Shodh Sari-An International Multidisciplinary Journal

2025, Vol. 04, Issue 04, 42-66
ISSN: 2959-1376
DOI: https://doi.org/10.59231/SARI7863

A Study on Different Indian Space Agencies and Their Role in Bio Geographical Studies

Chauhan, Nisha[1] and Singh, Manoj Kumar[2]

[1]Assistant Professor, Department of Geography, S D College Muzaffarnagar, Uttar Pradesh, India

[2]Lecturer/Ex Coordinator (S.C.17009), Government I College Kunda U S Nagar/ U O U Haldwani Nainital, Uttarakhand, India

Abstract

This study explores the contributions of various Indian space agencies to the field of bio-geographical studies, an interdisciplinary area that investigates the interactions between biological life and geographical environments. With India's diverse ecosystems and rapidly evolving space technology, agencies such as the Indian Space Research Organisation (ISRO), Physical Research Laboratory (PRL), National Remote Sensing Centre (NRSC), and Indian Institute of Remote Sensing (IIRS) have taken active roles in monitoring, analysing, and understanding the country's rich biodiversity and ecological changes. The study highlights how these agencies utilize remote sensing, Geographic Information Systems (GIS), satellite imaging, and geochemical analysis to collect critical data on land cover, vegetation patterns, climate variability, soil health, and natural resource distribution. This information plays a vital role in environmental monitoring, agricultural planning, disaster management, and conservation efforts. The paper also examines PRL's specific contributions to astrobiology, planetary analog research, and early Earth studies, which offer insights into the origin and evolution of life on Earth and the potential for life on other planets. Furthermore, the study emphasizes the practical applications of this research in addressing current global challenges such as climate change, biodiversity loss, and sustainable development. Through interdisciplinary collaboration and data-driven decision-making, Indian space agencies contribute not only to national development but also to global scientific progress. This research underscores the growing importance of integrating space science with ecological and geographical studies to

@2025 International Council for Education Research and Training 2025, Vol. 04, Issue 04, 42-66
ISSN: 2959-1376 DOI: https://doi.org/10.59231/SARI7863

better understand and manage Earth's complex biosphere. It calls for continued investment in technology, research, and policy integration to ensure the sustainable use of natural resources while preparing for future planetary exploration.

Keywords: ISRO**,** PRL**,** Remote Sensing**,** Bio-Geography**,** Environmental Monitoring**,** Geospatial Technology

Introduction

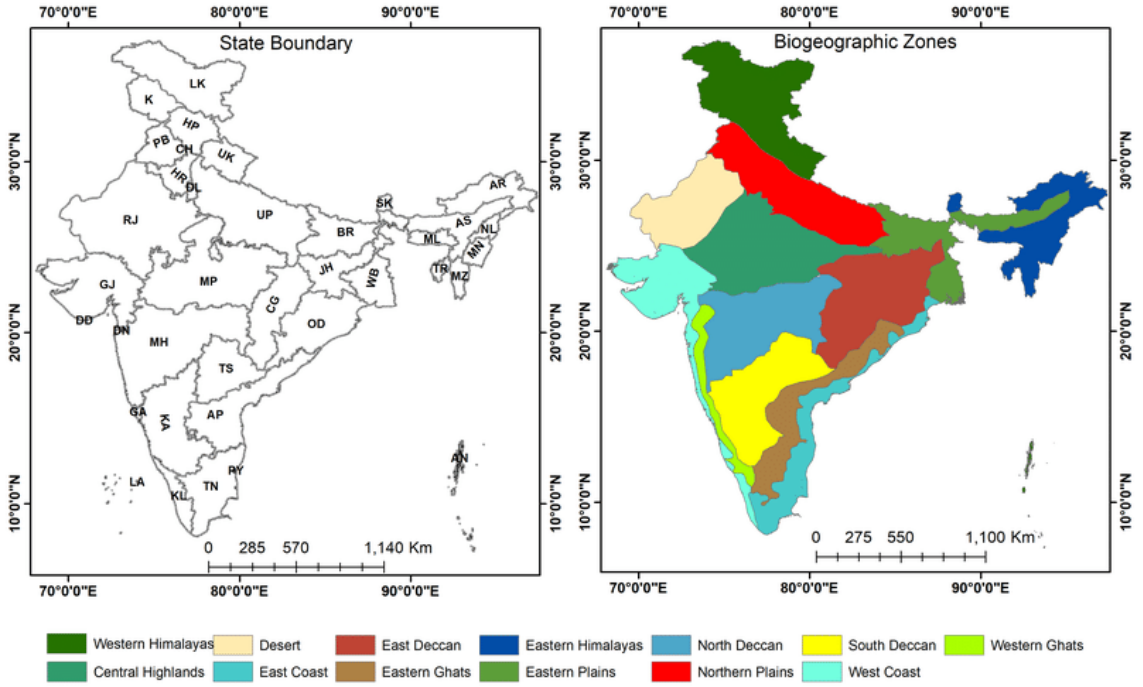
In recent decades, space technology has revolutionized the way we understand and manage the Earth's diverse ecosystems and biological resources. In India, this transformation has been driven by the pioneering efforts of space agencies—most notably the Indian Space Research Organisation (ISRO)—which have developed and deployed a wide range of Earth observation satellites and geospatial technologies. These tools have proven invaluable in the field of bio-geographical studies, a discipline that examines the distribution of species, ecosystems, and biodiversity across geographical spaces and through time.

Bio-geography, which sits at the intersection of biology, ecology, and geography, relies heavily on accurate, large-scale spatial data to monitor forests, wetlands, protected areas, migration patterns, habitat fragmentation, and climate change impacts. Indian space agencies have played a key role in enabling such studies through missions like the Indian Remote Sensing (IRS) satellite series, Resource sat, and Carto sat, as well as through platforms like Bhuvan and the Indian Biodiversity Information System (IBIS). These agencies collaborate with institutions such as the Forest Survey of India (FSI), Wildlife Institute of India (WII), and National Remote Sensing Centre (NRSC) to provide critical data for environmental monitoring and conservation planning.

This study explores the contributions of Indian space agencies to bio-geographical research, highlighting how remote sensing, satellite imagery, and geospatial analysis have enhanced our understanding of India's rich and varied biological landscape. It also examines the growing synergy between space-based data and ground-level biodiversity initiatives, which together

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

support more effective environmental policy-making and sustainable development. By analysing the structure, programs, and applications of different Indian space agencies, this study aims to underscore their pivotal role in advancing bio-geographical knowledge and addressing pressing ecological challenges in the 21st century.



Review of Literature

Indian space agencies, notably the Indian Space Research Organisation (ISRO) and its affiliated institutions, have significantly contributed to biogeographical studies through advanced remote sensing technologies. These agencies have enabled comprehensive monitoring of biodiversity, ecosystem dynamics, and environmental changes across India. India has developed a robust space program led primarily by the Indian Space Research Organisation (ISRO). Alongside ISRO, other organizations such as the National Remote Sensing Centre (NRSC), North Eastern Space Applications Centre (NE-SAC), and academic partnerships have played crucial roles in applying space technologies to various scientific domains, including bio-geographical studies. ISRO's Earth

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

Observation (EO) satellites like IRS, Carto sat, Resources at, and RISAT have significantly contributed to the monitoring of India's diverse ecosystems. These satellites help in Mapping the forest cover and biodiversity hotspots (Roy et al., 2015), Monitoring land use/land cover changes (Reddy et al., 2017), Studying vegetation indices for understanding ecological health (Ramachandran et al., 2019). ISRO's Bhuvan portal and National Biodiversity Characterization Project (NBCP) offer accessible satellite data for ecological research. The NRSC, a vital wing under ISRO, plays a central role in Developing thematic maps of wetlands, forests, and agricultural zones (NRSC, 2018), Disaster management support for floods, droughts, and forest fires using real-time satellite data (Murthy et al., 2020), Supporting ecological zoning and landscape-level planning. NRSC's Indian Bio-geographical Information System (IBIS) integrates spatial and non-spatial data for conservation planning.NE-SAC's Regional Bio-Geographical Initiatives the North Eastern Space Applications Centre (NE-SAC) focuses on the North-Eastern region of India, known for its rich biodiversity. Key initiatives include High-resolution land use classification (Gogoi et al., 2021), Mapping of shifting cultivation (jhum) and its environmental impact, Wildlife corridor assessment using GIS and remote sensing techniques. Bio-geographical studies require a comprehensive understanding of spatial patterns and ecological processes, which has increasingly been enabled through the use of satellite remote sensing and geospatial technologies. Several Indian institutions and researchers have contributed to the body of literature that explores the role of space-based platforms in monitoring biodiversity, ecosystems, and environmental changes.

Remote sensing technology has been instrumental in habitat mapping, species distribution modelling, and landscape-level ecological monitoring. The Indian Remote Sensing (IRS) satellites, developed and operated by ISRO, have been extensively used for generating high-resolution land cover maps. According to Roy et al. (2016), IRS satellite data has played a key role in national-level biodiversity assessments and ecological zoning. ISRO, through institutions like the National Remote Sensing Centre (NRSC) and the Space Applications Centre (SAC), has facilitated several environmental

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

monitoring programs. The National Biodiversity Characterization Project (NBCP), jointly implemented by ISRO and the Department of Biotechnology, is a landmark project in this area. Murthy et al. (2003) emphasized the utility of remote sensing data in delineating biodiversity-rich areas across India's varied eco-regions. The Forest Survey of India (FSI), in collaboration with ISRO, has adopted satellite data for biennial forest cover mapping. This has been crucial in tracking forest loss, afforestation efforts, and habitat quality. Reddy et al. (2015) highlighted how satellite-derived NDVI (Normalized Difference Vegetation Index) data has been used to evaluate vegetation health in bio-geographical zones. Recent studies, such as those by Kumar and Bhatt (2020), have used remote sensing and GIS to model the potential distribution of endemic and threatened species under various climate change scenarios. The integration of bioclimatic variables with geospatial data provides insights into shifting habitats and emerging conservation priorities. Bhuvan, ISRO's geo-platform, has been increasingly used by researchers and policymakers to access thematic maps and satellite-derived data for ecological and bio-geographical studies. As noted by Ghosh and Joshi (2018), such platforms democratize access to data, enabling local-level biodiversity monitoring and participatory conservation planning.

Material and Methods

This study adopts a descriptive and analytical methodology to explore the contributions of Indian space agencies in the field of bio-geographical research. The approach includes qualitative and quantitative analysis of data sourced from both primary and secondary materials. Data were collected from secondary sources, including official websites of ISRO, PRL, NRSC, and IIRS, peer-reviewed journals, government reports, and mission documents. Research papers and case studies related to satellite missions (such as IRS, Carto sat, and Resource sat) were reviewed to understand their application in ecological and geographical studies. The study used content analysis to interpret mission objectives and outcomes, and comparative analysis to evaluate the role of different agencies in bio-geographical studies. This methodology ensured a comprehensive understanding of how space technologies are used for ecological

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

monitoring, resource planning, and environmental sustainability in India.

Observations: Based on the review of literature, institutional reports, and relevant space-based initiatives, the following key observations were made regarding the role of Indian space agencies in bio-geographical studies. There are several agencies established in India which can be helpful in various sectors of bio-geographical studies given in table 01.

Table 01

S no.	Name of agency
A	Indian Space Research Organisation (ISRO)
B	National Remote Sensing Centre (NRSC)
C	Space Applications Centre (SAC)
D	Forest Survey of India (FSI)
E	Wildlife Institute of India (WII)
F	Indian Institute of Space Science and Technology (IIST)
G	Indian Institute of Remote Sensing (IIRS)
H	Physical Research Laboratory (PRL)
I	Development and Educational Communication Unit (DECU)
J	National Atmospheric Research Laboratory (NARL)
K	Indian National Space Promotion and Authorization Centre (IN–Space)

Indian space agencies established in India which can be helpful in various sectors of bio-geographical studies

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

A. Indian Space Research Organization (ISRO) and Indian Space Research Organization (ISRO)

The Indian Space Research Organization (ISRO) is India's national space agency, established in 1969 under the leadership of Dr. Vikram Sarabhai, the father of the Indian space program. Headquartered in Bengaluru, ISRO operates under the Department of Space (DoS), Government of India. Its primary objective is to develop space technology and its applications for various national needs, such as communication, earth observation, navigation, weather forecasting, and scientific research. Over the years, ISRO has gained global recognition for its cost-effective and innovative space missions, including:

- **Chandrayaan-1 & 2 & 3** – India's lunar exploration missions
- **Mangalyaan (Mars Orbiter Mission)** – First interplanetary mission
- **Gaganyaan** – Upcoming human spaceflight mission
- **PSLV and GSLV launch vehicles** – Known for reliable satellite launches

ISRO also contributes significantly to national development in areas like agriculture, resource mapping, disaster management, urban planning, and education, making space technology accessible and beneficial to all (Table 02)

Table 02

Thematic Applications of ISRO's Earth Observation Data			
Application Area	**Satellite Data Used**	**Scale**	**Purpose**
Land Use/Land Cover	LISS-III	1:50,000	Urban planning, agriculture
Wetland Mapping	Resourcesat-2/2A	1:50,000	Conservation, biodiversity
Flood Hazard Zones	Multi-source data	1:250,000	Disaster management
Soil Moisture	High-resolution SAR	Operational	Agriculture, drought monitoring

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

Role in Bio-geographical Studies

The Indian Space Research Organization (ISRO), India's premier space agency, has played a pivotal role in advancing bio-geographical studies by leveraging satellite technology, remote sensing, and geospatial tools. Through its Earth observation missions, ISRO has enabled large-scale monitoring of India's diverse ecological zones, enhancing our understanding of biodiversity patterns, ecosystem dynamics, and environmental changes. ISRO has developed and deployed a series of Earth observation satellites that have become fundamental to ecological and bio-geographical research. These include:

- **IRS (Indian Remote Sensing) series** – used for land use/land cover mapping and ecosystem monitoring.
- **Resource sat** – provides multi-spectral, medium-resolution data for forest cover, agriculture, and natural resource mapping.
- **Carto sat** – delivers high-resolution imagery for terrain modeling and landscape analysis.
- **RISAT (Radar Imaging Satellite)** – useful for all-weather observation, including in cloud-covered forest areas.

These platforms provide consistent and wide-scale spatial data crucial for bio-geographical assessments. ISRO has led or co-led several national projects that directly support bio-geographical research in various ways:

i- **National Biodiversity Characterization Project (NBCP):**

A joint initiative with the Department of Biotechnology aimed at characterizing biodiversity at the landscape level across India’s 10 bio-geographic zones using remote sensing and GIS technologies.

ii- **Biosphere Reserve Monitoring:**

ISRO supports long-term monitoring of India’s biosphere reserves by providing satellite-based vegetation indices and land use trends.

iii- **Forest and Wildlife Habitat Assessment:**

Collaborations with the Forest Survey of India (FSI) and Wildlife Institute of India (WII) allow for remote sensing-based forest classification, fragmentation analysis, and habitat quality assessment for flagship and endangered species.

iv. **Bhuvan Geoportal:**

ISRO's web-based GIS platform that provides free access to satellite imagery,

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

thematic maps, and ecological data. Bhuvan supports decision-making for biodiversity conservation, watershed planning, and climate adaptation.

v.**VEDAS (Visualization of Earth Observation Data and Archival System):**

Used for analysing satellite imagery and geospatial data for ecological modelling and environmental monitoring.

vi. **Climate Change and Species Distribution Modelling**

ISRO data is widely used in **climate change impact studies**, particularly in modelling **species distribution** under various emission scenarios. The integration of remote sensing with climatic and topographic data allows researchers to forecast changes in habitat suitability and identify vulnerable biodiversity hotspots.

vii. Capacity Building and Institutional Support ISRO actively promotes training programs, collaborative research, and capacity building through its outreach arms like:

- Indian Institute of Remote Sensing (IIRS)
- National Remote Sensing Centre (NRSC)

These institutions work with universities, NGOs, and government departments to promote the use of space technology in ecological research.

viii. Limitations and Scope for Improvement

Despite its contributions, ISRO faces some limitations in:

- Frequent updates of high-resolution ecological datasets
- Field validation of satellite-based models
- Cross-sectoral integration with biodiversity, forestry, and policy agencies

Continued innovation, increased partnerships, and data transparency can further strengthen ISRO's impact in bio-geographical research.

B. National Remote Sensing Centre (NRSC):

This institution is a branch of Indian Space Research Organization (ISRO) established in the 1974 Headquarter of this organization located at Hyderabad, Telangana, India. The Primary Functions are Acquiring, processing, and distributing remote sensing data for a wide range of applications. The National Remote Sensing Centre (NRSC) is a key unit of the Indian Space Research Organization

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

(ISRO)**.** It is responsible for the acquisition, processing, and distribution of satellite remote sensing data**.** NRSC plays a vital role in using satellite imagery for Natural resource management, Agriculture and forestry monitoring**,** Disaster management and environmental studies **and** Urban planning and infrastructure development It operates several ground stations and manages India's geospatial platforms like Bhuvan, which provides satellite-based maps and services to users. By transforming satellite data into actionable insights, NRSC supports decision-making in key sectors and promotes sustainable development across India.

NRSC's Role in Biogeographical Studies

NRSC provides high-resolution satellite data from Indian satellites like IRS (Indian Remote Sensing satellites) series, Carto SAT, Resource sat, RISAT, and EOS missions. This data is crucial for mapping vegetation, forests, wetlands, and wildlife habitats. Biodiversity Mapping can be done by using satellite imagery, NRSC supports mapping and monitoring of biodiversity hotspots (e.g., Western Ghats, Himalayas), habitat fragmentation studies and Forest type classification using spectral signatures. NRSC collaborates with the Forest Survey of India (FSI) and other conservation bodies help to monitoring protected areas, monitor changes in forest cover, detect encroachments in protected areas and to Track wildlife corridors and migration patterns. NRSC contributes to the National Wetland Inventory and Assessment (NWIA) using remote sensing. It helps in tracking coastal ecosystem changes (mangroves, coral reefs) and their biodiversity significance. NRSC is involve also in Disaster and Climate Change Impact Studies. Remote sensing helps assess the impact of climate change on ecosystems, such as glacial retreat, desertification, and sea-level rise. NRSC supports adaptation strategies for vulnerable eco-regions. NRSC develops Geoportals like Bhuvan (Indian Geo-platform), WRIS, VEDAS, and MOSDAC portals which provide access to data, maps, and analytical tools for researchers and policymakers in biodiversity and land-use planning.

C. Space Applications Centre (SAC)

The Space Applications Centre (SAC) is a major research and development centre of the Indian Space Research Organisation (ISRO), located in Ahmedabad, Gujarat. It was established to develop space technology and applications that directly benefit to the

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

society. The key roles and responsibilities of this centre are to Design and development of payloads for communication, meteorology, remote sensing, and navigation satellites. Development of satellite-based applications in areas like telecommunication, television broadcasting, disaster management, agriculture, and environmental monitoring. It also helps in research in microwave, optical, and infrared sensors for satellites. The organization supports national projects through space-based information systems and services. SAC plays a central role in translating space technology into practical solutions for societal needs. It bridges the gap between space-based observations and their use in sectors like education, healthcare, natural resource management, and governance.

Role of Space Applications Centre (SAC) in Biogeographical Studies

The Space Applications Centre (SAC), a key arm of ISRO based in Ahmedabad, plays an important role in biogeographical studies by developing satellite sensors, data products, and applications that help monitor and understand the distribution of ecosystems, species, and natural resources. The key contributions of SAC to Biogeographical Studies in various ways. SAC designs and Develop Earth Observation Sensors optical, thermal, and microwave sensors used in satellites like IRS, Carto SAT, Resource sat, and Oceans at. These sensors capture detailed imagery that supports the study of vegetation cover, forest types, land use, wetlands, and biodiversity hotspots. SAC plays a leading role in national-level mapping projects to classify forests, grasslands, deserts, wetlands, and other ecological zones. These maps are crucial for tracking habitat changes, species distribution, and conservation planning. Satellite data processed and analysed by SAC is used to monitor to Deforestation and afforestation, Fragmentation of habitats and Ecosystem health indicators like NDVI (Normalized Difference Vegetation Index). SAC supports to initiatives such as National Wetland Inventory and Assessment (NWIA), Forest Cover Mapping (in coordination with FSI) and National Biodiversity Action Plan (NBAP). This organization provides remote sensing tools to assess the impact of climate change, forest fires, droughts, and floods on biodiversity and ecosystems. It also Helps in planning climate adaptation strategies for sensitive bio-geographic regions. SAC develops models and decision-support tools

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

to predict species distribution, habitat suitability, and environmental threats using spatial data. SAC plays a foundational role in enabling and advancing biogeographical research in India. By providing high-quality satellite instruments, data products, and application tools, SAC helps scientists, conservationists, and policymakers better understand and protect India's rich ecological and biological diversity.

D. Introduction to Forest Survey of India (FSI)

The Forest Survey of India (FSI) is an apex national organization under the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India. It was established in 1981, succeeding the Pre investment Survey of Forest Resources (PISFR), with the objective of conducting comprehensive surveys and assessments of the forest resources of the country. Headquarter of FSI located at Dehradun, Uttarakhand, FSI plays a pivotal role in generating reliable data on forests and tree resources using advanced technologies such as remote sensing, GIS (Geographic Information System), and field inventories. It also monitors forest fires, estimates forest carbon stock, and provides training to forestry professionals.

One of its flagship publications is the India State of Forest Report (ISFR), which is released biennially. This report provides a detailed and updated account of the forest cover, tree cover, biodiversity, growing stock, and other key indicators related to the forest ecosystem across all states and Union Territories of India. The main objectives of FSI are

- Regular assessment and monitoring of forest resources.
- Creation of a national forest database using modern technology.
- Inventory of forests and trees outside forests (TOF).
- Forest fire monitoring and reporting.
- Capacity building and training for forestry professionals.

Through its work, FSI significantly contributes to sustainable forest management, environmental conservation, and supports India's commitments to global environmental agreements, including efforts to combat climate change.

Role of Forest Survey of India (FSI) in Biogeographical Studies

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

The Forest Survey of India (FSI) plays a critical supporting role in bio-geographical studies by providing accurate, up-to-date data and spatial analysis related to India's forests, vegetation, and ecological regions. Though FSI's primary mandate is forest resource assessment, its work significantly aids biogeographical classification and research in the following ways: FSI uses satellite imagery and ground surveys to classify forests based on floristic composition, structure, and ecological conditions. This helps in understanding biogeographical zones and sub-zones as defined by ecological characteristics. The India State of Forest Report (ISFR) provides data on forest cover by state, district, and even biogeographical zones (like the Himalayas, Western Ghats, Deccan Plateau, etc.). This helps ecologists and conservationists analyse how forest distribution varies across different ecological zones. By assessing forest types, density, and continuity, FSI data supports studies on Habitat suitability, Species distribution and Migration corridors. FSI especially useful to study the biodiversity hotspots such as the Western Ghats and Northeast India. FSI's forest fire monitoring system helps to track disturbances that affect ecological stability in different biogeographic regions. This is crucial for ecological resilience and restoration planning. This agency provides data on forest carbon stock, which is essential for understanding the climatic role of different biogeographical zones. Helps in modelling carbon sequestration potential of specific forest types. FSI supplies geospatial data and mapping services to other scientific institutions conducting in-depth biogeographical and ecological research. It also Facilitates spatial analysis of ecosystems, fragmentation, and land use change. While FSI does not directly conduct biogeographical classification, its high-quality, nationwide forest data and mapping services are foundational for ecological, conservation, and biogeographical studies in India. It acts as a technical backbone for researchers, planners, and policymakers working in biodiversity conservation and environmental planning.

E. Wildlife Institute of India (WII)

The Wildlife Institute of India (WII) is a premier national institution under the Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India, dedicated to wildlife research, training, and conservation. Established in 1982, the

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

institute is headquartered in Dehradun, Uttarakhand. The institute located within a lush, green campus near the Rajaji National Park. The key objectives of WII are to Conducts scientific research on wildlife and ecosystems to support conservation policies and management practices, Offers training programs for forest officials, wildlife managers, and researchers in areas such as biodiversity conservation, wildlife forensics, and habitat restoration. This institution also provides to offers of diploma and degrees i.e. postgraduate diploma and Master's programs in wildlife sciences. The WII provides technical support and policy advice to the government and other stakeholders in wildlife and environmental conservation.

Role of The Wildlife Institute of India (WII) in bo-geographical Studies-

The Wildlife Institute of India (WII) plays a pivotal role in biogeographical studies, significantly contributing to the understanding and conservation of India's diverse ecosystems.

WII has undertaken extensive biogeographical classification of India, delineating the country into 10 major zones and 26 provinces. This classification serves as a foundational framework for conservation planning and management, guiding the establishment of protected areas and the prioritization of conservation efforts. WII established the WII Herbarium, which is a recognized repository that houses plant collections from various protected areas across India. This extensive collection aids in the identification and documentation of plant species, supporting biodiversity assessments and conservation strategies. WII has developed standardized protocols to identify and classify landscape-habitat-plant physiognomic units. This approach enhances the understanding of habitat characteristics and supports effective conservation management by providing detailed information on elevation, slope, soil type, and dominant vegetation. WII conducts comprehensive research and monitoring programs, such as the study of prey and predator dynamics in tiger reserves like Similipal and Satkosia. These studies assess prey density and predator habitats, providing valuable data to inform conservation management and ensure the sustainability of wildlife populations. Leveraging technologies like Geographic Information Systems (GIS) and remote sensing, WII conducts detailed mapping of forest cover,

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

land use, and geomorphology. These technological tools facilitate the delineation of protected area boundaries and the preparation of thematic maps, enhancing the precision of conservation planning. WII offers training programs and academic courses that focus on biogeographical studies and conservation management. These initiatives build capacity among wildlife professionals and researchers, fostering a deeper understanding of biogeographical principles and their application in conservation efforts. Through these multifaceted contributions, WII plays an instrumental role in advancing biogeographical research and conservation in India, ensuring the preservation of the country's rich biodiversity. WII has Played a critical role in Project Tiger and other flagship conservation programs. WII Conducts Ecological Impact Assessments (EIAs) and biodiversity surveys across India.

F. **Indian Institute of Space Science and Technology (IIST)**

The Indian Institute of Space Science and Technology (IIST), established on September 14, 2007, is Asia's first dedicated space university. Located in Valia Mala, approximately 25 km from Thiruvananthapuram, Kerala, IIST operates under the Department of Space, Government of India, and is recognized as a Deemed University under Section 3 of the UGC Act, 1956.IIST offers a range of undergraduate, postgraduate, and doctoral programs with a focus on space science, technology, and applications. Undergraduate courses include B.Tech in Aerospace Engineering and B.Tech in Avionics. Additionally, the institute provides a 5-year Dual Degree Program (B.Tech + M.Sc/M.Tech) in Engineering Physics, Astronomy & Astrophysics, Solid State Physics, Earth System Science and Optical Engineering. IIST aims to be a world-class educational and research institution contributing significantly to space endeavours. Its mission includes Creating a unique learning environment enriched by the challenges of the Space Programme, Nurturing the spirit of innovation and creativity, Establishing Centres of excellence in niche areas, providing ethical and value-based education and Promoting activities to address societal needs.

Role of IIST in Bio-Geological Studies:

IIST is primarily focused on space science, technology, and applications, it also plays a

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

significant academic and research role in interdisciplinary areas, including bio-geological studies—though this is not its core domain. Although IIST is not exclusively a bio-geology institution, its contributions come through the integration of space science, remote sensing, planetary geology, astrobiology, and Earth observation technologies that are relevant to bio-geological research. Here's how: IIST conducts research on planetary surface processes, mineralogy, and possible biosignatures—especially on Mars and other celestial bodies. Studies include simulation of Martian environments, analysis of extremophiles, and examination of life-supporting geological conditions. These studies contribute to understanding early Earth conditions and the search for extraterrestrial life, linking biology and geology. IIST develops tools and methods using remote sensing and satellite data to analyse Earth's geological features, vegetation patterns, and ecological systems. Applications include land cover change detection, soil health monitoring, and habitat mapping, all of which support bio-geological assessments. While IIST is not a dedicated bio-geological institute, its space-based approach, interdisciplinary research, and technology-driven methods support and enhance bio-geological studies, especially in Planetary bio-geology, Earth system sciences, Astrobiology and geobiology and Remote sensing applications in biosciences.

G. The Indian Institute of Remote Sensing (IIRS)

The Indian Institute of Remote Sensing (IIRS) is a premier institution in India dedicated to research, education, and training in the field of remote sensing, geoinformatics, and GPS technology for natural resources, environmental, and disaster management. IIRS established in 1966 as Indian Photo-Interpretation Institute it further renamed as Indian Institute of Remote Sensing in 1983. Headquarter of this institute located at Dehradun, Uttarakhand, India. Main objectives and aims of this institute are to Provide high-quality education and training in remote sensing and geoinformatics, promote research and development in the application of space technology, Support capacity building in India and developing countries. It also Collaborate with national and international organizations for knowledge exchange and technological advancement. IIRS offers some

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

long term and short term academic and training Programs. IIRS organized Postgraduate Diploma and M.Tech programs in collaboration with recognized universities like the Indian Institute of Technology (IIT) Roorkee.

Role of Indian Institute of Remote Sensing (IIRS) in Bio-Geological Studies

The Indian Institute of Remote Sensing (IIRS), a premier centre of the Indian Space Research Organization (ISRO), plays an important role in bio-geological studies by utilizing remote sensing, geospatial technologies, and satellite data to investigate the complex interactions between biological systems and geological features. IIRS applies multispectral and hyperspectral satellite data to monitor and analyse the relationships between soil, vegetation, microbial activity, and geological formations. It helps identify vegetation patterns linked to underlying geology, contributing to the understanding of eco-geological zones and bio-mineral associations. Through the use of high-resolution satellite imagery and digital elevation models (DEMs), IIRS supports geological mapping of areas with biological relevance, such as fossil-bearing sedimentary basins, mineralized zones, and volcanic terrains. These maps assist in understanding how geological substrates influence biological diversity and distribution. IIRS conducts studies on soil types, nutrient availability, and chemical composition using geospatial techniques, which are critical for assessing soil-plant-microbe interactions. These assessments support land capability classification, crop suitability analysis, and soil degradation monitoring, all of which are important for understanding bio-geological dynamics. The institute uses Earth observation data to monitor climate-induced changes in terrain and biospheres, such as glacial retreat, wetland shrinkage, and desertification. These studies reveal how geological changes (e.g., erosion, sedimentation) affect habitats, biodiversity, and ecological resilience.

H. Physical Research Laboratory (PRL)

Physical Research Laboratory (PRL) is a premier research institution in India, dedicated to space and fundamental science research. It was established in 1947 by Dr. Vikram Sarabhai, widely regarded as the father of the Indian space program. PRL is headquartered in Ahmedabad, Gujarat, and functions under the Department of Space,

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

Government of India. PRL's vision is to advance knowledge in space science and allied areas, contributing significantly to the global scientific community. Its mission is to pursue high-quality research in the field of Astronomy and Astrophysics, Space and Atmospheric Sciences, Planetary Sciences and Exploration, Theoretical Physics, Geosciences and Cosmochemistry.

Role of Physical Research Laboratory (PRL) in Bio-Geological Studies

The Physical Research Laboratory (PRL) plays a significant role in bio-geological studies, which involve understanding the interactions between biological and geological processes over Earth's history. This interdisciplinary field merges geochemistry, cosmochemistry, planetary sciences, and astrobiology, all of which are active areas of research at PRL. PRL conducts detailed isotopic and elemental analysis of meteorites and terrestrial rocks to understand the origin and evolution of the Earth and solar system. This research helps in reconstructing primitive Earth conditions that may have been suitable for the origin of life. PRL investigates life forms in extreme environments (e.g., high-altitude regions, deep subsurface rocks) to understand the limits of life. These studies provide clues about potential extraterrestrial life and inform planetary missions searching for biosignatures on Mars or icy moons. PRL uses stable isotopes (like carbon, oxygen, and sulfur) in rocks and minerals to trace ancient biological activity and environmental changes. Isotopic signatures help identify biogenic processes preserved in geological records. By analysing lake sediments, cave deposits (speleothems), and ice cores, PRL reconstructs past climates and ecosystems. These studies reveal how life and climate co-evolved, and how geological events influenced biodiversity. PRL examines Earth analog sites (e.g., Ladakh, Rann of Kutch) that resemble Martian or lunar terrains. These studies support astro biological research by understanding how biological traces could be preserved in planetary geology.

I. The Development and Educational Communication Unit (DECU)

The Development and Educational Communication Unit (DECU) is a specialized division under the Space Applications Centre (SAC) of the Indian Space Research Organisation (ISRO). Established to leverage the power of space technology for national development, DECU

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

focuses on using communication satellites and media tools for promoting education, health, rural development, and other socio-economic welfare programs across India. The Key Objectives of DECU are to use satellite communication to reach remote and underserved regions, disseminating information that supports agriculture, health, education, and disaster management. It designs and implements programs that enhance literacy and promote formal and non-formal education, especially through satellite-based networks like EDUSAT. DECU develops high-quality audio-visual content, documentaries, training films, and multimedia materials for educational and developmental purposes.

It conducts socio-economic studies and field trials to evaluate the effectiveness of communication strategies and technologies. DECU serves as a bridge between advanced space technologies and grassroots development needs. It helps ensure that the benefits of ISRO's technological advancements reach the most marginalized sections of society through impactful communication strategies.

Role of Development and Educational Communication Unit (DECU) in bio geographical studies

The Development and Educational Communication Unit (DECU) of ISRO plays an indirect but significant role in bio-geographical studies by utilizing space-based communication and remote sensing technologies to support data dissemination, awareness generation, and decision-making related to biodiversity, ecology, and sustainable development. While DECU's primary mandate is communication for development and education, it contributes to bio-geographical studies in the following ways: DECU aids in communicating findings from remote sensing and GIS data—collected by other ISRO units like the National Remote Sensing Centre (NRSC)—to stakeholders including local communities, policymakers, and researchers. These datasets are crucial for mapping vegetation types, land use/land cover, wildlife habitats, and ecological zones. DECU develops and broadcasts educational content on environmental conservation, biodiversity, and sustainable land use through satellite-based platforms such as EDUSAT. This content helps local populations understand and engage with

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

conservation efforts, which is essential for biogeographical research and its applications. Through interactive platforms like Village Resource Centres (VRCs), DECU enables the exchange of traditional ecological knowledge and modern scientific insights. This community involvement supports citizen science and enhances data collection in biodiversity monitoring and habitat conservation. DECU facilitates partnerships among institutions working on ecology, agriculture, geography, and education. These collaborations foster integrated studies on topics such as ecosystem services, species distribution, and climate impacts on biogeographical zones.

J. The National Atmospheric Research Laboratory (NARL)

The National Atmospheric Research Laboratory (NARL) is a premier research institution under the Indian Space Research Organisation (ISRO) dedicated to advanced studies in atmospheric and space sciences. Located in Gadanki, near Tirupati in Andhra Pradesh, NARL was established with the goal of enhancing India's capabilities in atmospheric research using both ground-based and space-based observation systems. The main vision and missions of NARL are to be a centre of excellence in atmospheric research contributing to national development and global scientific understanding. To conduct cutting-edge research on atmospheric processes and support space missions by improving understanding of weather, climate, and ionospheric phenomena. NARL contributes to national forecasting systems and disaster preparedness. NARL supports research on air quality, greenhouse gases, and long-term climate trends.

Role of the National Atmospheric Research Laboratory (NARL) in Biogeographical Studies

While the National Atmospheric Research Laboratory (NARL) primarily focuses on atmospheric and space weather research, it plays an important supporting role in biogeographical studies, especially in the context of understanding how atmospheric conditions affect ecosystems, species distribution, and habitat dynamics. NARL provides detailed data on temperature, rainfall, wind patterns, humidity, and other atmospheric parameters. These variables are critical for Mapping biogeographical zones, understanding species distribution, Studying climate-driven migration and habitat changes

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

in flora and fauna. ARL studies the transport of aerosols, dust, and pollutants which affect photosynthesis, soil chemistry, and aquatic ecosystems. These insights help in analysing how atmospheric pollution impacts biodiversity health and ecosystem stability. NARL contributes to national and regional models of climate variability and change, which are essential for predicting Shifts in biogeographical boundaries, extinction risk of species sensitive to temperature and precipitation changes and alteration of ecological niche. It provides atmospheric correction data for satellite imagery, improving the accuracy of vegetation and land-cover maps.

K. **The Indian National Space Promotion and Authorization Centre (IN-SPACe)**

The Indian National Space Promotion and Authorization Centre (IN-SPACe) is an autonomous agency under the Department of Space (DoS), Government of India, established to promote, regulate, and authorize private sector participation in India's space activities. Announced in 2020, IN-SPACe represents a major policy shift in India's space ecosystem, aiming to liberalize and commercialize access to space infrastructure and services. The purpose of this organisation is to act as a single-window agency to facilitate and enable private players—including startups, academia, and industry—to carry out end-to-end space activities such as satellite development, launch services, and space-based applications. Its main **vision is** to transform India into a global hub for space entrepreneurship and innovation by democratizing access to space.

Role of the Indian National Space Promotion and Authorization Centre (IN-SPACe) in Biogeographical Studies

While the Indian National Space Promotion and Authorization Centre (IN-SPACe) is primarily focused on enabling and regulating private participation in India's space sector, it plays an important facilitating role in biogeographical studies by opening up access to satellite data, space infrastructure, and application development capabilities for non-governmental entities. IN-SPACe allows startups, universities, and private companies to access remote sensing satellites, which are critical for Mapping biogeographical zones, Monitoring vegetation cover, wildlife habitats, and land-use changes and Tracking climate-related shifts in ecosystems. IN-

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

SPACe supports the development of space-based tools and applications that can Monitor deforestation, desertification, and biodiversity loss, support ecological zoning and species distribution modelling and assist in habitat conservation and restoration planning. Through incubation, technical support, and funding facilitation, IN-SPACe encourages innovation in Environmental monitoring platforms.

Utility of study:

This study has significant practical applications in environmental management, scientific research, and policy formulation. Indian space agencies like ISRO**,** PRL**,** NRSC**,** and IIRS etc. play a pivotal role in integrating satellite-based technologies with biological and geographical research to address key challenges in biodiversity, climate change, and sustainable development. One major utility is in environmental monitoring. Remote sensing data is used to observe changes in forest cover, land use, soil quality, and water bodies. This helps in conserving biodiversity hotspots**,** managing natural resources**,** and protecting fragile ecosystems. The study also aids in disaster management, as satellite data enables the detection and assessment of floods, droughts, and forest fires—particularly in ecologically sensitive zones. This helps in planning relief and recovery operations effectively. In agriculture, space-based tools help monitor crop health, soil moisture, and pest infestations. These insights improve agricultural productivity and support precision farming, especially in bio-geographically diverse regions. From a scientific perspective, the study supports astrobiology and planetary science. Institutions like PRL conduct planetary analog research, contributing to the search for life beyond Earth by studying Earth's extreme environments. Additionally, the study has implications for policy making, as it provides accurate data to support environmental regulations, conservation planning, and sustainable land use. It also enhances educational value, inspiring interdisciplinary research and skill development in space and earth sciences. Overall, the study's utility lies in combining space technology with ecological awareness to promote a deeper understanding of the Earth's biosphere and its management.

Conclusion

The study of different Indian space agencies and their role in bio-geographical studies

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

highlights the growing interdisciplinary approach in India's space and environmental research landscape. Agencies like ISRO (Indian Space Research Organisation), Physical Research Laboratory (PRL), National Remote Sensing Centre (NRSC), and Indian Institute of Remote Sensing (IIRS) have been instrumental in integrating space science with Earth system sciences, particularly in understanding the dynamic interactions between biological and geographical elements.

These agencies utilize satellite remote sensing, GIS technologies, geochemical analysis, and planetary analog research to study diverse aspects such as vegetation patterns, climate change, ecosystem health, soil biology, and even potential extraterrestrial life. PRL, in particular, has made notable contributions in astrobiology and planetary geology, providing insights into early Earth conditions and life-supporting environments on other planets. IN-SPACe is a cornerstone of India's evolving space policy, ushering in a new era of public-private collaboration. By opening up access to space for private players and startups, it is driving innovation, creating jobs, and positioning India as a key player in the global space industry. Although not directly involved in ecological or biogeographical research, IN-SPACe plays a strategic enabling role by unlocking access to India's space assets for private and academic actors. This empowers a new generation of innovations in biogeography, conservation science, and ecosystem management, expanding the reach and impact of space technology in sustainable development and biodiversity protection. The NRSC plays a foundational role in supporting bio-geographical studies in India through advanced remote sensing technologies. Its ability to capture, analyse, and share real-time spatial data significantly enhances the country's capacity to understand and conserve its diverse ecosystems in the face of rapid environmental changes. The Indian Institute of Remote Sensing (IIRS) plays a vital role in advancing bio-geological studies by integrating remote sensing, Earth observation, and geospatial technologies. Overall, Indian space agencies have shown a strong commitment to sustainable development, biodiversity conservation, and Astro biological exploration, reaffirming their role not just in technological advancement but also in scientific

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

understanding of life and Earth's biosphere. Their continued collaboration and innovation are essential for addressing global challenges related to climate, ecology, and planetary habitability.

References:

1. Ghosh, S., & Joshi, P. K. (2018). Remote sensing for biodiversity conservation: A review of Indian initiatives and future directions. *Environmental Monitoring and Assessment*, *190*(6), 1–17. https://doi.org/10.1007/s10661-018-6691-7
2. Gogoi, P., Das, A. K., & Neog, P. (2021). Remote sensing-based land use change detection in North-East India. *Environmental Earth Sciences*, *80*(14), 520.
3. Guo, R., Zhang, W., Ai, S., Ren, L., & Zhang, Y. (2017). Fluctuating asymmetry rather than oxidative stress in Bufo raddei can be an accurate indicator of environmental pollution induced by heavy metals. *Environmental Monitoring and Assessment*, *189*(6), 293. https://doi.org/10.1007/s10661-017-5991-6
4. Kumar, M., & Bhatt, D. (2020). Predicting the impact of climate change on species distribution using remote sensing and bioclimatic modeling. *Journal of Environmental Geography*, *13*(1–2), 1–11.
5. Murthy, M. S. R., Dutt, C. B. S., & Roy, P. S. (2003). Biodiversity characterization at landscape level using geospatial modelling technique. *International Journal of Remote Sensing*, *24*(21), 4315–4330. https://doi.org/10.1080/0143116021000021080
6. Murthy, M. S. R. et al. (2020). Use of satellite remote sensing in disaster management in India. *Current Science*, *118*(6), 957–965.
7. National Remote Sensing Centre (NRSC). (2018). *Natural resources census and land use mapping reports*. NRSC Publications.
8. Ramachandran, R. M. et al. (2019). Vegetation dynamics analysis using MODIS NDVI time series data. *International Journal of Applied Earth Observation and Geoinformation*, *80*, 183–192.

@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 04, 42-66
DOI: https://doi.org/10.59231/SARI7863

9. Reddy, C. S., Jha, C. S., & Dadhwal, V. K. (2015). Assessment and monitoring of long-term forest cover changes in Odisha, India using remote sensing and GIS. *Environmental Monitoring and Assessment*, *187*(8), 1–12. https://doi.org/10.1007/s10661-015-4674-3
10. Roy, P. S., Behera, M. D., & Murthy, M. S. R. (2015). Biodiversity characterisation at landscape level using remote sensing and GIS. *Indian Journal of Remote Sensing*, *43*(1), 1–15.
11. Roy, P. S., Behera, M. D., Srivastava, V. K. et al. (2016). New vegetation type map of India prepared using satellite remote sensing: Comparison with global vegetation maps and utilities. *International Journal of Applied Earth Observation and Geoinformation*, *39*, 142–159. https://doi.org/10.1016/j.jag.2015.03.001
12. Agarwal, R. (2023). Use of technology by higher education students. *Shodh Sari-An International Multidisciplinary Journal*, *02*(04), 152–161. https://doi.org/10.59231/sari7631
13. Kumar, S. (2025). Cognitive Behavioral Therapy (CBT) for Tech-Stress in Children and Adolescents: A Research Review. *Eduphoria - an International Multidisciplinary Magazine*, *03*(01), 23–31. https://doi.org/10.59231/EDUPHORIA/230425

Received on Jul 05, 2025
Accepted on Aug 28, 2025
Published on Oct 01, 2025