ArcIndia News

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GEO-ENABLED FOREST GOVERNANCE

Vol 15, Issue 2 | For private circulation, not for sale

esri India

FROM THE MD'S DESK

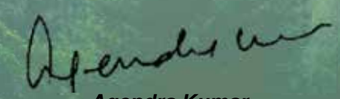
The history of the evolution of humans reveals that forests are vital to life on earth, making conservation of the world's biodiversity of paramount importance. Geospatial technologies hold the key for sustainable forest management and aid through contextualizing complex ecosystem challenges.

Forests cover 30% of the planet's surface, support 80% of the world's biodiversity, and provide invaluable environmental, social, and economic benefits to all. However, factors like rapid industrialization, unabated urbanization, and climate change are putting extensive pressure on our forests and are a cause of global concern today. Forests are a vital part of our daily lives in more ways than we can imagine which makes it even more crucial to divert our dedicated efforts towards protecting our future.

India launched the National Mission for a Green India or Green India Mission (GIM) in 2014 with the objective of sustainable management of forests and other ecosystems, adaptation of vulnerable species and ecosystems to the changing climate and harmonization of forest-dependent communities. At the United Nations Climate Change Conference in 2015 (COP21), India pledged the creation of an additional carbon sink equivalent to 2.5-3 billion tons of CO2 by 2030 through the addition of forest and tree cover to 33% of its land area. As per a 2019 study by The Forest Survey of India (FSI), forest area represented an increase of 78,852 (2.4%) square kilometers over the past two decades. Remote sensing & geospatial technologies have and are playing an instrumental role in our nation's roadmap towards achieving these goals.

Many state government departments have already been using GIS technology for forest management practices such as wildlife management, joint forest management, plantation / afforestation activities, forest fire management, protected area management, commercial forestry, and more. MP Forest is using ArcGIS for a central dashboard for forest monitoring, mapping entire forest boundaries and correcting it vis-a-vis revenue boundaries, utilizing mobile-based GIS for data collection, incident management, and tracking beat guard movement. Recently, the Uttar Pradesh State Forest Department used ArcGIS in their initiative for 'geotagging of 30 crore saplings' planted during 'Mega Plantation Drive-2021'. Forest departments are now looking at scaling up their existing technology infrastructure to set up GeoHubs for a more coordinated approach to sustainable forest management as well as driving inclusive participation with larger stakeholder communities including citizens. The recent announcements of new geospatial data policy and Drone Rules 2021 by the Government of India will further enable organizations to leverage GIS technology by making data access easier and help drive the utilization of GIS and remote sensing in many new innovative ways.

Geography is at the heart of a resilient and sustainable future. Geo-Enabled Forest Governance holds the key to solving earth's most pressing challenges with geographic expertise. With the ability to visualize and analyze along with advanced spatial analytics, geo-enabled forest governance will empower forest stakeholders and policymakers to further strengthen their forest management efforts to restore our forest ecosystems sustainably. GIS professionals like you, play a key role in advocating the positive impact of using GIS technology to achieve the ultimate vision of 'Sustainable Forest Management in India'.



Agendra Kumar
Managing Director, Esri India

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Esri India Certified As a ‘Great Place to Work’

In April, Esri India was recognized as a ‘Great Place to Work’ by the Great Place to Work® Institute. This acknowledgment serves as a testament to Esri India’s commitment towards creating a safe, credible, and equitable workplace for all its staff members. Esri India has earned this recognition by focusing on five dimensions of building a High-Trust, High-Performance Culture™ - **Credibility, Respect, Fairness, Pride and Camaraderie.** The Certification is awarded by Great Place to Work®, which is the global authority in creating, assessing, and identifying the best workplaces the world over.

Speaking on the certification, Agendra Kumar, Managing Director, Esri India, said, “We have built a people-centric culture, where trust and mutual respect are important pillars. We are humbled and honored to be counted among great places to work in India. This certification is special to us as we participated in the study for the first time, and we are now certified as Great Place to Work. The certification reinforces our commitment towards fostering a culture, led by purpose and passion, where learning, growth and innovation are encouraged amongst all.”

Every year, globally over 10,000 organizations from across 60 countries apply for Great Place to Work® Certification for assessment, benchmarking, and planning actions to strengthen their workplace culture. On meeting the qualification criteria, organizations are certified as a ‘Great Place to Work’ for a period of one year.

During the pandemic, Esri India institutionalized a comprehensive approach to providing a safe, healthy, and engaging virtual environment through various initiatives and programs. One such initiative was the ‘Let’s Talk’ program where different teams came together and shared their personal experiences with each other. Health and wellness sessions were organized under the initiative ‘Reset, Reboot and Repower’, to ensure the physical and mental wellbeing of each member of the team. Additionally, a one-day Coronavirus disease (COVID-19) leave was also granted as a special intervention during the pandemic. These initiatives have helped Esri India build and sustain a great workplace culture.

Esri India Introduces New Drone Mapping Software Site Scan for ArcGIS

In September, Esri India introduced Site Scan for ArcGIS, a complete cloud-based drone mapping solution. The solution encompasses flight planning, data capture, data processing, analysis, data sharing, and drone fleet management. It is offered as ‘Software as a Service’ (SaaS) with unlimited storage and computing. Site Scan for ArcGIS is hosted in India, on a cloud approved by the Government of India, and ensures that the drone data is stored and processed within India in compliance with the government regulations. Site Scan for ArcGIS exhibits the capability to process data captured by most of the drones manufactured in India or abroad.

The recent announcement by the Ministry of Civil Aviation on the New Drone Rules 2021, simplified the

procedures and reduced the compliances required for operating a drone in India. Earlier in February this year, the New Geospatial Data Guidelines announced by the Department of Science and Technology had deregulated the collection, processing, and storage of geospatial data. These landmark policy announcements in the regulatory environment have made it easier to collect geospatial data through drones which is of paramount importance to the successful implementation of government schemes like SVAMITVA, Smart City program, Bharatmala project, Interlinking of Rivers, National Mission for Clean Ganga, and various other infrastructure development projects. With the automation and scalability of Site Scan for ArcGIS, the data collected through drones can now be processed quickly, cost-effectively and with minimal human intervention, while eliminating any disruptions during processing. This will result in reducing the cost and time significantly for its users ranging from drone service providers to critical infrastructure organizations, governments, and enterprises.

Agendra Kumar, Managing Director, Esri India, said "With the new Drone Rules 2021, Geospatial data creation through drones is set to get a boost in the country. There is a need for a solution that simplifies drone flying, data capture, processing, and consumption. Site Scan for ArcGIS hosted on a government-approved cloud in India meets these requirements and provides much-needed manageability, reliability, scalability, and cost efficiency for drone data processing. Site Scan will also be a great enabler for our partner community and numerous Drone service providers."

With Site Scan for ArcGIS, organizations involved in construction, engineering, utilities, natural resources, and government agencies will be able to easily capture high-resolution imagery for the areas of interest to examine, visualize, analyze, and make decisions based on the latest information. The acquired 2D & 3D information can be further disseminated as secure services and conveniently consumed anywhere, anytime on any device. A secure, highly available, and scalable cloud platform ensures that drone data processing is not limited by hardware.

Geospatial Infrastructure Critical to Drive Economy to USD 5 Trillion

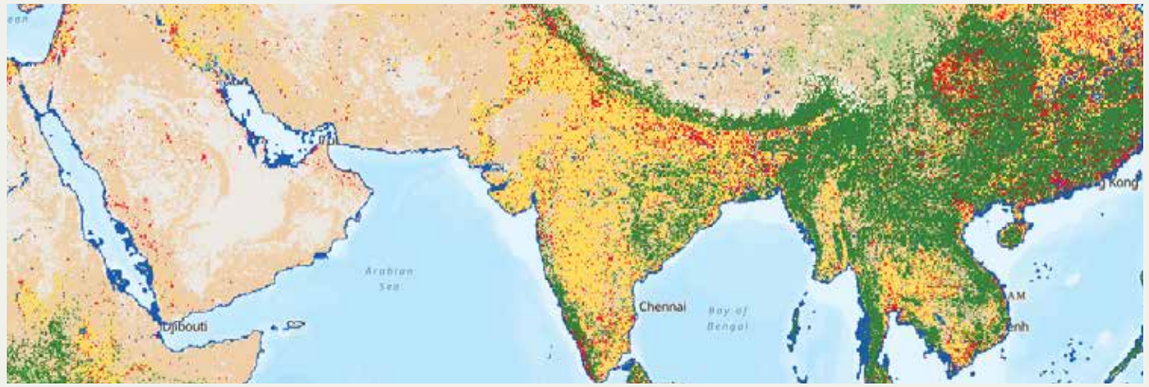
Esri India at the 2021 Esri India User Conference highlighted the use of GIS technology for not only creating a sustainable future but also driving growth to take the country towards its goal of USD 5 trillion economy. The two-day virtual User Conference held between 28-29 July, witnessed thought-provoking & inspiring talks and presentations by more than 20 speakers. Over 4000 delegates attended this largest gathering of GIS professionals from across the country.

Esri India reiterated its focus on empowering the entire ecosystem of government, enterprises, academia, researchers, and NGOs with Geospatial Infrastructure for the development of India and announced several new initiatives to support 'Make in India'. Geospatial Infrastructure consists of content/data, maps, apps, and GIS system apart from the usual IT infrastructure such as systems, storage, and networking.

Highlighting the role of GIS for Sustainable Economic Growth, Agendra Kumar, Managing Director, Esri India, said, "GIS technology has played a key role in the growth of economies across the world. With the rising adoption of GIS in India, we are beginning to see its impact on the Indian economy as well. GIS work undertaken by organizations like Registrar General & Census Commissioner of India, Survey of India, NRSC, MoHUA, NIC, CBDT, Punjab Police, NWIC, Planning Dept. of Govt of Meghalaya, Reliance Jio, Gujarat Gas Ltd. and DHBVNL amongst many others are a testimony of the pivotal role GIS technology is playing towards achieving India's vision of becoming $5 trillion economy."

Delivering the Keynote Address, Kunal Kumar, IAS, Joint Secretary & Mission Director (Smart Cities Mission), Ministry of Housing and Urban Affairs (MoHUA) highlighted the importance of geospatial technology for better management and development of smart cities while also driving ecosystem restoration, innovation, and economic growth. He shared examples of India Urban Observatory and GMIS (Geospatial Management Information System) developed on Esri GIS Technology at MoHUA.

Esri Releases New 2020 Global Land Cover Map



In June, Esri, the global leader in location intelligence, announced it is releasing for the first time ever a new high-resolution, 2020 global land cover map as part of the company's Living Atlas. The map was built using European Space Agency (ESA) Sentinel-2 satellite imagery and developed using a new machine learning workflow teaming with new Esri Silver Partner Impact Observatory, as well as long-time partner Microsoft. The new map will be updated annually supporting change detection and highlighting planetary land changes, especially related to the effects of human activity.

A consistent map of land cover for the entire world based on the most current satellite information, the 2020 Global Land Cover Map can be combined with other data layers for green infrastructure, sustainability projects, and other conservation efforts that require a holistic picture of both the human and natural footprint on the planet. Later this year, Esri and Impact Observatory will make this new land cover model available to support on-demand land cover classification, allowing the GIS community to create maps for project areas as often as every week.

"This is a critical year for climate action," said Jack Dangermond, Esri founder and president. "With the UN Climate Change Conference of the Parties (COP26) bringing international parties together to address a set of common goals, we are happy to do our part in making this map available to users that are working towards the health of our planet." Users will also be able to manipulate the map in association with other GIS layers such as terrain, hydrology, and more, all available in ArcGIS Living Atlas of the World, the foremost collection of geographic information from around the globe, including maps, apps, and data layers. Through the visualizations being released, planners worldwide will better understand the geography around them to make more informed decisions—enabling them to gain insight into locations with distinctive land cover, as well as a human activity affecting them.

High-resolution, open, accurate, comparable, and timely land cover maps are critical for decision-makers in many industry sectors and developing nations. These maps improve understanding of important topics such as food security, land use planning, hydrology modeling, and resource management planning. In addition, national government resource agencies use land cover as a basis for understanding trends in natural capital, which helps define land planning priorities and is the basis of budget allocations. Impact Observatory, contracted by Esri, developed a deep learning AI land classification model using a massive training dataset of billions of human-labeled image pixels and applied this model to the Sentinel-2 2020 scene collection, processing over 400,000 Earth observations to produce the map. The unique machine learning approach used to create this global map will soon be available on-demand, supporting land managers who need to monitor change in a specific area of interest, looking at annual change and seasonal differences in land cover.

"Global efforts are urging world leaders to set and achieve ambitious conservation targets," said Steve Brumby, Impact Observatory co-founder and CEO. "With support from the geospatial experts at Esri, and access to incredible compute resources at Microsoft, we were able to build in record time a land cover map that provides leaders in governments, NGOs, and across industries with a novel, timely view of the planet, and a new AI-powered capability for actionable, science-based insights on demand. In doing so, Impact Observatory hopes to contribute towards the global conservation effort." Esri is releasing this valuable resource under a Creative Commons license to encourage broad adoption and ensure equitable access for planners creating a more sustainable planet.

Esri India to Skill Over 2 Lakh Students in GIS

Esri India announced its drive to skill over 2 lakh students in GIS technologies in India over the next 3 years. As per the Government of India's estimates, the Geospatial Data economy is expected to grow from 30,000 Cr. to about 1 lakh Cr. by the year 2030. Government is encouraging higher usage of GIS technology in many segments like Smart Cities, AMRUT, Water Resources, Agriculture, Insurance, Land management & SVAMITVA, and Utilities. With the new guidelines released by government earlier this year on de-regulating Geospatial data, the use of GIS in private sector is also likely to increase significantly. The increased usage of GIS is likely to create 10 lakh jobs by 2025.

As GIS is being used in almost all sectors of economy, it is important that every student in universities and higher education institutes gets an opportunity to learn GIS. To achieve this, Esri India today announced a comprehensive campus-wide program to help universities and institutes setup and scale their GIS learning infrastructure by establishing Center of Competence (CoC). CoC will provide an opportunity to the students in various streams to acquire the most advanced GIS technology skills. GIS skills when clubbed with other new emerging technologies like AI/ML, Big Data, 3D, AR/VR, Reality Capture, Data Science, Cloud Computing, etc. can create a strong differentiation and increase employability. This initiative will provide students with knowledge, expertise, best practices, and software infrastructure that can be accessed anytime, anywhere and from any device.

Agendra Kumar, Managing Director, Esri India, said, *"With the growing importance of GIS in economic growth, there is a need to increase geospatial literacy in the country. Government intervention through new policies like National Education Policy 2020, Geospatial Data Guidelines, and Drone Policy also provides opportunities for employment and higher value creation. We must act swiftly to scale up GIS learning infrastructure in Higher Education Institutes to build the much-required skill-base in the country."*

The National Education Policy 2020 (NEP) envisions all universities and colleges to become multidisciplinary. The NEP also states that the curricula of all the HEIs shall focus on projects in the areas of community engagement and service, environmental education, and value-based education for students.

"Through this initiative we aim to provide GIS technology to students of all disciplines. This will empower the students to practice and apply spatial thinking while they pursue their studies. For example, a student of supply chain management can learn GIS skills while on campus and later use them in his professional life for monitoring real time status, disruptions, etc. in the entire supply chain process" added Agendra.

Students, researchers, and professors will have access to e-learning content available at MyEsri Learning portal and guided lessons through Esri's Learn Hub. As part of this program, Esri India will also offer faculty training and student engagement programs. Esri India has been working with academia for more than two decades. Over 800 colleges and universities have established GIS labs for Core GIS Courses and Research Projects. The company also fosters GIS know how through other programs including GIS Academia Council of India and Esri India Young Scholar Program.

Decoding Forests Through Codes and GIS

Forest Research Institute (FRI), Dehradun is a premier research institute that implements research projects, provides advisory and consultancies, and conducts impact assessment studies in the field of forestry and the environment. The main objective of FRI is to impart education in such branches of forestry and environment as it may deem fit and to provide for research and the advancement of and dissemination of knowledge in the forestry and environment. In a constantly changing world, FRI has been able to strike a balance between using the conventional approaches in forestry research and implementing modern technologies - remote sensing and GIS. Today, GIS technology has become an integral part of almost all fields. In the forest sector, remote sensing and GIS are complementary tools that have largely impacted forestry research in the recent past. GIS tools have made it easy to monitor forest health, forest fires, create inventories of forestry data, and also analyze ecological parameters pertaining to forests.

Research

The GIS center at Forest Research Institute in the past has undertaken multifarious projects related to forestry and its allied branches. The center is credited for assessing the vulnerability of Indian forests to climate change as a part of the 3rd National Communication to UNFCC. The center has mapped the extent of forest lands in Uttarakhand fringe villages and evaluates the urban riparian zones in Uttarakhand using a combination of tools and software including ArcGIS. The ArcGIS software was used for the identification of fringe villages using the primary layers of villages developed by the Survey of India (SOI). One kilometer buffer zone was created around the forest cover layers that were overlaid upon the SOI layer to extract forest fringe villages of India.

Presently, the center is focused on using codes, models, and GIS tools to delineate the impacts of Invasive Alien Plant (IAP) species on Indian forests and develop a standardized method for mapping IAP species. The center is also involved in research that aims at the Geospatial mapping of Rare Endangered and Threatened species and other important Non-Wood Forest Product species found in tribal areas of Uttarakhand. A web-based GIS platform is also being developed by the center to support the biodiversity information system. One of the major disciplines of research involves the use of information technology by the center to develop forest informatics-related tools and products to support forestry research. The center is working to develop a forest vegetation model that can be used to test the probable impacts of climate change on the forest ecosystem. The center has successfully compiled and tested the existing models used worldwide like JULES, LPJ, IBIS, and at the same time, it endeavors to develop models of Indian origin.

In the last few years, there has been a phenomenal growth and rise in the adoption of GIS across sectors. Integrating it with other emerging technologies such as IoT, ML, AI, etc. - the importance of GIS will grow exponentially in the near future. With such rapid advancement in GIS technology adoption across diverse sectors, there is a need to create more GIS education infrastructure for skilling students. The Forest Research Institute (FRI) is renowned for its commitment towards capacity building in GIS and our association with Esri India has further encouraged us to ingrain critical thinking and innovation in our students to help 'prepare the employees of tomorrow'.

The GIS Centre in FRI is in charge of educating the students of the postgraduate courses in Forestry and Environment Management at Forest Research Institute (Deemed to be) University about the fundamentals of Remote Sensing and GIS. The center also has the provision for interested students to gain in-depth knowledge about advanced methods in GIS and its applications in forestry research through various elective courses. The students are provided hands-on training through the state-of-the-art laboratory along with a research-oriented perspective and are equipped with the necessary skill to find high-end jobs in the field.

Teaching and Training

A weeklong training program on the "Application of Remote Sensing GIS (RS-GIS) in Forest Resource Assessment" is organized by the center every year. The training program aims to equip the participants to use tools of RS-GIS and GPS. Participants are provided enough exposure for the hands-on exercise to make them handle licensed ArcGIS and ERDAS. The program equips participants to test and apply the tools of RS-GIS for developing essential maps for various disciplines of research and developmental projects. The program is aimed at mid-career professionals, students, and researchers involved in using RS-GIS and have no prior exposure to RS-GIS tools. To date, more than 100 professionals have been trained to the customized training program to use RS-GIS in their professional careers. Participants who attend the training belong to prestigious organizations and institutes of India such as IIM, IIT, Wildlife Institute of India, NEERI, IUCN, IMD, etc.

CASE STUDY

Reliance General Insurance Leverages GIS Technology for Crop Insurance

The agriculture industry is known to operate in the most volatile environment. Despite the volatility, agriculture continues to be one of the largest employment generating sectors in India. However, the sector is constantly subjected to vagaries of nature such as floods, landslides, cyclones, etc. severely affecting crop output and farm income. Such risks not only impact farmers but the entire supply chain including the food industry. In line with the Pradhan Mantri Fasal Bima Yojana (PMFBY), Reliance General Insurance (RGI) provides crop insurance schemes protecting farmers against financial losses due to unforeseen crop losses.

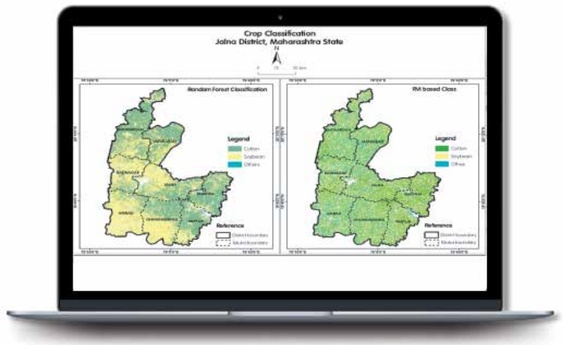
In any industry insurance payout is based on the actual loss and in the agriculture sector crop damage insurance covers losses due to specific perils such as flooding, droughts, hailstorm, etc. The level of risks involved in agriculture insurance made it necessary for RGI to ensure its crop insurance solution not only covers farmers' production and financial risks but also the ability to first analyze and assess the potential risk to farmland and accordingly charge a premium. RGI invested in satellite-based analysis, which helped in addressing risks in crop health during the on-going season, sowing patterns, area sown, localized calamity, and yield estimates.

Esri India team implemented ArcGIS (Aeronautical Reconnaissance Coverage Geographic Information System) and ENVI (Environment for Visualizing Images) software, satellite-based remote sensing technology helped accessing satellite-based information and analytics, and quick high-resolution images processing. Analytics helped RGI gain visibility on crop classification and acreage estimation; crop health monitoring; loss event monitoring, and yield estimation. The GIS technology intervention helped RGI eliminate the on-field physical visits to every gram panchayat/ village/ to monitor crop health and identify risks and also reduced the operational and administrative costs involved.

Challenges

In agriculture, like many other industries, it is critical to identify potential risks, in the beginning, and take necessary risk mitigation steps, to reap benefits at the later stage. Reliance General Insurance wanted to measure in-season crop health to identify potential risks to crop production or farmland at the beginning of the season to accurately estimate the risk and calculate the premium. However, due to variations in season and diverse types of crops grown in multiple agro-climatic regions, monitoring crops was a major challenge. Below, some of the major challenges faced by RGI:

- Difficulty in classifying crops spread across multi-cropped areas
- Acreage estimation in multi-cropping fields
- Identification of plant and disease
- Physical verification of damaged crops using mobile applications
- Data collection and data processing cost
- Reduction of Crop Cutting Experiment (CCE) in heterogeneous fields



Solution

The agriculture sector, being the backbone of India's economy also faces challenging times such as beleaguered farmers' rendezvous with farm crisis and lack of technology intervention. Today, the sector requires a solution that not only fosters innovation but can assess the damage most accurately and further enable faster loss adjustment and payout to the insureds. In the crop insurance business, high-resolution imagery plays a key role in speeding up the claim process. Esri technology helped RGI with cutting-edge mapping, analytics software ArcGIS, and image processing software ENVI offering field data collection, real-time data feeds, intuitive data visualization, processing, and analysis.

The solution provided by Esri supported by accessing satellite images of a particular area/crop field followed by processing the images. ArcGIS ensured rapid data collection and real-time analysis. ENVI assisted in processing satellite images and revealed the below insights:

- Total count of the crops in an agricultural field Location and sizes of the agricultural field
- Identify different crop rows in the field and also gaps within a row
- Damage to the field, crops, and plants
- Hotspot image displaying the health of vegetation in a single field or a larger geographic extent

Once all satellite images are processed, the crucial insights are mapped to further assess the damage, develop dashboards, high-level summary reports for crop-planning, crop-management, harvesting, and administrative planning. ArcGIS and ENVI together helped in rapid and accurate data processing that further assisted in identifying risk-prone areas in a cluster or a district. The software also helped in-season crop health monitoring which enabled prioritizing areas prone to exposures and diverted efforts towards attending the same.

Benefits

The integration of ENVI, the latest spectral image processing, and ArcGIS, analysis technology with an intuitive and user-friendly interface from Esri India helped Reliance General Insurance attain actionable and meaningful information. The use of satellite technology has helped RGI with quicker turn-around and cuts down on costs.

The process implemented by Esri eliminated the time taken to physically monitor large scattered geographies to assess and analyze the vegetative index, water index, soil index, leaf area index, etc. The satellite-based analysis helped RGI in early monitoring of crop sown area and prediction of 'prevented sowing'. Today, RGI has successfully implemented insurance schemes for the FY 2020-21 in 35 districts across 4 states in India and has saved a considerable sum of money on manual/ operational interventions. Below, some of the benefits:

- Faster claim process and payouts in return uplifting customer satisfaction
- Visibility on in-season crop condition at different time intervals fostering risk analysis and decision making
- Crop classification and crop risk analysis enabled estimating the crop yield
- Acreage estimation of different crops
- Identification of Inundation area an exposure monitoring
- Significantly reduced time taken to physically verify farmland
- Reduced operational and data processing cost

Reliance General Insurance Company Ltd (RGI) is the fourth largest non-life insurance company. With 135+ offices/branches across India, the company is backed by the support of 3,600+ employees. RGI offers a plethora of insurance solutions for auto, health, crop, home, property, travel, marine, commercial, and other specialty products with a massive customer base that includes individuals, companies, as well as SMEs.

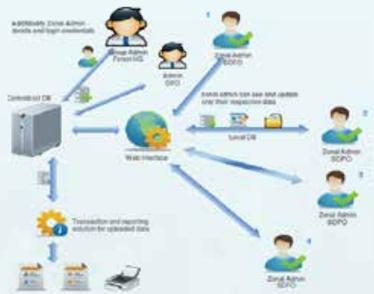
Emitech Collaborates With Esri India to Develop Forest Management Solution

The application of Geographical Information Systems (GIS) has transformed almost every field in the engineering, natural and social sciences, offering accurate, efficient, reproducible methods for collecting, viewing, and analyzing spatial data. Forests are important renewable natural resources and have a significant role in preserving an environment suitable for human life. Forestry involves the management of a broad range of natural resources within a forested area. However, forest resource management in today's ever-changing world is becoming more complex and demanding to forest managers. Geographic Information Systems (GIS) and related technologies provide forest managers and resource planners with powerful tools for planning, management, and decision making.

Emitech Infosystems Private Limited (EIPL), a Kolkata-based Geospatial Products and Services company has been working with Esri India in providing GIS-based solutions including remote sensing and image processing, digitization, thematic mapping, digital image processing, contour mapping, and spatial analysis across India. Emitech Infosystems Private Limited (EIPL) collaborated with Esri India to develop a Web GIS-based Forest Management solution for Tripura Forest Development Corporation (TFDC) under the supervision of Tripura Space Application Centre (TSAC). The solution uses Esri ArcGIS API for JavaScript 3.x, ArcGIS Server 10.x along with ArcGIS Desktop 10.x and underlying SQL, Oracle, or Postgres database servers which enables forest department in resource management, harvest planning, fire management, among others. The application enabled the forest department in:

- Managing plantation and nursery data
- Easy tracking of budget allocation and expenditure
- Uploading and retrieving field data
- Zonal officers (Admin) for different locations of data centers
- Providing specific access to zonal admin
- Zonal admin can see of update only of his respective zonal data
- One final report to check uploaded data with various filter and query builder options

The below diagram shows the workflow of the application:

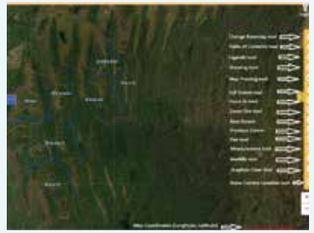


Features

1. Security management: The tool enables the admin to manage different levels of users and their access rights in the application.

2. Standard GIS functionalities:

- The full extent tool shows the initial view of the map i.e., the extent of Tripura state.
- Zoom In tool helps zoom a particular area of the map. A user can click on this tool and draw a rectangle around their subject site to zoom to the site.
- Zoom out tool enables the user to zoom out by drawing a rectangle on a map.
- The next extent helps users to go to the next extent, where they can browse different locations on the map.
- The previous extent allows users to go to the previous extent if the user has browsed different locations on the map.
- Pan tool helps the user in panning through the map. The user can use this tool to see the adjacent areas on the map.
- The Measurement tool enables a user to measure distance, area, and coordinates by drawing graphics on the map. Measurement units can be changed as per user preference.
- Identify tool is used to see detailed information and related images of layers at the clicked point by the user.
- Graphics clear tool helps clear all the graphics drawn by the user on the map.
- Show current location tool can be used to show a user's current location on the map. In browser, the application will ask to use the user location, which should be allowed by the user.



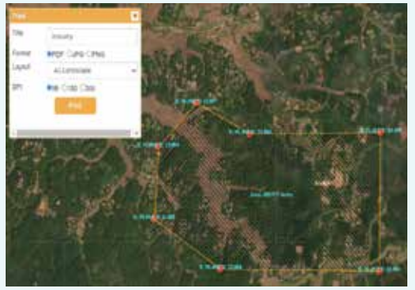
3. Option to choose different base maps (like Imagery, topographic, street, etc.) layer.

4. Layer control tool, with which user can switch on and off the layers on the map.

5. Legends tool dynamically displays symbology of visible layer on the map.

6. The drawing tool helps the user to draw the area of interest and get the area of the drawn polygon and mark the coordinates.

7. Printing of maps in different format and size.



8. Attribute information display on map: This tool displays attribute info from spatial and non-spatial database filtered through a query or on the selection of map

9. Spatial query tool: This tool facilitates users to select features based on graphics drawn on the map. E.g., finding habitations/waterbodies under a forest area.

10. Buffer tool: This tool helps in doing proximity analysis. E.g., finding habitations under 5 km area from a national park.

11. Facility to upload the data directly through excel sheet for different zones.

12. Report generation tool: Reports can be generated based on a combination of spatial or non-spatial information.

Benefits

1. A comprehensive GIS-based analytics and reporting solution to visualize, locate forest assets, and track changes.
2. Exporting single-page and multi-page PDF reports based on customized advanced queries to GIS data.
3. Easy interface to upload department-related data in a prescribed format.
4. Smooth coordination between different zones for production, complaint redressal, and management.
5. Reduced cost of managing the forest asset monitoring and field operations.
6. Easy user creation and assignment of roles.

ArcGIS Solutions for Protected Area Management

ArcGIS Solutions for Protected Area Management is part of ArcGIS Solution which is a collection of focused maps and apps that helps users improve operations, provide new insights, and enhance services.

ArcGIS for Protected Area Management provides area managers with a configured suite of apps that supports key workflows essential for managing natural areas.

The program includes:

- Secure cloud-based content management
- Living Atlas content
- Configurable Mobile and Web Apps
- Analysis app
- Role-based access

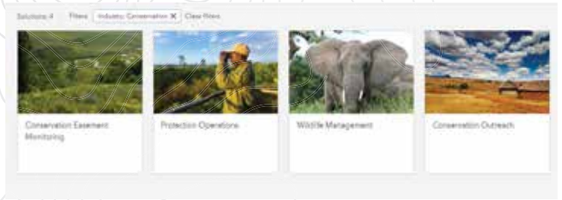
ArcGIS for Protected Area Management allows protected area management staff to work more effectively and transparently on conservation area management challenges both within and beyond a park boundary.

Deploying ArcGIS Solutions

The ArcGIS Solutions app was recently released on May 25, 2021, for ArcGIS Enterprise 10.9. Like its counterpart in ArcGIS Online, the ArcGIS Solutions App for ArcGIS Enterprise allows users to quickly deploy ArcGIS Solutions to the ArcGIS portal.

The users can either download and install ArcGIS Solution for ArcGIS Enterprise from My Esri downloads and launch it from ArcGIS Portal or may launch it from ArcGIS Online using the App Switcher.

Browse the gallery of ArcGIS Solutions and use the filters on the left to narrow down the list of solutions to those which best fit your needs.



Some examples of conservation solutions available in the gallery are as below:

1. **Conservation Easement Monitoring**

   Conservation Easement Monitoring is typically implemented by the forest departments, natural resource departments, and other conservation organizations that intend to take a data-driven approach to manage conservation easements.

2. **Protection Operations**

   The Protection Operations solution delivers a set of capabilities that helps users track poaching and illegal activity, monitor protection operations, and visualize patterns of illegal activity.

3. **Wildlife Management**

   Wildlife Management can be used to capture wildlife observations and monitor the status of wildlife populations in and around the protected areas.

4. **Conservation Outreach**

   Users get 24/7 access to conservation outreach information and the location-enabled wildlife conflict reports help the staff mitigate future wildlife conflicts.The user can select the solution and click on “Get Now”. Upon this, all of ArcGIS items included in the solution such as hosted feature layers, hosted feature layer views, maps, apps, surveys, groups, etc. are created in the user’s content page. The content is summarized in a new solution item that helps users visualize ArcGIS related items (for example, hosted feature layers, hosted feature layer views, maps, apps, surveys, groups, etc.) and understand where each map, layer, and view is used.

These ready-to-deploy solution contents can be edited and modified as per the user’s requirement. The first release of the ArcGIS Solutions app includes a collection of solutions supported with ArcGIS Enterprise 10.9. They are supported in the most complex of ArcGIS Enterprise environments. The users require a base deployment of ArcGIS Enterprise to get started and simply deploy these geo-enabled solutions.

ArcGIS Field Maps with Utility Network Support

ArcGIS Field Maps is an all-in-one app that uses data-driven maps to help fieldworkers perform mobile data collection and editing, find assets and information, and report their real-time locations. ArcGIS Field Maps is the go-to field app, powered by field maps, that streamlines the critical workflows field personnel use every day. As it is built on ArcGIS, everyone—whether in the field or the office—will benefit from using the same data.

What can you do with ArcGIS Field Maps?

Streamline Field Workflows

Replace paper processes and disparate tools to bring efficiency to fieldwork with a single app that can be configured for specific workflows. Fieldworkers have the preconfigured field maps and forms they need on their mobile devices to complete their work efficiently and accurately.

- Users can configure maps to support specific field workflows, wherever work is done, including offline or indoors.
- Map-driven forms fuel the ArcGIS Field Maps mobile app for data capture and editing, recording, and reporting notes, and completing field workflows.
- The users can carry maps anywhere and use the in-map search to find anything. They can also use markup tools to make notes and document the findings.
- Location tracking supports greater situational awareness for field supervisors and improves transparency between the office and the field.

Empower Your Field Workforce

ArcGIS Field Maps provides fieldworkers with secure, 24/7 access to the organization's ArcGIS maps on their mobile devices, ensuring they have the most current information. Fieldworkers can easily locate assets and data and even add markups and notes to document and share findings with others. Maps are dynamic even in disconnected environments.

Access Current Data 24/7

Get greater accuracy when reporting data from the field by using a mobile data collection and editing app that avoids errors introduced from transcription, transfer, and other manual and paper-based processes. New or edited data is automatically fed into the ArcGIS system and accessible across the organization.

Transparency in Field Activities

Users can achieve real-time location awareness of field personnel to quickly adapt to changing circumstances. Location tracking analysis can be used to verify when, where, and by whom field activity was done. Identify patterns of workforce movement that reveal where efficiency is gained or lost.

Deploy Quickly and Easily

ArcGIS Field Maps can be quickly deployed to any field workforce. Field Maps is available for download from app stores. As an all-in-one field app, one download supports many capabilities and means greater efficiency for your fieldworkers and IT associates. Fieldworkers can get familiar with the process quickly and with minimal training to be further productive right away.

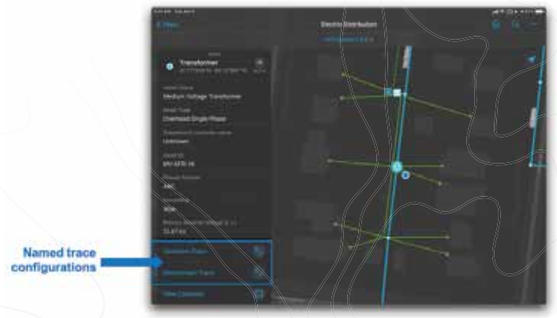
Working with Utility Networks

Starting with the iOS platform, we are adding support for the Utility Network. Important to our development is that we expose the sophistication of the Utility Network but maintain simplicity and ease of use within ArcGIS Field Maps.

Network Tracing

Within ArcGIS Pro, the users can configure a trace and provide network tracing capabilities to the mobile workforce using a named trace configuration. Named Trace Configurations contain all the parameters of a trace and further hide the complexity from the mobile worker.

Each map can have a set of named trace configurations shared with it and any named trace configuration shared will show up when that map is used in Field Maps after when a network element is selected.

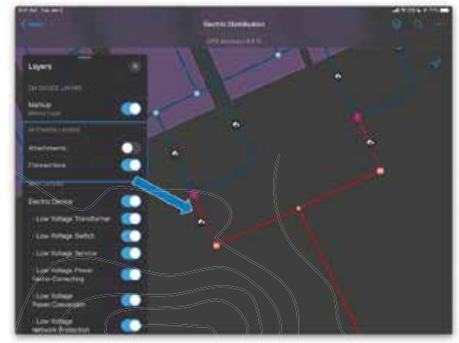


The above map includes both an Upstream and Downstream named trace configuration included with the electrical distribution network.

Tapping on a trace configuration, the users can see the required parameters. The trace is executed, and the results are selected on the map and inside of the panel. Network functions that may have been included in the configuration are provided as well.

Showing Connectivity and Structural Attachment Associations

Field Maps is an ideal mobile app for viewing a utility network. Distribution networks include several layers of maps and grouping layers together enabling users to work with them effectively on a mobile device. When a map includes a utility network, Field Maps gets notified of the network, and the users can discover additional ways to visualize the content within their network. Opening the Layers tool, you will see a section titled NETWORK LAYERS where you can turn on/off the visualization of network connections and attachments.



In this example, we can visualize the structural connections between the high voltage transformer bank, switches, and terminals inside of a substation.

Containment

Containment is an association relationship in the Utility Network. When a user selects a feature, which acts as a container in the Utility Network, the View Contents feature action will be visible in the panel which appears when a feature is selected and will provide the number of contained elements. Tapping on the feature action will enable the users to drill down and select each element and access its details.

GEO-ENABLED FOREST GOVERNANCE FOR PROTECTING OUR PLANET

How often do we realize that forests are vital to existence of life on the planet? Forest products have become inseparable part of our day-today lives. Providing us with shelter, livelihoods, water, food and energy security, forests are home to 80% of the world's terrestrial biodiversity. Providing jobs to more than 13 million people across the world, forests are source of livelihood for many human settlements. About 300 million people live in forests which include 60 million indigenous people. Over centuries this relationship of humans with natural resources has been closely knitted and have always coexisted.

From early periods of civilization, humans have been close to forests and natural resources. Ancient literature reflects the importance of forests in the society laying equal emphasis on the productive and protective aspects of the forests. Over a period of time humans have taken forests for granted, underestimating their indispensability. Humans continue to increasingly exploit forests and other natural resources indiscriminately. Despite heavy dependence, human endeavour for development has inflicted a serious damage to forest ecosystems, adversely impacting the environment and biodiversity. This is a cause of global concern today.

It is rather unfortunate that world has lost one-third of its forests since the end of last ice age. Global forests have shrunk from 4.7 Billion Ha in 1950's to 4 Billion Ha in 2018, thereby exposing us to multi-disaster vulnerabilities. Historically India had a forest cover of 65% which shrunk to 40% by middle of the century and stands at 21.67% in 2019 as per India State of Forest Report (ISFR) with a tree coverage of meagre 2.89%.

DID YOU KNOW?

1. Forests cover one-third of the world's land area and host more than half of the world's land-based plant and animal species.

2. A quarter of all modern medicines come from tropical forest plants, including two-thirds of all cancer-fighting drugs. Medicinal plants are worth US$108 billion a year.

3. Trees in forests are natural aqueducts, redistributing up to 95 percent of the water they absorb to where it's needed most. Trees hold water in the soil, preventing erosion, and later release it back into the atmosphere, producing a cooling effect.

4. Trees are a great carbon sink, with the world's forests removing an estimated 2.1 Gigatonnes (billion tonnes) of carbon dioxide annually! This plays a fundamental role in balancing the world's carbon cycle and helping to combat climate change.

5. Trees are important for creating sustainable cities: in urban areas, they can cool the air by up to 8 degrees, reducing air conditioning needs by 30 percent.

6. Wood fuel provides 40 percent of today's global renewable energy supply – as much as solar, hydroelectric and wind power combined.

7. More than one third of our biggest cities, including New York, Bogota, Tokyo, and Barcelona, get a significant proportion of their high-quality drinking water from protected forests.

8. The world is witnessing a net loss of 3.3 million hectares of forest area a year - an area the size of Meghalaya and Tripura put together.

9. Every year on 21 March, the world celebrates the International Day of Forests. The theme for 2022 is "Forests and Sustainable Production and Consumption" and the theme for 2023 is "Forests and Health".

Cross linkages between forest resource consumption, climate change, land degradation and biodiversity loss are scientifically well established. With economic development taking precedence, demand and stress on the forests is likely to continue. While it may not be possible for humans to cut-off their dependence from the forests, time has come to be more responsible and judicious towards protecting the forests before it is too late. With recognition of the critical role played by forest ecosystems in fostering ecological, water and food security more than ever, and integrated approach to "Sustainable Forest Management" is need of the hour.

What is Sustainable Forest Management?

Sustainable forest management is *"The stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems."* (Forest Europe and adopted by the UN Food and Agriculture Organization (FAO).
In simple terms, sustainable forest management is a holistic approach to ensure forest activities deliver social, environmental, and economic benefits, while balancing the economic and ecological functions.

Sustainable forest management relies heavily on timely data that provides accurate and reliable insights in the geographical context. Being interconnected and interdependent, forest functions demand enhanced situational awareness, knowledge, and actionable intelligence for informed decisions. With complex interactions within all the spheres of our environment and communities with local, regional, and global dimensions, there is need for assessing, measuring, and monitoring the forest systems and processes - spatially and temporally. With multiple stakeholders including governments, communities, corporates, civil society, and individuals at play, there is a need for harmonization of efforts that converge towards common goals.

Over years government of India's policies have tried to address the changing dynamics of the forest management and challenges posed. Governance of forest management has undergone change over last few decades. The forest policies of 1894 & 1952 stressed on the production & revenue generation aspects of the forests whereas the principal aim of National Forest Policy (NFP), 1988 was to ensure environmental stability and maintenance of ecological equilibrium. NFP 2018 (Draft) emphasizes on integrated vision for sustainable forest management towards safeguard of the ecological and livelihood security of people of the present and future generations, which is a welcome move, in the light of complex challenges we are faced with.

For India, The UN Decade on Ecosystem Restoration (2021-30) that marked beginning on the World Environment Day (June 5th) this year, provides added focus on achieving existing international commitments and domestic targets. This includes India's commitment to restore a combined 26 million hectares under the Bonn Challenge and Land Degradation Neutrality (LDN), the nationally determined contribution goal to sequester additional 2.5 to 3 gigaton CO2 equivalent by 2030 through improved forest and tree cover, the National Mission for a Green India, the National Mission for Sustainable Agriculture and its sub-mission on agroforestry, and other schemes/programmes. An integrated approach to sustainable forest management will critical for achieving these.

Forests and Technology

In the times of data-driven digital transformation every sector is relying more and more on data and insights for decision support. However, this is yet to make its mark on the forestry sector despite the huge potential it offers. Recent decades have witnessed adoption of technology for forest governance in India, but absence of reliable pan country interoperable forest data continues to be a matter of concern. Inability of the current systems to embrace complexity and facilitate stakeholder convergence are hurdles in the way of addressing multi-disciplinary challenges like ecosystem security, climate change and global warming associated with forest management. It is a herculean task to strike a right balance between the economic compulsions and complex ecological issues. "The Science of Where" comes to our rescue by aiding in contextualizing complex issues and the same time unifying all the actors on a common platform.

Ability to obtain accurate data and reliable insights in the geographic context is critical for the success of forest governance. With their unmatched capabilities Geospatial technologies offer enormous potential to solve complex problems with ease. While use of GIS and remote sensing in forestry has witnessed an increase in recent decades, absence of a standardized framework in the forestry sector and siloed efforts have been preventing stakeholders to leverage the potential benefits holistically. This is despite easy availability of large volumes of location intelligent data.

It is time for bringing a paradigm shift in the way power of geography is harnessed for contextualizing the forest ecosystem as a whole, instead of forests in isolation and unifying actors on a unified environment. Time has come for embracing "Geo-Enabled Forest Governance", which can harness "The Science of Where" to discover insights from within data and transform how governments and communities see, think and act towards forest ecosystems holistically.

Geo-Enabled Forest Governance

With geospatial infrastructure playing a vital role in integrating physical, social, institutional, and economic infrastructure at national, state, and local levels, Geospatial technologies can transform the way we govern our forests and take care of our forest ecosystems.

Conventional GIS offers powerful tools for the collection, storage, management, and intuitive visualization of data from multiple disparate sources on desktop, web, and mobile environments. By bringing together diverse data sets (spatial and non-spatial) and systems together, geospatial technologies aid in identifying complex ecosystem challenges, and address within the political, economic, ecological, and social systems in which they exist.

With its simplification and deployment on the web and in cloud computing as well as the integration with real-time information (the Internet of Things), GIS has proven to be a robust and scalable platform for building forest ecosystem management information systems. As a unified digital environment Geo-enabled Forest Ecosystems Management Information System (GFEMIS) provide capabilities across the forest governance life cycle, including a way to understand knowledge through data exploration, analytics, visualization and sharing and dissemination.

With increased availability and access, satellite data provides birds-eye-view of the forests at a regional scale and advanced optical and LiDAR techniques using helicopters and UAV's provide real-time high-resolution data at local scales. This clubbed by advances in real-time image processing offer capabilities for change detection and spatio-temporal analysis. Mobile GIS tools continue to play a vital role in democratizing geo-information and empowering stakeholders with real-time information for informed decisions and risk mitigation.

Advanced GIS capabilities like spatial modelling and predictive analysis using artificial intelligence, machine learning and big data provide enhanced situational awareness for accurate forecast of likely scenarios to mitigate, plan and respond, including the impact of changing economic, demographic, and climatic conditions. Spatially simulated models provide decision-makers with interactive tools for understanding the physical system and judging how actions on the ground can affect the overall ecosystems. And by integrating these capabilities, "precision forestry" is the new kid on the block - promising to transform the way forests can be assessed, analysed, monitored, and managed through accurate data capture, processing, integration, and dissemination, in real-time.

"Geo-Hub's" are revolutionizing open access of the authoritative forest data, fostering collaboration, and sharing among governments, scientists, NGOs, communities, and other forest stakeholders for informed decisions through data driven insights. Fostering spatial thinking, "Story Maps" are redefining the way we communicate intuitively and spread awareness to a larger audience.

Geospatial Technologies for Sustainable Forest Management

Sustainable forest management calls for maintenance of ecological equilibrium and striking a right balance between ecological, economic, and social priorities. The role of forest ecosystems in protecting fragile ecosystems, watersheds, freshwater resources, biodiversity and biological resources and their impact at local, regional national and global scales is also paramount and needs to be recognized at every level.

Be it reducing threats to forests, forest fire prevention, productivity improvement of natural forests and biodiversity conservation, with context of spatial and temporal diversity at the core, geospatial technologies offer powerful capabilities to assess, evaluate, plan, manage and monitor diverse range of activities on a unified platform.

Reversing the degradation, checking denudation and soil erosion and maintenance of health of forests (vegetation and soils) are vital for enriching ecosystem services. By integrating diverse datasets and simplifying the complex interconnections and interdependencies, GIS provides enhanced situational awareness and actionable intelligence for informed decisions.

With green accounting, valuation of ecosystem services and climate change concerns becoming integral part of the forest planning and management initiatives, contextualized data and insights become critical. By facilitating a common operational picture with data and insights, GIS technologies offers tools to augment measures towards climate change mitigation and adaptation through the mechanism of REDD+(Reducing Emissions from Deforestation and Forest Degradation plus).

Satellite imageries aid in timely detection of changes and response. Spatial modelling can help with better understanding of the extent of damage and deterioration helping stakeholders to be better prepared and respond to the situations. Thus, aiding in strengthening risk assessment, preparedness, and response strategies.

With indigenous communities and dwellers being integral part of the forest ecosystems, need for embracing them along with their livelihood and cultural interests is an important element of sustainable forest management. By fostering community participation and inclusiveness, Geo-Enabled forest governance promotes participative and collaborative problem-solving across the spectrum of ecosystem services, while supporting the strengthening of resilience which is critical for our future.

Planning, Assessment, and Monitoring

Forest resource planning, assessment and monitoring are fundamental to sustainable forest management. Assessing, measuring, and analysing the ecosystem parameters are critical for understanding the ground situations and monitoring them. Be it conservation and restoration, research and development or policy advocacy and development, it is data driven insights that aid in informed decisions. It is important that information on forest and forest ecosystems is timely, reliable, and accurate and easily available and accessible for informed decision-making.

Given the large expanse of areas, structural complexity, spatial and temporal heterogeneity, geospatial technologies play a vital role in planning, assessment and monitoring through data collection and analytics. Powerful capabilities for multi-temporal analysis, area measurement and calculation for assessing deforestation, and analysing the forest cover changes aid in actionable intelligence which is critical for

informed decisions. Terrestrial scanning techniques are proving to be very promising for accurate 3D measurements of the in-situ data, thereby helping in improved accuracies and efficiencies. Clubbed with accurate real-time location intelligence mobile GIS tools are transforming disparate field activities and processes into a unified forestry workflow thereby improving coordination and operational efficiencies.

Protection and Restoration

It is no secret that forests are vulnerable to damage, deterioration, and exploitation, due to various factors. These factors include anthropogenic (e.g. illegal tree felling, burning, etc.) or natural (e.g. earthquake, cyclones, natural landslide, etc.). Other factors could be pests and diseases or human-induced. Protection and restoration of forests and their ecosystems, whether against anthropogenic or natural or human activities calls for spatial understanding of the situations on ground. GIS and remote sensing techniques provide powerful tools to identify the vulnerabilities, assess, model, and prepare to respond.

Given the spread of the forests and their densities, surveillance of forests is always a challenge. Remote sensing techniques and location intelligent IoT devices double up as surveillance tools helping the agencies to monitor the forests with ease and timely identification of unscrupulous and illegal elements / activities with power to respond in time.

With economic value forest produce and trees provide clubbed with climate change concerns restoration efforts need to be ecologically, economically, and socially sound. Geo-enabled restoration efforts aid stakeholders with informed decisions for rehabilitation, reforestation and re-establishment of forests striking a right balance between increasing forest productivity and minimizing the negative impact on biodiversity and livelihoods of forest dwellers.

Biodiversity Conservation Management

Natural forests are rich repositories of biodiversity. Destruction of biodiversity results in equilibrium disturbances which can

be fatal. The widespread damage and suffering inflicted by the COVID-19 pandemic in recent times and SARS, MERS, Ebola, and HIV in the past have been linked to animals by many studies. This is a grim reality of how damage to forest ecosystems is increasing the risk of zoonotic disease transfer from animals to human. There is a need for regular survey and documentation of biodiversity for their taxonomic and ecological value. There is also a need for protecting and preserving habitats of species including that of Relic, Endangered and Threatened (RET) species.

This will not be possible without a proper understanding of the species habitats and their interdependencies. While geo-enabled surveys augment real-time data collection, GIS platforms can support the stakeholders with contextualized information of the species and their habitats and their interdependencies. Spatial modelling using big data, AI and ML facilitates predictive analyses aiding in better understanding of predictive future scenarios which are critical biodiversity management and conservation.

Wildlife Management

India's rich diversity of wild flora and fauna housed in varied ecosystems are integral part of the forest ecosystem. In addition, they also offer economic potential in terms of tourism. Wildlife habitats and corridors are constantly under pressure due to anthropogenic pressures, rising human animal conflicts, illegal trade in wild species and climate change impacts. This calls for a holistic management of protected areas, monitoring and assessment of species, human-wildlife conflict management and strengthening of vigilance to safeguard the wildlife habitats and prevent poaching and other illegal activities.

With spatial and temporal dynamics at the play, geospatial technologies offer powerful capabilities for monitoring and management of wildlife. Over years location intelligent animal collars have proved to be very useful in tracking the movement of the wildlife species and ensuring their protection. Mobile GIS tools are proving to be powerful tools to report animal sightings and their movements. Centralized Geo-enabled platforms are aiding in the visualization and analysis of the animal habitats, their movement patterns, potential human-wildlife conflict situations and species vulnerable to poaching, thus providing actionable intelligence for prevention, protection, and mitigation measures.

Precision Forestry

Precision forestry is the new kid on the block. While currently being adopted in localized environments, geospatial technologies offer enormous potential to adopt precision forestry at regional and national scales.

Taking advantage of accumulated data on ecological processes in forests, AI and ML can provide insights and advanced analytics across all stages of forest management viz. planning, operations, and monitoring. With availability of funds being one of the major challenges for forest ecosystem activities, advanced spatial modelling can aid in building future scenarios helping in optimizing the operations and making them cost effective.

Climate Change

Climate change is real, and we have been witnessing the impact of climate change on the forest ecosystems in recent years. Loss of forests are triggering increase in temperatures and change in rainfall patterns resulting in increased disruptive events along with stress on food and water security. Ironically loss of forests happens to be one of the major contributing factors for the climate change and forests also offer an opportunity to abate the future climate change.

With multiple factors at the play, GIS technologies offer a great potential in addressing the challenges posed by climate change. GIS aids in locating areas where temperatures are particularly high or erratic, discovering how natural atmospheric processes might affect global warming, create models to show how a warming climate might impact the ecology and biodiversity of various regions, examine the relevance of shifts in land cover, deforestation, urban activity, wildlife, etc. By bringing together the diverse multi-disciplinary datasets, spatial modelling, and predictions aid in better understanding of the likely scenarios thus helping in mitigation of the impacts of climate change in an effective manner.

In Closing

When we take away the forest, it is not just the trees that go. The entire ecosystem begins to fall apart, with dire consequences for all of us (FAO). Given the diversity and complexity of the forest ecosystem processes and the threats they face, there is a need to halt the degradation, restore them to reverse the damage and protect them in future. And for this need for data driven digital transformation in the forestry sector is more than ever.

As we kick-off the "The UN Decade on Ecosystem Restoration (2021-30) this year, geo-enabled forest governance offers opportunities to strengthen the forest ecosystem processes across their life cycle. A systemic approach to identify areas of weakness, devising, and implementing suitable responses, monitoring results, continuing adaptation, and strategy calibration to ensure continuity is paramount for forest land restoration (FLR) and ecological security of the country.

Spatial thinking holds the key for sustainable forest management, which can ensure contextualized delivery of social, environmental, and economic benefits, while balancing the economic and ecological functions. Geo-enabled Forest Ecosystems Management Information System (GFEMIS) aid in contextualizing complex forest ecosystem processes to achieve this balance while unifying all the actors on a common platform for actionable intelligence and informed decisions.

Sustainable Forest management can be achieved only through collective efforts of all stakeholders. There is a need for governments and institutions to bring together all the actors including the Forest Protection Committee's, Van Panchayats, Gram Sabhas, NGO's and Civil Society, Communities, Private enterprises, Individuals and Citizens together on a common platform and provide them with accurate and reliable data and insights for participation and collaboration. GFEMIS is a powerful medium to democratize forest information to all stakeholders and will be vital for India to meet its environmental and ecological commitments.

Rapidly changing dynamics of the forest ecosystem call for a periodic revision to policy and regulatory framework backed with evidence and science-based rigour. With capabilities to visualize, analyse, participate, and collaborate along with advanced modelling and spatial analytics, geo-enabled forest governance empowers the forest stakeholders and policy makers to harness the "science of where" along with timely and accurate information for policy interventions.

Finally, by empowering us to holistically manage our forest resources prudently and restore our forest ecosystems sustainably, "Geo-Enabled Forest Governance" is the way forward for safeguarding our planet for future generations responsibly. With time running out, it is now, or never!

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

Capturing thoughts and opinions on how 'Wildlife Institute of India' is spearheading training and education in wildlife management and conservation.

A brief about Wildlife Institute of India

Established in 1982, Wildlife Institute of India (WII) is an internationally acclaimed Institution, which offers training programs, academic courses, and advisory in wildlife research and management. The Institute is actively engaged in research across the breadth of the country on biodiversity-related issues. The mission of WII is to nurture the development of wildlife science and promote its application in conservation, in consonants with our cultural and socio-economic milieu.

What are the key priorities, goals, and vision of the Wildlife Institute of India?

We all are familiar with the issues of climate change that our world faces today, but there is an equally or more important issue faced by us, i.e., rapid loss of biodiversity and habitats. Wildlife Institute of India is dedicated to achieving ecological security for the country. Since inception, we have been working towards building up scientific knowledge on biodiversity resources, training personnel at various levels for conservation and management of wildlife, and carry out research relevant to management. WII is acclaimed for wildlife conservation and management both across National and International forums. We provide technical assistance to the state and central government on policies concerning wildlife research and management. Our research projects span across the length and breadth of the country and are the primary source of scientific information to help conservation.

Currently, in what ways, GIS, is already a part of the cross-functional activities of Wildlife Institute of India?

GIS is part of our ongoing project 'Tracking the Rainbird'. In this project, we try to understand the migratory route of the bird Pied Cuckoo (a brood-parasitic bird migrant to Northern India) utilizing satellite transmitters and ArcGIS for analysis and visualization. We tagged two individuals of Pied Cuckoo from Dehradun, India, using 2gm Argos Platform Transmitter Terminal (PTT) tags to understand its movement patterns. One of the tagged individuals covered approx. 5,000 km distance. Our study provides the first evidence that the bird traveled to Africa from Northern India crossing the Arabian sea. The solution from Esri India, helped us visualize and map near real-time movement and flight path of the Pied Cuckoo. Features like the easy-to-operate interface and agile designing tools of ArcGIS Pro enabled us to create informative and detailed maps. Below, projects where ArcGIS is enabling our organization:

- All India Tiger Monitoring
- Biodiversity Conservation and Ganga Rejuvenation project
- Endangered species recovery programme namely, Great Indian Bustard, Dugong, Gangetic Dolphin, and Manipur Brow-antlered Deer

What have been the key achievements attained by your organization from using Esri technology?

Without robust technology backup, conservation actions are rarely a success. The advancement in geospatial technology makes it possible to study the complex spatial dimension in ecology. In addition, the living atlas, and inbuilt analytical tools in ArcGIS Pro aids to visualize, analyze, and map spatial patterns. In our study, the locational data enabled us to map the movement pattern of the Pied Cuckoo. The data revealed that the migratory pattern of the Pied Cuckoo from India to Africa coincides with the receding Indian Southwest monsoon.

How do you see the role of GIS expanding further to help you achieve your vision?

Rapid advancements in technology have provided conservationists and scientists with the opportunity to better understand wildlife, their habitats, and the threats they face. Application of satellite imaging, analysis, and visualization via Geographic Information technology helps in framing conservation strategies. Wildlife tracking and monitoring are two very significant components of wildlife management wherein GIS enables:

- Ecological and environmental data collection; contributing towards a much greater understanding of species
- Monitoring of animal movements over vast distances and time
- Distribution modeling of species

The integration of satellite tracking, remote sensing, and GIS mapping is helping our organization to tackle large-scale conservation questions through conservation strategies. Having said this, while traditional management methods help, solutions backed by state-of-the-art technologies effectively help in conservation efforts through sustainable management.

RESEARCH PAPER

Land Use Land Cover Change Impact on Carbon Storage and Sequestration in Ranthambhore Tiger Reserve

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The accumulation of CO2 in the atmosphere due to fossil fuel use, deforestation, and other anthropogenic sources is changing the global climate. Carbon emissions from tropical deforestation have long been recognized as a key component of the global carbon budget, and more recently of our global climate system. The Intergovernmental Panel on Climate Change (IPCC) estimated that 1.86 billion tons of carbon is released annually due to LULC change, of which the major part is tropical deforestation, and it is a major source of carbon emissions and an active contributor to global warming. Agriculture expansion due to increasing population has been regarded as one of the primary causes of LULC change / deforestation and a major source of carbon emissions from terrestrial ecosystems. The main objective of this study is to investigate the possible effects of LULC change and increasing CO2 concentration on the carbon storage potential of the Ranthambhore tiger reserve. For this purpose, Esri ArcGIS-10x based InVEST 3.9.0 Carbon Model has been used to estimate the carbon stock in the Ranthambhore tiger reserve. The forest area in Ranthambhore tiger reserve is 529.48 Km2 in 1991, 510.03 Km2 in 2001, 462.64 Km2 in 2011, and 406.48 Km2 in 2021, which is continuously decreasing. Subsequently, carbon storage and sequestration have also decreased from 32.35 (Million Kg / Ha) in 1991 to 24.36 (Million Kg / Ha) in 2021. Carbon storage and sequestration are decreased 7.99 Million Kg / Ha in the last three decades. These changes in forest area can be primarily attributed to human activities at a large scale (tourism) and deforestation in the Ranthambore tiger reserve.

Introduction

The state of terrestrial ecosystems in the present day is a product of past climate and anthropogenic land cover change (Pongratz et al., 2009; Strassmann et al., 2008). Many processes in the terrestrial biosphere operate on centennial to millennial timescales including the growth and development of forests and the dynamics of soil organic matter decomposition (Trumbore, 2000; Canadell et al., 2007). Although there is evidence that even old trees continue to accumulate carbon at a steady rate (Luyssaert et al., 2008), forests tend to be most productive during their early stages of growth; as a forest ecosystem matures, the rate at which it sequesters carbon tends to decrease (Albani et al., 2006) and net ecosystem production approaches zero (Canadell et al., 2007). Thus, the potential for carbon to be stored in terrestrial ecosystems in the future depends strongly on past ecosystem history and the trajectory of ecosystems at present (Magnani et al., 2007).

About the Study Area

The study area is the Ranthambhore tiger reserve, which is located at Sawai Madhopur district of western Rajasthan, and the junction of the Aravalli and the Vindhyanchal mountain ranges (Figure 1). The Ranthambore tiger reserves spread over 1394.48 Km2, out of which 666.92 Km2 is a reserve forest, 726.81 Km2 is protected forest, and 0.75 Km2 is unclassed forest. The Ranthambhore tiger reserve is divided into almost two equal parts by the river Banas. The area south-west of Banas having Ranthambhore national park, Sawai Madhopur Sanctuary, Sawai Mansingh Sanctuary, and Qualji closed area constitutes the core division of the Ranthambhore tiger reserve with HQ at Sawai Madhopur. The national park area is considered as the core area of the tiger reserve and the adjoining forest areas and the sanctuaries are treated as the buffer for the core. North-east of Banas having Keladevi sanctuary constitutes the buffer division, with HQ at Karauli. The Keladevi Sanctuary also acts as a buffer for the Ranthambhore national park (core area).

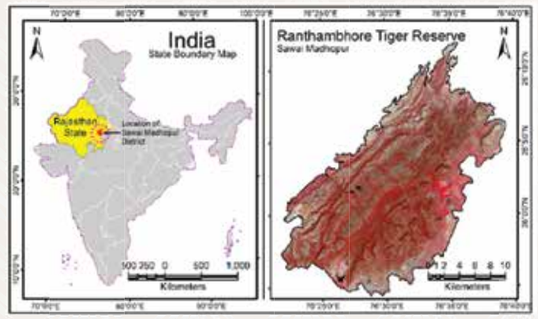


Figure 1. Location Map of the Study Area

Data Used and Methodology

Landsat satellite imageries of years 1991, 2001, 2011, and 2021 have been downloaded from Earth Explorer, USGS: https://earthexplorer.usgs.gov. The detail of these datasets with satellite name, sensor type, spatial resolution, and acquisition date is given below.

- *Landsat-5 TM (30 m spatial resolution): 14th March 1991*
- *Landsat-5 TM (30 m spatial resolution): 02nd April 2001*
- *Landsat-7 ETM+ (30 m spatial resolution): 21st March 2011*
- *Landsat-8 OLI (30 m spatial resolution): 16th March 2021*

These raw data or separate bands have been stored in a specific folder and by using ESRI ArcGIS 10.7.1 software (with ArcToolbox => Data Management Tools => Raster => Raster Processing => Composite Bands) these satellite imageries were geo-processed including the removal of haze and noise. The projection system - Universal Transverse Mercator (UTM) zone no. 43, and datum - World Geodetic System 1984 (WGS-84) were used for better calculation and verification of distances between utilities, riverbank, and land use land cover classes. The nearest neighborhood method was used for the transformation of the raw satellite data to geo-referenced satellite data. An automatically generated root mean square error (RMSE) has been maintained at less than 0.23 (Figure 2). Digital image processing (DIP) and visual image interpretation techniques using ArcGIS 10.7.1 software were used for land use and land cover (LULC) mapping of the study area.

LULC Mapping and Change Pattern Analysis

The LULC pattern of any region is an outcome of various physic-cultural factors and their utilization by man in time and space. Image Classification Toolbar (ArcToolbox => Spatial Analyst Tools => Multivariate => Iso Cluster Classification) in ArcGIS 10.7.1 software has used to generate different raster based LULC layers of year 1991, 2001, 2011 and 2021. It is an essential tool for extracting quantitative information from remotely sensed image data. LULC of the study area comprises mostly of forest land (average 63%) and agricultural land (average 17%) (Figure 2). This initial observation is confirmed by the statistics given in Table 1.

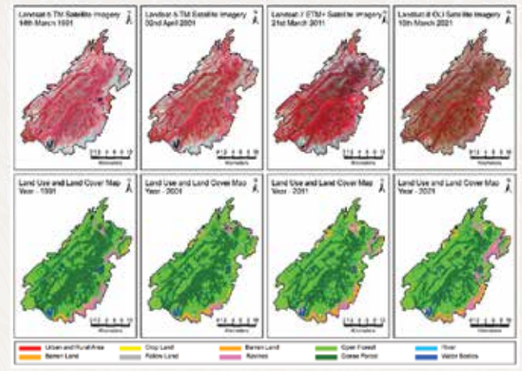


Figure 2. Satellite Imageries and LULC Maps of the Study Area

The post-classification approach is used in the study to detect the changes between two dates. In this approach images belonging to different dates are classified and labeled individually. Later, the classification results are compared directly, and the area of changes is extracted (Jensen, 1996; Yuan et al., 1999). Individual classification of two date images minimizes the problem of normalizing for atmospheric and sensor differences between two dates. To find out the change categories, the Image Analyst extension of ArcGIS 10.7.1 software was used. Images of two years were input and as a result, the output image contained the change categories. The summary of the LULC change pattern analysis of the Ranthambhore tiger reserve is given in Table 1.

Table 1. Land Use and Land Cover (LULC) Classes and Change Pattern Analysis

S. No.	LULC Classes	LULC Area (Km2)				LULC Change (Km2)		
		1991	2001	2011	2021	1991-2001	2001-2011	2011-2021
1	Settlement	2.31	2.57	4.47	7.86	0.26	1.90	3.39
2	Crop Land	40.54	53.27	85.31	40.44	12.73	32.04	-44.87
3	Fallow Land	89.94	90.52	60.49	78.62	0.58	-30.03	18.13
4	Barren Land	44.03	45.57	71.58	141.51	1.54	26.01	69.93
5	Open Forest	247.94	268.50	271.84	242.83	20.56	3.34	-29.01
6	Dense Forest	281.54	241.53	190.80	163.65	-40.01	-50.73	-27.15
7	Ravines	50.20	56.26	73.69	84.77	6.06	17.43	11.08
8	Riverbed	14.05	15.96	12.30	9.58	1.91	-3.66	-2.72
9	River	6.82	4.17	7.61	8.22	-2.65	3.44	0.61
10	Water Bodies	4.86	3.88	4.14	4.75	-0.98	0.26	0.61
	Total	782.23	782.23	782.23	782.23			

Overview of Forest Carbon Stock Measurements

The main carbon pools in tropical forest ecosystems are the living biomass of trees and understory vegetation and the dead mass of litter, woody debris, and soil organic matter. The carbon stored in the aboveground living biomass of trees is typically the largest pool. Estimating aboveground forest biomass carbon is the most critical step in quantifying carbon stocks and fluxes from tropical forests. Measurement protocols for other carbon pools are described elsewhere (Post et al., 1999; Brown et al., 2003; Pareta et el., 2011).

The dry biomass can be converted to carbon content by taking half of the biomass weight (carbon content ≈ 50% of biomass; Westlake, 1966). Carbon is lost to the atmosphere as CO2. To convert carbon in biomass to CO2, the tonnes of carbon are multiplied by the ratio of the molecular weight of carbon dioxide to the atomic weight of carbon (44/12). Estimating the biomass density of forest components is, therefore, the first step in forest carbon accounting.

The InVEST 3.9.0 Carbon Model

Carbon storage on a land parcel largely depends on the sizes of four carbon pools: aboveground (AGB) biomass, belowground (BGB) biomass, soil organic (SOM), and dead organic matter (DOM). The InVEST Carbon Storage and Sequestration model aggregates the amount of carbon stored in these pools according to the LULC maps. For each LULC type, the model requires an estimate of the amount of carbon in at least one of the four fundamental pools, described in Table 2.

Table 2. Carbon Stored in Above and Below-Ground Biomass Differs Strongly among LULC Classes

LULC Classes	Amount of Carbon Stored (Mg ha-1)*			
	AGB	BGB	SOM	DOM
Dense Forest	140	70	35	12
Sparse Forest	65	40	25	6
Crop Land	23	35	30	5
Fallow Land	15	35	30	4
LULC Classes	**Amount of Carbon Stored (Mg ha-1)***			
	AGB	BGB	SOM	DOM
Scrub Land	30	30	30	13
Open Land	5	5	15	2
Urban Area	4	5	15	1
Other Land	0	0	0	0

Note: The unit for all carbon pools is Mg of elemental carbon ha-1. This means that if your data source has information on Mg of CO2 stored ha-1, you need to convert those numbers to elemental carbon by multiplying Mg of CO2 stored ha-1 by 0.2727.

The model runs on a gridded map of cells called raster format in ArcGIS software. Each cell in the raster is assigned a LULC type such as forest, pasture, or agricultural land, etc. After running the model in raster format, results have been summarized and given in Table 3.

Year	1991	2001	Change 1991-2001	2011	Change 2001-2011	2021	Change 2011-2021
Forest Area (Km2)	529.48	510.03	-19.45	462.64	-47.39	406.48	-56.16
Carbon Stored (Million Kg / Ha.)	32.35	30.66	-01.69	27.52	-03.14	24.36	-03.16

Over the past century, human activities like the burning of fossil fuels, deforestation, and urbanization have resulted in the high concentration of CO2 and other greenhouse gases in the atmosphere. CO2 is one of the most common greenhouse gases resulting in global warming which in turn brings about a rise in sea level, drought, deforestation, etc. The forest area in the Ranthambhore tiger reserve has continuously decreased from 1991 to 2021. In the last three decades, the forest area (including open forest and dense forest) has lost 123.01 Km2, subsequently, carbon storage and sequestration have also decreased from 32.35 (Million Kg / Ha) in 1991 to 24.36 (Million Kg / Ha) in 2021. Carbon storage and sequestration are decreased 7.99 Million Kg / Ha in the last three decades. Changes in forest area have resulted from human activities at large scale (tourism), and deforestation in the Ranthambore tiger reserve.

Conclusion

Analysis of the carbon sequestration potential of the Ranthambore tiger reserve can have great implications in assessing its input on mitigating climate change. Monitoring changes and time series analysis is quite difficult with the traditional method of surveying. Remote sensing and GIS analytical techniques can be applied for forest cover change detection and change in biomass. Through multi-temporal satellite images, it is not only possible to monitor the changes in coverage over the years but also provide estimates of carbon stocks built-up or lost. Remote sensing provides the synoptic view of the study area with coverage on different timelines used for detection of change. Remotely sensed satellite data is a technology to calculate the biomass and ultimately carbon sequestration value of plants in a larger area in quick turnaround time and is cost-effective.

If Our Forests Could Talk:
New Maps Spotlight Forestry Concerns in Canada

Researchers upended much of what people thought they knew about forests when they discovered that subterranean networks of fungi actually help trees communicate and cooperate. The symbiotic relationship was first observed when fungi were found to be helping trees transport water and nutrients. Then researchers saw that the fungal threads connecting all trees carry alarm signals and even hormones from tree to tree. With greater awareness of forest interconnectedness—and a realization that old-growth forests are healthier and more tolerant of climatic stress—many industry leaders are rethinking forest practices.

There is growing consensus that it makes much less sense to clear-cut a primary forest—one made naturally and existing for ages. Nor is it prudent to plant only a monoculture species of a tree because growth slows when old forests are replaced by plantations. As tree planting operations commence on a massive scale around the world, scientists are more certain that natural forests can better support our planet through carbon storage and sequestration.

For advocates in British Columbia—where the awareness of fungal forest communication first took hold—government policies and industrial practices are not changing quickly enough. Volunteers with Conservation North work to protect wild plants, animals, and their habitat in the north of the province. When they learned the locations of primary forests, they shared an interactive map with the intent to preserve them or at least drive awareness of their critical status.

The Seeing Red map, created by importing logging data into a geographic information system (GIS), reveals that very few primary forests remain. Many areas have been disturbed by industrial logging, noted in red on the map, while shades of green show the untouched forest.

"What shows up as red are the human-created landscapes—industrially managed areas," said Michelle Connolly, director of Conservation North. "The government and industry like to say how sustainable forest management is in BC, and meanwhile, the evidence points otherwise, including the fact that the iconic mountain caribou are basically in an extinction vortex. We're grateful for this tool because it really communicates something completely different from what we've been hearing."

Getting beyond All-Green Images

To build its interactive map, the team at Conservation North gathered GIS layers from the BC Data Catalogue, the BC Oil and Gas Commission Resource Centre portal, and Canada's National Forest Information System. A report on old growth forests prepared by scientists served as an impetus.

"The report was a pioneering effort to look at old growth from a provincial perspective that only included tiny static maps, and we wanted to have something we could zoom into," Connolly said. "Both our Seeing Red Map and Old-Growth map use the report's methodology, and the scientists who wrote the report have reviewed and approved of our maps. —we're proud that they told us the maps are solid and defensible."

The Conservation North team knew it was important to be accurate in their scientific inquiry and mapping because they knew the data revelation would stir emotions. The maps contained indisputable visual evidence many people were

unprepared to accept.
“I heard from a critic the other day claiming that we could have just used Google Earth or satellite imagery to show the forestry impacts,” Connolly said. “That does not work though, because all the land will look green if it’s grown back. We needed GIS to look at the cumulative impact of industrial logging and roads.”

Much of the historical logging that took place in the Pacific Northwest was fairly low impact until clear-cutting became the standard practice. The maps detail the more recent story. “Most of what you see on our maps are the result of modern industrial activity over the last 60 or 70 years,” Connolly said. “Our maps are actually an overestimation of what’s natural because they don’t show all of the historical logging.”

While showing the current state of forests in the region, Connolly and her team also wanted the project to help quantify the value of the primary forest and identify where old growth can be saved. “The exercise started because we needed a conservation planning tool,” Connolly said. “We spend a lot of time in the field, witnessing the impacts of industrial forestry. We wanted to know where the largest intact areas are. We could figure that out partly by hiking into these areas, but we needed the perspective only a map could provide.”

The Seeing Red Map and Old-Growth map may now be more crucial to the region’s conservation efforts. In 2020, the BC government placed an emphasis on wood pellets—a biomass fuel burned for heating or electricity—but did not specify that the fuels should come from second growth forests.

“All forests may now be on the chopping block, and this is terrifying,” Connolly said.

Avoiding Industrial Harm

Conservation North calls itself biocentric—valuing nature for its own sake—with the conviction that by just being in a natural setting, people reap therapeutic benefits.

“We recognize that people derive a lot of really important things from forests,” Connolly said. “But products should not come from primary forests. They should come from previously logged areas. Sometimes people call this second growth.”

In the group’s primary focus area in northern BC, they found three valleys still intact and several more pockets across the landscape they feel are important to protect. “We know that the biggest, oldest trees are at the most risk from logging, and we’ve heard that the forest companies have been using lidar to identify all the remaining old-growth forest in the Robson Valley, which is just east of here,” Connolly said. “The motivation for our map is to change policy and protect these places for the long term.”

Conservation North is focusing on the region known as Ltha Koh in the local language of the Dakelh people, which translates to Big Mouth River. This apt description covers an area that sits at the headwaters of the Fraser River, one of the longest river systems in the world. “The Fraser River is a wild river, it’s never been dammed,” Connolly said. “Ltha Koh is a critical opportunity for protection.”

Looking for Biodiversity Returns

The volunteers with Conservation North hope their maps can change mindsets to foster broader conservation efforts and inspire industry or government leaders to reconsider approaches to forestry.

“There’s a pervasive belief within professional forestry that nature needs our help and that humans need to intervene to manage forests,” Connolly said. “The map challenges that belief system by showing unmanaged forests as having value on their own. Some places ought to be left alone.”

Much of the local industrial pressure in old-growth forests calls for large spruce trees to be harvested as lumber. While the team at Conservation North works to salvage the region’s biodiversity, they worry about losing plants and animals that cannot be replaced if ecosystems continue to degrade.

“We don’t have the towering coastal trees like Vancouver Island and California. We do have a natural rain forest in the interior, and our group was focused on that ecosystem, but we’ve realized that everything is under threat,” Connolly said. “We know that wildlife populations are collapsing across Canada. I’ve spoken with wildlife biologists who tell me that every species we’re bothering to measure is in decline.”

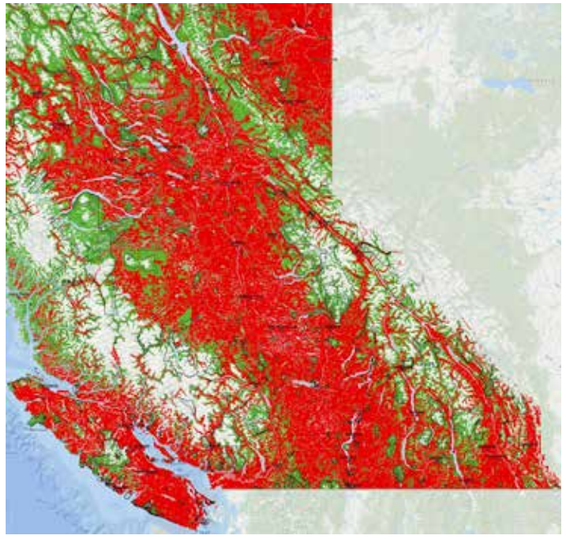
Energizing Further Forest Activism

Public awareness of the biodiversity problem has been growing. And when Conservation North’s Seeing Red map was released, it drew a lot of attention.

“We knew at an intuitive level that industrialization has had a massive impact on the land in BC, but we didn’t have a way to see it or communicate it,” Connolly said. “Until we did this, no one had a bird’s-eye view of just what is left of natural forest in BC.”

People and groups from across the province got in touch to express their appreciation for the map. “We heard from community groups and First Nations communities who said the map had a real impact on their work because now they realize what they need to protect,” Connolly said. “We’re all coming from the perspective that what’s already been harmed should be where we harvest, keeping our footprint to those areas and leaving natural areas alone.”

Suzanne Simard is the scientist at the University of British Columbia whose PhD thesis vaulted into the prestigious journal Nature in 1997, because her research “shows unequivocally that considerable amounts of carbon—the energy currency of all ecosystems—can flow from tree to tree, indeed, from species, in a temperate forest.” Connolly took Simard’s Forest ecology course as an undergraduate, and like most who learn the language of trees, it changed how she looks at the forest.



Simard’s work to understand forests continues, with a growing focus on resilience and adaptation to climate change. To advance this work for the health of forests and the planet, primary forests must first be preserved. That is where the mapping work of Conservation North could be pivotal—showing where to harvest, protect, and renew—to promote greater carbon capture and biodiversity for both flora and fauna.

TIPS & TRICKS

Transforming Field Operations for Environmental Compliance

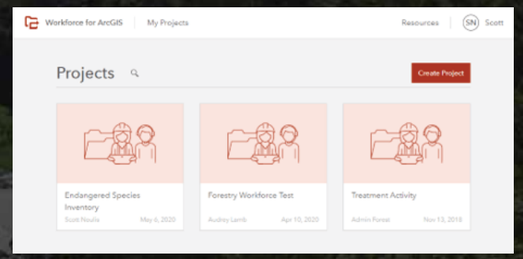
Forests support a delicate ecosystem that provides raw materials and recreational opportunities for humans and serves as a habitat for diverse species and wildlife. Forestry involves the management of a broad range of natural resources within a forested area. In addition to timber, forests provide resources such as grazing land for animals, wildlife habitat, water resources, and recreation areas. For forest organizations, the management of productive timberlands with a high standard of environmental stewardship is key to maintaining this balance.

The core function of any active forest company is to monitor sensitive wildlife species within the area of their operation. Using the power of location, the ArcGIS platform offers a streamlined workflow that allows wildlife surveys and observations to be completed in a much more efficient manner. The platform also provides near real-time status updates of wildlife monitoring activities, enabling faster and better-informed decision-making related to forest activities in sensitive areas.

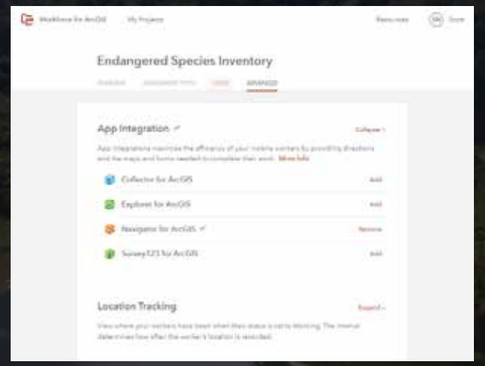
Workforce for ArcGIS: A Coordination and Management Tool

Workforce for ArcGIS is a coordination and management tool that addresses many of the challenges that occur in the coordination and management of fieldwork in forestry. With Workforce, a dispatcher in the office can assign work to each field worker, track the progress of completed work, and address unplanned issues that arise throughout the job. Workers in the field can use the mobile app to view a digital to-do list, update the status of complete assignments, and launch other apps to navigate, view maps, and collect data – all completely offline.

- Create a Workforce Project: Workforce for ArcGIS is a project-based application in both ArcGIS Online and ArcGIS Enterprise in which a user can create a project to coordinate and managed inventory and survey activities.



- Assignment types can be added next which lets a user define the scope of work within the project. An assignment is a task or activity required to be performed in the project.
- Roles can be provided, and users can be added to participate in the project. Roles define where the project can be used.
- It is possible to customize and configure the maps used by the web app and mobile app with your layers to provide additional context. Also, additional settings can be configured to allow App Integration to enable apps such as Collector, explorer, and Survey 123.



Data Collection

The accuracy of the information captured is equally important as the content that is recorded. Data if entered incorrectly or not recorded can flaw the results. Survey123 can be used as a form-centric solution for data collection requirements and specific reporting standards needed for a project. Forms can be designed with predefined questions, logic, easy-to-fill answers, and attachments to support rapid and accurate data collection both online and offline.

Monitoring and Situational Awareness

The ability to monitor the progress of field crews and process collected data quickly and efficiently enables more confident decision making and a quicker response to issues that arise. ArcGIS Dashboards can be configured to track and monitor the overall progress of the field workforce by comparing planned and completed activities.

Using the ArcGIS platform to support endangered species monitoring can help streamline workflows, increase efficiency and accuracy during data collection, and support enhanced decision making. This enables your organization to responsibly manage timberlands while protecting the delicate ecosystems that lie within.

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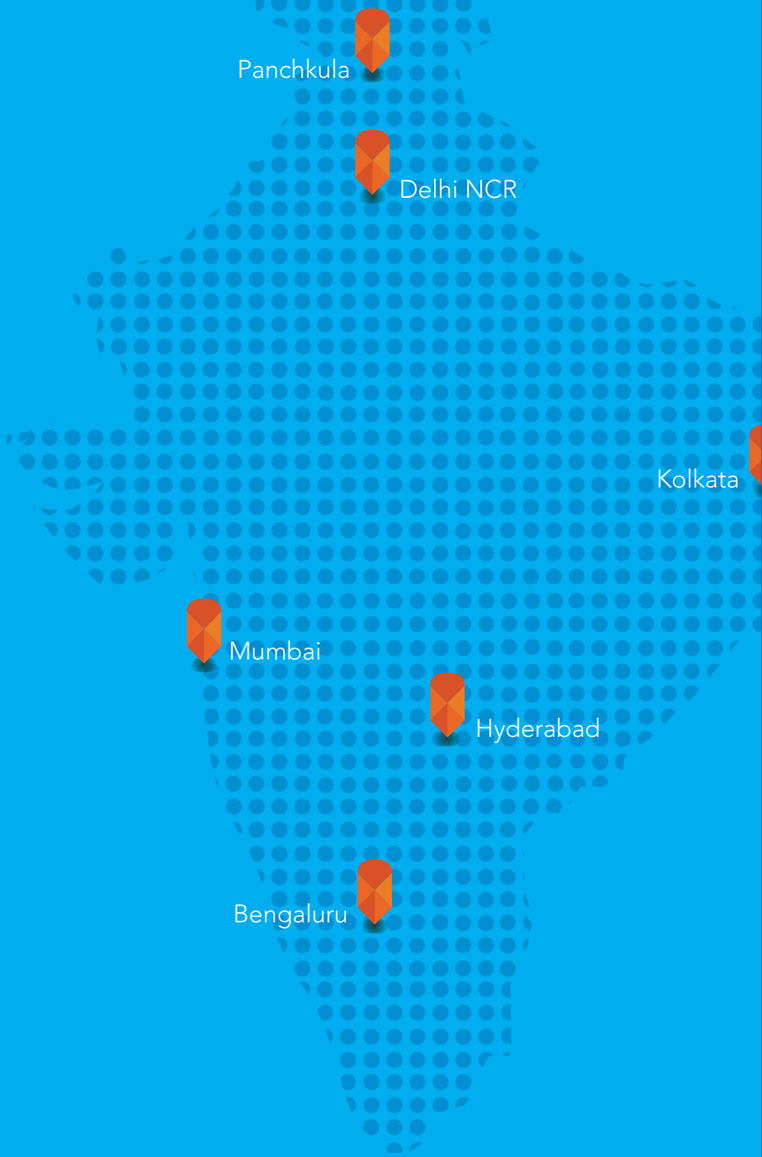

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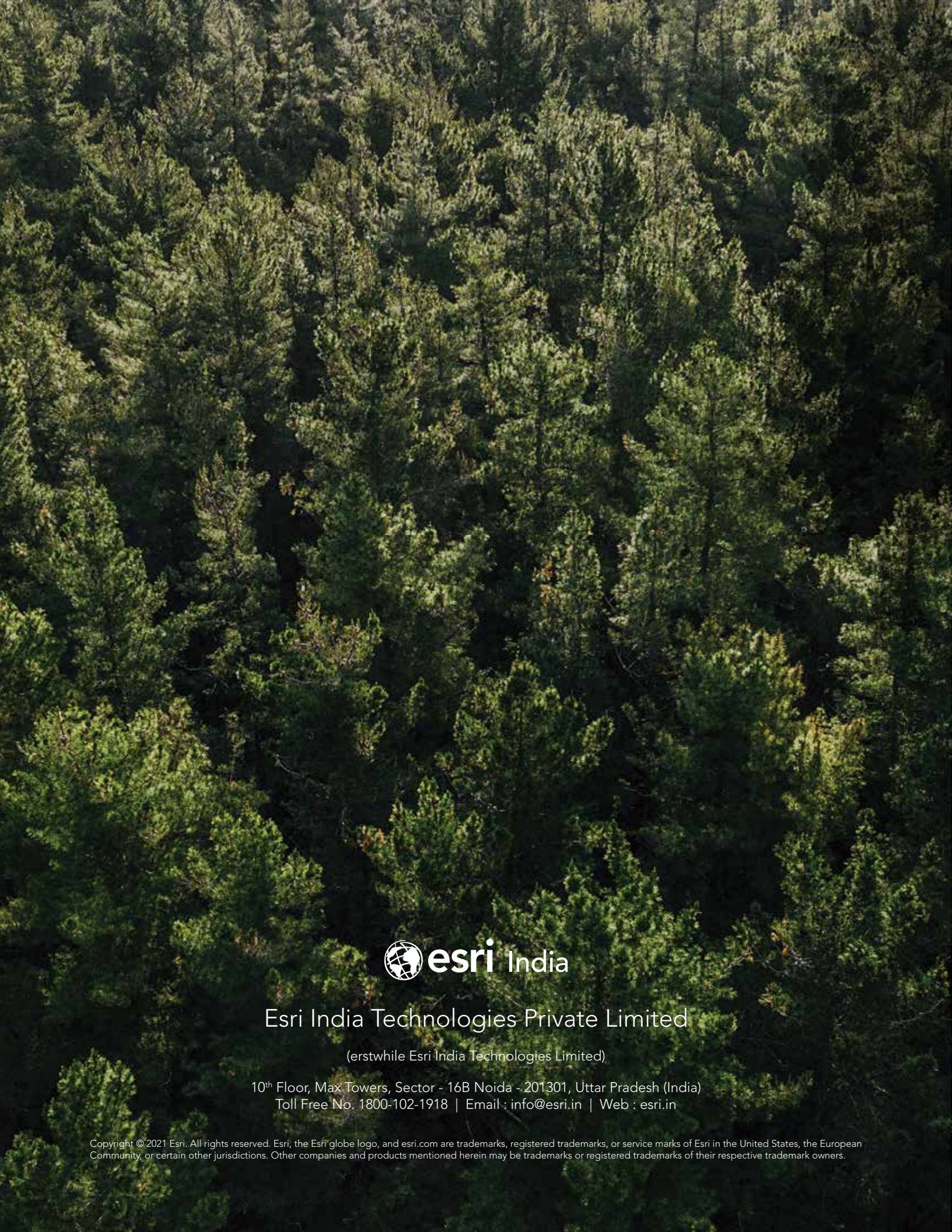

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