ISRO'S ROLE IN RURAL DEVELOPMENT

Rural development is vital for India, which has 65% rural population. To support this large population, space technology can be used as an aid in agriculture water, disaster management, health, education, and infrastructure, driving sustainability through ISRO-led initiatives and satellite applications. Geospatial solutions support rural development by enabling real-time natural resource databases, analytics, and customized water and land conservation plans through systematic planning and implementation in the rural sector.

Both central and state governments have launched several programmes to improve rural infrastructure and promote agricultural growth. Key initiatives include Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), Accelerated Irrigation Benefit Programme (AIBP), Integrated Watershed Management Programme (IWMP) and On Farm Water Management (OFWM), National Health Resource Repository (NHRR) Project. Advanced tools like remote sensing and GIS for better execution are used in these initiatives

Agriculture and Food Security

- Agriculture is central to India's economy, contributing 18-20% of GDP and supporting food security, employment, and exports. India leads in rice, wheat, pulses, and achieved food self-sufficiency through the Green Revolution.
- **Remote sensing satellites provide crop data** to estimate yields, analyse productivity, plan food storage, ensure food security, and guide stakeholders on export potential for surplus agricultural products across regions and seasons.
- The satellite imagery also provides crucial **information about the crops affected by pest** and its propagation to contain the extent of damage. It also provides the demand of fertilisers and pesticides based on the crops and timely distribution for effective application and control.
- The **land records mapping and asset tagging** is very important for the farmers for regularising the loans and insurance claims in case of any calamity.
- The transactions will be authenticated and secured using the satellite images to assess the extent of damage and substantiate the claims.
- Satellite data is much useful in **assessing the soil moisture** and super-impose the soil fertility information for assessing the water demand and suggesting a productive crop, that yields a balanced revenue for the farmers.
- Indian farmers, mostly in low-income groups, benefit from schemes like PMFBY and Soil Health Card. Satellite data aids crop damage assessment, insurance claims, and soil fertility analysis, enhancing support and productivity.

Horticulture

- Horticulture, including fruits, vegetables, and flowers, boosts revenue. Hyperspectral satellite data monitors plant health and stress, aiding seasonal crop yield, distribution, and sustainable supply chain planning for the agricultural economy.

Aquaculture

- Satellite imagery enhances aquaculture by enabling efficient management and sustainability. It monitors water parameters like chlorophyll, turbidity, and temperature for site selection, identifies optimal locations using geographic data, and tracks surface water temperatures, ensuring fish and shrimp health.
- Satellites detect sediment levels to assess water clarity, monitor chlorophyll for plankton abundance, and track algal blooms, mitigating fish health risks. High-resolution images aid spatial planning, infrastructure mapping, and continuous monitoring of water quality, vegetation, and temperature to prevent disease outbreaks in aquaculture.

Digital Agriculture Mission

- The Digital Agriculture Mission is designed as an umbrella scheme to support various digital agriculture initiatives. These include creating **Digital Public Infrastructure (DPI)**, implementing the **Digital General**

Crop Estimation Survey (DGCES), and supporting IT initiatives by the Central Government, State Governments, and Academic and Research Institutions.

- The scheme is built on two foundational pillars:
  - Agri Stack
  - Krishi Decision Support System.
- Additionally, the mission includes 'Soil Profile Mapping' and aims to enable farmer-centric digital services to provide timely and reliable information for the agriculture sector.
- The Krishi Decision Support System (DSS) will integrate remote sensing data on crops, soil, weather, and water resources into a comprehensive geospatial system.

Water Resource Management

Satellite technology and data play a transformative role in water resource management by providing accurate, timely, and large-scale information about water availability, distribution, and quality. These tools aid in decision-making, planning, and sustainable management of water resources.

- **Mapping and Monitoring Water Bodies:** Satellites monitor water body size, storage, and seasonal variations, assess clarity, sediment transport, and groundwater patterns. DEMs delineate watersheds, aiding recharge structure design and tracking climate, urbanization, and hydrological changes effectively.
- **Irrigation Management:** Satellites provide data on vegetation health and evapotranspiration, optimizing irrigation schedules. Monitoring irrigated areas ensures efficient water allocation for agriculture. Satellites provide critical data on soil moisture levels, aiding drought forecasting.
- **The Integrated Watershed Management Programme (IWMP)** utilizes geospatial data and Web GIS solutions for transparent governance. High-resolution satellite images and smartphone field data monitor soil conservation measures, farm ponds, and check dams, tracking changes before and after project implementation. 8200 micro watershed projects to be monitored for five years. Utilisation smart phone application-based geotagging of activities is being handled by State agencies. Visualization of assets brought in high level transparency that is acknowledged widely.

Space technology facilitates mapping of water bodies, groundwater recharge zones, and watershed areas. This data is crucial for irrigation planning and drought mitigation.

- **Government Initiative:** Under the **Jal Shakti Abhiyan**, satellite data is used to monitor water conservation projects and rejuvenation of water bodies in rural areas.

Disaster Management and Preparedness

- **Flood Prediction and Early Warning**: Real-time satellite data identifies areas at risk by monitoring rainfall, river discharge, and water levels.
- **Damage Assessment:** Post-flood imagery maps inundated areas to evaluate the extent of damage and aid in recovery efforts.
- **National Agricultural Drought Assessment and Management System (NADAMS):** This initiative combines satellite data with meteorological data to assess drought conditions, providing timely information for farmers and policymakers to manage agricultural risk.
- **Early Warning Systems:** Satellites like INSAT provide timely weather updates and disaster alerts, reducing vulnerability to cyclones, floods, and droughts.
- **Post-Disaster Assessment:** High- resolution imagery aids in damage assessment and planning for relief operations.
- ISRO's Flood Early Warning System (FEWS) has been integrated into rural flood-prone areas, enhancing disaster preparedness.

Rural Connectivity, Employment, and Infrastructure

- ISRO established Village Resource Centres (VRCs) with NGOs and government departments, offering services like tele-healthcare, education, agriculture advisories, and skill development. Rs 18 crore funded 473 VRCs.

- The Ministry of Rural Development is utilizing the Geographic Information System (GIS) for improvement in planning and implementation of projects. GIS planning is being used for Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) and Pradhan Mantri Gram Sadak Yojana (PMGSY).

Healthcare - Telemedicine

- ISRO's satellite-based telemedicine services bridge the healthcare gap in rural areas, enabling specialist consultations remotely.
- Telemedicine initiative has been broadly divided into the following areas:
  (a) Providing Telemedicine Technology & Connectivity between remote/rural hospitals and Super Speciality Hospital for Teleconsultation & Treatment and Training of doctors & paramedics.
  (b) Providing the Technology & Connectivity for Continuing Medical Education (CME) between Medical Colleges & Post Graduate Medical Institutions/Hospitals.
  (c) Providing Technology & Connectivity for Mobile Telemedicine units for rural health camps especially in the areas of ophthalmology and community health.
  (d) Providing Technology and Connectivity for Disaster Management Support and Relief.
- ISRO's Telemedicine pilot project was started in the year 2001 with the aim of introducing the Telemedicine facility to the grassroots level population as a part of 'proof of concept technology demonstration' programme.
- **eSanjeevani:** The National Telemedicine Service of MoHFW, Government of India has evolved into the world's largest documented telemedicine implementation in the primary healthcare.
- State-space agencies and international organizations like UNOOSA and UN-SPIDER have promoted space technologies for global health, enhancing disaster management and emergency response over several decades.

Tele-Education

- ISRO's Tele- education programme provides satellite-based distance education services for bridging rural-urban divide and improve quality in education sector across the country.
- Initiatives like EDUSAT provide distance learning opportunities for rural students, improving access to quality education.
- **Objectives:**
  - Supplementing curriculum-based teaching
  - E-learning through satellites
  - Access to quality resource persons and education
  - Taking education to every nook and corner of the country

Land and Property Management

- **Digital India Land Records Modernization Program (DILRMP):** Integrates satellite imagery for accurate mapping of land parcels, ensuring better land governance.
- **The Bhoomi initiative:** The Bhoomi initiative uses satellite imagery along with Ground Control Points (GCPs) to maintain accurate land records and streamline land transfer processes, thus promoting transparency in land dealings.
- **SVAMITVA Scheme:** Launched in 2020, this programme uses drones and geospatial technology to map rural land parcels, providing ownership records and resolving property disputes.

Bhuvan Panchayat

- The Bhuvan Panchayat portal supports the National Natural Resources Management System (NNRMS) by providing geospatial data, including 1:10k thematic products and high-resolution satellite imagery. The SISDP project has completed two phases, sharing datasets through the portal.
- Bhuvan Panchayat provides comprehensive information and tools to download data as shapefiles or access via OGC WMS/WMTS services. It offers pan-India, 1:10k scale thematic data for g-governance, R&D, and geospatial applications at no cost.

Bharat Net

- Bharat Net, a major rural telecom project, aims to provide broadband access across 2.5 lakh Gram Panchayats, enabling e-health, e-education, and e-governance services.
- By October 2024, 2,14,283 GPs will be service-ready.
- **Objectives:** Bharat Net aims to provide high-speed broadband to over 2.5 lakh Gram Panchayats (GPs) across India using optical fibre, enabling access to e-governance, e-health, e-education, and other digital services. Its last-mile connectivity extends broadband access to households, schools, hospitals, and other public institutions.
- **Implementation:** The project has progressed through phases:
  - **Phase I** (completed in 2017): covered over 1.25 lakh Gram Panchayats.
  - **Phase II:** GPs are to be connected through multiple implementing models like State-led Model, Private Sector Model and CPSU Model, along with Last Mile connectivity in GPs through Wi-Fi or any other suitable broadband technology.

SPACE TECHNOLOGIES: TRANSFORMING RURAL INDIA

Dr. Vikram Sarabhai, the father of Indian space, envisioned using space sciences for societal benefits. ISRO strives to fulfil this vision, revolutionizing agriculture, and rural development through space technologies for crop monitoring, resource management, disaster response, and agro-advisories.

India's first remote sensing space application enabled early coconut wilt detection in Kerala. Since the 1960s, advancements in thematic satellites like Resource Sat, Cartosat, and INSAT have revolutionized agriculture, enhanced rural development while made India a global leader in earth observation data.

Remote Sensing: A Tool for all Seasons

- Remote sensing in agriculture began with **IRS-1A in 1988**, initiating Crop Acreage and Production Estimation (CAPE) for pre-harvest forecasts. National projects now operate under National Natural Resource Management System (NNRMS), led by ISRO centers in Hyderabad and Ahmedabad for application development and implementation.
- The **Mahalanobis National Crop Forecast Centre (MNCFC),** established by the Ministry of Agriculture, collaborates with ISRO on projects like **FASAL**, which integrates remote sensing, weather models, and field data to forecast acreage and production of nine key crops nationwide.
- **Project CHAMAN** focuses on assessing and forecasting horticultural crop areas and production for improved management. It integrates remote sensing, GIS, and field surveys to map zones, estimate yields, and identify pests and diseases collaboratively.
- **NADAMS (National Agricultural Drought Assessment and Monitoring System)** is a very critical project for Indian agriculture as it helps prevent losses due to abnormal weather conditions. Developed by National Remote Sensing Centre, Hyderabad, it provides near-real time information regarding the prevalence, persistence, and severity levels of the agricultural drought at state, district, and sub-district levels.
  - Project covers 17 drought-prone states, and uses rainfall datasets, district-wise soil moisture models and remote sensing derived vegetation indices for issue of drought warnings.
  - After careful computation, analysis and study, drought warnings are issued from the datasets of June, July, and August months in the form of 'normal', 'alert' and 'watch'.
  - Whereas, drought declaration is done after incorporation of the datasets during September and October months in the form of 'mild', 'moderate' and 'severe' category.
- Large number of beneficiary farmers under **Pradhan Mantri Fasal Bima Yojana (PMFBY**) are getting quick and hassle-free claims due to application of RS data in the process.
  - PMFBY envisages to provide the insurance cover and to meet the financial needs of the farmers when the crops get destroyed by various natural calamities and incidence of pests and diseases.
  - As per revised guidelines and protocols, the RS data from satellites and UAV (Unmanned Aerial Vehicles or Drones) are now used for area and yield estimations, loss assessment, risk zoning etc.

- Remote Assessment (RA) approaches expedite claim settlements and reduce disputes. Using AI, crop yield estimation integrates crop calendars, weather data, and remote sensing. Advanced technologies like hyperspectral sensing, IoT, and intelligent systems enhance remote sensing for planning and resource management.

Soil, Water and Advisories

- Space-based Earth observation provides accurate land cover data for weather prediction, resource availability, and planning. Using satellites like **Resourcesat**, sensors map land use, cover, and wastelands nationwide at various scales, aiding comprehensive resource management.
- Satellite datasets support land resource planning at village and taluka levels, identifying crop types and cycles, and aiding rural management.
- **IRS, Landsat, and SPOT satellites** assist in land degradation studies, erosion detection, and soil moisture analysis for crop root zones, enhancing agricultural and allied activities.
- ISRO leverages remote sensing and Earth observation satellites to enhance water resource management. Integrating GIS, it supports surface water harvesting, irrigation, watershed management, and sustainable usage.
- Satellites like **IRS** and **Resourcesat** enable real-time monitoring, hydrological modelling, infrastructure planning, and decision support systems for effective resource utilization. Satellite data covers India's entire territory, including transboundary river catchments, aiding in managing floods and droughts.
- During monsoons, continuous satellite monitoring informs resource deployment and relief operations. Additionally, satellite data supports flood hazard mapping, the India Water Resources Information System, and monitoring natural disasters like cyclones and landslides.
- Weather based crop advisories enable farmers to take informed decisions on various crop management practices leading to higher yields and increased income.
- The **India Meteorological Department (IMD),** through **Gramin Krishi Mausam Sewa (GKMS),** provides agrometeorological advisory services. IMD uses INSAT satellite data for weather forecasting, supporting agricultural planning and technical inputs via geostationary meteorological satellites.
- **Agromet advisories** are issued twice weekly for over 700 districts and 3,100 blocks. IMD shares forecasts through various media, including print, electronic, social media, and mobile apps, ensuring broad dissemination to farmers.

Transforming Rural Lives

- Rural development is essential for national growth and poverty reduction. Government schemes like MGNREGA utilize space technologies, including Remote Sensing and GIS, to effectively implement and manage resources.
- These tools collect, store, and analyse assets such as watersheds and irrigation channels, enhancing transparency and decision-making. **GeoMGNREGA** integrates geospatial data for rural assets using mobile geotagging and a **GIS-enabled Bhuvan portal**. Developed by NRSC, it enhances planning, monitoring, and transparency in MGNREGA.
- A collaboration with IIT Delhi under the **BhuPRAHARI** project aims to modernize asset management and optimize resource allocation for rural development. The SVAMITVA scheme uses drone surveys and GIS mapping to issue property cards to rural landowners, ensuring transparent land administration.
- High-resolution drone mapping has covered over 3 lakh villages, distributing 1.35 lakh property cards. ISRO's Geoportals provide satellite imagery for planning and rural development across India**. Bhuvan Panchayat (4.0)** supports Gram Panchayat governance with geospatial data, aiding decentralized planning and national development.
- The **National Database for Emergency Management (5.0)** provides disaster risk reduction inputs. Space technologies enhance land records via ULPIN, and support watershed and road mapping for major schemes like PMKSY and PMGSY. Space-based technologies are transforming rural India, driving economic growth, and addressing local issues like land use, agriculture, and water harvesting.

- Government initiatives focus on capacity building at the Panchayat level. Inspired by Dr. Vikram Sarabhai's vision, India's space community continues to innovate for rural development and improved quality of life.

GEOSPATIAL DATA FOR RURAL RESOURCE MANAGEMENT

ISRO's geoportals, like Bhuvan Panchayat and NDEM, enhance rural development and disaster management by providing satellite imagery and geospatial data. They support science-based planning, emergency response, transparency, and sustainable governance, complementing Digital India for holistic national development.

Space-based Geoportal for Rural Development Bhuvan Panchayat

- Recently, an important geoportal developed by ISRO - **Bhuvan Panchayat (version 4.0)** has been launched in the country. The aim of these initiatives is to improve governance and decision-making by using space-based information in the field of geospatial database monitoring and rural development.
- The Bhuvan Panchayat geoportal by ISRO empowers Gram Panchayats with geospatial data and satellite images for planning, resource management, and monitoring land use, forests, water, and development, enabling science-based implementation of local development initiatives.
- ISRO's initiative uses satellite data to help Panchayats manage resources, plan water and land use, address socio-economic issues, improve health-education, and create and monitor development plans.
- Bhuvan Panchayat Geoportal 4.0 enhances rural development by integrating space-based data for governance and research at Gram Panchayats. **Developed by NRSC**, it offers web map services at 1:10,000 scale under SIS-DP.
- The Bhuvan Panchayat platform uses web technologies for seamless access, real-time data, and analytics, promoting transparency, accountability, and resource efficiency. It supports holistic rural planning in agriculture, water, infrastructure, and social services for sustainable development.
- Gram Panchayats can accurately assess the status of their areas through Bhuvan Panchayat and make better use of local resources. This makes their plans more accurate and effective. Geospatial data from Bhuvan Panchayat can be used to manage water, land, and other natural resources, ensuring balanced and sustainable use of resources.
- Bhuvan Panchayat (version 4.0) is playing a vital role in the development of rural India as an effective geospatial platform. It empowers local administration, ensures better management of resources, and makes citizens partners in governance. Also, it promotes transparency and accountability in monitoring developmental activities, thereby facilitating holistic and sustainable development in rural areas.

National Database for Emergency Management (NDEM) for Disaster Management

- The recently launched **National Database for Emergency Management (NDEM version 5.0)** is a landmark initiative developed by ISRO with the objective of **providing geospatial data and decision support tools for emergency management**. Version 5.0 of NDEM provides enhanced features to further strengthen India's disaster preparedness and response mechanism.
- NDEM, a national geoportal, integrates multi-level databases with Decision Support System tools for disaster forecasting, aiding assessment, decision-making, and Disaster Risk Reduction. It supports all disaster phases and serves as a recovery data node.
- NDEM covers all disaster phases, minimizing loss through real-time data and forecast analysis for timely decisions. It ensures resource efficiency, agency coordination, and community education, empowering preparedness and reducing disaster impacts.
- NDEM version 5.0 is an important step to strengthen and make the disaster management process in India more effective. It promotes holistic disaster management, coordination, and community resilience, as well as helps in making timely decisions, which can reduce the impact of disasters. This version of NDEM further strengthens India's disaster preparedness and response mechanism, making India more capable to deal with the impact of natural disasters.

Space-based Information Support for Decentralized Planning at Panchayat Level Project (SIS-DP)

ISRO, with NRSC and State Remote Sensing Centres, launched the SIS-DP Project to empower Panchayati Raj Institutions. It enhances local planning using high-resolution satellite imagery, GIS platforms, and geospatial tools, ensuring accurate, data-driven governance and decision-making.

The key objectives of the SIS-DP project are to facilitate decentralized planning, promote transparency and improve governance at the Panchayat level. The work associated with this project is explained in the following points:

- **Preparation of satellite imagery maps for decentralized planning:** The project is preparing high-resolution orthorectified satellite maps for the entire country. These maps serve as the fundamentals for planning at the Panchayat level.
- **Preparation of thematic and base layers:** The project is working on topics such as land use/land cover, drainage, settlements, transport network, slopes and angles. Additionally, agricultural land records are being vectorized and geo-referenced to provide more detailed data.
- **Creation of Centralized Databank:** A centralized databank is being created which will include satellite imagery maps, thematic layers, slope maps, and other non-spatial data (such as census data, climate data, and village level data). All these data are being made available on a GIS platform so that they are easily accessible for planning.
- **Development of Web Portal for Panchayati Raj Institutions and stakeholders:** The project will develop a comprehensive web portal which will be accessible to Panchayati Raj Institutions and other stakeholders. This portal will become a tool for decentralized planning, governance, citizen outreach, and data dissemination.
- **Capacity Building for stakeholders:** An important component of the project is the capacity building of Panchayat members and stakeholders to enable them to effectively use space-based information in decentralized planning and governance.
- **The SIS-DP project is being implemented in two phases**.
    - **In the first phase,** a national mosaic (a large collection of remote sensing data, which are stitched together to produce a detailed and accurate map) of high-resolution ortho products and digital elevation models obtained from Cartosat-1 and Resourcesat satellites was prepared. Thematic layers like land use, drainage, and road networks, along with supporting data like maps and meteorological details, were added. Detailed satellite-based maps aid planning and development in the project's first phase.
    - **In the second phase,** the scope of the project will be expanded to update geospatial data with the latest high-resolution satellite data and integrate geospatial data analysis to create ready-to-use geospatial products and services. These services will be provided through a geoportal at the Gram Panchayat level - Bhuvan Panchayat, which will act as a central hub for access and management of geospatial data.
- The SIS-DP project empowers Panchayati Raj Institutions by enhancing local governance and planning through satellite data and geospatial tools, improving decision-making quality and fostering sustainable development at the Panchayat level.

Digital India Land Records Modernization Programme (DILRMP)

- The DILRMP programme, run by the Ministry of Rural Development and **Department of Land Resources**, is supported by **ISRO** through its geospatial technical expertise, satellite imaging, and remote sensing.
- ISRO plays a vital role in modernizing land records under the DILRMP, enhancing transparency, accessibility, and accuracy of land data, benefiting government departments and citizens alike.
- DILRMP aims to create a transparent, integrated land information system, improving real-time data, resource use, and planning while reducing disputes and fraud. Extended to 2025-26, it adds Aadhaar integration and revenue court digitization.

- ISRO provides high-resolution satellite imagery and geospatial data, which are useful for mapping land records. These images are used to update and digitize cadastral maps, which are essential for accurate land record management. These imageries help create a digital map of land boundaries.
- The programme geo-references traditional cadastral maps using satellite positioning, aligning them with geographic coordinates. Integrated with Bhuvan Geoportal, it digitizes land records, enhances accessibility, and tracks changes in land use or boundaries.
- ISRO's satellite technology is used to identify plots earmarked for single ownership or single use, so that land record management includes accurate geographic information. This process prevents problems like land disputes and encroachments.

95% of Land Records of Rural India Now Digitized

- ISRO's satellite technology digitizes land records, providing high-resolution images for accurate boundaries, resolving disputes, and improving surveys, making land management more effective, equitable, and reliable.
- Approximately 95% of rural India's land records are digitized under DILRMP, revolutionizing ownership management and empowering millions through enhanced transparency, efficiency, and accountability in land governance.
- Land record digitization is transforming rural India by addressing complex paperwork, ownership disputes, and fraud. Union Minister Shivraj Singh Chouhan highlighted its role in simplifying management, reducing court burdens, and expediting dispute resolution.
- Online land ownership data provides rural households, especially disadvantaged communities, with security and easier transactions. Geographic mapping ensures accurate surveys, aiding disaster response and fair compensation during land acquisition.
- The programme has so far completed digitisation of 95% of land records, digitization of 68.02% of cadastral maps, and integration of 87% of sub-registrar offices with land records, creating a more systematic, transparent, and accessible land governance system.
- Clear, accessible land records empower rural communities to claim land rights, fostering economic growth, stability, and equity. This milestone strengthens governance and enables inclusive participation in national progress.

Digitization of Land Records: Improving Transparency, Better Management and Development

ISRO's satellite technology and remote sensing data play a vital role in digitization of land records, ensuring accurate survey of land, geo-referencing, and transparency, and helping resolve land disputes. The Government of India has initiated the process of digitization of land records in 6.26 lakh villages, which is an important milestone in the efforts to make land ownership secure, transparent, and accessible. This digitization aims to improve the land management system and solve various land related problems.

Importance of Digitization of Land Records:

- **Land Disputes:** More than 60% of litigation in India is related to land. Digitization can reduce these disputes.
- **Encroachment and Benami Properties:** Digitization of land records will help in controlling encroachment and benami properties.
- **Inefficiency of manual processes:** Digitization of land records will eliminate manual processes, thereby increasing efficiency.
- **Precise survey and planning:** Transparency is being brought in land records through geospatial mapping, which will ensure equitable access to vulnerable sections.
- **Boosting agricultural credit:** Clear ownership of land will ease the supply of agricultural credit, giving farmers access to capital.
- **Other benefits:** Better targeted delivery of agricultural subsidies, timely compensation for land acquisition or disasters, and increased GDP.

ISRO Satellites Involved in Digitization of Land Records and Land Survey Work

Cartosat satellites: Cartosat-1, Cartosat-2, and its subsequent versions, such as Cartosat-3, provide high-resolution images, which are essential for determining the exact boundaries and use of land. These satellites are helpful in generating geospatial data, which accurately document the actual shape and boundaries of land. Cartosat satellites are also used in geo-referencing and thematic mapping.

ResourceSat Satellites: Resourcesat-1, Resourcesat-2, and Resourcesat-2A satellites provide important information about land use, environment, water resources, and agricultural activities. Data obtained from these satellites is used to obtain information such as land use change, agricultural production, and drainage, which helps in digitizing land records and making land management accurate.

- The data obtained through these satellites provide geospatial data required for valuation, determination of land use and rights, and development plans. With the help of these satellites, land records can be digitized in a more accurate, transparent, and effective manner.
- The 73rd and 74th Amendments grant Panchayati Raj Institutions more autonomy. This initiative enhances efficiency, enabling better decision-making through spatial data, satellite technology, and transparent governance.
- **Navigation Signal System (NavIC),** which is an Indian satellite-based navigation system, will also be used to provide location-based services to Gram Panchayats. Through this, information about the correct location and necessary data for local development plans will be available in an accurate and timely manner.
- The **Bhuvan-Panchayat Geoportal** empowers state governments and panchayats to implement government schemes effectively. Reaching 2.56 lakh Gram Panchayats, it uses satellite technology to streamline rural development, monitoring, and resource management under Digital India.
- ISRO's geospatial platforms, like Bhuvan Panchayat and **NDEM**, revolutionize rural resource management, planning, and disaster response. These initiatives promote transparency, sustainability, and empowerment, improving land record digitization, governance, and disaster management for India's rural development.

SPACE TECHNOLOGIES: BRIDGING THE RURAL-URBAN GAP

Space technologies, led by ISRO, transformed India by advancing communication, agriculture, disaster management, education, and environmental monitoring. Satellites like GSAT and RISAT improve connectivity, enable telemedicine, e-learning, and support farmers with data-driven insights.

Space Technology is Committed to the Service of Rural Population

- Space technologies enhance disaster management with early warnings for cyclones, floods, and earthquakes. NavIC supports navigation in transport and defense.
- Missions like Chandrayaan showcase India's innovative, cost-effective space exploration and foster pride and global collaboration.
- By leveraging space technologies, India continues to address pressing socio-economic challenges, empowering its citizens, and contributing to sustainable development.
- The nation's commitment to harnessing space for the betterment of humanity underscores its vision of "space technology in the service of the common man."

Applications of Space Technologies in Agricultural Sector

Space technology has become a powerful tool for transforming Indian agriculture, a sector vital to the country's economy and food security. With its vast expanse of cultivable land and diverse agro- climatic zones, India leverages satellite technology and geospatial data to modernize farming practices, enhance productivity, and mitigate risks.

Crop Monitoring and Yield Estimation

Remote sensing satellites from ISRO monitor crop health, detecting pests, nutrient deficiencies, and water stress. Satellite data aids yield estimation, improving procurement, storage, and distribution planning for better agricultural management.

Satellite-derived Data Helps in Estimating Crop Yields

Soil Health and Land Use Planning

Satellite imagery is instrumental in mapping soil types, moisture content, and fertility levels. This data is crucial for precision agriculture, enabling farmers to use inputs like fertilizers and water judiciously. Additionally, geospatial information supports land use planning, identifying areas suitable for specific crops and improving overall land productivity.

Irrigation Management

Space technology plays a pivotal role in optimizing water resources, especially in water- scarce regions. Satellites help track groundwater levels and surface water availability. The data aids in designing efficient irrigation systems and monitoring their performance, ensuring sustainable water use in agriculture.

Crop Insurance and Risk Assessment

Satellite imagery facilitates the assessment of crop damage due to natural calamities, ensuring fair and transparent crop insurance settlements. This reduces delays and disputes, offering financial stability to farmers.

Agricultural Advisory Services

Space-based data powers platforms like Kisan Call Centers and KisanSabha app, offering real-time farming advice, pest control, and market insights. These technologies enhance efficiency, sustainability, and resilience, benefiting Indian agriculture, especially small and marginal farmers.

Village Resource Centres

ISRO's Village Resource Centres (VRC) program, in partnership with NGOs and government agencies, delivers space-based services to rural India. VRCs have conducted over 6,500 programs supporting agriculture, healthcare, women empowerment, computer literacy, and skill development, benefiting many.

A Glimpse of Village Resource Centre

Radio Stations to create awareness

Radio is a very effective medium to disseminate information to the rural areas and creating awareness among rural population. INSAT (Indian National Satellite System) based radio stations provide reliable programme channels for rural development. At present, 326 All India Radio (AIR) stations have been equipped with receive terminals which specifically create awareness among rural people.

How Space technologies are useful in disaster management?

- Space technologies support disaster management by monitoring environmental changes and hazards using remote sensing and Earth observation. Weather satellites track cyclones and floods, enabling early warnings, evacuation planning, and effective response efforts.
- Satellite imagery maps disaster-hit areas, guides rescue operations, and aids damage assessment for resource allocation. GPS supports relief coordination, while satellite communication maintains connectivity in disrupted rural zones.
- Space-based systems are particularly valuable for monitoring large-scale events like wildfires, droughts, and earthquakes. They enable real-time data collection, which aids in predicting disasters and mitigating risks. For instance, satellites can detect temperature anomalies or land deformations, signaling potential volcanic eruptions or landslides.

Space technologies and environmental monitoring for rural development

- Space technologies drive rural development through environmental monitoring and resource management. Satellite imagery assesses soil, water, and vegetation health, aiding agriculture, forestry, and land planning.
- Precision agriculture optimizes yields by tracking soil moisture, pests, and weather, while satellites monitor deforestation and land degradation to protect biodiversity and restore ecosystems.
- Space-based technologies enhance disaster management in rural areas by providing real-time satellite data for early warnings, reducing loss of life and property. Remote sensing identifies flood-prone regions, enabling better planning.

- Satellite communication bridges the digital divide, connecting rural communities to education, telemedicine, and e-governance, fostering inclusion and empowerment.
- ISRO's Telemedicine program, launched in 2001, connects rural areas to specialty hospitals via satellites. Covering regions like Jammu & Kashmir, Ladakh, Andaman, North-East, and tribal districts nationwide, it ensures healthcare access in remote areas.
- By integrating space technologies with grassroots efforts, rural development becomes more resilient and sustainable.
- From improving agricultural practices to protecting natural resources, space-driven environmental monitoring is a cornerstone of progress in rural areas, enhancing livelihoods while safeguarding the planet.

Satellite based weather prediction technology for India's rural upliftment

- Satellite-based weather prediction aids India's rural areas by providing accurate forecasts, helping farmers plan activities and mitigate risks, essential for the 60% relying on agriculture for their livelihood.
- Satellites like INSAT-3D and Megha-Tropiques provide real-time weather, rainfall, temperature, and soil moisture data, enabling precise forecasts.
- This helps farmers make informed decisions and empowers rural communities to take proactive measures during disasters.
- Satellite-based weather predictions improve water resource management, reservoir operations, and irrigation in rural areas. They also aid in constructing weather-resilient infrastructure and enhance disaster response strategies, ensuring quicker evacuations and efficient relief during extreme weather events.
- Government initiatives like the Gramin Krishi Mausam Sewa (GKMS) leverage satellite data to deliver localized weather information and advisories via SMS, mobile apps, and community radios, ensuring the last-mile connectivity to farmers.
- Collaboration between ISRO, agricultural research bodies, and rural development programmes amplifies the impact of this technology.
- Satellite-based weather prediction, therefore, not only boosts agricultural productivity but also fosters sustainable rural development. It reduces vulnerability, promotes economic stability, and empowers rural India to thrive in an era of climate uncertainty.

Geospatial based solutions for flood, drought, landslide, and forest fire in rural areas

- Rural India faces a significant vulnerability to natural disasters like floods, droughts, landslides, and forest fires due to its varied topography and climatic conditions. Geospatial technologies, including Geographic Information Systems (GIS), remote sensing, and satellite imagery, play a pivotal role in developing efficient, scalable, and data-driven solutions to mitigate these challenges.

Flood Management

- India, prone to floods, uses geospatial solutions for real-time flood forecasting and monitoring through satellite imagery and hydrological modeling. GIS mapping, drones, and aerial surveys help predict floods, assess damage, and coordinate relief efforts effectively.

Flood Mapping through Geospatial Technique

Drought Mitigation

- In drought-prone areas, remote sensing technologies monitor soil moisture, vegetation health, and rainfall deficits. Satellite indices like NDVI and LST assess drought severity, guide crop planning, and aid water conservation, irrigation, and groundwater recharge efforts.

Landslide Risk Reduction

- In hilly terrains, GIS and remote sensing analyze slope stability, soil, vegetation, and rainfall to identify landslide risks. IoT sensors and geospatial data enable early warnings, while geospatial analysis aids in drainage system design and slope reinforcement.

Forest Fire Management

- Forest fires are a growing concern in rural areas. Satellite systems like MODIS and VIIRS detect fires in real time, while GIS maps high-risk zones based on temperature, wind, and vegetation. These tools enable fire

prevention, resource allocation, and monitoring efforts. Integrating geospatial technologies empowers communities for better disaster preparedness, resilience, and sustainable development.

In this way, we see that space technology has revolutionized sectors like agriculture, disaster management, communication, and environmental monitoring, enhancing efficiency, and literacy. Through satellite-based services and remote sensing, space advancements have become essential tools for rural development and societal well-being, showcasing the broad and transformative impact of space innovations on everyday life of rural communities.

REIMAGINING THE FUTURE OF LEARNING: EDUCATING ON SPACE TECHNOLOGY

- Space technology is vital for addressing global challenges. United Nations Office for Outer Space Affairs (UNOOSA) Space4SDGs highlights its role in advancing sustainable development. It supports quality education, economic growth, and disaster resilience, contributing to sectors like banking, agriculture, and climate resilience to promote GDP growth and development.
- The global space economy is projected to grow from $630 billion in 2023 to $1.8 trillion by 2035, with a 9% AAGR. India's space economy, expected to reach $77 billion by 2030, will outpace global growth, emphasizing investment in education and research.
- Integrating space technology into school curricula can inspire innovation and informed career choices. Teaching its applications in renewable energy and urban planning cultivates future leaders equipped to address global challenges through education and innovation.
- The demand for space technology to enhance education has surged post-Covid-19, with digital learning solutions and cost-effective satellite systems like VSAT supporting low-resource areas.
- It is crucial to equip students with knowledge of space technology trends and innovations. Geospatial data and GIS improve education management, resource allocation, and infrastructure.
- In India, geospatial technology enhances access to primary education, reduces inequality, and aids school consolidation in sparsely populated areas, promoting equity and efficiency.

Global Perspective

- The global demand for skilled professionals using space technology for sustainable development is rising. The space economy contributes 1.5% of global GDP, with satellite data underpinning over 10% of advanced economies' GDP, potentially generating $1.8 trillion by 2035.
- The global space economy is growing, fueled by digital advancements and international collaboration. NASA showcases the transformative power of technologies like augmented reality (AR) to enhance classroom learning and make space concepts accessible.
- Such immersive educational approaches can inspire students to pursue STEM careers while equipping them with practical problem-solving skills.
- Japan's JAXA advances space education through outreach programs, including school visits, workshops, and exhibits. It offers astronaut training and satellite design opportunities, while fostering global academic partnerships to encourage student research and engagement with space technologies.
- The UAE Space Science Program engages students in space projects and competitions, including satellite design and exploration, alongside plans for the first Arab astronaut program. The ESA promotes space education in Europe with programs, resources, and competitions.
- However, the UNESCO GEM Report 2023 highlights persistent inequities in technological access, especially in rural regions. Bridging these gaps through satellite- based inter net and affordable digital platforms can democratize access to space education.

Opportunities in India

- According to the Indian Space Policy 2023, the key strategies include the need to promote space- related education and innovation, support space-sector start-ups, and increase awareness on space activities. Sensitization and capacity building initiatives will need to be directed towards promoting Research and Development in space sector and educating to nurture scientific temperament in the society.

- In India, ISRO strengthens infrastructure and inspires future scientists through programs like YUVIKA, offering students opportunities in satellite building and mission planning. ISRO also promotes STEM education and provides internships and scholarships.
- The UN-affiliated Centre for Space Science and Technology Education in India offers short-term courses in fields like Remote Sensing, GIS, Satellite Communications, Space Science, and Global Navigation Satellite Systems.
- The initiatives put India on a pedestal and enhance opportunity to strengthen education systems and make the learners ready to contribute to design, development, and application of space technologies.

Opportunities for Strengthening Quality Education on Space Technology

- Access to informative materials and outreach programs on space technologies, trends, Indian missions (Chandrayaan, Mangalyaan, Gaganyaan), AI, robotics, and policy considerations can bridge the information gap through digital media, podcasts, and social channels.
- Integrating space tech R&D projects in secondary grades, like satellite models and planetary science, can inspire curiosity. Linking these projects to curricula and topics like climate change, GIS, and sustainable development ensures relevance.
- **Skill oriented curriculum-** Introduce optional/add on courses in satellite design, AI, programming for space applications, robotics, and data analysis. ISRO's focus on satellite technology offers a base for designing skill-oriented programmes at schools and universities.
- Improved collaboration between ISRO and private entities, through programs like SpaceKidz and IN-SPACE, can offer mentorship and foster international partnerships for scholarships, knowledge exchange, and student opportunities.
- Augmenting teacher capacity through specialized training is crucial for improving space technology education. Collaborating with ISRO and universities for workshops and expert speakers will help integrate space concepts into teaching effectively.
- **Promotion of start-up ecosystem-** Encourage students to develop entrepreneurial ideas by creating innovation hubs in schools, organizing competitions and providing necessary support for career guidance and counselling to enable them to make informed decisions.
- **Improving Access in Rural Areas-** Use ISRO's satellites to deliver e-learning content to rural and remote areas. Initiatives like EDUSAT can bridge the rural-urban gap in access to resources. Additionally, organizing space education camps and mobile exhibitions can be beneficial in inspiring students in rural areas. These could showcase space applications in farming, weather forecasting, and disaster management.

Challenges

Potential challenges in this area include:

- **Limited openness to learning about space technologies:** Space careers are often seen as niche. To address this, outreach, investments, and reforms are needed to make space education engaging and accessible, highlighting its relevance in industries like agriculture and disaster management.
- **Limited capacities of educators:** Many teachers and educators lack the technical knowledge and pedagogical skills required to deliver advanced concepts like satellite systems, remote sensing, or space exploration effectively or even introduce basic examples while delivering their lessons. This, along with poor perception and motivation of educators towards the subject, can hamper learning.
- **Resistance to change in terms of integration in curriculum:** Indian education's exam-oriented focus prioritizes rote learning, neglecting interdisciplinary approaches crucial for space technology. Integrating subjects like physics, chemistry, geography, and computer science requires substantial curricular reforms for effective space education.
- **Socio-economic disparities and remote regions:** while space technology can greatly benefit in rural development, agricultural practices and similar engagements, the reluctance to invest in educating youth due to preoccupation with other jobs to fend for the family, and poor internet connectivity poses a

significant barrier. This will call for strategic behavioural change and provision to have learning resources and outreach up to the last mile and ensure that no one is left behind.

Conclusion

- Space technology shapes the future of science, economy, and sustainability, impacting agriculture, disaster management, climate monitoring, and telecommunications. India's ambition to lead in space requires strengthened education to empower students and solve real-world problems.
- India must invest in education and capacity-building to integrate space topics into curricula, foster interdisciplinary learning, and support R&D. The Indian Space Policy 2023 requires strong educational initiatives and public-private partnerships for inclusive access.
- India can learn from global practices in the U.S., Japan, and the EU, which emphasize early space science exposure, teacher training, and collaborations. Tailoring these approaches to India's context can foster innovation and inclusivity.
- Emphasizing space-generated data in education, like satellite data for environmental monitoring and urban planning, along with educator training, rural outreach, and entrepreneurial support, ensures a relevant and impactful strategy.
- In conclusion, building a strong foundation in space technology education is essential for India's advancement as a global space power. By investing in education, policy implementation, and fostering a scientific temperament, the nation can inspire the next generation of space scientists, engineers, and entrepreneurs, contributing not only to technological progress but also to sustainable development and global leadership.

MOBILE APPS FOR FISHERMEN

When fisherman in India go to sea in India, often they cross the International Maritime boundary during their fishing routines. To prevent such trespassings ISRO has W developed the following apps for fisherman:

The MapmyIndiaNavIC Message Receiver App

This app alerts the fishers against putting out to sea during adverse weather conditions and recall those who are still at sea or have gone beyond the international maritime boundary. The app also aids fisherman convenience. The app works completely offline and showcases areas for potential fishing (tuna or normal). It also provides waypoint navigation from the fisher's current position to the selected area of potential fishing.

Through INCOIS (Indian National Centre for Ocean Information Services), the app also provides emergency messages for incoming adverse weather conditions cyclones, tidal waves, high tide etc

- Checking live location of the fisherman on the map
- Current position of the fisherman from the international maritime boundary
- Audio visual alert in case the fisherman is about to cross the international maritime boundary
- Provision to receive emergency messages - high tide wave, cyclone, etc. from INCOIS
- Location for potential fishing zones - tuna or normal
- Way point navigation from current location to selected potential fishing zone
- App works completely offline

Nabhmitra network & app for real time tracking of the sub-20 m boats

Nabhmitra is an Mobile Satellite Services (MSS) network **enabling real-time tracking** of sub-20m fishing boats, two-way messaging, weather alerts, and emergency warnings via a satellite-connected app for fishermen and boat owners. As this App works in conjunction with the MSS terminal, it is distributed by the concerned Nodal agency on Terminal registration.

Sagarmitra SAR emergency messaging app

Sagarmitra is a Satcom network **enabling fishermen to send emergency messages for Search and rescue (SAR) operations** via a Bluetooth-connected Android app. It supports distress alerts, acknowledgments, weather updates, PFZ notifications, and emergency warnings from the central control station.

As this network is developed for a specific Nodal agency and the app works in conjunction with the Distress alert transmitter- Second Generation terminal, hence it is distributed by the agency on registration.

SATELLITE-BASED EARLY WARNING SYSTEMS FOR DROUGHT AND FLOOD MANAGEMENT

Droughts and floods harm rural agriculture, reducing crop yields, damaging infrastructure, and threatening livelihoods. Effective strategies, like monitoring, early warnings, and sustainable practices, are essential to protect communities, ensure food security, and enhance resilience against climate challenges.

Droughts

Drought is a temporary, extreme water shortage caused by sub-normal rainfall, erratic distribution, or high demand, impacting ecosystems, vegetation, and humans. Meteorologists link it to rainfall absence; agriculturists focus on insufficient soil moisture. Drought types include meteorological, hydrological, agricultural, and socioeconomic, with drylands being most vulnerable. India's agricultural drought arises from monsoon irregularities like delayed onset, early withdrawal, or dry spells, reducing rainfall to 50-75% of normal levels.

In India, they significantly affect:

- **Crop Yields:** Insufficient water during critical crop growth phases reduces agricultural productivity, threatening food security and causing significant economic losses for farmers.
- **Livelihoods:** Persistent droughts lead to reduced income for farmers, pushing them into debt and forcing rural families to migrate for survival.
- **Livestock:** Scarce fodder and water during droughts weaken livestock health, lowering their productivity and adding to rural economic challenges.
- **Water Resources:** Over-reliance on groundwater during droughts depletes aquifers, creating long-term water scarcity and unsustainable agricultural practices.

Floods, often caused by excessive rainfall or overflowing rivers, pose immediate and long-term challenges:

- **Crop Destruction:** Floodwaters submerge standing crops, causing complete agricultural losses, and devastating rural farming communities.
- **Soil Degradation:** Nutrient-rich topsoil is eroded by floods, reducing fertility and making land less productive for future cultivation.
- **Infrastructure Damage:** Floods destroy essential rural infrastructure, including irrigation systems, storage facilities and roads, disrupting the agricultural supply chain.
- **Health Hazards:** Stagnant floodwater creates breeding grounds for diseases, threatening the health and well-being of rural populations.

The Role of Satellite Imagery in Early Warning Systems

Satellites equipped with advanced sensors capture data on various Earth parameters. This data, processed and analysed using Geographic Information Systems (GIS), provides invaluable insights into:

- **Rainfall Patterns:** Satellite imagery monitors precipitation levels and spatial distribution, offering precise data for weather forecasting, flood risk management and agricultural planning in vulnerable rural areas.
- **Soil Moisture:** Satellites estimate soil water content, enabling farmers to plan irrigation schedules effectively, reduce water wastage and adapt to drought conditions for sustainable agriculture.
- **River Levels:** Satellite altimetry tracks river flow and monitors rising water levels, aiding in flood risk assessment and disaster preparedness in flood- prone regions.
- **Vegetation Health:** Remote sensing analyses vegetation conditions, using indices like NDVI to assess crop stress, detect drought-affected areas and guide timely interventions.

Key Satellites and Programs

- **Indian Satellites:** INSAT, RISAT and Cartosat, developed by ISRO, provide critical data for monitoring weather patterns, soil conditions and disaster-prone areas to support agricultural and disaster management efforts.

- **Global Initiatives:** Programs like Sentinel (ESA) and Landsat (NASA) complement Indian satellite data, offering global perspectives and enhanced imagery for more comprehensive applications in rural development.
- **Collaborative Efforts:** Partnerships with organizations such as FAO and WMO integrate satellite data globally, ensuring efficient analysis, better disaster response and enhanced agricultural planning strategies.

Drought Management through Satellite Technology

Monitoring and Assessment

- **Rainfall Anomalies:** Satellites identify deviations in precipitation levels, helping predict and address drought risks by monitoring rainfall distribution and intensity patterns.
- **Soil Moisture Mapping:** Tools like SMAP provide precise, real-time soil moisture data, enabling better water management and informed agricultural decisions during droughts.
- **Vegetation Indices:** NDVI and EVI measure crop health and stress, offering insights into water scarcity impacts and guiding adaptive agricultural practices.

Early Warning Systems

- **Seasonal Forecasting:** Predicting drought risks based on long-term climatic trends helps farmers and policymakers prepare for potential water shortages.
- **Dynamic Monitoring:** Regular satellite updates allow timely interventions, such as supplemental irrigation and shifting planting schedules, to minimize crop losses.
- **Community Alerts:** Warnings shared via mobile apps, SMS and local media empower rural communities to implement drought preparedness measures effectively.

Mitigation Strategies

- **Water Resource Management:** Satellite-guided resource mapping prioritizes water use, promoting efficient irrigation, rainwater harvesting and groundwater replenishment to ensure sustainability during droughts and enhance long-term agricultural resilience.
- **Crop Diversification:** Encouraging drought-resistant and short-duration crops reduces vulnerability to climate extremes, ensuring steady income and food security for farmers in rural areas affected by water scarcity.
- **Government Schemes:** Integrating satellite-based insights into initiatives like PMKSY and MGNREGA improves water conservation, infrastructure development and sustainable agricultural practices, mitigating the impact of droughts on rural livelihoods.

Flood Management through Satellite Technology

Flood Risk Assessment

- **Rainfall Intensity:** Satellites monitor heavy rainfall patterns, enabling authorities to anticipate potential floods and initiate timely disaster mitigation strategies.
- **River Monitoring:** Satellite altimetry tracks river water levels, providing early warnings for regions prone to flooding and guiding risk management.
- **Floodplain Mapping:** Identifying high-risk flood- prone areas through satellite imagery allows targeted resource allocation and preventive measures.

Early Warning Systems

- **Real-Time Alerts:** Satellite systems deliver timely flood predictions and alerts, minimizing risks to life, property, and agriculture in vulnerable regions.
- **Hydrological Models:** Integrating satellite data with local ground observations enhances accuracy in flood forecasts and improves response strategies.
- **Community Preparedness:** Training rural communities in interpreting flood warnings and implementing evacuation plans reduces disaster- related casualties and losses.

Mitigation Strategies

- **Structural Measures:** Satellite imagery assists in designing and constructing embankments, reservoirs, and drainage systems to control flooding effectively.
- **Non-Structural Measures:** Promoting afforestation, land use planning and community engagement reduces flood impact by mitigating environmental degradation.
- **Relief and Recovery:** Satellite-guided mapping aids rescue operations, resource distribution and efficient post-flood rehabilitation, minimizing recovery time for rural communities.

Challenges and Limitations

- **Data Accessibility:** Ensuring timely and affordable access to satellite data for local authorities and farmers.
- **Infrastructure Gaps:** Building ground stations and communication networks in rural areas.
- **Awareness and Training:** Educating stakeholders on using satellite-based insights effectively.
- **Policy Integration:** Aligning satellite data applications with national and state-level disaster management plans.

Future Directions

- **Technological Advancements:** Harnessing AI, ML, and lot to enhance satellite data analysis.
- **Collaborative Platforms:** Fostering partnerships between government agencies, private sectors, and research institutions.
- **Community-Centric Approaches:** Developing localized solutions tailored to the needs of rural populations.
- **Policy Support:** Strengthening funding and regulatory frameworks for satellite-based disaster management.

Conclusion

Droughts and floods harm rural agriculture, threatening livelihoods, and food security. Satellite technology, AI, ML, and IoT enhance disaster preparedness and sustainable farming. Community-driven policies and advanced tools can boost resilience and ensure rural sustainability in India.

KRISHI-DECISION SUPPORT SYSTEM(KRISHI-DSS)

The geo-spatial platform, Krishi- Decision Support System (Krishi DSS), is a powerful tool to empower stakeholders with real-time data-driven insights on weather patterns, soil conditions, crop health, crop acreage and advisories. Krishi-DSS, **launched by the Agriculture Department**, is **India's first geospatial platform offering satellite** images, weather, soil, groundwater, and reservoir **data for seamless agricultural insights anytime, anywhere.**

Unlocking the Power of Data for Sustainable Agriculture Development

Krishi DSS spearheads a transformative journey in Indian agriculture through cutting-edge geospatial technologies. Often referred to as the "**Gati Shakti" for Indian agriculture**, Krishi DSS presents a master plan to expedite the development and adoption of geospatial and non-geo spatial technologies. Hosting hundreds of agriculture data layers in one place, Krishi DSS embodies the potency of data in driving evidence-based and cost- effective solutions. Krishi DSS will empower Indian agriculture with a seamless integration of geospatial insights.

Indigenous Geo-Spatial Platform for Informed Decision-Making in Agriculture

Krishi DSS is a transformative geospatial platform integrating state, central, and global data for sustainable agriculture. It empowers agriculturists with maps, digital tools, and databases, fostering informed decisions and revolutionizing agriculture through data-driven innovation over time.

Connecting Stakeholders with Data-Driven Solution

- Krishi DSS, **developed by the Agriculture Department and Space Department** under a **2022** MoU, leverages geospatial technologies to empower farmers, scientists, and stakeholders with data-driven tools for informed agricultural decision-making.

- **Krishi-DSS, using RISAT-1A satellite and Visualization of Earth observation Data and Archival System (VEDAS) portal**, integrates with ISRO's Meteorological and Oceanographic Satellite Data Archival Centre (MOSDAC), BHUVAN, and ICAR systems to enhance agricultural decision-making. RISAT-1A captures high-resolution geospatial images in all-weather and lighting conditions.
- Krishi DSS bridges farmers and policymakers with data-driven insights, offering blogs, news, surveys, and closed group interactions. Accessible to all, users can register at krishi-dss.gov.in for exclusive services and agricultural transformation.

Applications of Krishi DSS towards Sustainable Agriculture Development

Krishi-DSS includes several advanced modules designed to support comprehensive agricultural management. From the vast expanse of fields to the smallest soil particle, Krishi-DSS has it covered.

- With crop mapping and monitoring, it enables to understand cropping patterns by analysing parcel- level crop maps over the different years This information helps in understanding crop rotation practices and promotes sustainable agriculture by encouraging the cultivation of diverse crops.
- Drought monitoring provides real-time data on soil moisture, water storage, crop conditions, and dry spells, while crop weather watch updates stakeholders on weather impacts, harvest status, and crop residue burning.
- Field parcel segmentation enables precise analysis of unique parcel needs and cropping patterns. The One Nation-One Soil system provides comprehensive soil data, aiding crop suitability, land capability, and soil-water conservation efforts.
- Ground truth data library of Krishi-DSS fosters innovation by providing essential resources like ground truth data and spectral libraries for different crops to the researchers and industry.
- From flood impact assessment to Crop insurance solutions and many more, Krishi-DSS is a holistic solution. It is about empowering our farmers, informing our policies, and nourishing our nation.
- By integrating various data sources available on the Krishi DSS, various farmer-centric solutions can be developed such as right individual advisories to farmers, early disaster warning like Pest attack, Heavy rain, Hail storm etc.

Types of DSS

Data-driven DSS

- Used to query a database or data warehouse
- It is deployed via a main frame system, client/server link, or via the web

Document-driven DSS

- The purpose of such a DSS is to search web pages and find documents on a specific set of keywords or search terms.
- Technology used to set up such DSSs is via the web or a client/server system

Knowledge-driven DSS

- Users within the organization
- Interacting with the organization, (consumers of a business)
- silent/server systems, the web, or software running on stand- alone PCs

Model-driven DSS

- Used by complex systems that help analyse decisions or choose between different options.
- Used by managers and staff members of a business, or people who interact with the organization,
- Used for scheduling, decision analyses etc.
- Deployed via software/hardware in stand-alone PCs, client/server systems, or the web.

Digital Agriculture Mission: Tech for Transforming Farmers' Lives

- Krishi-DSS is more than just a tool, it's a catalyst for innovation and sustainability in agriculture. Developed as part of the Digital Agriculture Mission, its second major component is the Agri Stack.

- AgriStack's completion will revolutionize agriculture, featuring Soil Profile Mapping and farmer-focused digital services, offering timely, reliable information to foster resilient, sustainable, and prosperous agriculture in India.
- The Digital Agriculture Mission was approved by the Union Cabinet Committee, chaired by Prime Minister Narendra Modi on September 2, 2024 with a substantial financial outlay of Rs. 2,817 Crore, including a central government share of Rs. 1,940 Crore.
- The Digital Agriculture Mission is designed as an umbrella scheme to support various digital agriculture initiatives. These include creating Digital Public Infrastructure (DPI), implementing the Digital General Crop Estimation Survey (DGCES), and supporting IT initiatives by the Central Government, State Governments, and Academic and Research Institutions.