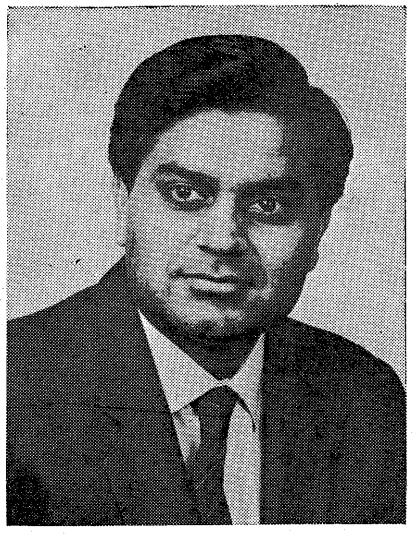


SATISH KUMAR MODI
President

"Born on 19th October, 1946, Graduate in Electronic Engineering from BIT. At this young age he has headed many leading associations and industries, namely Indian Cotton Mills Federation, Northern India Textile Research Association and All India Carpet Manufacturers Association. He holds prestigious positions in many public sector institutions, federations and organisations as well as in the private sector companies. He is also a member of National bodies like Indian National Committee of International Chamber of Commerce."

GUJARMAL MODI MEMORIAL LECTURES

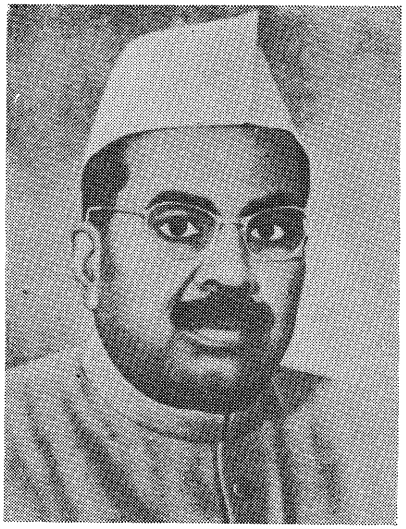
1989

SPACE TECHNOLOGY IN SUPPORT OF THE MANAGEMENT OF THE NATURAL RESOURCES OF JAMMU & KASHMIR AND USING SCIENCE FOR DEVELOPMENT A POSSIBLE APPROACH FOR HIMACHAL PRADESH

by

PROF. SATISH DHAWAN

G.M. MODI SCIENCE FOUNDATION
MEZZANINE FLOOR, HEMKUNT TOWER
98, NEHRU PLACE, NEW DELHI-110 019



Shri Gujar Mal Modi (1902-1976) founder of the Modi Science Foundation was a pioneering industrialist, a far sighted businessman and an ardent supporter of education and research.

The citation for the Padmabhushan awarded to him in 1968 read.

"Shri Gujar Mal Modi, the moving spirit behind the large industrial complex of Modinagar, is the founder of the industrial township of Modinagar. It is due to his vision, foresight and drive that this township with more than a score of factories has emerged out of the wilderness of Begmabad.

Shri Modi made substantial contribution in rehabilitating displaced persons by constructing Govindpuri Colony, consisting of 5,000 houses and 25 small scale industries. All those persons who were rehabilitated in Modinagar were given employment elther in Modi enterprises or in small scale industries built in this colony.

For the benefit of the workers at Modinagar and people of neighbouring villages, he has established a fulfledged post-graduate college, two intermediate colleges, one junior high school, one women's trainlng college and a chain of primary schools which are providing education to about eight thousand students. He has also established a number of charitable trusts and has constructed Dharamshalas at various centres of pilgrimage. Shri Modi has rendered immense service in providing sacial welfare with the zeal of an industrialist."

A distinguished functionary of numerous professional organisatlons and institutions of higher education, Shri Gujar Mal Modi was President af the Federation of Indian Chambers of Commerce and Industry 1968-69.

FOREWARD

The Gujar Mal Modi Science Foundation was founded in 1974 by the late Rai Bahadur Gujar Mal Modi who, apart from setting up various industries, also perceived the need to develop indigenous scientific knowledge and propogate a scientific temper for the long term benefits to the country. Motivated by this philosophy, this Science Foundation has been conducting research in various fields particularly cotton breeding with a view to once again placing India as a leader in world markets.

To further the dissemination of scientifjc knowledge and its applicatlon in the development efforts of the nation the Foundation has been presenting an Annual Award to an outstanding Indian Scientist for his innovative research work. The awardee is required to deliver lectures to audiences including, among others planners, scientists etc. The first awardee was the noted Space Scientist, Prof. Satish Dhawan. He delivered two lectures—one each at Srinagar (J&K) and Shimla. The theme of these lectures was 'Space Technology in Support of the Management of the Natural Resources of Jammu and Kashmir' and 'Using Science for development: A possible approach for Himachal Pradesh' respectively.

Since the lectures were very well received, the Foundation has compiled them for wider circulatiun. It gives me great pleasure to release this booklet.

(S.K. Modi)
President

Space Technology in Support of the Management of the Natural Resources of Jammu & Kashmir

G.M. Modi Award Lecture

By
S. DHAWAN

SYNOPSIS

Among the essential elements of the development process are the timely knowledge of the natural renewable and non-renewable resources. Indian orbiting satellites are in a unique position to provide regular and accurate information of the natural resources of the whole country as well as each state. The lecture illustrates how through assessment of the mineral and forest resources. location of ground water, extent of snow cover, flood forecasting, environmental monitoring and urban planning, etc., the the development of Jammu and Kashmir can be significantly advanced by active use of remote sensing technology.

Dr. Satish Dhawan's deep involvement in the field of science began well over thirty-five years ago. After a brilliant academic career,during which he obtained degrees in various disciplines such as Mathematics, Mechanical and Aeronautical Engineering and Ph. Ds in Aeronautics and Mathematics, he joined the academic profession as Professor at the Indian Institute of Science, of which in 1963 he was designated as a Direcfor. With his professional achievements and scholarly qualities of leadership, imaginative approach and spirit of innovation, the Indian Institute of Science emerged under his guidance as a uniqne centre par excellence in instruction and research for science and technology with a strong interface with industry and the community. constantly reviewing its goals and objectives, exploring new horizons and taking up new challenges.

While Dr. Dhawan was totally absorbed in the growth and development of the Indian Institute of Science, he was also holding responsible positions in several other Committees and Commissions whose findings and recommendations have profoundly influenced the science and technology policy in India. To name only a few, he headed the Indian Space Commission, worked as Secretary, Government of India, Department of Space, Member, University Grants Commission, Member, Science Advisory Committee to the Cabinet, Member, Atomic Energy Commission, Member, Electronics Commission, Member, National Committee on Science and Technology, Member, Defence Research and Development Council, Chairman INSAT Co-ordination Committee and many other honourable and important positions.

Use of Space Technology for Management of the Natural Resources of Jammu and Kashmir

G.M. MODI AWARD LECTURE

S. DHAWAN

April 29, 1989

Dr. Farooq Abdullah
Shri S.K. Modi
Dr. O.N. Kaul
Col. Nagrani
Distinguished invitees, Ladies & Gentlemen,

I am grateful to the Modi Science Foundation and J & K Government for the opportunity, through this lecture, to pay my respectful and humble tribute to the people of J&K and the city of Srinagar where I was born.

1. Introduction :

Rich in natural beauty and resources and peopled by an amalgam of gifted communities Jammu and Kashmir, the northern most state of India, is one of the most beautiful but less economically developed states. Historically many great names have been associated with Kashmir among them—Ashoka, Akbar, Ranjit Singh; Abdullah the Sher-e-Kashmir, and Jawaharlal Nehru.

Occupying nearly 230,000 sq. km and crossed by two major mountain ranges, the Karakoram and the mighty

Himalayas, the area is potentially rich in minerals, forests and well watered by rivers. The population of nearly 7 million people is centered mainly in the Jhelum valley and Jammu province. Only 6% of the land in the valley is used for agriculture. The State and the Central Governments are of course eager to develop the state and provide a better life for the people.

2. Resources Management :

Planning for development of the state implies a range of activities which are embodied in the successive plans of the State. The Draft Annual Plan for 1989-90 calls for an investment of Rs. 620 crores—(7th Plan outlay Rs. 1400 crores)—a whole range of areas are covered including the Priority sectors ; Agriculture, Irrigation, Power, Water Supply, Housing, Social and Community Services.

For all these activities it is essential to have an accurate assessment of physical resources and assets—existing and potential, renewable and non-renewable. First of all surveys are required of the extent and location of the mineral resources—estimates of quality and quantity, physical data and the feasibility of exploitation. In the case of renewable resources like forests and agriculture, the information on the soil and rainfall as well as availability of water is called for. The normal, classical methods of generating this information are well known to be deficient, time consuming and costly. The various departments such as geology, agriculture, forestry, etc., collect and collate this relevant information and try to update it as often as possible. The process is well known but seldom integrated into a coherent time bound programme with realistic linkages.

The key to the practical and effective use of Resource Information is that it must be :

—Timely
—Accurate
—Regular
—Capable of quantitative manipulation.

The problems are well known. For example the last geological and mineral resources survey of J&K is dated 1977—actually the data was collected in 1969. Since then some further studies have taken place which give more information than just the occurance of minerals. However essentially there is a great deal of time lag especially since the terrain is mountainous and very difficult to survey. It is precisely such problems which call for the application of advanced Science and Technology.

3. Use of Space Technology—How can Space Technology help ?

Orbiting satellites cover the earth in a few hours. Placed in appropriately chosen orbits and carrying suitably designed instruments these satellites can "see" and photograph the earth's surface in a matter of days. Meteorological satellites can give information about the weather as it develops and communication satellites can almost instantaneously interconnect places on the earth which are thousands of kilometers apart. Remote Sensing Satellites can rapidly survey vast areas of the earth in a few weeks.

India has currently in orbit two national satellites which provide communication, weather, TV and survey services for the whole country. These are the INSAT and IRS satellites. The data from these satellites is supplemented by data from US and French satellites for which India has ground stations which directly record the information (LANDSAT, NOAA, SPOT). The IRS satellite, about 900 km above the earth in a polar orbit, covers the whole of India with its cameras in 22 days and is the back-bone of the NATIONAL NATURAL RESOURCES MANAGING SYSTEM. *FIG. 1* shows the IRS-1A system and *FIG. 2* the IRS satellite which was launched about a year ago by a Soviet Rocket. IRS has completed 5000 orbits and 16 cycles of covering India. *FIG. 3* shows Bombay as seen by IRS. *FIG. 4* depicts a cyclone photographed by INSAT-1B in 1987. The INSAT system

provides regularly early warnings to the coastal areas of India, as also cloud and weather information over the whole region.

I propose to briefly discuss a few examples of how these satellites can be usefully used by J&K for resource management. Before discussing the concrete examples it is useful to briefly note the scientific basis of the technology.

4. Remote Sensing :

FiG. 5 illustrates the scientific principles of remote sensing. The Sun's rays passing through the atmosphere illuminate objects on the surface of the earth. The reflected radiation and the radiation emitted by the earth contain information about the objects. The satellite sensors in orbit register in electrical form the reflected and emitted radiation and transmit the recorded information by radio waves to the ground receiving station. At the ground station the remotely sensed data is processed and transformed to photographic and digital information for use by the users. Various corrections for the distortions by the atmosphere, movement of the satellite, etc., have to be made before the data can be used for interpretation. The IRS spececraft repeatedly covers the same spot in 22 days. The data is therefore especially useful for discerning changes. FIG. 5 also shows the electromagnetic spectrum covering a wide range of wave lengths from X-rays to radio which provide a means of deciphering the 'signature' of the objects on earth, The visible part of the spectrum is indeed only a small window. By now there are hundreds of users all over India who are familiar with the LANDSAT, SPOT & IRS pictures for use in Agriculture, Forestry, Soil Survey, Geology, etc., and currently there are many national missions e.g., on waste land mapping, water and drought which depend on satellite imagery for information. The spectral bands of the IRS cameras are especially suited for Indian applications.

5. Some examples : for J&K :

(i) GEOLOGY AND GEOGRAPHY are the key to mineral location. *FIG. 6* shows a 1969 Geology and Mineral Map; (The scale is 1:2,25,000) showing minerals at occurrence level. Subsequent work by the Geological Survey has indicated that some minerals have promise at the *resource* level :

—Bauxite		Kalakote Coal Fields Mahagola of Jammu	
—Coal and Lignite	*Coal & Lignite	0.1-0.2 M tons/year Marewari in Kashmir	
—Graphite	(Regional Industry)	Valley (8 million tonne deposits of lignite)	
—Gypsum			
—Limestone	*Limestone	Anantpur Baramula Srinagar	important for Cement Industry
—Magnesite			

The potential of Geothermal source is good [Puga Valley : 10 KW Pilot Plant]. The area is very large and terrain difficult to reach for survey. Only satellite imagery can cover the whole area in a reasonable time. The generation of a Geothermal source map of J&K would be useful for long range planning.

FIG. 7 Shows an IRS image (May 1988) for an area east of Jammu

—The rivers, the folded Siwalik hills can be clearly seen.

FIG. 8 Shows the interpretation for ground water potential. Such maps need to be prepared for the whole of J&K. In many areas of India where such imagery has been used, the success rate in locating water has dramatically improved. Similarly soil erosion maps and data for laying roads can be derived for practical use.

(ii) VEGETATION DYNAMICS :

Drought conditions and changes in vegetation cover can be monitored evcry 2 weeks—(NOAA S/c). Drought management requires : (i) Early warning; (ii) Monitoring of Changes & (iii) Vegetation index.

FIG. 9 Compares the vegetation status over the whole country in early September of two years 1987 and 1988. 1987 was a drought year. The biomass in 1988 is distinctly greater (Grey/purple/yellow—low leaf density.)

FIG. 10 Shows a comparison between June and September 1988 Large barren areas in June have greened up in September.

FIG, 11 Shows the position in J&K during September of 87 & 88. 1987 was a drought year and the '88 imagery shows the larger bio-mass. Analysis of such comparisons can prove useful for prior planning of strategies to meet drought contingencies.

FIG. 12 Shows the change during June, September and November of 1988 i.e. the effect of monsoon, harvesting and the season change. (Red colour indicates healthy vegetation—larger area in 1988).

(iii) FORESTRY

FIG 13 Shows photo-physiographical zones in J&K (LANDSAT TM). These are important for environmental evaluation and identification of problems and solutions.

FIG. 14 shows J&K forest cover in 1972-75 and 1980-82. In the interval of about 7 years there is an overall 3% reduction in the covered area. The *net forest area is reduced by 36%*.

FIG. 15 (LANDSAT MSS shows that land cover and land

use in Srinagar and its environs :

* Conifers & Pine—(Blue)
* Broad leaf species (light blue)
* Settlements--(dark brown)
* Snow—(Red)
* Lake/Water—(Black)
* Water land—(Light Pink)

(IV) FLOODS :

FIG. 16 Shows the Jhelum flood of May-June 1987 (Dark blue/black-flood inundated areas)

FIG. 17 Is the interpreted map
Standing Water—dark blue (29,000 hectares)
Wet area—orange (51,000 hectares)

Accurate knowledge of flood affected areas not only allows rapid deployment of relief operations but also the follow up actions.

(v) SNOW COVER :

Forecast of snow melt is important for planning utilisation of water for Power ann Irrigation and flood forecasting.

FIG. 18 Shows the maximum seasonal snow cover over the Chenab-Bias-Sutlej and Ganga-basins—during March 1988.

FIG. 19 Is a Snow Cover Map prepared by NRSA for the Sutlej basin for the Bhakra System.

Such studies are now regularly used by the BHAKRA DAM SYSTEM to regulate Power and irrigation. Accuracies are close to 95%. This is being extended to all river basins. An important part of the work which needs improvement are "ground truth" information about snow depth etc. Research workers in Kashmir could contribute significantly. I understand some work is already being done.

The SALAL HYDRO project (UDHAMPUR Dist.) on river Chenab is an important project for J&K and needs similar studies. Like Bhakra, SALAL depends critically on snow melt (MARCH—maximum snow cover).

(vi) URBAN PLANNING : The growth of cities.

FIG. 20 Shows a topo map of Srinagar as it was in 1968-69.

FIG. 21 Shows an 1988 IRS view of the City and DAL Lake and other landmarks.

FIG. 22 Shows analysis of the satellite data and the earlier map to show the growth over a 20 year period. Long range urban planning is urgent if our cities have to survive as healthy places.

There are many other areas which can benefit directly from satellite Remote Sensing. These include :

(i) Soil maps and soil erosion studies.

(ii) Monitoring the environment and pollution including water bodies such as the Wular and DAL lakes.

(iii) Targetting and locating ground water zones.

(iv) Agricultural and horticultural crop monitoring, pest detection and control.

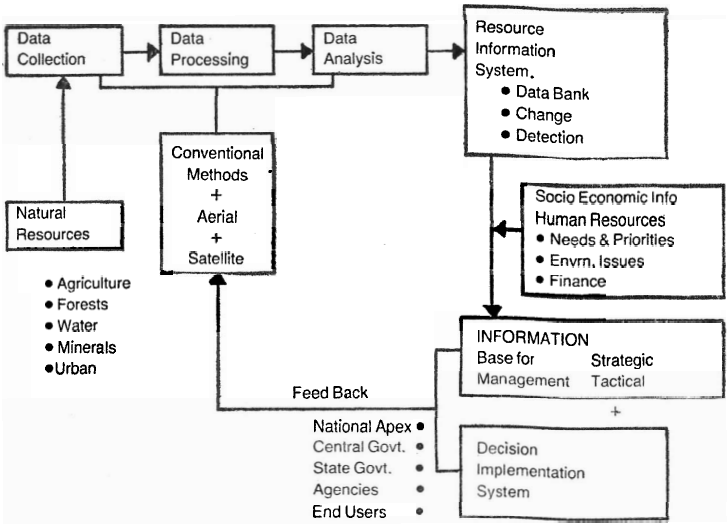
6. CONCLUSION :

It is clear that J&K can very profitably use Remote Sensing Technology for support of assessing, developing and monitoring its natural resources and environment. Under the aegis of the Planning Commission a nation wide resource management system based on the IRS System and supplemented by other satellites, aerial and ground surveys is evolving. Some 15 departments of the Central Government and all the States of India are participating in one form or another. The nodal agency is the Department of Space which operates the IRS & INSAT systems

and also NRSA, the operational agency for satellite and aerial imagery. There are five regional remote sensing centres—at Bangalore, Nagpur, Jodhpur, Kharagpur and Dehra Dun. 19 State level centres have also come into belng or are in the process of being set up. Some are very active others not so. I would urge the J&K Government to activise the State Remote Sensing activity with specific tasks which fit into the State's planned priorities. It is important that apart from the Government departments, research personnel from the academic institutions are involved. Kashmir University, the Engineering college, the Agricultural university have staff and students who can conduct basic studies which are essential for later practical use of Satellite and aircraft imagery. The J&K State Council for Science and Technology could provide the forum for bringing together scientists and personnel from various disciplines. I am sure the rewards would be tangible progress for many activities in the State as well as an enhanced feeling of involvement by the professional community.

Of course remote sensing and Satellite Technology by itself is not enough. The critical element to complete the development process is political will and support of the people. The full system can be represented as in the sketch below :

An Operational Remote Sensing System

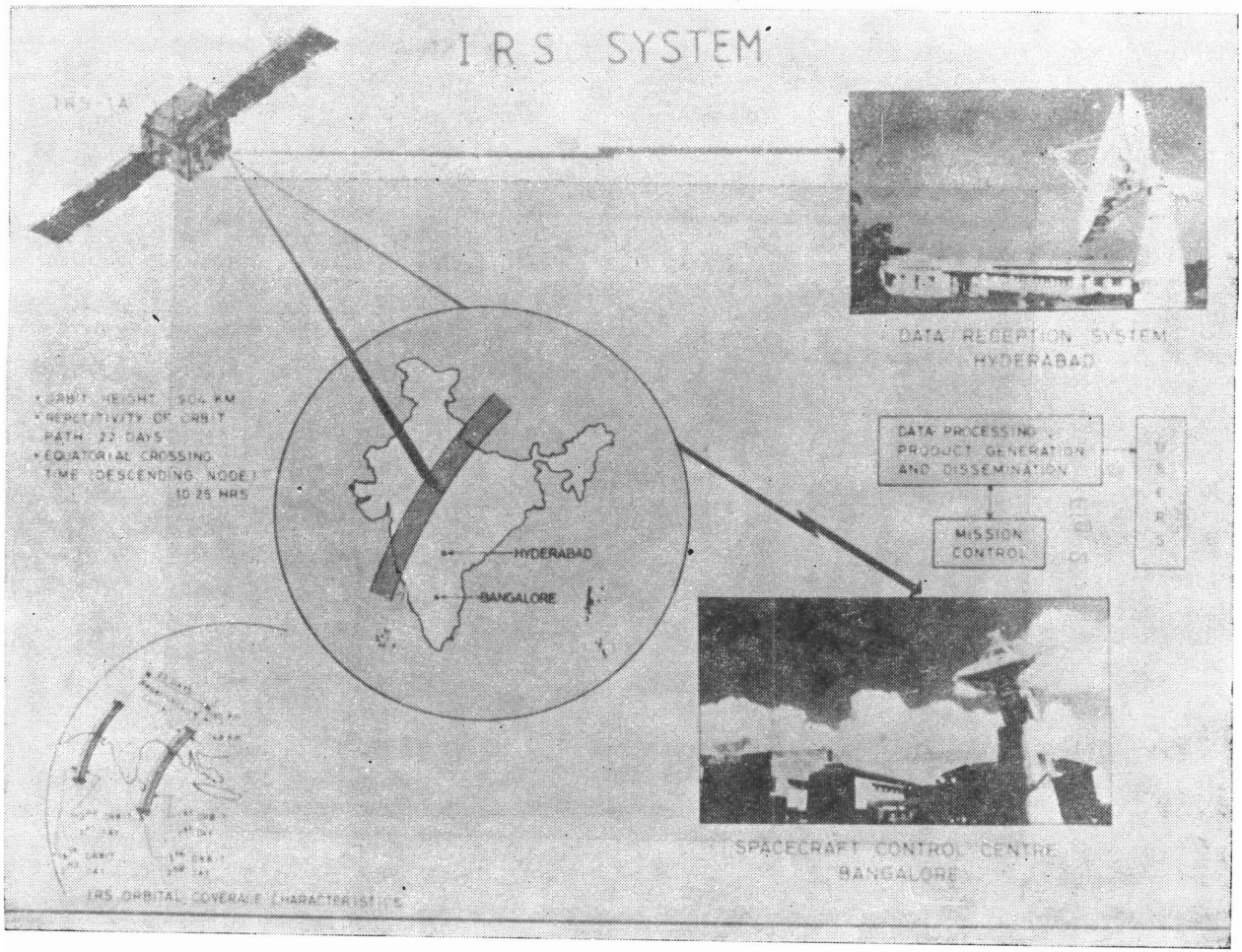


The *comparative time and costs* for satellite survey per sq. km as compared to other methods are summarized :-

Satellite— 1 Rs. 3 to 4/ sq. km. (20 times faster than ground survey

Aerial— Rs. 4.5 -do-

Ground— Rs. 16 -do-


IRS SYSTEM
IRS-1A
DATA RECEPTION SYSTEM
HYDERABAD
• ORBIT HEIGHT 904 KM
• REPETITIVITY OF ORBIT PATH 22 DAYS
• EQUATORIAL CROSSING TIME (DESCENDING NODE) 10.25 HRS
HYDERABAD
BANGALORE
DATA PROCESSING, PRODUCT GENERATION AND DISSEMINATION
MISSION CONTROL
USERS
SPACECRAFT CONTROL CENTRE BANGALORE
IRS ORBITAL COVERAGE CHARACTERISTICS

Fi

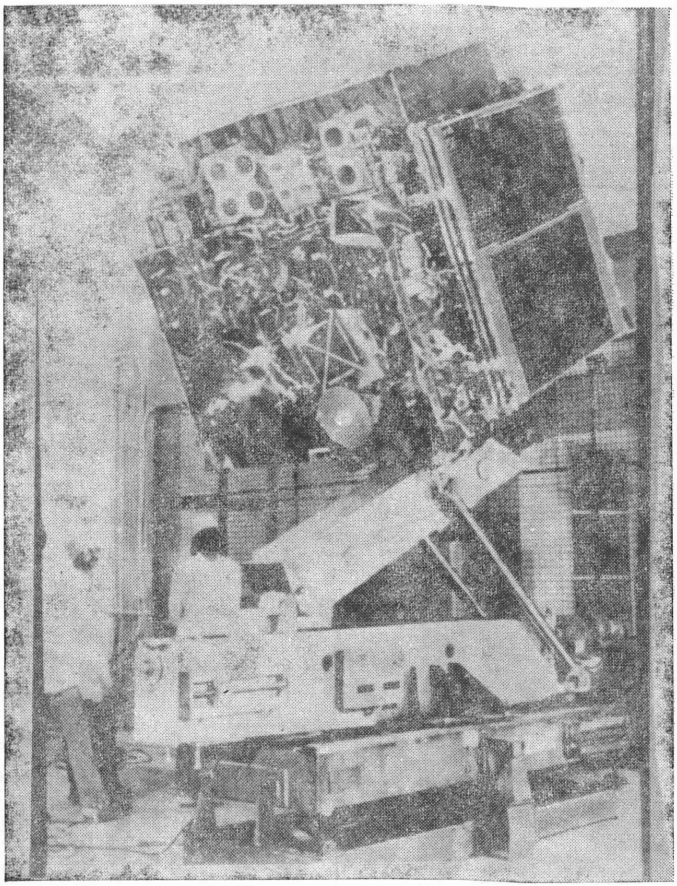


Fig. 2

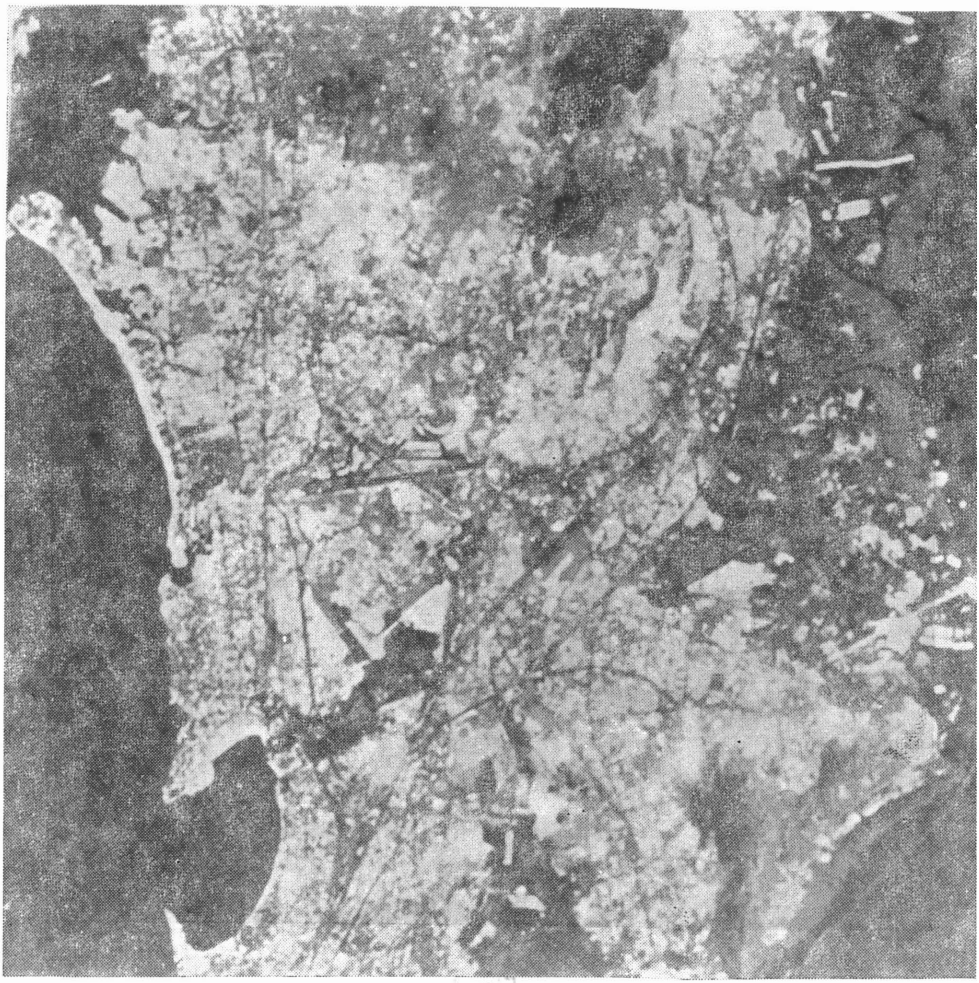


Fig. 3

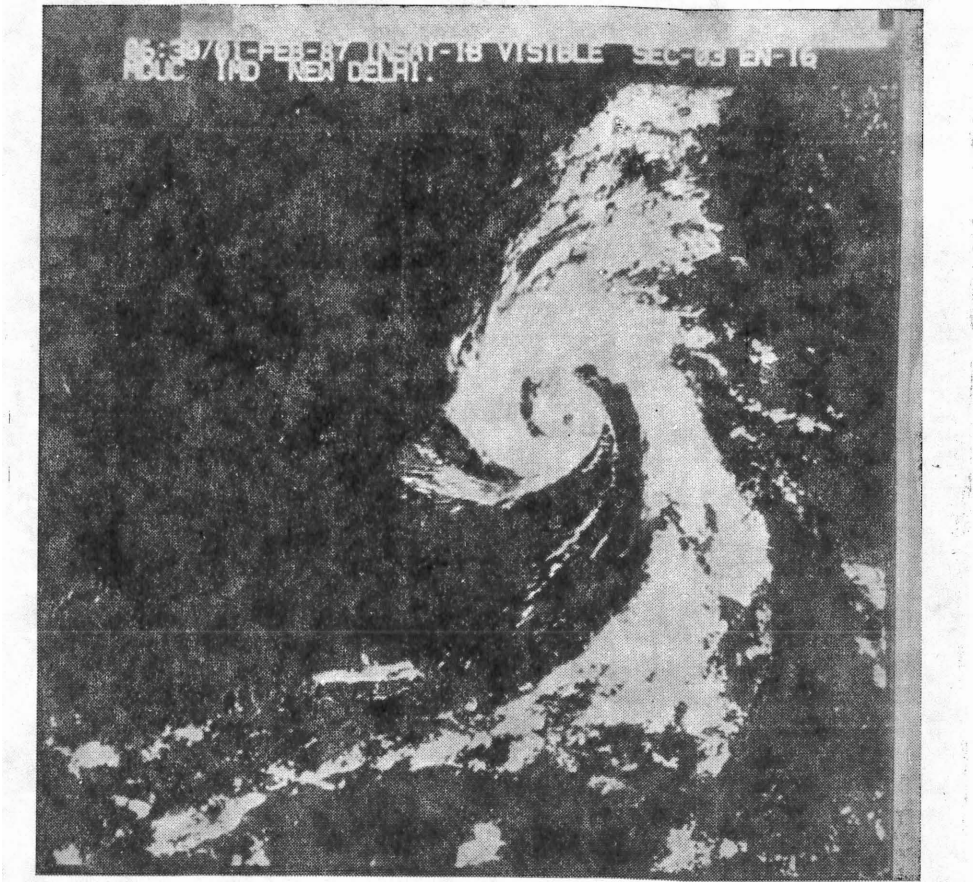


Fig. 4

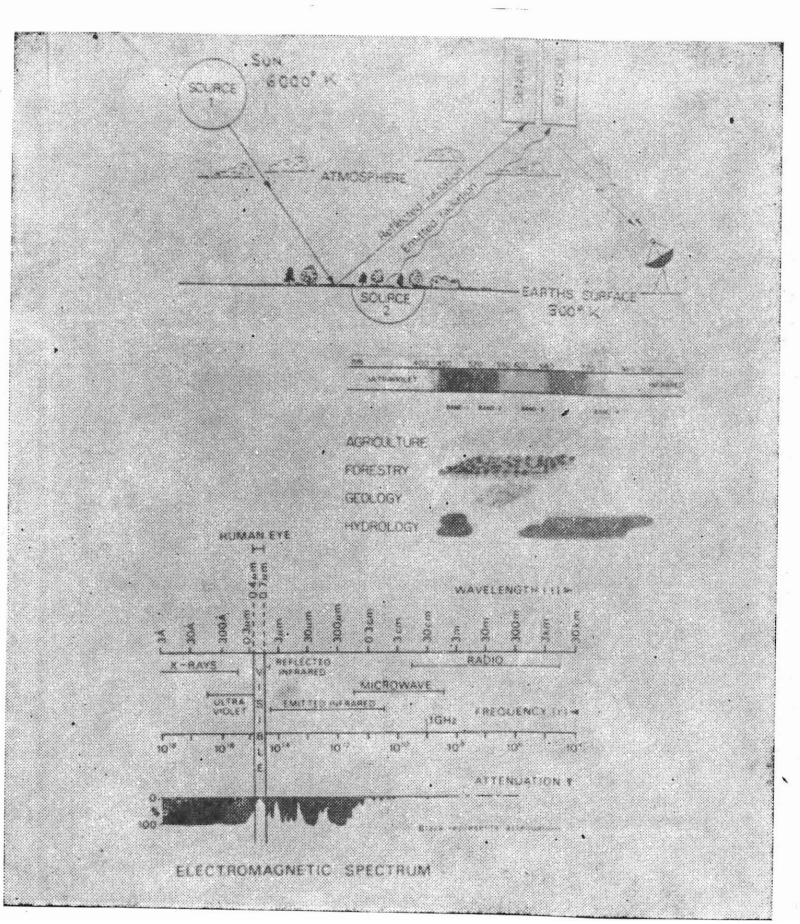

SUN
6000° K
SOURCE 1
ATMOSPHERE
REFLECTED ENERGY
EMITTED ENERGY
SOURCE 2
EARTHS SURFACE
300° K
ULTRAVIOLET
AGRICULTURE
FORESTRY
GEOLOGY
HYDROLOGY
HUMAN EYE
WAVELENGTH
X-RAYS
REFLECTED INFRARED
RADIO
MICROWAVE
ULTRA VIOLET
EMITTED INFRARED
1GHz
FREQUENCY
ATTENUATION %
ELECTROMAGNETIC SPECTRUM

Fig. 5

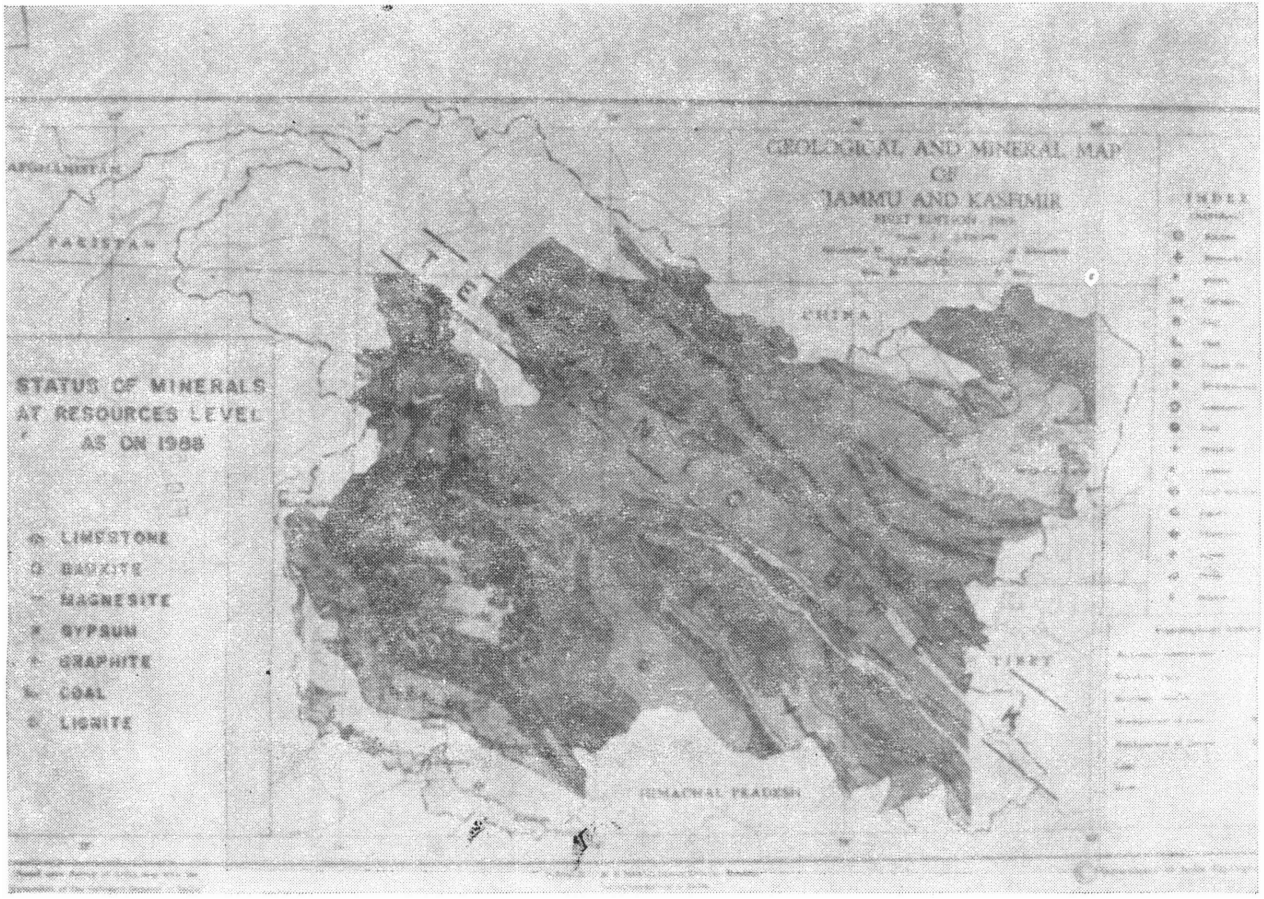

GEOLOGICAL AND MINERAL MAP
OF
JAMMU AND KASHMIR
STATUS OF MINERALS
AT RESOURCES LEVEL
AS ON 1988
LIMESTONE
BAUXITE
MAGNESITE
GYPSUM
GRAPHITE
COAL
LIGNITE
PAKISTAN
CHINA
TIBET
HIMACHAL PRADESH
INDEX

Fig. 6

Fig. 7

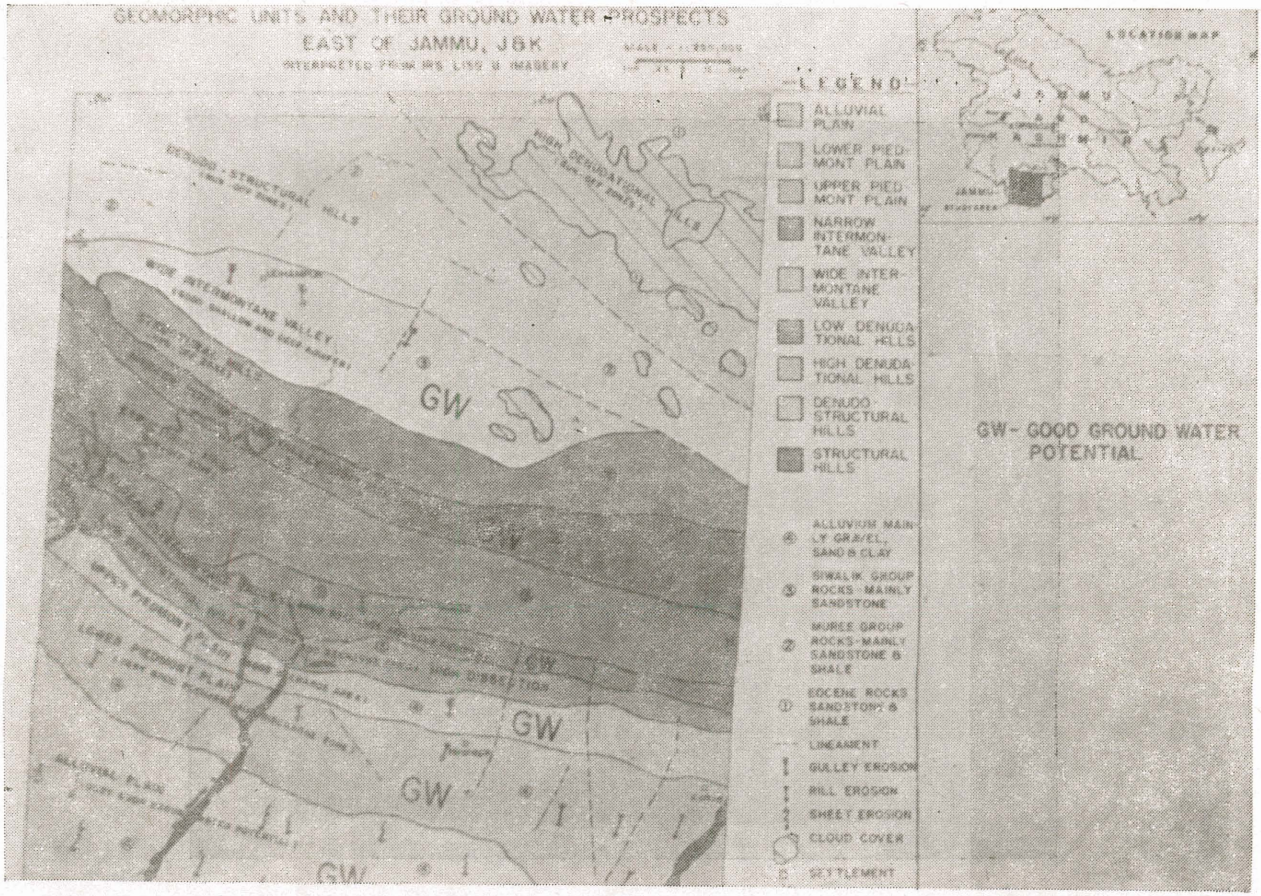
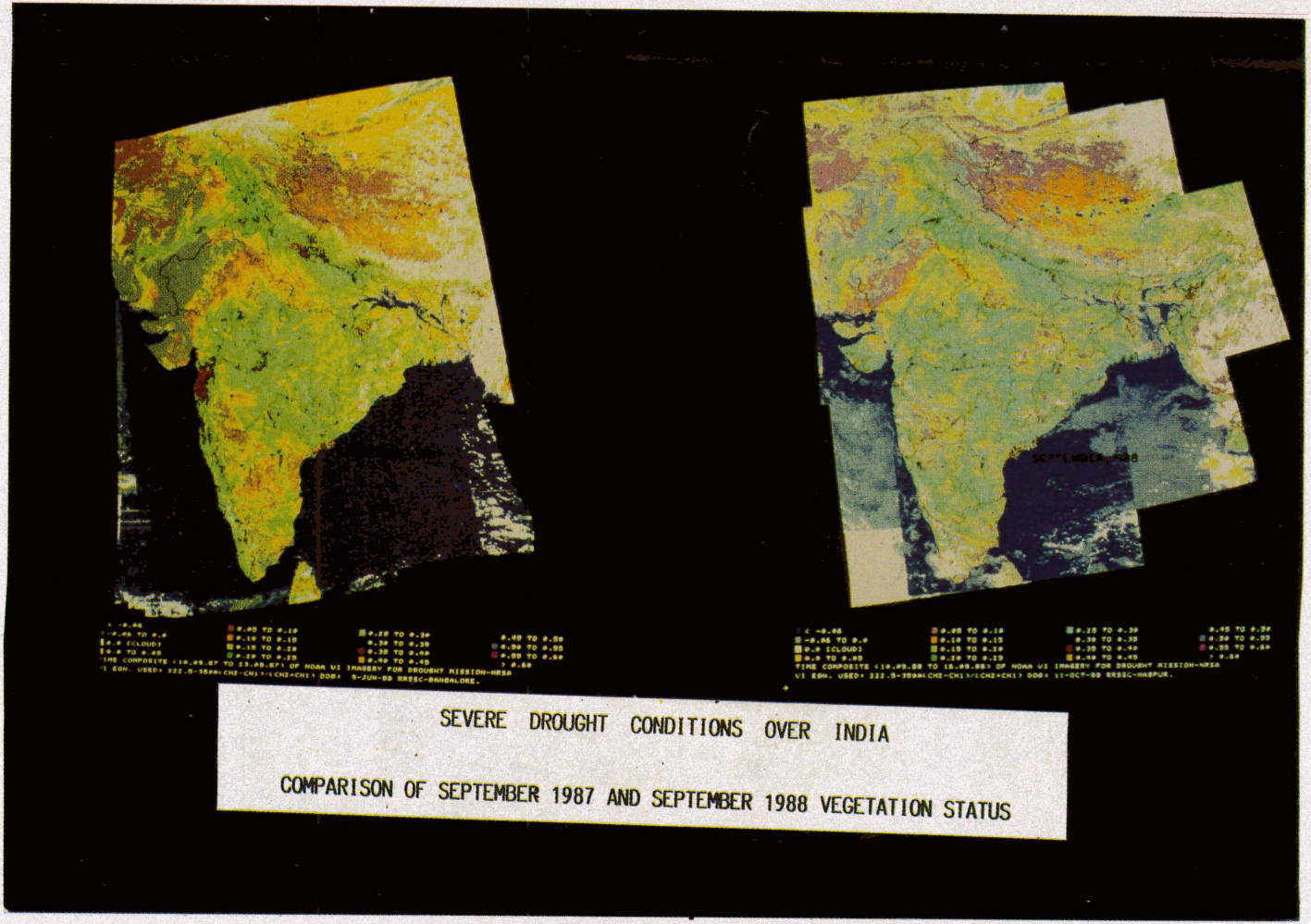

GEOMORPHIC UNITS AND THEIR GROUND WATER PROSPECTS
EAST OF JAMMU, J&K
INTERPRETED FROM IRS LISS II IMAGERY
LEGEND
ALLUVIAL PLAIN
LOWER PIEDMONT PLAIN
UPPER PIEDMONT PLAIN
NARROW INTERMONTANE VALLEY
WIDE INTERMONTANE VALLEY
LOW DENUDATIONAL HILLS
HIGH DENUDATIONAL HILLS
DENUDO STRUCTURAL HILLS
STRUCTURAL HILLS
ALLUVIUM MAINLY GRAVEL, SAND & CLAY
SIWALIK GROUP ROCKS - MAINLY SANDSTONE
MURREE GROUP ROCKS - MAINLY SANDSTONE & SHALE
EOCENE ROCKS SANDSTONE & SHALE
LINEAMENT
GULLEY EROSION
RILL EROSION
SHEET EROSION
CLOUD COVER
SETTLEMENT
LOCATION MAP
GW
GW- GOOD GROUND WATER POTENTIAL

Fig. 8

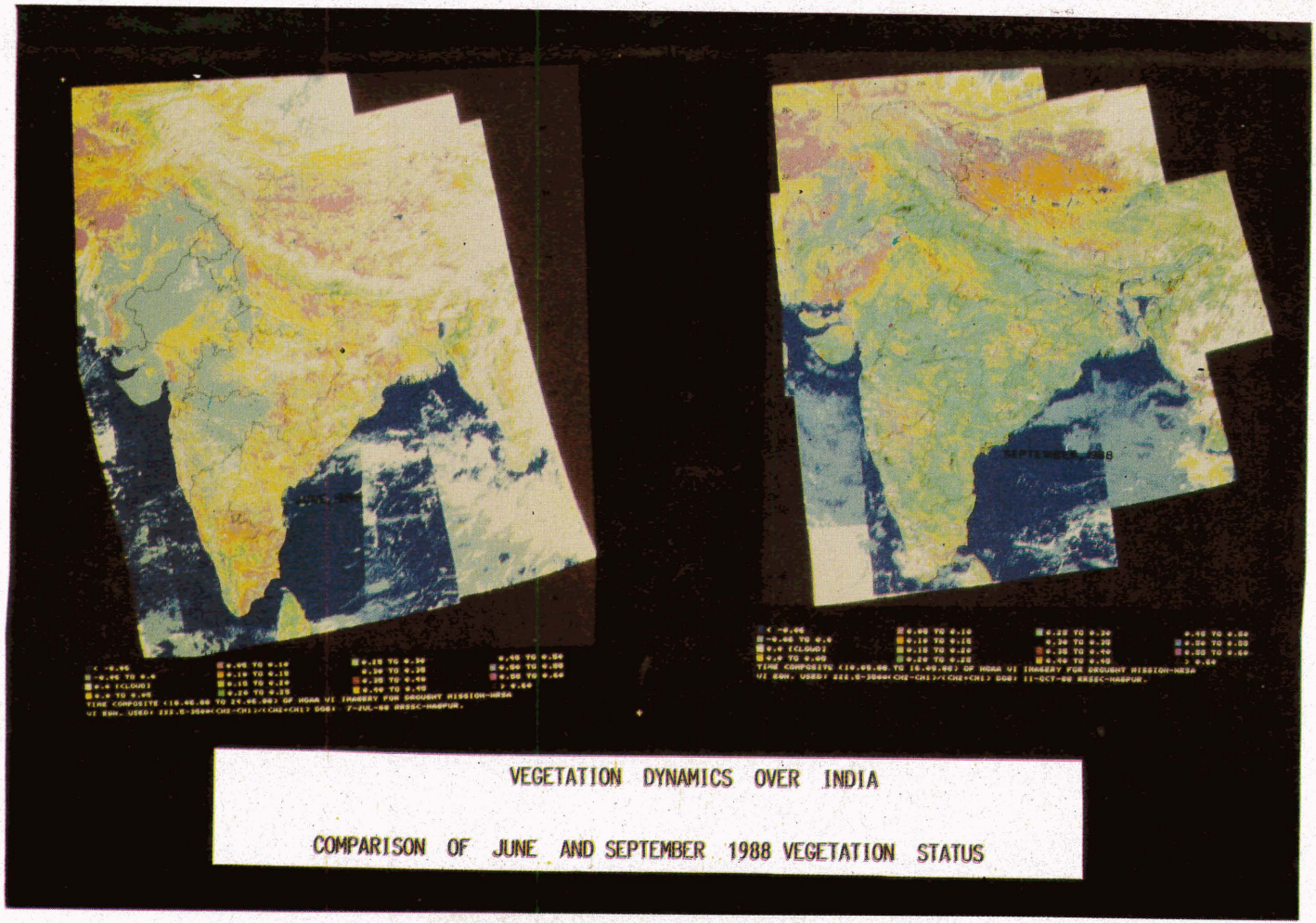
Fig 9



SEVERE DROUGHT CONDITIONS OVER INDIA

COMPARISON OF SEPTEMBER 1987 AND SEPTEMBER 1988 VEGETATION STATUS

Fig 10



VEGETATION DYNAMICS OVER INDIA

COMPARISON OF JUNE AND SEPTEMBER 1988 VEGETATION STATUS

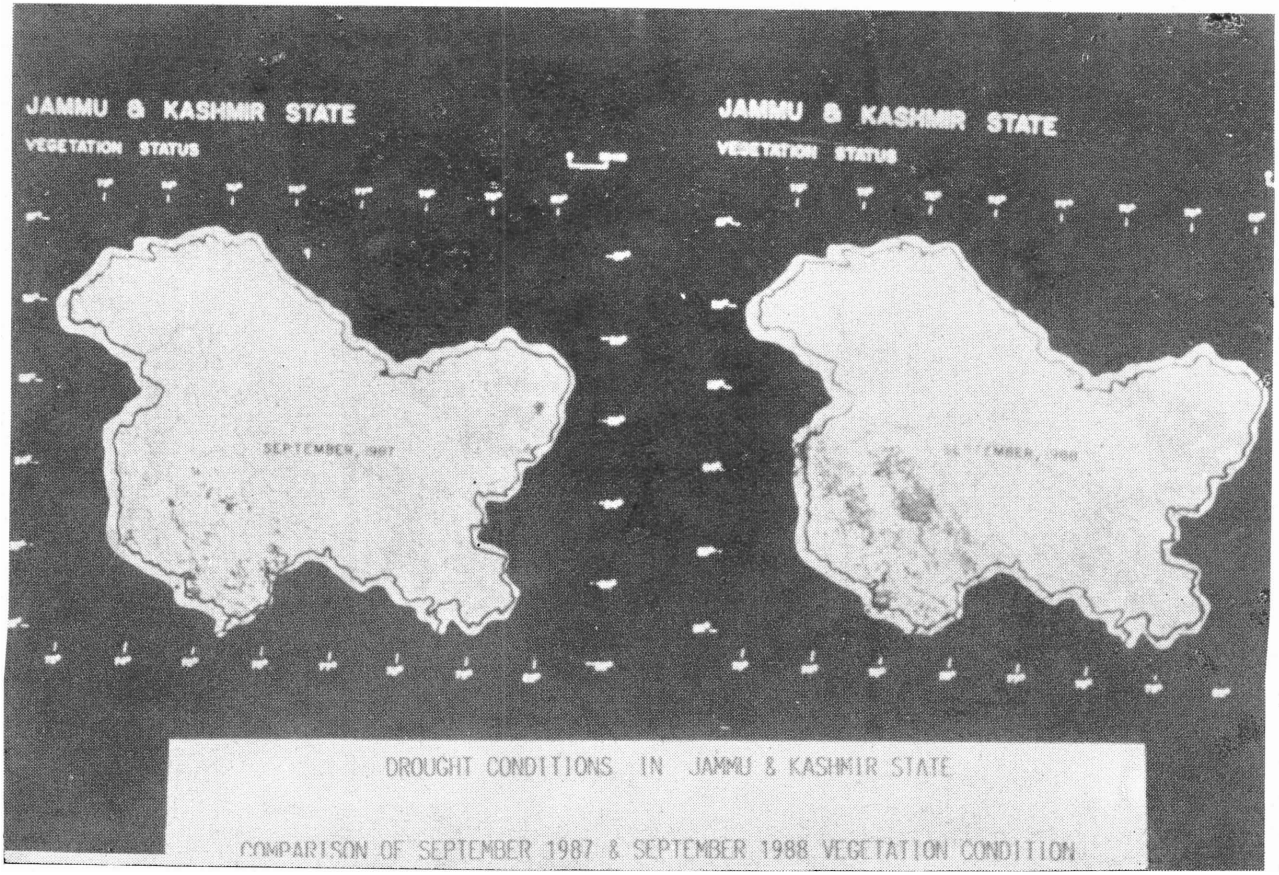
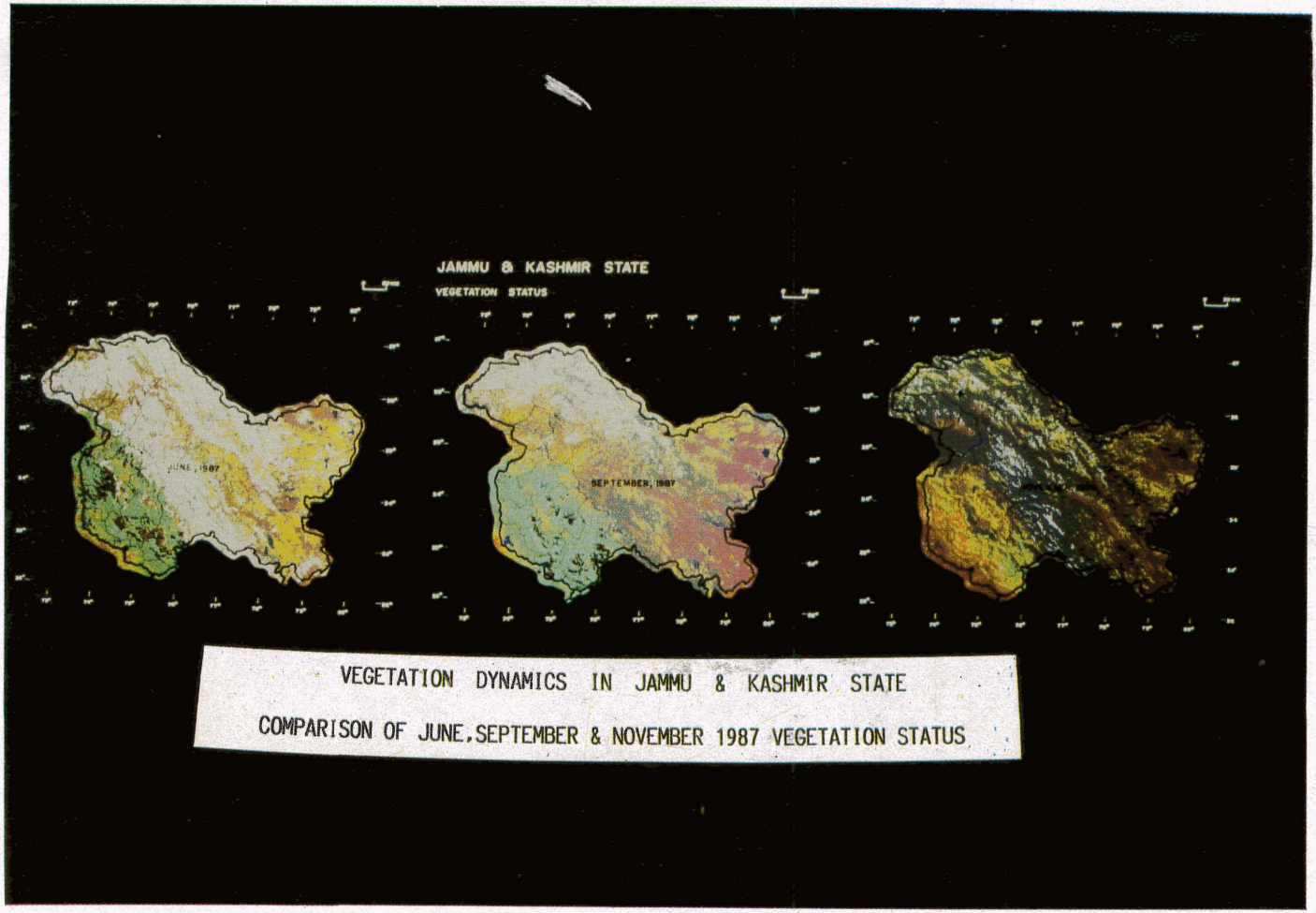

JAMMU & KASHMIR STATE
VEGETATION STATUS
JAMMU & KASHMIR STATE
VEGETATION STATUS
DROUGHT CONDITIONS IN JAMMU & KASHMIR STATE
COMPARISON OF SEPTEMBER 1987 & SEPTEMBER 1988 VEGETATION CONDITION

Fig. 11



VEGETATION DYNAMICS IN JAMMU & KASHMIR STATE

COMPARISON OF JUNE, SEPTEMBER & NOVEMBER 1987 VEGETATION STATUS

FIG 12

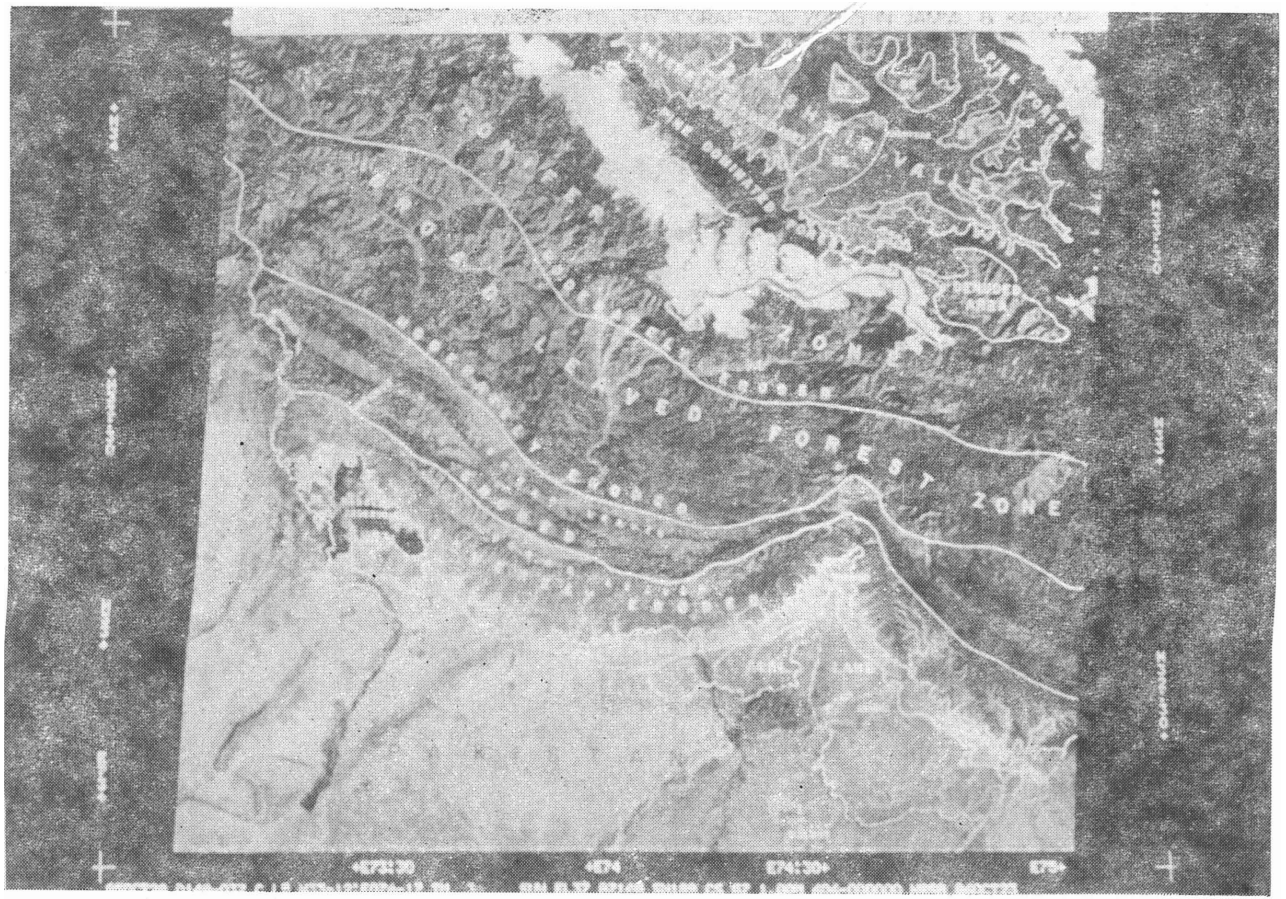


Fig 13

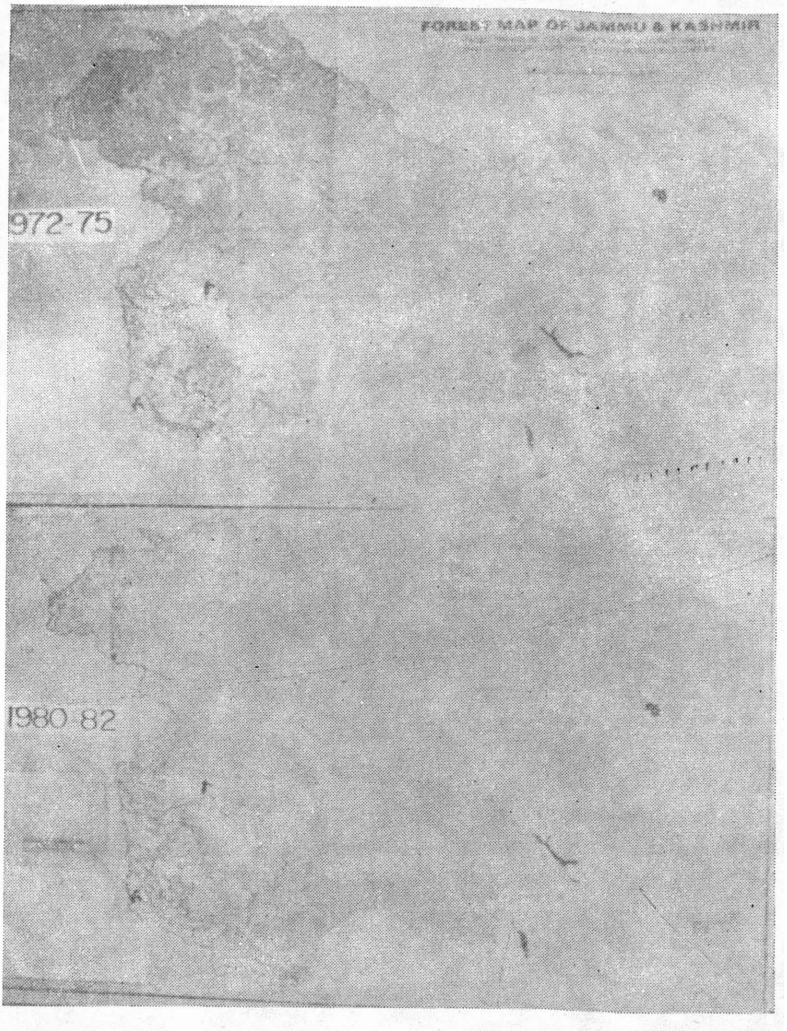
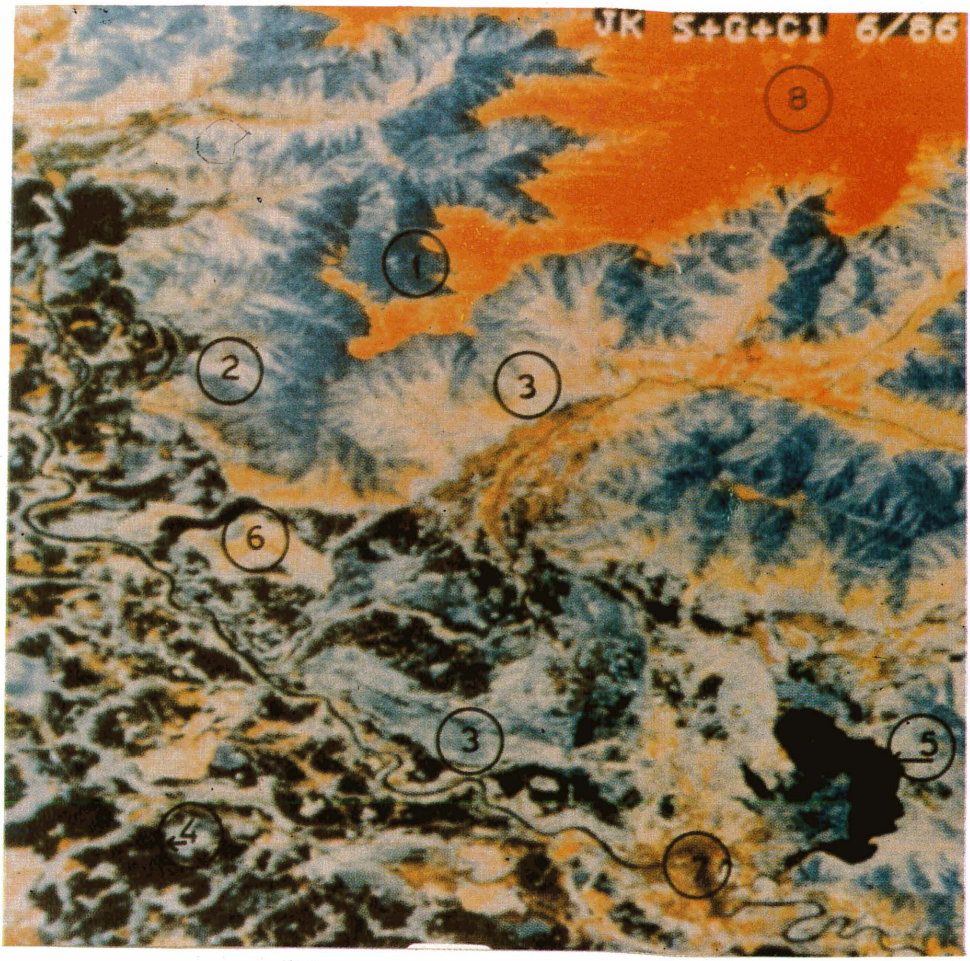


Fig. 14



ENHANCED IMAGE FOR HIGHLIGHTING LANDUSE/LAND COVER CATEGORIES
(COMPOSITE OF BRIGHTNESS, GREENNESS AND 1ST PRINCIPAL COMPONENT IMAGE)

	CLASS	COLOR		CLASS	COLOR
1.	CONIFERS	DARK BLUE	5.	WATER BODY	BLACK
2.	PINE	BLUISH WHITE	6.	WASTELAND	LIGHT PINK
3.	BROAD LEAVED	LIGHT BLUE	7.	SETTLEMENT	BROWN
4.	FALLOW/BLACK SAL	BLACKISH BROWN	8.	SNOW	RED

SRINAGAR & ENVIRONS - LAND COVER & LAND USE

FIG 15


MOSAIC OF SATELLITE IMAGERIES OF 12 JUNE, 1987 SHOWING FLOOD SITUATION IN KASHMIR VALLEY
SCALE 1:250,000 (approx)
WULAR LAKE
WET AREA
BARAMULA
STANDING WATER
DAL LAKE
SRINAGAR
BADGAM
ANANTNAG
WET AREA
PUNCH
KULGAM
VERINAG
MENDHAR

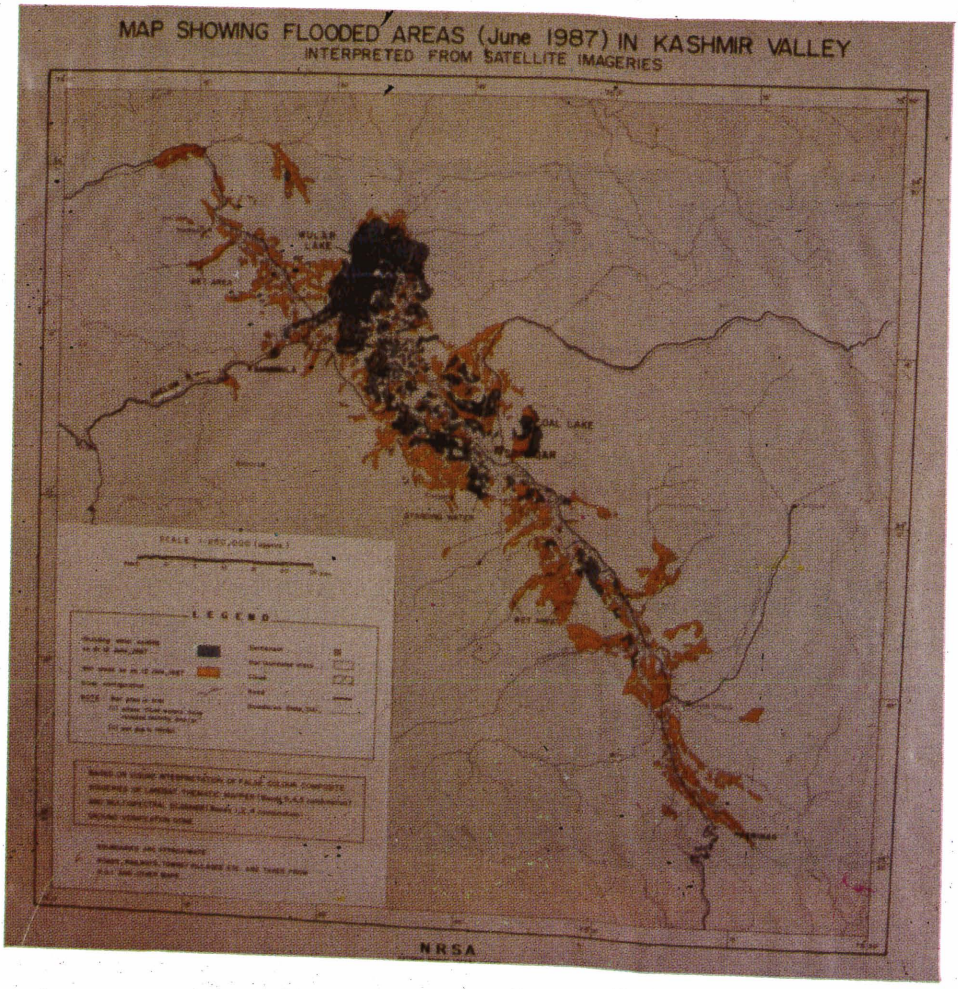

MAP SHOWING FLOODED AREAS (June 1987) IN KASHMIR VALLEY
INTERPRETED FROM SATELLITE IMAGERIES
WULAR LAKE
LEGEND
NRSA

FIG 17

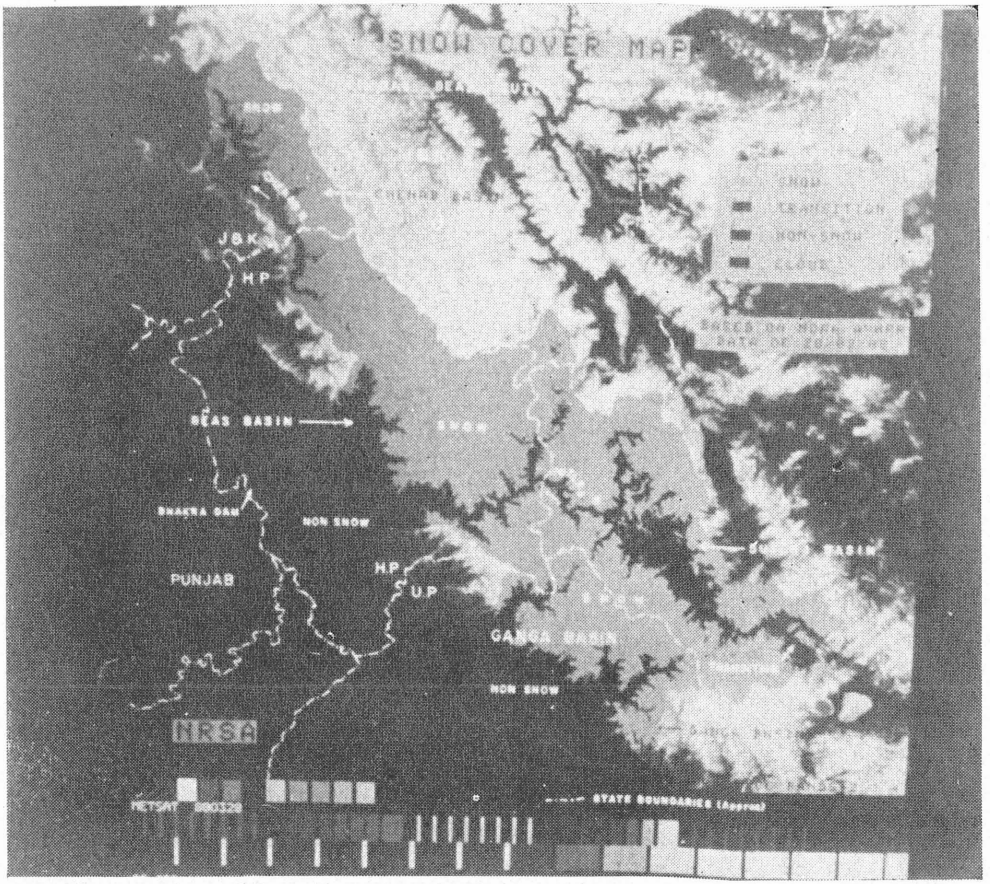

SNOW COVER MAP
J&K
H.P
BEAS BASIN
BHAKRA DAM
NON SNOW
PUNJAB
H.P
U.P
GANGA BASIN
NON SNOW
NRSA
STATE BOUNDARIES (Approx)

Fig. 18

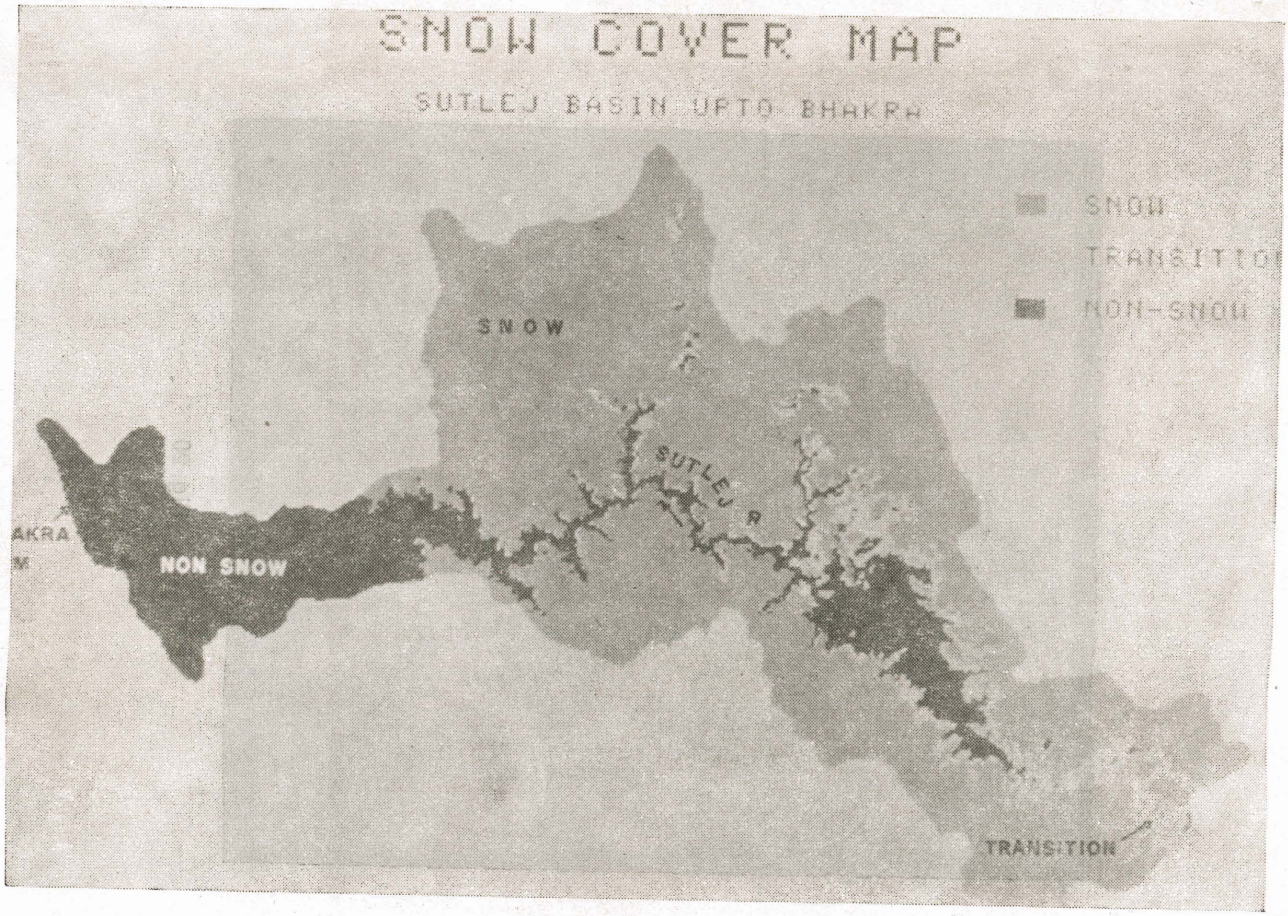

SNOW COVER MAP
SUTLEJ BASIN UPTO BHAKRA
SNOW
TRANSITIO
NON-SNOW
SNOW
SUTLEJ R
NON SNOW
TRANSITION

Fig. 19

Fig. 20


SRINAGAR VIEWED BY IRS-1A ON 24-5-88
UNIVERSITY
NAGIN LAKE
SECRETARIAT

Fig. 21

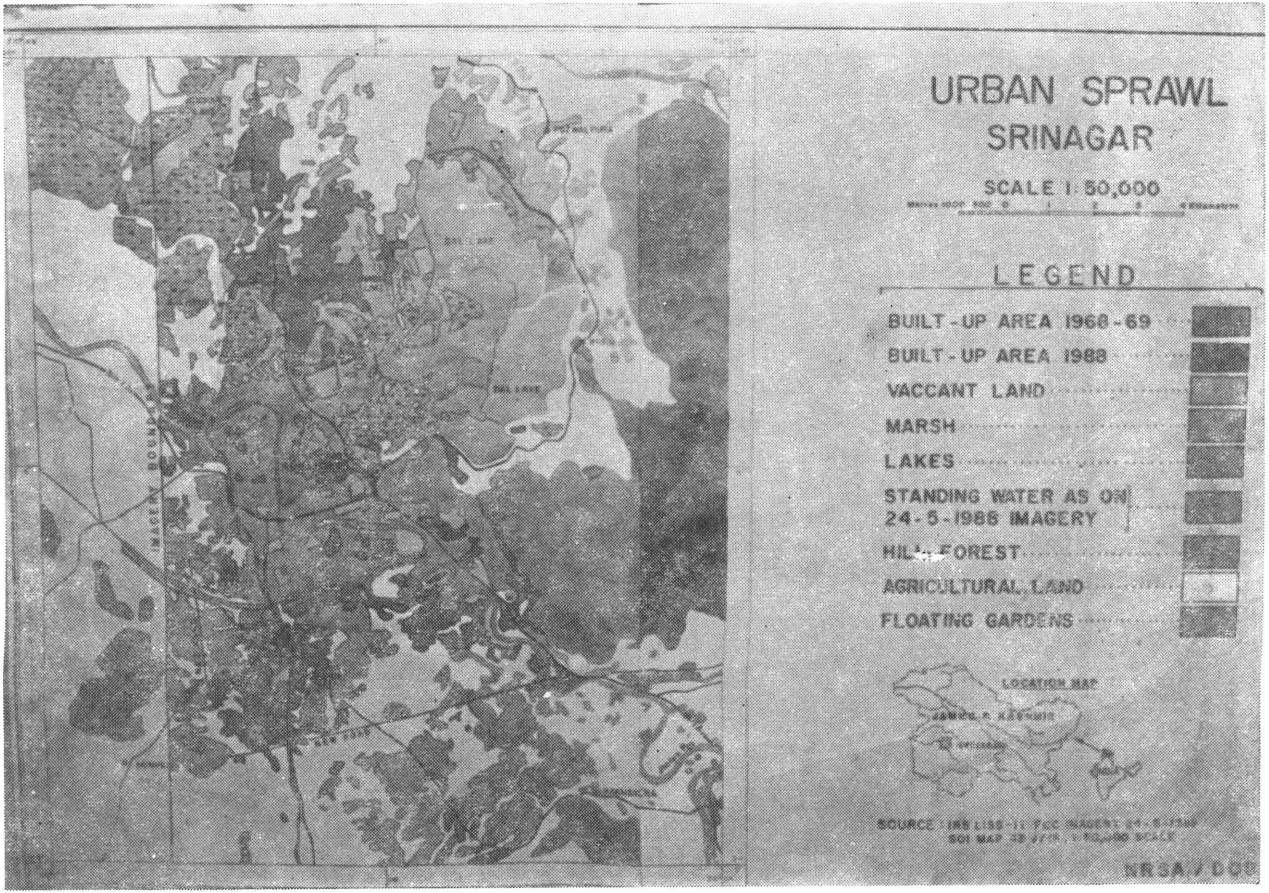

URBAN SPRAWL
SRINAGAR
SCALE 1:50,000
LEGEND
BUILT-UP AREA 1968-69
BUILT-UP AREA 1988
VACCANT LAND
MARSH
LAKES
STANDING WATER AS ON 24-5-1988 IMAGERY
HILL FOREST
AGRICULTURAL LAND
FLOATING GARDENS
LOCATION MAP
DAL LAKE
NAGIN LAKE
NRSA/DOS

Fig 22