इसरो isro

राष्ट्रीय सुदूर संवेदन केंद्र
स्वर्ण जयंती
Golden Jubilee
50
Years of Bridging Space & Earth
National Remote Sensing Centre
1974 - 2024

nrsc

विकसित भारत की ओर 2047
Towards Vikasit Bharat 2047

अंतरिक्ष प्रौद्योगिकी अनुप्रयोगों से भारत में परिवर्तन
Transforming India through Space Technology Applications

50 समाज को प्रभावित करने वाली उपलब्धियां
Major Accomplishments of Societal Impact
वर्ष की यात्रा
Years of Journey

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Hyderabad - 500 037

50 Major Accomplishments of Societal Impact

Years of Journey

National Remote Sensing Centre
Dept. of Space, Govt. of India
Hyderabad - 500037

License & Certification

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उत्कृष्ट वैज्ञानिक & निदेशक
Outstanding Scientist & Director

FOREWORD

The NRSA / NRSC has made a significant progress in the last 50 years, since its inception in the year 1974. Initially, NRSA had commenced its operations as Aerial Flight Facility of the Nation under the umbrella of DST, Govt of India. Later NRSA was brought into the fold of ISRO in the year 1979 with the establishment of the first data acquisition system of Earth Observation satellite (Landsat1).

In line, with its mandate of nodal agency for Earth Observation Satellite data acquisition, processing, dissemination of satellite data and developing applications for the benefit of citizens, aerial remote sensing and capacity building of user departments, the NRSA / NRSC has transformed as a hub of EO satellites data acquisition, processing and developed many citizen centric applications over the period. These activities were not only confined to our country, but also showed its presence in several countries through the establishment of International Ground Stations and geoportal development.

The ISRO's Geoportals (Bhoonidhi / Bhuvan / NICES) developed at NRSC showcased the satellite and aerial remote sensing based applications. The capacity building activities made a modest beginning in eighties and matured into a full-fledged Centre of Outreach as well as training including programmes for friendly nations.

Coinciding with completion of 50 years of glorious journey, the 50 major accomplishments of societal impact that served Land, Water and Ocean areas along with portals of Data and Services Dissemination were highlighted in this compilation.

The collaboration and support from sister institute of ISRO, State Remote Sensing Centres, Academia and Users (Ministries / Departments / PSU's etc) have been invaluable to the growth of our Organisation.

I wish NRSC achieves many more milestones and work towards the dream of Viksit Bharat - Transforming India through Space Technology Applications.

September 13, 2024

(Prakash Chauhan)

भारतीय अन्तरिक्ष अनुसंधान संगठन Indian Space Research Organisation

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Past & Present Leaders

Dr. K. R. Rao
Feb 1975 - Jan 1982

Dr. B .L. Deekshatulu
Sep 1982 - Oct 1996

Dr. D. P. Rao
Nov 1996 - Apr 2001

Dr. R. R. Navalgund
May 2001 - Nov 2005

Dr.K.Radhakrishnan
Nov 2005 - Aug 2008

Dr. V. Jayaraman
Sep 2008 - Apr 2011

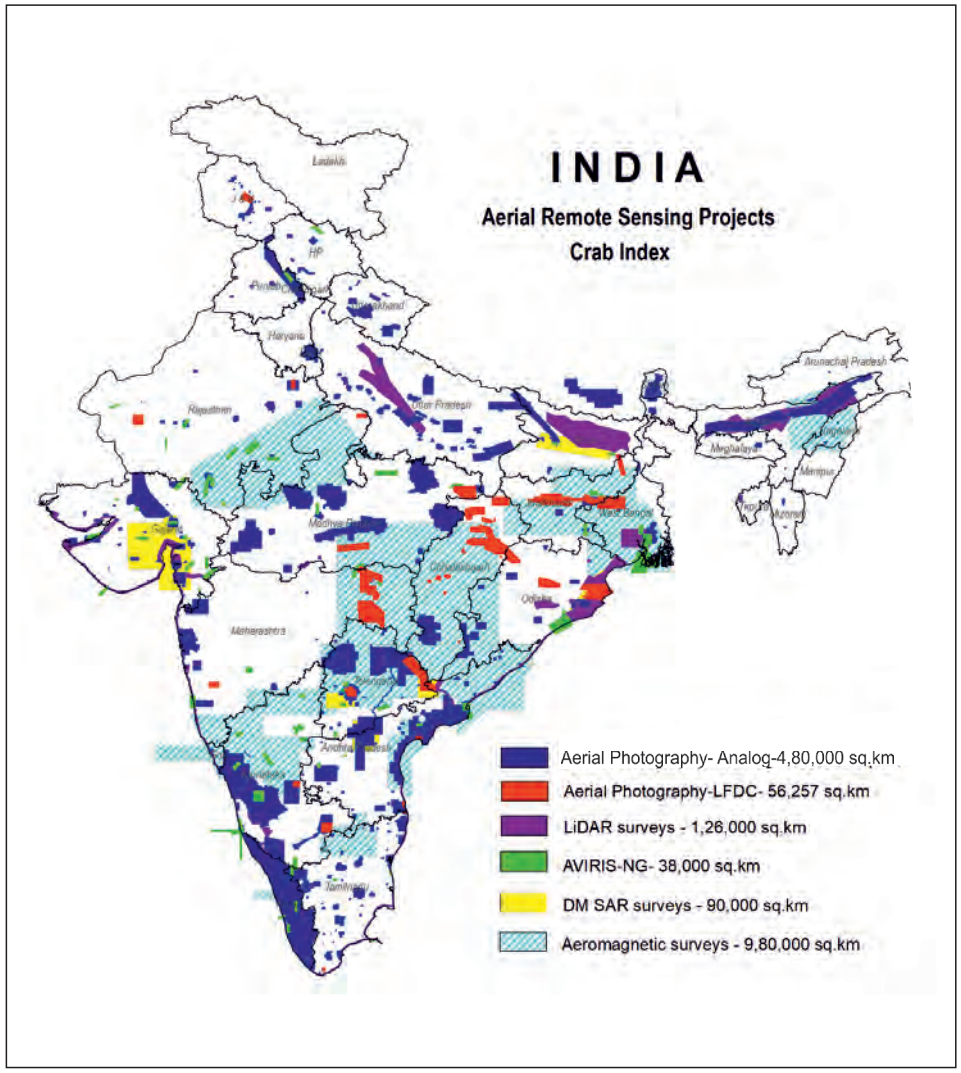
Dr. Vinay Kumar Dadhwal
May 2011 - July 2016

Dr. Y. V. N. Krishnamurthy
Jul 2016 - Mar 2018

Shri. Santanu Chowdhury
Apr 2018 - Dec 2020

Dr. Raj Kumar
Jan 2021 - Feb 2022

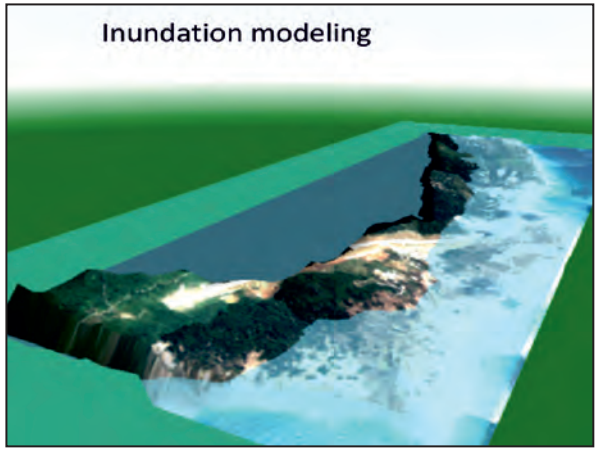
Dr. Prakash Chauhan
Mar 2022 Onwards



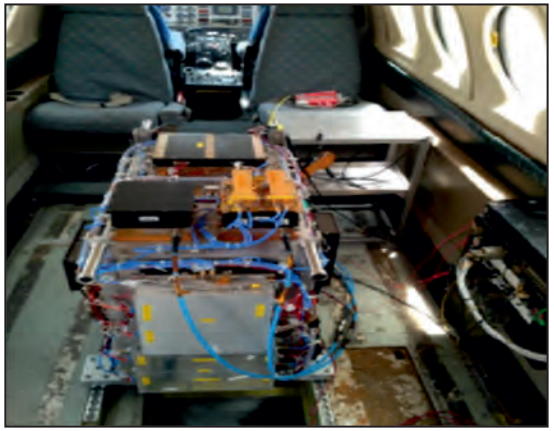
Aerial Surveys Coverage by NRSC in the Past Five Decades

Aerial Survey Coverage of NRSC 01

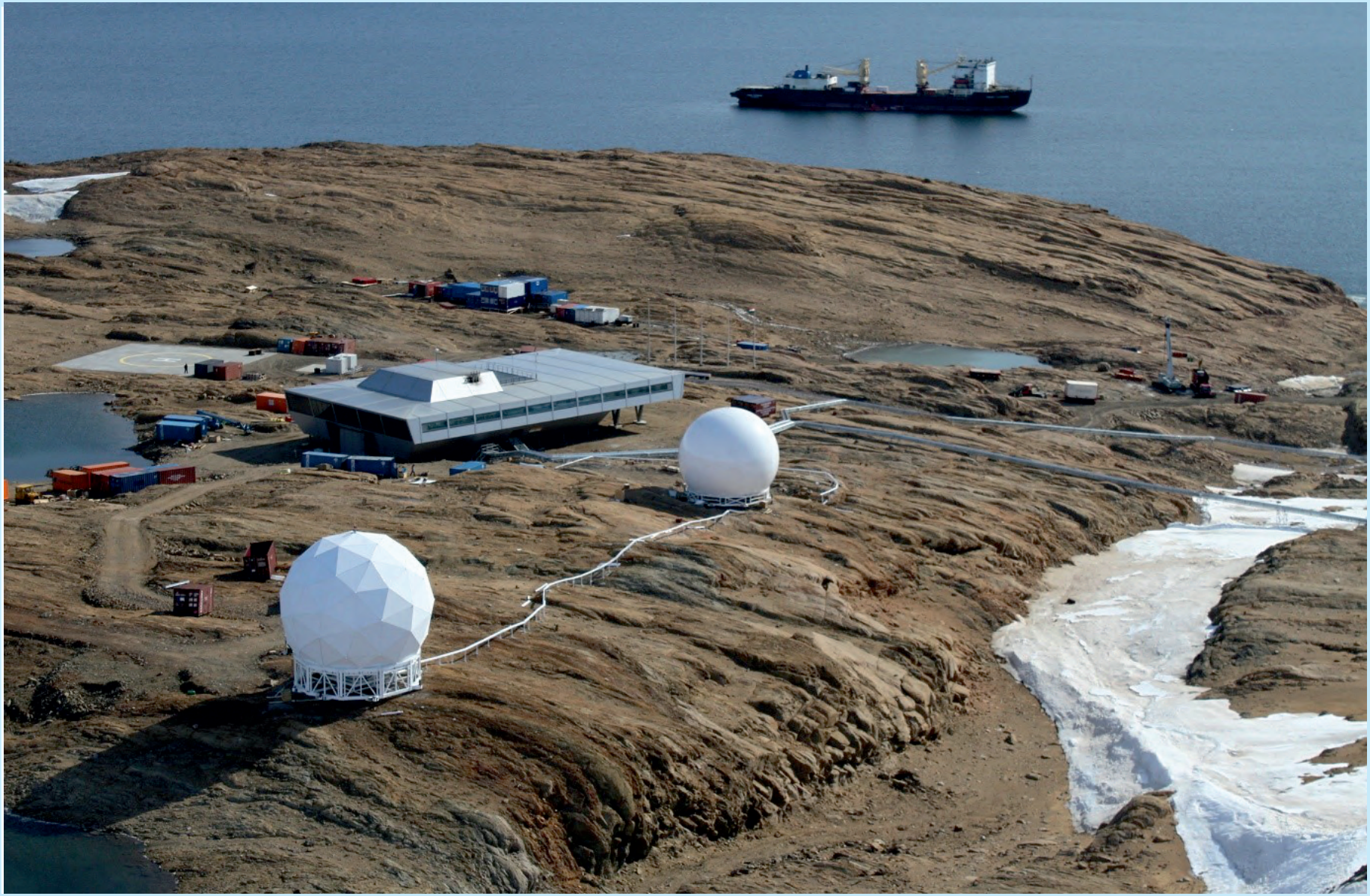
Aerial Services and Data Management Area (AS&DMA) at NRSC is possessing the state-of-the-art facility for aerial remote sensing activities in the country. The journey of NRSC (formerly NRSA) started with the aerial remote sensing by taking over aerial survey works and functions from Research Flight Facility (RFF) of Ministry of Defence. The Aerial Services and Data Management Area (AS&DMA) is currently equipped with two Beechcraft Super King Air B200 aircrafts customized for undertaking aerial survey operations with advanced aerial sensor systems like Large Format Digital Camera, LIDAR Sensor, Multi Spectral Camera, etc. The first aerial survey project was carried in the year 1976. Since then, various aerial remote sensing surveys were conducted for acquisition of large-scale aerial photographs and for generation of very high-resolution digital elevation & geospatial data sets spread across the country. About 17.73 lakh sq.km of airborne data was acquired in the past five decades.



These databases formed critical inputs for various applications, namely: natural resources inventory, urban city planning, reservoir planning, railway line/gas pipeline/canal alignment planning, Tsunami early warning & flood early warning systems development, satellite sensor development and disaster management support, etc. The aerial survey data generated by AS&DMA, NRSC contributed to National Projects such as: Tsunami Early Warning System; National Hydrology Project, Flood Management Improvement Support Centre (FMISC)-Bihar, ISRO's Disaster Management Support Programme (DMSP),



IRCON-Railway Alignment Project; Ken-Betwa River Link Project; Town & Country Planning Organisation (TCPO)/Survey of India (SOI)-Urban Planning Project; GSI/DGH Regional Aeromagnetic Survey; etc. The NRSC Aerial services has served the first phase of the JPL Hyperspectral sensor AVRIS NG over selected test sites of India, testing of several atmospheric sensors, SAR payloads developed at SAC and Hyperspectral developed by DRDO apart from calibration of Chandrayaan instrumentation. The AS&DMA has also undertaken international aerial survey projects in Maldives, Sri Lanka, UAE, Bhutan and Nepal.



AGEOS Facility at Bharati, Larseman Hills, Antarctica

AGEOS - Antarctica Ground Station for Earth Observation Satellites

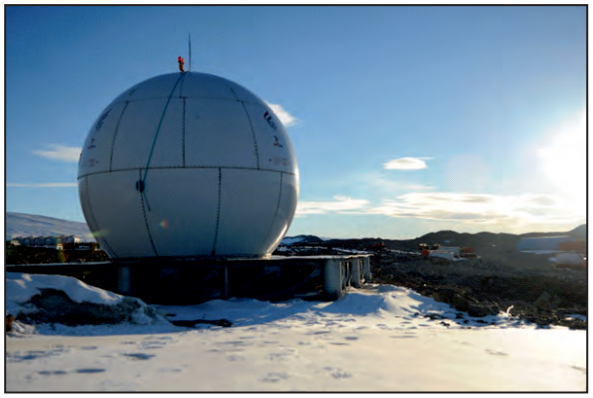
02

NRSC has established a satellite ground station Antarctica Ground station for Earth Observation Satellites (AGEOS) with one S/X Band Data Reception System (DRS-1) and one Data Communication System (DCS) during 2012-13 at Bharati, Larseman Hills,

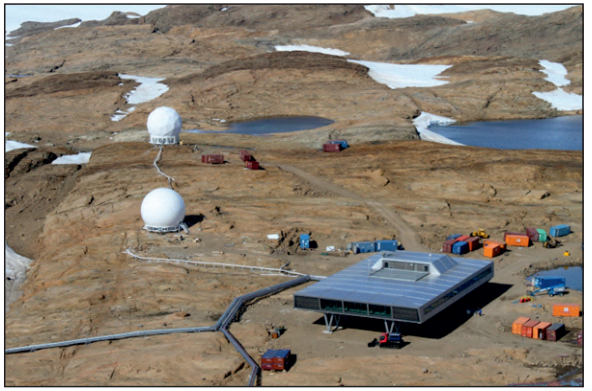
Antarctica (69° south and 76° east) to receive data from all Indian remote sensing satellites. NRSC established a tri-band (S/X/Ka) band data reception system (DRS-2) in 2017-18 to cater high data rate missions like Cartosat-3 (Ka band).

AGEOS station at Larseman hills Antarctica is operationalized in 2013 and receiving Indian remote sensing Satellite (IRS) payload data and also supporting TTC operations. Apart from TTC and Payload operations, AGEOS is supporting for Launch

vehicle tracking of National and International missions. Due to its geographical location, 10-11 satellite passes per day from each mission is visible at Bharati station. Presently, TTC operations of all IRS missions carried out and payload data from 8 IRS missions is being collected and transferred to NRSC every day and is expected to increase in future with ongoing launches of new missions.

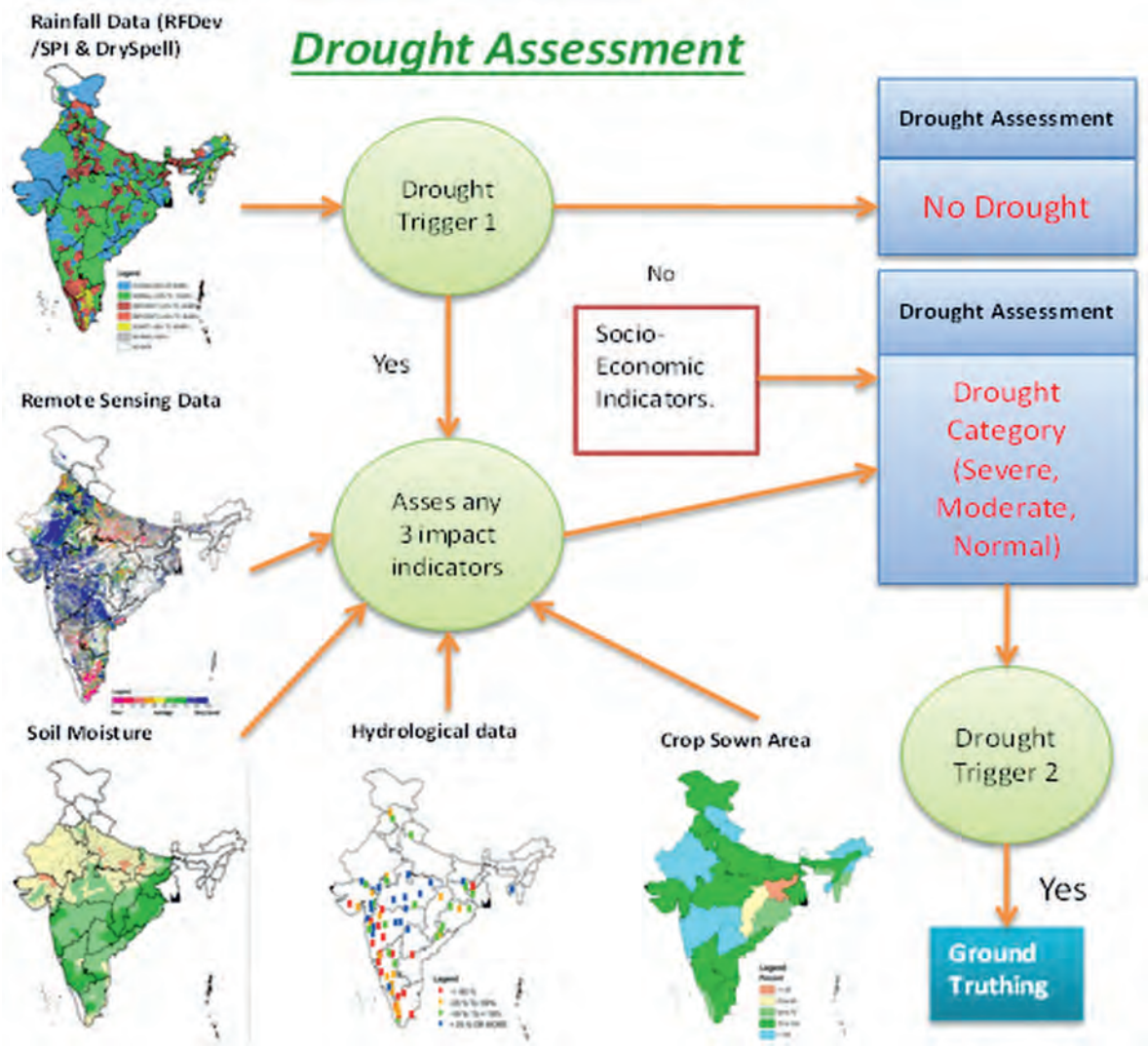


Data Communication System (DCS) Operating in C band, presently using GSAT-17 for transferring the data collected from DRS (DRS-1 & DRS-2) antenna to NRSC Shadnagar.



Apart from payload data transfers from Antarctica to NRSC Shadnagar, DCS also provides 2 way communication services to NRSC Shadnagar and NCPOR Goa . DRS and DCS are built with state of art technology and are having full redundancy with monitoring & control from NRSC. The station is continuously manned by 3 or 4 engineers deputed from NRSC/ISRO, to carry out regular (24x7) operations and maintenance of the station throughout the year.

Approximately 500 GB of data per day is acquired at AGEOS and transferred to IMGEOS by using DCS antenna via GSAT-17. The Antarctica station enabled the IMGEOS to handle high data rates in missions like Cartosat-3 (Ka band) and future missions like NISAR.. AGEOS facilitated reduced turnaround time for satellite delivery, especially during emergencies and natural disasters.



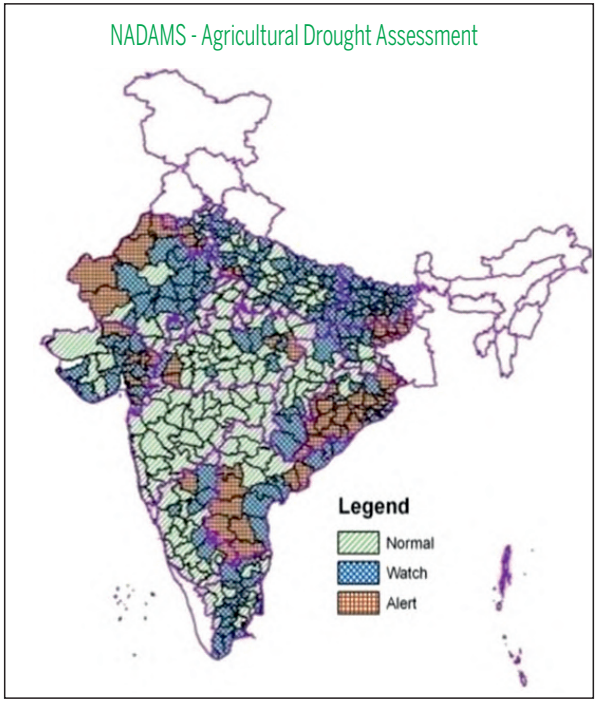
National Drought Monitoring Framework

Agricultural Drought Assessment and Monitoring System

03

The National Agricultural Drought Assessment and Monitoring System (NADAMS), initiated in 1988 by the National Remote Sensing Centre (NRSA/NRSC) under the Indian Space Research Organisation (ISRO), Department of Space, is designed to provide near real-time data on the presence, severity, and persistence of agricultural droughts. The system initially focused on 13 drought-prone states in India, primarily those with agricultural economies vulnerable to drought.

NADAMS utilized daily NOAA AVHRR satellite data to monitor agricultural conditions at the state and district levels. Over time, NADAMS evolved to include multi-sensor satellite data, incorporating newer satellites like NOAA AVHRR, IRS WiFS, MODIS, and Sentinel-2, with improved resolution and accuracy. Based on satellite, weather, and ground-based data, areas are flagged under three categories: normal, watch, or alert from June to August. The classification of drought severity (normal, mild, moderate, or severe) is made during the critical September to November period, reflecting the impact on crops. Since 2012, NADAMS has been managed by the Mahalanobis National Crop Forecast Centre (MNCFC) under the Ministry of Agriculture,



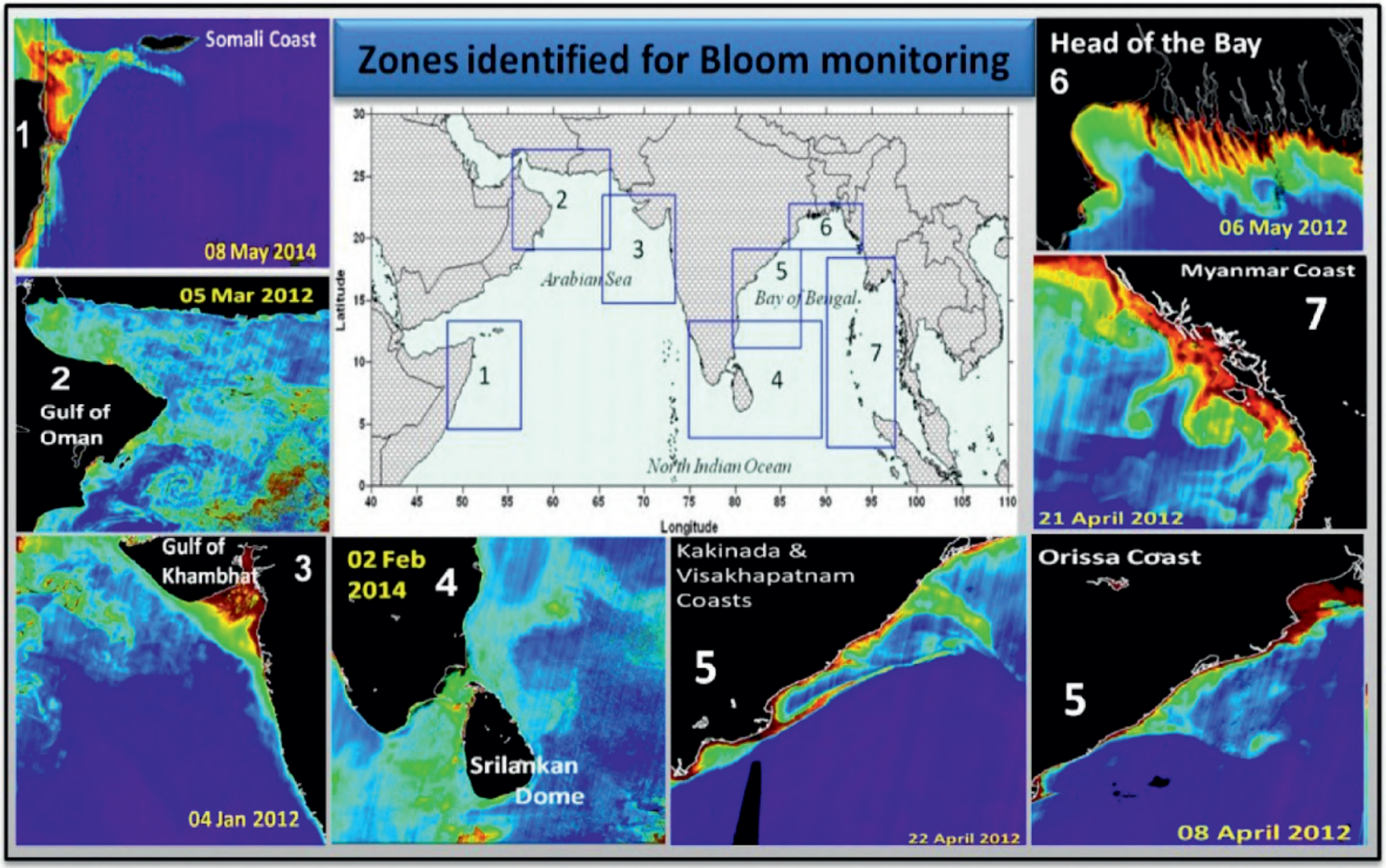
expanding its scope to monitor 17 states that are highly susceptible to drought. These states include Andhra Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, and West Bengal.

The NADAMS, utilises the fortnightly composite NDVI, deviation of NDVI/NDWI from normal levels and the month-to-month progression of these indices offer a clear indication of the agricultural conditions in the region. This information is further validated with on-

ground data, including rainfall patterns and sown area progression, to provide a comprehensive assessment of the agricultural drought situation. Reporting of this data is done monthly, allowing user departments to receive timely updates about the agricultural drought situation for effective decision-making.

NADAMS provides critical information on crop conditions and drought progression in near-real time, assisting both central and state governments in objectively declaring drought conditions in drought-prone districts across India. The system's reports, provided fortnightly or monthly, aid in long-term drought mitigation planning.

This regular reporting through NADAMS provided comprehensive, actionable information for coordinated drought relief planning and mitigation strategies across the country.



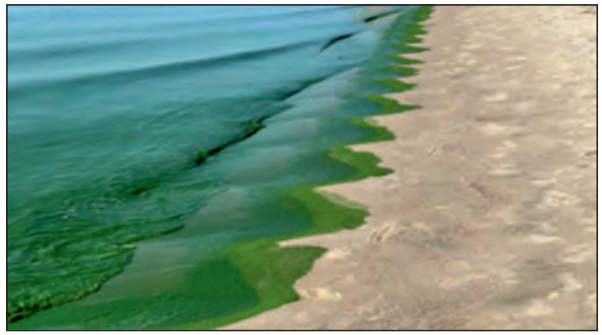
Zones Identified for Bloom Monitoring

Algal Bloom Studies 04

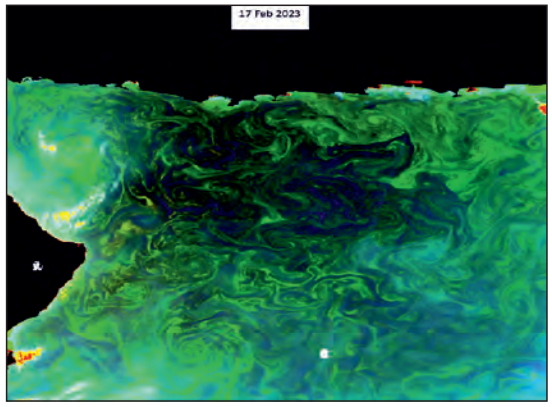
Algal bloom refers to the swift growth and building up of phytoplankton (i.e., an accumulation of algae in one place due to eutrophication) on the ocean surface (and other bodies of water) that exhibits satellite-detectable fluorescence signals. Although algal blooms occur naturally, their frequency and magnitude have been increasing alarmingly due to anthropogenic eutrophication and climate change. In general, algal blooms are beneficial, fixing carbon at the base of the food chain and supporting fisheries and ecosystems worldwide. However, proliferations of algae that cause harm (termed harmful algal blooms) have become a major environmental problem worldwide. There are hundreds and thousands of species of algae, but a moderately small number of these produce toxins that move up to the food chain. Thus, early detection and

monitoring of algal blooms are essential for effectively managing and mitigating potential ecosystem and public health impacts.

Using satellite data, one of the most effective ways to monitor algal blooms in coastal and marine waters is to determine Chlorophyll (Chl-a) concentrations. Beyond Chl-a retrievals, Earth Observation Satellites (EOS)



equipped with multiple spectral bands at different wavelengths have been used to measure algal bloom indices. Algal bloom indices, describing bloom spatial



extent, intensity, duration, and severity, are being derived using the Ocean Colour Monitor (OCM) sensor onboard the EOS-06 (OceanSat-03) satellite observations from 2022 to the present (and its predecessors OceanSat-01 and OceanSat-02 for 1999 to 2021). Using 360-meter resolution daily observations from the OCM sensor, phytoplankton bloom occurrence is generated to characterize the spatial and temporal patterns of global algal blooms in coastal oceans. Inside the full domain of South Asia, seven regions have been identified as bloom hotspots, as depicted in the figure, which is demarcated in a blue colour box. Modern computation power and improvements in data access, which allow for near-real-time product delivery, have provided stakeholders with

Coccolithophore Blooms from EOS-06 OCM3

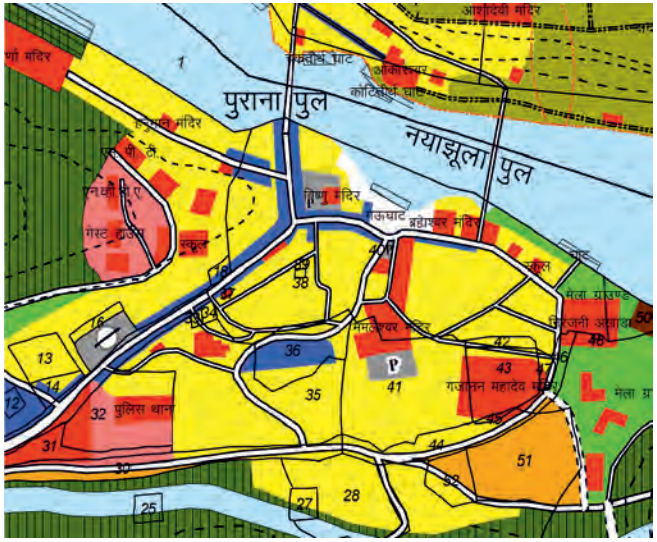
early warning of bloom risks. In addition, this data assists in identifying areas of potential concern, quantifying spatiotemporal trends, further understanding bloom dynamics and drivers, as well as guiding and determining the effectiveness of implemented management actions.

This information will be useful for identification of Potential fishing zones (PFZ's) along with other marine biological parameters.

OMKARESHWAR

1. Very High Resolution Satellite Data

4. MASTER PLAN

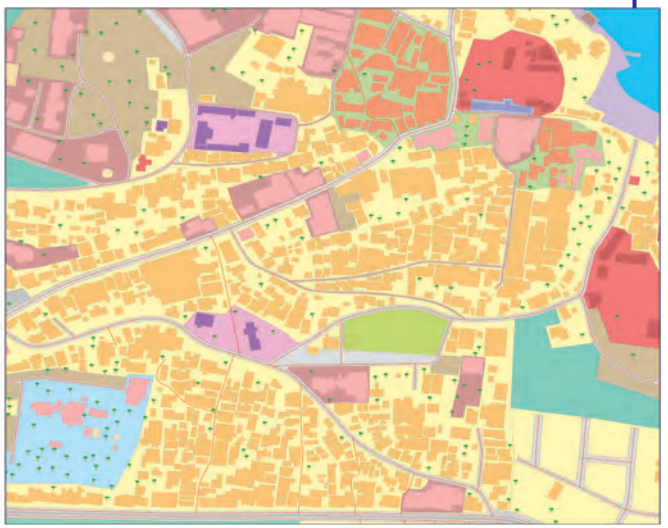


2. AMRUT PRE - FIELD GEOSPATIAL DATABASE

Urban Landuse
- Road
- Residential
- Road
- Traffic related
- Public Utilities
- Transportation
- Green Areas
- Wastelands
- Vacant Land
- Specific Land use
- Religious
- Recreational
- Water Bodies

Buildings
- Building Footprint

3. AMRUT POST - FIELD GEOSPATIAL DATABASE



Urban Landuse
- Road
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- Road
- State Govt. Property
- Traffic related
- Commercial
- Public Utilities
- Mixed
- Transportation
- Public& Semi-public
- Educational
- Green Areas
- Wastelands
- Vacant Land
- Specific Land use
- Religious
- Recreational
- Water Bodies

Buildings
- Mixed
- Educational
- State Govt.Property
- Transportation
- Residential
- Commercial
- Public & Semi-public
- Recreational
- Religious

AMRUT Master Plan Generation

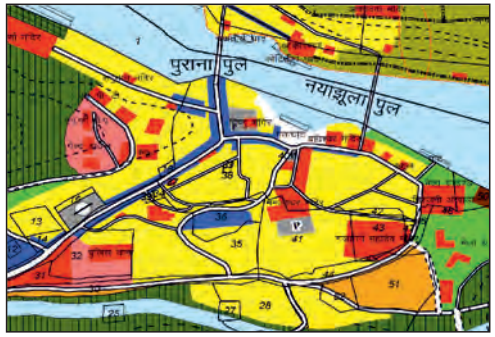
Atal Mission for Rejuvenation & Urban Transformation (AMRUT) - Formulation of GIS Based Master Plans

05

The Atal Mission for Rejuvenation & Urban Transformation (AMRUT) Mission was launched by Government of India (GoI) in 2015, with 'Formulation of GIS based Master plan' as one of its important reforms targeting 500 Class-I cities (Population greater than 1,00,000) considering the availability of master plans for less than 20% of cities. NRSC has prepared very large scale (1:4000) urban geospatial databases for 238 cities in the country using very high-resolution satellite (VHRS) data, to meet the primary objective of the important reform 'Formulation of GIS based Master

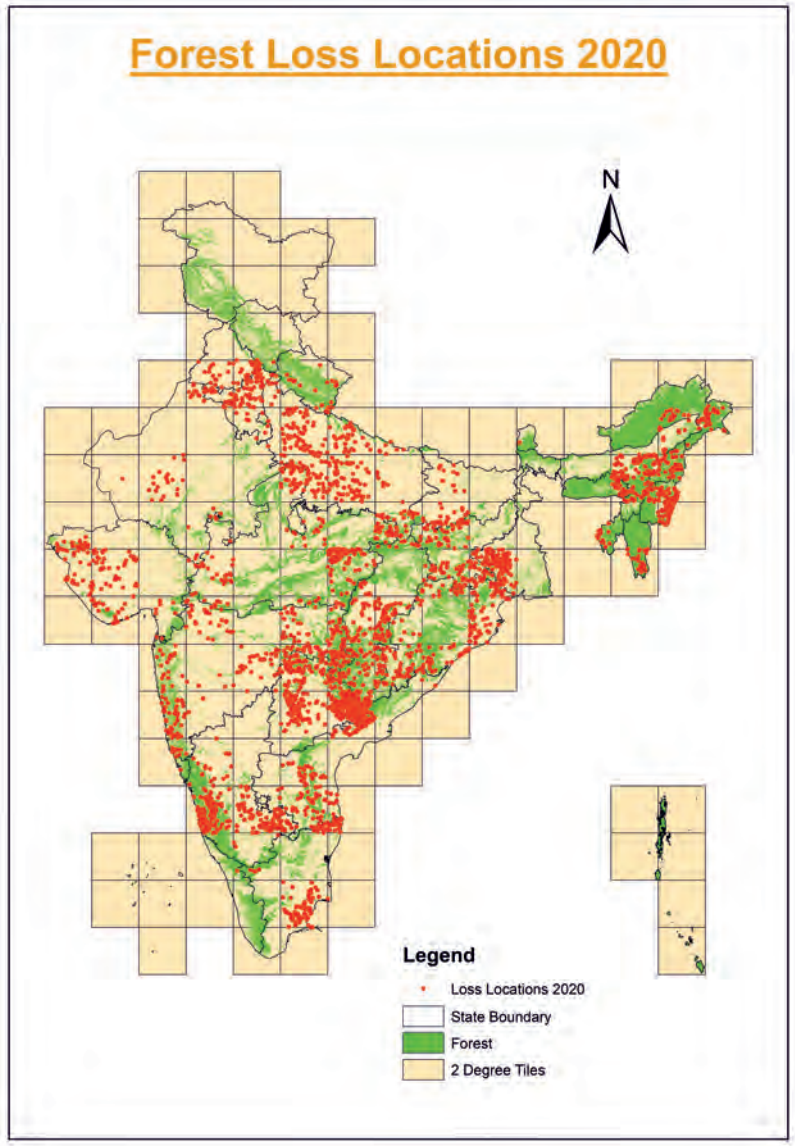
plan', under the AMRUT Mission. The geospatial database comprises mainly of (a)Base layers, (b) Urban Land Use and (c) Building footprints generated from satellite data besides incorporating secondary data like Utility layers, Boundaries etc. Private geospatial industry had an important role in the urban geospatial databases preparation at 1:4,000 scale under the aegis of NRSC. Nearly 300-350 persons from an empaneled set of Vendors have worked at NRSC Outreach Facility for creating this database for 238 AMRUT cities.

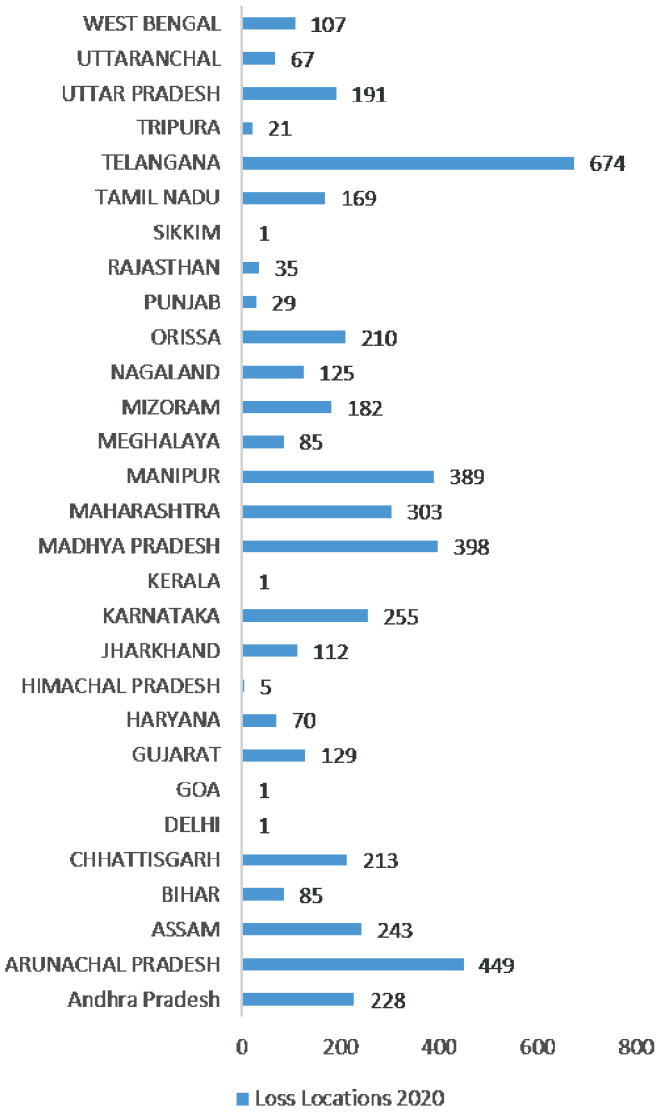
Up-to-date comprehensive geospatial database has been made available to Urban Local Bodies (ULBs) which serve as the primary input/base map for the city Master Plan formulation. This has enabled ULBs to quickly assess the existing situation and carry out various analyses in a spatial environment leading to better, scientific land use proposals for future growth and development. Urban Master Plans ensures proper growth of a city/urban area, minimize haphazard



development and efficient utilization of resources. This would further enable better provision of infrastructure, services, facilities to the citizens. AMRUT has provided the Urban Local Bodies (ULBs) with a comprehensive geospatial database which can be used not only for Master Plan preparation but also for Development plans, monitoring, utility planning, geospatial governance etc.

The project facilitated designing of new set of geospatial database standards for urban geospatial data content and nation wise uniform schema for geospatial database creation. The project outputs are finding extensive use in further value addition like – identification of potential solar rooftop areas for solar power generation, estimation of rainwater harvesting capacities with urban areas, property taxation and also generation of indices for estimation of urban quality of life. The AMRUT Mission as a whole is encouraging and supporting the States in conducting reforms that will improve the financial health of the ULBs, delivery of citizen services, transparency and cut the cost of services, adopt model building bylaws with 14 essential features.





Key Results for the Change Year 2019-2020 (Forest Loss Cycle 2021)

Automated Detection of Annual Forest Loss Locations using IRS AWiFS

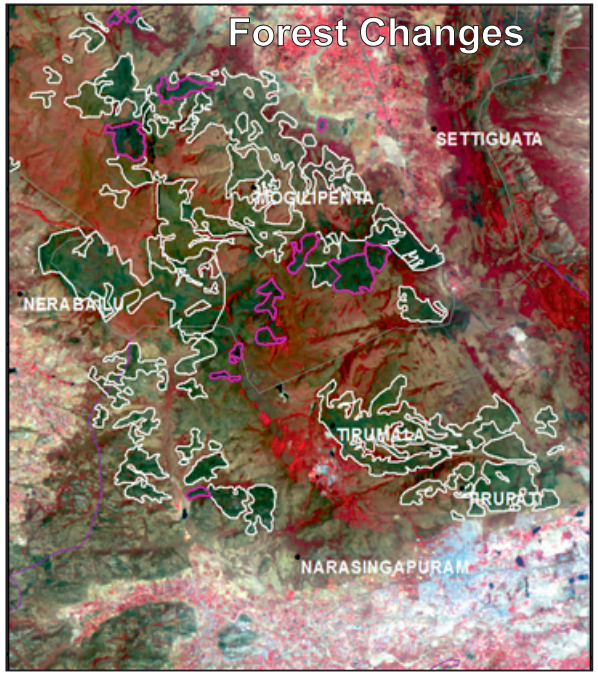
06

Forest cover change occurs due to both increases and decreases in forested areas. An increase in forest cover can happen through afforestation, where new forests are intentionally planted, or through the natural expansion of existing forests. Conversely, a reduction in forest cover can result from deforestation, where

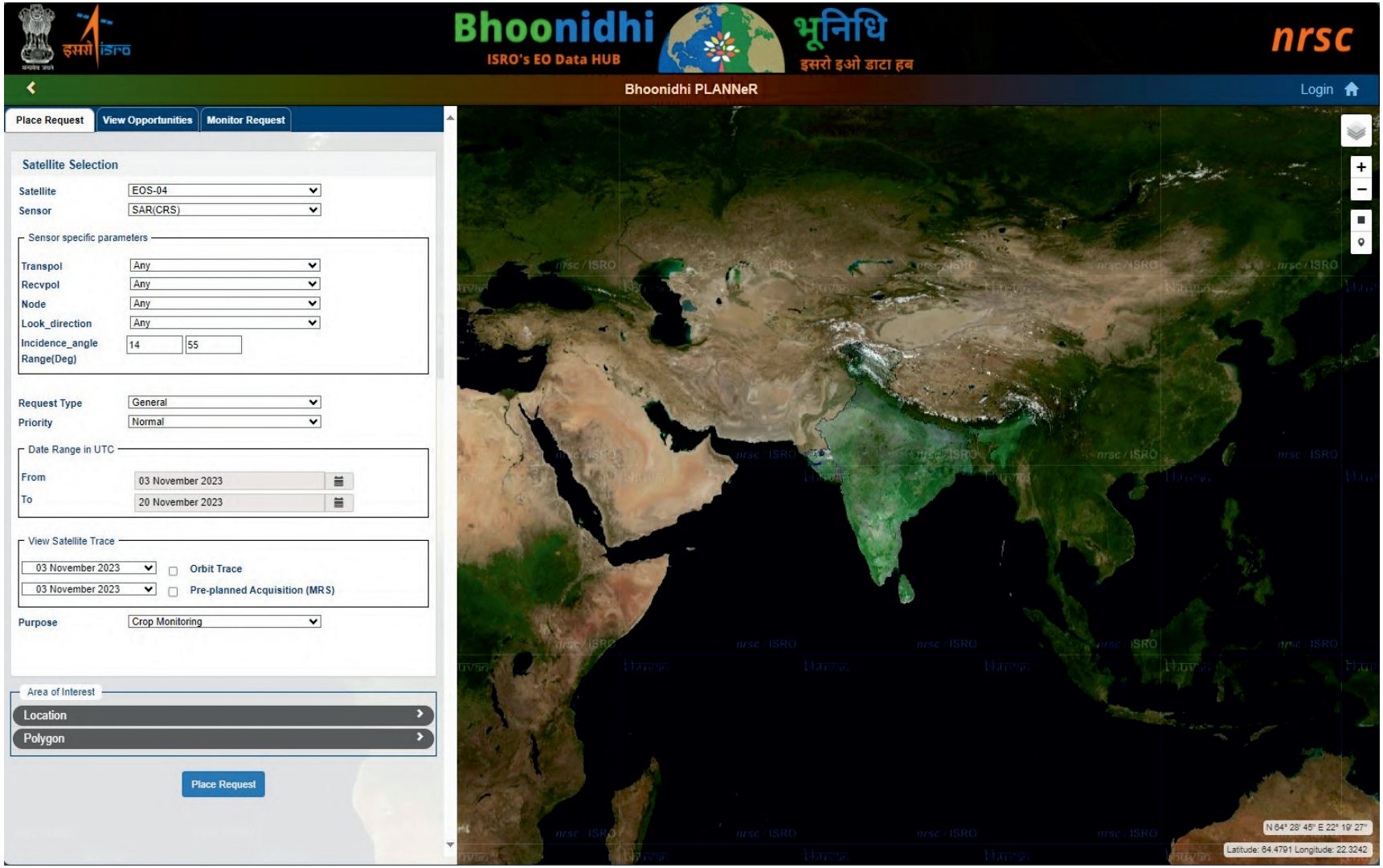
forests are cleared for agriculture or infrastructure, or from natural disasters, such as wildfires, storms, or floods, which can damage or destroy forests. These factors together shape the dynamics of forest ecosystems and land use. However, when part of a forest is cut down and then replanted (reforestation) or when the forest regenerates on its own within a relatively short period (natural regeneration), the overall forest area remains unchanged. These processes help restore forest cover, maintain ecological balance, and preserve biodiversity, mitigating the long-term impacts of deforestation.

The net change in forest cover is estimated as the difference in forest cover between two points in time. This approach accounts for the losses from deforestation and gains from forest regeneration and tree plantations. This is usually divided by the years between the two periods to get an annualized net deforestation rate. The changes are also gradual and develop over a season. Importantly, the change in forest cover happens against a backdrop of dramatic phenological and seasonal changes in the forest vegetation accompanied by “transient changes” from factors such as cloud cover and forest fires, among

others. Automated approaches for monitoring forest cover in the country addressed gross and net deforestation. It also helped to have the capability of detecting seasonal changes in forest cover. The road



map ahead is to extend and adapt the methods developed for the AWiFS sensor to sensors such as LISS-III, EOS-4, and others. It will be a critical input for sustainable forest resource management. Over the last three decades, India has paid great attention to remote sensing applications for forestry. It has been mapping forest coves biennially, which has greatly increased forest cover at the national level. The present study provides annual/sub-annual scale forest loss / alert information for forest management. The spatial outputs provide potential solutions to enhance and strengthen forest management and meet climate change goals.



Bhoonidhi Planner

Bhoonidhi – ISRO's Earth Observation Data Hub 07

The Bhoonidhi – ISRO's Earth Observation Data Hub is Open Data Access geoportal and web application facilitating seamless ordering and dissemination of Open & Priced satellite data products through various interfaces to online users as per policy.

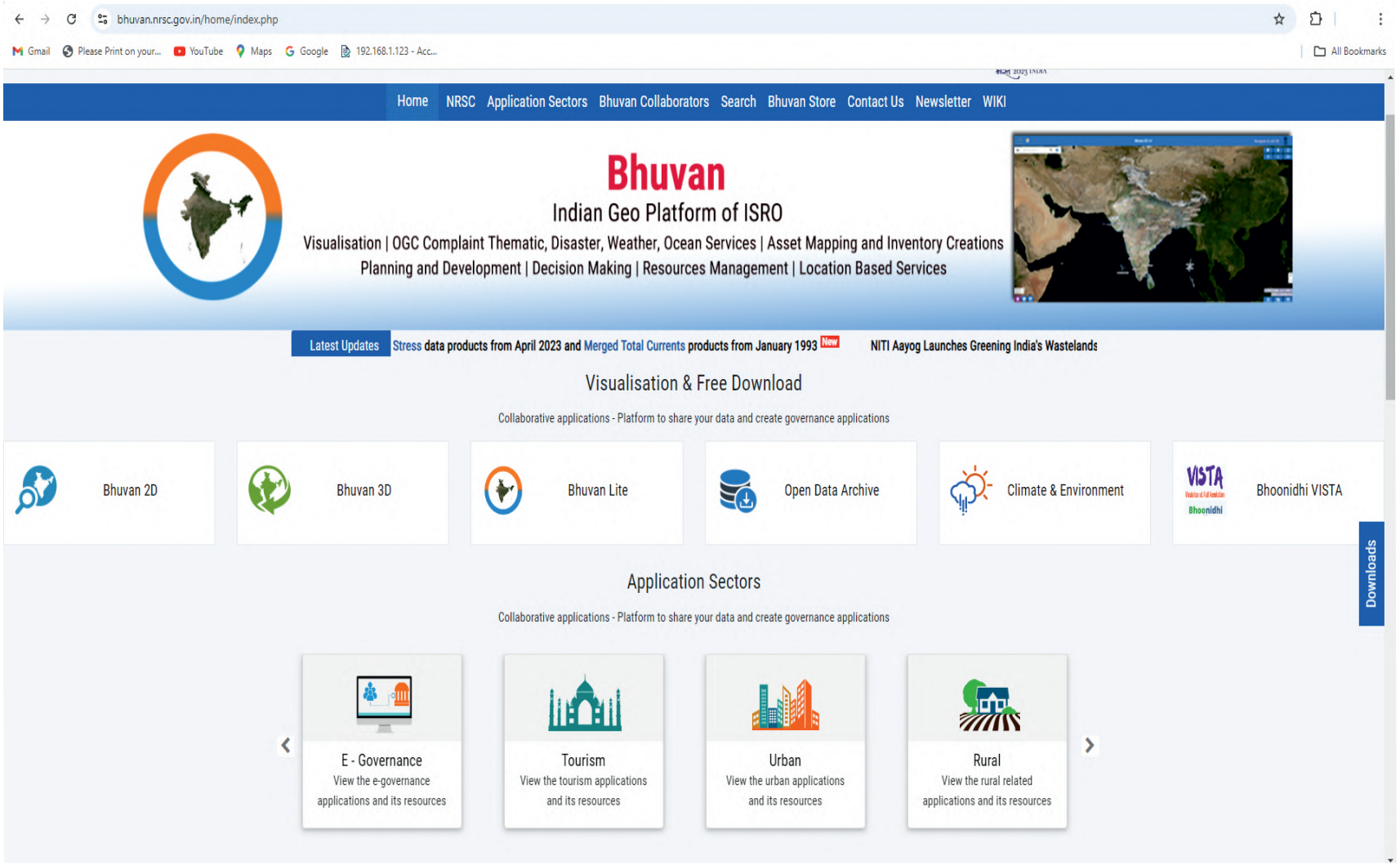
Bhoonidhi has a huge repository of EO data, which spans wavelengths, imaging modes, missions, and sensors, with fresh acquisitions being added to the archive daily covering INDIA and its surroundings. Various user-friendly search options are available to ease Target AOI/ Event/ Time series/ Satellite data identification and subsequent instant or delayed download of satellite data products. CART interface allows users to select the products and store them for later download. Bhoonidhi was released to users during NRSC User's meet, in January 2020 (https://bhoonidhi.nrsc.gov.in).

Bhoonidhi, the regional hub, hosts data from satellites of the Copernicus program, namely Sentinel-1A, 1B and Sentinel-2A, 2B and Landsat-8 and Landsat 9 data acquired at IMGEOS.

BHOONIDHI-Vista (Visualisation of Terrestrial acquisitions) showcases how India looked in the past few hours or days by EO sensors in native resolution. The high-quality images captured by Indian and other Earth observation sensors provide important information for applications that require quick responses, such as monitoring and assessing areas affected by floods, cyclones, and other disasters. The On-Demand Processing and Codelab Platform represent a cutting-edge technological solution, providing users with an innovative and efficient environment for algorithm processing, code development, and collaborative workflows. This comprehensive technical literature thoroughly examines the platform's architecture, highlighting its major components, such as the Kubernetes cluster, Docker images, product archives, workflows, user interface, and schedulers.

The backbone of this platform is a robust Kubernetes cluster designed for high availability. Comprising two master nodes and five worker nodes with three high-end configuration workers, the cluster ensures resilience and optimal resource utilization. The dual-master setup enhances fault tolerance and system reliability, which is critical for the continuous

availability of the platform. The current deployment has 500TB storage for data products attached as online storage to the application servers for direct download and an additional 6 PB of object storage for dissemination and 10TB storage for cataloguing (metadata + image chips). To meet the Open data platform guidelines of New Space Policy 2023, NRSC has established 'Bhoonidhi' as a platform for data dissemination. Under the open data policy, 5 PB of archived data is made available for users.



Landing Page of Bhuvan-Geoportal of ISRO

Bhuvan – Geoportal of ISRO 08

Bhuvan (means earth in sanskrit) is a Geoportal platform of ISRO - hosts wide range of services that cover visualization of multi-date, multi-platform, multi-sensor satellite data, thematic maps, and advanced query and analysis tools, free data downloads, disaster services, apps for crowd sourcing and diverse geospatial applications.

Users can access free data downloads, products, and near-real-time disaster information. With its advanced visualization and extensive data services, Bhuvan has expanded its main applications to support disaster management, crowdsourcing, and mashup applications. It collaborates with state and central government agencies and supporting ministries to enhance G-Governance initiatives. The application can be accessed at https://bhuvan.nrsc.gov.in/.

Bhuvan utilizes Indian Remote Sensing Satellites Images of 56m to < 1m high-resolution satellite images to update its base maps continuously. Additionally, it utilizes various mobile applications to collect geospatial data using technologies such as GPS and NAVIC. The data collected through these mobile applications undergo a moderation process before being made available to users, increasing accountability and transparency.

The Bhuvan is a unique platform with seamless visualization of multi-sensor, mutli- Add Content (allows user to add their volunteered platform) and multi-temporal images with capabilities to overlay thematic information like soil, wasteland, water resources etc. Bhuvan facilitates dissemination of Near real-time information from Automatic Weather Stations (AWS), Potential Fishing Zone (PFZ) information, Bhuvan Postal, Aadhaar Seva Kendra, disaster support related information like forest fire alerts, periodic agricultural drought assessment etc.

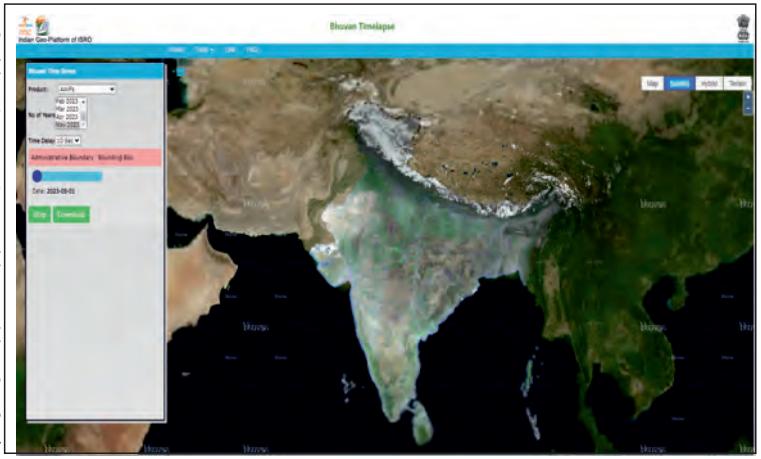
These applications are seamlessly integrated with government systems to improve public service delivery, enhance accessibility, and expand outreach. Ultimately, these efforts benefit citizens by providing them with timely and pertinent information.

Bhuvan is actively involved in supporting key flagship programs of the Government of India, as well as various ministries and state departments in the field of geo-governance. The platform encompasses over 195 applications spanning 24 ministries and state departments. Furthermore, it offers over 75 Android applications designed for field data collection, assisting organizations in creating asset inventories and monitoring on-the-ground activities.

Bhuvan also ensures ongoing support and updates for several crucial national-level applications, such as GeoMGNREGA to support MGNREGA, Housing for All to support Pradhan Mantra Awas Yojana - Urban, NSSO to support Urban Frame Survey, IWMP, RKVY, NABARD, and Jala Shakthi Abhiyan (JSA). Applications for State Departments are CDMA-Phase2 for property mapping, TWRIS, APSHCL, and State Portals.

Bhuvan also supports the creation of over 100 million Points of Interest (POI) data, enhancing the accuracy and usability of geographic information. The new version of Bhuvan is about to be released and is built to cater to diverse societal needs through the continuous innovation and user-centric design using 5 distinct modes: Standard, Thematic, Scientific, Governance and Disaster, consolidating relevant data for the entire country as a single gateway.

Being an Indian platform, it is well aligned with the government's Mission of Atma Nirbhar Bharat built on Open source platform. Bhuvan's data is not only more comprehensive but also cater to specific needs and challenges being faced at the local scale. This level of detail is expected to significantly enhance decision-making processes across multiple disciplines.



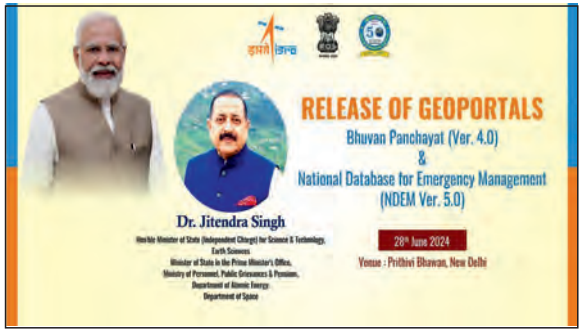
Bhuvan Panchayat

Bhuvan Panchayat Portal 09

The 73rd and 74th Constitution Amendments of 1993 facilitate the realization of consistent and conscious efforts towards Decentralised planning for rural and urban areas, respectively. These amendments have provided much-needed constitutional legitimacy to local governance institutions, defined their functional domains and provided financial devolution to these institutions. The Space-based Information Support for Decentralised Planning (SISDP) project was formulated by NRSC and was implemented in partnership with State Remote Sensing Application Centres in the country to provide basic planning inputs derived from satellite data.

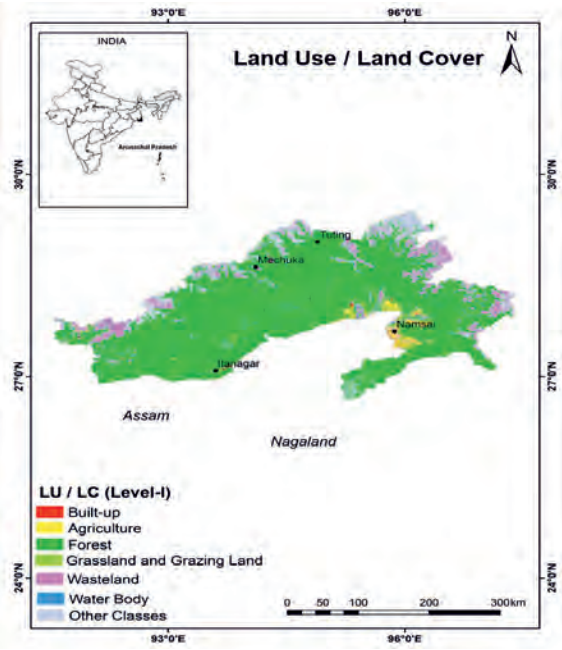
The "Space-based Information Support for Decentralized Planning" (SISDP) project, formulated by NRSC and approved by the 17th Planning Committee of National Natural Resources Management System (PC-NNRMS) in 2009 to strengthen the Panchayati Raj Institutions (PRIs) for decentralized planning at the Gram Panchayat level. Satellite data of 2.5m spatial resolution and thematic maps (land use/land cover, drainage, infrastructure such as roads and railways, and slope) generation at 1:10,000 scale was provided in addition to the development of the portal for data visualization and dissemination.

The second phase of the project - SISDP-Update (SISDP-U), was executed from 2019 to 2023 with the support of State Partner Institutions. The specific objectives are (1) Updation of LULC) and base layers (drainage, road, rail, settlements) at (2) Generation of geospatial products and services for planning; and (3) Updation of Bhuvan Panchayat portal with easy-of-use Graphical User Interface (GUI), time series data and advanced spatial analytics.



A classification scheme is enhanced to 89 classes at Level IV for LULC thematic database. The database is hosted on the "Bhuvan Panchayat" portal (https://bhuvanpanchayat.nrsc.gov.in). This is a significant achievement benefitting all segments of users from the geospatial industry, ministries, and the public with a focus on "Ease of Use" and "Ease of Access." Data from the Bhuvan Panchayat portal is available as OGC WMS / WMTS services to facilitate dynamic use in the derived applications of ministries, states, industry, and academia. Bhuvan Panchayat portal (Ver. 4.0) is released to the public by Dr. Jitendra Singh, Hon'ble MoS, on June 28, 2024

The highlights of the Bhuvan Panchayat portal are the Online availability of large-scale (1:10k scale) thematic



data along with cadastral data for a few States, theme segregated Layers Tool, layer visualization tools –"Swipe", "Transparency," & "Coverage Zoom", "Fly to Place" with an exhaustive place search from millions of Points of Interest, scale-based rendering with curated and standardized style sheets, dedicated links for planning, area profiles, success stories, technical Documents, etc., free data downloads and OGC WMS services for cross-platform environments, mobile applications for ground data collection and crowdsourcing.

Integrative Framework to Monitor Multiple Components of Biodiversity

Biodiversity Characterisation at Community Level in India Using Earth Observation Data

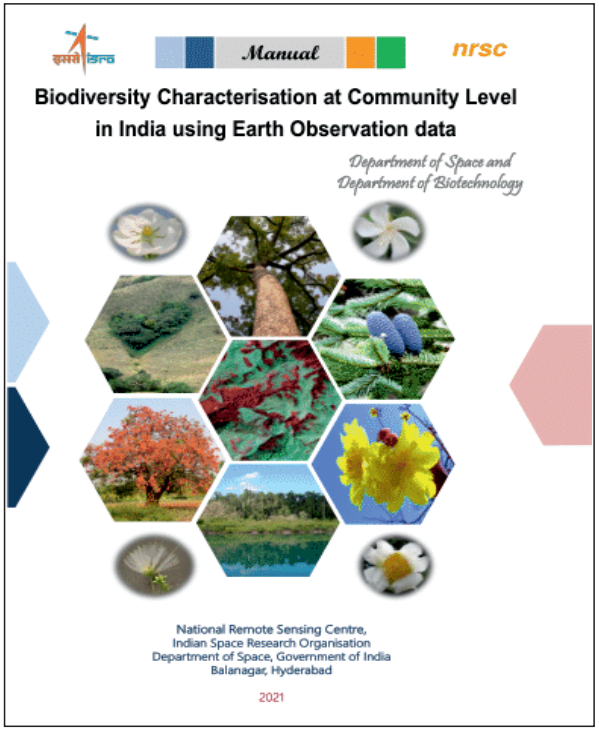
10

Sustainable Development Goal (SDG) 15 of the 2030 Agenda is focused on protecting, restoring, and promoting the sustainable use of terrestrial ecosystems, managing forests sustainably, combating desertification, halting and reversing land degradation, and halting biodiversity loss. In line with these global goals, India initiated this project in 2018, a joint effort by the Department of Biotechnology and the Department of Space, with support from the National Natural Resources Management System (NNRMS) under the Department of Space, Government of India.

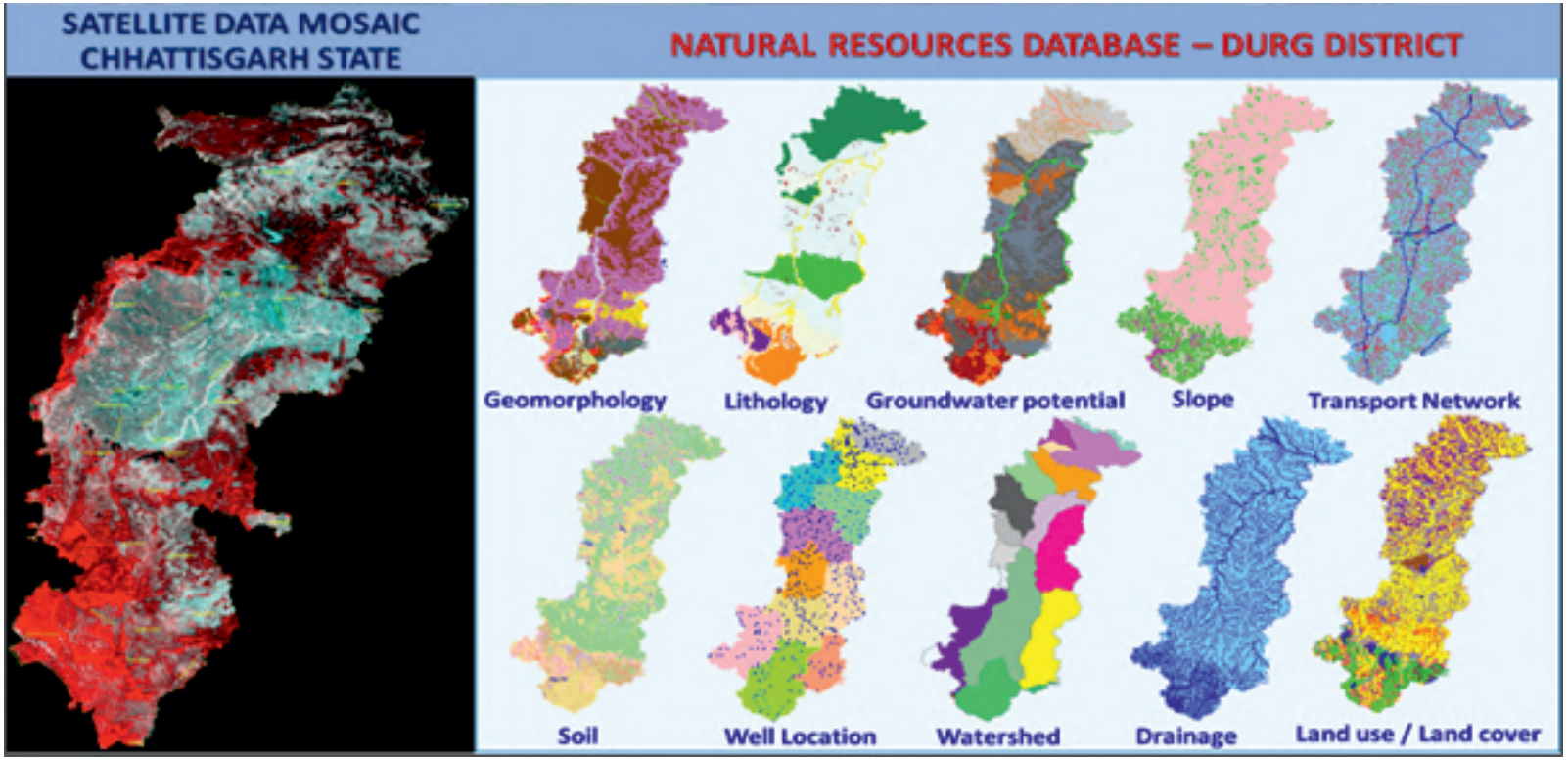
The project on "Biodiversity Characterisation at Community Level in India using Earth Observation Data" is targeted at developing an Earth observation-based strategy for monitoring biodiversity at the community level in India. The approach is to create a description of vegetation composition, structure, and function from remote sensing and field studies. It aims to assess decadal changes to the regional forest landscape, characterize vegetation communities, identify Earth observation variables relevant to monitoring biodiversity, and generate a web-based data repository and information system.

Biodiversity Informatics includes the application of information technologies to the mapping, measuring, modeling, monitoring, management, algorithmic exploration, analysis, and interpretation of species-level data and species response to a changing environment. Integrating ecologically pertinent data into the chain of information from the species level to the biosphere level will enhance our understanding and promote actionable natural resource management. Biodiversity informatics links diverse dimensions of organismal biology, phylogenetics, taxonomy, ecology, biogeography, geoinformatics, and conservation.

Biodiversity Studies contributed to ISRO's Vision for 2017-2030, which highlighted bioresources assessment, biodiversity mapping, and study of human activities' impact to derive plans for conservation using space technologies. The project outcomes led to the development of an earth observation-based biodiversity monitoring system that benefited both



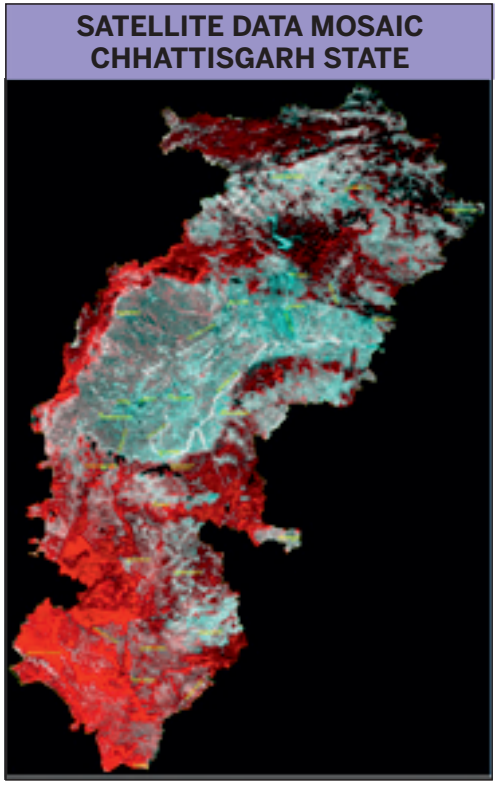
national imperatives and reporting to international commitments on biodiversity goals.The development of cross-disciplinary biodiversity informatics and standardized data plays a significant role in conservation. Application of ecological informatics to biodiversity information can yield new ways to observe and analyze existing information and predict future scenarios.



Chhattisgarh GIS Project

Chhattisgarh GIS Project – An Initiative for Developmental Planning and e-Governance

The Government of the newly formed state of Chhattisgarh in the year 2001 took a step forward to use latest technology for the development and e-governance of the state. Realizing the importance of



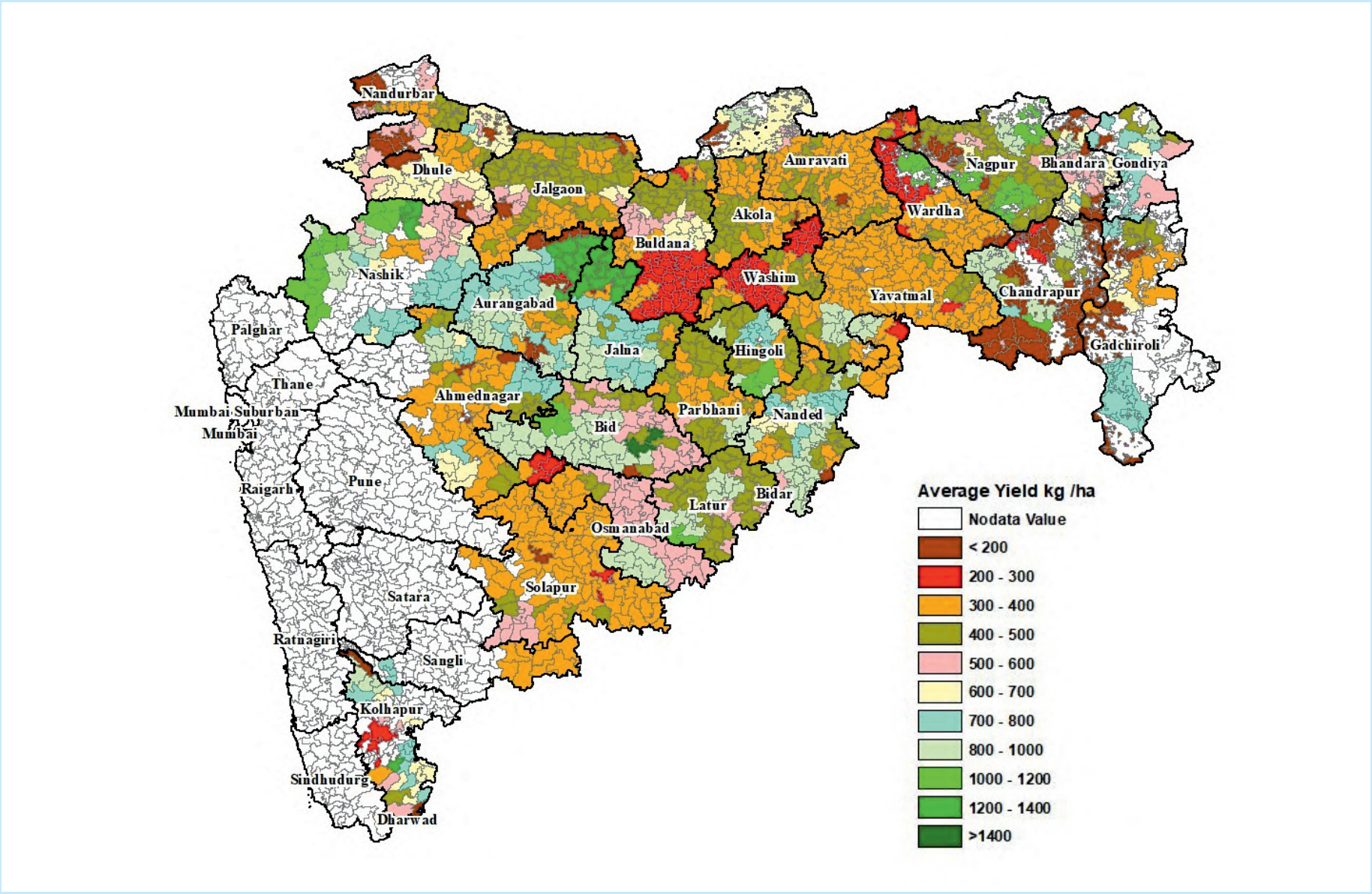
remote sensing and GIS in developmental planning and optimal use of natural resources, the Chhattisgarh GIS Project (CGIS) was conceptualized, and executed during 2002-2007 with the aim of generation of a comprehensive digital geospatial database for the entire state on 1:50,000 scale and geo-referencing of nearly 20,000+ village maps for development of the cadastral information system utilizing the state-of-art Indian Remote Sensing satellite's digital data and geoinformatics technology.

Important outcomes of the project include generation of digital GIS database of land use/land cover, soil, slope, drainage, watershed, transport network, lithology, geomorphology, structure, settlement, and derived layers on land capability, alternate land use, water use, etc.

The database is designed for seamless integration and retrieval at district, tahsil and village level for planning, implementation and monitoring various developmental programmes involving people's participation. Other major outcome includes geo-referencing of village (cadastral) maps of the entire state for about 20,000+ villages and development of Cadastral Information System for entire state of Chhattisgarh. These two significant outputs have met the operational needs of the respective state departments for planning, implementation and monitoring of the various developmental activities in the state. GIS databases generated were customized to develop software packages, viz., NAKSHA (for Land Records), Chunav (for Chhattisgarh Election Commission) and Gyan (village-information system).

The databases generated under the CGIS have extensively benefitted the several line-departments of Chhattisgarh state towards developmental planning. Few examples include, identification of suitable sites for sericulture, floriculture and horticulture; identifying potential sites for industrial development; identification of shortest routes and providing connectivity to villages in densely forested areas, shortest path for electrical transmission lines, etc. The customized software packages have benefitted the Government of Chhattisgarh extensively for several e-Governance activities in the state, few examples include, providing 'chaturseema naksha' to the citizens, delimiting the administrative boundaries for election commission of Chhattisgarh, development of village

resources, etc. Seamless database of the entire state from 1:50000 scale down to cadastral level (1:4000 scale) has found multifarious applications for optimal use of natural resources, developmental planning in various sectors and e-Governance in various departments of the Chhattisgarh Government.



Cotton Crop Yield Estimation Using Simulation Modeling in Maharashtra State

Crop Insurance Studies 12

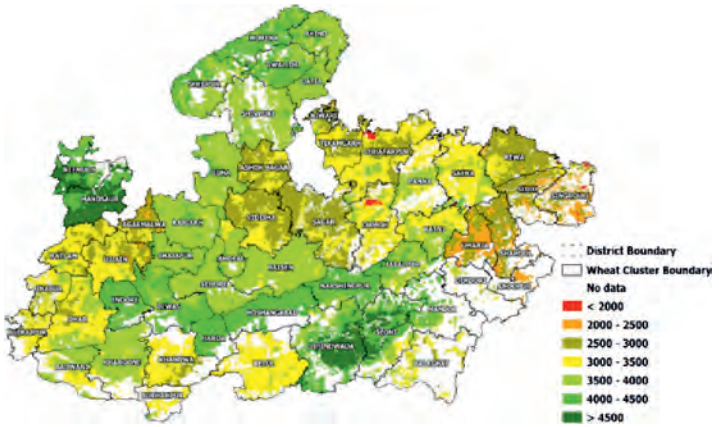
Crop insurance is a means of protecting the agriculturist against financial losses due to uncertainties that may arise from crop failures/losses arising from named or all unforeseen perils beyond their control. The Government of India launched several technology support programmes like PMFBY, YES-TECH in which the geospatial technology plays a major role.

ISRO, as a knowledge partner, collaborates with several state governments to leverage space-based technology for agriculture.

Focusing on states like Madhya Pradesh and Maharashtra. ISRO supports effective utilization of satellite data and weather stations to enhance decision-making, planning, and risk mitigation in agriculture, particularly for technology based yield estimation aimed towards crop insurance solutions. These efforts aim to double farmers' income by integrating satellite data, ICT, IoT, and AI/ML technologies for real-time, customized farm-level information and advisory.

Remote sensing derived spectral indices along with weather data was assimilated into crop growth simulation models for technology based yield estimation for the crops like cotton, soybean, paddy and wheat at insurance unit level for Maharashtra state. Machine learning based algorithms were envisaged for technology based yield estimation for the crops of paddy, soybean and wheat in Madhya Pradesh state.

Soybean Crop Yield Estimation Using
ML Based Approach in Madhya Pradesh



Developed an innovative composite index derived from satellite and weather-based indices for crop insurance in West Bengal. A composite index derived from satellite and weather-based indices, used for insurance claim disbursements since Kharif 2020. Mentored the Technology implementation partners (TIP) for effective implementation of Technology based yield under PMFBY for the states of Odisha, Tamilnadu, Karnataka, Madhya Pradesh and Maharashtra states. Accurate pre-harvest yield estimates aiding in effective insurance claim settlements for major crops in Maharashtra and Madhya Pradesh.

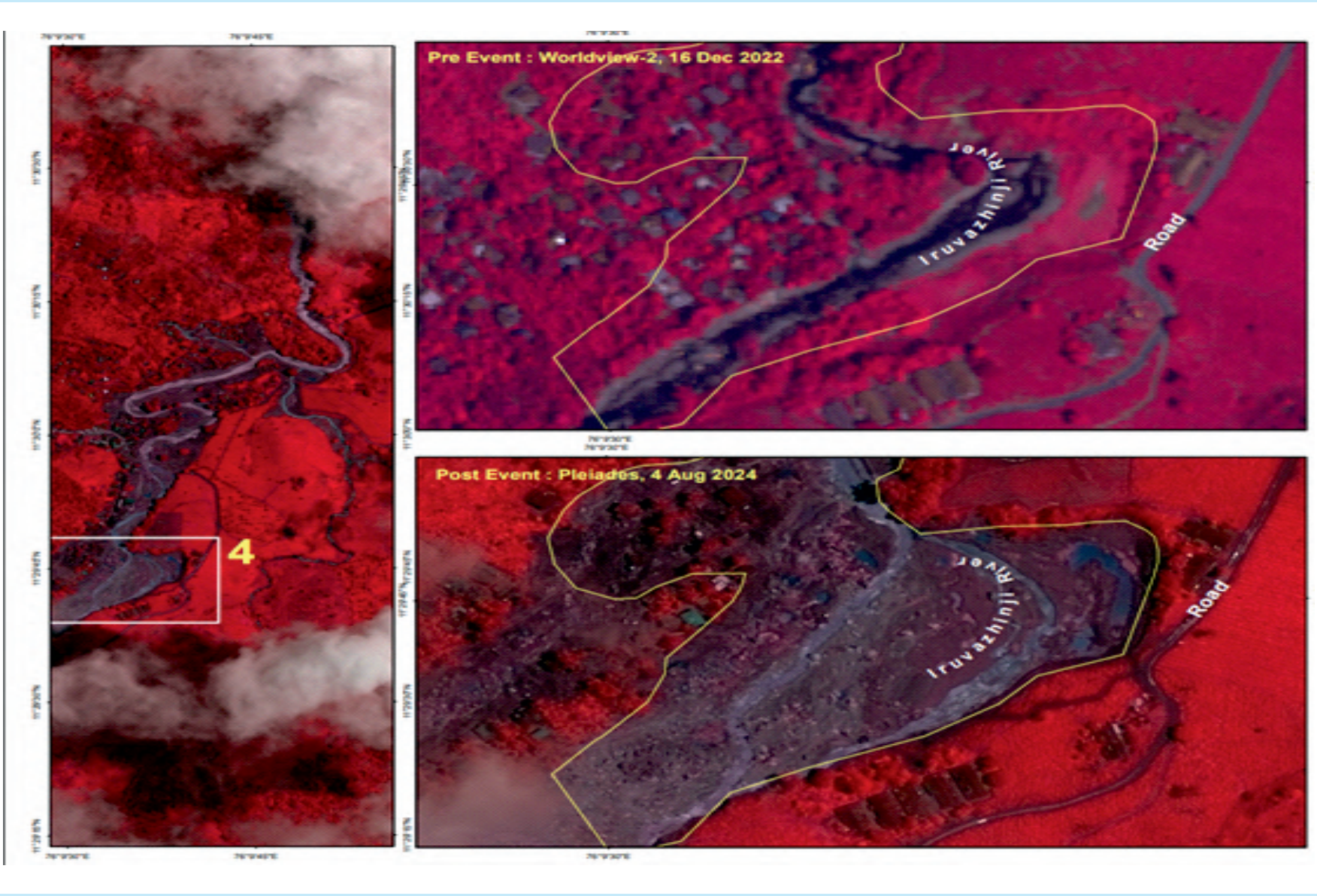
The deliverables are:

- Sown Area Progress: Monitored at 15-day intervals from sowing to harvest.
- Crop Condition and Stress Monitoring: Including drought and flood damage assessment
- Pre-harvest Crop Yield Estimates: For major crops like soybean, paddy, cotton, Wheat
- Satellite Data Provided: Nearly 25,000 high-resolution Cartosat-2S images delivered to 13 states for the Agristack project, aiding in the georeferencing of cadastral maps.
- A composite index derived from satellite and weather-based indices, used for insurance claim disbursements since Kharif 2020.

The major benefits accrued are:

- ✓ Enhanced Decision-Making and Planning: Improved planning and risk mitigation in agriculture through data-centric technologies.
- ✓ Insurance Claims Efficiency: CHF facilitated insurance claim disbursements, benefitting over 50 lakh farmers in West Bengal with Rs. 1456 crore in claims across five seasons.
- ✓ Crop Yield Estimates: Accurate pre-harvest yield estimates aiding in effective insurance claim settlements for major crops in Maharashtra and Madhya Pradesh.

These initiatives demonstrate ISRO's commitment to enhancing agricultural resilience and supporting the sustainable development of the farming sector through innovative applications of geospatial technologies.



View of Satellite Image During Pre & Post Landslide – Wayanad, Kerala

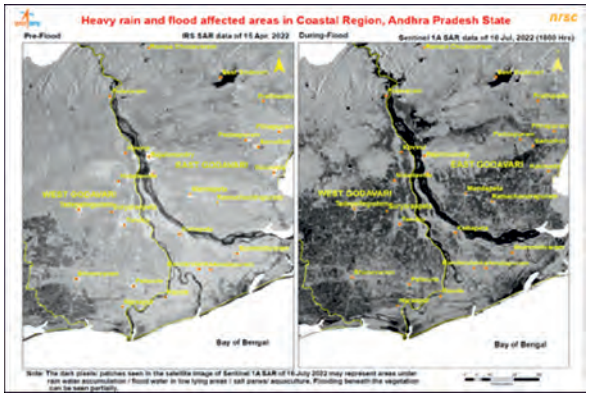
Decision Support Centre, Disaster Management Support Programme

13

The application of remote sensing observations to the task of forecasting, tracking, and alerting the society to extreme weather events is conversant, and the significant progress in satellite sensor technology is facilitating access to a wide range of observations in response to a much wider range of disasters. The Decision Support Centre (DSC) of NRSC provides space-based and aerial-based disaster-specific products in near real-time to support disaster management programmes addressing natural disasters, viz. floods, cyclones, landslides, earthquakes, forest fires, etc. The value-added products/ services generated using satellite data help in addressing the needs during preparedness, early warning, response, and mitigation phases of disaster management addressing the above-mentioned natural disasters.

The Disaster Management Support (DMS) program advances science and build tools to help communities make informed decisions for disaster planning. These programs disseminate free and accessible resources that use Earth observations to reveal how natural hazards interact with social vulnerability, exposure, and coping capacity in a changing climate.

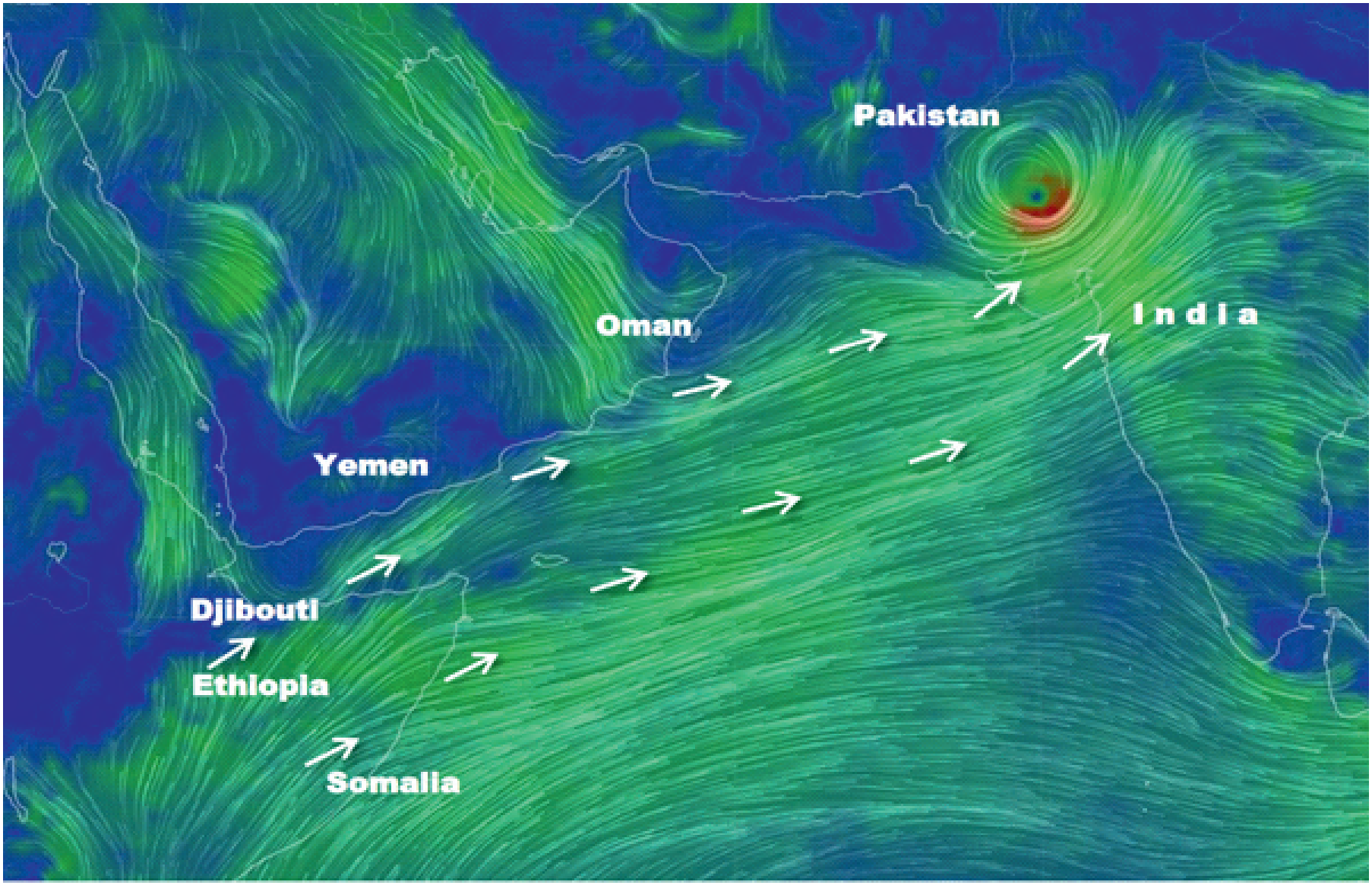
NRSC/ISRO has been monitoring and mapping the floods and cyclones in the country using multi-mission, multi-sensor satellite remote sensing data. Flood inundation maps, Flood progression maps, Flood persistence maps, and value-added products are prepared and disseminated to the MHA, NDMA, DMA's State Remote Sensing Applications Centres, etc. Similarly, Landslide damage assessment, inventory, early warning, susceptibility mapping, volume estimation, and monitoring are also disseminated. An experimental Landslide Early Warning System was generated for Rainfall Triggered Landslides along the Northern region for nine pilgrimage routes, and Landslide Hazard Zonation was carried out for Himachal Pradesh, North Eastern region, and Uttarakhand. Spatial flood/Landslide early warning is the best non-structural damage mitigation method. This supports the administration to evacuate people well before the event occurs.



Moreover, as part of the Rapid Response and Emergency Services (RRES) activity carried out under the Disaster Management Support Programme (DMSP) of the Department of Space (DOS), timely observations on active forest fires are generated to meet the requirements of forest fire management in India. Near Real Time information on active fires helps in fire mitigation and management, aids in reducing air pollution, climate perspective and ecology, environment economical and climate change.

The DSC provides actionable insights, maps of affected areas, assesses damage, and identifies critical zones for immediate attention. The DSC has significantly improved India's disaster preparedness and response, saving lives and reducing economic losses. DSC at NRSC exemplifies the integration of advanced remote sensing technologies for effective disaster management, contributing to a safer and more resilient scenario

3D Visualization of Assam Flood



Biparjoy-Borne Migration of Desert Locust From Ethiopia to Bikaner During June 2023.

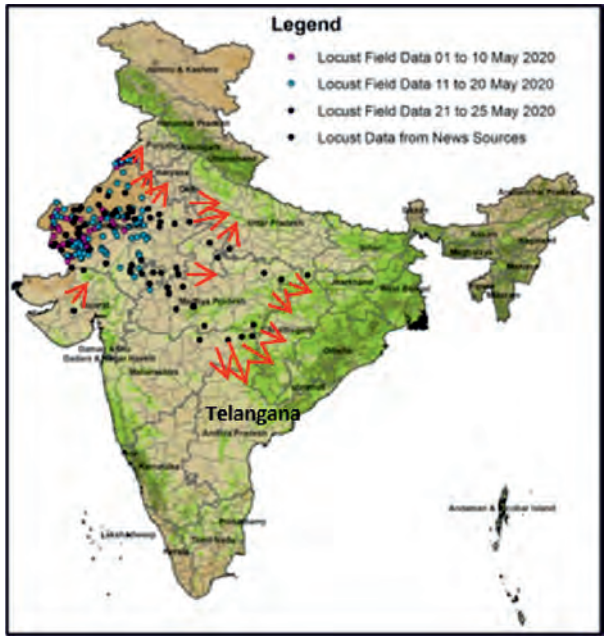
Desert Locust Surveillance Using Geospatial Technology

14

The desert locust, Schistocerca gregaria Forsk, a species belonging to the African continent, is considered a dangerous insect and has a natural presence in 30 countries, primarily in arid and semi-arid regions. As a coherent unit, swarm formation will occur that contains millions or billions of individual adult locusts, which requires significant control operations to combat their menace; otherwise, they threaten global food security.

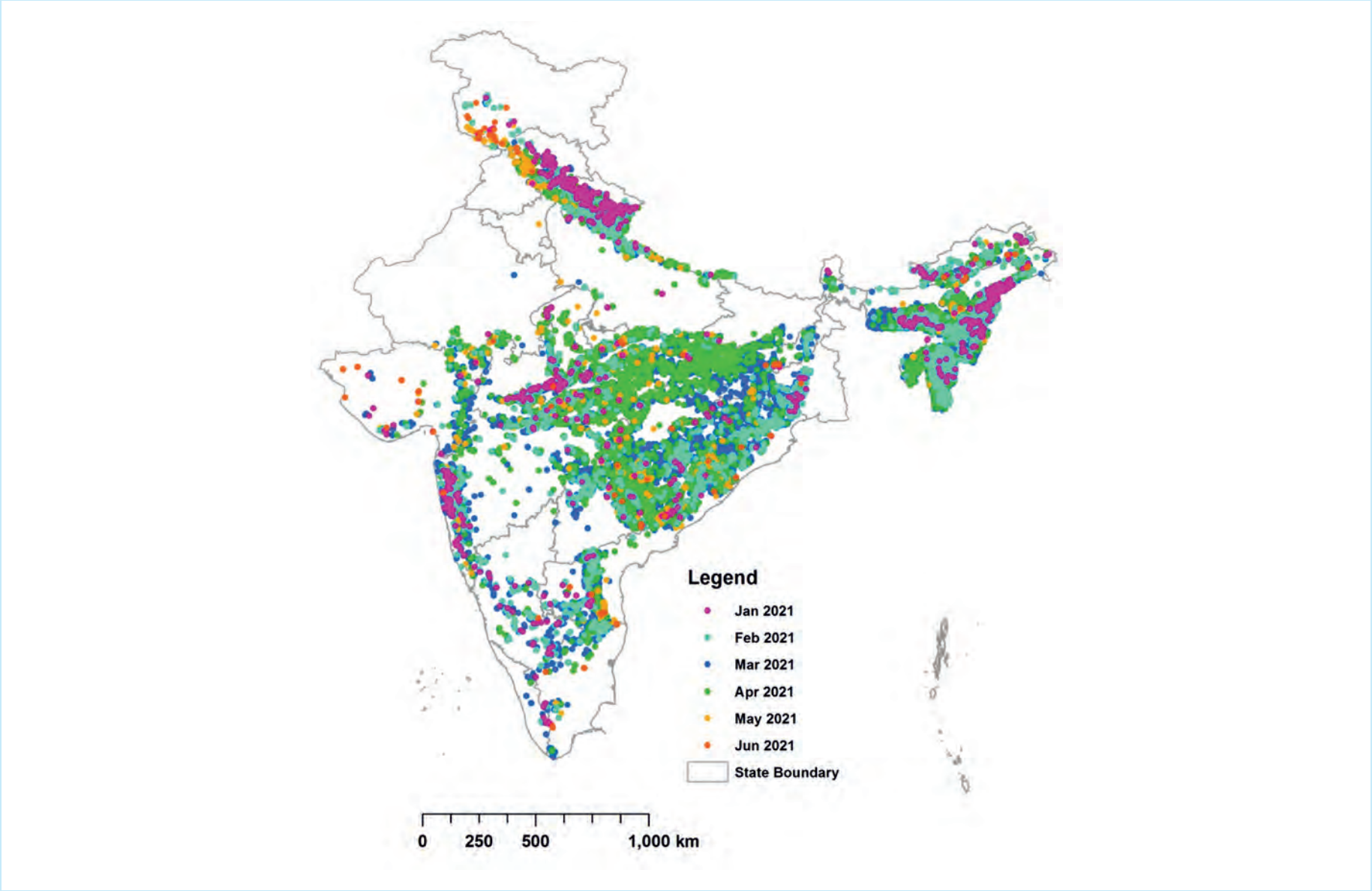
The issue of Desert Locust presence and migration spans continents, making it necessary to conduct studies using remote sensing and continental-level data. RRSC-W,Jodhpur, NRSC carried out studies on Locust Surveillance due to its proximity to the Thar Desert region, utilizing data from space-borne sensors. The life cycle of the desert locust consists of three stages: egg, nymph to hopper, and adult, all of which are highly influenced by environmental and climatic variables. The Normalized Difference Vegetation Index (NDVI) provides a glimpse of vegetation status, and platforms like AWiFS/LiSS-III/IV can be used to generate vegetation products for global monitoring. Geophysical products related to soil moisture aid in detecting desert locust habitats and identifying breeding conditions. The NICES geoportal disseminates geophysical products focusing on land, ocean, atmosphere, and cryosphere, playing a crucial role in correlating swarm migration with environmental conditions.

In 2002, a customized GIS-based solution was implemented by the government of Kazakhstan to address the persistent issue of locust infestations in the country. The solution aimed to provide operational decision support by identifying potential high-frequency locust breeding areas in deserts and semi-deserts through a comprehensive analysis of various biophysical variables. In 2018, cyclones such as Sagar, Mekunu, and Luban resulted in heavy rainfall in the Empty Quarter of the Arabian Peninsula, creating favorable ecological conditions that exacerbated the outbreaks of Desert locusts. The FAO issued an alert for a Locust Upsurge in 2019-2020.



Heuristic Prediction Map of Locust Migration

During the Amphan cyclone in the Bay of Bengal, the migration of locust swarms intensified, extending their migration trajectories to cover most parts of the affected countries. Multi-platform and multi-sensor satellite data from open-source platforms such as MOSDAC and Bhuvan have been utilized. From May 29th, 2020, RRSC-W has issued 36 alerts and bulletins based on the situation.



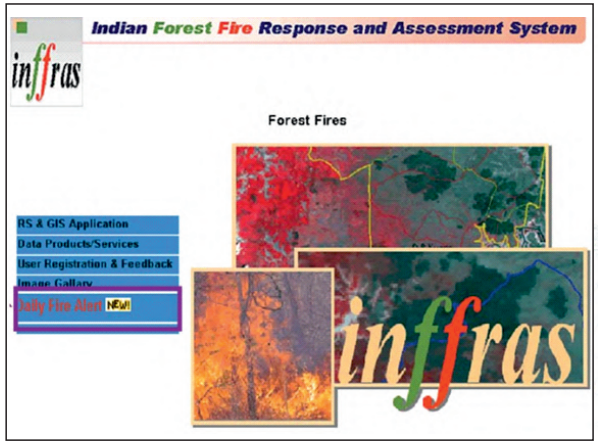
Reported Forest Fires During the Period Jan-June 2021

Forest Fire Monitoring Using Satellite Data

15

Forest fire or wildland fire is considered as one of the most important disasters causing adverse ecological, economic, and social effects worldwide. The country's total geographic area is 328.73 M ha., out of which 70.2 M ha. is covered by forests (21.34% of TGA) (Forest Survey of India, 2015). Different normal and peak fire seasons vary from January to June. A national-level concerted effort, which facilitates providing quantitative and qualitative inputs on fire monitoring, damage assessment, and mitigation planning in regulating fire management, is needed. As part of the

Disaster Management Support Programme (DMSP), forest fire alert products are generated and provided to forest departments /FSI for preparatory planning for fire control, Damage and recovery assessment, and mitigation planning in addition to the hosting of data on Bhuvan portal and SMS service to the stakeholders. A common protocol for estimating the crop residue/stubble burning estimation was developed in consultation with the organizations involved in generating and disseminating the information, and daily data is disseminated to MoEF&CC and state departments during the Kharif and rabi burning seasons.



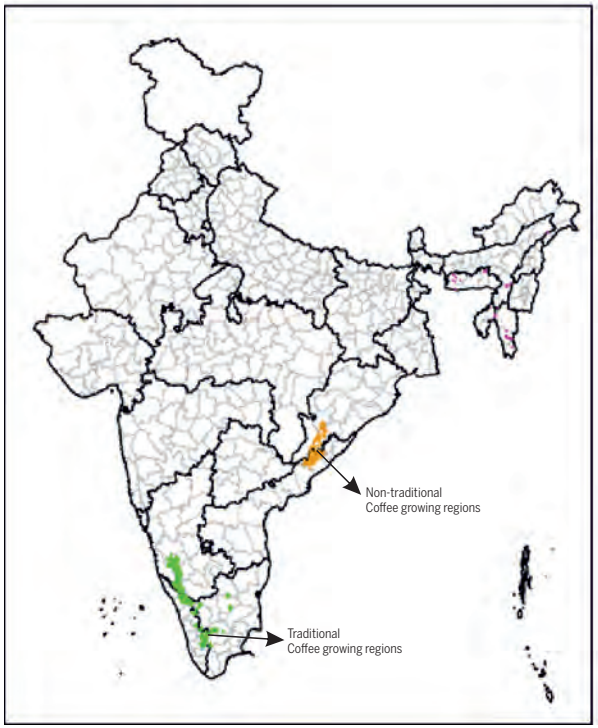
Real-time alerts for active forest fires using MODIS and VIIRS satellite data cover India and generate fire location information at three different spatial resolutions: MODIS (1000m), VIIRS (750m), and VIIRS (375m). The data is disseminated via email to the Forest Survey of India (FSI),Dehradun and is also published on the Bhuvan website at https://bhuvan-app1.nrsc.gov.in/disaster/disaster.php?id=fire. Selected state forest departments will also receive SMS alerts with fire information. Daily reports of agriculture residue burning fire locations, viz., Punjab, Haryana, Rajasthan, and Uttar Pradesh, are being emailed to the MoEF&CC and Central Pollution Control Board (CPCB). The fire alert information is also published

onlineapp1.nrsc.gov.in/moef. Remote sensing technologies, satellite-based monitoring systems, and platforms like Bhuvan (with its environmental applications) can support the timely dissemination of fire location data to stakeholders. This allows for informed decision-making, improved firefighting strategies, and better management of natural resources, contributing to climate resilience and adaptation effort

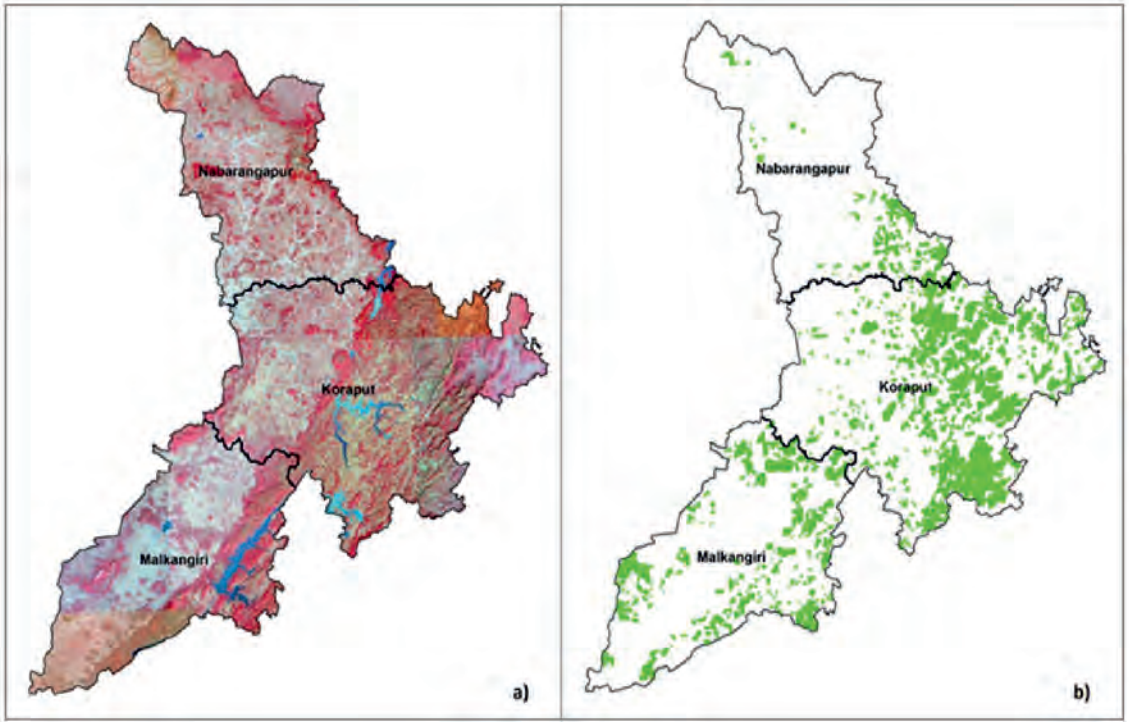
Sensor	Forest Fire Count (Jan-Jun 2021)
MODIS AQUA	32,088
MODIS TERRA	12,107
SNPP VF375	3,27,443
SNPP VF750	51,899
JPSS VF375	2,97,745
JPSS VF750	48,487

Key Results for the 2021 Forest Fire Season

National Level Coffee Map



Potential Areas for Coffee Cultivation in Odisha



Coffee Plantations at National Level (GeoCUP)

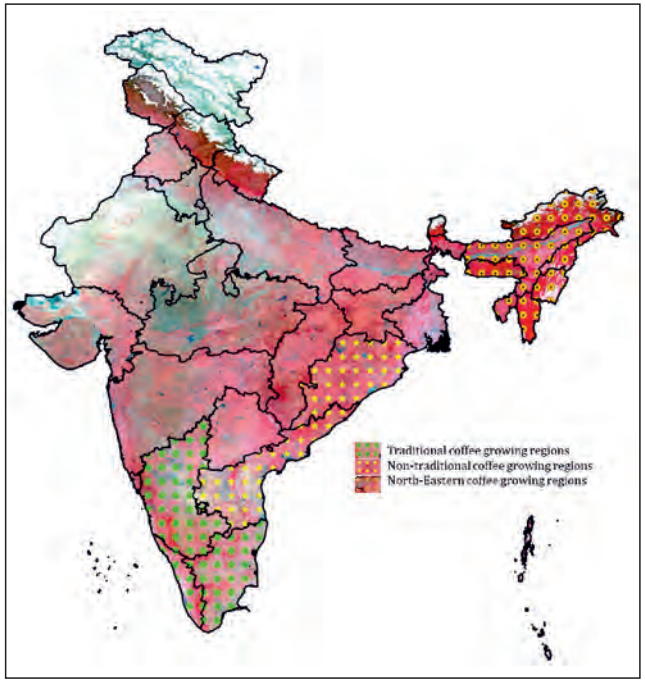
Geospatial Inventory of Coffee Plantations at National Level (GeoCUP)

16

Coffee, a vital commercial crop, significantly contributes to India's economy, with nearly 80% of its production being exported. Despite its global reputation for producing high-quality, shade-grown coffee, India lacks a systematic, up-to-date inventory of its coffee plantations. The "Geospatial Inventory of

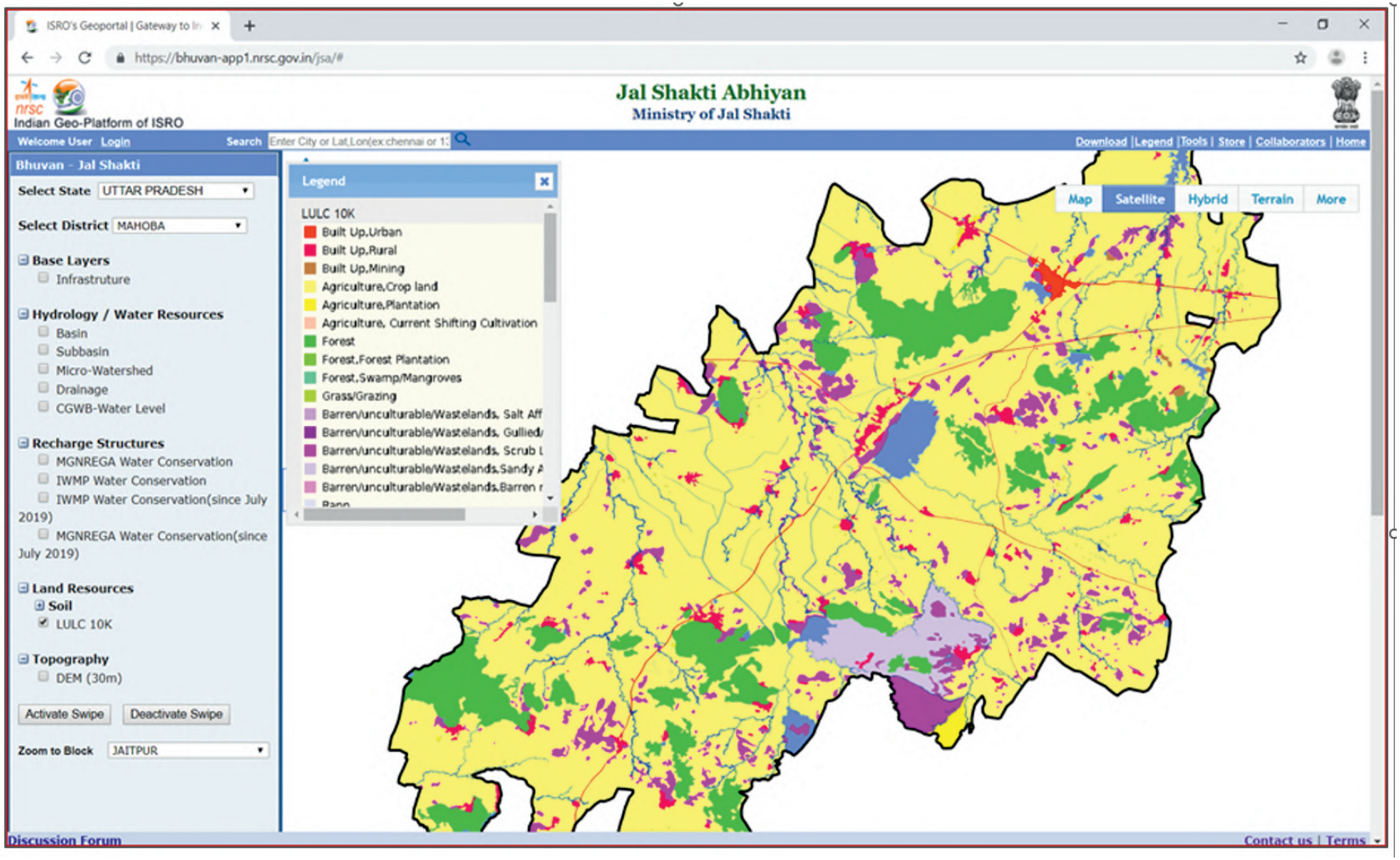
Coffee Plantations at National Level (GeoCUP)" project is an innovative initiative to map and analyze coffee plantations across India using advanced geospatial technologies. ISRO initiated this project in collaboration with Coffee Board of India, Ministry of Commerce and Industry, to address the gap by creating a comprehensive geospatial inventory of coffee plantations across traditional regions (Karnataka, Kerala, Tamil Nadu), non-traditional regions (Andhra Pradesh, Odisha), and the North Eastern states. It also includes a site suitability analysis for expanding coffee cultivation in selected districts of non-traditional regions.

Given the complexities of coffee cultivation—often grown under shade with varying plantation sizes—GeoCUP utilized high-resolution LISS-IV data from Resourcesat-2 and panchromatic data from Cartosat-1 to accurately map these plantations. The methodology incorporates temporal satellite data to capture the phenology of coffee plants. The site suitability analysis considers factors such as rainfall, temperature, relative humidity, elevation, and slope, identifying 1.20 lakh hectares of land suitable for coffee cultivation in the states of Odisha, Chhattisgarh, Himachal Pradesh, and West Bengal.



The GeoCUP project is the first in India to apply geospatial technology to create a national coffee plantation map. The results are integrated into the Coffee Board's Decision Support System "KSHEMAM," aiding in expanding coffee plantations and providing crucial agro-advisory services to farmers, thereby enhancing the development of India's coffee sector. The study suggested that a potential area of 1.20 lakh ha is found to be suitable for expanding coffee plantations in India.

This national geospatial database on coffee plantations and suitable areas will also serve as a reference for the overall development of the coffee sector in India, offering essential agro-advisory services to the farming community.

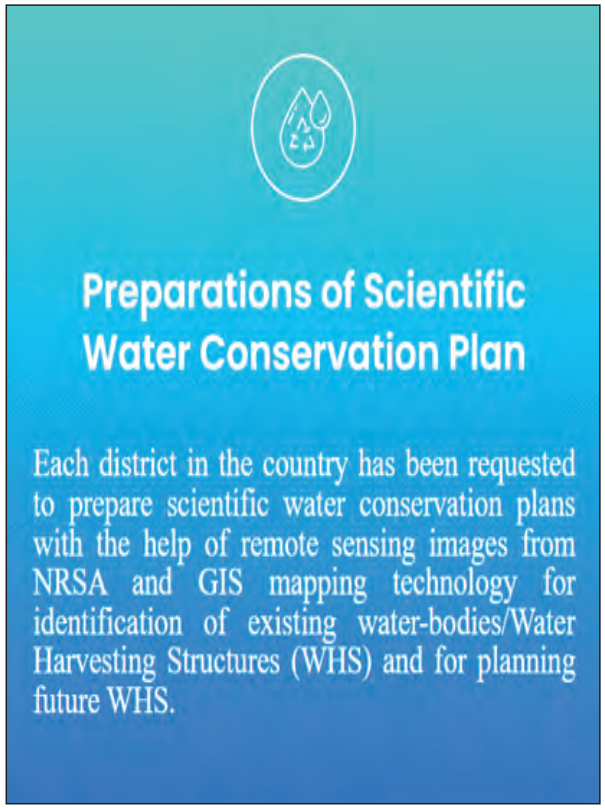


Bhuvan – Jal Shakti Abhiyan Portal for hosting and dissemination of the block-wise thematic database for 1240 JSA blocks required for planning water conservation interventions

Geospatial Support for Jal Shakti Abhiyan Mission 17

The Government of India launched the "Jal Shakti Abhiyan" Mission (JSA) on 1st July 2019 in around 1592 water-stressed blocks across 256 districts to implement water conservation and harvesting measures for improving the water situation.

A campaign "Catch The Rain" with different tag lines is launched in each year to emphasize the importance of rain water harvesting.

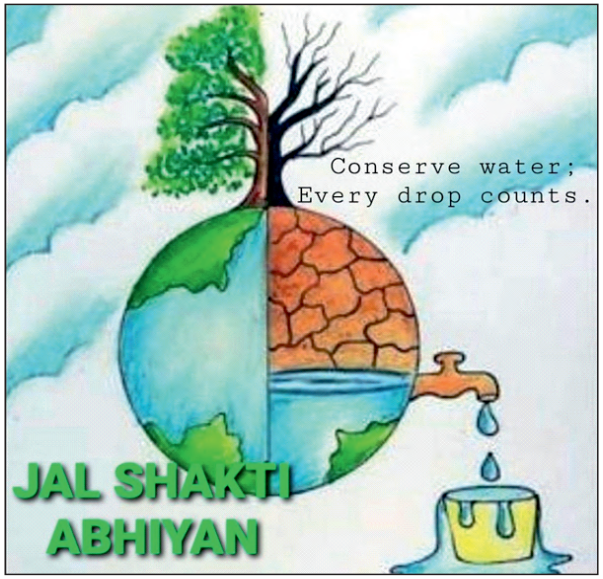


During a pre-launch meeting of the Committee of Secretaries, Cabinet Secretary and Principal Scientific Advisor (PSA) to GoI emphasized the need to use space technology inputs for planning water conservation interventions under JSA. ISRO has taken up a project to create a geospatial database that will support the planning and execution of different water conservation initiatives. The goal was to produce personalized geospatial maps for nine key parameters required for planning water conservation efforts and development of the Bhuvan-JSA portal.

Further, the water conservation assets were analyzed using geotagged data from the Bhuvan-JSA portal, and field data was collected through mobile applications. Customized geospatial maps viz. Land use/Land cover, Soil Texture, Water bodies and Drainage, Micro-watershed, Groundwater levels, Existing water conservation/Recharge assets created under MGNREGA & IWMP, Potential zones for Farm ponds, Groundwater prospects, and Proposed sites water conservation and Recharge structures are prepared by NRSC.

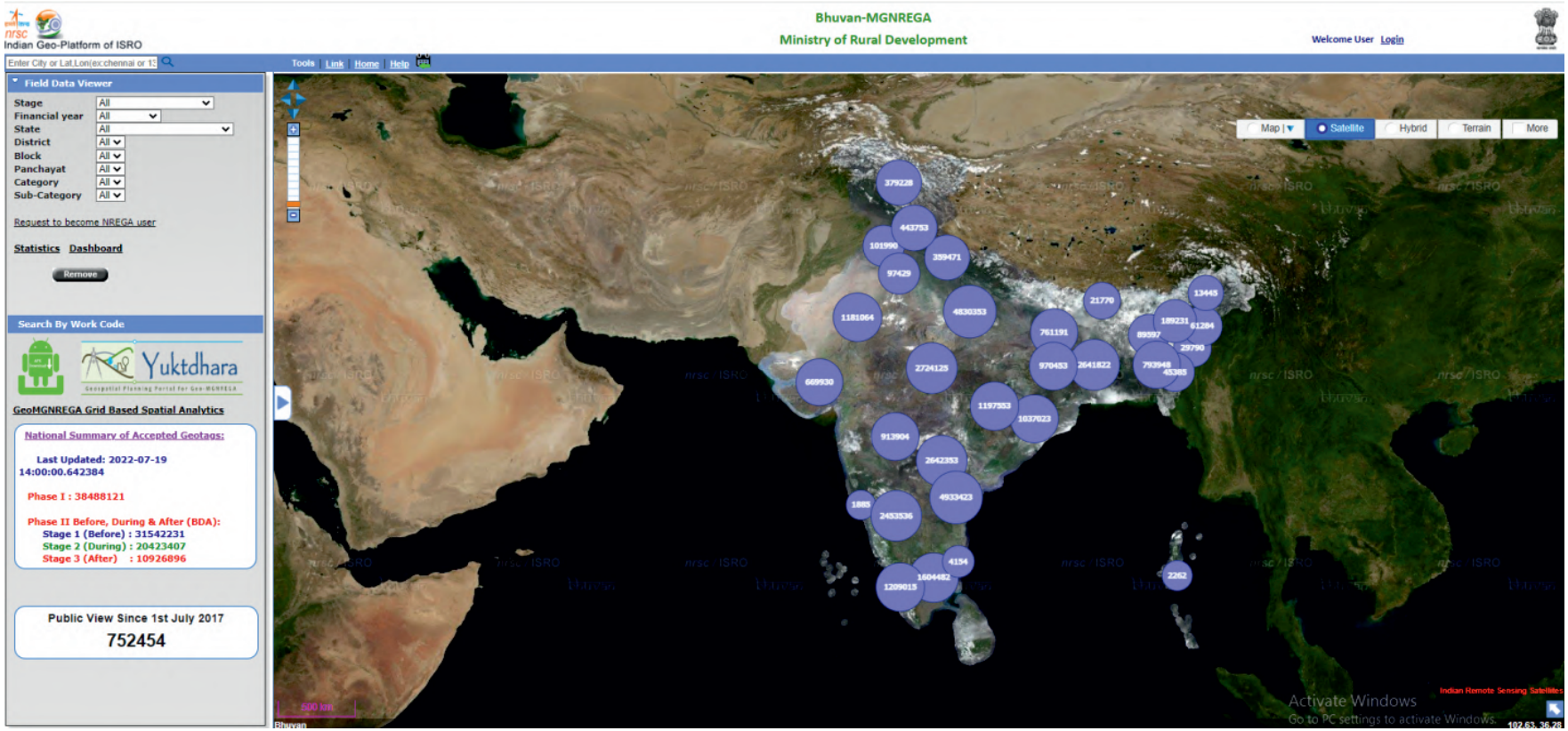
A total of 11,000 geospatial products have been created for the 1240 JSA blocks across various states. These products are essential for planning and executing water conservation initiatives in these blocks facing water stress. The Bhuvan-JSA Geoportal was designed specifically to offer high-resolution satellite data and a pertinent thematic database for all the blocks.

Fifty capacity-building workshops/technical sessions



have been conducted for field teams representing various state-line departments. The GIS-based impact analysis has focused on post-implementation phase analytics for the 15.3 lakh Assets/Activities (geotagged) at the district level, along with approximately 10931 geotags available on the Bhuvan JSA portal. Furthermore, the spatial distribution and trends of intervention-wise activities undertaken across the country under the JSA have been analyzed.

The satellite remote sensing data in optical and microwave domains has been utilized to identify and study the impact of these assets on the ground. The geospatial maps provided by NRSC have been used by district-level planning officials for scientific water conservation planning.



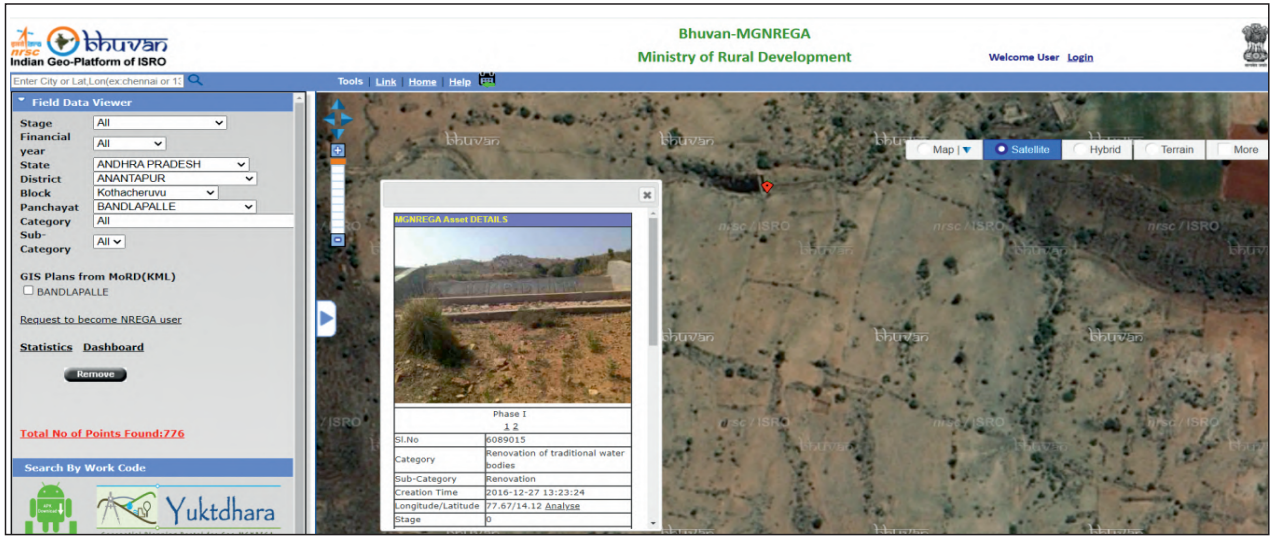
GIS Implementation of Mahatma Gandhi National Rural Employment Guarantee Act (Geo-MGNREGA)

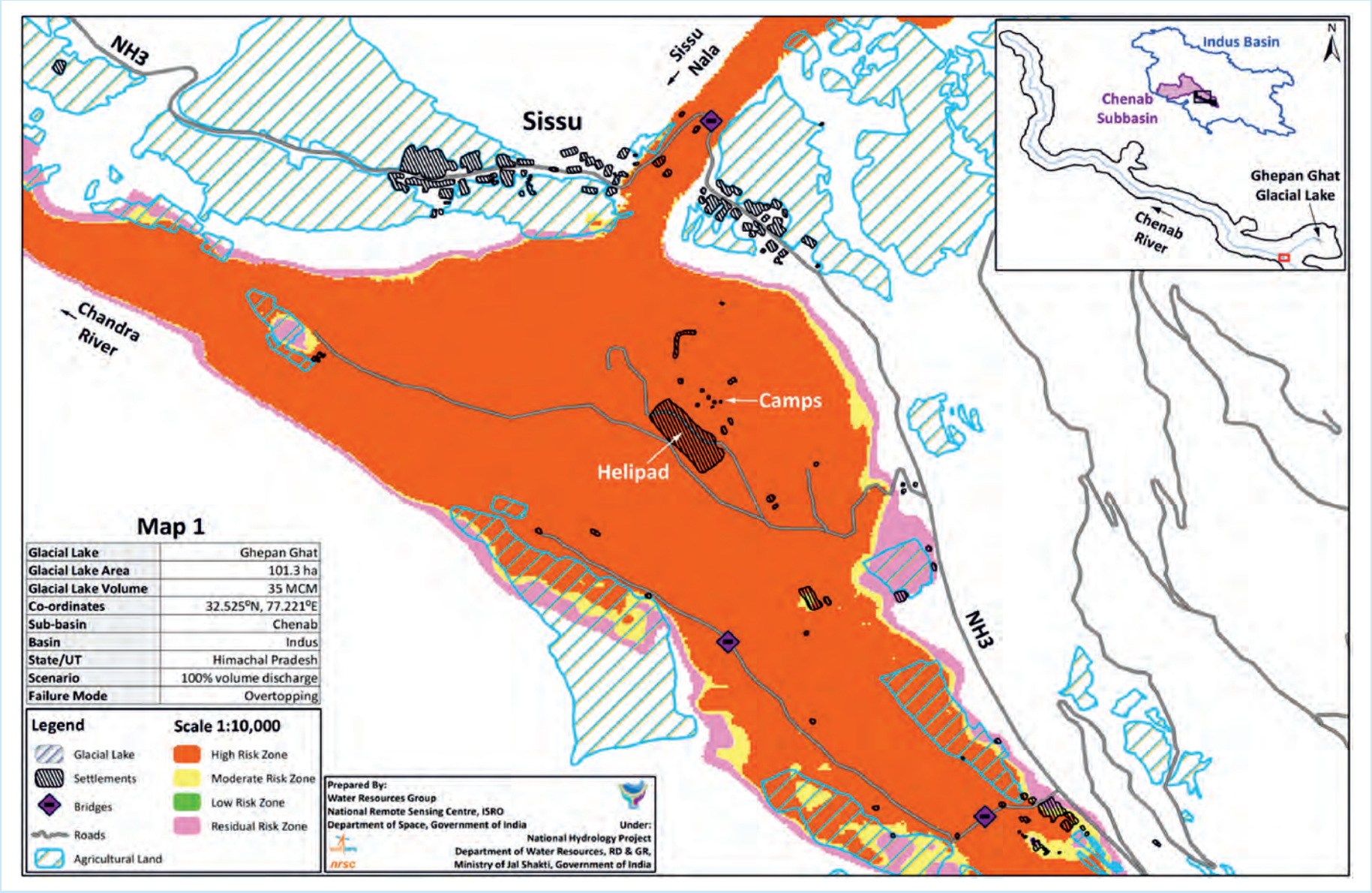
GIS Implementation of Mahatma Gandhi National Rural Employment Guarantee Act (Geo-MGNREGA)

The project facilitates enhanced transparency and accountability in the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) service delivery for the Department of Rural Development, Ministry of Rural Development, Government of India. NRSC provided a unique solution in implementing the MGNREGA Scheme that aims to enhance the livelihood security of households in rural India by providing guaranteed wage employment. It provides the real-time inventory of the assets completed on the field by employing rural landless job seekers on a day-to-day basis on ISRO's Portal. Indian remote sensing images serve as a spatially explicit context for reporting the precise location of the assets created. The process enhances transparency by providing verifiable on-the-ground information, thereby improving accountability. As of now, 3.9 crore assets have been geotagged in Phase I (2006 to 2017-18) of the project. Phase II focuses on monitoring the entire asset creation process under MGNREGA, supported by financial linkages for each stage of work completion. Over 9.4 crore geotags have been captured and rendered on the GeoMGNREGA portal in Phase II.

After development of the Pan Indian database on all completed assets of MGNREGA since 2006, the web-enabled smartphone-controlled mechanism of tracking key steps in asset creation (before, during, and after the asset creation) is adopted at the operational level. The financial allocation of each stage is linked to the geotagging stage, which brings in quality and timely execution of assets. Further, new activities are also taken up through the web GIS portal "Yuktdhara" to bring spatial planning aspects to rural employment generation. Yuktdhara incorporates thematic information coupled with customized GIS tools to facilitate decentralized planning. This is facilitated to overcome the poor planning during its initial years of implementation (such as massive criticism due to spurious transactions, ghost assets, double booking, etc.); the scheme is today eulogized for its futurist mandate and positive impacts due to the adoption of GIS technology in a phased manner. Further, an enhanced faith in the rural poor and their enhanced participation in the scheme across the country was observed.

A significant byproduct of the GeoMGNREGA solution is the creation of a rich asset data bank, providing a wealth of spatial data related to rural infrastructure and natural resources. This data bank offers immense potential for spatial data analytics, which can be harnessed to generate insights for more strategic rural development planning. By analyzing trends, patterns, and relationships between different types of assets and their geographical contexts, policymakers can optimize resource allocation, enhance environmental sustainability, and plan for long-term rural growth. This comprehensive geospatial database not only strengthens the MGNREGA program but also serves as a valuable tool for broader rural development initiatives, driving data-driven governance and informed decision-making across sectors.





GLOF Risk Map of Ghepang Ghat Glacial Lake Near Sissu Village

Glacial Lake Outburst Flood (GLOF) Risk Assessment

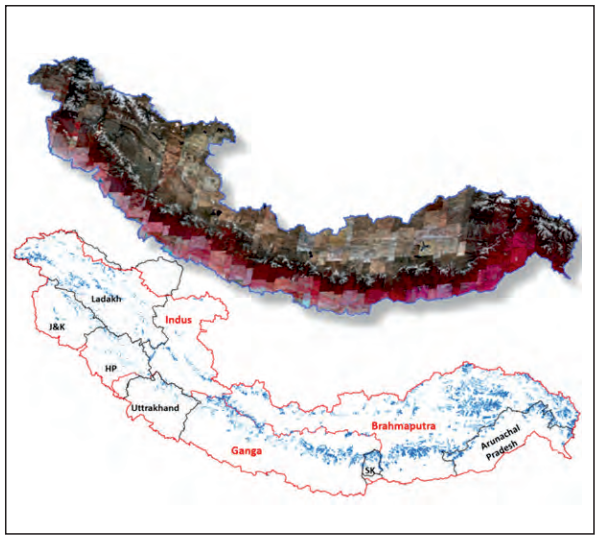
Glacial lakes associated with glaciers are common in high-altitude regions like the Himalayas. At times, glacial meltwater stored in these glacial lakes suddenly gets released, causing flash floods called Glacial Lake Outburst Floods (GLOF). These flash floods create havoc on the river's downstream areas, affecting people and infrastructure like roads, hydropower plants, crops, etc. Many GLOF events occurred in the Himalayas and are increasing in trend. It is essential to know the location of glacial lakes, their susceptibility, and the probable consequences of their breach. Due to their remote locations, rugged terrain conditions, and high altitude, monitoring these lakes is challenging by traditional surveys. Remote sensing technology is useful for inventory and monitoring of glacial lakes and GLOF risk assessment.

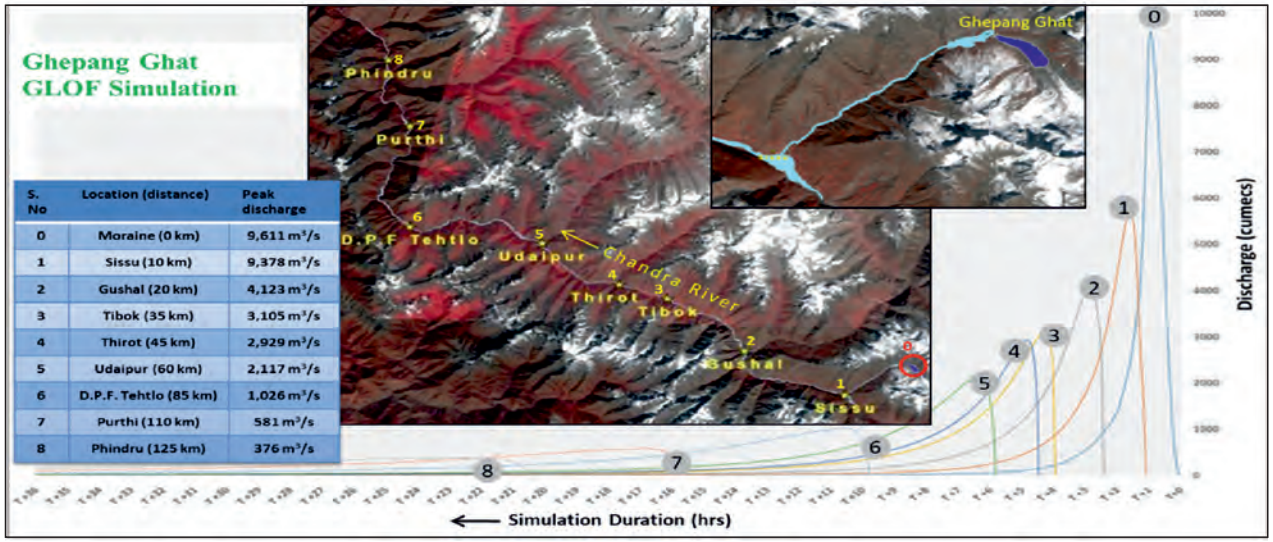
NRSC, under the National Hydrology Project, has taken up the GLOF risk assessment of glacial lakes in the Himalayan Region of the Indian River Basins. As part of this activity, an inventory of 28,043 glacial lakes of size greater than 0.25ha has been prepared for entire catchment areas of Indian Himalayan rivers (~9.8 lakh sq. km) using high resolution satellite data from Resourcesat-2 LISS-IV of majorly 2016-2017. Using the glacial lakes database, Glacial Atlases of the Indus, Ganga, Brahmaputra, and combined Indian Himalayan river basins are prepared and shared online (https://www.nrsc.gov.in/Atlas_Glacial_Lake). The entire glacial lake database is shared with the Central Water Commission, National Disaster Management Authority, and other Organisations in soft copy format.

Further, glacial lakes were ranked for their downstream GLOF risk considering satellite-derived terrain and hydrological parameters for the Indus, Ganga, and Brahmaputra river basins.

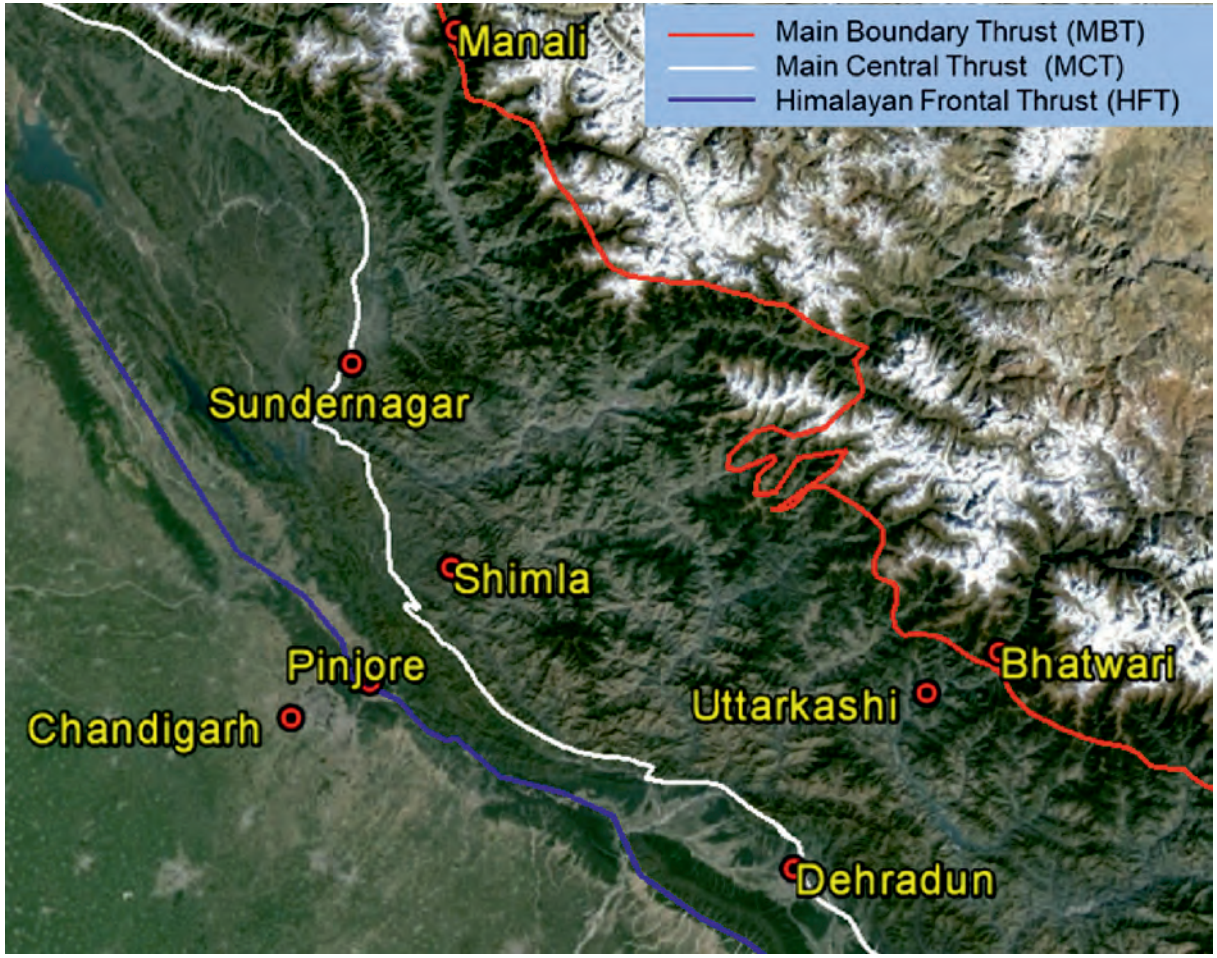
GLOF inundation modeling for different scenarios is generated using high-resolution Digital Terrain Models to simulate flood inundation maps along the river downstream of the lake. High resolution satellite data is used to identify the vulnerable elements due to GLOF inundation. GLOF risk assessment is carried out by integrating the simulated flood hazard maps and elements of vulnerability.

The information generated from this study will benefit National / State Disaster Management Authorities and decision-makers in implementing disaster risk reduction measures in both the short and long term.





S. No	Location (distance)	Peak discharge
0	Moraine (0 km)	9,611 m³/s
1	Sissu (10 km)	9,378 m³/s
2	Gushal (20 km)	4,123 m³/s
3	Tibok (35 km)	3,105 m³/s
4	Thirot (45 km)	2,929 m³/s
5	Udaipur (60 km)	2,117 m³/s
6	D.P.F. Tehtlo (85 km)	1,026 m³/s
7	Purthi (110 km)	581 m³/s
8	Phindru (125 km)	376 m³/s



GNSS CORS Locations in Western Himalaya Across Major Fault Systems

GNSS CORS Studies for Geodynamic Strain Modelling in Western Himalayan Region

20

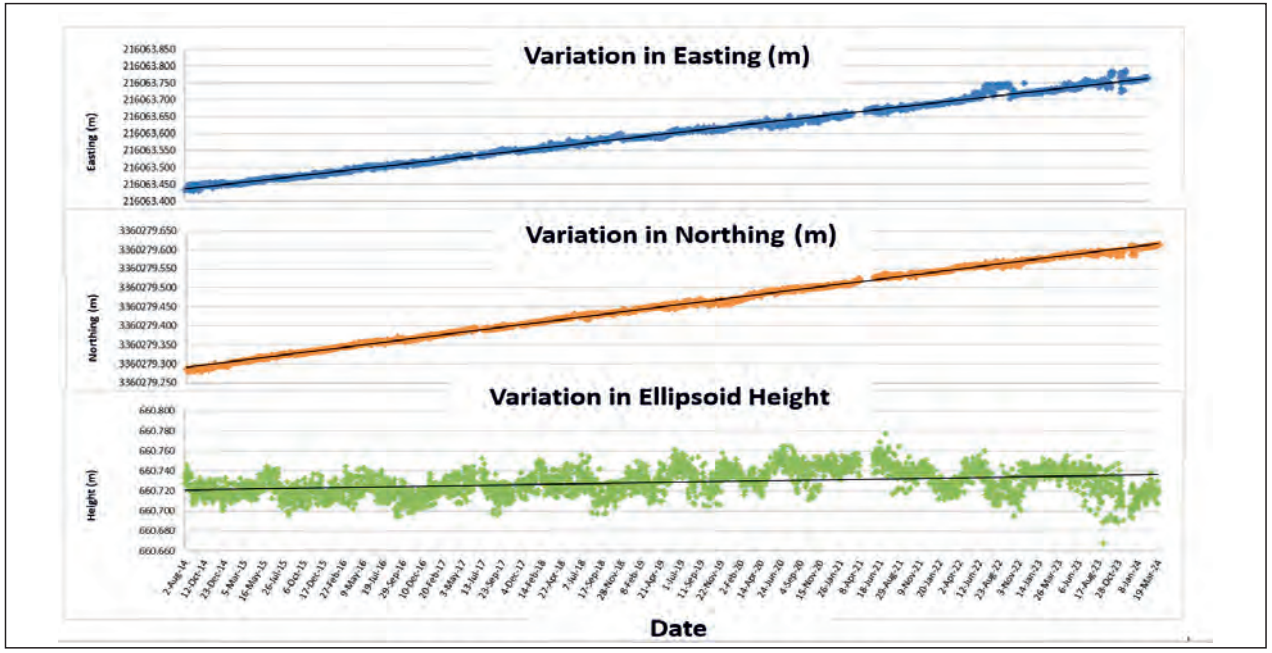
NRSC, ISRO has established GNSS CORS stations with the objective of monitoring the segments of Himalayan Thrusts Systems along the Central Seismic Gap to understand the tectonic plate motion with a relevance to the seismicity of these areas and estimate the geodynamic strain across the regional geological structures in part of the Central Seismic Gap.

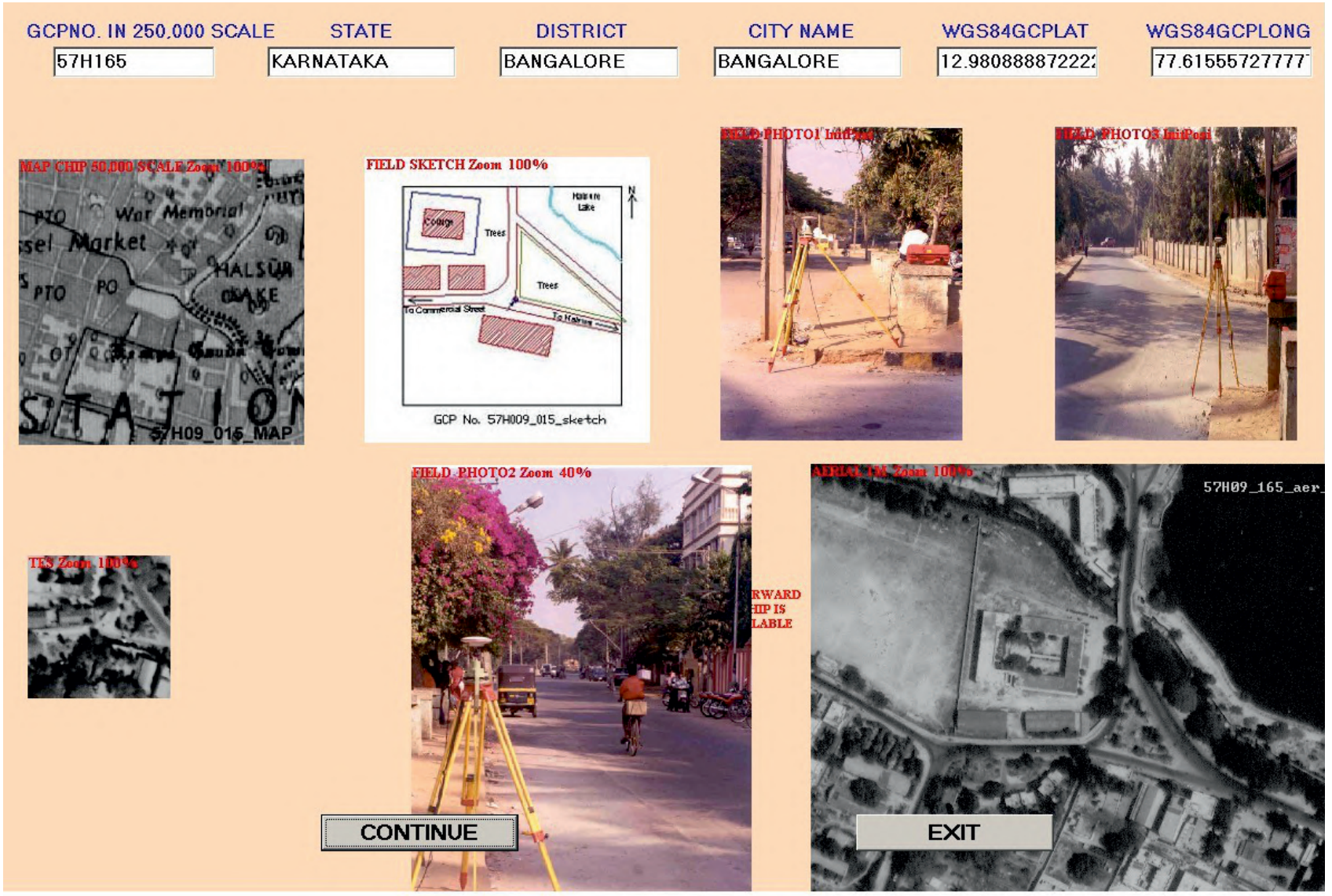
Eight GNSS CORS stations were installed to collect GNSS data continuously 365 days at 24x7 basis to monitor the geodynamic strain across the main fault systems of the Himalayas in the Central Seismic Gap region, viz. Himalayan Frontal Thrust (HFT), Main Boundary Thrust (MBT) and Main Central Thrust (MCT). Each GNSS CORS station is equipped with geodetic-grade, multi-GNSS and multi-frequency receiver with data logging at 1Hz along with choke ring antenna and are mounted on circular concrete pillars of 5 meters height from the earth surface. These pillars are constructed to a depth of 4 meters from the ground, reaching the geological bedrock, ensuring stability and accuracy of the measurements. The GNSS CORS are powered by a combination of internal batteries, a 150 Ah external battery and solar panels, possess internal data storage and transmit the data in real-time from the CORS to the central server at NRSC.

The GNSS CORS data is processed using a scientific post processing software to generate daily time-series coordinates (X, Y, and Z) for each station at better than 1 cm accuracy. Using these time-series, the displacement vector and the velocity of each station in all three directions are calculated. The data processing follows the standard double-difference mode starting from preprocessing of RINEX observation files and precise orbit information, resulting in a SINEX solution file containing coordinates, troposphere, and ambiguity parameters.

Normal equation parameters are also generated for estimating station velocities. The final output is high-precision station coordinates with millimeter-level accuracy. The GNSS CORS station coordinates and velocities are generated in a geocentric, Earth–Fixed, Cartesian system, as well as in geodetic latitude, longitude, and ellipsoidal height.

The time series analysis of CORS GNSS data from Dehradun and Manali, spanning across the Main Boundary Thrust (MBT) and Main Central Thrust (MCT), indicated an annual average crustal compensation of approximately 11 mm/yr. In the Himachal Pradesh transect, a compensation of 11 mm per year is observed across the Himalayan Frontal Thrust and a compensation of 10 mm per year is observed across the MCT. Observations from CORS station provided insights on the tectonic movements of the major fault systems in the Himachal Pradesh and Uttarakhand transects which supported plate tectonic movement analysis, seismic hazard assessment and related earth quake research studies in the Indian Himalayan Region.





GCP Library Search Based on City Name

Ground Control Point Library Establishment 21

The Ground Control Point Library (GCPL) project is aimed at generation of high accuracy Ground Control Points (GCPs) database as part of IRS-P5 programme for carrying out geometric corrections of Cartosat Satellite images, for further generation of digital elevation model (DEM) for whole country and also to facilitate geometric calibration of high-resolution satellite missions. The project is executed in three phases over 9 years, using Global Navigation Satellite Systems (GNSS) technology in a big way.

Under this project, a reference framework of WGS-84 datum was created using extensive GNSS surveys covering entire India. Till today, around 14741 GCP's were collected using ground, aerial techniques with an accuracy varying from 15cm to 50cm. Each GCP record in the database consists of GCP meta information like ground coordinates & accuracy, description, zone, nearby features etc. and the images (field sketch, Topo map, Field photos and satellite image chips). The important feature of GCP Library is that coordinates of every GCP are stored in two-dimensional spatial object of Oracle database which enables quick, efficient and flexible querying for the GCPs falling in the area of interest of the user.

GCPL Phase-I (1999-2005):

It was taken up in 1999 for creation of necessary GCPs for stereo strip triangulation of Cartosat-1 stereo data. Global Positioning System (GPS) surveys were carried out for whole India using basic surveying principle "Whole to Part". Three levels of hierarchical surveys were completed resulting in following GCPs.

- 26 Zero Order stations establishment with accuracy of better than 5 cm
- 300 First Order stations with an accuracy of better than 10 cm
- 2914 Second Order or Ground Control Points (GCPs) with an accuracy of better than 50 cm
- 450 GCPs covering 3 test bed sites namely Alwar, Hyderabad and Bangalore

GCPL Phase-II (2009-2011):

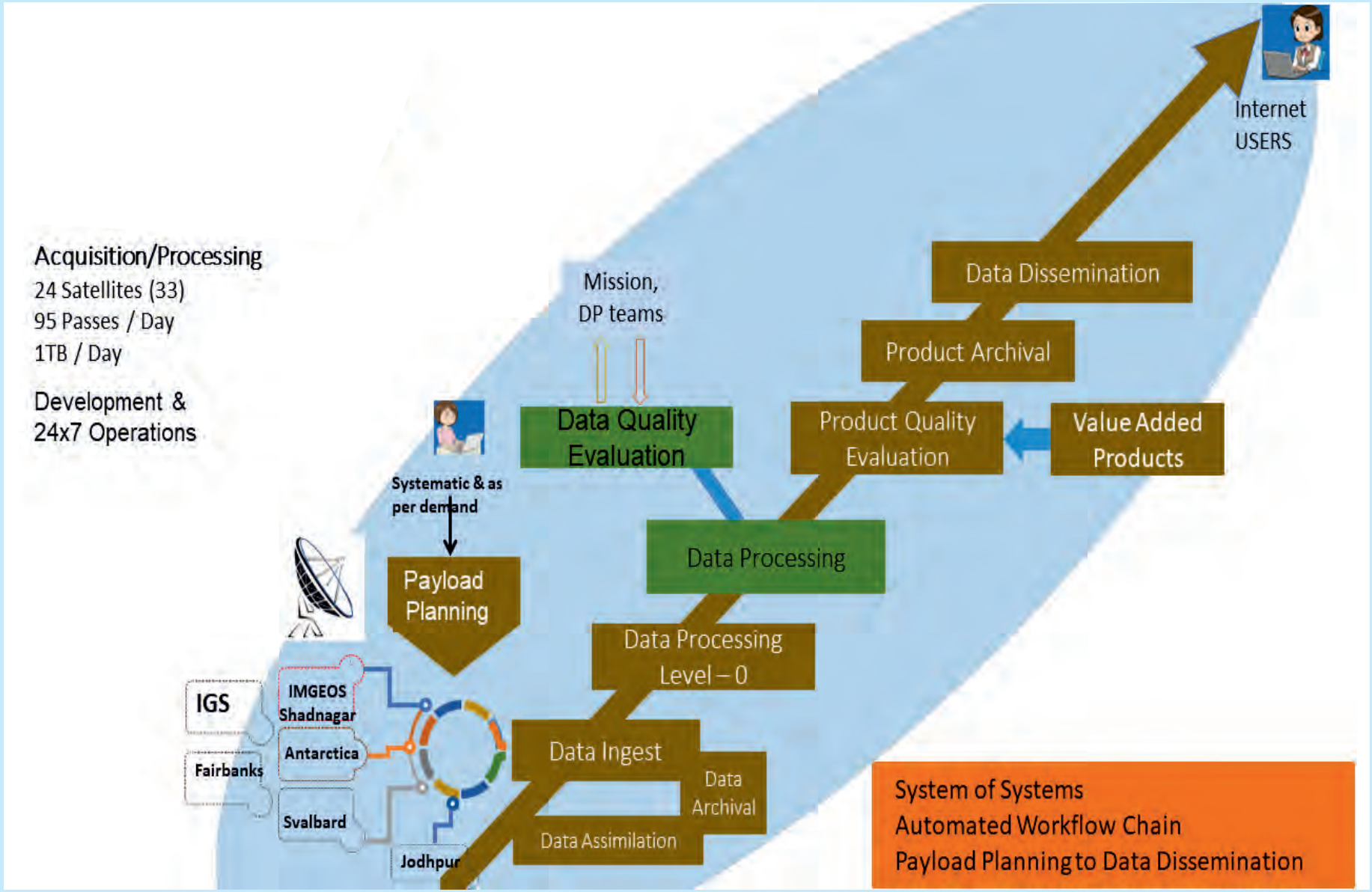
This phase was executed as follow up of Phase–I for collection of GCPs in North Eastern (NE) states, Jammu & Kashmir, Coastal region, Andaman & Nicobar and Lakshadweep islands. A total of 1029 GCPs were collected by implementing new survey technique namely Precise Point Positioning (PPP) resulting reduction of project cost and time schedule. In addition to the above, a total of around 2605 GCPs from aerial and satellite mapping projects were also populated into GCPL database.

GCPL-III (2014-2016):

The baseline distance of GCPs established under Phase-I and II was about 50-75 km. Under phase-III, densification of these GCPs was taken up so as to improve the planimetric accuracy of data products generated from Cartosat-2S and Cartosat-3. A total of 7243 GCPs (one point for every 9km x 27km coverage area) and 1050 Pre-signalised Points (PSPs) were collected using Differential GNSS and PPP approaches. SBAS-GAGAN enabled receivers' approach was employed for collection of GCPs in rapid mode for first time in this project.

The GCPL is extensively used in the process of planimetric correction and generation of high resolution digital orthoimages. The GCPL has supported DEM generation for the whole country using Cartosat-1 stereo data. The Indian plate is found to be moving at the rate of 4.5cm to 5cm/year based on the analysis of zero order stations established 1999 and 2009.

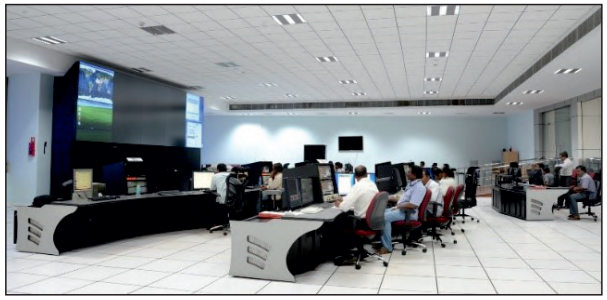
Ground Control Point Library (GCPL)



Overview of IMGEOS

Integrated Multi Mission Ground Segment for Earth Observation Satellites (IMGEOS) 22

The Integrated Multi Mission Ground Segment for Earth Observation Satellites (IMGEOS) facility was established in Shadnagar campus in the year 2011. This facility is equipped with state of the art data acquisition systems which receive data from various Earth Observation satellites. User requests are consolidated through Payload programming based on the feasibility of tracking a particular satellite and acquisition schedules generated for each of the antenna in ground station. Global coverages are handled through on-board recordings and play back mechanism through ground station services at polar regions.



Multiple antenna receive systems (8 no's) at this ground station are capable of receiving data in S / X / Ka band frequencies. Automated facility exists for transferring down converted demodulated data into Level 0 data processing systems for further correction/ value addition and dissemination to the user. Satellite data acquisition planning also covers speculative collections based on the current needs and archival requirements. Emergency scheduling is also planned in case of disasters like floods for providing the data in near real time for disaster management support.

The IT infrastructure at IMGEOS ground segment encompassing the data acquisition, processing, dissemination and archival domains is housed in the Data Center. The storage systems holding valuable data are a crucial component of the infrastructure. The Data Centre with 1000 square meter area was equipped with 3-tier storage infrastructure with high-performance shared SAN file system and policy based movement of data across tiers. Additional 2000 Square meters was operationalized to meet the Cartosat / NISAR and future mission and IT needs of and NRSC in the year 2022

To meet the Open data platform guidelines of New Space Policy 2023, NRSC has established 'Bhoonidhi' as a platform for data dissemination. To cater to the needs of GOI New Space Policy, 5 PB of archived data will be available for users. Keeping in view of the forthcoming missions over the next five years around 60 PB of data would be available for free download. In addition, IT infrastructure of the geo platform 'Bhuvan' and NICES portals are also housed and services are hosted from this Data Center.

The establishment of IMGEOS facilitated the automation of data dissemination (8.5 lakh satellite data products in 2023), reduced the turn around time of data delivery to the users.

http://www.india-wris.nrsc.gov.in

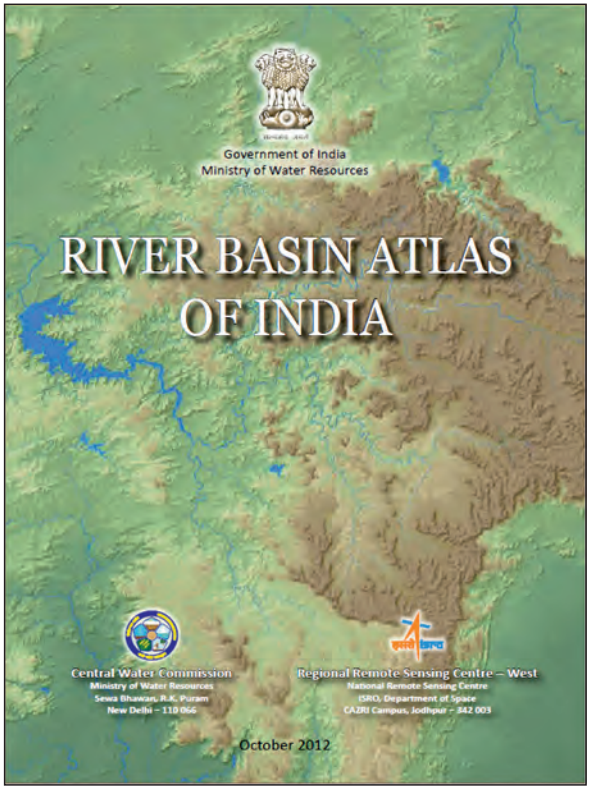
GUI of India-WRIS V 4.0

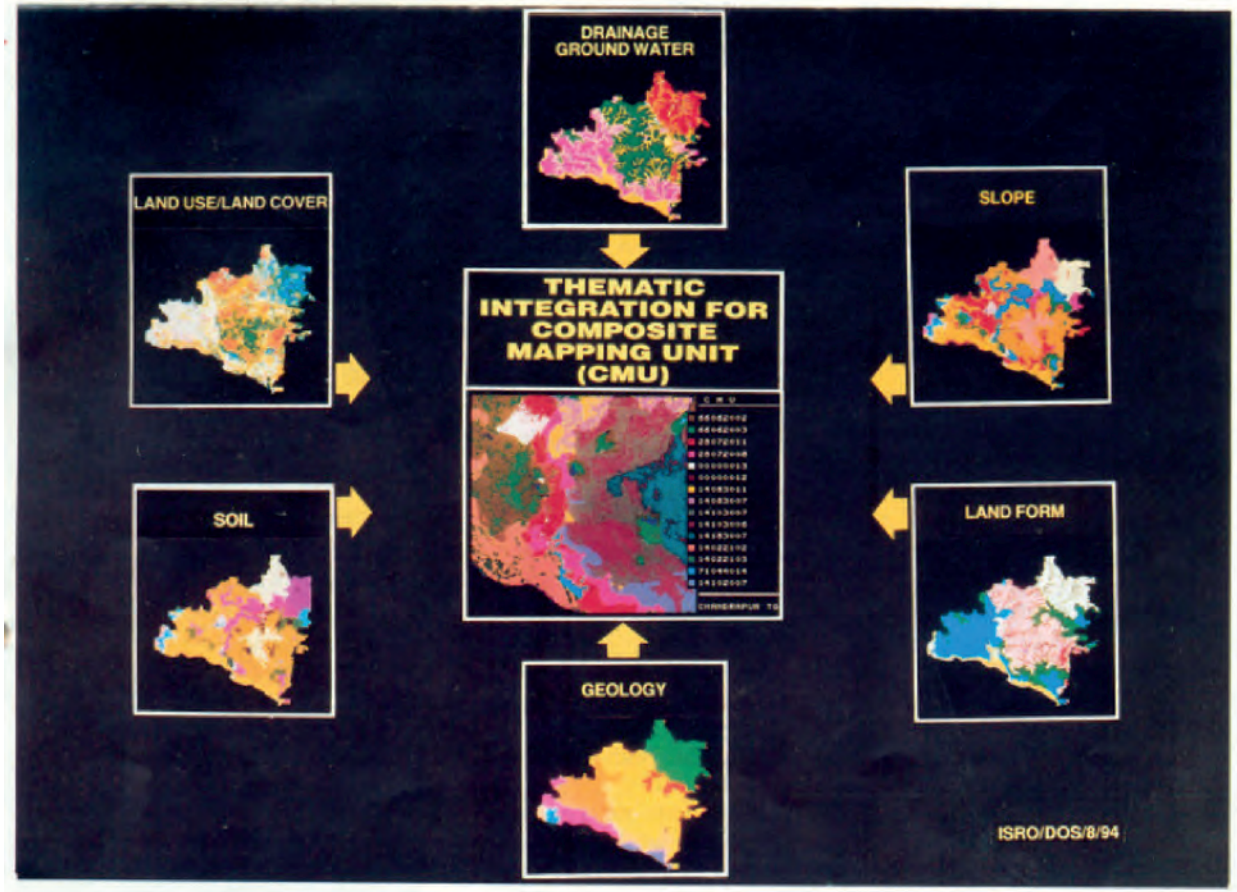
India-WRIS: Water Resources Information System of India 23

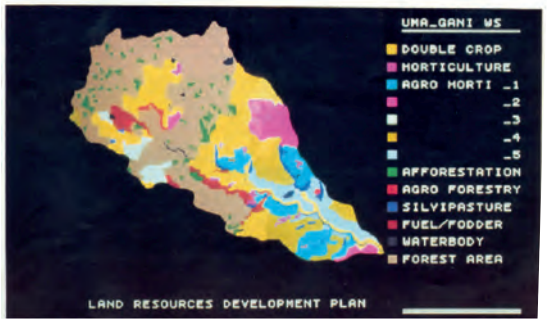
The India-WRIS WebGIS serves as a comprehensive and authoritative "Single Window" solution for accessing consistent data and information on India's water resources and related natural resources. It is designed within a standardized national GIS framework and equipped with tools for searching, accessing, visualizing, understanding, and analyzing the data. The project was conducted by RRSC-West from 2009 to 2018 and offers up-to-date information crucial for water resource planning and management. By increasing public awareness and encouraging participation in the management and development of the nation's water resources, the project contributes to the holistic goal of water security.

Dissemination of data in the public domain constitutes the most important aspect of water resources management, being multi-stakeholder involvement, people's participation, and information sharing to increase transparency and public awareness, elevating the importance of water information, and enlightening public involvement in water management. Much of the data is spatial, but the amount of associated data is very large, has a time series, and will increase exponentially with time. Creating and managing such data is a colossal feat and requires state-of-the-art tools. The database generation software used has the capabilities of making maps, viewing or exploring data, editing data, storing, conflation (integrating datasets from different sources), transforming (into different coordinates systems, different representations, re-sampling, resulting in new representation/format of the same data), querying, analyzing, etc.

'India-WRIS WebGIS Version 4.0' was released on 28th March 2014. The portal contains 12 major info systems, 35 sub-info systems, 95 spatial layers, and many attributes (> 700) with 5-100 years of data on the country. The database has been updated based on the input received from CWC and various state departments to date. The portal (www.india-wris.nrsc.gov.in) has been designed and developed keeping in view multi-users from all sections of society, varied and multi-sources data input, current map policy, existing guidelines by CWC, the requirement of regular updates, near real-time data accessibility, data security domains and scale of information. The portal also provides an 'Automatic Map' and 'Report Generation' facility. About 20,000 people visit the portal per month. The public domain version has been developed based on the National Map Policy (2005) and CWC data dissemination guidelines.







Geospatial Data Integration for Action Plan Generation

Integrated Mission for Sustainable Development (IMSD) 24

The Integrated Mission for Sustainable Development (IMSD) programme was launched by the Department of Space in June, 1992. The term "integrated" in the IMSD refers to integration of information obtained through different techniques like

(a) remote sensing and conventional means such as ground-based surveys,

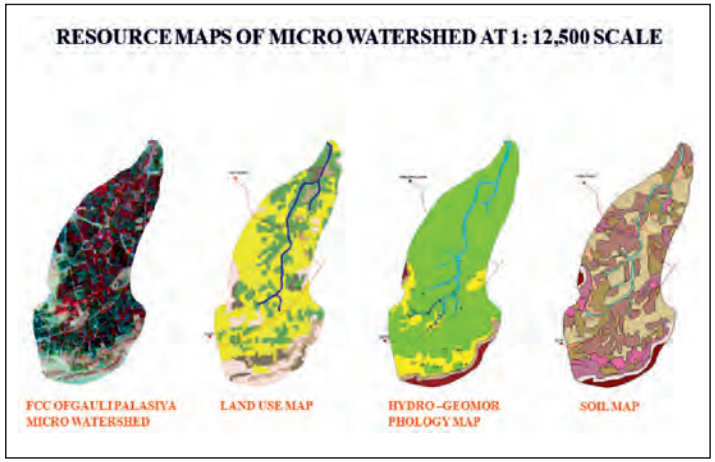
(b) efforts of people with expertise in diverse areas like soil conservation, agriculture, forestry, public health and administration,

(c) various programmes like integrated rural development programme, desert development programme, drought prone area programme, hill area development programme and so on,

(d) socio economic programmes like the Jawahar Rojgar Yojana, training of rural youth of self-employment, etc.

Sustainable development takes in to account the physical limits imposed by the ecological systems and regenerative capabilities of the natural resources. Development could become unsustainable for various reasons like over exploitation of the natural resources which would lead to short term gains but long-term degradation. In other words, sustainable development minimises adverse impact on the environment and ensures long term progress.

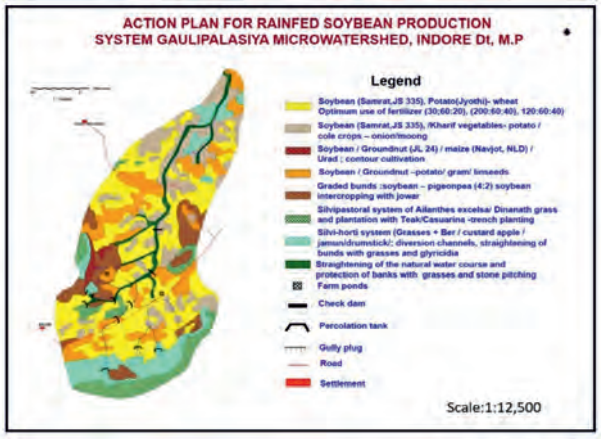
In 1988, the DoS undertook pilot studies in 21 districts of the country to combat drought. The approach consisted in integrating thematic information on natural resources obtained from Indian Remote Sensing Satellite (IRS) with meteorological and other relevant data. The pilot studies in which several departments and agencies of the central and state governments, agricultural universities, research institutions and voluntary agencies took part, demonstrated efficacy of the integrated approach in combating drought on a long-term basis.

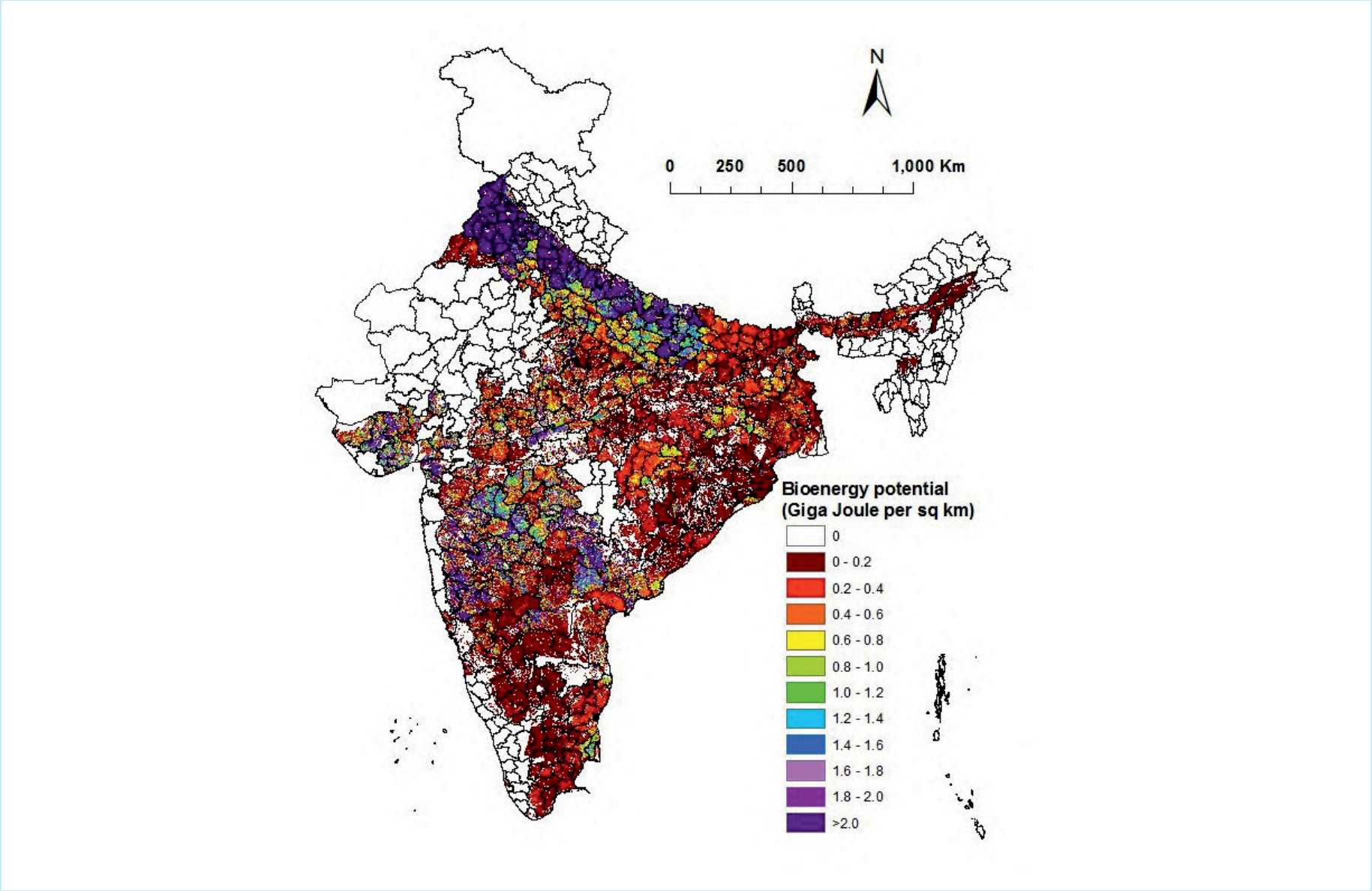


The results of the pilot studies were reviewed by the Planning commission in November 1991 and a high-level committee was set up to identify priority areas / districts for undertaking similar pilot studies. In January 1992 the recommendations of this committee led the Planning Commission to conclude that the approach demonstrated through studies could be accepted as a suitable model for development.

The implementations of the prescriptions made under IMSD has resulted in the construction of check dams, hectares of soil bunds and tank silt applications over hundreds of hectares. The check dams have received fillings during monsoon and the resultant recharge of ground water caused a rise in water-table in the dug wells. Dry wells have also received water and the borewell yields have increased; thus, crops like groundnut and mulberry have now been raised.

Thus, IMSD has proved to be a unique planning tool that transcends the traditional sectorial approaches. Subsequently, with the availability of high resolution satellite data is being extensively used for planning and monitoring of soil and water conservation structures in mini and micro watershed programmes with thematic resource maps generated from high resolution data at 1:12500 scale.





Bioenergy Potential from Surplus Residues of Crops(Rice, Wheat, Cotton and Sugarcane) over India

JAIVOORJA: Spatial Information System of Bioenergy Potential from Crop Residues

25

India ranks as one of the top energy consumers in the world. However, its per capita energy consumption is significantly lower than the world average, with wide disparity between urban and rural areas. With growing population and increasing GDP, significant growth is expected in the energy demand in the country. The native energy reserves of India are not adequate, making the country dependent on foreign imports of oil and natural gas.

As per COP26 commitments, India would reach 500 GW non-fossil energy capacity by 2030 and achieve net zero emission by 2070. Agriculture residues are an important source of renewable energy. With gross cropped area of 195 M ha covering multiple crops, a huge pool of residue biomass is available across India. Effective utilization of such biomass leads to sustainable, secure and economically-stronger future in terms of providing domestic clean energy, reduction in fossil fuel imports, besides creating new employment opportunities to rural India.

However, information gaps on crop residues availability causing supply chain issues, land use constraints, policy incentives etc. NRSC (ISRO) in collaboration with TIFAC, DST has generated a systematic geospatial database on biomass residues from four major crops and created a digital platform to visualize, annotate, delineate and query towards informed decision making.

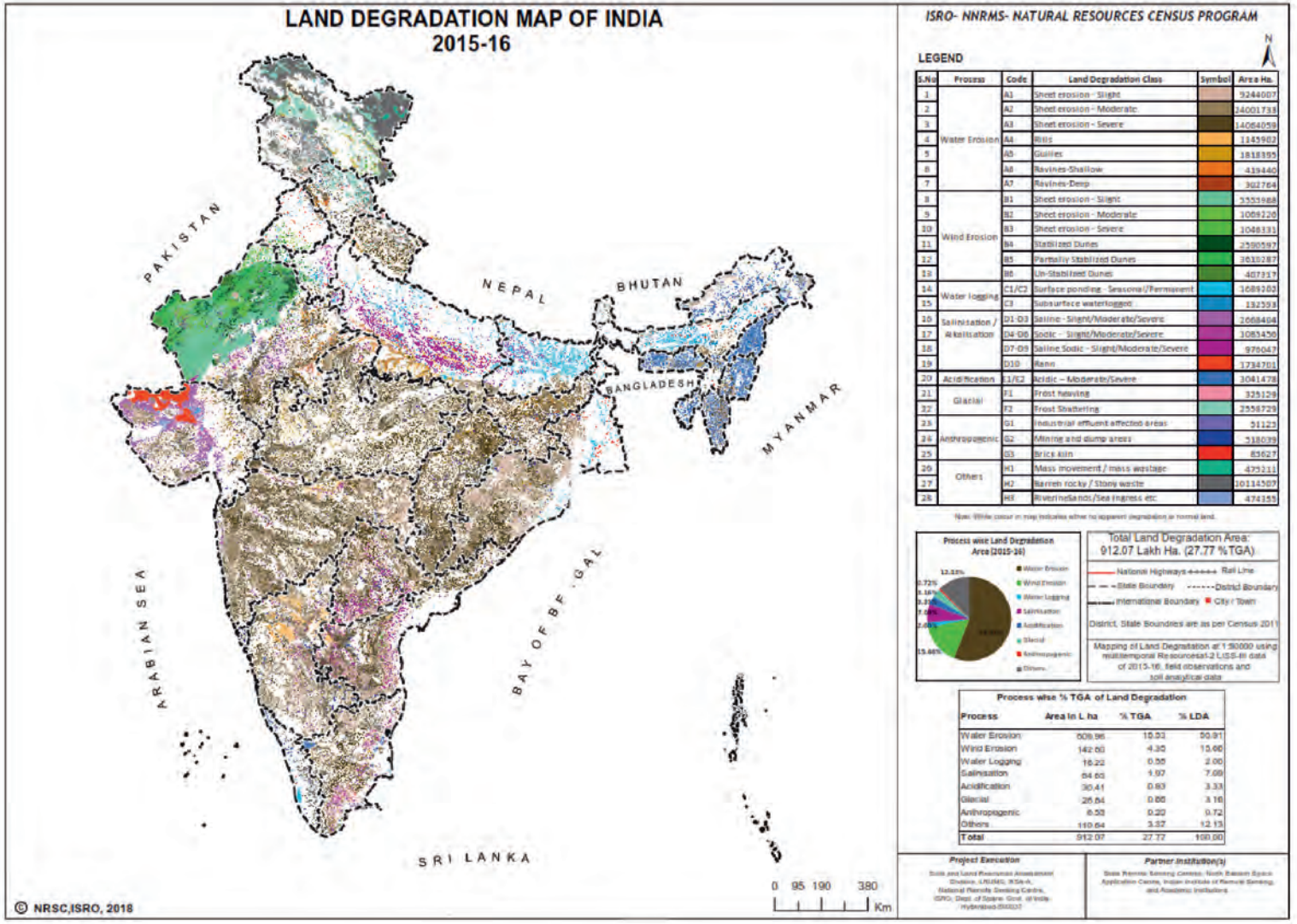
The highlights of the Jaivoorja project are:

- Satellite derived crop maps, primary productivity along with secondary data on crop production estimates and biomass utilization pattern were amalgamated using a data fusion technique
- Maps of gross and surplus biomass residues and its bioenergy potential were generated at 1 km grid and was augmented with other thematic and administrative layers to develop a unique spatial information system called BHUVAN-JAIVOORJA (https://bhuvanapp1.nrsc.gov.in/bioenergy/home/).
- The platform offers users to visualize, annotate, delineate and query on crop residue biomass towards informed decision making.

The major outcomes are generation of Sixteen unique geospatial maps (1 km) on biomass availability (gross and surplus) and bioenergy potential of rice (kharif, rabi), wheat, cotton and sugarcane crops at all India level and a dedicated open access spatial information system called BHUVAN JAIVOORJA was prepared

The project resulted in generating near real time information on :

- Supports identification of prospective districts/regions for setting up of biomass/biofuel plants, by providing objective information on supplies, land-use and logistics.
- Helpful for decentralized planning of small to medium capacity biofuel plants tailored made for locally available crop residue biomass
- Support policy making for agro-based biofuel

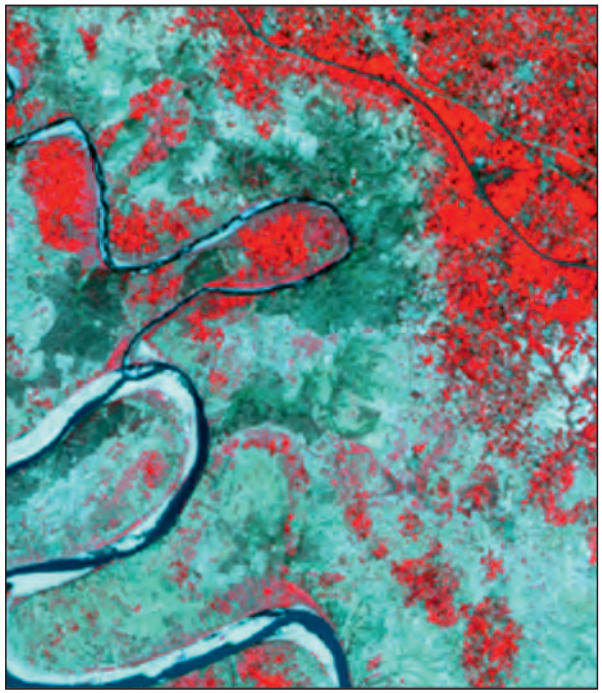


S.No	Process	Code	Land Degradation Class	Symbol	Area Ha.
1	Water Erosion	A1	Sheet erosion - Slight		9244007
2		A2	Sheet erosion - Moderate		24001738
3		A3	Sheet erosion - Severe		14064059
4		A4	Rills		1145903
5		A5	Gullies		1818395
6		A6	Ravines-Shallow		419440
7		A7	Ravines-Deep		302764
8	Wind Erosion	B1	Sheet erosion - Slight		5553988
9		B2	Sheet erosion - Moderate		1088226
10		B3	Sheet erosion - Severe		1048331
11		B4	Stabilized Dunes		2590597
12		B5	Partially Stabilized Dunes		3610287
13		B6	Un-Stabilized Dunes		407317
14	Water logging	C1/C2	Surface ponding - Seasonal/Permanent		1689203
15		C3	Subsurface waterlogged		132593
16	Salinisation / Alkalisation	D1-D3	Saline - Slight/Moderate/Severe		2668404
17		D4-D6	Sodic - Slight/Moderate/Severe		1083456
18		D7-D9	Saline Sodic - Slight/Moderate/Severe		976047
19		D10	Rann		1734701
20	Acidification	E1/E2	Acidic – Moderate/Severe		3041478
21	Glacial	F1	Frost heaving		325129
22		F2	Frost Shattering		2558729
23	Anthropogenic	G1	Industrial effluent affected areas		51123
24		G2	Mining and dump areas		518039
25		G3	Brick kiln		85627
26	Others	H1	Mass movement / mass wastage		475211
27		H2	Barren rocky / Stony waste		10134507
28		H3	River/nallahs/Sea ingress etc		474155

Land Degradation Map of India

Land Degradation of India at 1:50,000 Scale 26

India with vast natural resources suffers from accelerated land degradation (LD). Space-borne multispectral and multi-temporal data provides rapid and reliable inventory and monitoring of degraded



lands. The nationwide land degradation mapping has been taken up by ISRO under Natural Resources Census (NRC) program for generating information on land degradation at 1:50,000 scale using multi-temporal Resourcesat-1/2 LISS-III data.

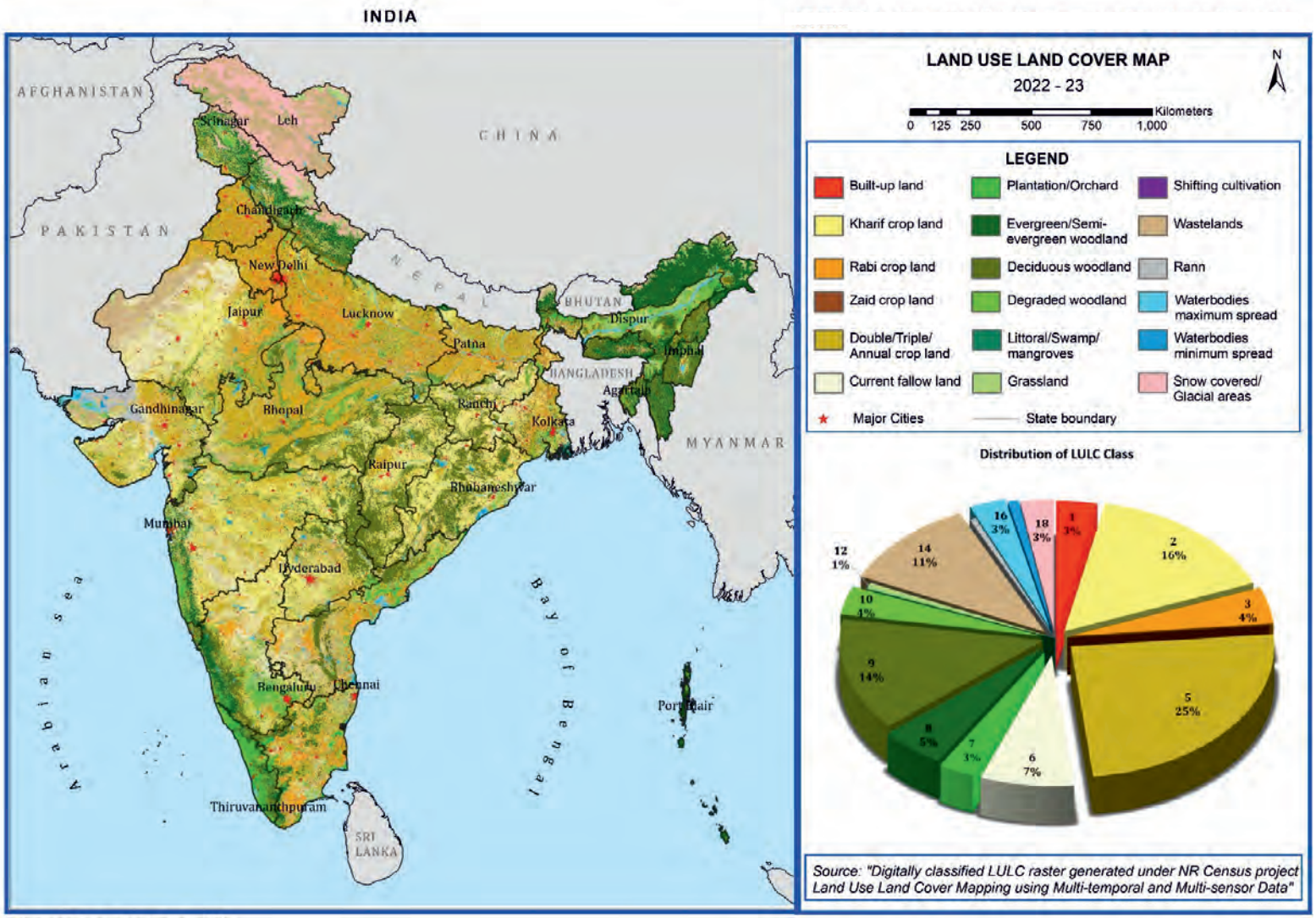
The first and second cycle of land degradation mapping was carried out using Resourcesat-1 multi-temporal LISS-III data of 2005-06 and 2015-16 respectively

addressing 8 major processes- Water erosion, Wind erosion, Water logging, Salinization/Alkalization, Acidification, Glacial, Anthropogenic and others through onscreen interpretation, limited ground truth and soil chemical analysis. The output of the project is an improved LD map of 2005-6 and LD map of 2015-16 along with changes in the land degradation status. The total land degradation area in India is around 91.21M ha

which constitutes 27.77 % of total geographic area (TGA) during 2015-16 periods. The major land degradation in India is water erosion (15.53% TGA), followed by wind erosion (4.35 %TGA) Table 1 and figure 1. The major land reclamation happened in water logged areas, sand dunes and salt-affected areas which were brought under plough. However, sizable extent of normal areas have gone to water erosion and also increase of land degradation due to anthropogenic activities during the 10 years period. Overall net change in land degradation is a decrease of 916sq km area during the 10 years period.

The information is used for identification of priority areas for planning various developmental programmes like soil and water conservation, reclamation of degraded lands, watershed development, prioritization of watersheds, climate change studies, carbon sequestering

Sl. No.	Process	Area (Sq km.)		%TGA	
		2005-06	2015-16	2005-06	2015-16
1	Water Erosion	510237	510018	15.53	15.53
2	Wind Erosion	143997	142796	4.38	4.35
3	Water Logging	18499	18212	0.56	0.55
4	Salinisation / Alkalisation	65193	64656	1.98	1.97
5	Acidification	30439	30400	0.93	0.93
6	Glacial	28840	28840	0.88	0.88
7	Anthropogenic	4890	6552	0.15	0.20
8	Others	111162	110871	3.38	3.38
9	**Total**	**913257**	**912346**	**27.81**	**27.78**



Land Use Land Cover Map (1 : 2,50,000)

Land Use/ Land Cover Mapping and Monitoring 27

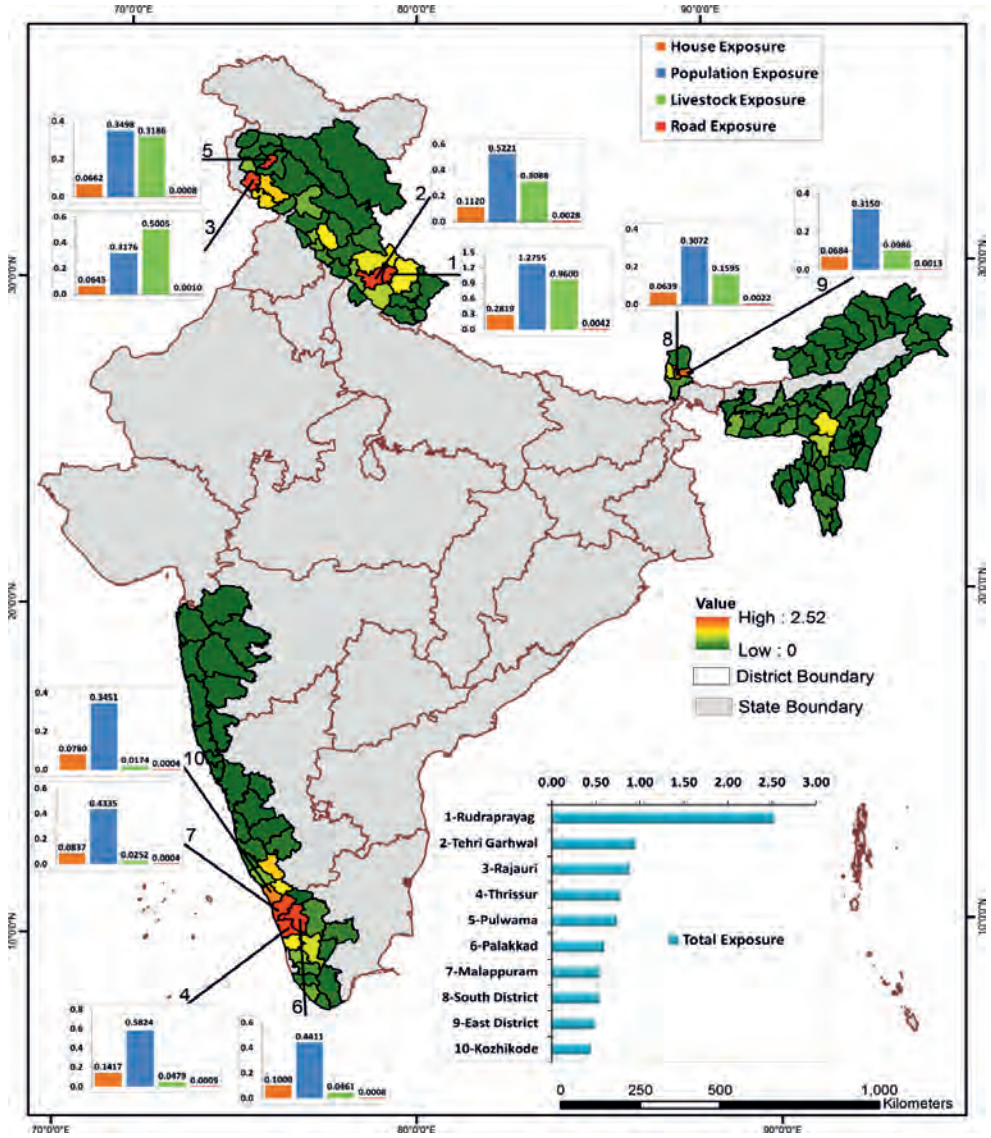
Regularly updated accurate Land Use Land Cover (LULC) datasets provide the basis for many developmental programs of government and are vital for a variety of applications such as urban and regional

planning, disasters and hazards monitoring, natural resources and environmental management, and food security. Moreover, changes in LULC are crucial in climate modelling and landslide susceptibility models. Land Use and Land Cover (LULC) mapping can be instrumental in addressing major large-scale challenges, including global warming, the rapid loss of species habitat, human impact on the carbon cycle, and other natural and human-induced processes. Therefore, it is crucial to generate precise LULC maps.

To address this need, a national program was initiated to conduct Land Use Land Cover Mapping on a 1:50,000 scale at 5-year intervals and a 1:250,000 scale annually from 2004 to 2025. This endeavour utilized multi-temporal data from the Indian Remote Sensing (IRS) satellites, including Resourcesat-1 (2003-2013), Resourcesat-2 (2011-present), and Resourcesat-2A (2016-present). These satellites provide multispectral images with spatial resolutions of 24 m (LISS III) and 56 m (AWiFS) and temporal resolutions of 24 days and five days, respectively. The thematic classification of AWiFS data involves georeferencing of multi-temporal datasets using Land Cover Characterisation projection and WGS84 datum. Land use/land cover data at a 1:50,000 scale were generated using a visual interpretation approach based on three seasons of LISS-III data, while data at a 1:250,000 scale is being prepared using a digital classification approach involving rule-based integration.

The land use/land cover classification scheme at the 1:50,000 scale includes Level-I: 8 classes, Level-II: 31 classes, and Level-III: 54 classes, whereas the 1:2,50,000 scale consists of 18 classes. The Land use/land cover map of India prepared using

Resourcesat satellite data at 1:50,000 and 1:250,000 scales, is depicted in the figure. The LULC datasets are being disseminated through Bhuvan GeoPortal and are regularly used by various government departments (central/state/others), academia, industrial houses, NGOs, etc. This data also includes information on crop fraction for use in earth and climate modeling processes. Additionally, the data is being utilized by the Central Board of Irrigation and Power for "Identification of Potential Land for Renewable Energy Projects." Moreover, it is useful for various scientific research programs such as climate change studies, weather forecasting, carbon sequestering, growth trend analysis, etc.



District-wise Landslide Exposure Map of India

Landslide Inventory 28

The geospatial landslide inventory database consisting of ~80,000 landslides in India under three categories: seasonal, event-based, and route-wise, has been mapped under its DMS programme during 1998-2022. The database covers landslide-vulnerable regions in 17

states of India in the Himalayas and Western Ghats. The seasonal inventory contains the pan-India landslide database, which relates to India's 2014 and 2017 rainy seasons. The event-based inventory includes details of some significant triggering events, such as the Kedarnath and Kerala disasters, the Sikkim earthquakes, and a few large valley-blocking landslides. Route-wise inventory contains details of landslides along selected routes of importance for tourists and pilgrims. The seasonal landslide inventory database contains information on each landslide's 19 parameters (e.g., lithology, slope, land use, geomorphology, etc.). The database was used to rank 147 districts in 17 states of India for their exposure to landslides in terms of key socio-economic parameters.

The semi-automatic method developed by NRSC for detecting landslides from high resolution satellite data and DEM was used to create the annual landslide inventory database. This method adopted a knowledge-based generic spectral-spatial-morphometric approach for detecting landslides from high resolution satellites and DEM using an object-

based image analysis technique. The purpose is to rapidly create a landslide inventory for planning disaster response using newly acquired post-event images and to prepare a historical landslide database by time series images from archives.

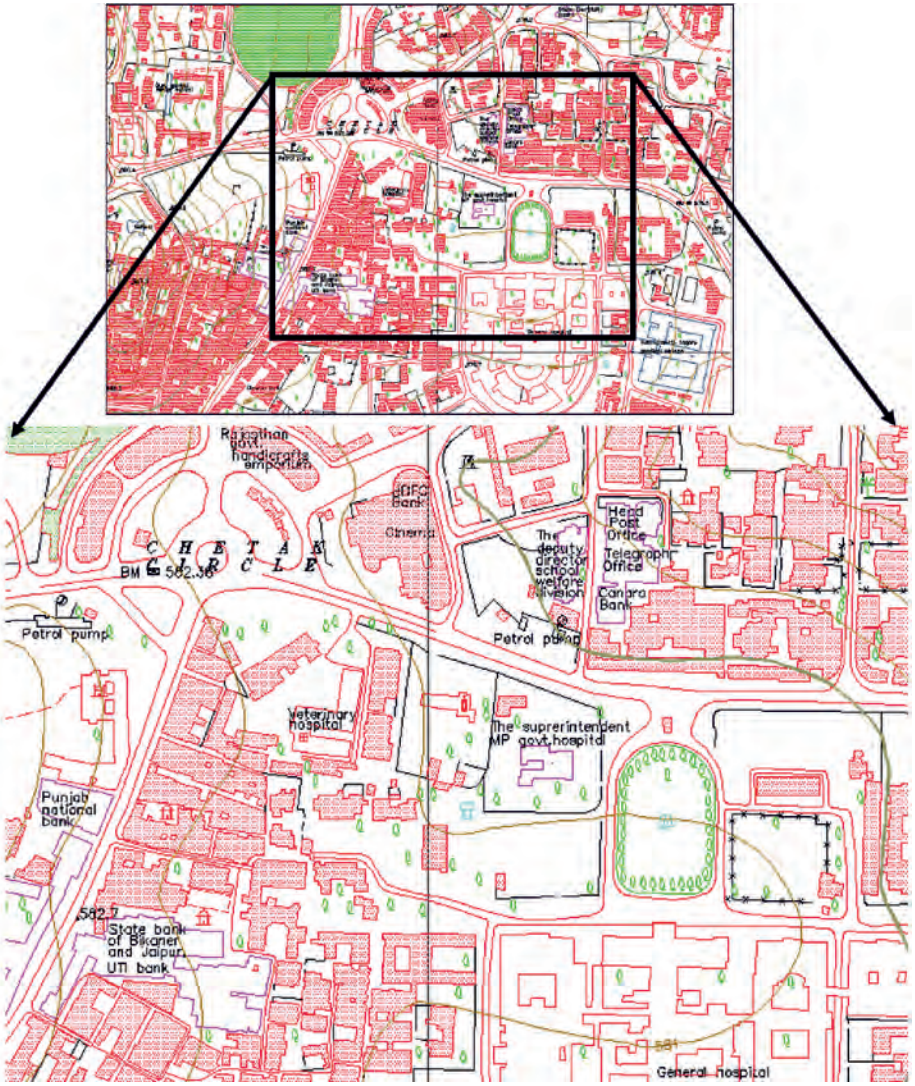
The database has been provided to the Geological Survey of India (GSI) for pan-India Landslide susceptibility modeling. The event-based landslide response information is given to the National Disaster Response Force (NDRF) and state disaster management centers to coordinate rescue and relief operations. The district-wise landslide rank of India was used by organizations such as NDMA to prioritize long-term landslide mitigation strategies. The database is

available in a web GIS platform - the Bhuvan and NDEM geoportals of ISRO.

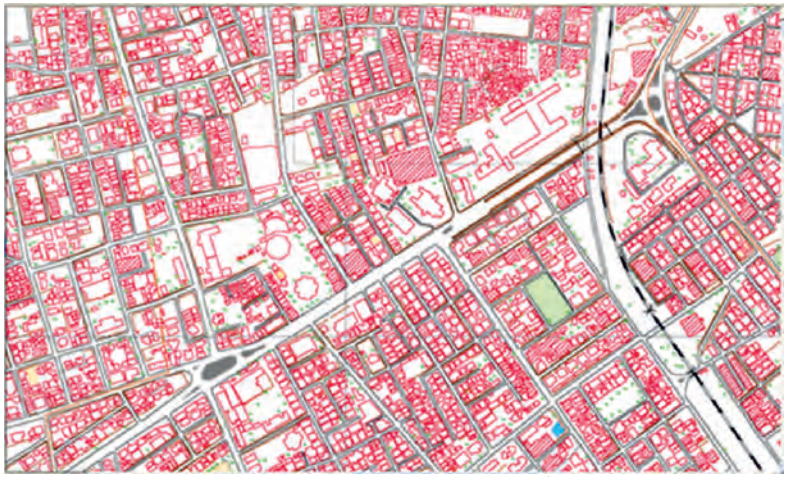
This is district-wise landslide exposure map of India. The national landslide inventory data was analyzed with respect to major elements of risk such as population, building, road and live stock. Total 147 hilly districts of India were ranked in terms of their landslide exposure. Rudraprayag district in Uttarakhand is most exposed to landslide in India.

Information drawn in integration with socio-economic data will aid disaster management authorities in taking measures to prepare and respond to landslide risk.

Part of Udaipur



Part of Asansol



Part of Map of Rajkot Municipal Corporation

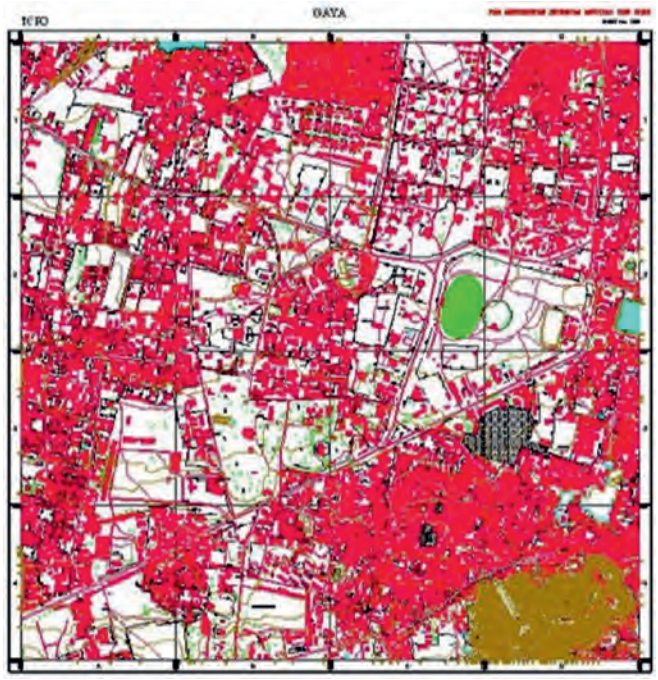
Large Scale Maps Generated at Different Scales for Part of Udaipur, Asansol and Rajkot

Large Scale Mapping of Urban Area (Airborne) 29

Large scale mapping of urban areas is undertaken to generate large scale topographic maps at scales viz 1:2500, 1:1000 and 1:500 scales along with Digital Terrain Models, Contours and Orthoimages for urban applications viz. town planning, urban planning, development of master plans, zonal maps etc.

Airborne camera both Analogue & Digital have been used to acquire data at very high resolution images with GSD varying from 5 cm to 20 cm depending on project specification. Analog images were converted to digital form using high photogrammetric scanners for subsequent digital photogrammetric process. Advancements in positioning and orientation measurements using Kinematic GNSS and Inertial Measuring Unit (IMU) are incorporated to derive precise position and orientation angles of images. Few ground control Points (GCPs) are collected in the field on sharp features like culverts and compound wall corners. Bundle adjustment of images are done to derive its precise Exterior orientation (X, Y, Z, Omega, Phi, Kappa). DEMs are generated using semi-automatic methods by image matching methods with manual breaklines for correct representation of terrain elevation. Orthophotos and Orthomosaics are generated using DEM and cutlines. Few important projects carried out are:

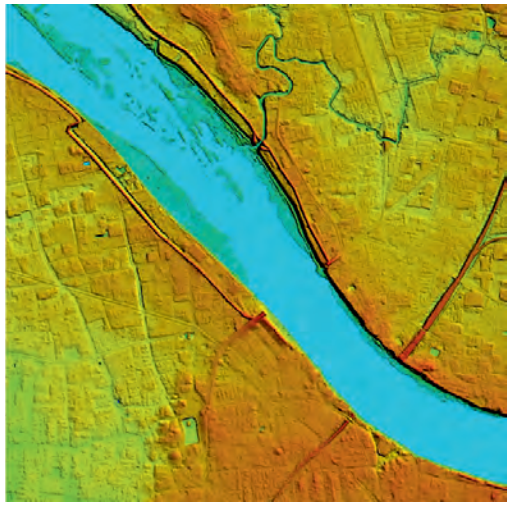
- Large scale topographic mapping (1:2500) for 53 towns covering an area of 10000 sq.km for Town & country planning department.
- Large scale topographic mapping (1:2500) scale for six towns under Rajasthan State Urban Infrastructure Development Project covering an extent of 1200 sq.km.



- Large Scale Maps generation for Bangalore Development Authority covering an area of 1424 sq.km at various scales viz. 1:1000, 2000, 5000, 10000 and 20000 scales.
- Large Scale topographic mapping at 1:1000 scale covering 112 sq.km of Vizag municipal area with scale of photography at 1:6000 for Vizag Municipal Corporation.
- Large scale topographic mapping at 1:500 scale for Kolkata Municipal Corporation (KMC) covering an area of 188 sq.km. Scale of photography is 1:4000 scale and data was used for creating GIS for Infrastructural development.
- Large scale topographic mapping (1:2500) scale for Hyderabad Metro Water Supply & Sewerage Board (HMWS&SB) for purpose of urban mapping, covering an area of 463 sq.km.
- Large Scale Geo Spatial Data base generation at scale of 1:1000 for 3 cities viz., Hyderabad (256 sq.km), Kolkata (186 sq.km), Bangalore (400 sq.km). Detailed floor level mapping was carried out in stereo mode.
- Aerial photography is acquired for an area of 97500 sq.km for purpose of town and urban planning applications for various user departments (NUIS/SoI, TCPO, State Remote Sensing Application Centers, etc.).

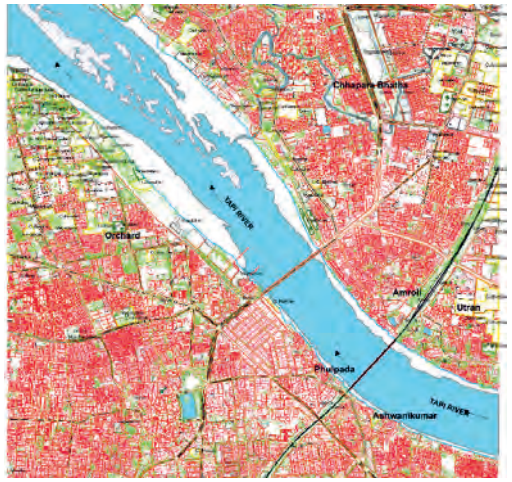
Large scale topographic maps with 2D/3D geodatabase containing 150 different feature layers are used for urban planning & governance. These data sets supported Town & country planning/Urban departments towards municipal tax collection, utility management, 3D visualization for infrastructure planning, urban flood modeling, tourism and e-governance applications.

Digital Surface Model (DSM) generated from LiDAR point data



Digital Terrain Model (Hydro conditioned) generated after editing DSM and adding breaklines

Digital Ortho image generated (35cm GSD) from Medium Format Digital Camera



Geo-Spatial database mapped from digital orthoimage suitable to produce 1:5000 scale map

DSM, DTM Generated from LIDAR and Digital Ortho from Digital Camera.
Geo-Spatial Database extracted from Ortho.

LIDAR Studies for High Resolution DTM 30

The airborne LIDAR based studies were undertaken to generate high resolution geo-spatial database for major flood prone areas in the country for spatial flood early warning systems development and for vulnerable areas along Indian coast (2km inland from coast) for Tsunami Early Warning System development. It is aimed to produce topographical maps suitable to 1:5000 scale with contour intervals ranging from 40cm to 1m, Digital Elevation Models (DEMs) with height accuracy ranging from 20cm to 35cm and Digital ortho images from 35cm to 50cm GSD, L-sections & cross sections along corridor, etc. for flood and tsunami inundation modeling and towards preparation of DPRs for river link projects.

Acquired airborne LiDAR data with point spacing of 2m and Medium Format Digital Camera images of 35cm GSD and generated the products – Digital Terrain Models (AMSL), Large scale Topographical maps and Digital ortho images. The areas completed are:

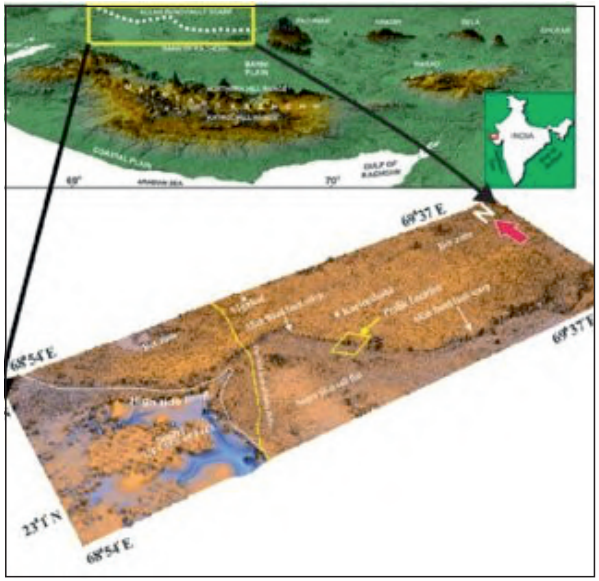
- Flood inundation modeling of Kosi basin for Flood Management Improvement Support Centre (FMISC) – 7930 sq.km (2017-2024)
- Flood inundation modeling of river basins viz., Mahanadi, Godavari, Brahmaputra, Ganga under Disaster Mapping Support Programme (DMSP) Phase-1 – 66239 Sq.Km (2007-2017)
- Indian mainland Coastal zone disaster vulnerability mapping – 24020 Sq.Km (2004-2020)
- Tapi and Godavari river basins under National Hydrology Project (NHP) – 6420 Sq.Km (2017-2020)
- Krishna-Godavari link canals (Inchampally-Nagarjunasagar and Inchampalli- Kinnerasani) for National Water Development Authority (NWDA) – 469 line kms (2003-2006)
- Netravati river diversion to South Kannada region for Water Resources Department, Government of Karnataka – 1756 sq.km (2005-2010)

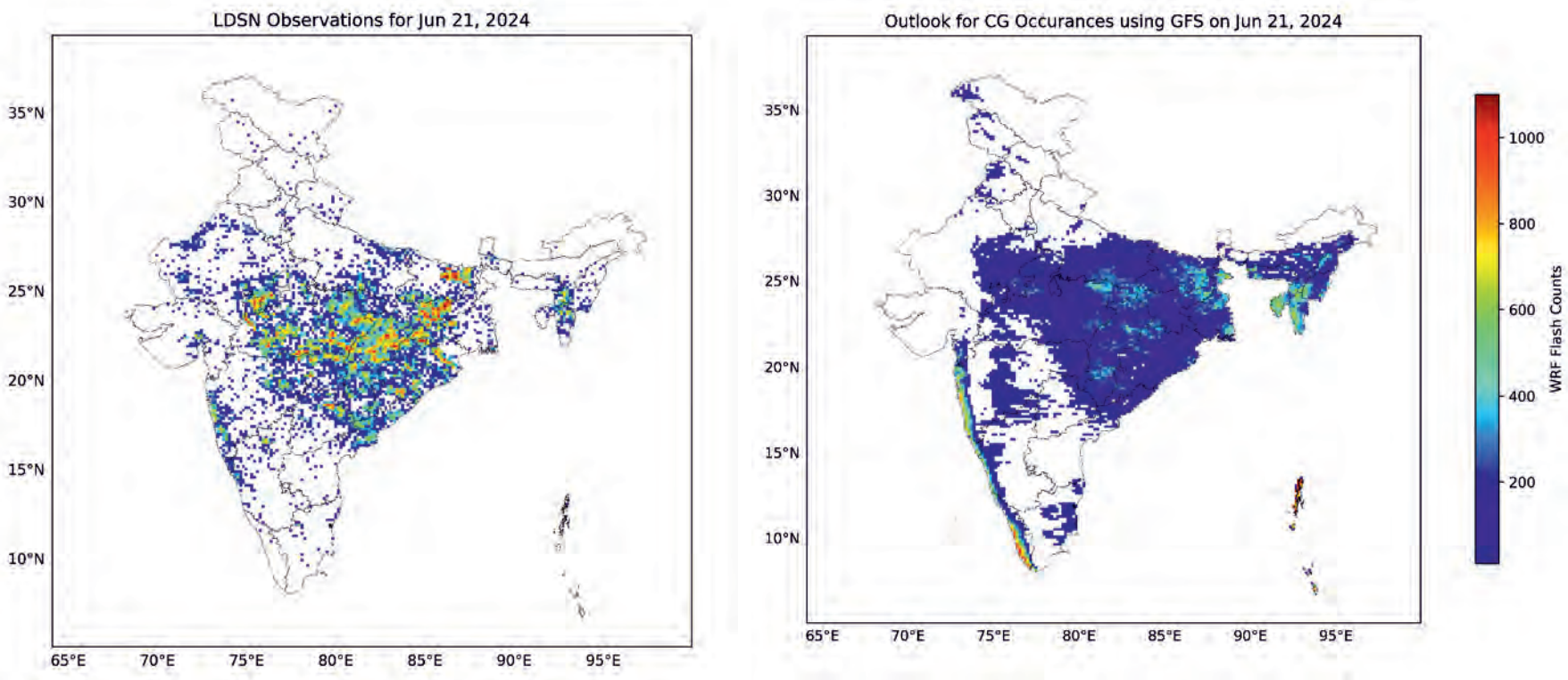
Outcome in terms of benefits to the Society / Governance

Generated high resolution topographical products for 129000 sq.km cumulatively under various projects using LiDAR+DC surveys. These products form primary input for hydrological and hydrodynamic modelling of surface runoff and river discharge simulations. Further, the high resolution DTMs helped in estimating the extent of flood inundation, depth of flooding, duration of flooding, velocity of flow, etc.

This led to development of spatial flood & Tsunami early warning systems supporting disaster risk reduction programmes through non-structural interventions.

Spatial inundation simulations using this high resolution DTMs provided more precise information on potential areas that are likely to be flooded in spatial environment prior to the event. This information is critical for flood risk management, flood relief & rescue operations towards minimizing the flood damage. High resolution DTMs also assisted in planning & evaluation of new river link projects/reservoirs providing critical inputs for DPR preparation for canal alignment planning, irrigation command area assessment, reservoir submergence analysis, etc. minimizing the conventional ground survey campaigns and providing objective assessment of terrain conditions.





Comparison of the Observed CG Lightning Flashes (left) by the NRSC-LDSN with the Lightning Outlook (Right) Obtained Using the WRF-Elec Forecasting Results on 21 June 2024

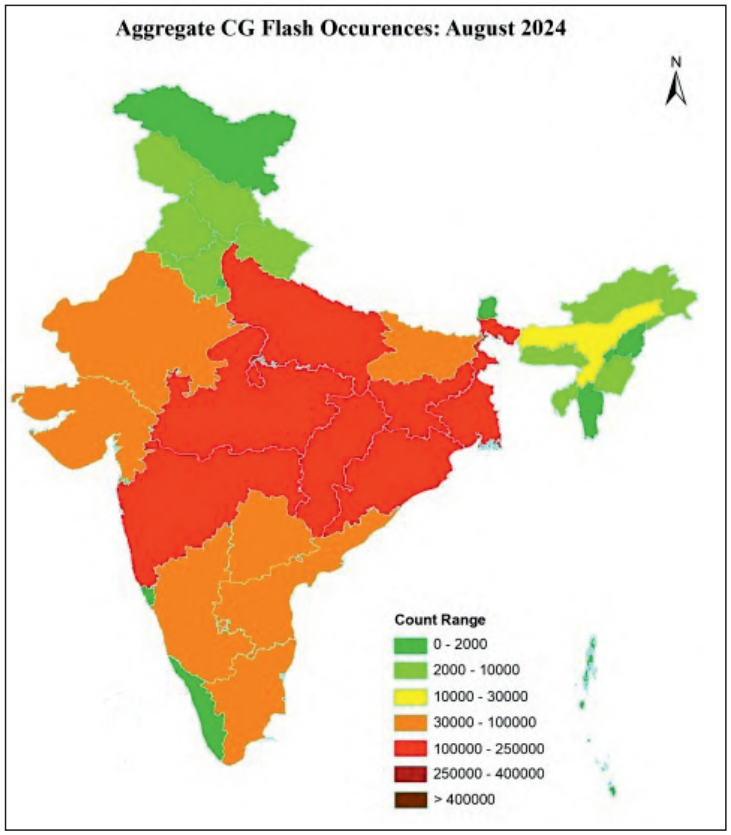
Lightning Sensor Detection Network 31

The National Information System for Climate and Environmental Studies (NICES) is an NRSC/ISRO effort that hosts the climate qualified data records recommended as ECVs or geophysical parameters per the WMO criteria. The data recorded with LDSN are utilized to derive the Lightning ECV. Global Climate Observation System (GCOS)-WMO introduced Atmospheric lightning as an ECV and thus NRSC initiated a Lightning Detection program under NICES.

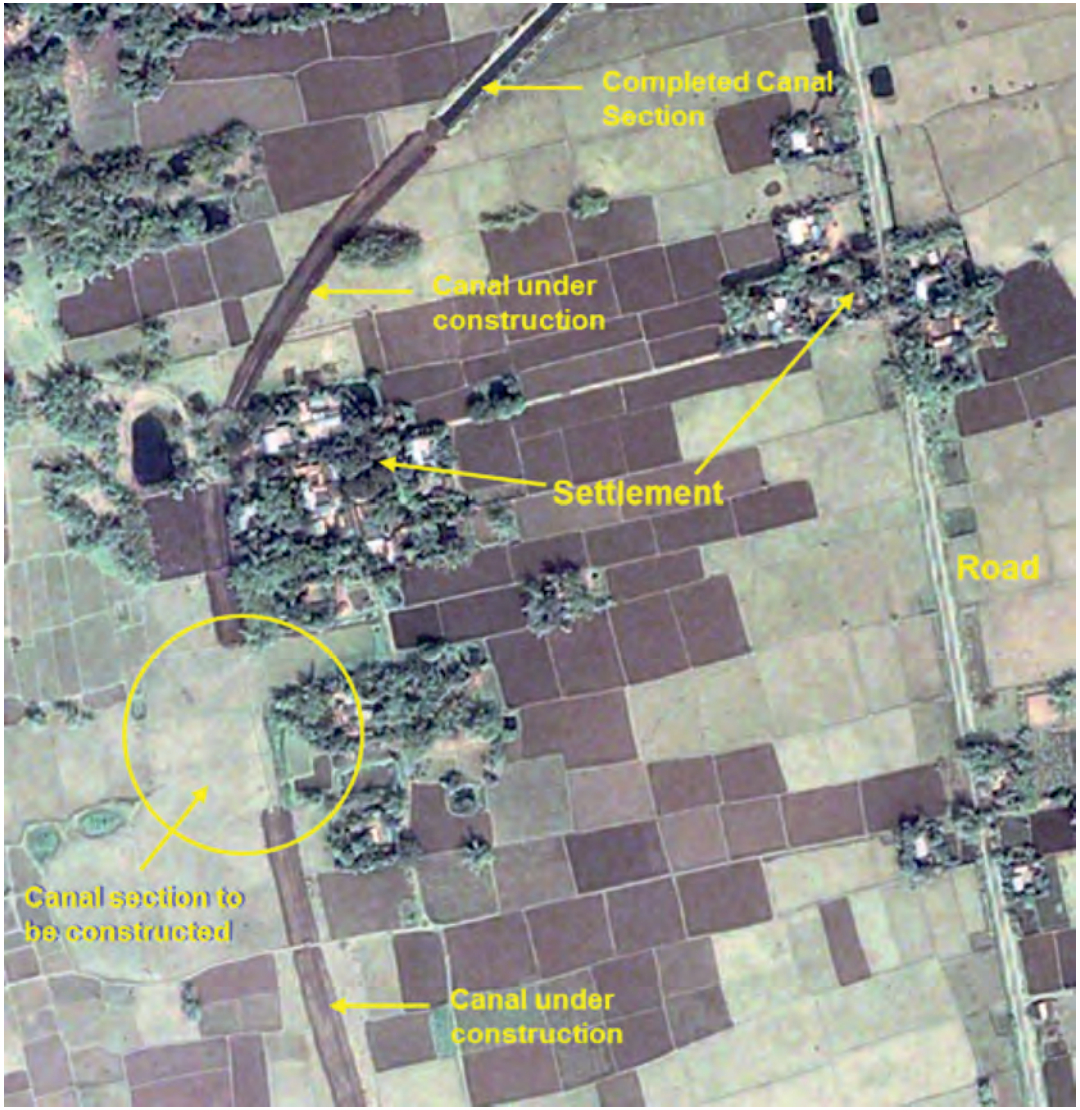
Atmospheric lightning, an extreme event occurring due to complex meteorological processes, is considered a major natural disaster. With earth's climate getting warmer, the lightning is expected to increase by about 15% per degree. Understanding its importance, the World Meteorological Organization (WMO) has classified cloud-to-ground (CG) lightning occurrences as an Essential Climate Variable (ECV) in the year 2016. The CG lightning can cause severe damage to establishments, apart from directly impacting human life upon the strike. Increases in such cases are noted over India (and worldwide) from year to year. The NRSC has established a lightning detection system network (LDSN) to understand lightning phenomena and their impact on atmospheric processes.

The LDSN consists of long-range sensors distributed over 46 locations connected to a server located at NRSC for a near real-time estimate of lightning occurrences and associated currents. The lightning occurrences are geo-located using the time of arrival algorithm recommended by the WMO. The vulnerable zones can be thus categorized by identifying the geospatial characteristics of the lightning occurrences.

The disaster support groups can also use the estimated lightning vulnerable maps to assess the mitigation requirements. Further, It would provide ground truth to validate any future Indian space-based Lightning sensor. The assimilated database feed to the numerical weather prediction model can provide much improved now-casting. The awareness programs and safeguarding set up at vulnerable zones can safeguard lives and protect the establishments.



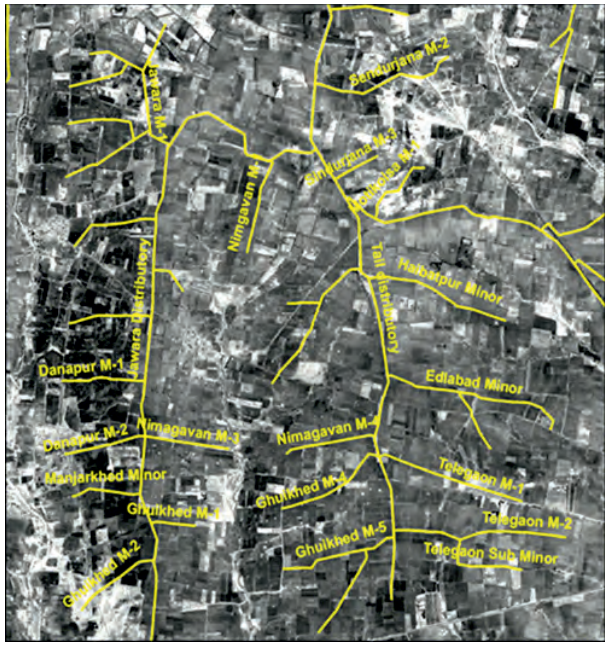
Lightning Hotspot Map for August 2024



High-resolution Satellite Data Depicting Irrigation Infrastructure Creation Progress

Monitoring of Accelerated Irrigation Benefit Programme 32

The Government of India launched the Accelerated Irrigation Benefit Programme (AIBP) in the year 1996-97, to provide financial assistance for ongoing major/medium irrigation projects targeting the early realization of irrigation potential creation in the country. Periodic monitoring of infrastructure created under AIBP is traditionally carried out through field inspection of a few selected locations and inputs provided by implementing state agencies. The advent of high-resolution satellite data enabled irrigation infrastructure identification and assessment of its creation progress. At the request of the Central Water Commission (CWC), NRSC assessed the physical progress of irrigation infrastructure & potential creation in 103 irrigation projects across the country covering 6.19 million hectares of targeted irrigation potential. High-resolution satellite data from Cartosat-1/2 was used to inventory the constructed irrigation infrastructure & irrigation potential created was assessed in AIBP projects and was compared with planned infrastructure to generate compliance reports.



Irrigation canal network inventory from high-resolution satellite data

The information generated from high resolution data assisted CWC in monitoring the physical progress of irrigation infrastructure creation and identifying the critical gaps for early completion of the AIBP-funded irrigation projects. Further, NRSC developed the Bhuvan-AIBP portal with customized tools for online monitoring of irrigation project creation progress, thus simplifying the satellite data access and usage.

The application project demonstrated the effectiveness of high-resolution satellite data, particularly through the use of over 2,500 Cartosat-1 satellite products, for inventorying and monitoring the creation of irrigation infrastructure. The study further validated the potential and utility of such data for the development of the irrigation sector, highlighting its role in improving planning, monitoring, and management of water resources and infrastructure. The objective assessment of irrigation infrastructure creation focuses on evaluating the current status and progress in relation to the planned targets. This process involves identifying critical gaps in the irrigation canal network and prioritizing areas for intervention. By utilizing satellite technology-based inputs, this approach facilitates the early realization of irrigation potential, ensuring that infrastructure is developed more efficiently.

National Database for Emergency Management - Landing Page

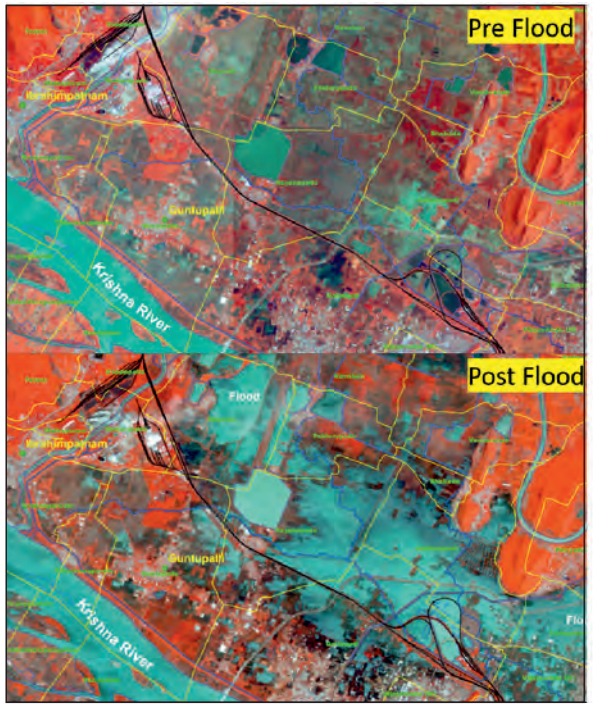
National Database for Emergency Management (NDEM) 33

National Database for Emergency Management (NDEM) is a national repository of multi-scale geospatial database coupled with decision support system tools. NDEM provides space-based support and services to forecasting organizations addressing all phases of natural disasters for Disaster Risk Reduction in the country. It is a unique and homogenous database that serves the entire country with essential database elements for addressing emergency/disaster management. NDEM framework is designed to handle situations with effective decision making by integrating the repository of information, tools, and methods, real-time field information collection, situation assessment, resource identification, and mobilization.

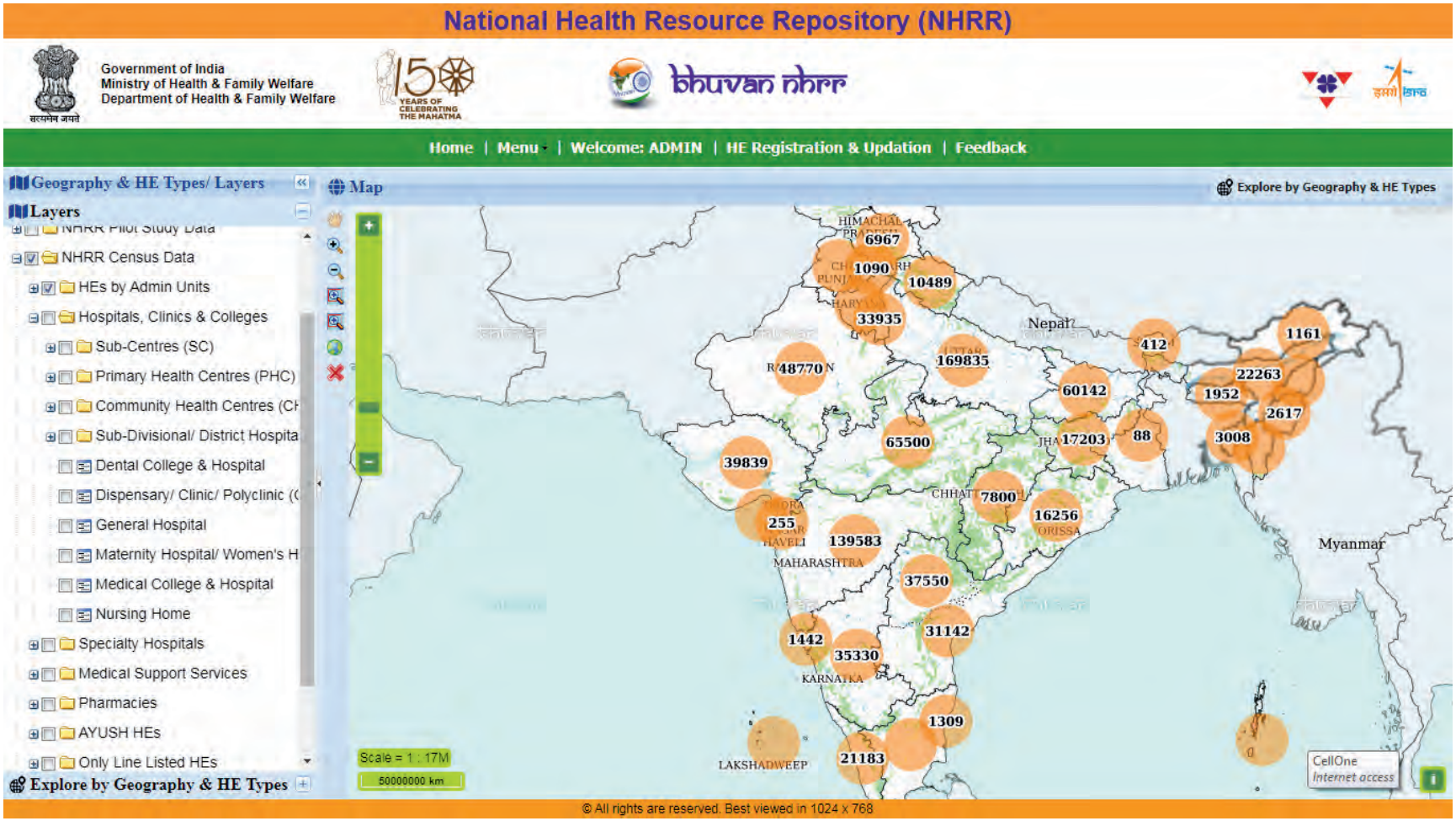
The Committee of Secretaries (CoS) entrusted the responsibility to the Department of Space (DOS) to design, develop, and implement NDEM. National Remote Sensing Centre (NRSC), ISRO, DOS is the lead agency in implementing and operationalizing NDEM. A state-of-the-art facility is established with multi-institutional participation of all States/UTs for preparedness and emergency response at the behest of the Ministry of Home Affairs, under the Disaster Management Support Programme (DMSP) of ISRO. NDEM services have been operationalized since 2013, providing timely information and disaster-specific products for effective decision making. Honourable Minister of state, DoS has launched the current version of NDEM 5.0 on 28 June 2024.

The salient features of NDEM V5.0 geoportal include a disaster dashboard showcasing all major disasters, alerts, and warnings of various forecasting agencies enabled to users at a single platform. NDEM 5.0 has Pan India Disaster Scenario on the main dashboard to showcase disasters in the country on any given day. New Decision Support System (DSS) tools, Product catalogue, disaster event card, Indian Disaster Resource Network (IDRN) updates, etc, have also been developed and integrated into NDEM version 5.0. Implementation of Post Disaster Need Assessment (PDNA) tools was also initiated to collect post-disaster-specific information for assessing relief and reconstruction. 3D visualization of disaster-specific layers in satellite data as a backdrop is another major feature of NDEM 5.0.

The gamut of information available in NDEM provides a national basis for vulnerability assessment, disaster preparedness, alerts, deployment of the required resources for evacuation in emergencies, and damage estimates and helps the government and associated bodies in decision making and assessment of disaster-specific aid contributions.



Floods in Andhra Pradesh 13-09-2024



NHRR Landing Page

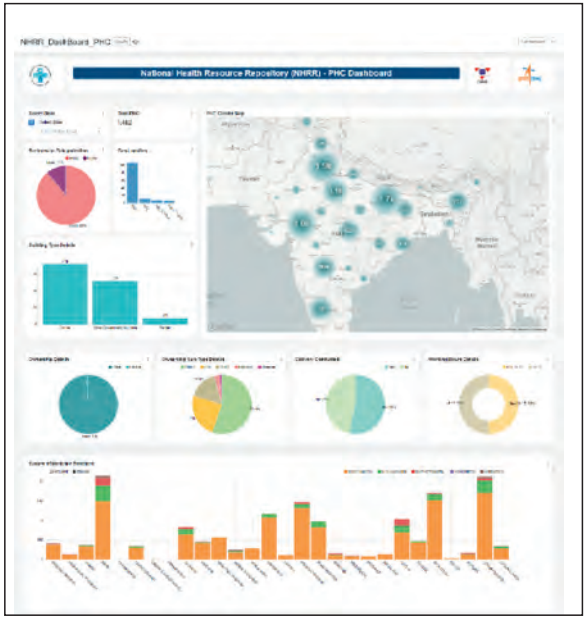
National Health Resource Repository 34

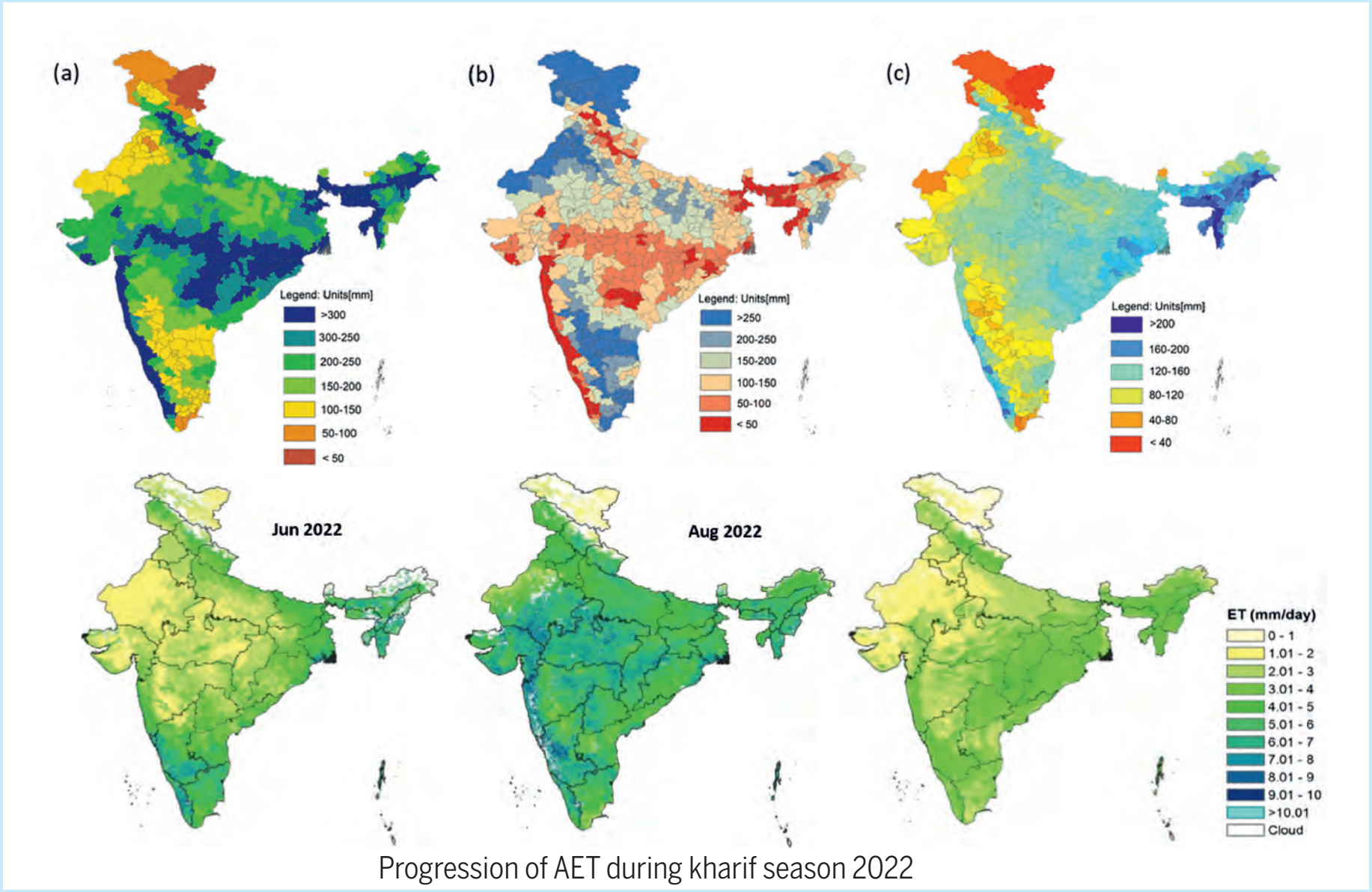
National Health Resource Repository (NHRR)

An enhanced healthcare system is an urgent priority in India, and there is a need to gain a comprehensive understanding of the Indian healthcare sector through an updated database. This will enable the provision of accessible, acceptable, affordable, equitable, and patient-centric quality healthcare services for the community. In line with this, the Central Bureau of Health Intelligence (CBHI), DGHS, Ministry of Health & Family Welfare (MOHFW), and GOI have envisioned the establishment of a consolidated platform called "National Health Resource Repository (NHRR)," which will serve as a single source of healthcare resource information for the public and private sectors in the country. NRSC, ISRO has been engaged as a technology partner for this project to design, develop, and deploy a technology platform (including a mobile/tablet app and a Geo-Web portal) to facilitate the generation of a comprehensive health sector database, conduct a health resources census, and create a GIS-based enabling environment.

The NRSC/ISRO has accomplished the objectives of the NHRR Census. This includes developing all the necessary tools and techniques for data collection (via a mobile app), management information system and quality check, data visualization and analytics, report generation, use cases, data updation and sustenance, geo web portal development, and data and portal hosting. By the conclusion of phase I of the project in May 2021, 10,27,715 health establishments have been mapped and surveyed as part of the project. The NHRR project has provided a comprehensive profile of all private and public healthcare providers, an in-depth inventory of the nation's healthcare assets across all sectors, and assigned unique codes for health establishments. Furthermore, it has been integrated with MoHFW's flagship healthcare schemes such as NIN, ROHINI, PAN number, and PMJAY empanelment. Notably, NHRR stands as the first ever fully digital census conducted in the country.

The data collected through NHRR is invaluable for various decision-making activities and is being used by many government departments to promote India's Digital Health initiatives. The NHRR data has been instrumental in COVID-19 pandemic management, wherein it was used to identify healthcare facilities that are relevant to treating patients. Currently, activities towards phase II of the project are in progress, wherein this data will be made available to the stakeholders and the general public. This will ensure a wide outreach and fulfilment of the objectives of health access and integrated health planning..





Progression of AET during kharif season 2022

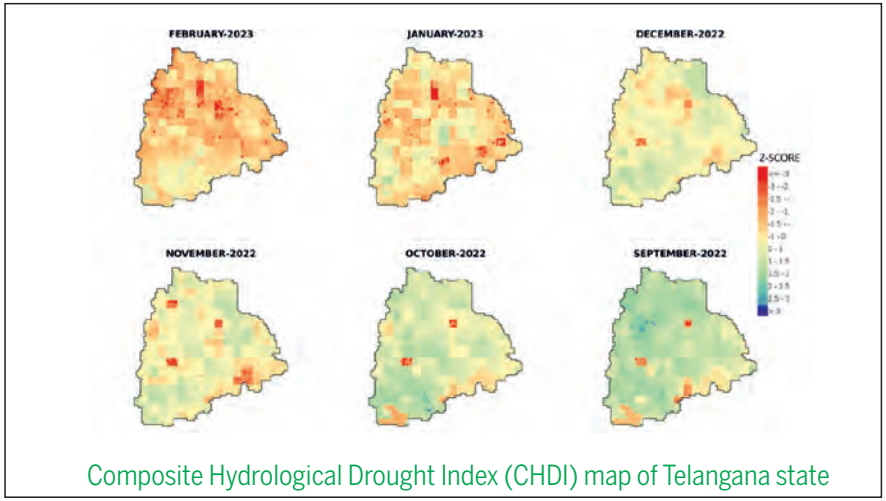
Water Balance Components for (June- Sept) 2023; (a) Rainfall; (b) Surface Runoff; (c) Evapotranspiration

National Hydrology Project - Geospatial Hydro Products and Services

35

National Hydrology Project (NHP) was initiated by Department of Water Resources, River Development & Ganga Rejuvenation (DoWR, RD&GR) under Ministry of Jal Shakti with the objective to improve the extent, quality, and accessibility of water resources information, decision support system for floods and basin level resource assessment/planning and to strengthen the capacity of targeted water resources professionals and management institutions in India. The mission is to establish an effective and sound hydrologic database and Hydrological Information System (HIS), together with the development of consistent and scientifically-based tools and design aids to assist in the effective water resources planning and management within each to the implementing agencies based on sound scientific driven framework.

National Hydrology Project (NHP) initiated by Department of Water Resources, River Development & Ganga Rejuvenation (DoWR, RD&GR) to establish an effective and sound hydrologic database and Hydrological Information System (HIS), together with the development of consistent and scientifically-based tools and design aids to assist in the effective water resources planning and management. NRSC is engaged with generation of geo-spatial products & services pertaining to water resources sector, generation of high-resolution digital elevation models, development of flood early warning systems, decision support system development for irrigation water management, modelling & dissemination of hydrological products to support water resources management and capacity building to NHP stakeholders.



Composite Hydrological Drought Index (CHDI) map of Telangana state

NRSC has generated various geospatial hydro products and services under this project and the same is disseminated through Bhuvan-NHP portal (https://bhuvan.nrsc.gov.in/nhp/). Apart from significant contribution to Flood Early warning in Godavari and Tapi rivers and inventory of Glacial Lakes, significant achievements are as given below, which are ap.Near Real time daily Actual Evapotranspiration (AET) product is being generated since November 2019 at 5.5 km and 750 m spatial resolution

DSS for irrigation scheduling & performance benchmarking was developed using Satellite data-based inputs for Narayanpur Irrigation Project command area

Daily spatial snowmelt rate during 1st April to 30th June, since 2019 for entire catchment of Indian Himalayan River basins is being generated and 3-day (T+3 days) snowmelt runoff forecast for entire basin & short-term forecast at selected basin outlets are being given Web-based SWAT hydrological modelling interface called "Hydrologic Unit Model for India (HUMID)" (https://bhuvan.nrsc.gov.in/humid/) was developed in collaboration with IIT-Madras

Hydrological drought indices were developed using satellite observations, hydrological model outputs and field observations data and operational hydrological drought services are provided

More than 26 customized RS & GIS training programmes were conducted as part of the capacity building for NHP stakeholders (more than 600 officers from around 50 Implementing Agencies).

National Information System for Climate and Environment Studies

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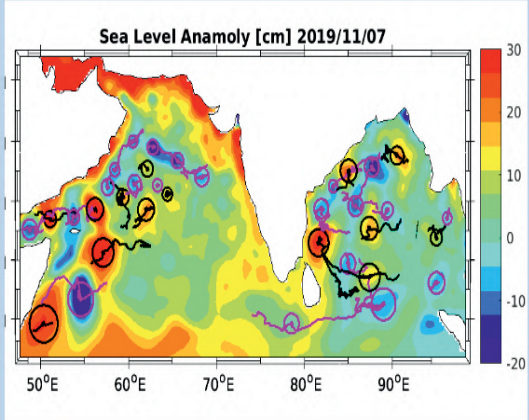
GATEWAY FOR EARTH & CLIMATE DATA PRODUCTS AND INFORMATION

NICES

Important Update: Opportunities are under evaluation and the outcome shall be announced in August 2024.

CLIMATE STORIES



Mesoscale Eddies in the north Indian Ocean

Satellite-measured daily sea level anomaly data are used from 1993 to 2021 to study the characteristics of mesoscale eddies in the north Indian Ocean. The procedure utilises information on the vorticity vector, Okubo-Weiss velocity gradient tensor and its threshold and Lagrange transport. The continental margin of the Arabian Sea (AS) with its western and northeastern flanks, the mouth of the Gulf of Aden, the Lakshadweep Sea, the western margin of the Bay of Bengal (BOB) and the Andaman Sea have been depicted as the hotspot regions for eddy occurrences. Read More..

FOR MORE STORIES

HIGHLIGHTS

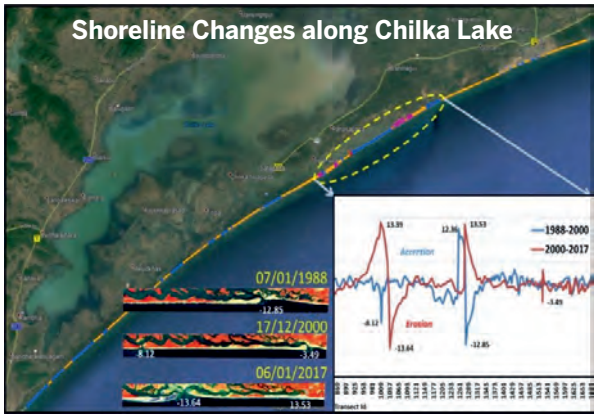
- Extension of deadline for NICES project proposal
- Workshop on "Ocean Colour Sciences and Applications" at NRSC
- MoU signing ceremony between CCRI & NRSC
- Observations of GHGs as Climate Indicator
- Deciphering the Signatures of Convective Rain Cells
- Wind power potential over Indian region
- Hot Weather Outlook
- Fog intensification - Probable region

National Information System for Climate and Environment Studies - Landing Page

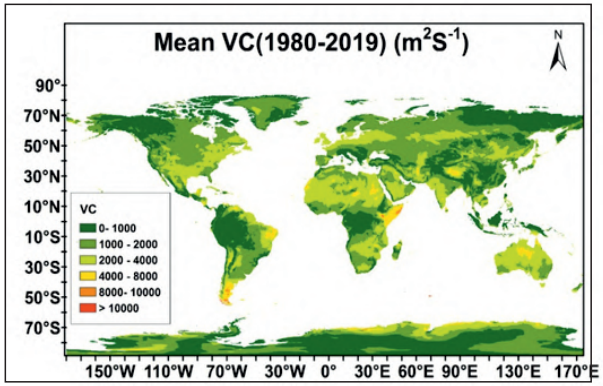
National Information System for Climate and Environment Studies (NICES) 36

The main objective of the National Information System for Climate and Environment Studies programme is generation and dissemination of long-term Essential Climate Variables (ECVs), derived from Indian and other Earth Observation (EO) satellites that critically contributes to the characterization of Earth's climate. NICES is a multi-institutional venture with the participation of ISRO/DOS centres and other departments and national Institutions under various Ministries, which help to strengthen the information base with contributions (in-situ observational and model outputs) from the participating organisations. Since its inception, built a strong database of 12 ECVs and around 60 geophysical variables pertaining to the land, ocean and atmosphere; which are disseminated through the NICES portal under the Bhuvan platform of ISRO. NICES (National Information system for Climate and Environment Studies) was conceptualised in 2012 in order to meet the continuing challenge of monitoring climate variability and climate change from space. Currently the second phase of NICES is in progress.

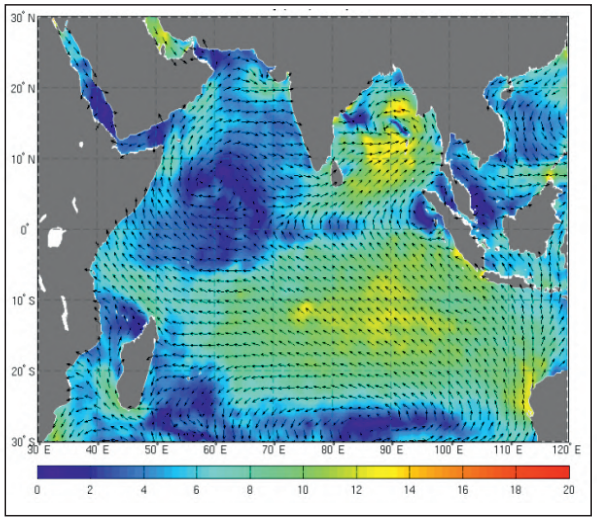
In order to establish the product uncertainties and transforming the geophysical parameters to ECVs, ground-based in-situ data is being collected through NICES observational network pertaining to Ocean, Terrestrial and Atmosphere. Currently, not all the available geophysical variables are meeting climate-quality standards, but 13 with potential to qualify as ECV are being taken up in NICES. This observational network is also contributing to the dissemination of cloud-to-ground lightning strikes over India. Further, methodologies are also developed for generating daily-mean variables by merging the similar products from different multiple-satellites. By linking the existing set of NICES geophysical products that meet the quality requirements have utilised for documenting the climate monitoring and impact studies ranging from establishing the causes behind the warming over Northwest India; inter-annual variability of sea level in the tropical Indian Ocean; alterations in cloud properties over the Indian ocean during the monsoon season; quantification of aerosol-cloud interaction strength over the Arabian Sea; monitoring the shoreline change over selected locations of India and counting



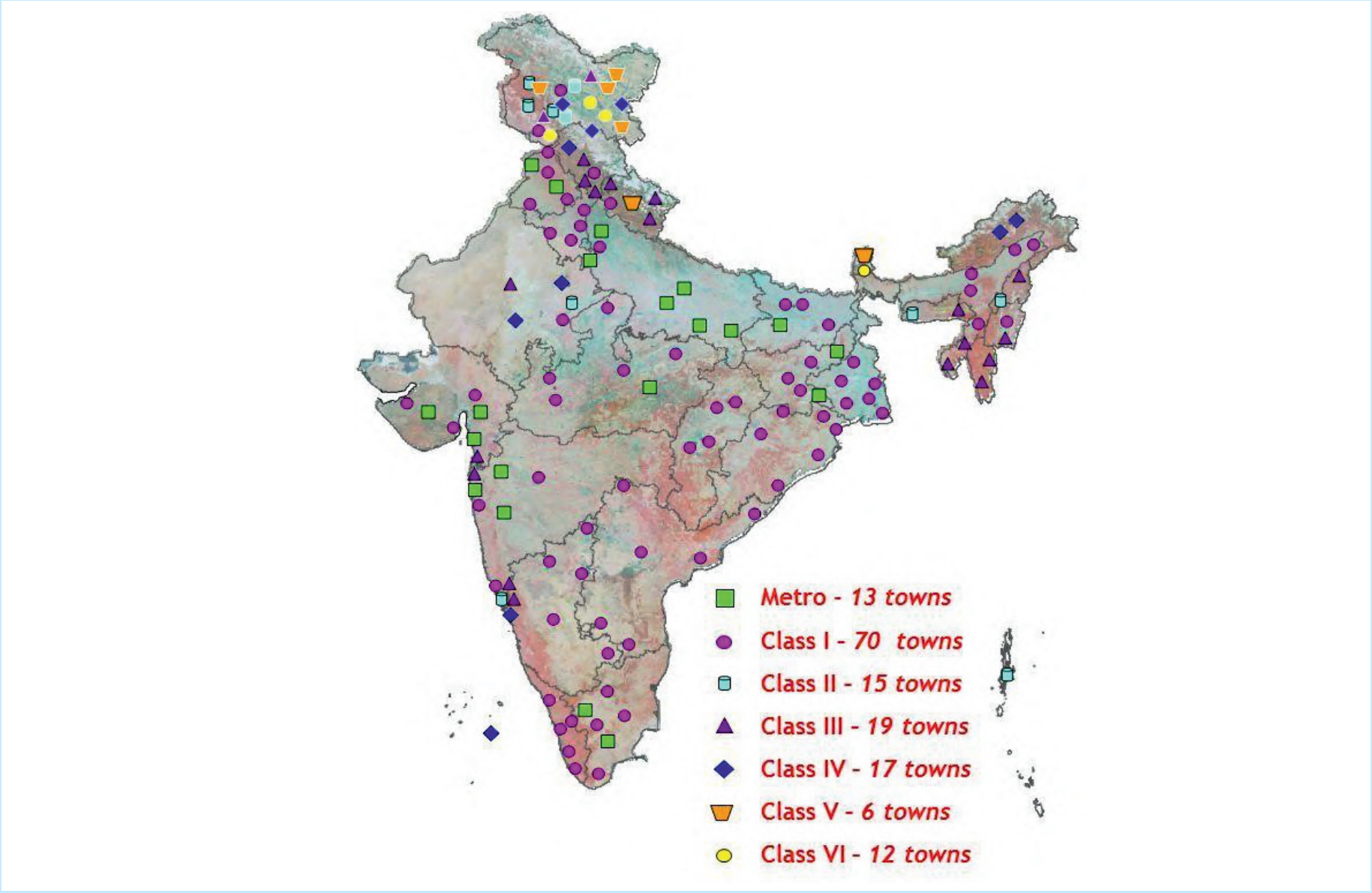
the carbon using the carbon cycle modelling.
The generated data sets of ECV and geophysical parameters provide the empirical evidence needed to understand and predict the evolution of climate, to guide mitigation and adaptation measures, to assess risks and enable attribution of climate events to underlying causes.



Spatial variations in annual mean (1980-2019) VC/GAPPI



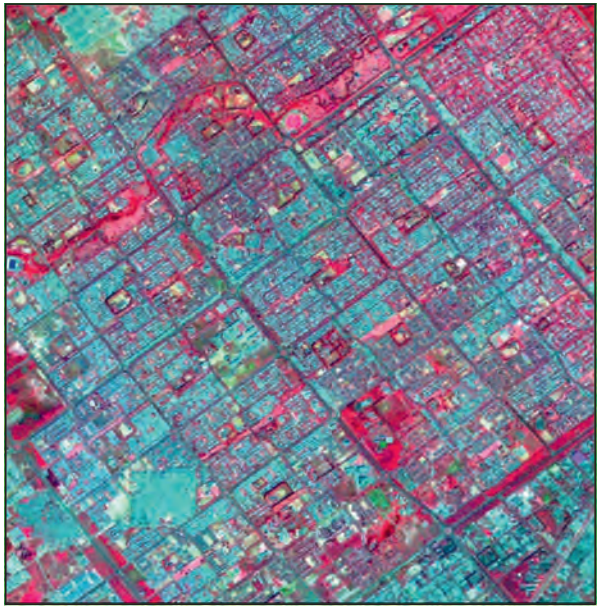
OSCAT Wind Velocity (mps) Composite



Database Generation for the Identified Urban Local Bodies

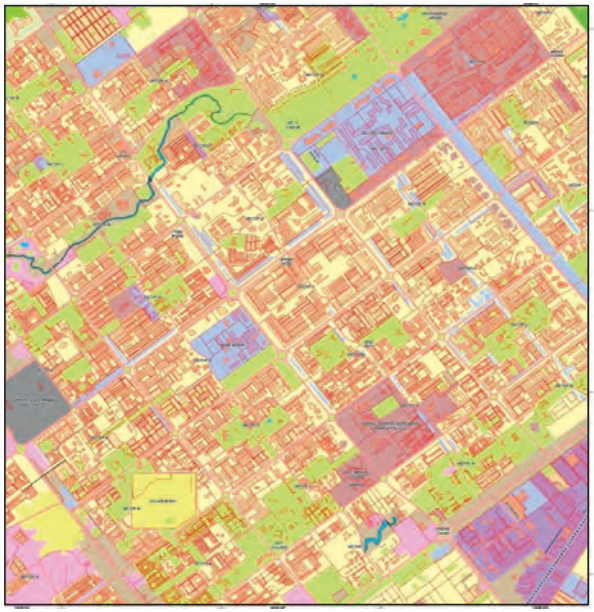
National Urban Information System (NUIS) 37

National Urban Information System (NUIS) is a National Mission launched by Govt. of India in 2008 to create an Urban Spatial Information System to meet the spatial data (base and thematic maps/image) requirements of various levels of urban planning, management functions and e-governance. Urban Local



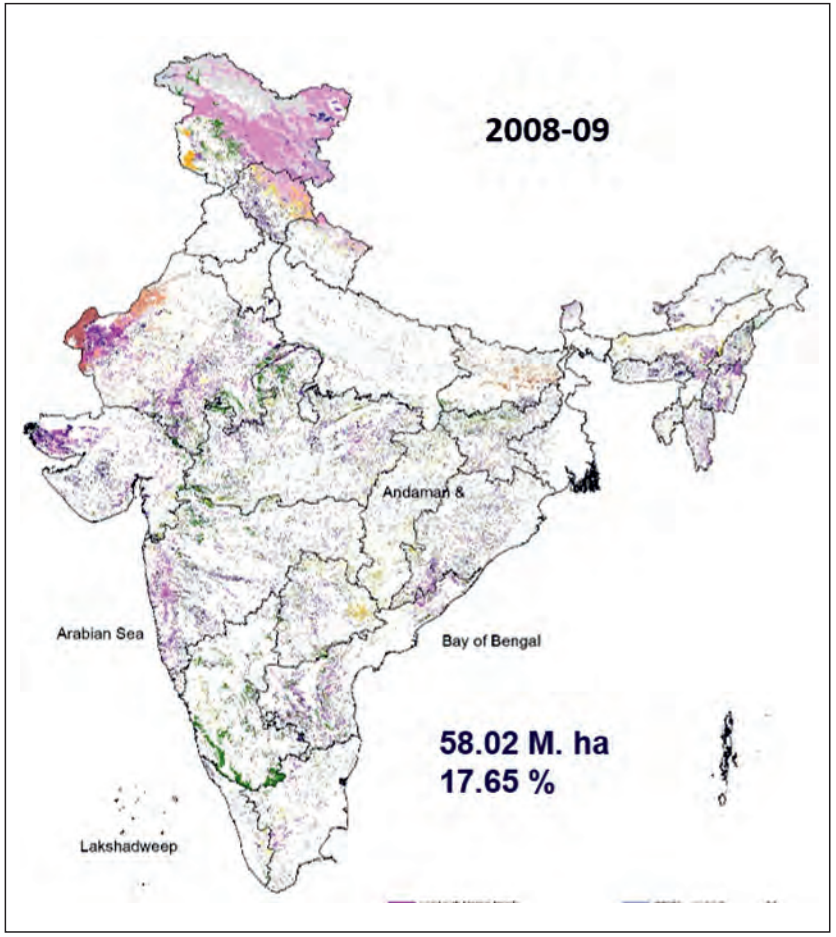
Bodies (ULBs) or Development Authorities (DAs) prepare the master plan, a statutory document for guided and planned development of a city/urban area. Historically, these plans were prepared manually and were time-consuming. State-of-the-art geospatial tools and technologies, remote sensing and GIS are used to prepare the inputs and formulation of the Master Plan. NUIS was one of the first National level projects carried out during 2008-2012 to generate a multi-scale hierarchical urban geospatial database for urban planning, management, and governance of cities nationwide.

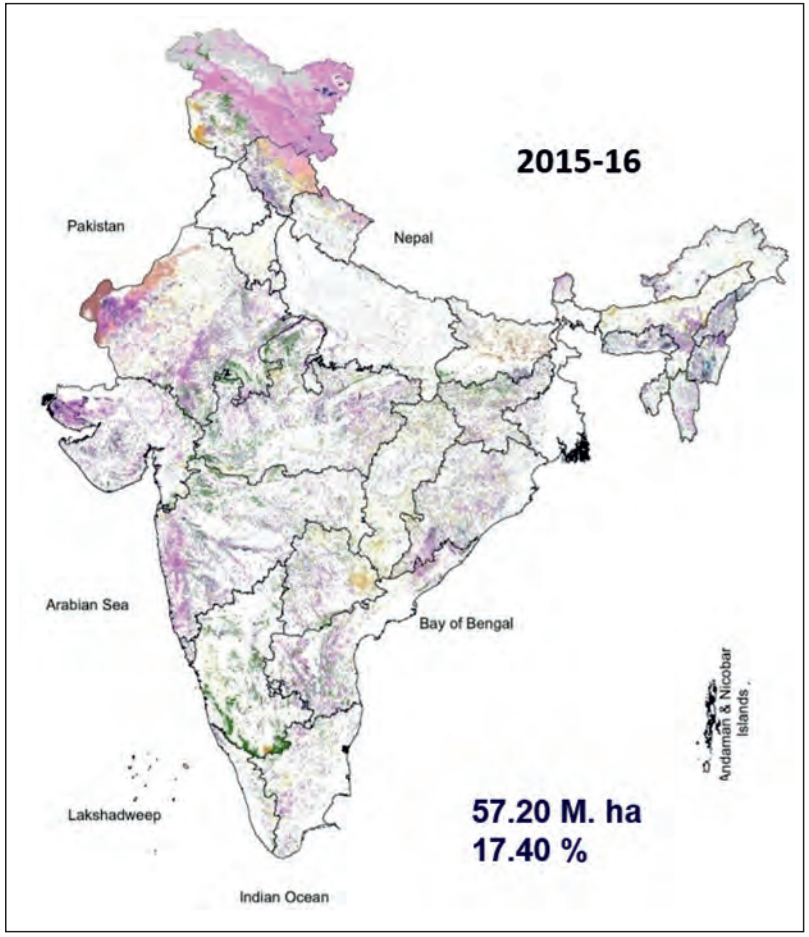
The NRSC and 32 partner institutions have generated high-resolution urban databases for 152 cities in the country. These include base layers, urban land use, physiography, lithology, geomorphology, and soils. Developed the "Bhuvan-NUIS" web application for urban master plan preparation and monitoring at different levels. Around 2400 town planning officials were trained on Bhuvan-NUIS through workshops.



NUIS urban geospatial database has been used by the Urban Local Bodies (ULBs) to prepare Master

Plan/Development Plan and Infrastructure development. It facilitated the preparation of Master plans for 28 of the 152 cities by the urban local bodies and became the prototype for generating GIS-based Master Plans. The Bhuvan-NUIS application has given town planners a basic understanding of using remote sensing and GIS technology for Master Plan preparation. NUIS has played a significant role in encouraging the adoption of remote sensing data and GIS technologies within the user community, replacing conventional methods for Master Plan preparation. NUIS has also contributed to the revision of Urban and Regional Development Planning guidelines to incorporate RS and GIS technologies in urban planning and facilitated the creation of a valuable and objective geospatial database of urban assets for future reference as an authenticated urban geospatial database.

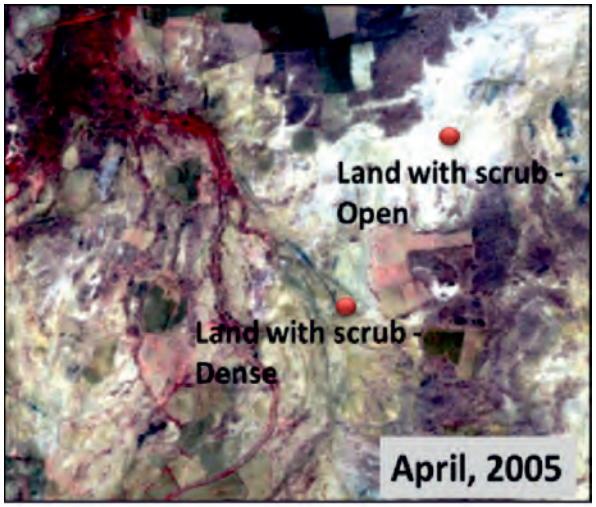




Change Analysis of Waste Land 2008-09 and 2015-16

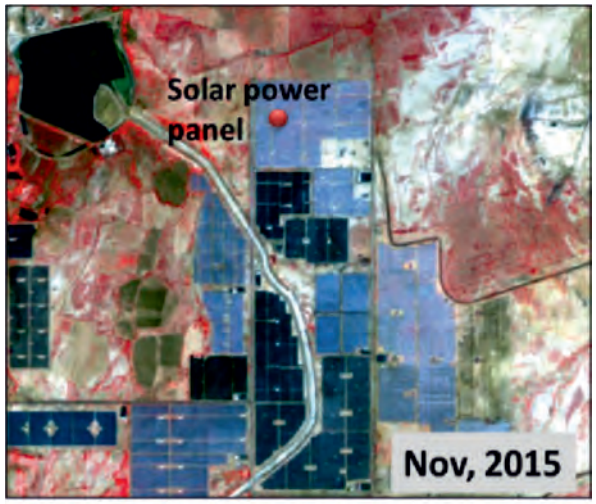
National Wastelands Change Analysis and Monitoring 38

The "National Wastelands Change Analysis and Monitoring" project, undertaken by the National Remote Sensing Centre (NRSC), ISRO, at the behest of the Department of Land Resources (DoLR), Ministry of Rural Development, Government of India, provides a critical database for planning and developmental activities related to wasteland management. With an



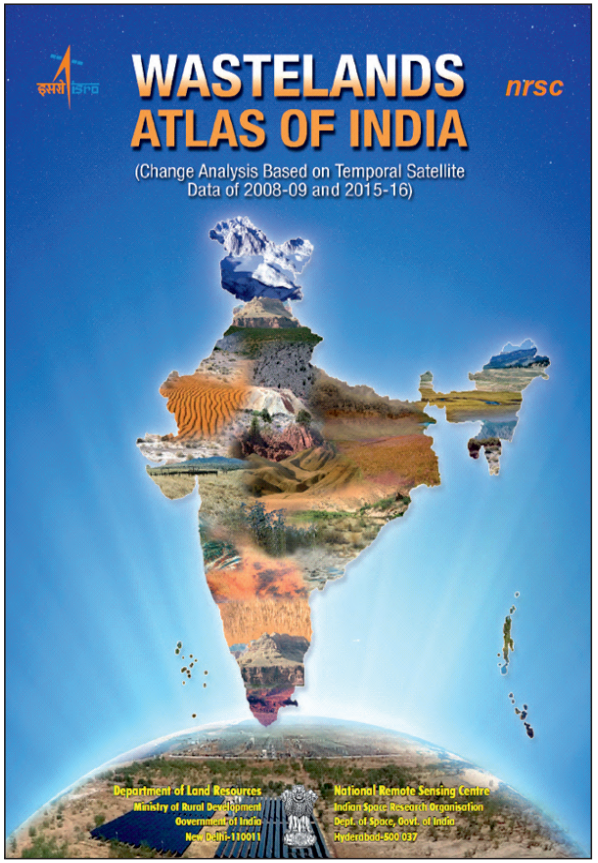
aim to track and analyze changes in wasteland areas across India, it offers valuable insights into reclamation trends and land use transformations. Historically, the extent of wastelands in India has decreased, with significant areas reclaimed for agriculture, industry, and urban development since 1986. The recent study of change mapping between 2008-09 and 2015-16 shows that, total wastelands in the country in 2015-16 are 3,96,728.02 sq.km. (12.98% of total geographical area) compared to 4,03,925.91 sq. Km (13.21% of total geographical area) in 2008-09. The trend indicates overall decrease in Wastelands by 0.24% from 2008-09 to 2015-16.

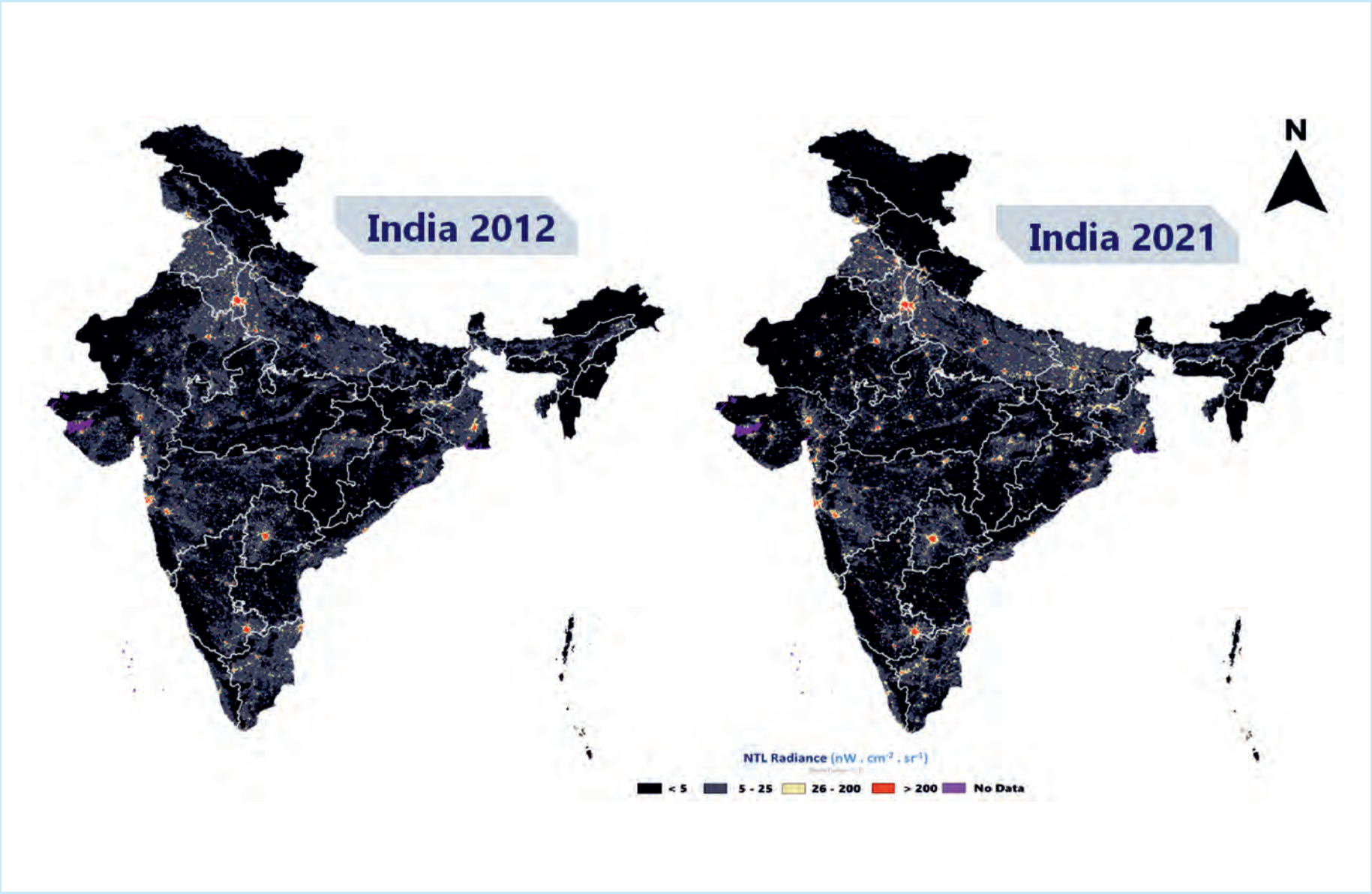
Utilizing optical remote sensing data, including IRS Resourcesat-2 LISS-III images from multiple seasons, to map and monitor wastelands at a 1:50,000 scale. The project classifies wasteland areas and tracks change over time by analyzing spectral reflectance in visual and near-infrared bands. The visual image interpretation approach with remote sensing techniques creates an accurate and comprehensive



wasteland database. This initiative is linked to the National Natural Resource Management System and benefits a wide range of societal needs as follows:

- Reclamation of wastelands for agriculture, plantation, industrialisation etc.
- Utilised for identification of suitable sites for renewable energy, Agroforestry plantation, energy plantation etc.;
- Site suitability for rehabilitation, disaster support, siting of Industries, etc.
- Data is being used for increasing green cover through afforestation;
- Bringing Green Revolution in Eastern India (BGREI), Crop Intensification, Perspective planning etc.





PAN India NTL Decadal Analysis for the Period 2012 to 2021

Night Time Lights Analysis: Unveiling Socio-Economic Insights

For sustainable future, monitoring and analysing human activities on Earth is a very crucial factor to be done periodically. Night Time Lights (NTL) represent the intensity of artificial lights, which can be related to many dimensions of Earth's developmental activities. Night Time Lights (NTL) acquired by satellites is now-adays becoming one of the indicator to analyse widerange man made activities by correlating NTL with Land Use patterns, Socio-Economic parameters (like GDP, Poverty, Population, Electrical Consumption, Crime rates etc), Environment Variables (like Climate change,Carbon emissions etc)).

A significant increased trend was observed in almost all the states, indicating the economic development, urbanization, and infrastructure development over PAN India. Designed and developed a web portal for the Visualization of Night Time Lights, which can be accessed from the Bhuvan portal through https://bhuvan-app1.nrsc.gov.in/bhuvan_ntl/

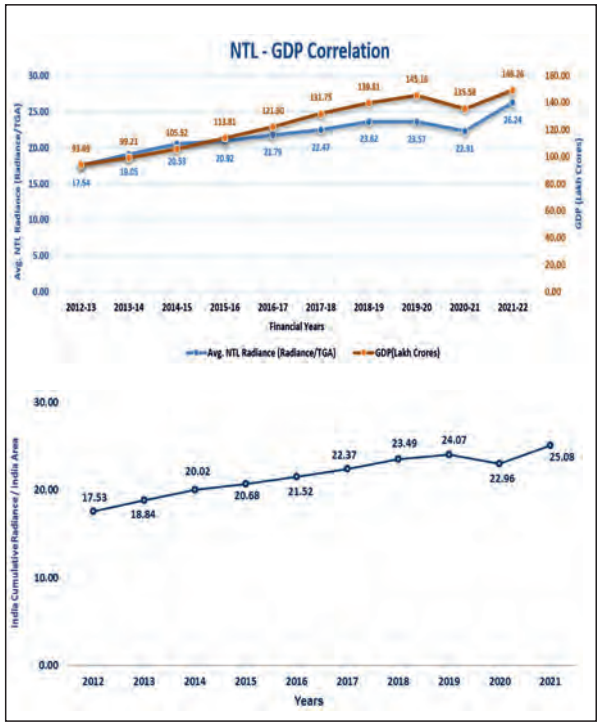
Approx 43% increase observed from 2012 to 2021 with respect to base Year 2012, then 5% decrease observed in 2020 with respect to 2019, which could be due to COVID - 19 pandemic and 9% increase in 2021 with respect to 2020

AIML based Regression Analysis of NTL and GDP:

NTL is often used as a proxy for socio-economic parameters, as more lights typically mean increased activity, infrastructure development, and economic growth. The relationship between NTL and quarterly Gross Domestic Product (GDP) at constant prices, along with various economic parameters such as Energy met at the national level (Energy-met) and Consumer Price Index (CPI), has been carried out using cutting edge AIML technologies. Lasso 5 fold and Random GLM 5 fold analysis showed high correlation with Yearly GDP at constant prices of India and NTL (Avg. NTL radiance) with R2 Score: 0.91.

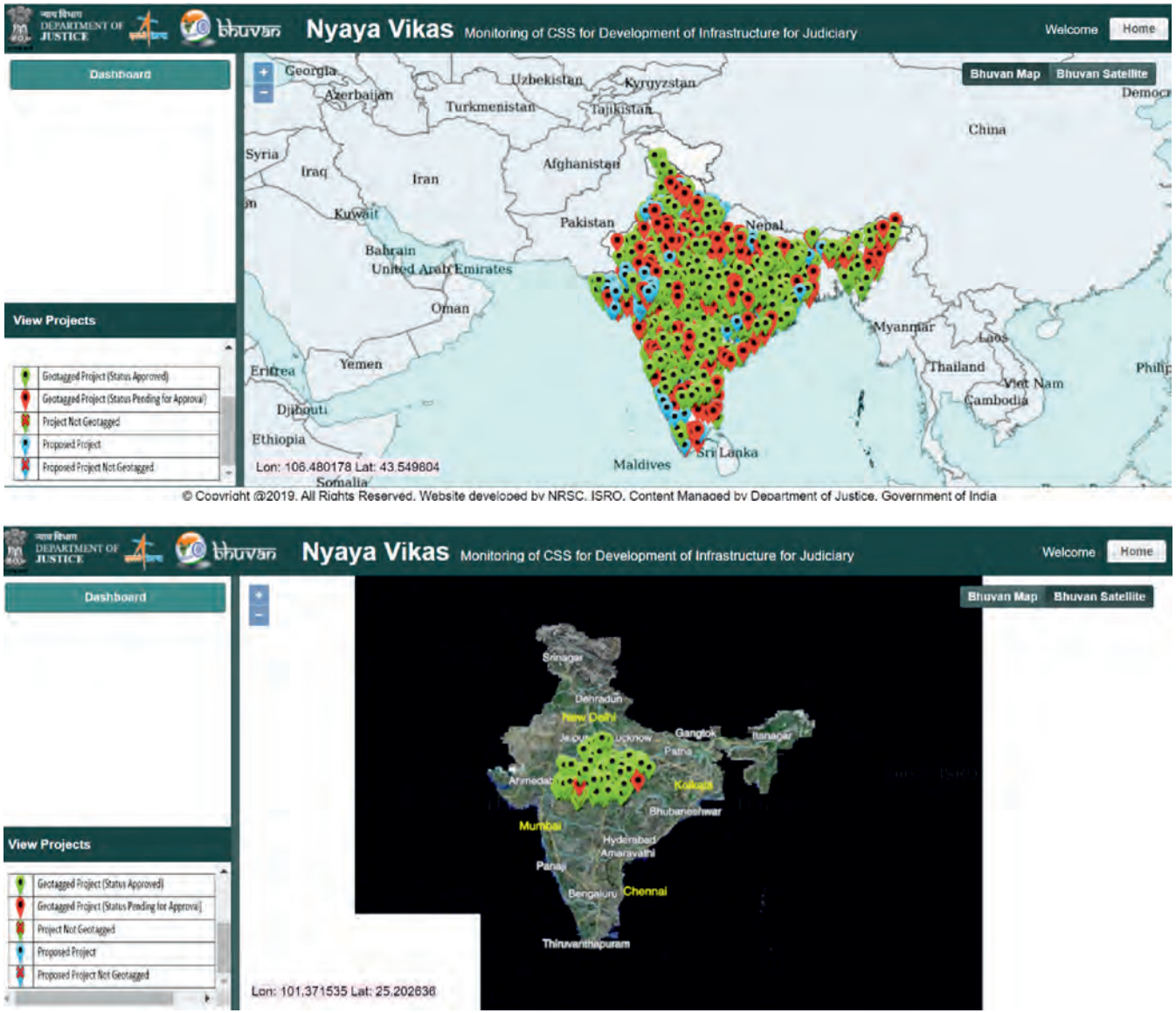
Deep learning based algorithms to forecast short-term GDP:

To forecast short-term GDP using NTL as indicator, trained various time series models like SimpleRNN, GRU and LSTM with various combinations of socio-economic parameters like Energy-met, CPI. NTL+Energy-met+CPI has been selected has optimal combination, which gave lowest RMSE for the all models. SimpleRNN model results are shown below.



Feature Combination	Test Average RMSE (Core)	Test Average RMSE[0-1]	Test Average R2-score
GDP+NTL	124731.32	0.0576	0.8623
GDP+NTL+Energy-met	103764.19	0.0479	0.8962
GDP+NTL+CPI	115586.75	0.0534	0.8753
GDP+NTL+Energy-met+CPL	97442.75	0.0450	0.9062

RMSE, R2-Score for different Feature combination using SimpleRNN



Nyaya Vikas Monitoring of CSS for Development of Infrastructure for Judicary

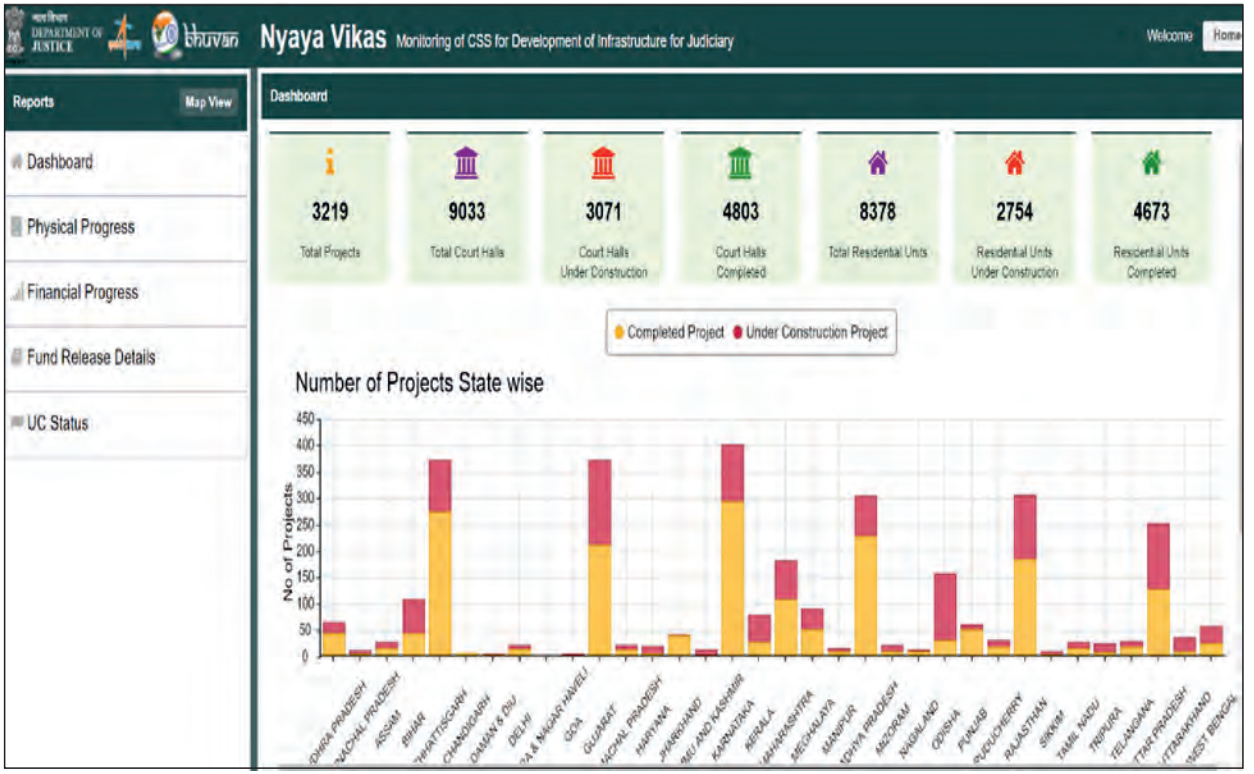
Nyaya Vikas 40

A geoportal called "Nyaya Vikas" was developed to monitor the progress of infrastructure facilities in buildings under the Ministry of Law & Justice. This pilot project includes five states: Kerala, Madhya Pradesh, Rajasthan, Bihar, and Maharashtra. Additionally, a mobile application for Monitoring Projects under the Centrally Sponsored Scheme (CSS) was developed as

Hon'ble Minister Shri Ravi Shankar Prasad Launching the Nyaya Vikas

part of this initiative. Further project was extended to the entire country.

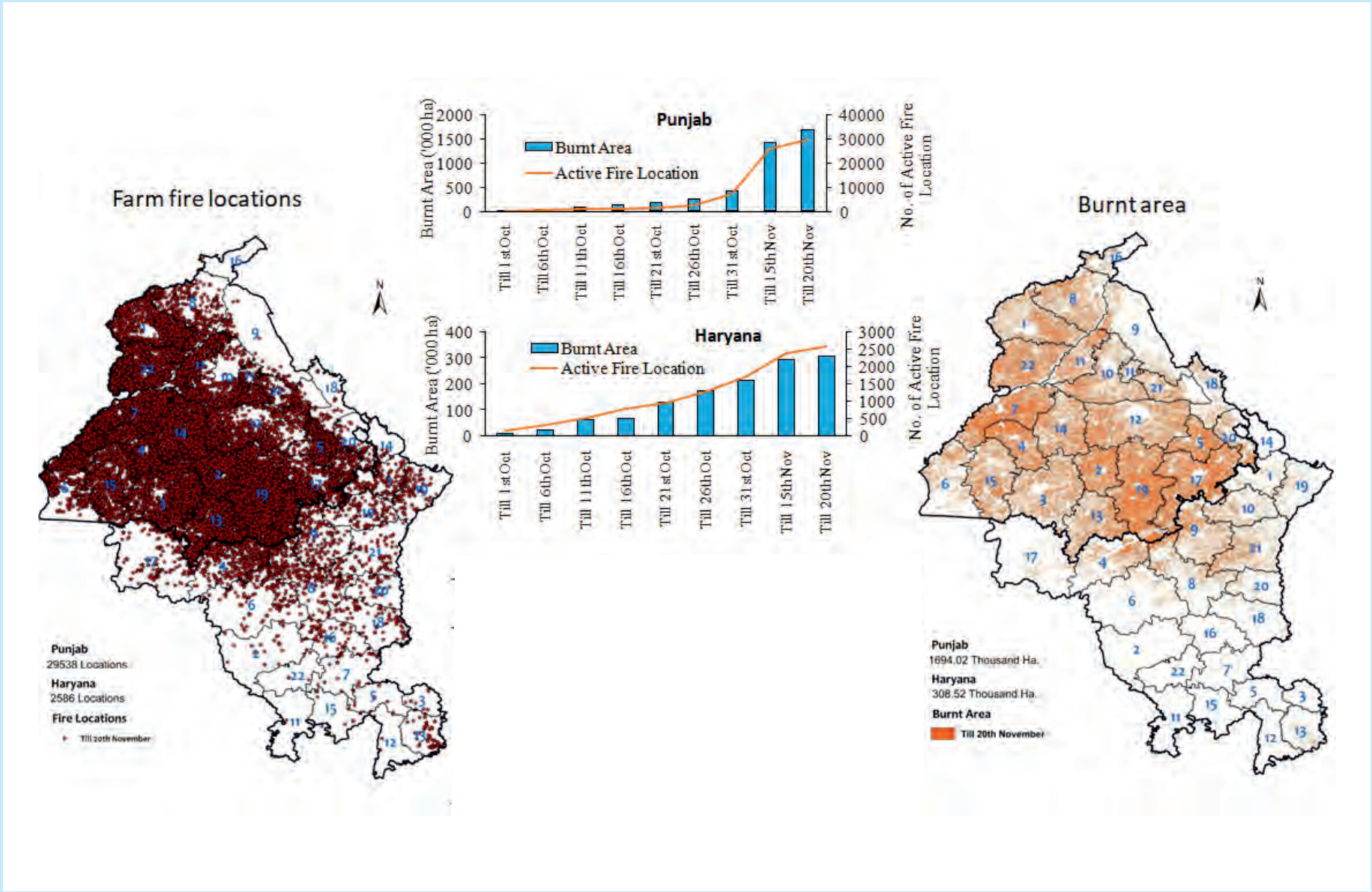
The project components are the Development of a mobile application for geotagging Judicial infrastructures, adding attribute information with pictures, and periodically updating the status, the Development of ISRO-Bhuvan based web application system, Capacity building of MoLJ officials from states and UTs officials, enabling online visualization of CSS assets, analysis and generation of status reports of the uploaded CSS assets, maintenance of customized web



application on the Bhuvan portal and mobile application and technical support.

Nyaya Vikas version-1 was launched on 11th June 2018 by Hon'ble Minister of Law and Justice, Shri Ravi Shankar Prasad, in the presence of Shri P. P. Chaudhary, MoS for Law & Justice and Corporate Affairs, Shri Amitabh Kant, CEO, Niti Aayog, Shri Alok Srivastava, Secretary, MoLJ, Shri Shantanu Chowdary, Director NRSC and Hon'ble judges and Registrars of High Courts. Nyaya Vikas version-2, with improved functionalities for monitoring and mobile application with iOS compatibility, has also been developed and released.

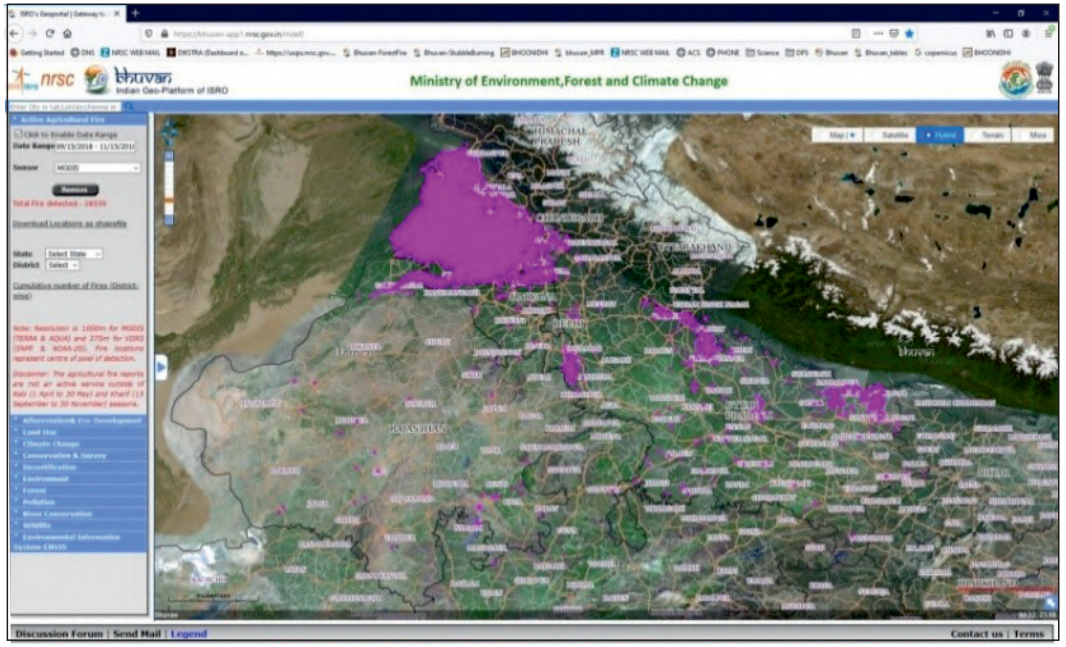
Nyaya Vikas system enables the officials of the of Justice and Ministry of Law and Justice to monitor the physical and financial progress of ongoing projects geospatially in a very simple and easy-to-use manner, bringing transparency and efficiency to the system. Nyaya Vikas has become an excellent example of G-Governance in the country.



Paddy Stubble Burnt Area Progression over Punjab & Haryana 2023.

Monitoring Paddy Stubble Burning over Punjab & Haryana 41

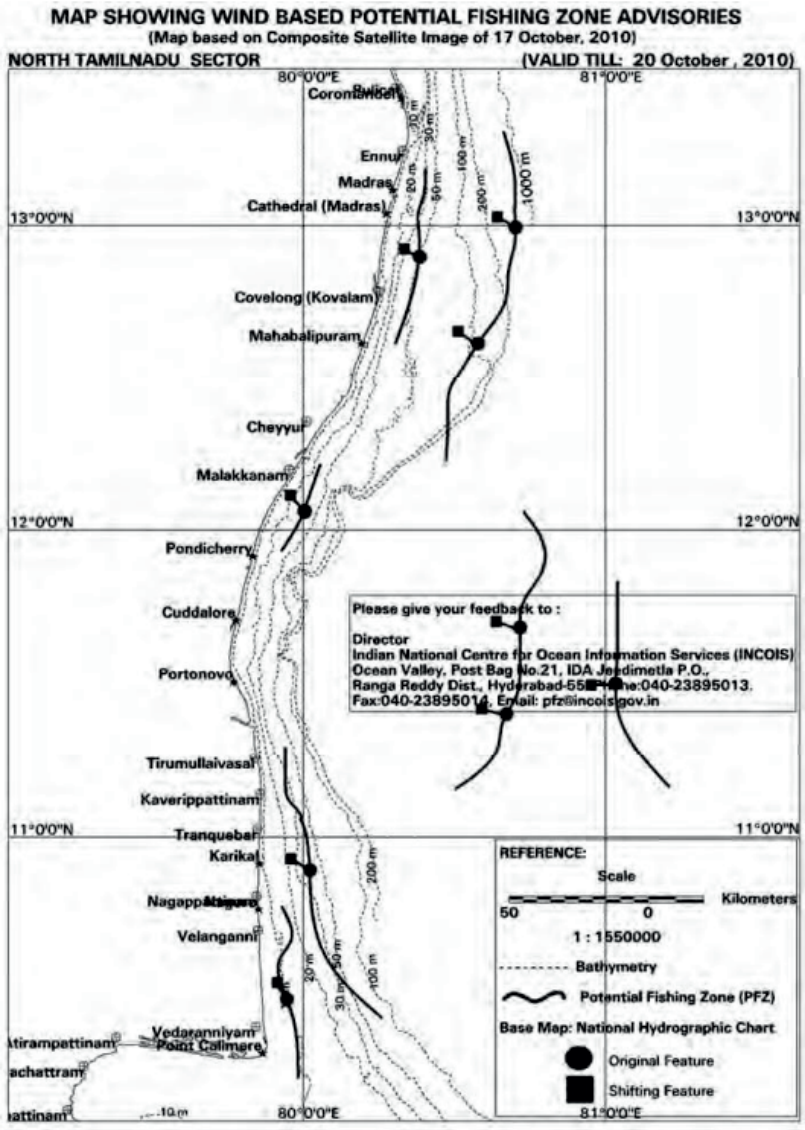
The post-harvest burning of kharif crop residues (paddy in particular) in northern Indian states of Punjab & Haryana is a serious challenge – both in terms of the pollution being caused as well as the resulting photochemical smog in the neighbouring areas. Various measures by government for crop residue management have been addressing the issue but to a very limited extent. Need of the hour is the availability of a spatial information of stubble burnt area and its dynamics for monitoring, assessing and planning preventive measures. Satellite technology can provide a unique synoptic view of the time progressive farm fire locations/counts and post-fire burnt area assessment in near-real time.



The project was taken up with specific objectives of (i) Near real time satellite based daily detection of active fire locations within agricultural area, (ii) Assessment of the burnt area using MIRBI (Mid Infrared Burn Index) index, which utilizes a combination of two SWIR bands. Continuous monitoring and assessment of the actual paddy stubble burnt areas and its weekly progression (depending on cloud free data) was carried out during 1st October to 31st November, during the years (2022 and 2023).

Total kharif rice area of Punjab and Haryana was estimated to be 11.95 and 29.19 lakh ha respectively in the year 2023 and approximately 62% and 27% of total rice area were found to be burnt in Punjab & Haryana, respectively. The project resulted in the generation of near real time information on In-season monitoring of progressive biomass burning, Year to year variation in stubble burning towards assessing the impact of policy intervention and also supported the national Level inventory of emission

Period(2023)	Burnt Area in('000 ha)	
	Punjab	Haryana
October 1st	10.62	7.21
October 6th	45.16	23.66
October 11th	86.91	60.68
October 16th	122.18	67.21
October 21st	20.4.5	129.43
October 26th	286.39	172.66
October 31st	412.78	212.9
November 15th	1414.54	294.96
November 20th	1694.02	308.52

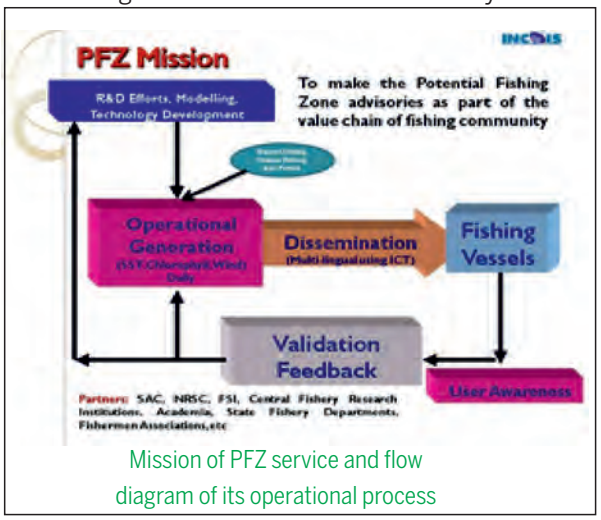


Map Showing Wind Based Potential Fishing Zone Advisories

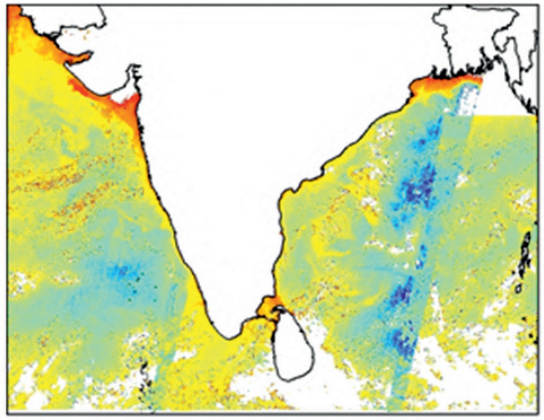
Potential Fishing Zone Advisories 42

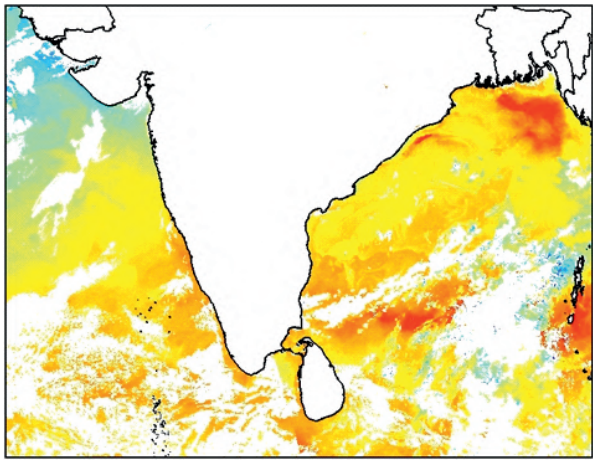
India's 7517 km long coastline is supporting about 35% of its population. Fishing is one of the major economic activities, and India is the third largest fish producer. However, locating and catching fish is becoming a challenging task as fish stocks dwindle and are scattered, thus increasing the search time, cost, and effort. It has become possible with the advent of remote sensing satellites, like the IRS-OceanSat series satellite for Ocean color, NOAA-AVHRR series of satellites for sea surface temperature, etc. The remote sensing data from various national and international satellites assists in identifying important oceanographic features that have proved to be prospective sites for fish congregation and migration. These oceanographic features are mapped in real-time and are used to identify a Potential Fishing Zone (PFZ).

Forecasting of PFZ is considered economically and environmentally significant in ensuring a profitable base of the economy and planning to sustain the existing fishing pool. Utilizing satellite remote sensing data, the Indian National Centre for Ocean Information Services (INCOIS) in Hyderabad (under the Ministry of Earth Sciences) is presently successfully disseminating the PFZ advisory in various local languages daily through modern Information and Communication Technologies (ICT, including mobile services/ mobile applications, e-mail, web-portal, etc.). These PFZ advisories are provided daily, which contain information on the location (latitude, longitude), the depth at PFZ location, and the distance and direction from easily identifiable prominent sites on the coast like fishing landing center, and lighthouses. These advisories, valid for 2-4 days, have helped to reduce search time by up to 70%, resulting in a significant increase in catch per unit effort. This operational service is rendered throughout the year except during the Marine Fishing ban imposed by the Government of India and adverse sea state conditions such as Cyclones, High Waves, Tsunamis, etc.

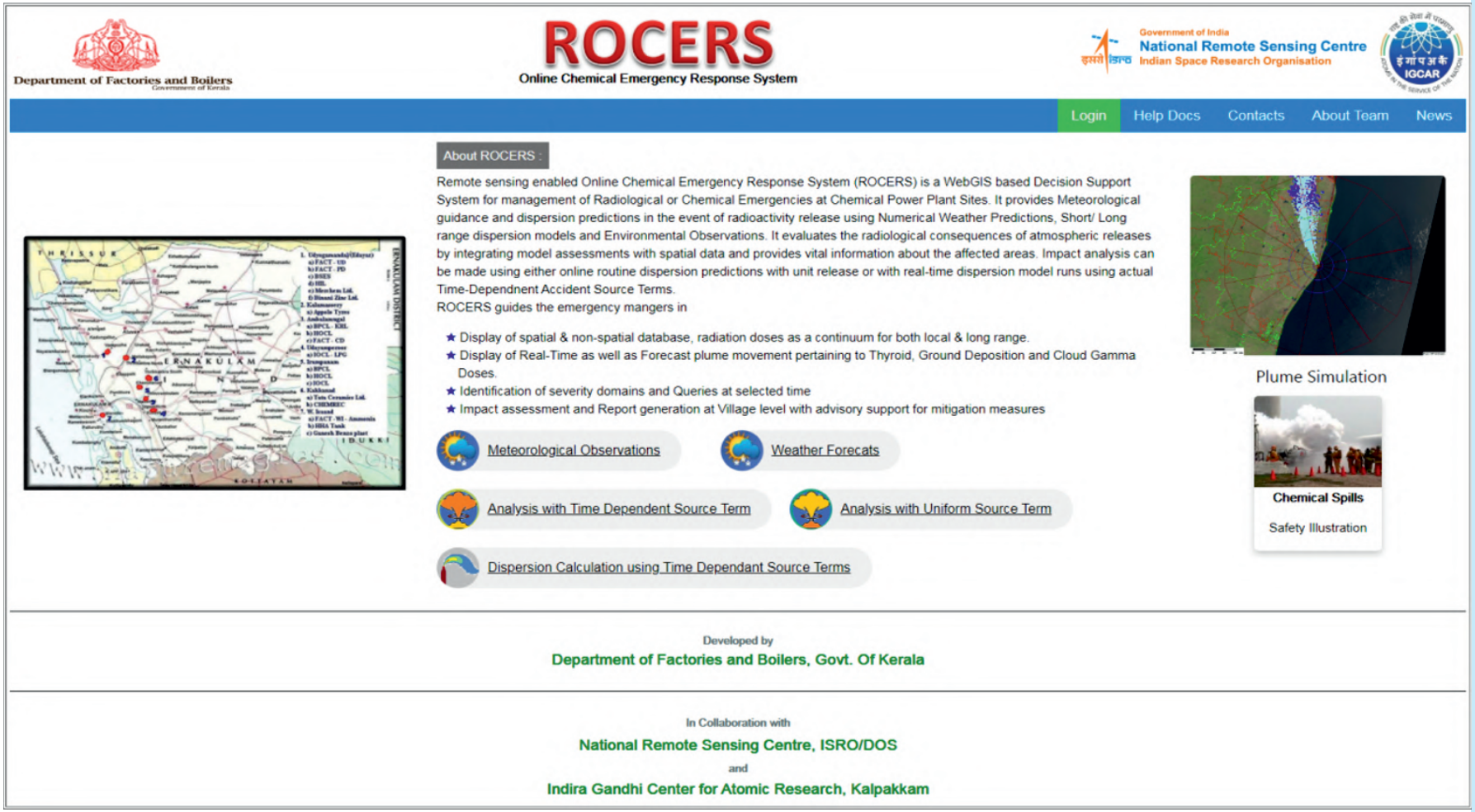


Mission of PFZ service and flow diagram of its operational process


Chlorophyll Image retrieved from Oceansat-2 Satellite Data


Sea Surface Temperature (SST) Image retrieved from AVHRR

The feedback obtained from researchers working on various extensive validation projects and the feedback collected from fishermen indicates that the catch in the PFZ area is substantially higher than that in the other regions. PFZ advisories were found to be more beneficial to artisanal, motorized, and small mechanized sector fishermen engaged in pelagic fishing activities such as ring seining, gill netting, etc., thereby reducing the searching time, which in turn results in the saving of valuable fuel oil and also human effort.



Industrial Clusters in Ernakulam District - Chemical Refineries

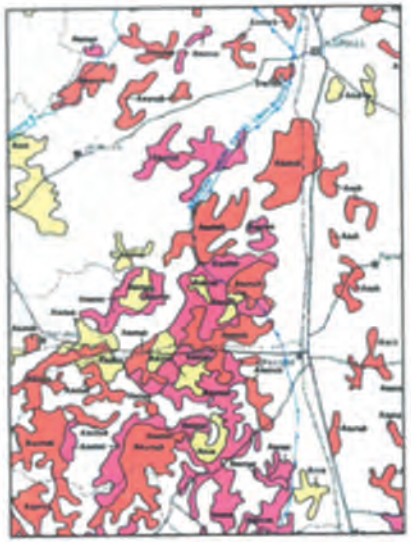
Remote Sensing Enabled Chemical Emergency Response System (ROCERS)

India's industrial development has increased accident vulnerability viz. Bhopal gas accident (1982), LPG Tanker Accident at Chala in Kannur (2012). The Environment Protection Act mandates technology to reduce response time to chemical releases and facilitate the use of ICT, space-based support, WebGIS, and disaster management techniques for real-time emergency preparedness and response. The state of Kerala has about 40 Major Accident Hazardous (MAH) installations distributed in nine of its districts (Kannur, Kozikode, Malappuram, Palakkad, Ernakulam, Kottayam, Alappuzha, Kollam, Thiruvananthapuram) and they have prepared an off-site emergency plan and a chemical emergency response center (CHEMREC) functioning at Kakkanad with the strong commitment and support of the government of Kerala. Among these, Ernakulam district is densely populated with a harbour and distribution of a large number of chemical industries (19 MAH units). This calls for effective measures of Disaster Management with the latest tools and techniques.

The Dept of Factories and Boileries, Govt of Kerala, IGCAR, and NRSC have collaborated on the "ROCERS" project to provide a near real-time Decision Support System for Chemical Emergencies using state-of-the-art Geospatial Technologies, Weather & Dispersion models for monitoring chemical spreads, and integration of live sensors for various chemicals. This pilot project in Ernakulam, Kerala, is planned to scale up to other areas of importance and is tailored to assist emergency management personnel responsible for handling real-time emergency events. It is cost-effective and based on Open Source technologies.

Industrial Clusters in Ernakulam District - Chemical Refineries

Real-time data on Meteorological parameters (2 m, 10 m above ground level) and Chemical sensors specific to each species & industry are installed around each identified industrial site. The data is logged in real time in the central server through GPRS/ RF networking. An automated procedure for accident detection using real-time sensor data is established. The software consists of several spatial query tools in a GIS environment to highlight areas of interest in terms of areas of chemical plume incidence and their concentration levels, population affected, and areas needing protective actions using emergency guidelines. ROCERS is made operational by installing it in the newly created data centre at CHEMREC, Kochi, under the Department of Factories and Boilers, State Govt of Kerala. Multiple industrial clusters are now operationally providing release data through real-time sensors and are undergoing expansion to other major clusters around the state. ROCERS is released to the public at https://rocers.fabkerala.gov.in.



Salt-affected soils map for part of Haryana

Salt-affected soils map of Andhra Pradesh

	Physiography	Nature of salt-affected soils		Degree of salinity / sodicity		Extent of area in mapping unit	
A	Alluvial plain	Saline	s	Slight	1	< 1/3	
B	Aeofluvial / Aeoline / Arid plains	Sodic	n	Moderate	2	1/3 – 2/3	
C	Deltaic plains	Saline -sodic	sn	Strong	3	> 2/3	
D	Coastal plains						
E	Lacustrine plains						
F	Penninsular plains						
G	Mud flats / Mangrove swamps						
H	Any other						
	Normal soils						

Legend for Salt-affected soils map of part of AP&Haryana

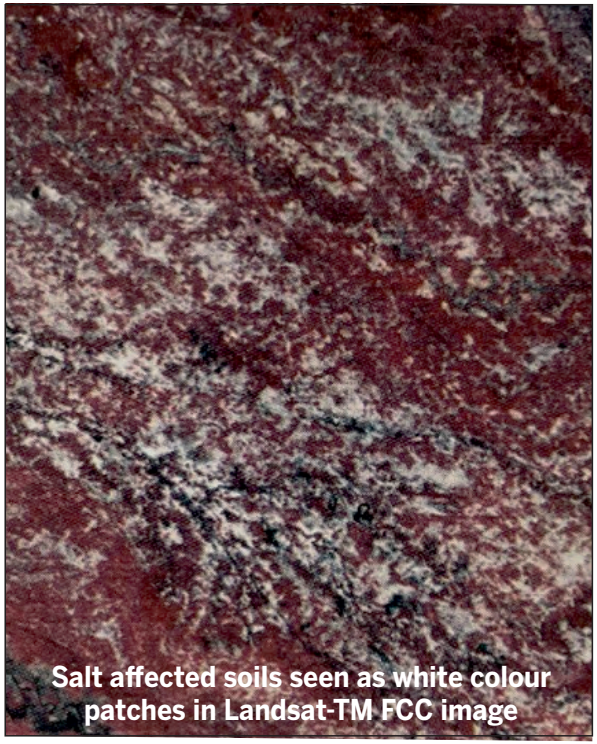
Salt Affected Soil Mapping for Parts of Harayana & Andhra Pradesh

Salt Affected Soil Mapping (1:2,50,000) 44

The ever increasing pressure of population on land for food, fuel and fodder calls for optimal utilization of available land and water resources. It is implied that the good agricultural land be managed scientifically for improving their productivity on sustainable basis. Efforts need to be made not only to restore the productivity of degraded lands like salt affected soils, eroded lands, etc., but also needs to be protected them from further deterioration. Salt affected soils cover an estimated seven million ha land of our country. For planning the strategies for their reclamation, precise information on nature, extent, magnitude and spatial distribution is a pre-requisite.

Calcareous saline soils in Muzaffarpur, Bihar

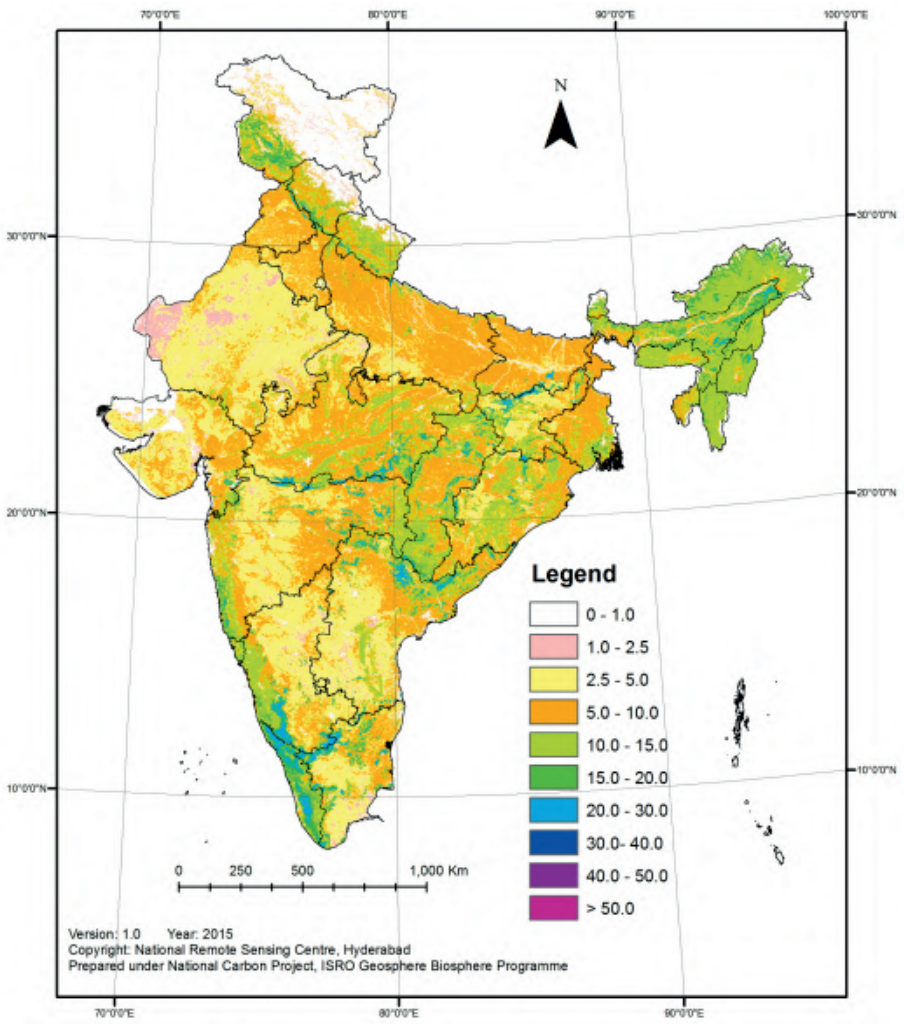
Realizing the potential of space borne multispectral measurements for detection and delineation of salt-affected soils, a project titled "Mapping salt-affected soils of India on 1:250000 scale" was taken up under Remote Sensing Applications Mission for Agricultural Applications (RSAMAA) at the instance of the Department of Agriculture and Co-operation, Ministry of Agriculture, Government of India in collaboration with All India Soil and Land Use Survey, National Bureau of Soil Survey and Land Use Planning, the concerned Central and State Government organisations, with a specific objective to map salt-affected soils of entire country using Landsat-TM data acquired during 1986-87 period. In this project, maps were generated highlighting various categories of salt- affected soils namely saline, saline sodic and sodic at 1: 250,000 scale for the entire country along with district/ state wise area statistics of salt- affected soils. The methodology consisted of development of nation-wide mapping legend, satellite data interpretation, ground truth collection, analysis of soil samples, post field interpretation, reconciliation and area estimation.



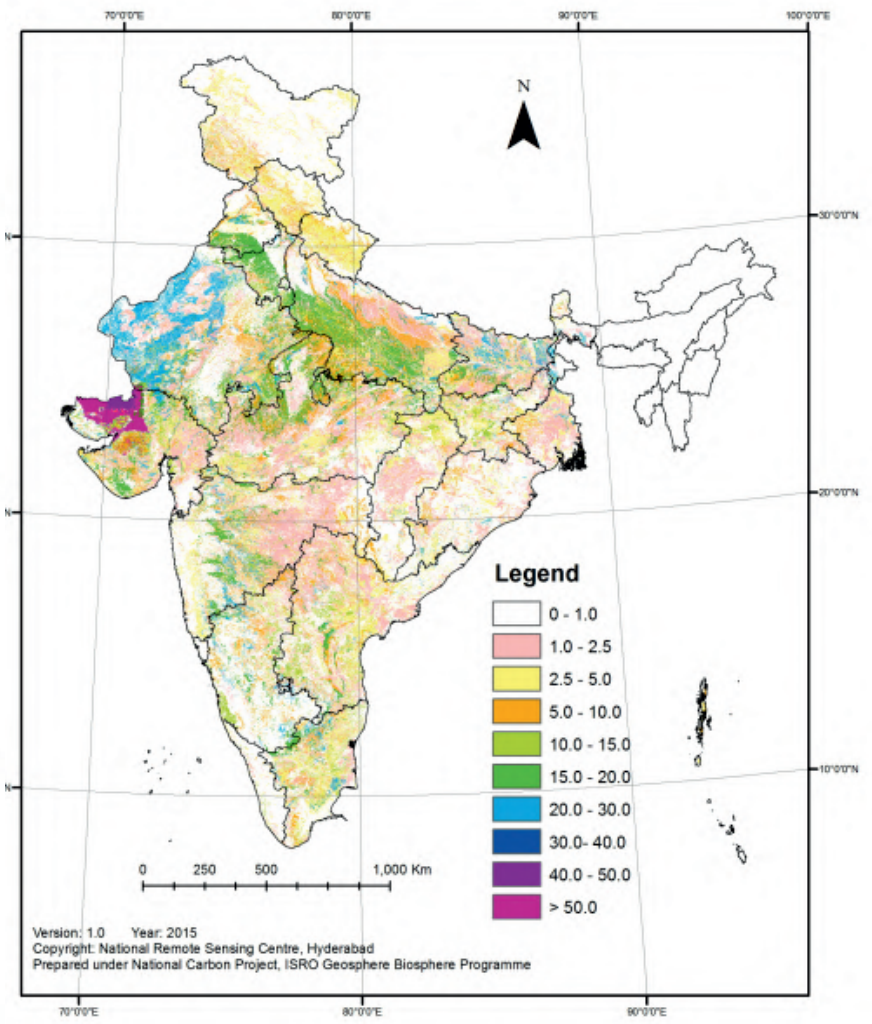
Salt affected soils seen as white colour patches in Landsat-TM FCC image

Poor growth of wheat crop growth due to sodicity in Etah district, UP

This project had resulted in the generation of reliable information on salt-affected soils of our country with respect to their nature, magnitude, extent and spatial distribution. This information was extremely useful not only in planning reclamative measures for salt-affected soils but also in chalking out strategies for devising preventive measures. It also helped in prioritizing the areas to be taken up for further investigation at larger scale.



Soil Organic Carbon Density Map



Soil Inorganic Carbon Density Map

Soil Carbon Stock Estimation

Soil Carbon Stock Estimation 45

Soil carbon is linked to three dimensions of food security, the first one is increasing the food availability, the second being restoration of productivity in degraded soils and the third most important is increasing the resilience of food production systems whereby the ability to withstand the adverse effects of human induced climate change. Soil organic (SOC) and inorganic carbon (SIC) constitute the largest terrestrial carbon pool, storing more than thrice the quantity of carbon in vegetation or double the quantity of carbon in atmosphere. Though the global estimates gave an idea of pool size, the precise local estimates and the factors affecting the soil carbon dynamics are very important from management perspective. Being the largest contributor to global carbon pool, even a minor change in soil carbon stocks could result in significant changes in atmospheric CO2 concentration. Hence, both SIC and SOC pools play an important role in understanding the future soil carbon dynamics and its management.

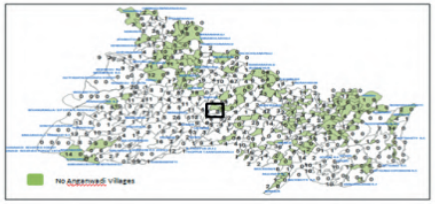
In the recent past the greenhouse effect has created a great concern that has led to several studies on the qualities, kinds, distribution and behavior of SOC. Fluxes between terrestrial soil organic carbon and the atmosphere are important and can be positive(sequestration) or negative (emission of CO2). The main factors acting on organic matter evolution are the vegetation (residue input, plant composition), climatic factors (temperature/moisture conditions) and soil properties (texture, clay content and mineralogy, acidity). Soil respiration is the second largest terrestrial carbon flux and is sensitive to climate, vegetation type, and soil properties. Spatial pattern and differences in soil C fractions within a climatic or soil zone or land use/management can provide important information about the mechanisms of C sequestration. Thus, assessment of spatial distribution of Soil C stocks with regard to soil type, land use, the climate is critical in understanding the soil C dynamics, mean residence time (MRT), gaseous flux, and agronomic productivity. A study was carried out as a part of ISRO Geosphere –Biosphere Programme (IGBP) in NRSC with an objective to establish spatially explicit soil organic and inorganic carbon density maps as well as to estimate the size of these pools using a remote sensing and data mining based spatial modelling approach.

In this study, first spatially explicit mapping of SOC and SIC at 250 m resolution and an estimate of their pool size in India was undertaken using a large number of remote sensing derived data layers and data mining approach. The SOC and SIC densities up to 100 cm depth or paralithic contact (whichever is shallower) were estimated for 1198 soil samples located across India using a stratified random sampling that integrated land use, soil, topography and agro-ecological regions. Using Random forests (RF) based spatial prediction procedure with climatic, land cover, rock type, soil type, multi-year NDVI, irrigation status as independent input variables, models for predicting carbon density at 250 m spatial resolution were developed. For modelling with RF algorithm, about 898 soil profile observations (75% observations) were used, while the rest of 300 (25% of total observations) were used for validation. It was observed that the data distribution of sample points don't have significant influence on RF model predictions. The relationship between observed and predicted values was characterized by Mean Squared Deviation (MSD) and Root Mean Squared Error (RMSE) parameters. The SOC, SIC and total soil carbon pool size of India has been estimated at 22.72 0.93 Pg,12.83 1.35 Pg and 35.55 1.87 Pg, respectively, which are comparable to previous studies while providing first spatially explicit 250m map of their distribution. The spatial distribution indicates that majority of the carbon stock resides in the northern part of India. The soil carbon stock of eastern India has contribution from organic carbon, while the western portion has contribution mainly from inorganic carbon.

Utility of outputs

- Understanding contribution of Indian soils to CO2 emissions.
- Environmental studies
- Soil carbon Sequestration
- Climate Change Impact study
- Land Degradation Neutrality
- Soil fertility

Identification of Gap Areas for Anganwadi Centres
Case Study using SISDP Phase I Database



Aim - To identify gap areas for Anganwadi Centres in Dharmapuri District, Tamil Nadu

Data Used:

S.N	Data	Source
1	Socioeconomic	Census 2011
2	Asset DB	Bhuvan Panchayat Portal (EPRIS)
3	Admin Boundaries	SRSAC

As per Integrated Child Development Services Scheme (ICDS) norms **[14]** minimal one Anganwadi centre is essential in a village with population 150

Findings & Recommendation

- Total Villages : 486
- Villages having Anganwadi : 235
- Villages lacking Anganwadi : 251
- Eligible villages for Anganwadi : 230
- No. of Anganwadi present in district : 537
- Total Anganwadi required/district: 1601

Assessment of Adequacy & Spatial Allocation of Public Utilities
Case Study using SISDP Phase I Database

Aim - To identify the suitable places for adequate number of banks essential for the residents of Gauhargani Block, Raisen, Madhya Pradesh

Data Used

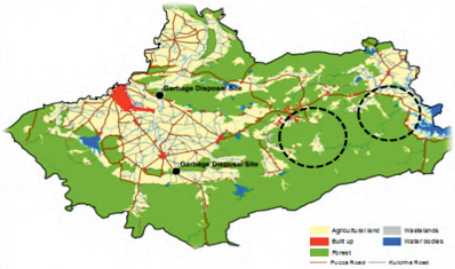
S.N	Data	Source
1	LULC	SISDP Phase I
2	Infrastructure	
3	Socioeconomic	Census 2011
4	Asset DB	Bhuvan Panchayat Portal (EPRIS)
5	Admin Boundaries	SRSAC

As per RBI norms [12], minimal one Banking facility is essential in a village with population of ~5000

Findings & Recommendation

- 6 Banks exist in Gauhargani Block, Raisen, Madhya Pradesh as per geo tagged asset database.
- No banks are found in Panchayats with ~5000 population in Eastern Region of the Block.
- Distance between available Banks and the Settlements without Banks is ~ 10-25 Kms
- New banks can be proposed In these Settlements.

Identification of Suitable Site for Garbage Disposal
Case Study using SISDP Phase I Database



Aim - To identify suitable site for Garbage Disposal in Gauhargani Block, Raisen, Madhya Pradesh

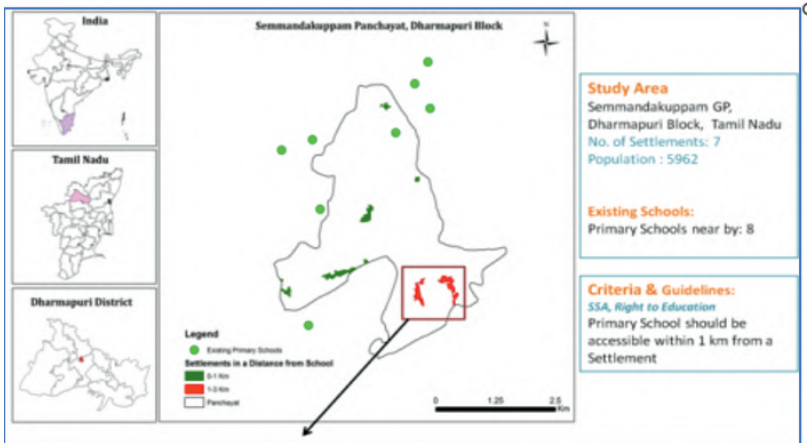
Data Used:

S.N	Data	Source
1	LULC	SISDP Phase I
2	Infrastructure	
3	Drainage	
4	Slope	
5	Socioeconomic	Census 2011
6	Asset DB	Bhuvan Panchayat Portal (EPRIS)
7	Admin Boundaries	SRSAC

As per the guidelines of RD & PR,TN [13], minimal one GDS to setup in a Village Panchayat with population of 10000

Findings & Recommendation

- Based on the Population of the Settlements shown in dotted circle and Distance to the existing GDS from these settlements it is found that the existing GDS are inadequate.
- Two New GDS can be proposed in these settlements, shown in dotted circle.



Study Area
Semmandakuppam GP,
Dharmapuri Block, Tamil Nadu
No. of Settlements: 7
Population : 5962

Existing Schools:
Primary Schools near by: 8

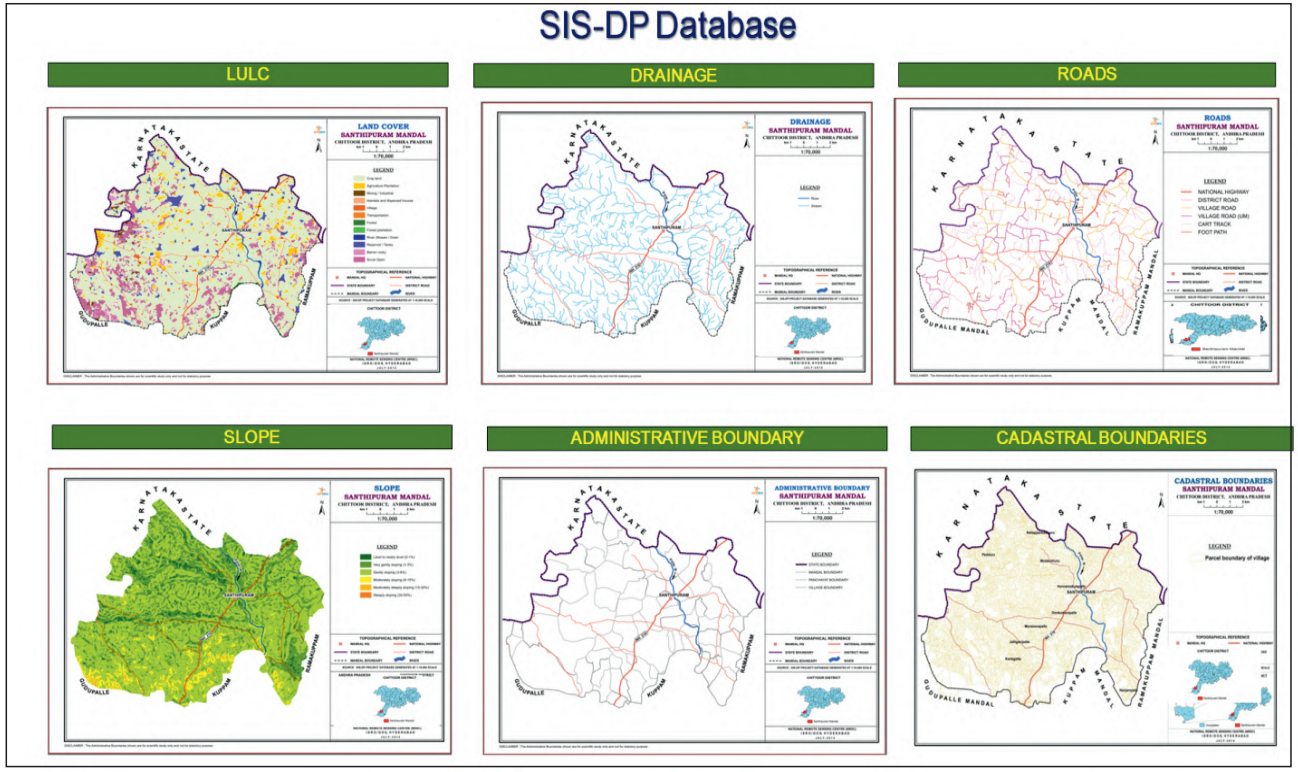
Criteria & Guidelines:
SSA, Right to Education
Primary School should be accessible within 1 km from a Settlement

Findings:
• Two Settlements are identified in the Panchayat where children have to travel more than 1 Km to reach nearest Primary school

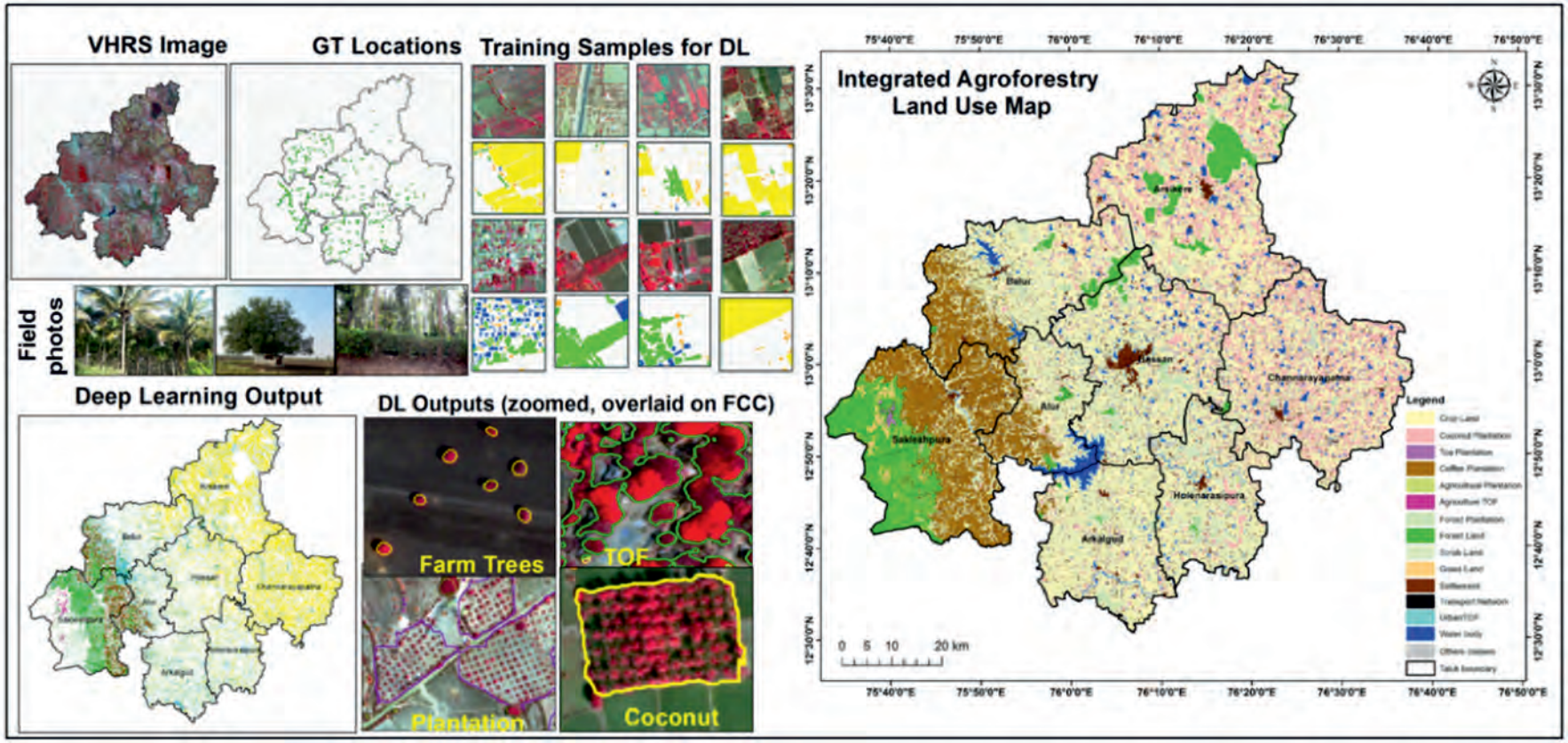
Space Based Information Support for Decentralized Planning

Space Based Information Support for Decentralized Planning (SISDP)

46



Developmental planning is essential for a country's progress, and spatial inputs are critical components for planning, including assets mapping and activity planning for effective governance and development at the grassroots level. In order to strengthen the capacity of institutions for efficient planning at the Gram Panchayat level, the SISDP project was launched as part of ISRO's NNRMS program. It was executed in two phases i.e. from 2009 to 2017 and from 2019 to 2023, with the collaboration of partner institutions from different states. SISDP project was conceptualized and implemented with a specific objective of empowering Panchayati Raj Institutions and stakeholders by providing space-based information to enhance decentralized planning and governance. A user-friendly Geoportal called Bhuvan Panchayat has been developed to visualize high-resolution satellite data with a resolution of 2.5 meters, thematic databases (such as LULC, Drainage, Rail, Road, Slope at 1:10000 scale), and model-based planning products at the Gram Panchayat (GP) level for the entire India. These services assist Gram Panchayats and other stakeholders in planning and decision-making. Currently, GPSDP data is available for 34 GPs, and EPRIS data covers approximately 10% of the country. Effective gap analysis and planning at the block or Panchayat level are evaluated using key indices such as (i) NRI (Natural Resources Index), (ii) SCI (Socio-Economic Index), (iii) HFI (Health Facilities Index), and (iv) EFI (Education Facilities Index), enabling the identification of priority and gap areas for development at the Gram Panchayat level. The SISDP project strengthens the segment of Natural Resources Information and collaborates with the NIC, Ministry of Panchayati Raj, and partner institutions to provide necessary data, tools, and analytics. These resources are made available through the Bhuvan Panchayat platform (https://Bhuvan-panchayat3.nrsc.gov.in).). This platform helped state-level institutions with necessary resources and guidance to create valuable datasets that aid in decentralized planning. The SISDP project has empowered Panchayati Raj Institutions (PRIs) by providing large-scale, space-based data on natural resources and infrastructure. Significantly benefited the country by implementing decentralized planning at the grassroots level through providing direct support to the Ministry of Panchayati Raj, the Ministry of Jal Shakti, and other line departments.



Integrated Agroforestry Land Use Map

Spatial Inventory of Agroforestry Resources Using Geospatial Technology and Artificial Intelligence (AI)

47

Agroforestry, the integration of trees into agricultural landscapes, is vital for enhancing environmental sustainability, economic resilience, and social welfare. Despite India's pioneering National Agroforestry Policy (NAP), which targets 33% tree cover by 2030, the policy's implementation faces challenges due to the lack of accurate and reliable agroforestry resource data. It is a unique study initiated at the behest of National Rainfed Area Authority (NRAA), funded by Food and Agriculture Organization, United Nations (New Delhi) under Technical Cooperation Programme covering 06 diverse study areas spread across different agro-ecological regions of India. Major objective of study was to generate integrated agroforestry land use system maps for 6 pilot study districts and its spatial

extent. The study areas selected for the study are Dharwad & Hassan (Karnataka), Sitapur (UP), Yamunanagar (Haryana), Bilara (Jodhpur, Rajasthan) and Jorhat (Assam).

Utilizing advanced deep learning techniques, particularly the U-Net convolutional neural network

(CNN) model with a ResNet 34 backbone, the project analyzes very high-resolution satellite images (0.6-0.7 meters) to classify various agroforestry components. The analysis incorporates 12,628 training samples, capturing the variability of agroforestry systems within

the study areas. The outputs are then integrated with harmonized land use/land cover (LULC) maps at a

1:10,000 scale, producing detailed agroforestry land use maps with 9-15 classes depending on the region's diversity.

The project's outcomes provide crucial data on agroforestry systems' spatial distribution and extent, supporting their prioritization, suitability analysis for expansion, and assessment of carbon sequestration potential. This work significantly enhances the operational capabilities of key Indian ministries, particularly the Ministry of Agriculture & Farmers' Welfare for agroforestry resources and the Ministry of Commerce & Industry for commercial plantations. It also has strong potential for scaling up to create a national-level database on Trees Outside Forests (TOFs), thereby supporting rural livelihoods by increasing income and ensuring food security.

Group Photographs of Different Training Programmes at Outreach Facility

Training, Education and Outreach Activities 48

The ISRO initiative had enabled availability of EO data over Indian region and opened avenues for utilization in various resources applications. The Training facility at the then NRSA, Hyderabad was established in 1985 to promote and popularize remote sensing data utilization by user community in India. Earlier data in the form of hard copy imageries from Landsat-TM and SPOT satellites were used in training programmes. But soon after the launch of India's first Remote Sensing Satellite (IRS-1A), IRS satellite data products were used for various applications. In earlier days, the Training Division had various optical instruments for hands-on sessions but later on these instruments were replaced with powerful workstations to switch over to digital era. Training Division conducted / being conducting a variety of courses – Regular courses of longer duration,

short term courses like special / thematic / appraisal / customised courses and internal courses like Structure Training Programmes as well as capacity building courses as a part of national projects carried out by

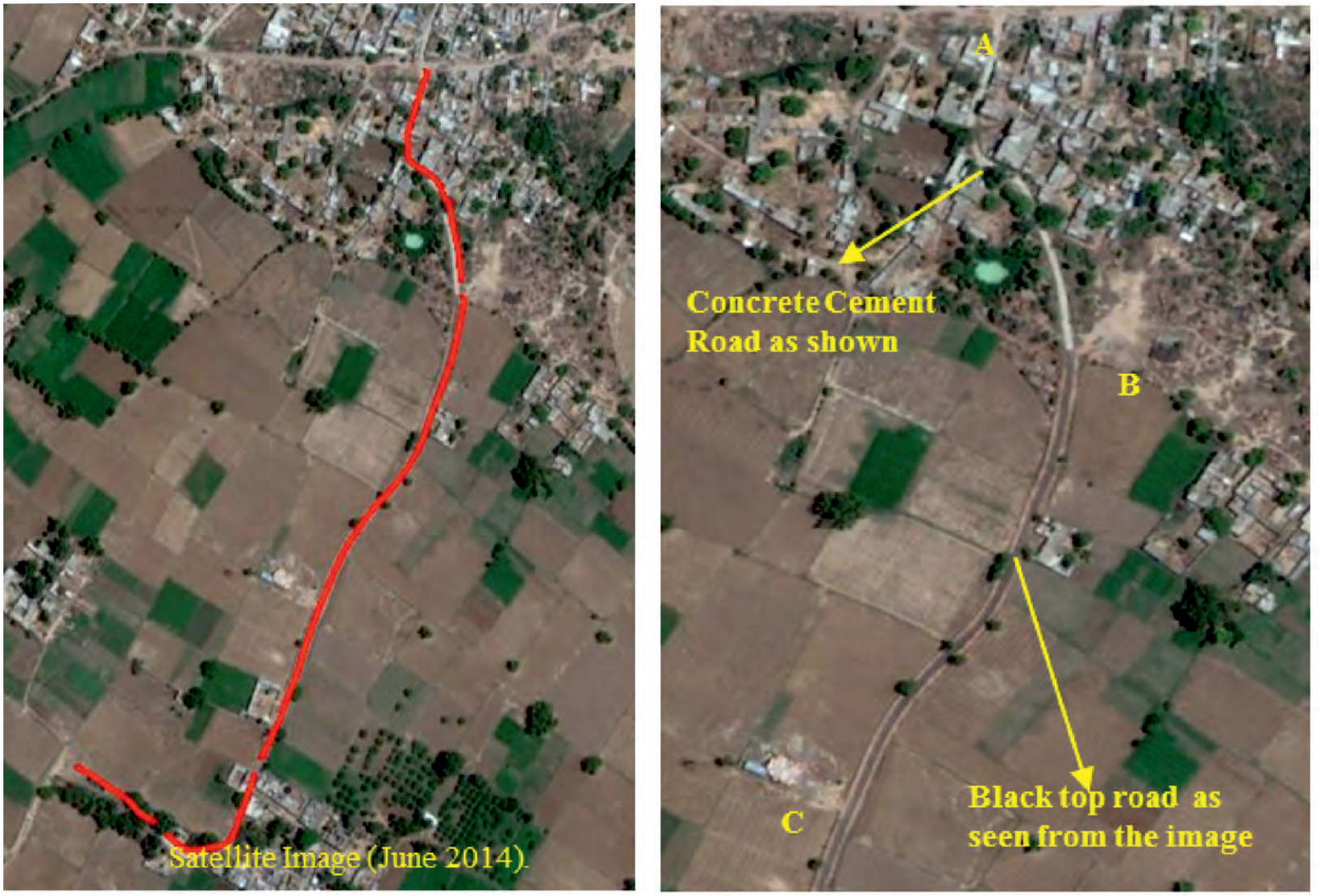
NRSA/NRSC. NRSC started an exclusive new Training facility at its Jeedimetla Campus, Hyderabad from September 2022. Since its inception in 1985, the Training Division conducted a total of 443 courses of different category and trained a total of approximately 10,500 participants. The short term courses for international participants also commences since 2023 in association with CSSTE AP.

NRSC's Outreach facility is established at Jeedimetla

campus, Hyderabad NRSC's in 2016 to promote widespread adoption of space and remote sensing technology and applications in the country.

The Outreach Facility is a centralised facility for disseminating knowledge, expertise, and resources to Academia, NGOs, Public, Industries, etc. It encompasses all the concerned activities of Training, Outreach, Outsourcing, Exhibition, Information Dissemination, Web Services and Incubation. As on September 2024 more than 50, 000 visitors have got benefitted from outreach facility. Further, NRSC is also equipped with Space on Wheels Bus to cater to the students in rural areas . More than 7.5 lakh students from Government schools and Public were educated through this service.

The support to student projects started in early nineties and full fledged facility has been operationalised in January 2018. More than 2500 students, pursuing various graduate/post graduate courses in Science & Technology as well as Research Scholars and faculty are enrolled and mentored from 44 academic institutions, spread across the country. Students are encouraged to publish and present their innovative, research ideas, technology demonstrations in various forums.



Use of Geo-informatics in Rural Road Projects under Pradhan Mantri Gram Sadak Yojana

Use of Geo-informatics in Rural Road Projects Under Pradhan Mantri Gram Sadak Yojana

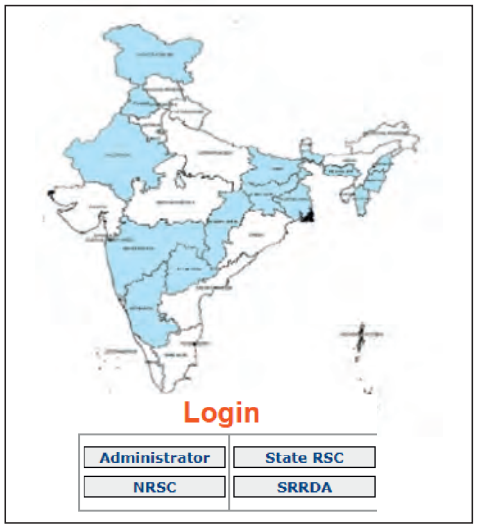
The "Use of Geo-informatics in Rural Road Projects under Pradhan Mantri Gram Sadak Yojana (PMGSY)" is

a strategic initiative by the Government of India to enhance connectivity to unconnected habitations by developing all-weather roads. This effort is part of a broader poverty reduction strategy, focusing on the

sustainable management of rural road networks to improve accessibility and socio-economic conditions in rural areas. PMGSY employs advanced geospatial technologies to generate a comprehensive rural road

geospatial database. By extracting road features from high-resolution satellite imagery, the National Remote Sensing Centre (NRSC) has created detailed road maps for 14 out of the 29 states in India. This database

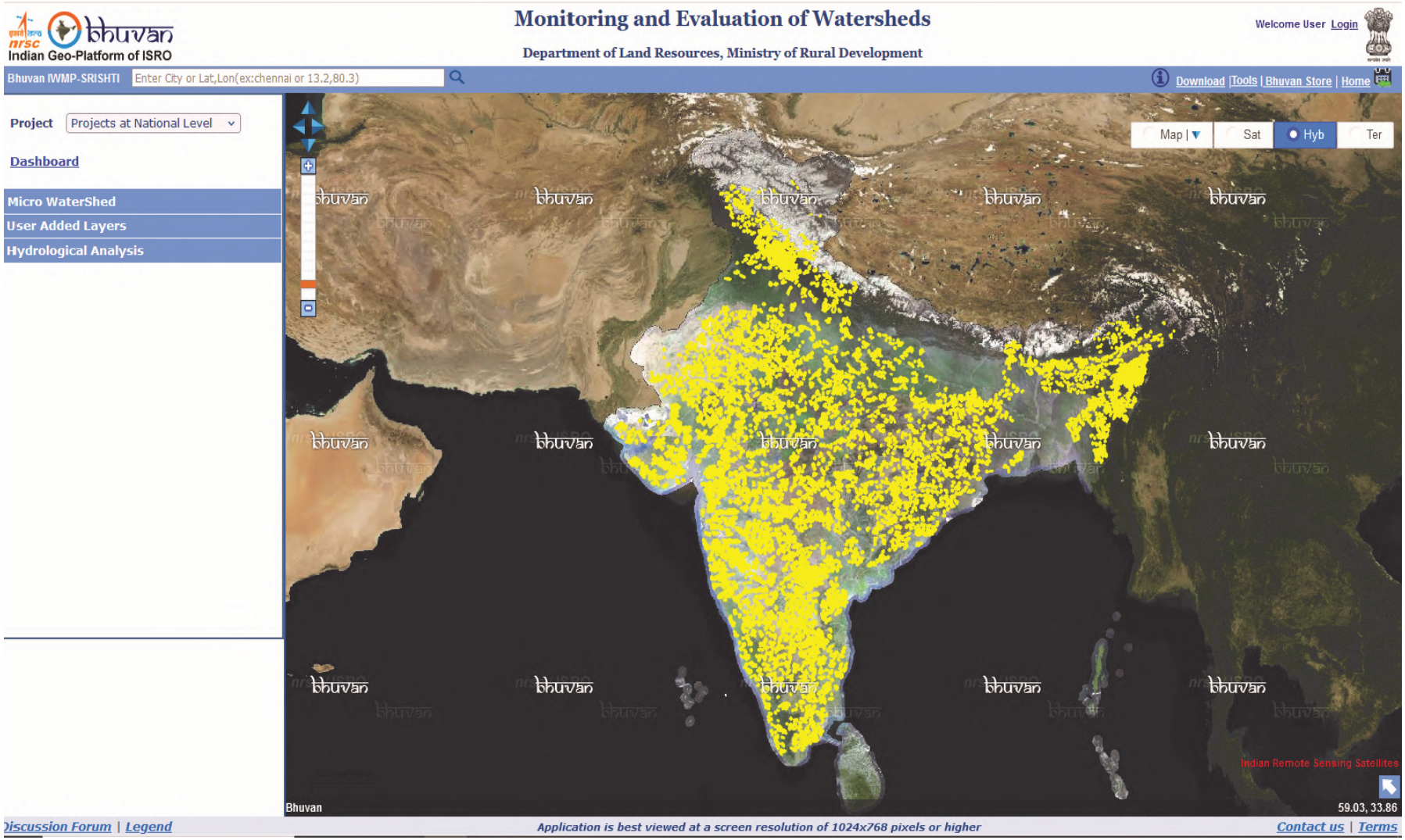
supports the monitoring and evaluation of road construction and connectivity efforts, ensuring that remote and underserved areas receive the necessary infrastructure. Under the PMGSY scheme, rural regions with a population of 500 or more, as well as hill states, desert areas, tribal regions, and other backward areas with a population of 250 or more, are targeted for road development. The program not only focuses on constructing new roads but also upgrading existing



ones to connect isolated habitations with nearby all-weather roads. This connectivity facilitates access to essential services such as education, healthcare, and market facilities.

The geospatial database developed by NRSC plays a crucial role in this process, enabling the Ministry of Rural Development and other decision-makers to plan and implement road projects effectively, towards providing connectivity to unconnected Habitations as part of a poverty reduction strategy, improving the village transport system

The improved connectivity enhances rural livelihoods by easing access to government welfare programs, boosting communication between farms and markets, and attracting private investments, thereby fostering long-term development and economic growth



Use of Geospatial Technologies in Monitoring of the WDC-PMKSY (IWMP) Projects

Use of Geospatial Technologies in Monitoring of the WDC-PMKSY (IWMP) Projects

50

The "Use of Geospatial Technologies in Monitoring of the WDC-PMKSY (IWMP) Projects" represents an e-Governance initiative by the Government of India, led by the National Remote Sensing Centre (NRSC), ISRO, in collaboration with the Department of Land Resources (DoLR). This project utilizes advanced geospatial technologies to enhance the Monitoring and Evaluation (M&E) of the Watershed Development Component of the Pradhan Mantri Krishi Sinchayee Yojana (WDC-PMKSY), formerly known as the Integrated Watershed Management Programme (IWMP).

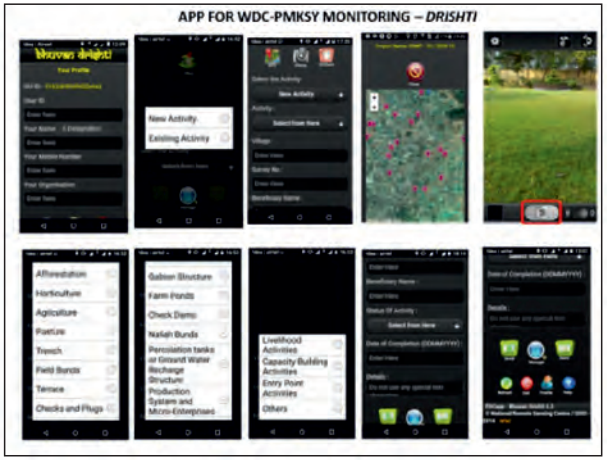
Central to this initiative is integrating geospatial technology with Information and Communication Technology (ICT) tools, primarily through the Bhuvan Geo-Web portal, specifically the SRISHTI component. SRISHTI provides a comprehensive landscape-level view of 6,600 watershed projects across India, enabling

macro to micro-level analysis from national to individual project scales.

Complementing this is the DRISHTI mobile application, an Android-based tool that allows users to capture real-time data on watershed interventions, including geo-tagged photos, locations, and user inputs. This data is seamlessly integrated into the Bhuvan SRISHTI portal, creating a robust, single-window information system. Since its inception, the project has seen the geo-tagging of 16.50 lakh interventions and the analysis of approximately 24,000 satellite images documenting

land-use changes resulting from watershed development activities. These changes are highlighted on the SRISHTI portal, providing stakeholders with a clear understanding of the program's impact at various levels.

Impacts at project level in terms of detecting the presence of asset using high resolution remote sensing data coupled with desirable land cover changes observed every year are served as reference for various functionaries. This information enables proper



understanding of the changes implemented through state initiative. About 16.50 lakh project interventions are geo-tagged and can be visualized across the country. The initiative has brought in more transparency, accountability and visibility to the WDC-PMKSY program and empowered citizens to monitor the implementation and progress of watershed projects in their regions.

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