6. APPLICATION OF REMOTE SENSING: EMERGING SCENARIOS

The satellite remote sensing plays an effective role in natural resource inventory, desertification and drought monitoring, geological, geomorphological and environmental hazard mapping, NNRMS, etc. (NRDMS and Kasturirangan, 1992). It provides vast scope to explore and analyse resources of underdeveloped regions. Scientists are making use of the features of different bands: near infrared and microwave to detect water and humidity, red, near infra-red and middle infra-red to detect plants, blue, green, near and middle infra-red for soil, and radar waves for hydrological studies.

The most frequent applied areas of remote sensing in India is the study of earth's sub-surface and surface features (Deekshatulu and Kamat, 1984; Murthy et. al., 1982; Singh et al., 1988). Aerial photographs are effective for the geological (Bhan and Krishnunni, 1984; Babu and Singh, 1982; Bhattacharjee et al., 1980), geomorphological, desertification (Dwivedi, 1991), physical relief and hydrological studies and land use mapping (Karali et al., 1991). Geomorphic units have been identified based on interpretation of the aerial photographs (Murthy, et al., 1980; Raghavswamy and Vaidyanathan, 1988) and the Survey of India topo-sheets and the Landsat imagery in the Pali district (Vats, 1987), Jodhpur District (Singh, 1983), Luni basin (Dhabriya, 1984) and Tripura state (Bhattacharya, 1980). These geomorphic units (Srinivasan and Gopal, 1982) have different physical potential and provide a sound base for disaster mitigation strategy.

Based on aerial photographs, a study carried out on the Hiran catchment (Jabalpur district) highlights the physical and hydrological characteristics of the area, using quantitative analysis (Singh, 1985) for land resource development and management (Rakshit, 1980). Series Level Soil Map project was started in Hasdo sub- watershed in Jangir Tahsil of Bilaspur district to prepare a series of level soil map at 1:15,000 scale. Finally, concepts of a stereoscopic model and morphometric interpretation for slope and erosion phases and risk were established (Saha et al., 1991; Rao, 1991; Singh, 1989 and 1992).

Based on irrigation, cropping pattern and physical attributes namely watersheds, slope, landforms, lithology, soils, land use and hydromorphic units (Muley and Nayak, 1983), the land suitability of agricultural use are identified (Rudhviraju and Vaidyanathan, 1980; Rao and Vaidyanathan, 1981; Rao, 1985; Singh, 1992) (Table 3: Source: Department of Space).

TABLE 3: REMOTE SENSING APPLICATIONS AND OPERATIONAL PROJECTS

Project Name / Objective	Status
1. National wasteland mapping project To identify type and extent of wasteland at village level	Maps have been prepared on 1:50,000 scale for 146 districts. The rest of the districts are being takenup.
2. Landuse/landcover mapping Nationwide mapping for landuse/cover for Agro-climatic zones on 1:250,000 scale	Over 250 districts have already been mapped. The mapping of the remaining districts are progressing
3. National Drinking Water Mission Hydrogemorpholigical maps (ground water potential on 1:250,000 scale) help in scientific source finding of Drinking Water	All the districts in the country have been mapped.
4. Agricultural Drought Monitoring To assess and monitor Agricultural Drought at district	Fortnightly drought bulletins on drought conditions are being issued for 10 states
5. Forest cover mapping Biennial forest cover on 1:250,000 scale for the entire country	Forest cover maps for 1987-89 has been completed
6. Integrated study to combat drought Preparation of integrated land and water resources maps at district level to identify long and short term measures to combat drought	18 districts in 12 states have been taken up
7. Urban Studies To study the urban landuse/ landcover sprawl, growth etc. of all major cities above 1 million population	Urban sprawl maps for Madras, Hyderabad, Nagpur, Calcutta, Bombay have been prepared
8. Crop acreage and production estimation To estimate the crop acreage and production	Project is being carried out for major crops like Rice, Wheat, Sorghum, Groundnut, Cotton etc. covering major parts of the country
9. Flood Mapping Near real time mapping of flooded areas and estimation	Major floods in Brahmaputra, Ganga, Godavari river basins are covered under this project
10. Snow Mapping Delineation of snow cover area and estimation	Run-off models were made and predicted the snow melt with an accuracy of + 2%
11. Environmental impact of mining and thermal power complexes To develop a suitable methodology for monitoring	Few test sites are being studied
12. Project Vasundhara Regional mineral targetting using multi-thematic data for area below $N16^0N$ in India	Geographical Information System Package has been developed
13. Oceanography To generate routine information on ocean and coastal related parameters To develop mathodology for microwave data analysis and parameter retrieval	SST charts are being generated and fishery potential zones identified Coastal mapping of entire coast completed Coastal landuse map for aquaculture/ inland water fisheries development taken up

Source: Department of Space

An integrated natural resource survey (Nageswara Rao,1991) aimed at making a comprehensive survey of land and water resources in Idukhi district of Kerala was carried out jointly by the SAC of ISRO and the Kerala State Land Board. About 270 maps at 1:15,000 scale, have been prepared on land use, geomorphology and structural geology. This enabled the planners to come out with a comprehensive plan for the region.

6.1 DROUGHT DISASTER

The drought-prone areas constitute about 68 per cent of total sown area of the country. The drought watch group, made up of representatives of the Ministry of Agriculture, Meteorological Department, Indian Council of Agricultural Research and Ministry of Information and Broadcasting exists at the national level to monitor weather conditions throughout the country (Singh, 1990) (Table 4).

TABLE 4: DAMAGE DUE TO DROUGHTS (1984-87), INDIA

Damage	1984	1985	1986	1987
No. of Districts	151	109	280	263
Population (Million)	70.5	78.6	191.9	285.4
Cropped Area (Million ha)	15.4	28.2	40.0	58.6
Cattle Population(Million)	47.5	65.4	112.0	168.1

Source · Ministry of Agriculture, New Delhi, 1990

In 1987, India suffered from a severe drought. This year marked significant development for satellite use of drought conditions in agriculture (Thiruvengadachari et al., 1991). The National Agricultural Drought Assessment and Management System (NADAMS) is being initiated by Department of Space for Ministry of Agriculture. This focuses on vegetation monitoring through National Oceanic and Atmospheric Administration (NOAA) Satellite Advanced Very High Resolution Radiometer (AVHRR) data. Since 1989, the NADAMS released biweekly drought bulletins for kharif season (June to December) for 246 districts in the ten states of Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, Orissa, Gujarat, Uttar Pradesh, Haryana, Madhya Pradesh and Rajasthan. The information on extent and magnitude was sent to concerned central, state and district officials through bulletins as well as telex/telegrams within 2 to 3 days. The drought assessment, which is based on a comparative evaluation of satellite observed green vegetation cover (both area and greenness) of a district for a particular period of current and past years, is very useful for getting first hand information on drought conditions (Figures 4 and 5).

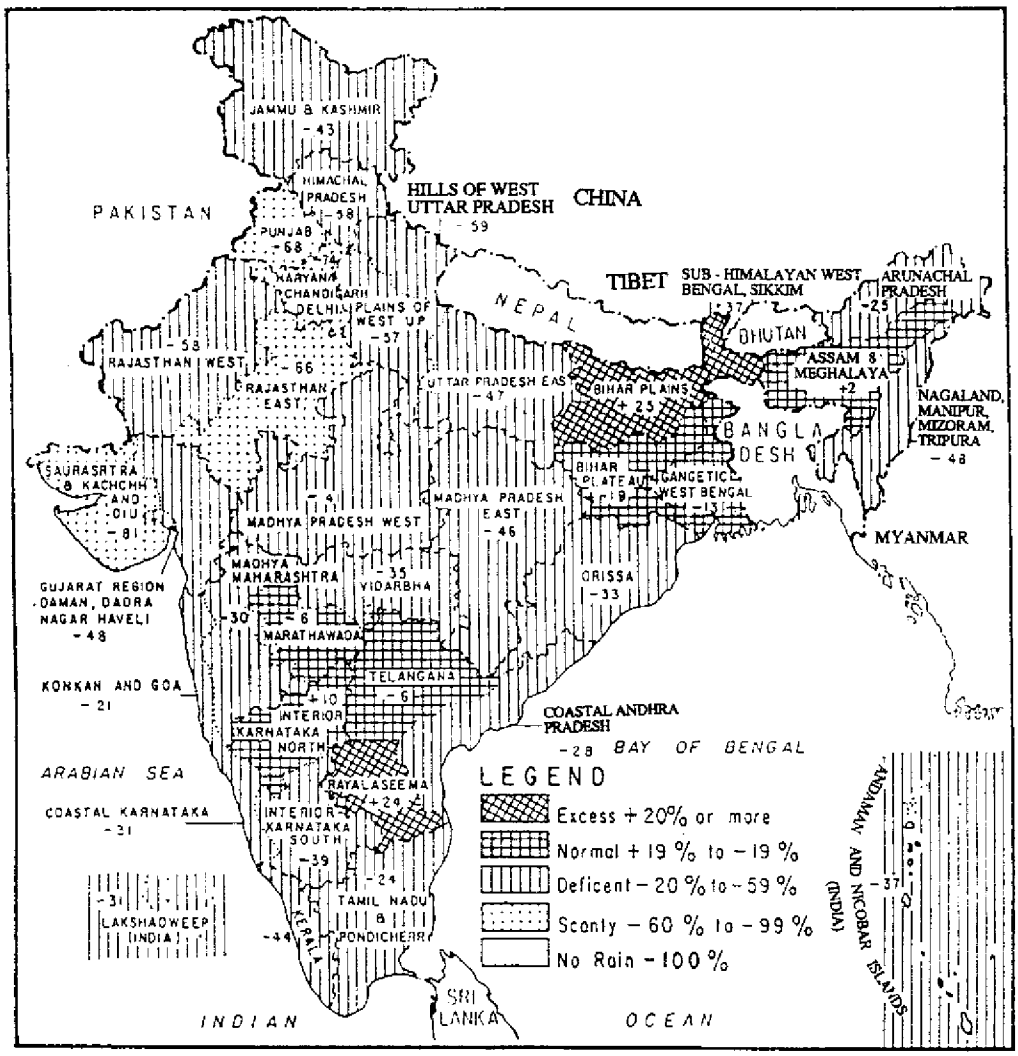

Figure 4: India: Percentage Departure of Normal Rainfall for the Period From June 1 to August 12, 1987 (Source: Ministry of Agriculture)

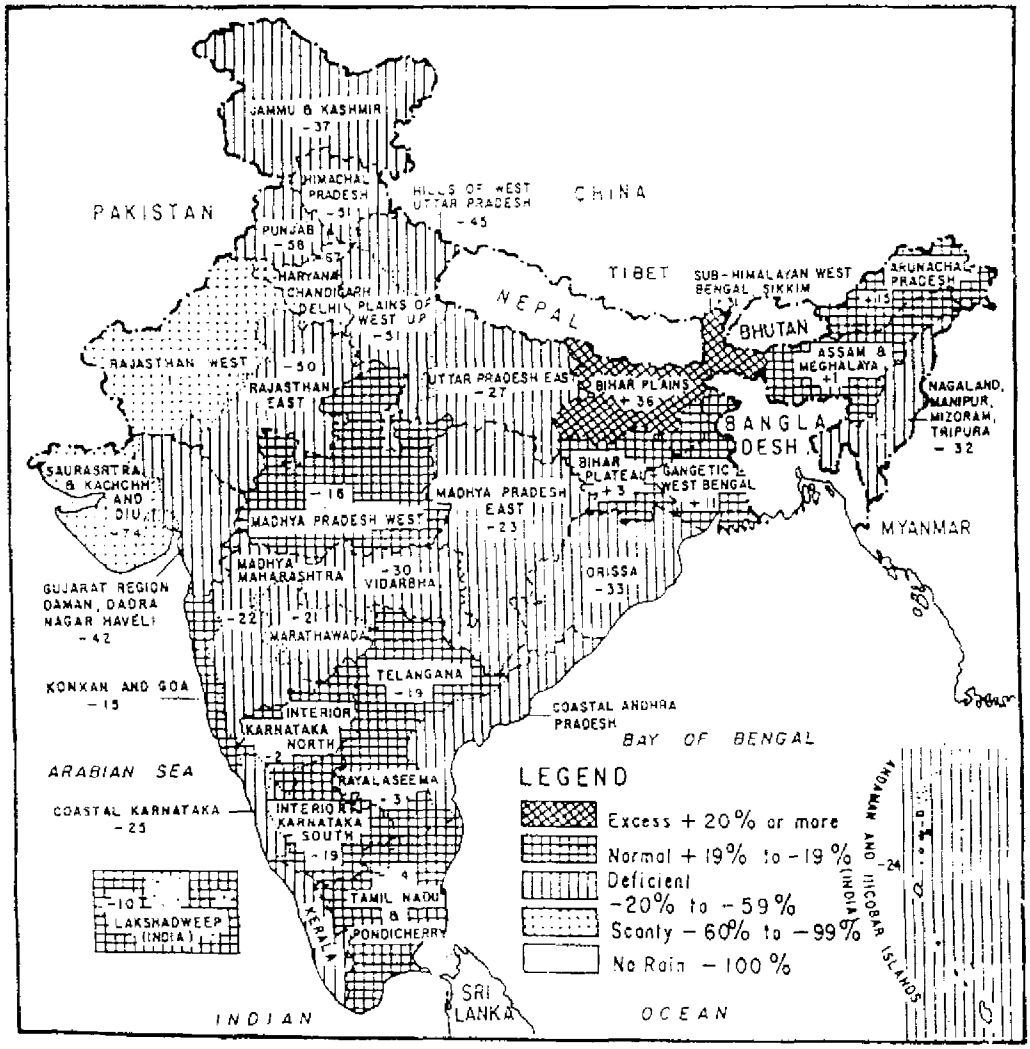

Figure 5: India: Percentage Departure of Normal Rainfall for the Period From June 1 to September 30, 1987
(Source: Ministry of Agriculture)

Such drought assessment was completed at sub-district level in Karnataka, Andhra Pradesh and Bihar states during 1991-1992, particularly for kharif season At present, quantitative drought impact on crop and fodder production and surface water availability by end of kharif season would be attempted. The use Synthetic Aperture Radar (SAR) data from ERS-1 satellite is being examined for drought assessment during the cloud covered southwest monsoon season (June-September) when optical remote sensing has limitations (Thiruvengadachari, 1993; Murai, 1991).

Another integrated pilot project to combat drought has been started by Department of Space in 21 districts in various states. The State Governments are actively participating in the project which integrates natural resources, demographic and socio- economic data base in order to manage land, water, agriculture and fodder resources. Maps derived from IRS-IA satellite at 1:50,000 scale is used to get resource data. The Survey of India topographical sheets and various census reports are also used to get secondary data. In collaboration with Planning Commission, six small watersheds have been identified in six districts like Anantpur (Andhra Pradesh), Dharamapuri (Tamil Nadu), Kalahandi (Orissa) , Ahmadnagar (Maharashtra), Jhabua (Madhya Pradesh) and Bhiwani (Haryana) for implementation of the project. The National Remote Sensing Agency carried out a survey for soil association mapping, land degradation and ground water exploration (Bhattacharya and Reddy, 1991) to aid drought relief in Bundelkhand region of Uttar Pradesh. On the basis of maps prepared, further geophysical exploration was taken up to suggest areas suitable for tube-wells and dug-wells, etc. The integration of remote sensing information with conventional ground based information and meteorological data is considered appropriate for land use, soil conservation, underground potential, wasteland delineation (Nagaraja et al., 1991) and forest cover mapping.

Drought monitoring is an important aspect of satellite monitoring in Maharashtra state. The study for the period 1986-1989 provides invaluable data base to study inter annual biomass production, agro-climatic zoning and rainfall use efficiency in addition to its use in drought monitoring. In the year 1986, the NRSA completed the survey and mapping of wastelands in India using Landsat data. The study utilises the 190 Landsat MSS FCC images to map on 1.1 million scale and estimates the gross area and types of waste lands.

6.2 GEOMORPHOLOGICAL/ GEOLOGICAL HAZARD

The Himalayas (Kawosa, 1988; Singh, 1991, 1992, 1993) hold an important place for survival of North India. To study the vegetation, soil and drainage basins, a total number of 126 images in bands of 5 and 7 were acquired covering the entire Himalayan region in different seasons of the year on the basis of which a broad land use types were delineated, with more emphasis on the forest vegetation and shifting cultivation (Kushwaha, 1991)(Table 5)(Figures 6-9).

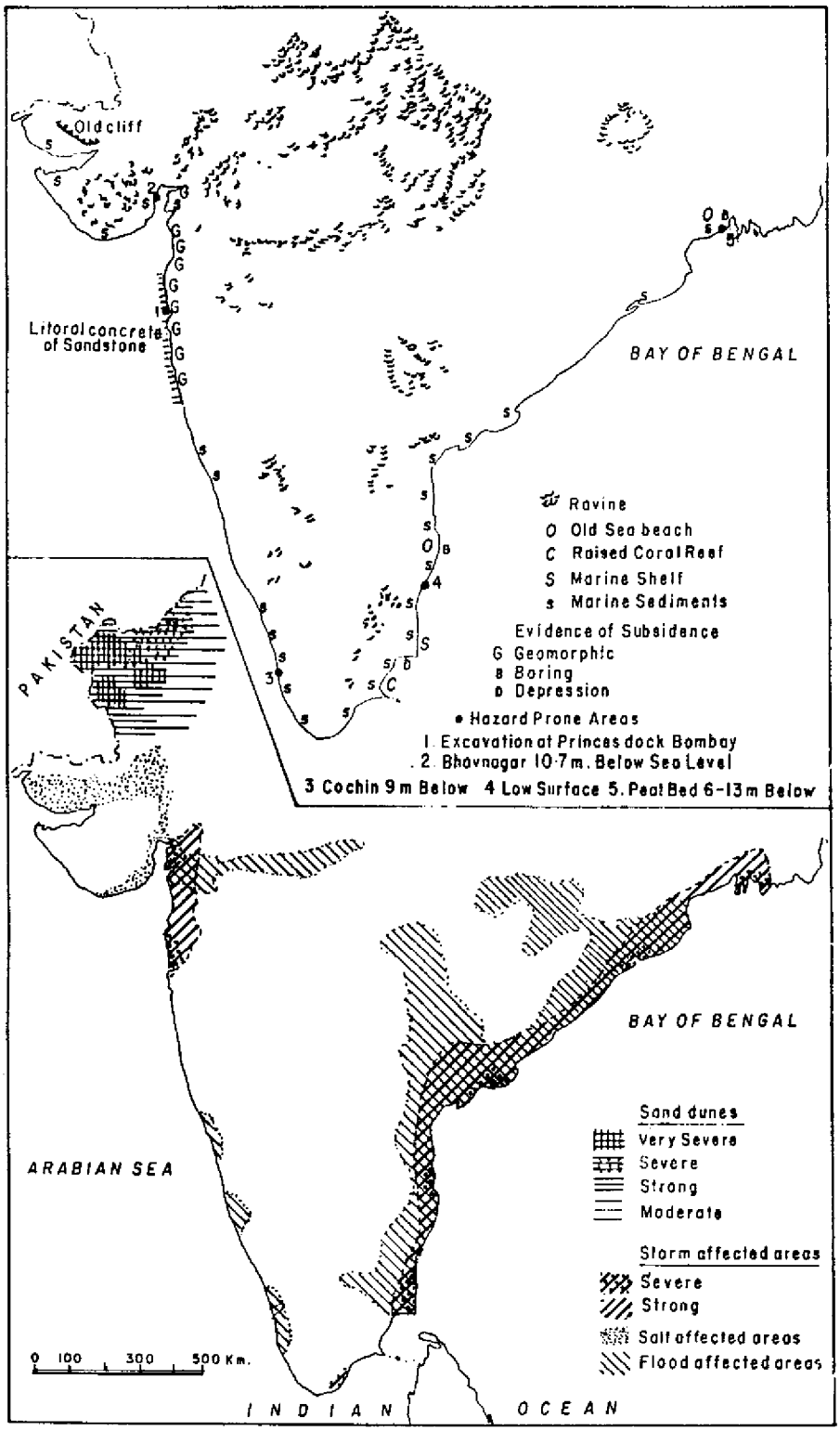

Figure 6: Geomorphological Hazards in Peninsular India (Source: R.B. Singh)