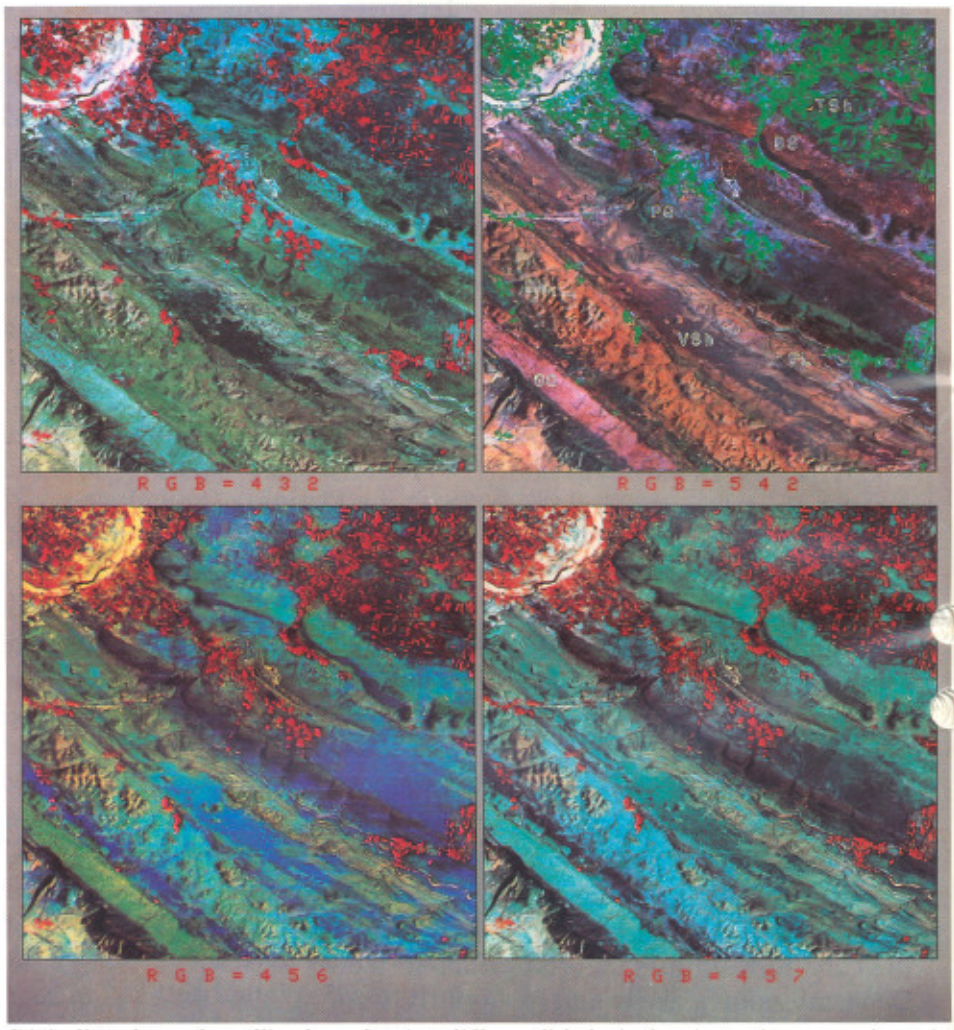
68. Secretary, Department of Ocean Development, informed the Committee that the Department is at present using an American Satellite NOAA, with the help of which it is in a position to give information on the sea surface temperatures for locating PFZs. In other words, this Satellite is facilitating the task of the Department in delineating zones where there is a temperature gradient. But NOAA also does not have the technology to cater to all the requirements of the Department. Therefore, in the second phase, the Department proposes to use another satellite for detecting chlorophyll, and this capability would be forthcoming from Sea Star Satellite to be launched by an American Company. The Department is incurring very nominal expenditure on the services derived from NOAA; and the basic purpose behind utilizing a foreign satellite is to have enough experience in putting to use this capability so that when the indigenous ocean satellite is launched no major problems are encountered.

69. On being asked a pointed question as to whether the dissemination of information in respect of PFZs, as at present, was not favouring big fishermen and the benefits were not actually percolating down to the community of small fishermen, the Secretary of the Department of Ocean Development was candid enough in admitting that there were some gaps here and there, in that the feedback which the Department was getting was good from some States and not so good from some other States. The Department was fully conscious of this problem, and awareness programmes had been launched. With an increase in the number of awareness programmes they would move to utilise the Sea Star Data which would be available in a year. As far as the satellite technology is concerned, it is for larger areas, and the Department of Ocean Development has a programme of giving communication sets to fishermen to ensure that the information about PFZs is transmitted to them in the quickest possible time. In response to a query from the Committee as to whether the

data on PFZs was being supplied by the Department free of cost or some charges were levied thereon, the Secretary clarified that the data was absolutely free of cost, but a request had been made to the National Remote Sensing Agency to start charging for the data. The basic consideration was that the data was being supplied to the outside user agencies and the value needed to be realised.

70. As regards the Fisheries forecasts, it was submitted by the Department of Space that such forecasts which are based on Sea surface temperature, derived from NOAA-AVHRR, are applicable mainly for the areas beyond 10 km from the coast, and since the fishing activities of traditional fishermen are confined to within 10 km zone, the satellite derived PFZ maps have a limited use for them. Touching upon another aspect as regards the validation of PFZ data, the Department explained that the feedback is collected from fisherman for validating the fishery forecasts by various means viz., (1) employing their own scientists in selected fishing centres, (ii) through States' fisheries department officials (iii) through government organisations like Central Marine Fisheries Research Institute (CMFRI), Fisheries Survey of India (FSI), Marine Satellite Information Service (MARSIS)and, (iv) through fishermen's organisation/ fishermen by conducting awareness programmes. The Department, however, plans to collect feedback from all the fishing centres in due course of time in order to strengthen the validation programme.

71. The Committee has noted that remote sensing techniques have been found to be quite useful, particularly in the area of fisheries forecast, and the



Digitally enhanced satellite data showing different lithological units and structural trends in Cuddapah, A.P.

efforts of both the Department of Ocean Development which sponsored the project in this area (PFZ) and the Department of Space which executed it, have been quite laudatory. The achievements in receiving, processing, disseminating and marketing various satellite data products have by no means been less significant. The Committee, however, feels that in the absence of an indigenous Oceansat the Department of Ocean Development is not able to pursue quite vigorously its objective to diversify the use of remote sensing technology in other marine areas. The Committee has taken note of the fact that both the Department of Ocean Development and Department of Space are seized of the problem, and Oceansat is planned to be put into orbit sometime in 1998-99. This Observation Satellite will cater to the Oceanographic and fisheries applications. Besides, the availability and utilisation of microwave remote sensing data will provide all weather capability. In combination with IRS data, the microwave data would be useful for obtaining information on soil moisture, Kharif crops (as they pose problems for optical data due to cloud cover), snow and other oceanographic applications, etc. The Committee hopes that the Oceansat will be launched as per the schedule and funds will not be a constraint in this endeavour.

Ministry of Mines

72. The Secretary, Ministry of Mines informed the Committee that the Ministry of Mines is having a very close interaction

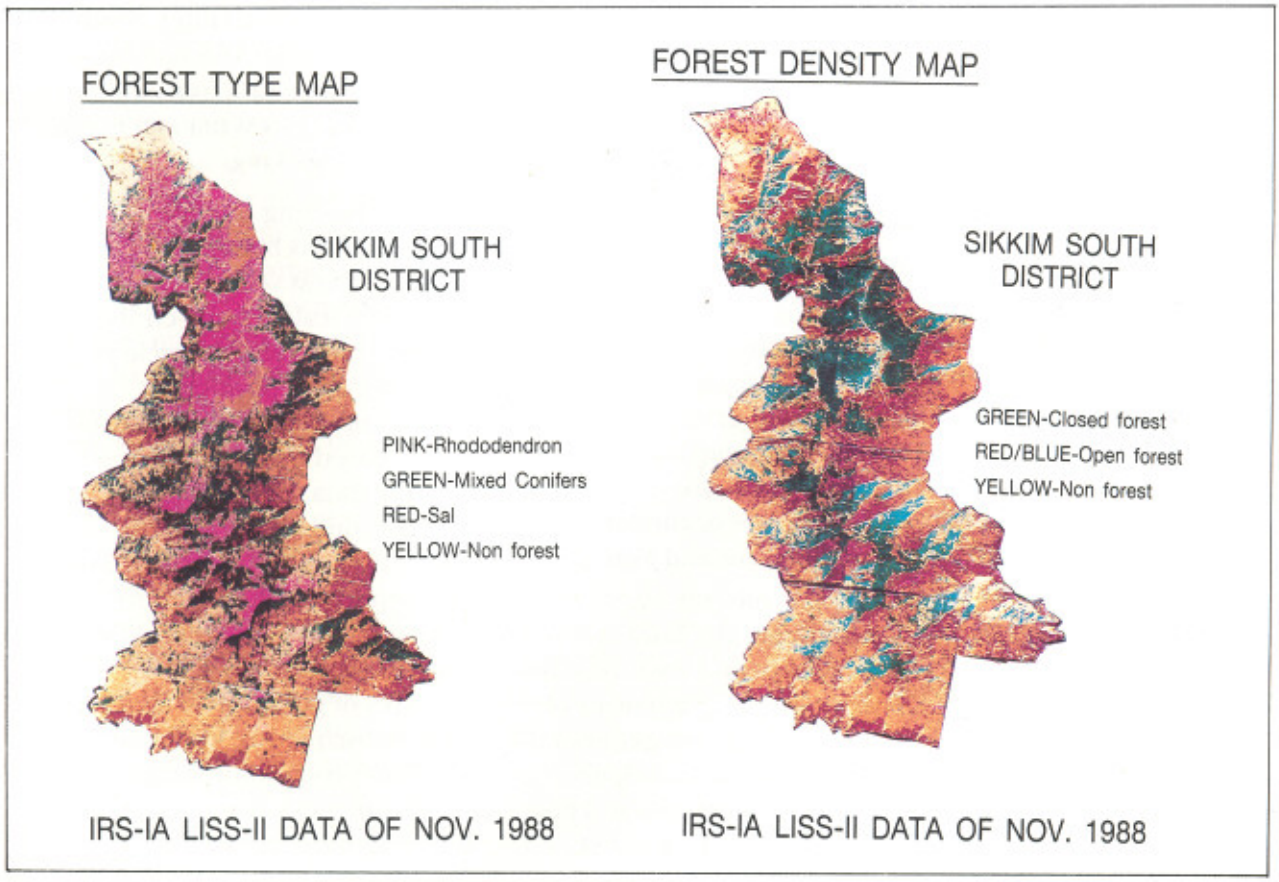
with the Department of Space. There is the National Mineral Resources Management System Standing Committee which is headed by the Secretary, Ministry of Mines, and a large number of user agencies are represented on it. The activities of the Geological Survey of India (GSI), particularly its technical programmes, are supervised by a Board of Management which includes the Secretaries of the Department of Space and the Department of Science and Technology. Geological Survey of India has used space data as a supportive tool for supplementing conventional methods. This has helped in the speeding up of geological mapping and other investigations. Remote sensing is one of the largest and extremely supportive tools for quick geological appraisal of large areas, and particularly for inaccessible, harsh and rough terrains which otherwise would have been difficult to deal with or taken a long time. No direct discovery of mineral deposits is possible through the application of remote sensing data alone, but it can focus attention on certain areas so that geologists can zero in an target areas for detailed ground truth verification.

73. The Geological Survey of India uses the space-borne data as well as air-borne platform data for targetting and exploitation of mineral resources, hydrological studies, geothermal hazard management and even for the environmental factors. Earlier, the preparation of structural maps on a broad regional scale used to take years which now with the help of space-borne data has become a matter of few months. The lineaments map and geological map of India on 1:2 scale have already been prepared by using remote sensing techniques.

74. In 1985-86, GSI took up 'Project Vasundhara', in collaboration with ISRO, for systematic analysis of remotely sensed data in conjunction with collateral geological, geophysical and geo-chemical information.

75. The Committee was also told that the study of earthquakes is a part of the study of earth processes being carried out by GSI. In the case of recent earthquakes in Uttarakashi and Latur, the GSI got a lot of help from the satellite data. Efforts are on to map the elements to identify the lineaments which are active.

76. Attempts are being made to study the existing geological and geophysical data critically, to collect new information, analyse and conceptualise the probabilities of various theories and to undertake relevant thematic indepth studies. Space imagery has been analysed to study the lineament patterns and to establish their significance in relation to crustal movement with the help of available geological and geophysical data.



Seismotectonic studies with geophysical surveys including seismic, gravity, magnetic and resistivity are being carried out by various organisations including GSI to re-assess the seismic stability of Peninsular India.

77. The Committee notes that remote sensing data are of great significance for investigation of mineral resources, and GSI is using such data for its various activities. The Committee hopes that with improvements in resolution and scale in the new IRS-1C and 1D satellites, scheduled to be launched in the year 1994-95, and 1996-97, better quality space data would be available which would help in more accurate investigation of mineral resources.

78. Geophysical studies of the Indian sub-continent is one of the areas which our nation can venture on and succeed; it has great value to society in terms of tectonic activities and its consequences. However, in the absence of our own satellite; GSI is facing difficulties in getting data, particularly for measuring the gravity of water covered area or sea. For such type of data GSI has to depend on the foreign satellite. The Committee impresses upon the Department of Space to look into the matter so that the expertise available in the country can be fully utilised.

79. LANDSAT/IRS satellite imageries having the resolution of 30 to 40 metre enlargeable upto a scale of 1:50,000 are capable of detecting large mining activities with visible surface manifestations. The more recent panchromatic and colour infra-red aerial photos/ air-borne scanner imagery will be quite useful for the purpose. The Committee recommends that attempts should be made to develop the interpretative approaches and determinants of such activities as a test case before its practical utility and applications are certified.

80. Mining of salt and sand in delta areas and river channels, cause problems of drainage congestion. From 1:50,000 scale satellite imagery such areas can be broadly detected; while in the case of larger domains, air-borne scanner/aerial photos will be useful for detailed study. The Committee recommends that the study of environmental impact arising out of such activities be taken up and likely solutions to such problems be found out.

81. The Committee feels that the satellite imageries can be helpful in checking the illegal mining of mineral resources. The satellite imageries of mining activities can be sent to the concerned states for their information and determination as to which mining activity is permitted and which others are not legal. The Committee recommends that the possibility of this sort of use of satellite imagery may be examined further.

Ministry of Environment and Forests

82. The Committee also took up the issue of application of remote sensing data for forest cover mapping, coral reef mapping and environmental impact of mining and discussed the matter with the representatives of the Ministry of Environment and Forests.

83. The Committee was informed that the Ministry of Environment and Forests is one of the major user agencies of remote sensing data generated by the Department of Space through its IRS satellites. The Forest Survey of India (FSI) located at Dehra Dun is engaged in the task of analysing the satellite imageries. Giving details to the Committee about the methodology of management of forestry before introduction of remote sensing techniques, the representatives of the Ministry stated that previously forests in India were being managed by means of working plans, and 80 per cent of the forest area was being covered by those plans. In the past, preparation of one such working plan used to take nearly two years, because each forest had to be visited and it had to be mapped to find the area under forest cover, its density, etc. Today, FSI is using the remote sensing technology for obtaining the information about the forest cover of the country. Now a working plan can be prepared in just about four months instead of two years. The first attempt to assess the forest cover of the country by visual interpretation of satellite imageries was made in 1984-85 when satellite imageries were made available from the US and French satellites. Since the availability of IRS satellites, FSI is utilising data from these satellites for forest management and forest working.

84. FSI, by using satellite imageries, has been preparing maps of forest vegetation on 1:250,000 scale for the entire country on a two year cycle to know accurate position in respect of the land under forest cover. Based on the analysis of satellite data, FSI so far has brought out four reports in 1987, 1989, 1991 and 1993. The first report which related to the period 1982-1987 revealed that the country was losing 47,000 hectares of good forest area per year. Subsequently, under the VII Plan programme, large scale plantation activity was initiated and with more professional forest management the

degradation of forest was checked. The analysis through the subsequent reports brought out in 1989 and 1991 indicated that the process of degradation of forest had not only been checked but there had been slight gain in forest cover. It was found that, on account of conservation measures taken up by the Government, there has been an increase of 28,000 hectares per year in the forest cover of the country. However, as per the latest report which came out in 1993, there has been a fall in the growth of forest cover and the same has gone down to the level of 1100-1200 hectares per year. The Committee was further told that the expenses in terms of cost of preparation of maps of forest cover have gone down substantially. By using the remote sensing technique, the process of preparation of maps costs just 50-80 paise per hectare. Moreover, quick and accurate information is available which helps in drawing the proper strategy for the forest management in the country.

85. To a specific query as to whether plantation done in private sector or is being taken note of, the representative of the Ministry submitted that at present, it is not possible to make difference between legal status of plantation through satellite imageries. It is also not feasible to measure agro-forestry, plantations and forests along roads and canals. However, this would be possible with the help of the data received from the next generation satellites to be launched in near future and the FSI would be able to report on forest activities going on in private sector and along roads and canals.

86. The Committee notes with satisfaction that the Ministry of Environment and Forests has made good use of the remote sensing data in forest cover mapping. The latest report prepared by the FSI using remote sensing data indicates that India has 11.73% of good forest cover of total geographical area of the country. However, as per the mandate of the Forest Policy, there should have been 33% of good forest cover of the total geographical area. The Committee finds that we are still short of this target. It hopes that with the technology of IRS-1C and IRS-1D satellites which will provide better resolution, Ministry of Environment and Forests would be able to keep a close watch on the situation and take necessary steps to increase the total area under good forest cover.

Coral Reef Mapping

87. Coral reef mapping is another area where remote sensing data is used. The representative of the Ministry submitted that in 1988, a project called 'Coastal Environment' was sanctioned, and the coral reef mapping was one of the components of that project. Maps in the scale 1:250,000 were prepared by the Department of Space using the remote sensing technology. With the help of these maps, a firm estimation of the extent of coral reefs in the country was made. Based on the analysis of the remote sensing data about the extent of coral reefs, a scheme has been evolved for conservation of coral reefs which envisages setting up of Marine National Parks and Marine Sanctuaries. The National Committee constituted for the conservation and management of wetlands and mangroves also looks into formulation and implementation of programmes of conservation, management and research on coral reefs.

88. The growth pattern which can determine the sustainable use of coral reefs is very clear from the satellite imageries; and it is very easy to detect the area being destroyed. In reply to a query, the representative of the Ministry told the Committee that the existing IRS-1B satellite can provide imageries of water upto the depth of 50 metre. However, the quality of maps would certainly improve with IRS-1C satellite.

89. The Committee finds that coral reef mapping is another area where the remote sensing technique is being applied and the destruction of coral reefs has been stopped by way of setting up of National Marine Parks and National Marine Sanctuaries. The Committee hopes that with the launching of IRS-1C and 1D satellites, better quality of imageries would be available which would enable the Ministry of Environment and Forests to chalk out a proper strategy for the growth of coral reefs.

Remote Sensing Data and Study of Environmental Impact of Mining

90. There are a variety of scientific studies which are being carried out to examine the impact of different developmental projects, including mining. The studies are carried out by IITs, Regional Engineering Colleges, University of Roorkee and by specialised bodies like the National Environmental Engineering Research Institute of CSIR, etc.

91. The representative of the Ministry told the Committee that remote sensing technique is one of the techniques used

Image processing at Regional Remote Sensing Service Centre, Bangalore

for assessing the environmental impact of the developmental projects as well as of the mining projects. In so far as the Ministry of Environment and Forests is concerned, mining has been an area of special interest because mining activities are on the increase and sometimes there is clash between mining activity and forest development. Studies relating to environmental impact are of great importance because these studies help in arriving at a decision about the fate of developmental projects. For this purpose, the Ministry has a Standing Committee on Bio-resources and Environment, which is chaired by the Secretary of the Ministry, and consists of nine members from user Ministries/Departments. This Commitee submits its report for approval or rejection of a project. The recommendations of the Committee form the basis for the Ministry's decision regarding approval/rejection of a project. Following the Notification of January 27, 1994 amended on May 4, 1994, Environmental Impact Assessment has been made statutory for 29 different activities in various developmental sectors including that of Mines. The Notification also deals with the constitution of an Experts' Committee for environmental assessment of different projects. The environmental viability of a project is assessed not only on the basis of reports of the Experts' Committee and views of user agencies but on the basis of the remote sensing data also. The remote sensing technique provides scientific and relatively error-free quick procedure because the data are scientifically obtained and the element of human error is much less. In this context, the Committee finds that the remote sensing technique has not only supplemented and simplified the studies of environmental impact of mining and other developmental projects, but also that the procedure of project appraisal from the environmental angle has also become more scientific, accurate and faster.

Application of Remote Sensing Data by Voluntary Organisations

92. In order to have an idea as to how remote sensing data are being used by the voluntary organisations, the Committee selected BAIF a non-governmental organisation (NGO) of Pune which was represented by its Executive Vice-President before the Committee. Throwing light on the utility of remote sensing data in the development of land and water resources, the representative of BAIF

submitted that the remote sensing data from their utility point of view, had two aspects. One is the application of planning of specific measures; and second is the monitoring of developmental activities. For example, remote sensing data provides information about the extent of wasteland which has been helpful in planning for the watershed catchment area. The BAIF has used the remote sensing data for the development of water resources in Ahmednagar district of Maharashtra.

93. Another application of remote sensing data in which the BAIF is presently engaged is monitoring of afforestation. 12 years ago, the BAIF started a wasteland development programme in Vansada Taluka of Valsad district in Gujarat. Under the programme, about 6,000 families developed the wasteland where 2 lakh mango trees and 25 lakh forest trees have been planted. Some plantation work has been done in that area by governmental agencies also. In order to have assessment of the growth of the plantations, remote sensing data were used which showed that there has been significant increase in vegetation cover both in forest and non-forest land. This proves that remote sensing data can be a very good monitoring tool.

94. The Committee was further told that the remote sensing data, as available presently, could be used for very broad level planning and estimates. Therefore, these data were useful either to district development authorities or to individual Departments or Ministries for planning and resource allocation at district level or state level or national level. These data could also be used at the monitoring stage of the projects undertaken by the district authorities or Department/Ministry. The Representative of BAIF submitted that when it came to action, it required the application of remote sensing data on a small scale and, therefore, suggested that data should be made available at village level or to a group of villages. The representative of BAIF also submitted that the data should be according to the needs of the users.

95. The representative of the NGO also suggested creation of geographical information centres where the information linked to the end-use of different users be made available, and such centres be created wherever there is demand in order to meet the requirements not only of the planners and monitoring agencies but also of the end-users. These centres can provide data for a particular small area by compiling and collecting various types of information available from different sources viz., Department of Space, Meteorological Centres, revenue offices, etc. Such information can be used by NGOs as well as Government agencies, etc., at village level. He further suggested that for the time being some of the NGOs could function as Geographical Information Centres.

96. The representative of BAIF however, admitted that creating new agencies to provide inputs for planning and monitoring of developmental activities in rural area might add to the bureaucracy which would not help in the long run; and it would be better to identify the existing agency or modify the existing mechanism which would provide the necessary information to the planning authorities for development and planning at village level.

97. The Committee notes that the data generated through remote sensing techniques have multitudinous applications in various fields and the data can be utilized as an effective and scientific tool for better planning and monitoring of developmental activities in the rural areas. The Committee is happy to note that BAIF has used the remote sensing technique as useful monitoring tool. The Commitee, however, observes that the full potential of the remote sensing data for the development of water resources and has applied the remote sensing technique as useful monitoring tool. The committee, however, observes that the full potential of the remote sensing data has not been exploited and its benefits have not reached the grassroot level. Presently, the remote sensing data are being utilised for formulating plans for larger areas covering some districts. Such data cannot be utilised for village level planning. The Committee was told by the Secretary, Department of Space that there was a proposal for launching the IRS-1C and 1D satellites and these satellites, with improved capabilities would greatly enhance the applications of remote sensing data in the rural areas as well.

98. The Committee feels that, at present, mechanisms are not fully geared up to make optimal use of remote sensing technique, as there exist no well equipped agencies which can provide relevant data including remote sensing data necessary for specific purposes. The Committee is not in favour of creating a new agency like Geographical Information Centre as suggested by the representative of BAIF. However, it recommends that necessary infrastructure should

be developed in one of the existing government agencies which can function as Geographical Information Centre and compile, correlate and coordinate remote sensing data and other data received from various sources and transfer the same to the NGOs and other Governmental bodies engaged in the developmental work. There is a necessity of creating awareness about the application of remote sensing technique among the NGOs working in the rural area to ensure their greater participation in the use of data generated through remote sensing techniques.

CONCLUSIONS

The Indian Space Research Organisation has, over the past quarter of a century, developed the area of remote sensing in a systematic manner; from the early air-borne experiments on coconut wilt disease in Kerala to the first two experimental remote sensing satellites Bhaskara-I and II and now the current range of highly successful operational IRS series. India presently has capabilities to design and build remote sensing satellites and associated detector systems, which are contemporary with developments elsewhere in the world. ISRO also now has the ability to launch satellites of the IRS class on its PSLV system. In addition to accomplishing successfully these developments relating to hardware, including ground stations, facilities for handling and analysing remote sensing data etc., all of which rightfully fall within ISRO's jurisdiction, ISRO has, for more than a decade, concerned itself with the effective use of remote sensed data in various areas of national development. It took the initiative in setting up the National Natural Resources Management System (NNRMS). This enabled linkages to be established with various user Departments and agencies, particularly in the Central Government. Specific, important and relevant areas were selected for application of remote sensed data. The Committee has in its deliberations, been given many examples of important and successful applications (ground water targetting, wasteland development, snow-melt, survey maps, etc.) since this programme started. In other areas, the Committee was informed that, based on the experience gained, specific demands have been placed on ISRO in terms of the imagery need eg., higher spatial resolution, measurement of various ocean parameters etc. Some of these will be fulfilled through programmes that ISRO is planning for the rest of this decade, including IRS-1C and 1D, and Oceansat. Also, new analytical techniques are being developed by ISRO to deal with the specific Indian situation of heterogenous agricultural production where more than one crop is taken out by a farmer in a small area. ISRO has also been implementing major activities for training in remote sensing and photo-interpretation techniques of large numbers of personnel from various user organisations in the Central, State and non-governmental sectors. It has set up National, Regional and State Remote Sensing Centres. Overall, the programme relating to remote sensing has been well thought out, and been implemented on a steady long term basis, so as to derive optimal advantage for our country from this hi-tech area. In many ways it is a unique programme in the world. The Committee would like to place on record its appreciation for the efforts of the Department of Space in this matter. □

Antrix Corporation and EOSAT Co., USA, Sign Ten-year Contract for Space Cooperation

Antrix Corporation Limited of India's Department of Space and EOSAT Co, USA, signed an agreement in San Francisco, California, on February 2, 1995 which provides for the commercial distribution of data generated by Indian Remote Sensing Satellites (IRS). The constellation of ten IRS satellites to be launched over the next ten years will make India a world leader in providing earth observations.

Dr Arturo Silvestrini (left) and Dr K Kasturirangan exchanging the documents.

On signing the agreement, Dr K Kasturirangan, Chairman of both Antrix and ISRO, said that India's remote sensing programme differs from those of other Countries, in that, besides supporting national efforts to achieve sustainable development, the programme also caters to commercial needs. India's long-term commitment to the programme also assures the users of uninterrupted supply of high quality earth observation data. Dr Arturo Silvestrini, President and CEO of EOSAT, stated that the Antrix-EOSAT partnership brings together the world's largest commercially-oriented earth monitoring programme and the world's most extensive commercial data distribution network. The earth observation data, made available through this partnership, is likely to generate, in excess of one billion dollars in commercial revenues for the world-wide remote sensing industry over the period of the contract.

Under the agreement, EOSAT Co, is the exclusive marketing agent world-wide for earth observation data generated by the IRS satellites, two of which (IRS-1B and IRS-P2) are already in operation. The data is sold commercially through EOSAT's international distribution network. The information from the IRS satellites is used for natural resource applications such as geology, forest mapping, environmental planning, crop monitoring and regional planning.

EOSAT's ground station at Norman, Oklahoma, is the first to receive IRS data outside India. EOSAT has been collecting the data from IRS-1B since June 1994 and from IRS-P2 since March 1995. EOSAT is also planning to strengthen their ground station.

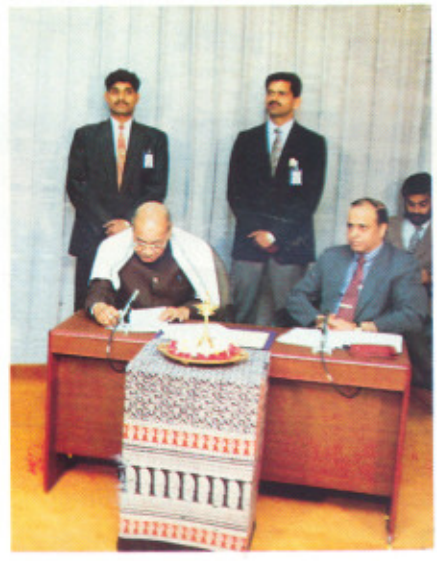
IRS-1C and IRS-1D, to be launched in the 1995 and 1997 respectively, will have spectral coverage in the short-wave infra-red region, stereo-viewing capability, on-board data recording facility, a panchromatic band with at least 10 metre resolution and a new Wide Field Sensor (WIFS). Besides, the IRS-P series of satellites, to be launched by India's Polar Satellite Launch Vehicle (PSLV), will have payloads specifically designed to carry out earth observations with emphasis on cartographic, oceanographic, and environmental applications. □

INSAT

Channel for Training and Development Communicatior Dedicated to Nation

The Prime Minister, Mr P V Narasimha Rao dedicated a channel on INSAT for Training and Development Communications to the Nation on February 23, 1995. In a unique function, the Prime Minister addressed from New Delhi the participants located at 19 district headquarters of Karnataka State, who were attending a satellite-based interactive training course. Mr H D Deve Gowda, Chief Minister of Karnataka was present at the studio set up at the earth station of the Department of Telecommunications (DOT) in Bangalore, which was the teaching end of the training course.

Dr K Kasturirangan, Chairman, Indian Space Research Organisation (ISRO) who was with the Prime Minister, explained the features of the INSAT channel. Speaking from Bangalore, the Chief Minister of Karnataka lauded the efforts of ISRO and said that Karnataka will fully exploit the channel for development education. A trainee, speaking over telephone from Dharwad in Karnataka expressed his views on the effectiveness of the system.

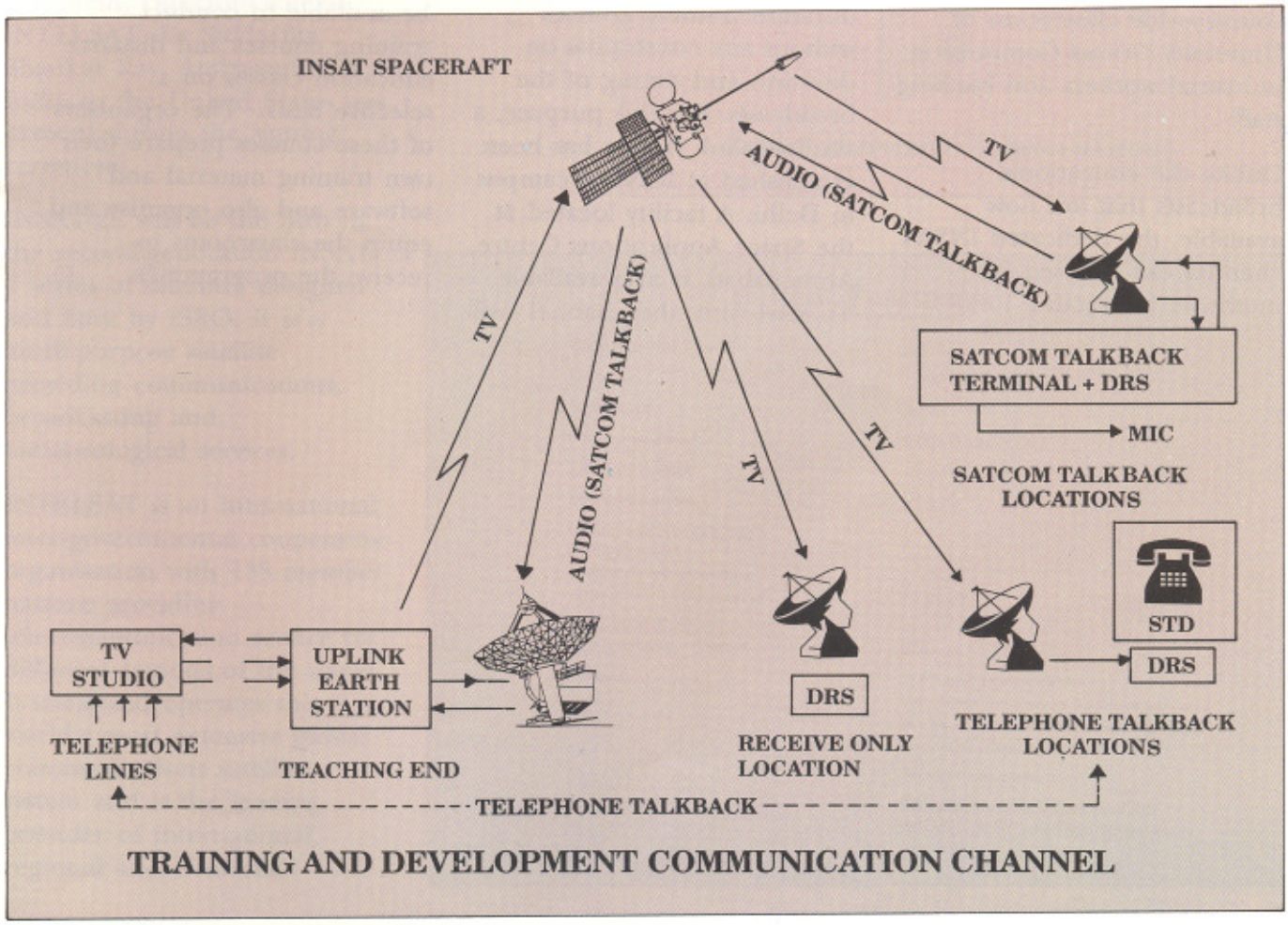


Mr P.V Narasimha Rao, Prime Minister delivering his address from New Delhi. Dr K Kasturirangan, Chairman, ISRO is seated on the right

The Prime Minister, pointed out the need for innovative approaches to training and development communications. He said that the INSAT channel will make it possible for the various sections of professionals, industrial workers, farmers and functionaries to interact with each other and with the best of the resource persons and teachers. He expressed the hope that a large number of institutions and government and non-government agencies dealing in developmental activities will come forward to use the facility.

It may be recalled that, over the past few years, ISRO has been carrying out several experiments designed to expand the scope of distant education, development communications and training employing the INSAT system. The objective is to simulate a class room condition by facilitating interaction between the teachers and the trainees. The lessons are received over television through small dish antennae and the questions are passed on over telephone lines which are looped back to be heard in all the class rooms. This interaction in real-time considerably enhances the quality of training as the participants can access the best available resource persons. In these experiments, a wide cross section of professionals, functionaries, trainers and students participated. These included functionaries associated with adult education and watershed development in Gujarat, agriculture extension workers and farmers in Haryana, engineering students of Institution of Electronics and Telecommunications, students of All India Management Association, counsellors and students of Indira Gandhi National Open University (IGNOU), viewers of the

Mr H D Devegowda, Chief Minister of Karnataka speaking from the Bangalore end. Mr K Narayanan, Programme Director, INSAT is on the right,



Interactive Training of Rural Development Functionaries - Pilot Project Conducted in Karnataka

The Government of Karnataka, in collaboration with ISRO, conducted a Pilot Project during February 15-18, 1995 for training Development Functionaries located in the far-flung rural areas of Karnataka using interactive satellite broadcasting network. The project was conducted in three areas - training of elected Gram Panchayat Women Members, training of village health workers and, training of progressive farmers and implementing functionaries of Watershed Development Programme.

A conference between policy planning officials and field level functionaries was also arranged using one-way video and two-way-audio teleconferencing Network. The problems related to the implementation, organisation and management of development programmes in the field level situation were discussed.

The training programme was conducted from a studio at the satellite earth station of Department of Telecommunication located in Bangalore. The studio was uplinked to INSAT-2B satellite and received by TV sets located at the District Training Institutes in all the 19 Districts of Karnataka. The participants used telephones for seeking clarifications from the resource persons. The questions were heard by all participants. About 30 participants from each of the 19 District Training Institutes attended the programmes.

country-wide classrooms of University Grants Commission, industrial workers and banking staff.

Unlike the educational broadcasts that are now available, the dedicated INSAT channel can be used for intensive, interactive, long-duration training courses without any constraints on duration and timing of the broadcasts. For this purpose, a studio-uplink facility has been established at IGNOU campus in Delhi. A facility located at the Space Applications Centre, Ahmedabad, is also available. To start with, the channel will be available to conduct training courses and distance education classes on a selective basis. The organisers of these courses prepare their own training material and software and also organise and equip the classrooms to receive the programmes. □

INSAT Transponders to be Leased to INTELSAT

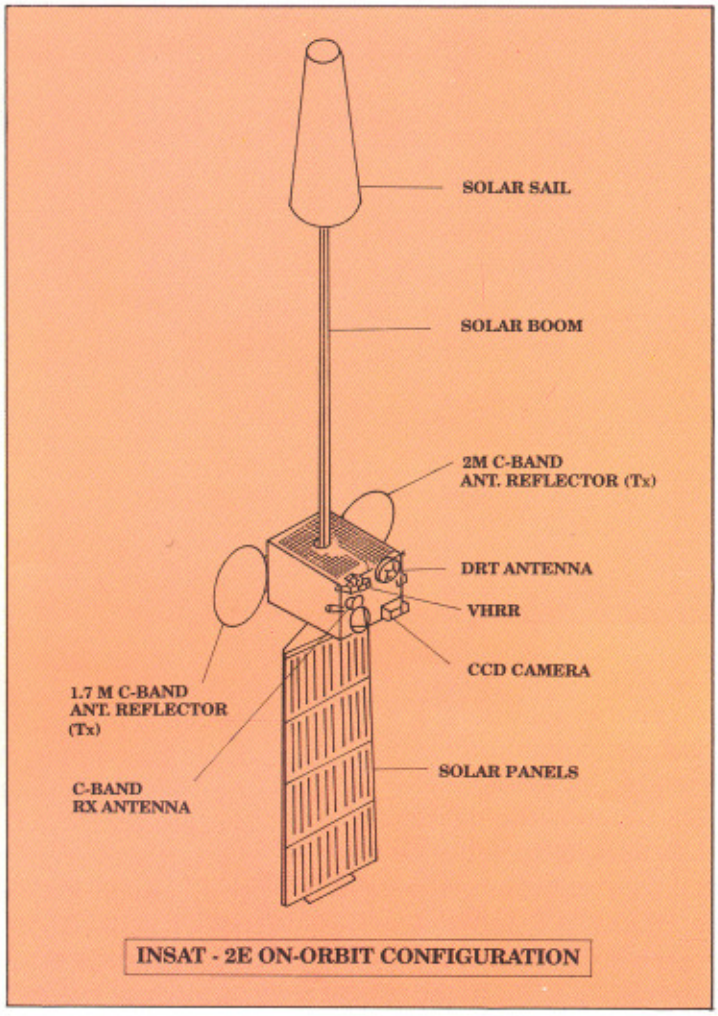
The Department of Space (DOS), has entered into an agreement with the International Telecommunications Satellite Organisation (INTELSAT) on leasing 11 transponders of 36 MHz equivalent capacity on India's INSAT-2E, planned for launch during 1997-98.

Under the terms of this long term agreement, INTELSAT will pay approximately US $ 100 million over a period of ten years.

The agreement was signed at INTELSAT Headquarters, Washington, on January 30, 1995, by Dr K Kasturirangan, Secretary, Department of Space, and Mr Irving Goldstein, Director-General, INTELSAT. Dr Siddartha Shankar Ray, Ambassador of India to the United States was present during the signing ceremony.

INSAT-2E will be the fifth in the second-generation INSAT-2 series of satellites designed and built by ISRO. It is a multi-purpose satellite providing communications, broadcasting and meteorological services.

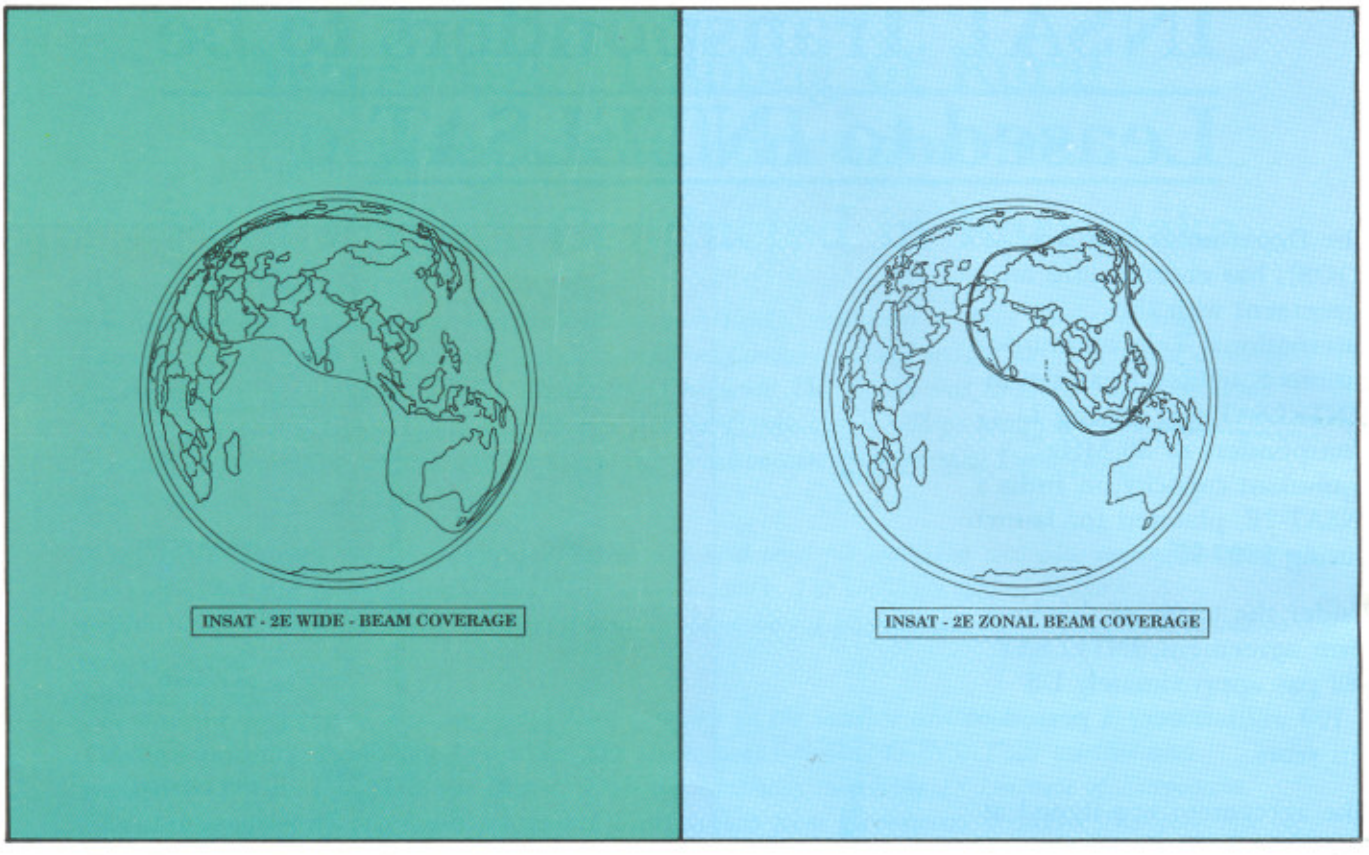
INTELSAT is an international inter-governmental cooperative organisation with 133 member nations providing telecommunication service for different regions of the world. It owns and operates the world's most extensive global communications satellite system and is the leading provider of international, regional and domestic



INSAT - 2E ON-ORBIT CONFIGURATION

Salient Features

Total mass (at lift-off)	:	2,500 kg
Dry mass	:	1,100 kg
Stabilisation	:	3 axis
On-board power	:	2,000 Watts (EOL)
Life (norminal)	:	12 to 14 years
Orbital location	:	83° east
Dimensions (in deployed configuration)		
North-South direction (tip of sail to tip of array)	:	27 metre
East-West direction (east to west reflector)	:	6 metre
Payload	:	17 C-band transponders Very High Resolution Radiometer (in Visible, Infra-red bands and with water-vapour channel) 3-band CCD camera 402 MHz Data Relay transponder 406 MHz Search and Rescue payload



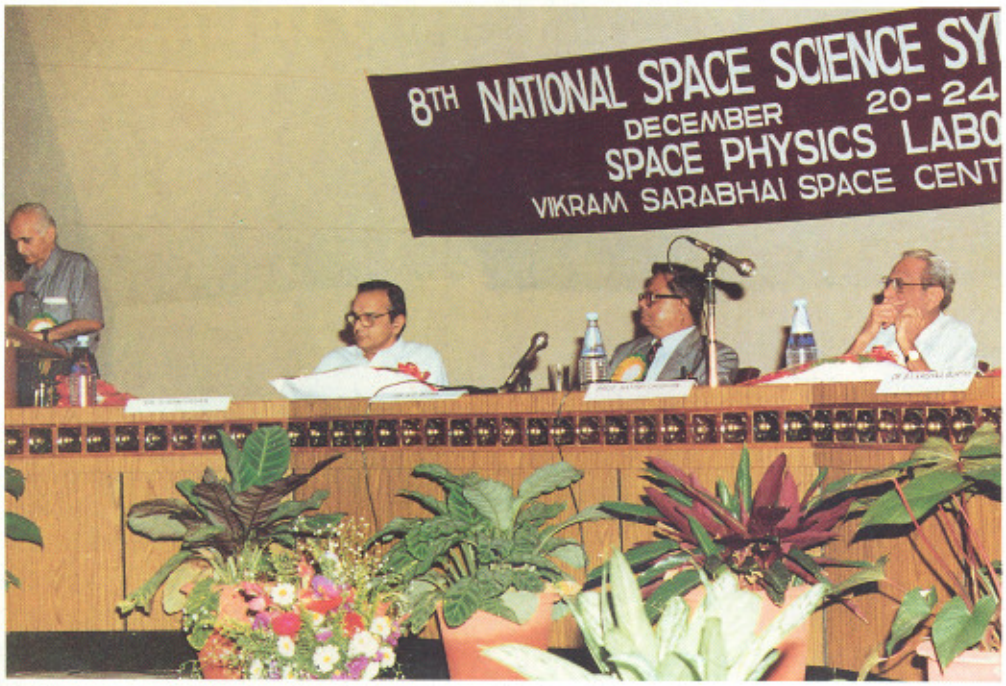
INSAT - 2E WIDE - BEAM COVERAGE

INSAT - 2E ZONAL BEAM COVERAGE

telephone, television and business communications services, including video-teleconferencing, facsimile, data and telex. India also holds a share of 2.1 per cent in INTELSAT and is a member of the Board of Governors; India is represented on the Board by the Videsh Sanchar Nigam Limited (VSNL).

INSAT is one of the largest domestic satellite systems in the Indian Ocean region comprising INSAT-1D, INSAT-2A and INSAT-2B at present. The launch of INSAT-2C and INSAT-2D in 1995 and 1996, respectively, will significantly add to the INSAT capacity. With the lease of transponders to INTELSAT, INSAT will play a significant role in the fast-changing satellite communication scenario in the Asia-Pacific region. This is the first time that INTELSAT is leasing the services of another satellite outside its own fleet. □

8th National Space Science Symposium Held at Thiruvananthapuram



At the inaugural function - Dr B V Krishna Murthy, Director, Space Physics Laboratory proposing vote of thanks. Seated (from left to right) are Dr Srinivasan, Director, VSSC, Dr A P Mitra, Chairman, ADCOS and Prof S Dhawan, Member, Space Commission

The Eighth National Space Science Symposium, held at Thiruvananthapuram during December 20-24, 1994, was inaugurated by Prof S Dhawan, Member, Space Commission. Dr A P Mitra, Chairman, Advisory Committee for Space Sciences (ADCOS), who presided over the function, dwelt upon the various experimental facilities available now to the space scientists in India.
Dr S Srinivasan, Director, Vikram Sarabhai Space Centre (VSSC), welcomed the delegates and Dr B V Krishna Murthy, Director, Space Physics Laboratory (SPL), Thirivananthapuram, proposed the vote of thanks.

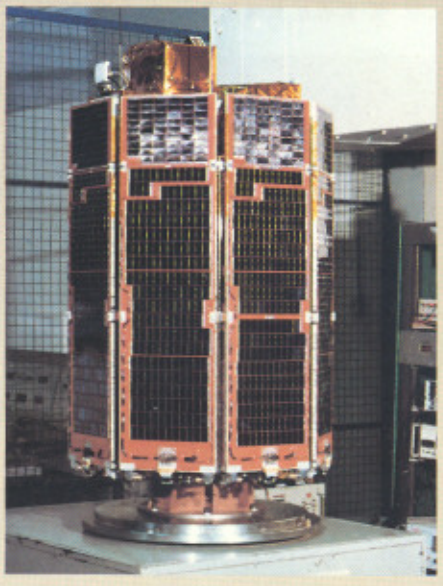
In his message, Dr K Kasturirangan, Chairman, ISRO, said that 1994 being the 75th birth anniversary of Dr Vikram Sarabhai, the Father of Indian space programme, Thiruvananthapuram is the most appropriate venue for holding the National Space Science Symposium, as it is from here that India entered the space era when the first two-stage sounding rocket took-off from the Thumba Equatorial Rocket Launching Station (TERLS) more than three decades ago.

These technical symposia serve as the main fora in which space scientists from the universities, research institutions and national laboratories, present their work, discuss the result and formulate plans for the future.

With the establishment of a range of modern facilities, space science research in India is poised for a great leap forward. For example, the National Mesosphere-Stratosphere-Troposphere Radar Facility, at Tirupati is a new and powerful tool in the hands of researchers studying winds. Similarly some excellent lunar occultation observations have already been made at the recently established infra-red telescope at Gurushikar. The two satellites, SROSS-C and SROSS-C2, launched in 1992 and 1994, with the Retarding Potential Analyser (RPA) and Gamma-ray Burst Detector (GRB), on board, have provided high quality observational data. Interesting results have been obtained on the ion composition of the low latitude exosphere. Several gamma-ray bursts have been observed, which coincide with those made by ULYSSES and BATSE. The Indian remote

SROSS-C2 Satellite Completes One Year in Orbit – Detects Interesting Gamma-ray Bursts

The SROSS-C2 satellite, launched by India's Augmented Satellite Launch Vehicle (ASLV) on May 4, 1994, has detected some interesting Gamma-ray bursts during its one year of successful operation in orbit. The satellite is functioning satisfactorily and, so far, it has detected 12 Gamma-ray bursts with potential celestial origin in the energy range 20 keV to 3,000 keV during its 5,500 revolutions around the earth. Ten of the bursts recorded by SROSS-C2 have also been detected by other satellites and, therefore, testify to be of cosmic origin.



SROSS-C2 satellite carries, on board, two scientific payloads, namely, Gamma-ray burst (GRB) detector and Retarding Potential Analyser (RPA). The GRB payload, designed and developed at the ISRO Satellite Centre (ISAC), Bangalore, is meant for detecting celestial Gamma-ray bursts. The RPA payload, designed by National Physical Laboratory (NPL), New Delhi, makes in-situ measurements of parameters like density and temperature of ionospheric electrons and ions in the earth's ionised part of the upper atmosphere.

The RPA has so far collected 600 sets of ionospheric data over the Indian sub-continent. It has been able to clearly distinguish densities of ionic constituents like O^+, H^+ and He^+. The variations of electron and ion temperatures from 0° latitude to 30° latitude have been mapped. An interesting observation has been that the electron temperature, the ion temperature and the neutral temperature although remain the same in winter nights do not seem to be so in summer nights. The electron temperatures appear to be higher than the ion and neutral temperatures by about 50° K.

The orbit of SROSS-C2 which initially had an apogee of about 930 km and a perigee of about 430 km was subsequently trimmed to an apogee of 630 km and a perigee of 430 km using the Reaction Control System on board. The satellite is expected to last for at least four years.

sensing satellite, IRS-P3, soon to be launched by India's launch vehicle, PSLV-D3, will carry an X-ray astronomy payload thus, providing new tool for the scientists.

There are a number of projects such as the Giant Metre-wave Radio Telescope (GMRT), Indo-Soviet Gamma-Ray Satellite Experiment (GRISP), etc, which are in advanced stages of completion. The Indian Solar Terrestrial Energy Programme (I-STEP) proposal has been recommended by ADCOS to be taken up as an inter-agency project. Another important achievement in the atmospheric studies is the development of balloon-borne cryosampler and Lidar instruments for measuring minor constituents and aerosols in the atmosphere. These measurements will be of help in studying the climate variability and global environmental problems.

The symposium in Thiruvanathapuram included a session on SROSS-C satellite experiments during which results of the ionospheric experiments were discussed. A special session on 'Progress in Space Science Research in India' was organised by Prof U R Rao, Dr Vikram Sarabhai Distinguished Professor to commemorate the 75th Brith Anniversary of Dr Vikram Sarabhai. The session was conducted in two parts chaired by Prof J E Blamont of French Space Agency (CNES) and Dr A P Mitra (Chairman of Advisory Committee for Space Sciences), respectively. □

National Conference on Air-Breathing Engines and Aerospace Propulsion

Dr. S.C. Gupta delivering the inaugural address. Also seen on the dais are (left to right): Dr. S. Srinivasan, Director, VSSC, Shri Arun Prasad, Chairman, NCABE, Dr. R.C. Mishra, Additional Director, GTRE, Shri Rajaram Nagappa, Dy. Director (VSSC)

The Second National Conference on Air-Breathing Engines and Aerospace Propulsion, was organised at Vikram Sarabhai Space Centre, Thiruvananthapuram, from December 15 to 17, 1994. The three-day event was sponsored by ISRO, National Laboratories, academic institutes and industry. Delegates from Europe, Japan and USA also participated in the proceedings.

Dr S Srinivasan, Director, VSSC, welcomed the delegates. Delivering the inaugural address, Dr S C Gupta (The Dr Brahm Prakash Distinguished Professor of ISRO) traced the chronological evolution of the Indian aerospace activity, from a modest aircraft factory started by Seth Walchand Hirachand, to the present status in the fields of sophisticated aircraft, satellite launch vehicles, missiles and allied systems. Dr Gupta said that R&D establishments have the capability to design, develop and manufacture power plants for aerospace application. The development of engine to power the indigenous aircraft at Gas Turbine Research Establishment (GTRE) and National Aerospace Laboratories (NAL) and satellite launch vehicles at ISRO clearly show that India has expertise in all the fields of immediate relevance to air-breathing: materials, propulsion, computational fluid dynamics, etc,

Dr R C Mishra, Additional Director, GTRE, delivering the keynote address, quoted specific examples of the design and development of many sophisticated aerospace systems in the country.

Dr K Kasturirangan, Chairman, ISRO, in his message to the Conference said that the participation by premier institutions like Hindustan Aeronautics Limited, Gas Turbine Research Establishment, Defence Research and Development Organisation, National Aerospace Laboratories, Aeronautical Development Establishment and Indian Institute of Science, is significant. He said that the current challenge is to maintain the lead these institutions have established; this, in turn, requires constant efforts in advanced R&D, intense interaction amongst specialists and a vision for the future. He observed that the need of the hour is to reduce the cost of transportation of cargo to orbit and that we need to look at the strengths of the various organisations in the country and set national goals, the attainment of which should enable India to participate in the international projects as an equal partner.

Dr Srinivasan, Director, Vikram Sarabhai Space Centre, released the proceedings of the conference and Shri Rajaram Nagappa, Deputy Director, VSSC, proposed the vote of thanks. □

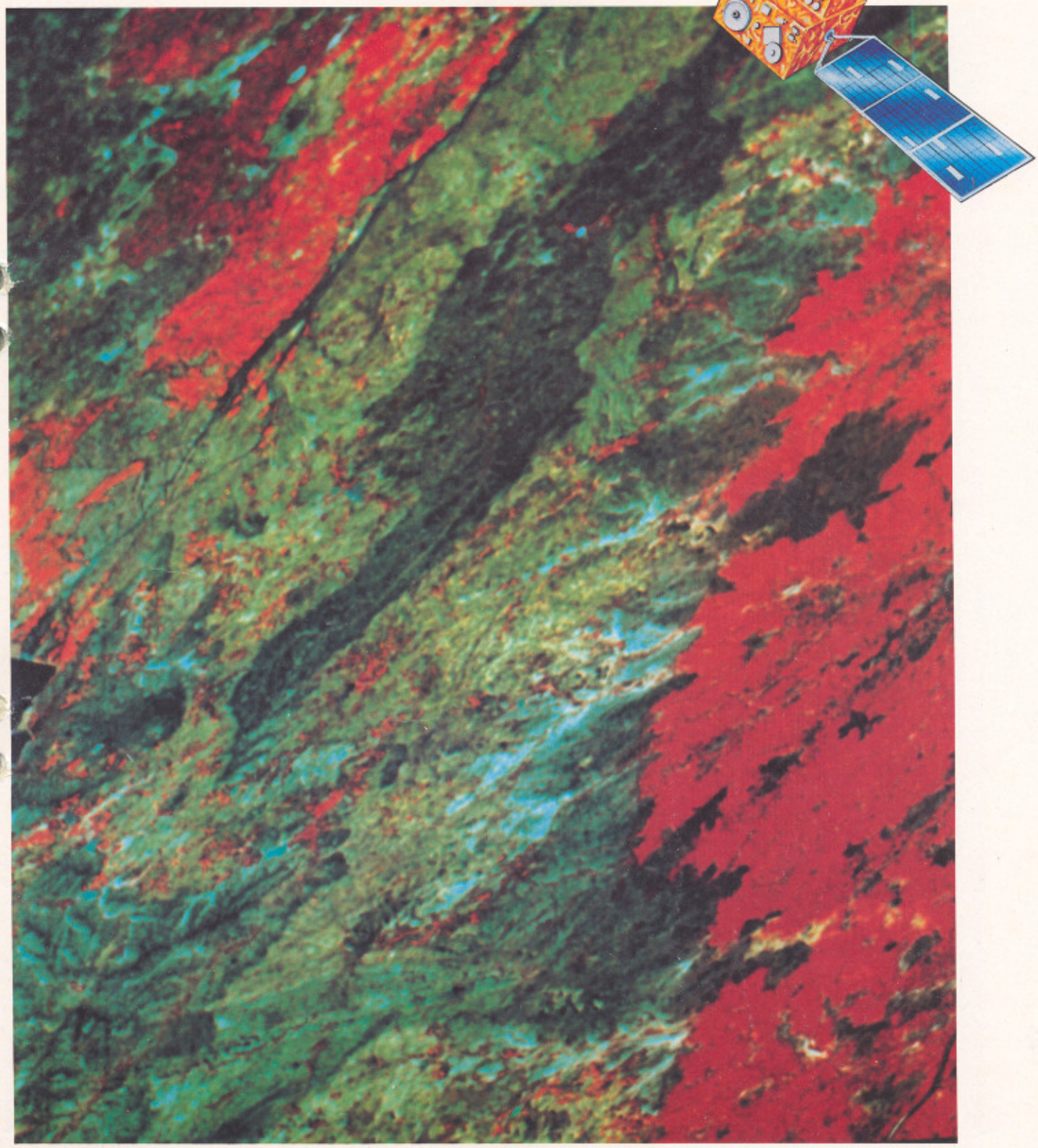
Dr James Dodge (middle) Leader of the NASA delegation and Dr P Krishna Rao, Leader of the NOAA delegation signing the Statement of Intent for co-operation. Dr K Kastururangan, Chairman, Space Commission, looks on

NASA Team Visits ISRO Centres

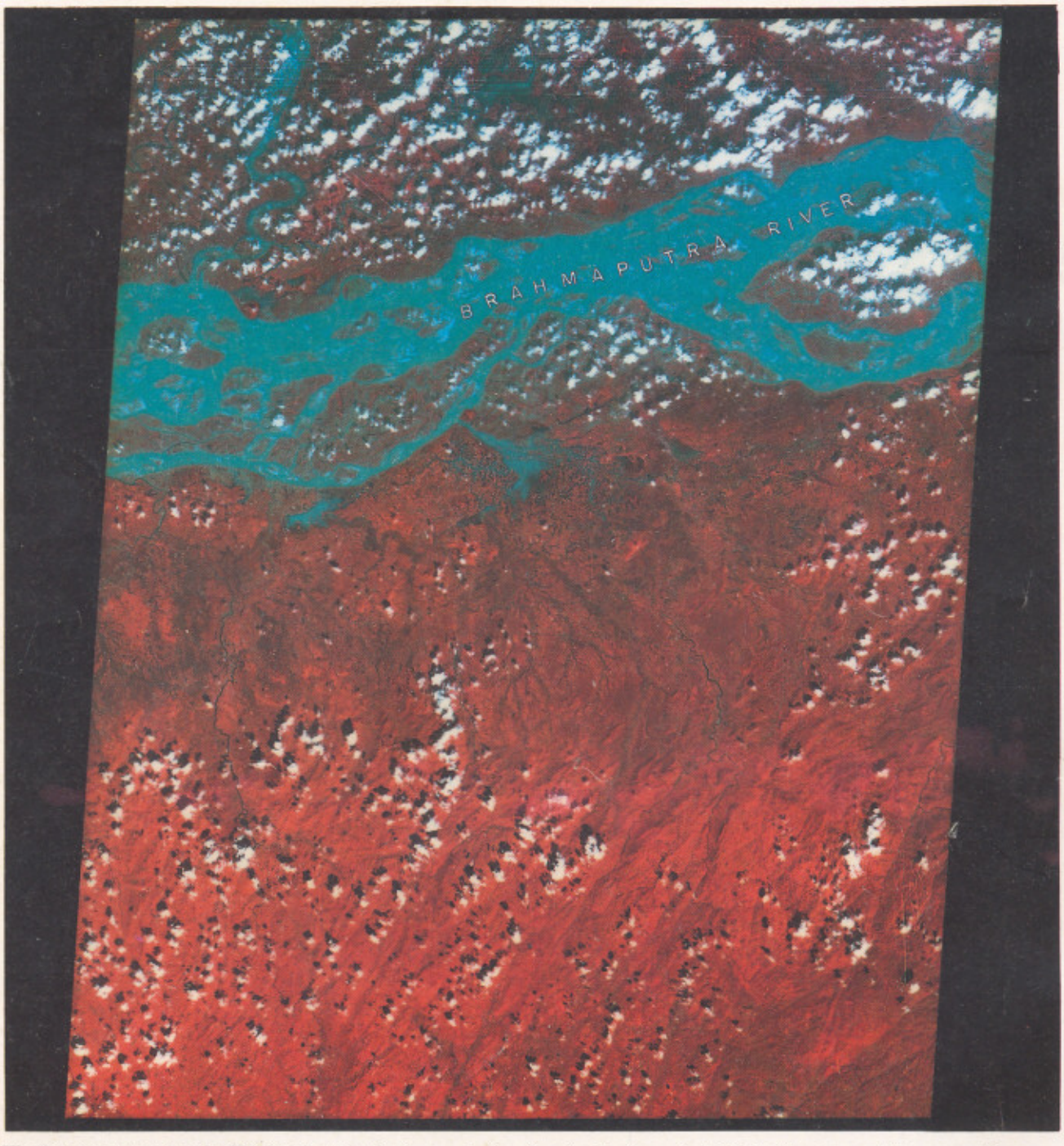
A six member joint team from the National Aeronautics and Space Administration (NASA) and National Oceanic Atmospheric Administration (NOAA) of USA visited the Space Applications Centre, Ahmedabad, and ISRO Satellite Centre, Bangalore, during May 22-25, 1995 and held discussions with the officials of the Department of Space (DOS), Department of Science and Technology (DST) and India Meteorological Department (IMD) at New Delhi and Bangalore on possible cooperation among DOS, DST/IMD, NASA and NOAA in the areas of earth observation and meteorology including exchange of data. The team's visit was a sequel to the invitation extended by Dr K Kasturirangan, Chairman of India's Space Commission during his meeting with Mr Daniel S Goldin, Administrator, NASA, in February 1995.

It may be recalled that there has been important cooperative programmes between Indian Space Programme and NASA. These include the conduct of Satellite Instructional Television Experiment (SITE) during 1975-76 using the Application Technology Satellite (ATS-6) of NASA and the setting up of the LANDSAT data reception station at Hyderabad in 1975.

The present visit of the NASA/ NOAA team is expected to further increase the cooperation in space between USA and India; the first step towards this will be in the areas of weather and climate studies using satellite data and numerical models in both countries and data exchange, especially those related to global change analysis and spatial data from microwave remote sensing satellites. Joint experiments under the Geosphere-Biosphere Programme are also envisaged. Establishment of communication links for exchange of data has also been discussed. The cooperation will be further expanded to take up other areas in future. □



IRS-1A satellite (inset) which was designed for 3 years life, completed 7 years of operations on March 17, 1995. The above imagery was taken by IRS-1A on March 9, 1995 over the northern parts of Karnataka State in Southern India. With the IRS-1B and IRS-P2 meeting adequately the requirements of remote sensing data, IRS-1A will now be used only when more frequent data (near real-time) is required such as for flood monitoring.



The first imagery taken by IRS-P2 showing the Brahmaputra river in the Kamrup district of Assam and its surroundings