

56th

National Engineers' Day 2023

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Theme: Engineering a Resilient Future: Building Stronger, Smarter, Safer

September 15 is celebrated every year in the country since the year 1967 as "Engineers' Day" to commemorate the birthday of the legendary engineer Sir Mokshagundam Visvesvaraya. Sir Visvesvaraya, an eminent Indian engineer and statesman was born in a remote village of Karnataka, the State that is incidentally now the Hi-tech State of the country. Due to his outstanding contribution to the society, Government of India conferred "Bharat Ratna" on this legend in the year 1955. He was also called the precursor of economic planning in India. His learned discourse on Economic Planning in India, Planned Economy for India and Reconstructing India, was the first available document on the planning effort of the country and it is still held as the parent source matter for economic planners. A theme of national importance is chosen every year by the Council of the Institution and deliberated at its various State/Local Centres to educate the engineering fraternity in general and the society in particular. This year the 56th Engineers' Day will be celebrated all over the country on the theme "Day: Engineering a Resilient Future: Building Stronger, Smarter, Safer".



Bharat Ratna Sir M Visvesvaraya

The Institution of Engineers (India) exhorts the entire fraternity of engineers to embark on a remarkable journey of engineering excellence to celebrate Engineer's Day on September 15th. With the resounding theme, "Engineering a Resilient Future: Building Stronger, Smarter, Safer," we pay tribute to the visionary Bharat Ratna Sir Mokshagundam Visvesvaraya and delve into the captivating realm of engineering perspectives.

In this dynamic era, engineers stand at the forefront of progress, crafting a future that is well fortified and unyielding. They are the architects of resilience, working tirelessly to build structures that withstand the test of time. With their expertise, they erect towers that brave the fiercest storms, bridges that span vast chasm and roads that pave the way to safer journeys. With resilience, engineers stand tall, symbolizing their commitment to a stronger tomorrow.

But engineering goes beyond fortification. It's about envisioning a world where technology unlocks endless possibilities. Our engineers tap into the power of innovation, leveraging cutting-edge advancement to create smarter systems. From intelligent cities that optimize resources to revolutionary transportation solutions they propel us towards a future where intelligence reigns supreme.

Yet resilience is not just physical; it extends to our safety and well-being. Engineers are the guardians of our security, meticulously designing structures and systems that safeguard lives. They implement stringent safety protocols, develop disaster management strategies, and pioneer ground breaking technologies that keep us shielded from harm. Their dedication to safety creates an environment where we can thrive and prosper with peace of mind.

In our quest for a viable future, sustainability becomes a guiding principle. Engineers lead the charge, embracing eco-friendly materials, renewable energy solutions, and sustainable practices. They shape a world that harmonizes with nature, where delicate balance between progress and preservation is upheld. Through their innovations, they ensure that future generations inherit a planet that thrives with abundant resources and thriving ecosystems.

Join us in embracing the power of innovation and resilience, as we honour the unsung heroes who shape our world and engineer a future that stands tall, thinks smart, and keeps us safe. Together, let's empower engineers and forge a path towards a brighter, more resilient tomorrow.

I)Theme for National Engineers' Day 2023 : "Engineering a Resilient Future:Building Stronger , Smarter , Safer".

Theme Paper downloaded from IEI website in the following link:

https://ieindia.org/webui/ajax/Downloads/WebUI_PDF/Activity_Pdf/World_Engg_Day_Sus_Dev_23.pdf?V20230724.1

(text as given in first page with the Photo of Bharat Ratna Sir M.Viswesvaraya)

II)Theme for World Engineering Day for Sustainable Development 2023 (March 4): " Engineering Innovation for a more Resilient World "

Worldengineeringday.net/about-us/

2nd UNESCO Engineering Report (2021)

Engineering for Sustainable Development :Delivering on the Sustainable Development Goals

Unesco.org/en/basic-sciences-engineering/report

UNESCO Digital Library Link:

<https://unesdoc.unesco.org/ark:/48223/pf0000375634>

The report provides a snapshot of the engineering innovations that are shaping our world, especially emerging technologies such as big data and AI, which are crucial for addressing the pressing challenges facing humankind and the planet. It analyses the transformation of engineering education and capacity-building at the dawn of the Fourth Industrial Revolution that will enable engineers to tackle the challenges ahead. It highlights the global effort needed to address the specific regional disparities, while summarizing the trends of engineering across the different regions of the world(Downloaded from UNESCO website)

III) Theme for National Technology Day 2023 (May 11): “School Startups - Igniting Young Minds to Innovate”

National Technology Day is celebrated every year on 11th May to commemorate the country's technological advancements. On this day in 1998, India had the prideful accomplishments of 'Operation Shakti'. The celebration of National Technology Day was started one year later by Prime Minister Atal Bihari Vajpayee in 1999 to honour Indian scientists, engineers, and technologists who worked for India's scientific and technological advancement and ensured the successful conduct of Pokhran tests in May 1998.

Department of Science and Technology

dst.gov.in/national-technology-day

<https://www.indiascience.in/videos/national-technology-day-2022-and-awards-e>

<https://www.youtube.com/watch?v=drsmOLeJBOI>

IV) Theme for National Space Day(August23)2023: “Applications of Spatial Technologies ”

National Space Day is a day of the year set aside in India to commemorate [Chandrayaan-3's](#) successful landing on the Moon. It is celebrated on 23 August.

On 23 August 2023, the [Indian Space Research Organization](#) (ISRO) reached a significant milestone by successfully landing [Chandrayaan-3's](#) lander and rover on the Moon. Recognizing this achievement, Prime Minister [Narendra Modi](#) proclaimed August 23rd as "National Space Day" in India.

Space Applications Downloaded from the ISRO website

<https://www.isro.gov.in/SpaceApplications.html>

Satellite Communication Applications

A fleet of commercial communication satellites, are operating over India with communication transponders in C-band, Extended C-band, Ku-band and S-band. These transponders support the services like television, telecommunication, radio networking, strategic communication and societal applications. The prominent users of the transponders are BSNL, Doordarshan, All India Radio, strategic govt. users, public sector units, private VSAT operators, DTH and TV operators, banking and financial institutions, etc.

Under societal applications, ISRO/DOS has supported programmes like Telemedicine, Tele-education and Disaster Management Support (DMS) Programmes

which are solely national development oriented with an aim to address specific requirements at different strata of the society.

Television

INSAT has been a major catalyst for the expansion of television coverage in India. DOS has made available the required transponders through INSAT/GSAT satellites and through leased capacity to cater to the needs of television service.

Radio Networking

Radio Networking (RN) through INSAT provides a reliable high-fidelity programme channels for National as well as Regional Networking. AIR is utilising one C-band transponder of INSAT-3C for uplinking RN carriers across the country.

Telecommunications

Satellites have been traditionally supporting telecommunication applications for providing voice and data communications. Satellite links are the primary means of connectivity to remote and far flung regions of the country and they are the backup links for large number of terrestrial connectivity in the mainland.

Very Small Aperture Terminals (VSATs) networks are designed to support all kinds of applications supporting video, voice and data, with a wide range of data rates from few kilobits per second (kbps) to 8 megabits per

seconds (mbps). A VSAT network comprises of a central hub and hundreds of terminals which are further interfaced to computers and other peripheral devices. The hub acts as a gateway with interface to external connectivity and several application servers. Rapid technological advancements and reduction in the cost of user equipment are increasing the popularity of VSAT network. A VSAT network works out to be a cheaper option while establishing a network to cover a wide geographical area, state wide or nationwide. VSAT networks operate in C, Extended C and Ku-bands.

Telemedicine

ISRO Telemedicine pilot project was started in the year 2001 as part of proof-of-concept demonstration programme, linking Apollo Hospital at Chennai with the Apollo Rural Hospital at Aragonda village in the Chittoor district of Andhra Pradesh. The Telemedicine technology involved the ICT based system consisting of customised medical software integrated with the computer hardware along with medical diagnostic instruments connected to the commercial VSAT at each location. The Telemedicine software consisted essentially of store-and-forward modules for Tele-radiology, Tele-cardiology and Tele-pathology purposes along with the video-conferencing facility.

As an on-going/continuous activity, tech support is provided to interested hospitals for conducting

Continuing Medical Education (CME); operations of Hub are monitored and continuous follow-up is done with all users for optimum utilisation

Tele-education

‘EDUSAT’, India’s first thematic satellite dedicated exclusively for educational services, was used extensively to cater to a wide range of interactive educational delivery modes like one-way TV broadcast, video conferencing, computer conferencing, web-based instructions, etc. EDUSAT had manifold objectives - to supplement the curriculum-based teaching, imparting effective teacher training, providing access to quality resource persons and new technologies, thus finally resulting in taking education to every nook and corner of India. EDUSAT provided connectivity to schools, colleges and higher levels of education and also supported non-formal education including development communication.

EDUSAT Programme was implemented in three phases: pilot, semi-operational and operational phases. Pilot projects were conducted during 2004 in Karnataka, Maharashtra and Madhya Pradesh with 300 terminals. The experiences of pilot projects were adopted in semi-operational phase. During semi-operational phase, almost all the states and major national agencies were covered under EDUSAT programme.

The networks implemented under EDUSAT programme comprise of two types of terminals, namely, Satellite Interactive Terminals (SITs) and Receive Only Terminals (ROTs). Many states have expressed their keen interest to upgrade their networks and DOS is extending necessary technical assistance towards upgradation and expansion.

Satellite Meteorology

The meteorological satellite data of INSAT is processed and disseminated by INSAT Meteorological Data Processing System (IMDPS) of India Meteorological Department (IMD) At present, INSAT/GSAT satellites carrying meteorological payloads are supporting weather forecasting services. IMDPS is capable to receive and process the data of all three existing geostationary meteorological satellites. The performance of the system has been maintained to the level of 98% operation efficiency (24x365 bases). The output generated by the system is used for efficient and successful forecasting the major weather events, particularly major cyclones in the past.

Satellite Aided Search and Rescue (SAS&R)

India is a member of the international COSPAS-SARSAT programme for providing distress alert and position location service through LEOSAR (Low Earth

Orbit Search And Rescue) satellite system. Under this programme, India has established two Local User Terminals (LUTs), one at Lucknow and the other at Bengaluru. The Indian Mission Control Centre (INMCC) is located at ISTRAC, Bengaluru. The system is operational from the past 24 years.

Standard Time and Frequency Signal Dissemination Services

A Standard Time and Frequency Signal (STFS) Dissemination Service using INSAT system is provided by National Physical Laboratory. This service is available round-the-clock in a broadcast mode and is receivable on a set up consisting of receive antenna, a front-end converter, an FM demodulator and a microprocessor controlled signal decoder. The service consists of a train of 5 KHz bursts signal, which is frequency modulated on the carrier. The timing service has a precision of better than one microsecond and accuracy of better than 20 microseconds.

GPS Aided Geo Augmented Navigation (GAGAN)

The implementation of GAGAN has numerous benefits to the aviation sector in terms of fuel saving, saving in equipment cost, flight safety, increased air space capacity, efficiency, enhancement of reliability, reduction in workload for operators, coverage of

oceanic area for air traffic control, high position accuracy, etc. Directorate General of Civil Aviation (DGCA) certified GAGAN for enroute services (RNP 0.1) on the December 30, 2013 and further certified for precision approach (APV 1) on April 21, 2015. With this, GAGAN signal is available for both civil Aviation and Non-Aviation users. GAGAN Payloads are operational through GSAT-8, GSAT-10 and GSAT-15 satellites.

Some of the benefits GAGAN is expected to bring for Civil Aviation sector are:

- Safety benefits – Vertical guidance improves safety, especially in adverse weather conditions
- Reduction of circling approaches
- Environmental benefits—Approach with Vertical Guidance procedures will help facilitate better energy and descent profile management during the final approach
- Global seamless navigation for all phases of flight including arrival, departure, oceanic and en route
- Allow direct routings, multiple approaches resulting in considerable fuel savings to airlines and provide for capacity enhancement of airports and airspace

In addition to aviation sector, GAGAN is expected to bring benefits to other sectors like:

- Navigation and Safety Enhancement in Railways, Roadways, Ships, Spacecraft
- Geographic Data Collection
- Scientific Research for Atmospheric Studies
- Geodynamics
- Natural Resource and Land Management
- Location based services, Mobile, Tourism, etc.

Some of the specific application initiatives are summarised below:

Surveying: (a) Karnataka forest department has used GAGAN dongle (a low end receiver devised to receive and process GAGAN) for forest surveys. (b) AAI is using GAGAN based surveys for airport survey requirements. (c) NRSC is using GAGAN for Ground Control Point Library recording.

Railways: NRSC, along with Indian Railways, are experimenting on various GAGAN based applications, particularly in providing unmanned level crossing warning to drivers using GAGAN – BHUVAN applications. NRSC is doing pilot work on Train tracking using GPS-GAGAN.

Marine: DG, Shipping had a meeting at ISRO HQ and is in the process of assessing GAGAN for marine operations and are coordinating for the same.

Space weather studies: GAGAN data is being used for space weather studies by SAC/ISAC and has also been

used for developing regional IONO model for Asia Pacific region.

Applications of IRNSS

Two types of services are envisaged by using IRNSS, namely Standard Positioning Service (SPS) which is provided to all the users and Restricted Service (RS), which is an encrypted service provided only to the authorised users. The IRNSS System will provide a position accuracy of better than 20 m in the primary service area.

Some applications of IRNSS are:

- Terrestrial, Aerial and Marine Navigation
- Disaster Management
- Vehicle tracking and fleet management
- Power Grid Synchronisation
- Location Based Services
- Earth and Atmospheric Studies
- Integration with mobile phones
- Fisheries
- Mining
- Precise Timing
- Mapping and Geodetic data capture
- Terrestrial navigation aid for hikers and travellers
- Visual and voice navigation for drivers
- Improved Availability of Position fix in Multi GNSS environment

Disaster Management Support (DMS) Programme

- **The Disaster Management Support** - Decision Support Centre (DMS-DSC) established at National Remote Sensing Centre (NRSC) is actively engaged in monitoring natural disasters such as flood, cyclone, landslides, earthquakes and forest fires. The major activities during the year were monitoring all the flood events, supporting the disaster management during the Nepal Earthquake and monitoring the landslide dammed Phutkal river in Jammu & Kashmir.
- **Floods:** Floods are mapped and monitored in all major states and flood inundation maps were provided in near real-time to the concerned State Relief Commissioners, Ministry of Home Affairs, National Disaster Management Authority, National Disaster Response Force, Central Water Commission and India Meteorological Department. Value added flood products were populated on the Bhuvan and NDEM web portals.
- **National Remote Sensing Centre (NRSC),** Hyderabad being a member of committee on scientific assessment of flood prone area, provides inputs on flood prone area based on DEM, water level and historic satellite data as input..
- **Cyclones:** All the depressions and cyclones originated in the Indian Ocean region were monitored and the track, intensity and landfall were predicted. All the information was regularly updated on the MOSDAC website (<http://www.mosdac.gov.in>) as part of information dissemination.
- **Forest Fire:** The Indian Forest Fire Response and Assessment System (INFFRAS) provides observations of active forest fires from TERRA and AQUA MODIS data on a near real time basis. Active forest information is available to users within 30 minutes of acquisition on Bhuvan as well as through Forest Survey of India.
- **Landslides:** Landslide is monitored using CARTOSAT data and regular updates on impoundment area, volume of water and possible scenario due to breach is provided to NDMA. The inputs are used by NDMA to assess the threat and clear the blockade. Monitoring of the status of Lhonak Lake in Sikkim and Pareechu Lake in Tibet was carried using CARTOSAT data and information was furnished to CWC.
- **Earthquake:** Pre- and post-disaster high-resolution satellite images (Cartosat-1/2, Resourcesat LISS IV) and 10 m DEM are used to map co-seismic landslides triggered during

the earthquake. Many landslide-dammed lakes have also been mapped.

The processed data and information were sent to Ministry of Home Affairs (MHA), National Disaster Management Authority (NDMA) and National Disaster Response Force (NDRF), in addition to uploading to Bhuvan and NDEM web portals of ISRO. The information derived from satellite data is shared among various international agencies for unifying the efforts and coordinating rescue operations.

Early Warning Systems Development: Medium range flood forecast models were developed for the many river basins and operationally used in real-time in collaboration with Central Water Commission. Web-enabled spatial flood early warning system has been developed and being implemented in real-time during the monsoon periods.

An experimental early warning system for rainfall triggered landslides was developed and implemented along the pilgrimage route corridors leading to Gangotri, Badrinath and Kedarnath as well as along the Pithoragarh-Malpa route in Uttarakhand. The early warning is generated based on the statistical relation between the spatial (geological, morphological and terrain factors) and temporal (triggering factor; primarily long term rainfall events and the triggered landslides) controls of slope failure.

Space Applications Centre (SAC), Ahmedabad has developed a model for thunderstorm predictions. Further, a prediction model for heat waves was developed in 2015. Satellite derived information such as landuse/ land cover, vegetation cover, albedo, etc., are major influencing factors for the model. The experimental forecast output is overlaid on a GIS format with base data layers such as district boundaries, roads, railway lines, land use/land cover, etc. Both the forecasts were made available in MOSDAC and the links were given in Bhuvan and NDEM portals.

National Database for Emergency Management (NDEM): NDEM version 2.0 was launched with improved features and functions on ISRO satellite based Virtual Private Network (VPN). This portal consists of multi-scale geospatial database covering base, thematic, infrastructure, disaster specific products and satellite imagery along with a set of customised decision support tools. Generation of multi-scale geospatial services for 36 States / UTs at 1:50,000 scale, 209 out of 350 most vulnerable and multi hazard prone districts at 1:10,000 scale and high resolution satellite data for 210 towns has been completed. Satellite data derived value added disaster specific products (~209) covering 11 States covering disaster events in 2015 were hosted on NDEM portal. Mobile apps and user manuals were also uploaded in NDEM private and public portals for better utilisation of the services. Simultaneously, NDEM

Public portal is hosted on ISRO Bhuvan platform through internet connectivity.

Seven regional training programmes for Central/State government departments (150 officers) have been organised across the country for the familiarisation of NDEM private and public portals for enabling the better utilisation of NDEM products and services.

Aerial survey for large-scale mapping: Close contour flood plain mapping is being carried out using airborne LiDAR / LFDC data for use in flood inundation modelling and flood depth assessment.

Communication Support: The satellite based satellite communication network, by interconnecting the National Emergency Operations Centre (NEOC) at MHA, the PMO, and the State Emergency Operations Centres (SEOCs) for Ministry of Home Affairs, is being maintained operational.

Satellite Aided Search and Rescue: The Satellite Aided Search and Rescue system which provides services to 7 neighbouring countries. Online Beacon registration system has been upgraded based on user requirements.

International cooperation in DMS: ISRO has carried out the Lead Role in International Charter Operations during April-October 2015. During this period, ISRO managed 17 activations, published three

communications and Universal Access was extended to 5 countries. During 2015, satellite data support (28 scenes) were provided for 10 emergency requests from Vietnam, Pakistan, Indonesia, Bangladesh, Japan, Myanmar, Nepal and Taiwan for floods, oil spill, landslides and Typhoon disasters.

Remote Sensing Applications

Remote sensing application projects at National, State and Local levels are being carried out through well established multi-pronged implementation architecture of National Natural Resources Management System (NNRMS) in the country. Major ISRO Centres, namely, National Remote Sensing Centre (NRSC), Hyderabad and Space Application Centre (SAC), Ahmedabad spearhead all such applications development and implementation initiatives from ISRO/DOS. Regional Remote Sensing Centres (RRSCs) of NRSC, North-Eastern Space Application Centre (NE-SAC), Shillong and the State Remote Sensing Application Centres play a key role in implementation and reaching out to the grassroots for effective utilisation of the technology. User Ministries of State and Central Government departments and other institutions play a major role in utilising remote sensing technology in their own departments. In addition, private sector, Non-Governmental Organisations and academia also utilise this technology in different developmental sectors of the country.

National Land Use/Land Cover (LU/LC) mapping on 1:250,000: LU/LC assessment is made using semi-automated approach which includes automated processing of AWiFS quadrant data and classification using rule based approach. Water spread as well as snow cover information is generated through automated process. Rule based data integration of temporal datasets was adopted to derive final LU/LC output.

Crop Acreage and Production Estimation: The semi-physical spectral-spatial yield model was developed for various crops and provided to Mahalanobis National Crop Forecasting Centre (MNCFC) and required training is being imparted to MNCFC personnel for running the model and deriving planting date from time series NDVI data.

Coordinated programme on Horticulture Assessment and Management using Geoinformatics (CHAMAN): This national level project has been taken up, with the major objectives of (i) area assessment and production forecasting of major horticultural crops in selected districts in India; (ii) geospatial applications for horticultural development and management planning; and (iii) detailed scientific field level studies for developing technology for crop identification, yield modelling and disease assessment. Temporal high-resolution data (LISS-IV and Cartosat-1) has been used for delineation of spatial extent of the crop of interest. A mobile application 'CHAMAN app'

was developed to aid in faster and efficient collection of ground information, as well as in building geodatabase through Bhuvan platform.

Cotton crop area mapping: Multi-temporal satellite (Landsat-8) data was classified and interpreted for cotton crop identification, discrimination and mapping for Wardha Taluka in Wardha district, Maharashtra. Land Use/Land Cover, forest, settlement, water bodies and ancillary data was used to mask the non-crop area. It was observed that around 17,900 ha area of study area was covered by cotton crop (21.4% of total geographical area). The results were subsequently validated in the field.

Indian Forest Cover Change Alert System (InFCCAS): A remote sensing based technique was developed for automated detection of forest cover loss of an area greater than 2 hectare for rapid annual monitoring. The forest pixels are identified on Resourcesat-2 AWiFS data (20 x 20 tiles) for Andhra Pradesh, Bihar, Chhattisgarh, Goa, Gujarat, Himachal Pradesh, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Telangana, Uttar Pradesh and West Bengal).

Study on Sundarban mangrove system: The mangrove ecosystem of Sundarbans region plays an important ecological and socio-economical role in both India and Bangladesh. The present study is aimed at

analysing the impact of cyclone of varying intensity and at different period of phonological cycle on mangrove forests in Sundarbans region. MODIS time-series (2001-2011), Enhanced Vegetation Index (EVI) and Land Surface Temperature (LST) products were used to compute the MODIS Global Disturbance Index (MGDI). In the present study, instantaneous disturbance caused by the super cyclones was analysed using MGDI approach. The combined impact of 'SIDR' and 'Rashmi' was successfully captured by the MGDI images of 2008. In case of 'Aila', the disturbed area was reasonably less in comparison to the areas with higher EVI changes (-50% to -30%). The spatial extent of disturbance in each island was mapped, which can further be integrated on a temporal scale to generate spatio- temporal severity map. This will help forest management to identify chronically disturbed areas, which may have potential for biological invasion.

Inventory and Monitoring of Glacial Lakes/Water

Bodies: The project is being carried out at the behest of Central Water Commission. The inventory of glacial lakes and water bodies was carried out for the year 2009 using IRS satellite data and monitoring in the months from June to October was completed for last four years (2011, 2012, 2013 and 2014). Similar activity for the year 2015 was taken up in June, 2015 for 477 glacial lakes and water bodies. Monthly monitoring reports are submitted.

Assessment of Irrigation Potential Utilisation (I.P.U)

using geospatial data: The study has been initiated in April 2015 to assess Irrigation Potential Utilisation (I.P.U) under Major & Medium (M&M) irrigation projects in Krishna basin using the geo-spatial data. Temporal AWiFS data, canal network, project boundaries and LULC data available under various projects (India WRIS, SIS DP, NRC) are being utilised. The data bases such as basin, sub-basin boundaries, M&M projects, their canal network, river/ stream network and other base layers are being organised.

Re-assessment of basin scale water resources

using Space inputs: ISRO and Central Water Commission (CWC) jointly executed demonstrative pilot studies in Godavari and Brahmani- Baitarani river basins wherein Space based geo-spatial inputs were used to estimate basin-level mean annual water resources. Ministry of Water Resources recommended upscaling the study to other river basins of the country by regional offices of CWC. CWC regional offices will carry out the study and NRSC will provide technical support and hand holding during the study execution.

Monitoring of Gas Pipelines of Gas Authority of India Ltd (GAIL):

GAIL has about 15,000 line km gas pipeline network in India. GAIL and ISRO have undertaken a joint project for studying feasibility of remote sensing, as an alternative/ complement to the helicopter survey, for monitoring the Right of Usage

(ROU) of the pipeline for any physical encroachments. A pilot study has been carried out for “Dahej-Vemar-Vijaipur” pipeline segment of about 610 line km. Results indicates that satellite remote sensing techniques (high resolution data) can be used to monitor the pipeline assets through periodic repeat coverage (say monthly) during the cloud-free season. A web application was also developed to demonstrate the usefulness and quick communication within the GAIL monitoring teams.

Island Information System (IIS): Department of Border Management, Ministry of Home Affairs constituted a Task force for holistic development of Islands in Maritime zones of India, with participation of all concerned Ministries/ Departments/ Agencies. Towards this, ISRO has prepared a geospatial inventory of all islands using satellite images and developed an Island Information System. A total of 1238 islands have been identified and reconciled by NRSC/ISRO, SOI, NHO and RGI. The Island Information System (IIS) has been shared with different ministries and departments.

Monitoring of Integrated Watershed Management Programme (IWMP) watersheds using geospatial technologies: Bhuvan – SRISHTI, a Web based GIS application (Geoportal), has been developed to enable monitoring and evaluation of IWMP watersheds, using satellite remote sensing and sample field data (collected using mobile application). This Geoportal

would facilitate monitoring and evaluation of all IWMP watersheds for 10 states and 50 identified districts in 28 states. Bhuvan – DRISHTI, an android based interface tool, has been developed for field data capture of the development activities undertaken for the IWMP Projects and includes a facility to upload photos to Bhuvan IWMP Server.

Space-based Information Support for Decentralised Planning (SIS-DP): The project aims at providing web based spatial information comprising of ortho-rectified satellite image, thematic and field data, resource maps, cadastral maps, administrative boundaries, infrastructure layers, climate and socioeconomic data which will act as input for Decentralised Planning at Panchayat level. The project is being executed by respective State Remote Sensing Applications Centres (SRSAC) under the technical guidance and financial support from Overlay of cadastre maps over high resolution satellite image has been completed for 5 States (AP, Telangana, Haryana, Assam and Kerala) and 2 Districts of West Bengal; Bhuvan-Panchayats portal version - 2.0 and Mobile app for Panchayat Raj Institutions (PRI) asset data collection has been demonstrated for operational use. Training on decentralised planning and use of SIS-DP data for planning is being implemented with PRIs through Bhuvan Panchayat.

Snow and Glacier Studies: It is a joint initiative of Ministry of Environment, Forest & Climate Change and Department of Space. Retreat/advance for 73 glaciers spread over different parts of the Himalayan region were estimated using CORONA (1965) and LISS-III (2001) images. Snow cover Atlas of the Bhutan was completed.

Spatial modelling of fluoride contamination in ground water:

The spatial modeling has been for fluoride distribution in ground water using knowledge guided models, data driven models and the combination of both. Fluoride prediction maps generated using hybrid neuro-fuzzy integrated approach compared favourably among the four mathematical models used, namely, weighted overlay, fuzzy overlay, artificial neural network and hybrid neuro-fuzzy models for prediction of fluoride in ground water. Results were validated with field data.

Groundwater storage assessment coupling hydromorphology with lithology: The standard procedure of ground water resource estimation is based on the specific yield parameters of each rock type (lithology) derived through pumping test analysis. However, terrain conditions in the form of geomorphological variations have an important bearing on the net ground water recharge. An attempt was made to use both lithology and geomorphology as input

variables to estimate the recharge from different sources in each lithology unit influenced by the geomorphic conditions (lith-geom) season wise separately.

Surface Energy Balance over Agro-ecosystems using Large Aperture Scintillometry: The unique advantage of Scintillometry is its ability to calculate areal averaged sensible heat fluxes over spatial distances comparable to those observed by satellites. The LAS system was set up in 2014 at the agricultural research farm of Indian Agricultural Research Institute (IARI), New Delhi. The LAS measures atmospheric turbulence and heat flux over path lengths between 250 m and 6000 m.

The LAS was augmented with an Automatic Weather Station (AWS) having sensors of net radiometer, pyranometer, anemometer (2 levels), humidity and temperature probes (2 heights) and a soil heat flux plate at 10 cm depth. The 5 min fluxes of net radiation (R_n), sensible heat (H), latent heat (LE) and soil heat (G) fluxes were averaged at hourly intervals. All the fluxes were integrated over the day to analyse their seasonal pattern. Using H and LE daily integrated fluxes, daily values of evaporative fraction, $EF = LE / (H + LE)$ are calculated and analysed for their seasonal pattern.

Monitoring and Assessment of ecosystem process in North Western Himalayas:

For sustainable environmental development, making disaster resilient society and improved livelihood in the North Western Himalayan (NWH) region, an interdisciplinary research project on “Monitoring and Assessment of Ecosystem Process in NWH” is being carried out at IIRS, Dehradun involving large number of research organisations with several sub-themes as given hereunder:

- Geodynamics and seismicity investigations
- Vulnerability assessment of forest ecosystems due to climate change
- Sustainable mountain agriculture
- Water resources status and availability
- Modeling temporal and spatial growth of cities and towns in NWH
- Rainfall retrieval using microwave remote sensing data and study of extreme rainfall events

NATIONAL INFORMATION SYSTEM FOR CLIMATE AND ENVIRONMENT STUDIES (NICES):

Realising the need for a comprehensive information base to build long term data records on various Essential Climate Variables (ECVs) for environmental and climate studies with inter and intra-departmental linkages, ISRO formulated the National Information System for Climate and Environment Studies (NICES).

The mandate of NICES is to build an information base for climate change impact assessment and mitigation.

Earth Observation Application Sciences

The R&D in various field of EO is a continuous endeavour of ISRO centres.

• Geosciences

Space Applications Centre of ISRO is involved in applications of remote sensing and GIS technology in geosciences and executes several projects for societal benefits. Some of the major thrust research areas are related to coastal and marine geosciences, geodynamics, geo-hazards, mineral, hydrocarbon and geo-archaeological exploration.

• Agriculture

Production forecasting of important agricultural crops using satellite remote sensing data initiated under the project “Crop Acreage and Production Estimation” by Space Applications Centre and carried out over a period of two decades at the behest of Ministry of Agriculture, Govt. of India (MOA). Subsequently a more inclusive model FASAL (Forecasting agricultural output using Space, Agro-

meteorology and Land based observations) was initiated in 2007-08.

- **Environment and climate change**

Human activities contribute to climate change by causing changes in Earth's atmosphere in the amounts of greenhouse gases, aerosols (small particles), and cloudiness. Climate change forms one of the most important global environmental challenges, with implications for food production, water supply, health, energy, etc. It is essential to study the impacts of climate change and thereby suggest mitigation measures. Goal of space based global change observation, together with other observations and studies, is to provide a sound scientific basis for developing national and international policy relating to natural and human induced changes in the Earth System.

- **Physical oceanography**

Oceans occupy almost 3/4th of the surface of our planet. They have profound impact on climate and weather. The current research includes Advanced Ocean State Forecast (AOSF) using numerical models and space-borne observations, Ocean Process Studies,

and development of Data Assimilation (DA) techniques.

- **Biological oceanography**

The Ocean contains thousands of microscopic, free floating, single-celled plants called “**phytoplankton**” capable of making their own food by harvesting the energy from sunlight, carbon dioxide and nutrients present in the upper well-lit layers of the ocean. This process known as photosynthesis also liberates oxygen and makes possible all animal life in the ocean. Phytoplankton are the oceanic equivalents of land plants and forms the basis of marine food chain. In addition, they play an important role in pulling the carbon dioxide from the atmosphere by exporting the dead cells to the ocean interior and bottom sediments.

- **Atmosphere**

The study of Atmospheric Sciences is a major programme. ISRO centre develops state of art techniques for the analysis and forecasting of the weather and climate from regional to global scales using various satellite data. The space based inputs are used by IMD and other agencies for their forecasts.

- **Cryosphere**

Cryospheric studies on the earth surface include inventory, dynamics, changes, and interaction with hydrosphere, atmosphere etc. of snow, ice cover on land, sea ice and permafrost. For the last more than two and half decades ISRO has been contributing to the development of methods/techniques for extraction and dissemination of reliable and quick information pertaining to polar and Himalayan cryosphere using data from Indian Remote Sensing Satellites.

- **Hydrosphere**

ISRO carries out studies related to land hydrological modeling and applications. It involves retrieval of hydro-meteorological parameters from satellite and modeling of Hydrological Processes from field to National scale. Timely and reliable assessment of available water resources through satellites and models provide important input to devise strategies and water management in the country(Source :

<https://www.isro.gov.in/SpaceApplications.html>)