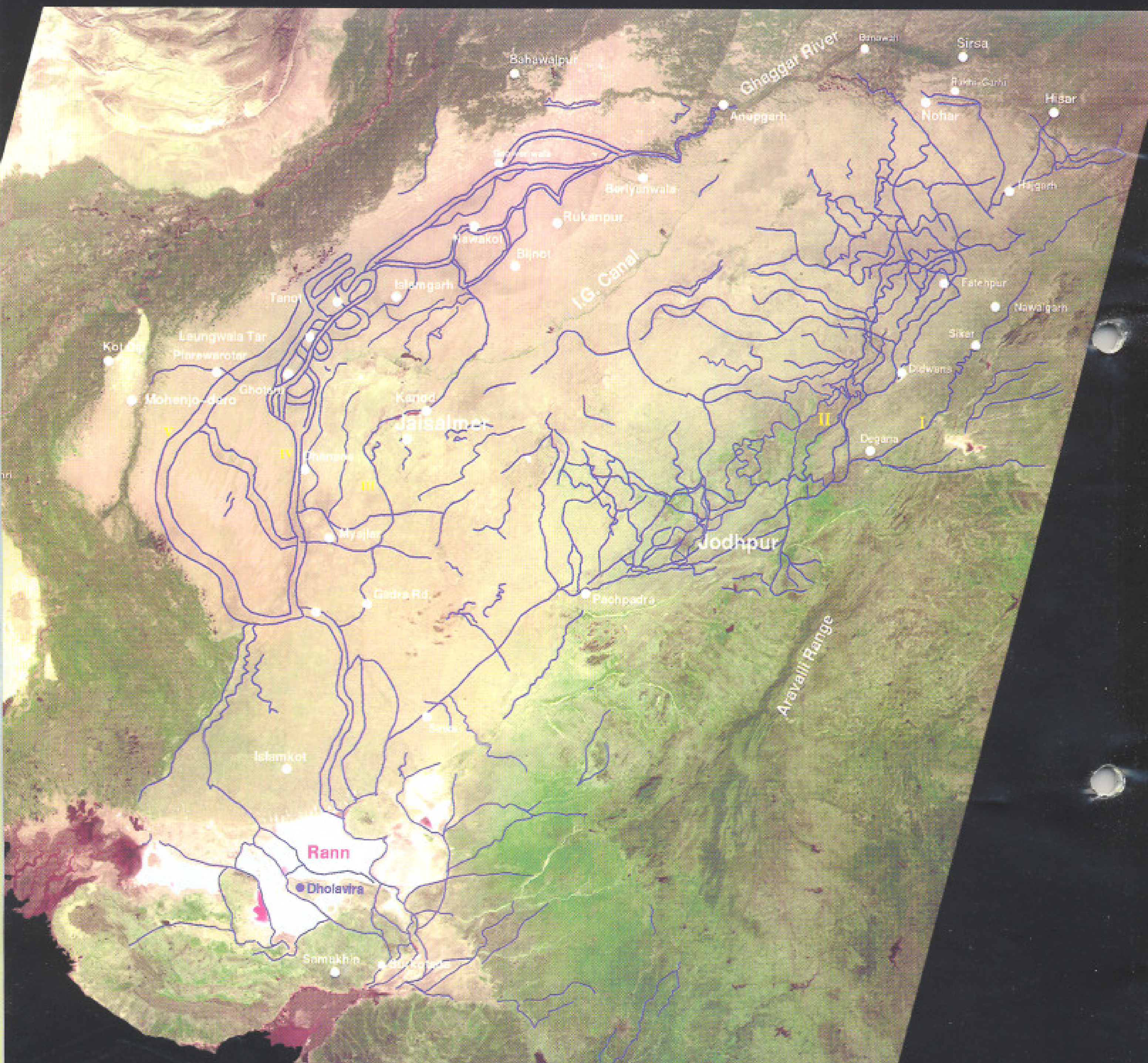
January-March 2002

SPACE india

INDIAN SPACE RESEARCH ORGANISATION



IRS-P3 WiFS Image Showing Palaeo Drainage in Saraswati River Basin
Thick channels represent the course of River Saraswati

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Cover Page : INSAT-3C

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Editor

S. Krishnamurthy

Editorial Assistance

Rajagopal

Editorial / Circulation Office

Publications & Public Relations Unit, ISRO Headquarters, Antariksh Bhavan, New BEL Road, Bangalore - 560 094, India.

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INSAT-3C Launched

INSAT-3C was launched by Ariane-42L Launch vehicle of Arianespace from Kourou, French Guyana, on January 24, 2002. The 147th flight of Ariane, carrying ISRO's 2,750 kg INSAT-3C, lifted off at 05:17 am IST and INSAT-3C was injected into a Geo-synchronous Transfer Orbit (GTO), 21 minutes after the lift-off, in a 3-axis stabilised mode, with a perigee of 570 km and an apogee of 35,920 km and an inclination of 4 deg. with respect to the equator.

ISRO's Master Control Facility (MCF) at Hassan in Karnataka acquired the telemetry signal from INSAT-3C at 5:47 am IST and carried out the initial health checks on the satellite. In the subsequent days, the satellite was successfully moved to geo-stationary orbit by firing the 440 Newton Liquid Apogee Motor (LAM) in four stages. The first LAM firing was on January 25, 2002 for 59 minutes that raised the orbit to 9,350 km X 35,930 km and reduced the orbital inclination from 4 deg at the time of injection to 1.75 deg. The second firing for 30 minutes on January 26, 2002 raised the orbit to 18,340 km X 35,787 km with the inclination reduced to 0.74 deg. The third firing for 26 minutes on January 28, 2002 raised the orbit to 32,448 km X 35,785 km and the inclination further reduced to 0.18 deg. The last firing of 3 minutes on January 30, 2002 brought the satellite to near geo-stationary orbit. At the end of orbit-raising operations, the satellite had 488 kg fuel left on board which is sufficient for its design life of 12 years. The satellite arrived at its designated orbital slot of 74 deg East on February 8, 2002 where it is now co-located with INSAT-1D (other INSAT satellite locations are: INSAT-2C and INSAT-2B at 93.5 deg East longitude, INSAT-2E and INSAT-3B at 83 deg East longitude, INSAT-2A at 48 deg East longitude and INSAT-2DT at 55 deg East longitude). INMARSAT Organisation's ground stations at Beijing (China), Fucino (Italy) and Lake Cowichan (Canada) helped MCF during the initial phases of the INSAT-3C operations.

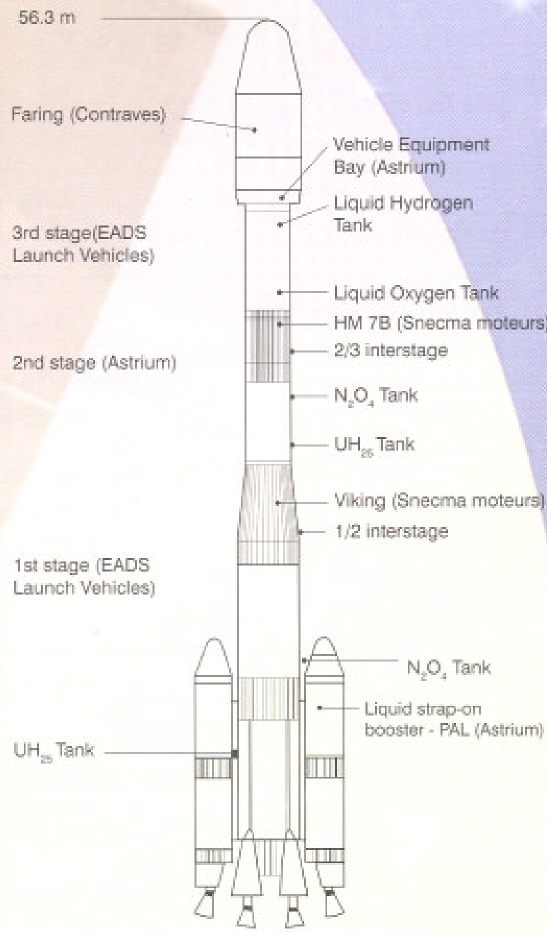
The deployment of solar arrays on the south and north sides of the satellite and the antennas on the west and east sides of INSAT- 3C was completed on January 31, 2002 when the satellite was in its drift orbit. By the end of February 2002, the testing of all transponders was completed and the satellite made ready for regular services.

INSAT-3C carries 24 C-band transponders, six extended C-band transponders, two S-band transponders and a Mobile Satellite Service transponder operating in S-band up-link and C-band down link. It has the main body in the shape of a cuboid of 2 m X 1.7 m X 2.8 m. The satellite measure 15.5 m in length with the two solar panels deployed in orbit,. The sun tracking solar panels generate 2.75 kW of power. Two 60 Ah Nickel-Hydrogen batteries support full payload operations even during eclipses. INSAT-3C, like all its predecessors in the INSAT series, is a 3-axis body-stabilised spacecraft using momentum/reaction wheels, earth sensors, sun sensors, inertial reference unit and magnetic torquers. It is equipped with unified bi-propellant thrusters. The satellite has two deployable antennas and three fixed antennas that carry out various transmit and receive functions.

INSAT-3C is the second satellite to be launched in the INSAT-3 series. The first satellite, INSAT-3B, was launched on March 22, 2000. INSAT-3C is expected to augment the present INSAT capacity for communication and broadcasting, besides providing continuity of the services of INSAT-2C as it reaches the end of mission life.

Ariane - 4

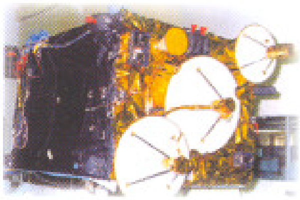
(Flight No. 147)



Mass lift-off: 371 metric tons
Thrust at lift-off: 4090 kN

Flight No. 147 of Ariane was the first commercial launch of the year 2002. INSAT-3C was the eighth Indian satellite to be launched by Ariane. The first satellite, an experimental communication satellite, APPLE, had been launched by the third developmental flight of Ariane in June 1981. INSAT-3C was launched using Ariane 42L which has two liquid propellant strap-on boosters with a lift-of weight of 371 tonne, and measuring 53.3 m in height. The first stage is a liquid propulsion engine. The second stage is also a liquid propulsion stage and the third stage is a cryogenic stage.

SALIENT FEATURES



Mission payloads	Communication
Orbit	Geo-stationary
Location	74° E Longitude
Mass at lift-off	2750 kg
Dry Mass	1218 kg
Size	Cuboid of size 2.0 m x1.77 m x 2.8 m
Length when fully deployed	15.445 m (Along North-South) 7.8 m (Along East-West)
Power	Solar array generates 2765 W during equinox and 2535 W during summer solstice. Two 60 Ah Ni-H_2 battery for full payload operation during eclipse.
Mission life	12 years

PAYLOAD SYSTEMS

NORMAL C-BAND CHANNELS : 24

Uplink frequency	5930-6410 MHz
Downlink frequency	3705-4185 MHz
Coverage	India
EIRP	38 dBW
Antenna	2.0 m deployable – Transmit 0.7 m fixed – Receive
Receive G/T	-3 dB/°k

EXTENDED C-BAND CHANNELS : 6

Uplink frequency	6755-6995 MHz
Downlink frequency	4530-4770 MHz
Coverage	India
EIRP	38 dBW
Antenna	2.0 m deployable – Transmit 0.7 m fixed – Receive
Receive G/T	-3 dB/°k

S-BAND BSS CHANNELS : 2

Uplink frequency	5850-5930 MHz
Downlink frequency	2550-2630 MHz
Coverage	India
EIRP	42 dBW
Antenna	1.1 m fixed – Transmit 0.7 m fixed – Receive
Receive G/T	-3 dB/°k

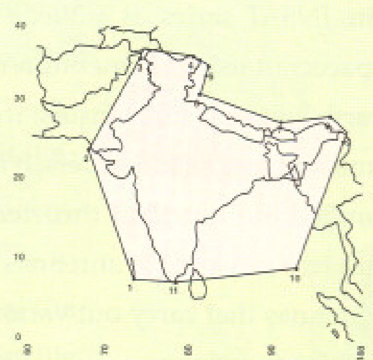
MSS CHANNEL (FORWARD LINK) : 1

Uplink frequency	6450-6470 MHz
Downlink frequency	2500-2520 MHz
Coverage	C-band India coverage S-band wide coverage
EIRP	39 dBW
Antenna	0.7 m fixed – C-Band Receive 0.9 m fixed – S-Band Transmit
Receive G/T	-4 dB/°k

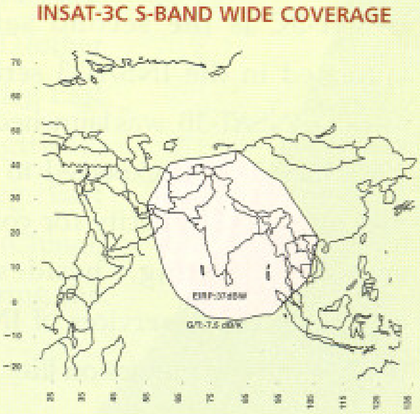
MSS CHANNEL (RETURN LINK) : 1

Uplink frequency	2670-2690 MHz
Downlink frequency	3680-3700 MHz
Coverage	C-band India coverage S-band wide coverage
EIRP	33 dBW
Antenna	0.9 m fixed – S-Band Receive 2.0 m deployable – C-Band Transmit
Receive G/T	-6 dB/°k

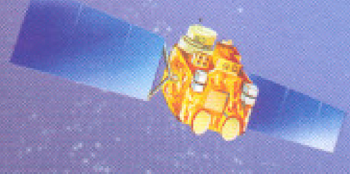
INSAT-3C FSS C-BAND AND BSS S-BAND INDIA COVERAGE



INSAT-3C S-BAND WIDE COVERAGE



Remote Sensing Helps to Trace the Course of River Saraswati



It is believed that long ago a mighty river, Saraswati, flowed in the north-western region of India. Mention of

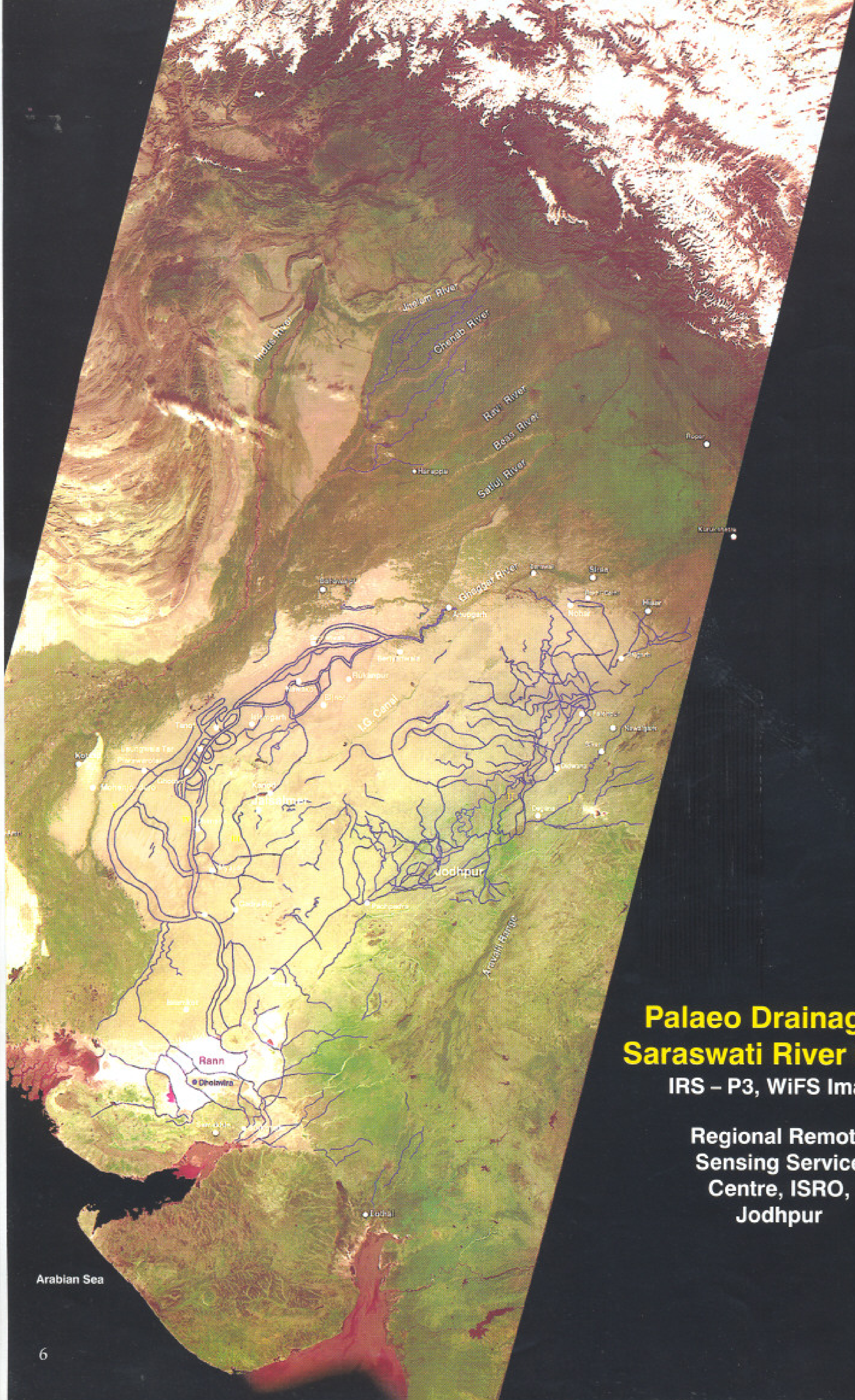
Indus and Ghaggar (Saraswati) depicted as parallel river systems – In Moghul Period Dutch map (Year 1746)

this holy river can be found in the Vedic and ancient literature like the Rigveda, Brahmana and Srautasutra literature, Mahabharata, Ramayana, Bhagvat Purana, Vamana Purana and Upanishads. Many seats of learning and ashramas, inhabited by Rishis like Yagyavalka, were situated on the banks of the river.

Several attempts have been made to discover the palaeo channels and reconstruct the Saraswati drainage system. Different courses of the river have been suggested by investigators, which are based on the mapped palaeo drainage patterns. The advancements in space-based sensor with varying spatial and spectral resolutions, as well as advancements in data processing technologies, have made it possible to map the palaeo drainage courses of the Saraswati River basin more accurately and arrive at the true course of the river and its tributaries.

The Regional Remote Sensing Service Centre (RRSSC/ISRO) of ISRO, located at Jodhpur, has carried out the detailed study to map the palaeo channels to establish the course of river Saraswati. Data from the Wide Field Sensor (WiFS) of Indian Remote Sensing Satellite, IRS, which has a spatial resolution of 188 m and a swath of 810 km, has been used for mapping prominent palaeo channels. Since the data has been obtained under identical radiometric and geometric conditions over the entire study area, the mapping is more reliable. Two satellite scenes covering most part of the Saraswati River basin have been mosaiced. Digital enhancement techniques like local area histogram stretching has been used to enhance the palaeo channel signatures. The courses, mapped using WiFS data, has been further refined using data from the Linear Imaging Self Scanner (LISS-III) of IRS, which has a spatial resolution of 23.5 m and Panchromatic data, which gives a spatial resolution of 5.8 m. Combining all these data, hybrid data products have been generated.

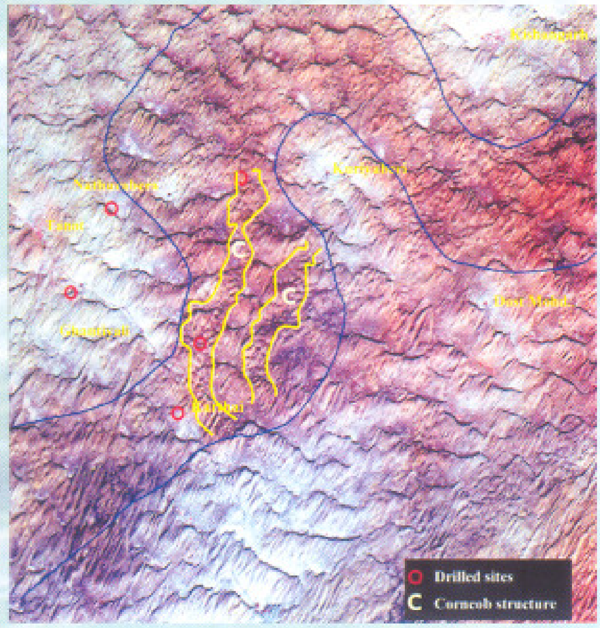
Imageries generated for specific areas on 1:20,000 and 1:50,000 scales have been used to select sites over the Palaeo channels for drilling and check for ground water.



Palaeo Drainage in Saraswati River Basin

IRS – P3, WiFS Image

Regional Remote Sensing Service Centre, ISRO, Jodhpur



Palaeo Channels in part of Jaisalmer District showing Exploratory Well Drilling Sites and corncob structure

The drilling of eleven bore wells on the predicted palaeo channels in Jaisalmer district and analysis of the age of ground water samples have confirmed the presence of palaeo channels. The chemical analysis of water samples from Ranau, Kuriaberi and Ghotaru (10 km from Longewala) indicates that these palaeo channels could form a source for good ground water in the Jaisalmer region. The thickness of palaeo channels ranges from 15 to 40 metre.

It is also interesting to note that the salinity of water in the area away from the palaeo channels rises sharply. For example, while a well drilled at Ghantiyali, which is just outside the palaeo channel on the outer edge has a Total Dissolved Salts (TDS) of 2500 parts per million, an existing well at Tanot about 1.5 km away from the channel has a TDS of 9000. The presence of gravel zone and medium to coarse-grained sand at varying depths of 40 to 125 m in many wells in the litho-log has been taken as the prime indicator of the palaeo channels. Gravel and medium to coarse sand have been encountered in 7 bore wells. Water levels in most of the bore wells drilled range between 35-40 metre.

Analysis of the water samples carried out by the Bhabha Atomic Research Center (BARC) indicates the ages of water to be: Kuriaberi 1340 BP (Before Present), Ghantiyali 550 BP, Ranau TW 1930 BP, Sadewala 18800 BP, Longewala 12400 BP, Ghotaru 8910 BP, Dost Mohd. 2000 BP (Nair et al, 1999). These areas are either on the palaeo channel or very close to it. Hence the analysis also indicates towards a palaeo source of water from the channels.

Archaeological data have also been plotted in a GIS environment and overlaid on the palaeo channels map to correlate the palaeo channels and the sites of Harappan and Pre-Harappan civilisation. An overlay of the archaeological sites in Rajasthan on the palaeo channel map shows a number of sites lying along the present day Ghaggar river indicating Ghaggar to be the Palaeo Saraswati. Maps of Indo-Pakistan region prepared during the Mughal period have also been studied. Some of these maps show the existence of Indus River as a parallel river system with a stream to its right. This indicates the occurrence of Saraswati as a parallel river system to the Indus River. Also, a map of the Kutchch peninsula is indicated as a series of islands and not as a single landmass.

From the prominence and the width of the palaeo channels on the satellite data, supported with data from archaeological finds, age and quality of ground water, sediment type data, etc, it can be concluded that Saraswati indeed flowed in the ancient time with major course passing through the present day river Ghaggar (in northern Rajasthan) and further flowing to Rann of Kutchch. A channel of the main river course passed through Jaisalmer district while a major part of the river was drained further west in-side Pakistan.

(This article is based on a report by Mr. A K Gupta, Dr. G Sreenivasan and Dr. J R Sharma, Regional Remote Sensing Service Centre, Jodhpur)

Anna University to Develop Micro-satellite

Indian Space Research Organisation (ISRO) and Anna University announced on February 15, 2002 at Chennai, the proposed development of a micro-satellite by Anna University. The announcement marks a significant milestone in ISRO's pursuit to strengthen its university linkages that could generate human resources for the space programme and build capacity in the universities to undertake advanced research and development activities.

According to the announcement, Anna University will build the micro-satellite and ISRO will launch the satellite as a piggyback payload on its Polar Satellite Launch Vehicle, PSLV. The satellite will be developed in about three years.

Being the first of its kind for an Indian University in spacecraft development, the micro-satellite will be a comparatively simple one weighing around 60 kg. It will have body-mounted solar panels generating about 40 Watt of electrical power and will be spin-stabilised. It will have a data store-and-forward payload for conducting experiments on message transfer across the country.

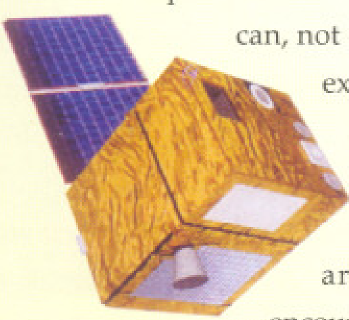
The micro-satellite development will provide a good opportunity for the students and the faculty of Anna University to get an insight into the various aspects of satellite technology. It will also help them to conduct meaningful application studies and gain experience in satellite mission operations. Anna University will establish necessary facilities for the satellite development including a clean room for assembly and testing besides providing other support facilities to sustain the activity. ISRO will provide technical and managerial guidance, besides necessary financial support.

Globally, there has been an interest in the development of micro-satellites by several universities. It is one of the most cost-effective ways for human resources development in space technology. These micro-satellites could be used to test advanced technologies for future operational satellites or for larger scientific missions. The advantage of micro-satellites is that they can be launched as piggyback payloads along with a primary satellite like IRS thus making the micro-satellite launch affordable. The universities can provide a multi-disciplinary environment to combine the educational and research capabilities for the focused programme. It is in this context that the proposal for development of micro-satellite by Anna University assumes significance. The mission is expected to provide impetus for other universities to take up similar projects in the coming years. ISRO will pursue other leading educational institutions in the country to take up such ventures in order to enrich and build necessary capabilities within the university system and stimulate interests among the younger generation to take up challenging careers in science and technology.

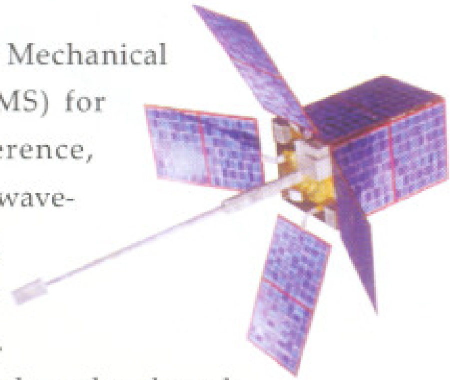
Micro-satellites and Their Applications

Micro-satellites may not replace large or medium-sized satellites but they will certainly provide opportunities for innovation in programme and systems design, technology and methodology, because they can be built at cheaper and faster rate. They are physically very small; nevertheless they are complex and exhibit virtually all the characteristics of large satellites – but in a microcosm.

There are many space applications that never take off because access to space is simply too expensive. Reducing mission costs can, not only spur growth in existing services, but also, foster new and as yet unimagined services in other areas. It can also encourage greater diversity and number of science missions.



The current technology revolution, driven by exponential growth in microelectronics performance and miniaturization can potentially reduce costs. Indeed, as with the "faster, smaller and cheaper" trend in mobile phones and laptop computers, we are seeing, since the end of 1980s, a breed of new generation of "micro-satellites" capable of lowering mission costs. The increasing scales of integration have made satellites themselves cheaper to build and by incorporating more components on PCBs and microchips, we can one day reach a stage where satellites can be put together under the microscope (system on a chip). Other ideas include exploiting Micro-Electro Mechanical Systems (MEMS) for inertial reference, antennae and wave-guides, using thin films in batteries, etc.



These satellites also reduce launch costs since they can be launched as auxiliary payloads on large vehicles or many of them can be launched as a cluster in smaller vehicles.

Micro-satellites can serve varied applications. They include the following:

Communication or data relay from LEO: Since micro-satellites orbit the earth once every 90 minutes or so, they can be operated in a 'store and forward' mode. In this way, data is up-linked to the satellite from one station, temporarily stored on board and then downlinked to a receiving station when the satellite comes within its range. Other communication services include electronic mail, computer data transfer, position location, etc.

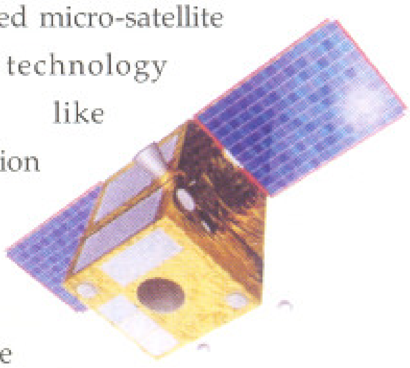
Remote Sensing: Using Charge Coupled Device (CCD) cameras and other widely available video technology, coupled with on-board processing and digital compression, relatively inexpensive but capable remote sensing payloads can be built, which can be incorporated on micro-satellites thus making remote sensing, especially for some specific mission, highly affordable.

Science Missions: Micro-satellites are suitable to understand the earth and its environment like atmosphere, pollution, gravitation, wave propagation, earthquake, etc.

Education and Training: Micro-satellites can be effectively used for education and training. The growing space industry and associated services as well as scientific organisations require a steady flow of trained and competent personnel to meet the challenges for the future. Although, micro-satellites are physically very small, they are nevertheless complex and exhibit virtually all the characteristics of a large satellite. This makes them suitable for providing education and hands-on experience to scientists and engineers in all aspects of a space mission – from design, construction, test and launch through the orbital operation.

Validation of new technologies: In view of low mission cost, Micro-satellites can be used for testing of new technologies that can be adopted in bigger satellites later.

In USA, several universities develop micro-satellites for student education and training in space technology. The micro-satellites developed by these universities serve for applications related to communications, validation of new technologies developed in industries and earth observation for specific application. In Europe, several universities are engaged in micro-satellite development as means of education and training in space technology besides conducting communication and remote sensing experiments. European Space Agency (ESA) has developed micro-satellite exclusively for technology demonstration like autonomous operation of spacecraft, validation of new processors, etc. German Aerospace Research Centre (DLR) has developed a micro-sat for validation of thermal infrared detector technology and on-board neural network processing besides using the data for hot-spot and fire detection application. University of Surrey in UK, has developed several micro-satellites for student training and education, besides providing them on commercial basis to other countries who want to acquire space technology (technology transfer). Centre for Space, France (CNES) has developed a range of micro-satellites for science and technology applications and even for telecommunication and earth observation missions. Universities in South Korea, Taiwan, South Africa, Israel, etc, are also engaged in micro-satellite development.



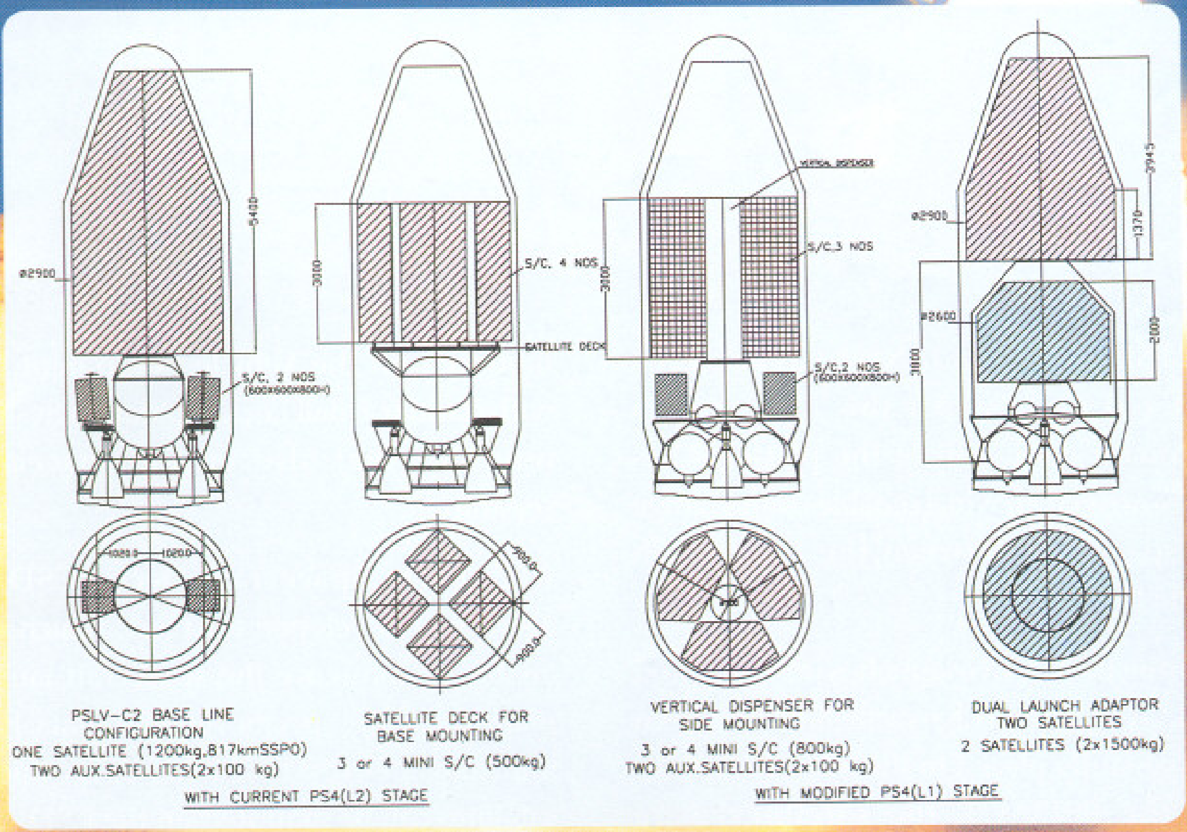
In ISRO, development of its early experimental launch vehicles like SLV-3 and ASLV, provided opportunity for building micro-satellites for technology demonstration besides-science missions.

(This article is contributed by Mr. K Thyagarajan, Programme Director, Small Satellite Systems, ISRO Satellite Centre, Bangalore)

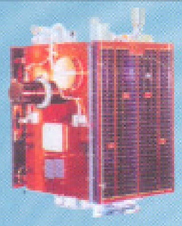
PSLV for Launching Micro-satellites

The successful development and commissioning of ISRO's Polar Satellite Launch Vehicle, PSLV, can act as a catalyst in the development of micro-satellites in India. The payload capability of PSLV has been steadily improved from 900 kg to about 1400 kg for polar missions. PSLV carries micro-satellites in piggyback mode along with Indian Remote Sensing Satellites (IRS) as primary payload. Two micro-satellites of mass up to 120 kg and having specified envelope can be carried as auxiliary satellites to sun-synchronous missions depending on the spare payload capability dictated by the main satellite mass and mission requirements. PSLV offers an auxiliary launch platform for micro-satellites with envelope, interfaces and environments compatible to other launch vehicles.

An agreement for co-operation between ANTRIX and Arianespace for the launch of auxiliary payloads either



Micro-satellites Launched by PSLV

Micro-satellite		Characteristics
KITSAT-3		Mass: 110 kg Size: 600X630X850 mm Deployable solar panels (2 Nos) Interface: IBL358
DLR-TUBSAT		Mass: 45 kg Size: 400 X 400 X 400 mm Body mounted solar panels Interface: IBL230
BIRD		Mass: 92 kg Size: 600 X 600 X 600 mm Deployable Solar panels (2 Nos) Interface: IBL298
PROBA		Mass: 94 kg Size: 600 X 600 X 800 mm Body mounted Solar panels Interface: IBL298

on PSLV or on ARIANE-5 has also been entered into. As per this agreement a common definition of the platform has been arrived at, which enables interchange of spacecraft between the two launch vehicles.

During the last two launches (PSLV-C2 and PSLV-C3) four auxiliary satellites have been successfully placed in the intended orbits. In the PSLV-C3, the satellites were mounted on the Vehicle Equipment Bay with standard 'Ball Lock Separation System' interface that also enable spacecraft separation.

A Circular Spacecraft Deck (CSD) is also being developed for PSLV, which will enable to configure the spacecraft launch platform to any specific requirements. Four mini-satellites (up to 300 kg) or six micro-satellites can be mounted on the CSD.

ISRO Joins International Charter on Space and Major Disasters

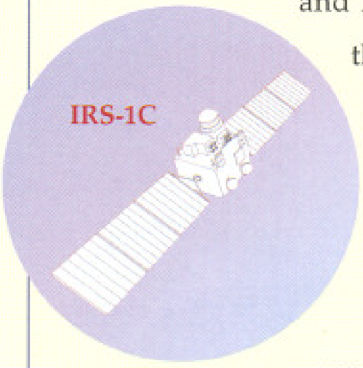
ISRO signed on January 9, 2002 the International Charter on Space and Major Disasters that envisages cooperation in the use of space facilities in the event of natural or technological disasters. The Canadian Space Agency (CSA), French Space Agency (CNES), the European Space Agency (ESA) and National Oceanic and Atmospheric Administration (NOAA) of US are the other space agencies that have already joined the Charter.

It was during the UNISPACE-III conference held in Vienna in July 1999 that the French Space Agency (CNES) and the European Space Agency (ESA) announced their intention to set up a coordinated access to space means that could contribute to prevention and mitigation of natural disasters. The idea was mooted keeping in view that no single operator or a single satellite can meet the challenges of natural disaster management. It calls for a strong international cooperation among space agencies and operators. Efficient use of space technology in disaster management

Operational Overview

- A 24 hour a day on duty operator receives requests
- Specialised on-call officer analyses the request and proposes actions
- On-request fast satellite tasking and image acquisition from the resources identified by all signatories
- Image processing and delivery under the Project Manager responsibility according to a predefined scenario

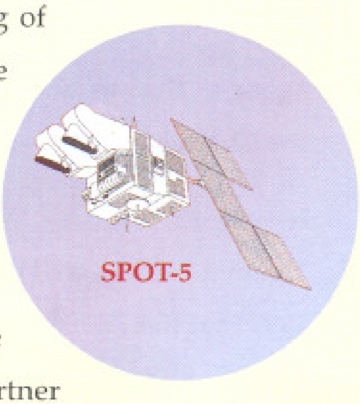
can be achieved through a long term working relationship between the civil protection community and space agencies. This is the objective of the International Charter on Space and Major Disasters. Even though the charter still relies on limited capabilities of the partners on a voluntary basis, it is an important step in merging the requirements of users' like Civil Protection Authorities.



The International Charter envisages supply of space-based data for critical information for the anticipation and management of potential crises to state or communities whose population, activities or properties are exposed to an imminent risk or are already victims of natural or technological disasters. The disaster could involve loss of human lives or large-scale damage to property caused by a natural phenomenon such as a cyclone, tornado, earthquake, volcanic eruption, flood or forest fire, or by a technological accident, such as pollution by hydrocarbons, toxic or radioactive substances.

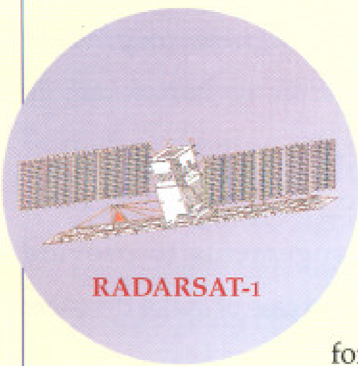
The Charter envisages the civil defence organisations to analyse support from space by calling a confidential telephone number on a 24 hours a day and 365 days a year basis. To activate the Charter, the authorities in the affected country send a Fax detailing the type, location, magnitude and time of occurrence of the event to the On-duty Operator of the Charter at European Space Research Institute (ESRIN), Frascatti, Italy. This Operator transmits the information to the Emergency On-call Officer (EOC). The EOC responsibility is shared by all the signatories to the charter (ESA, CNES, CSA, NOAA and ISRO) by rotation, on a weekly basis. EOC processes the request, identifies resources, proposes an action plan and passes on this to the Project Manager identified for this event by the Executive Secretariat.

A plan of action is immediately submitted to satellite planners of partner agencies for immediate tasking of their respective satellites and acquisition of new images. Once the operations are underway, the partner agencies nominate a project manager, who will supervise the case till completion. The project manager ensures proper data acquisition, processing and timely delivery. When possible, the project manager supervises interpretation of standard satellite data and production of rapid damage maps, which are delivered to the requestor.



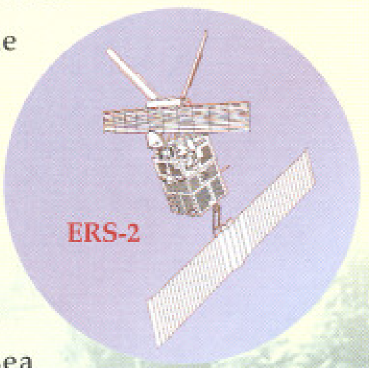
The International Charter on Space and Major Disaster Management is open to all space agencies and space operators of the world on a voluntary basis with no exchange of funds.

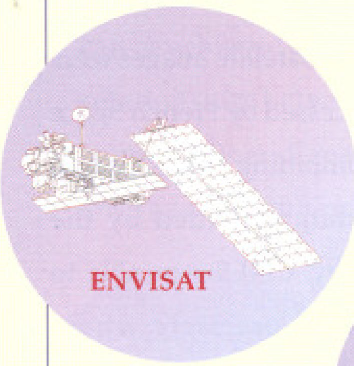
The remote sensing satellites provide images of wide areas in one pass with a precision of a few metre like the Indian Remote Sensing Satellite or the French SPOT satellite. There are also satellites like ESA's ERS-2, Canadian RADARSAT that can image the earth in all weather conditions and at all times of the day. Comparing the images acquired during the disaster with the earlier images, it is possible for detecting areas where changes have occurred. This information will be vital for the civil protection authorities to rescue people and restore damage services.

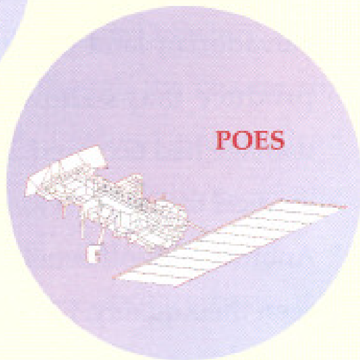

RADARSAT-1

An example where this International Charter has already helped includes the Earthquake on January 13, 2001 in El Salvador in Central America. The tremor demolished thousands of buildings and triggered mudslides, which engulfed entire village and reduced rural communities to rubble. Just a month later, another earthquake measuring 6.6 on the Richter scale struck again near San Salvador. In total, hundreds were known to have died and a million people left homeless. El Salvador's civil protection authorities were faced with a devastated capital and heavy damage to national road and utility networks. In both the cases, the French Civil Protection Agency triggered the Charter to support their medical assistance team. Satellite images were soon gathered and processed by French Space Agency, CNES. By combining these images with topographical data provided by the Salvadorian land survey, CNES was able to produce maps showing precisely where damage had occurred. The maps reached the medical team just before take-off to Salvador. Another spin-off benefit was to come. Having seen their quality, E1 Salvador's Public Safety Ministry obtained a copy of these maps to replace a 25 year old land survey for the reconstruction of the country!

Another example is the oil spill on January 16, 2001 when the tanker Jessica with 900 tons of fuel on board, ran aground on a sandbank near San Cristobal Island, one of the five major islands of the Galapagos Archipelago. Four days later, the oil slick spread and, while relatively small, it threatened unique flora and fauna, algae and sea urchins, pelicans, marine iguanas, sea lions, etc. Following a request from the Ecuadorian authorities, the European commission sent a task force of three experts on site and activated the Charter to support their mission. The satellite, RADARSAT, provided for an 'all at once' scenario of the oil spill, imaging an area of more than 1000 km. In these images, the spill could be seen

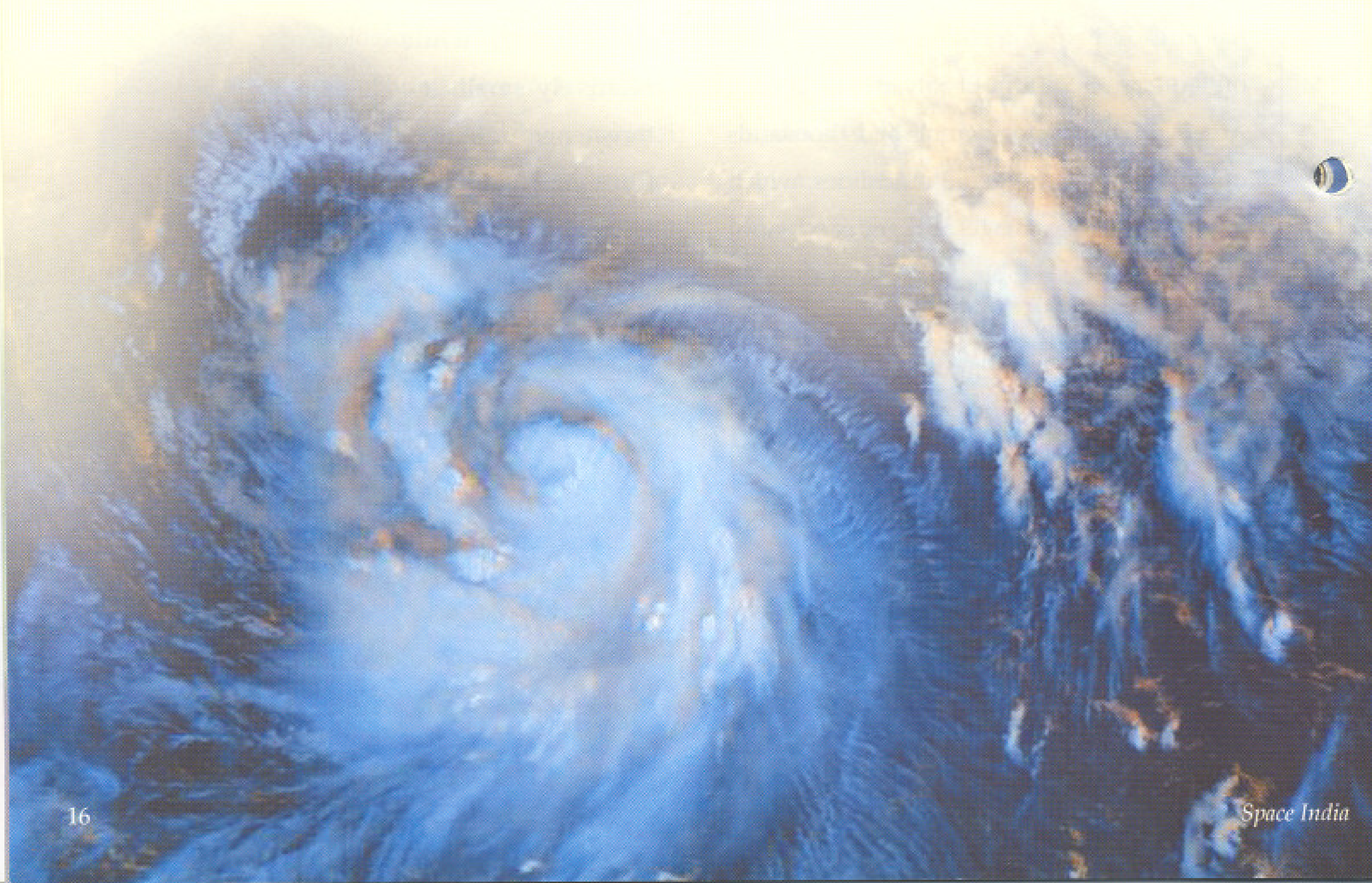

ERS-2





radiating from the western tip of San Cristobal Island and moving north-west towards the Santa Fe and Santa Cruz Islands.

ISRO, with a large constellation of Indian remote sensing satellites providing imageries in various spectral bands and a variety of spatial resolutions, can play an important role in the global context of disaster warning and mitigation. By signing the International Charter on Space and Major Disaster, ISRO has indicated its willingness to provide remote sensing data from its Indian remote sensing satellites for the purpose of disaster relief. ISRO is also setting up necessary organizational arrangements to provide required timely inputs in case of major disasters as per the Charter.



Space Co-operation
Agreements Signed

ISRO signed four cooperative agreements — with, European Space Agency (ESA), China National Space Administration, Thailand and Brazil — during January-March 2002.

Agreement with European Space Agency: ISRO signed on January 9, 2002, a cooperative agreement with the European Space Agency (ESA) that renews the arrangements for cooperation between the two agencies in the peaceful uses of outer space for mutual benefit. Dr K Kasturirangan, Chairman, ISRO, signed the cooperative agreement on behalf of ISRO while Mr Jean-Pol Poncelet, Director, Strategy and External Relations of ESA signed the agreement on behalf of Prof Antonio Rodota, Director General of ESA. This is an umbrella agreement that enables both ISRO and ESA to carry out programmes of common interest in space science and applications including communication, remote sensing for monitoring the environment and corresponding data processing, meteorology and navigation, and life and material sciences under microgravity conditions.

ISRO-ESA cooperation is long standing– ISRO's first experimental communication satellite (APPLE) was launched on board ESA's Ariane Launch Vehicle in 1981. Ariane also launched several INSATs of ISRO. Many ISRO scientists have received training in ESA's laboratories. ISRO receives microwave remote sensing data from ESA's ERS-1 and ERS-2 satellites, which is used for several applications. ISRO has launched ESA's PROBA satellite on board its PSLV in October 2001.

MOU with China: A Memorandum of Understanding was signed by Dr. K. Kasturirangan, Chairman, ISRO, and Mr. Wang Yi, Vice Minister of Foreign Affairs, China, on January 14, 2002, at New Delhi for cooperation between ISRO and the China National Space Administration (CNSA) in the peaceful uses of outer space. The MOU was signed in the presence of the Prime Minister of India Mr Atal Behari Vajpayee and the Chinese Premier Zhu Rongji. The MOU follows an earlier MOU signed in 1991 between the Department of Space of India and the Ministry of Aerospace Industry, China, under which the two countries have exchanged visits of experts in the area of remote sensing data applications. The present MOU is expected to further strengthen the cooperation, especially, in space applications for mutual benefit.

Agreement with Thailand: The India's Minister of State (Space) Ms Vasundhara Raje and Thailand's Minister of Foreign Affairs Mr Sura Kiart Sathirathai signed an agreement on cooperation in the peaceful uses of outer space on February 1, 2002. The agreement was signed at a brief function in New Delhi, in the presence of the Prime Ministers of both countries. ISRO and the Geo-Informatics and Space Technology Development Agency (GISTDA) of Thailand will be the implementing agencies for the Agreement. The Prime Minister of Thailand had visited ISRO in November 2001. This was followed by a visit of a delegation led by the Minister for Education and the Minister for Science, Technology and Environment to ISRO in January 2002 during which Thailand expressed keen interest in cooperating with India in the area of space. The present agreement, which is the result of these visits, is expected to lead to technical and commercial cooperation between the two countries in the area of space.

MOU with Brazil: The Memorandum of Understanding (MOU) with Brazilian Space Agency (AEB) was signed at Bangalore on March 1, 2002 by Dr K Kasturirangan, Chairman, ISRO and Dr Mucio Roberto Dias, President, AEB in the presence of India's Minister of State (Space) Ms Vasundhara Raje and Brazil's Minister for Science and Technology Mr Ronaldo Mota Sardenberg. The MOU envisages cooperation between the two space agencies in the peaceful uses of outer space and is expected to open up a long and enduring relationship between India and Brazil in the following broad areas:

- Cooperative programmes in satellites and use of sounding rockets, balloons and ground based facilities for space research and applications of space technology;
- Studies related to satellite communications, space-based remote sensing and meteorology applications;
- Operation of satellite ground stations and satellite mission management;
- Organisation of training programmes and;
- Exchange of technical and scientific personnel to participate in the studies and joint working groups to examine specific issues.

Speaking on the occasion, Ms Vasundhara Raje, Minister of State (Space) said that, though India and Brazil are located continents apart on the globe, they share several things in common. Both are large countries with rich endowment of natural resources, have long coastlines and rich bio-diversities and both the countries are striving to accelerate their economic growth through judicious use of science and technology. "Thus, there is a good scope for cooperative ventures between countries in the use of science and technology for development" she said. The minister also highlighted how India has been able to use space technology for a number of developmental applications.

Dr. Mucio Roberto Dias (left) and Dr. K Kasturirangan exchanging the documents after signing the MOU. Mr. Ronaldo Mota Sardenberg, Minister for S&T, Brazil and Ms. Vasundhara Raje, Minister of State (Space), India, look on.

United Nations – India Workshop on Satellite Aided Search and Rescue (SASAR)

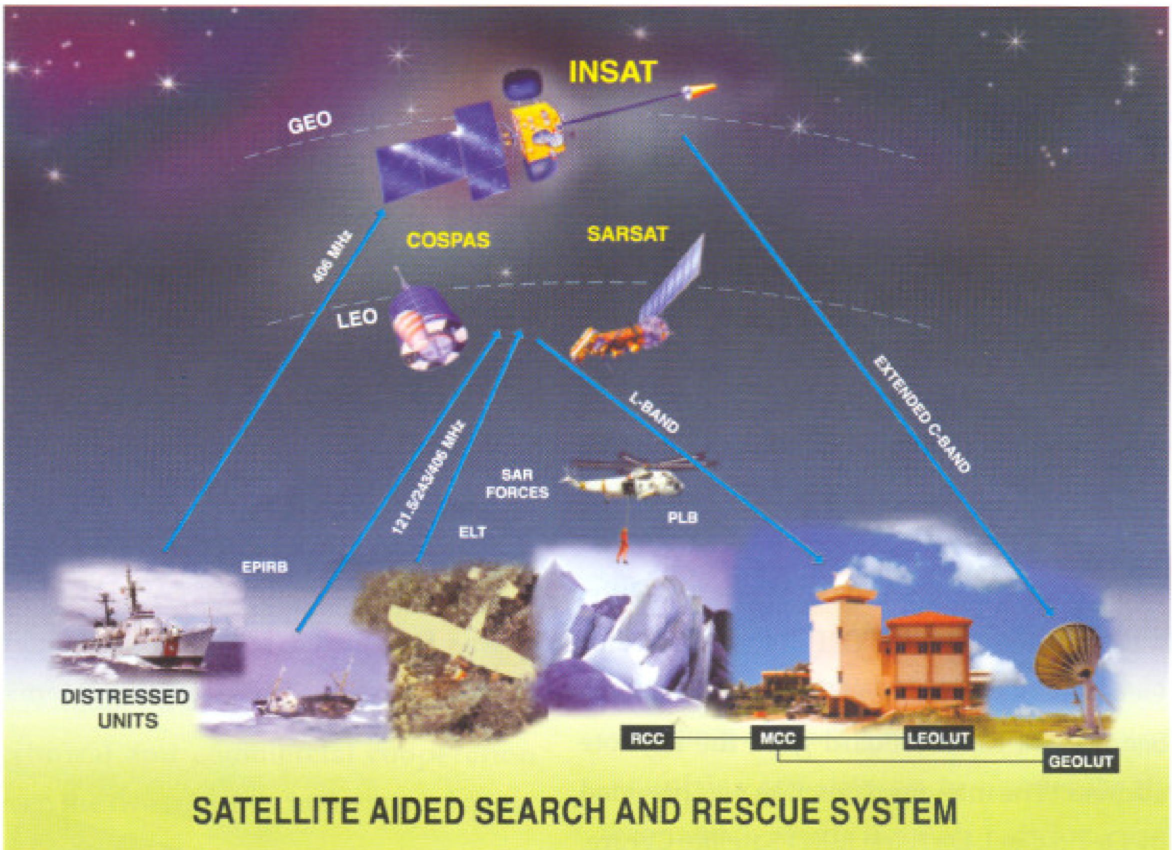
ISRO hosted the United Nations-India Workshop on Satellite Aided Search and Rescue during March 18-22, 2002 at Bangalore. The workshop was inaugurated by Dr V K Aatre, Scientific Advisor to Raksha Mantri. Vice Admiral O P Bansal, Director General Coast Guard and Chairman, National Search and Rescue Board gave the keynote address. The inaugural function was presided by Dr P S Goel, Director, ISRO Satellite Centre. Mr Victor Kotelnikov UN representative and Mr Daniel Levesque, Head COSPAS-SARSAT Secretariat also addressed the gathering.

The prime objective of the workshop was to promote awareness of International COSPAS-SARSAT Search and Rescue system and to establish formal interface with user countries under Indian Mission Control Centre of COSPAS-SARSAT for better understanding and co-ordination of the programme. The workshop will also benefit COSPAS-SARSAT users in neighbouring countries of Asia and the Pacific region.

The COSPAS-SARSAT is an international satellite system for search and rescue. It comprises of a constellation of satellites both in polar and geo-stationary orbits. This system provides distress alert and location information to search and rescue authorities for maritime, aviation and land users in distress.

The SARSAT programme was initiated by the USA, Canada and France in the seventies, using US NOAA satellites. The Russians had also developed a similar system known as COSPAS. In 1979, COSPAS-SARSAT system was formalised with the inter-operability between the two satellite systems being

established. Any aircraft or ship or personnel carrying an emergency transmitter (beacon) could activate the beacon manually or automatically in case of a distress situation such

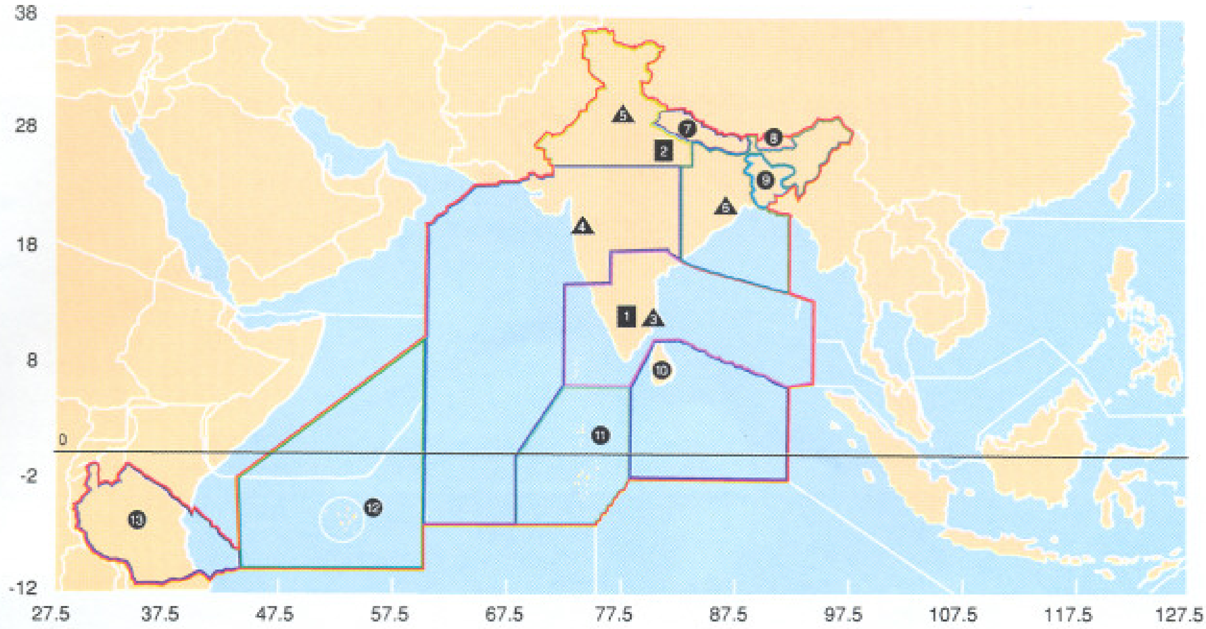


as an aircraft crash or a ship sinking. The location of the beacon transmitting the distress signal is determined by Doppler principle using the relative motion between the satellite and the beacon. The Mission Control Centre (MCC) of COSPAS-SARSAT collects, sorts and stores the data from the Local User Terminals and other Mission Control Centres. Information on distress alerts is passed on to the Rescue Coordination Centres which, based on this information, carry out rescue operations.

ISRO has also established two Local User Terminals (LUT), one at Bangalore and another at Lucknow along with a Mission Control Centre at Bangalore *(see Space India Apr-Dec 1998)*. An Inter Agency Steering Committee (IASC) represented by Coast Guard, Directorate General of Shipping, Civil Aviation, Defence Services, Department of Telecommunication and Ministry of Information Technology has been set up with Department of Space as the nodal agency for co-ordinating Indian COSPAS-SARSAT efforts. The Indian Mission Control Centre is linked to four national rescue co-ordination centres which are located at Mumbai, Chennai, Delhi and Kolkata operated by Airports Authority of India (AAI). The Indian LUTs provide a substantial coverage for the Indian Ocean region and covers seven countries – Bangladesh, Bhutan, Maldives, Nepal, Srilanka, Seychelles and Tanzania. The Indian MCC/LUTs have helped in rescuing about 1300 persons since its operations started in 1986.

India has also incorporated search and rescue transponders on its INSAT system to provide distress alerts even when any satellite in the

INMCC Service Area



Indian LUTs and MCC: 1. Bangalore (LEOLUT, GEOLUT, INMCC) 2. Lucknow (LEOLUT)

Indian RCCs: 3. Chennai 4. Mumbai 5. Delhi 6. Kolkata

INMCC SPOCs: 7. Nepal 8. Bhutan 9. Bangladesh 10. Sri Lanka 11. Maldives 12. Seychelles 13. Tanzania

COSPAS-SARSAT constellation is not within the visibility of the beacon carried by distressed aircraft or ship.

There are 35 countries and organisations who are now formally associated with COSPAS-SARSAT programme, including the four parties to the international COSPAS-SARSAT agreement namely USA, Canada, France and Russia, which provide and operate the space segment. There are 39 low earth orbit Local User Terminals and 7 Geo-stationary Earth Orbiting Local User Terminals and 22 Mission Control Centres around the globe. About 9,10,000 emergency beacons are currently in use. Since its inception, the COSPAS-SARSAT system has helped to rescue about 12,700 persons till the end of the year 2000.

During the Bangalore Workshop on Satellite Aided Search and Rescue, the participants discussed the various system concepts, the regulations, beacon specifications and coding, ground system operations, data distribution procedures, COSPAS-SARSAT distress alert formats, guidelines for national regulatory policies and future system development.

ISRO Tableau at the Republic Day Parade, New Delhi, January 26, 2002