ASSOCIATION OF GEOSPATIAL INDUSTRIES

NEWSLETTER

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Theme: Natural Resources

In this Issue

From the President's Desk

For decades, natural resource management has relied on traditional methods that were often time-consuming and geographically limited. However, the surge in adoption of Geospatial technologies has ushered in a paradigm shift, offering a powerful suite of tools that enhance our understanding, protection, and utilization of our most valuable assets: land, water, soil, mineral deposits, and forests

With its ability to gather high-resolution imagery and spectral information from satellites and aerial platforms, Remote Sensing helps monitor land cover changes, assess forest health, and identify areas of deforestation or soil degradation. But data alone isn't enough. That's where GIS steps in, integrating this data with other georeferenced information and geological surveys. GIS allows for spatial analysis, enabling resource managers to identify trends, understand complex relationships, and make informed decisions. Think of vulnerability maps for drought-affected areas and proactive water management strategies.

More advanced and diverse Geospatial technologies extend beyond mere observation to resource efficiency and minimum environmental impact. Precision agriculture, for instance, uses Geospatial tools to optimize fertilizer application and crop selection based on specific soil characteristics within a field. Geospatial technologies can analyze geological formations and mineral signatures, guiding exploration efforts toward areas with a higher probability of resource deposits.

By analyzing satellite imagery and LiDAR data (3D laser scanning), foresters can map tree canopy cover, assess forest biomass, and detect illegal logging activities, paving the way for sustainable forest management practices. The integration of Geospatial technologies into natural resource management, therefore, represents a significant leap forward.

At the Association of Geospatial Industries (AGI), our mission has always been to promote and advance both the Geospatial industry and Geospatial technologies and applications in India. As a forum for exchanging ideas, techniques, approaches, and experiences by those who design, implement, and use Geospatial technology solutions, AGI dedicates this Edition of its newsletter to the theme of Natural Resources and the role of Geospatial technologies in its effective management.

We hope this Edition comes across as insightful and enjoyable. Stay tuned for more insights, stories, and analyses from AGI in the coming months.

Enjoy Reading,

Warm regards,

Nikhil Kumar
President, AGI.

From forest management to water resource management to mining, our solutions are empowering the stakeholders with data insights and tools.

"Our solutions are facilitating planning, managing, and monitoring the natural resources efficiently and effectively," *notes Mr. Agendra Kumar, Managing Director, Esri India.*

Esri India has been a leader in GIS solutions for over 25 years, empowering organizations to make informed decisions across verticals. Can you share a specific success story where your solutions have impacted the management and conservation of India's natural resources?

Esri's ArcGIS System is empowering decision-makers across the natural resource management sector to manage the resources optimally. From forest management to water resource management to mining, our solutions are empowering the stakeholders with data insights and tools. Our solutions are facilitating planning, managing, and monitoring the natural resources efficiently and effectively. If we specifically talk about forests, Geo-enabled forest governance holds the key to solving the Earth's most pressing challenges with geographic expertise. With the ability to visualize and analyze along with advanced spatial analytics, geo-enabled forest governance, powered by ArcGIS, is helping authorities across multiple states to further strengthen their forest management efforts.

ArcGIS helps in integrating many types of data, including remote sensing data, whether it is from earth observation satellites, drones, or other aerial methods. Elevation and Land cover data which is obtained through remote sensing is very important for many applications, having this data in GIS makes it easy to use in applications. Remote sensing data is usually voluminous and requires time and a large IT infrastructure for processing and storage. It becomes imperative to get maximum value out of the investment made in this data. This is where ArcGIS technology plays a complementary role with remote sensing data by providing tools for data integration, spatial analysis, visualization, data management, modelling, simulation, and decision support, thereby helping the stakeholders to overcome the challenges associated with remote sensing.

ArcGIS includes capabilities for visualizing, managing, processing, and analyzing imagery and raster data. ArcGIS Image Analyst provides more advanced image analysis capabilities and ArcGIS Image Server comes in handy for serving the image data for users and applications.

Additionally, Indo ArcGIS offers specially curated solutions for solving some of the most pressing challenges of natural resource management in India. These unique solutions for burnt area assessment, forest fire management, water resource management, forest plantation management, disaster management, land management, etc. are paving the way for sustainable natural resource management in India. These solutions are supported by 900+ layers of data through the Indian edition of ArcGIS Living Atlas.

Esri India's solutions have been instrumental in water resource management across India. Can you elaborate on how your solutions are helping monitor water levels, identify areas of drought or scarcity, and plan for efficient water distribution?

For socio-economic growth and prosperity, enough water of good quality must be available to meet the requirements of agriculture, industries, the domestic sector, etc. We are working with the Ministry of Jal Shakti and central and state water agencies to create systems that can help in optimally utilizing water resources.

Esri's ArcGIS is playing a crucial role in the conservation efforts of the Ganga River. The GIS-based 'Web Centric Water Quality Dashboard', used by the National Mission for Clean Ganga (NMCG) authority aids in effectively assessing the current state of the Ganga River, identifying pollution sources, and planning conservation strategies.

Our GIS solution is also helping the National Water Informatics Centre

to foster both environmental conservation and economic development. Powered by ArcGIS, the India-Water Resource Information System ensures the provision of reliable, timely data and insights for comprehensive future water projections. The system supports informatics-based sustainable development in water resource management, delivering value-added products and services to all stakeholders.

We supported the development of an application called Water Accounting Plus (WA+) Dashboard (WADA) for the National Institute of Hydrology (NIH) Roorkee, the principal Hydro Research Institute of India, that enables the farmers/stakeholders to achieve higher agricultural production by analyzing green and blue water consumption patterns at sub-basin and district levels. The application helps in identifying the hot spots (districts that either have low water productivity or land productivity or both) and bright spots (districts that have both high water productivity and land productivity). This identification helps in taking timely actionable measures at the farm/region level and preparing effective agricultural water management plans to achieve the targets of 'water and food security 'and 'more crop per drop'. Moreover, as data related to water level, water quality, etc. get monitored in real-time through such applications, they largely help in sustainable water resource management.

These are a few of our solutions that are helping water resource departments across the country monitor water levels, identify areas of scarcity, and plan for efficient water distribution.

How is GIS enabling the hydrocarbon segment in India? Please share specific examples.

Location data and analytics underpin every element of the petroleum segment from finding and developing resources to refining and transporting products to supporting sales and marketing efforts. By employing spatial analysis and 3D modeling, companies accurately pinpoint resource locations, assess their potential, and plan extraction strategies that minimize environmental impact. Advanced GIS applications facilitate the design and monitoring of pipeline networks by incorporating terrain analysis, risk assessment, and real-time data from IoT sensors. This holistic view allows for the optimization of routes that lower construction costs and minimize environmental disturbance.

Networks of large transmission pipelines form energy highways. These pipelines carry both natural gas and oil over large distances — from remote locations to cities where the products are needed. A robust pipeline network is therefore critical for transferring the finished petroleum products to end-users or dependent industries. At the same time, safety is also a very important concern. GIS helps in establishing a robust pipeline network. We observed the benefits when our partner SECON used ArcGIS to customize a robust system of Pipeline Geographic Information System (PGIS) involving data of pipeline route survey, planning, and execution for GAIL, India's leading natural gas company. The system has helped GAIL to deliver unmatched results across the natural gas value chain. Esri's ArcGIS brought unmatched excellence in the pipeline route management process. The Alignment Profile and DEM Generated using high-resolution satellite images were useful for planning the pipeline network. The up-to-date base map prepared included information like land use information, terrain, vegetation information, topographical features, dwellings, developments, etc. along the pipeline,

The Seismic Hazard zonation of Dehradun has been adopted in the new building bylaws. The same has been proposed for Lucknow, but it is yet to be considered for the city's building code.

administrative jurisdiction, important locations, access to emergency locations, and more.

Data integrated with GIS can be used for the updation of Population Density Index (PDI) data, emergency location details, etc. at regular intervals. Also, using 3D-GIS we can convert complex infrastructure networks into easy-to-understand visualization. The operation and maintenance of pipelines also become easier with GIS since pipeline sections requiring due attention become immediately noticeable.

Additionally, since the development of renewable energy sources—such as wind, solar, hydrogen, and geothermal energy facilities and the infrastructure to support them are inherently spatial in nature, GIS can help stakeholders optimize energy transmission systems. GIS can be used to collect data about potential routes for new transmission lines and then analyze that data to map routes with the lowest costs and fewest hurdles.

Sustainable forest management is crucial for India's environment. How are Esri India's solutions being used to track deforestation, monitor forest health, and support conservation efforts in protected areas?

Through our forest management solutions, we have made it easier for stakeholders to monitor forest health, create inventories of forestry data, and also analyze ecological parameters. Many state government departments have already been using ArcGIS 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 them vis-a-vis revenue boundaries, utilizing mobile-based GIS for data collection, incident management, and tracking beat guard movement. This is largely helping in sustainable forest management. Forest departments are also 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.

Minerals are vital for India's economic development. Can you share some insights into Esri India's solutions for mineral exploration, optimizing extraction practices, and ensuring responsible resource utilization?

From mineral exploration to mine remediation, Esri's ArcGIS supports decision-making throughout the entire mining life cycle. Adani Natural Resources is harnessing the capabilities of ArcGIS to make informed decisions in mining. The GIS System is helping in:

Contiguous acquisition and tracking of land in areas of interest demarcated by mine planners designated to certain activities like mining, dumping, or infrastructure areas.
Infrastructure planning. GIS applications integrate geological model databases, surface features, and existing mining features to suggest suitable infrastructure areas.
Monitoring large mining landscapes from drone data and tracking land reclamation details, vegetation planning, vegetation health growth, and mining operations.

- Exploration planning in undulated topography and tracking exploration progress through GIS dashboards and analytics.
- Monitoring of safety and environmental parameters in the mining area.
- Effective evacuation and logistics planning.

We've seen rapid technological advancements in recent years. How do you see GIS offerings evolving to cater to the growing adoption of technologies like AI, Machine Learning, and Big Data in various fields?

GIS, by taking on a synergistic role with cutting-edge technologies such as artificial intelligence, machine learning, and big data, can elevate the precision of business outcomes. This synergy can bring novel advantages to tasks like site selection for infrastructure or commercial projects, optimizing intricate supply chains, and myriad other applications across core verticals such as banking and financial services, retail, manufacturing, and utilities.

Of late, we have been seeing cloud-based, scalable solutions in the GIS arena. These solutions can help organizations access GIS data anywhere, at any time, on any device, and in a much more affordable manner. For our customers who have a modern cloud strategy, ArcGIS Enterprise on Kubernetes provides several benefits. Administrators can enjoy fast, simplified deployment and

We are collaborating with academic institutes at all levels by way of learning resources, events, and training programs so that students can embark on GIS education, training, and research on time. Some of our specialized programs include the Young Scholar Program, Master's Scholarships in GIS, and MMGEIS.

and upgrade experiences, which no longer require preparing and managing individual servers and virtual machines. Users also receive increased visibility into the system's health, due to granular logging and metrics for individual systems and user-managed services.

As GIS becomes more accessible through cloud-based solutions and user-friendly interfaces, its potential for addressing complex challenges, from urban planning to disaster management, grows exponentially. By facilitating the integration of various types of data in GIS systems, data portals can enable easy sharing of data. Geo-Hubs can create more collaborative working environments and increase community engagement.

By integrating augmented reality (AR) and virtual reality (VR) with GIS applications, we can enable enterprises to visualize GIS data in novel ways and provide a deeper visual understanding of the operations. Digital twins and 3D digital twins are also set to be instrumental in providing organizations with a precise understanding of their operations. GIS and digital twins are revolutionizing decision-making and transforming work processes. Esri's geospatial technology is instrumental in this transformation, as it connects data, systems, models, and behaviors with spatial context.

The application of AI fused with geospatial data, science, and technology is already accelerating real-world understanding of business opportunities, environmental impacts, and operational risks. We call this Geospatial Artificial Intelligence (GeoAI). GeoAI is transforming the speed at which we extract meaning from complex datasets, thereby aiding us in addressing the earth's most pressing challenges. Organizations leveraging GeoAI are revolutionizing how they turn data into information, with models that adapt even as data evolves.

ArcGIS also provides big data processing and analysis capability. Through aggregation, regression, detection, clustering, and so on, one can visualize, understand, and work with big data. Using ArcGIS GeoAnalytics Server, users can gain insights that may otherwise be hidden in their data, such as patterns, trends, and anomalies.

A common challenge in advancing natural resources management with Geospatial technologies is the lack of a skilled workforce at the grassroots. How do you think the industry can help bridge this gap?

Lack of adequate talent is a major hurdle. This can be overcome by industry-academia collaborations. The Government and educational institutes of the country also need to step in to broaden the curriculum with a focus on geospatial technologies and their manifold applications. We are actively working towards building GIS capabilities in the country. This involves educating college graduates and fostering a culture of research and development (R&D) engagement among children and youth. We have established collaborations with various educational institutes to achieve this goal.

We are working with 800+ colleges and universities to skill students in the latest geospatial technologies. We are collaborating with academic institutes at all levels by way of learning resources, events, and training programs so that students can embark on GIS education, training, and research on time. Some of our specialized programs to promote GIS know-how include the Young Scholar Program, Master's Scholarships in GIS, and MMGEIS. Additionally, we offer internship opportunities to students each year, some of whom may even join Esri India based on specific criteria.

Also, GIS professionals who are associated with us are encouraged to upskill their technical competence by undertaking various certifications on ArcGIS. Esri India's HR team conducts specialized training programs to help employees bridge the gaps, and thus transition to higher responsibilities.

In our efforts to educate users about the usage and benefits of GIS, we regularly organize webinars and training programs. These programs encourage users to delve deeper into the GIS ecosystem and explore its full potential.

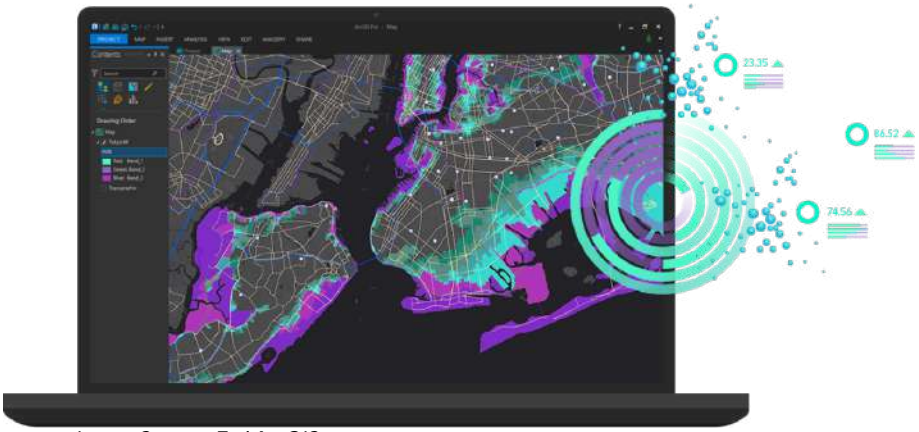


Image Source: Esri ArcGIS

Carbon sequestration analysis with Genesys' Digital Twin; Source: Genesys

ARTICLE

Digital Twins and 3D Mapping for Sustainable Urban Resource Management

Genesys International

In India, urban centres are grappling with significant environmental challenges, including the reduction of green spaces. For instance, Mumbai experienced a decrease of approximately 20% in its green cover between 1988 and 2018. This trend is evident across many Indian cities, highlighting the urgent need for effective management of natural resources in urban environments as cities continue to grow. The scarcity of green spaces, high carbon emissions and the urban heat island effect make it necessary to develop innovative and sustainable solutions. Digital Twins of Indian cities are being created by Genesys using LiDAR technology and aerial imagery, offering precise and dynamic virtual representations of urban areas thereby facilitating to do meaningful analysis of the city environment. LiDAR employs laser pulses to measure distances and detect shapes, creating the foundational of a Digital Twin, while imagery provides realistic appearances of structures and objects. These tools facilitate detailed analysis, real-time monitoring and scenario simulations, optimizing nature-based solutions and urban planning.

By harnessing these advanced technologies, cities can develop more resilient urban environments capable of effectively addressing global climate change. Genesys' 3D data and reality models are already demonstrating their capabilities in carbon sequestration and rooftop solar applications. Additionally, their potential to mitigate the urban heat island effect is an emerging field, particularly relevant in the Indian context where cities are experiencing unprecedented high temperatures.

Mapping and Quantifying Carbon Sequestration

Carbon sequestration is the process of capturing and storing carbon dioxide from the atmosphere. Trees are vital natural resources in urban areas that perform this essential environmental function, along with air purification and temperature regulation. At the core of this Digital Twin-based tree management system would be a comprehensive database of surveyed trees, mapped with data on species, size, and health. . This detailed mapping allows for precise estimation of each tree's carbon sequestration potential, enabling planners to understand the carbon sink capacity of existing vegetation.

By aggregating this data, cities can assess carbon sequestration potential over wider areas, while identifying critical zones where additional greening efforts would yield significant benefits. Furthermore, regularly updated Digital Twins can enhance the accuracy of carbon accounting in cities, allowing for more reliable reporting towards climate change programs such as the Climate-Smart Cities Assessment Framework (CSCAF). Figure 1 below shows how trees can be mapped on Genesys' Digital Twin platform, with data on species and

tools like buffer analysis to estimate carbon sequestration capacity within a selected area.

Digital Twins also support the strategic planning of new green spaces. By simulating different tree-planting scenarios, planners can optimize the placement of trees and parks to maximize their carbon sequestration impact. Leveraging Digital Twins for urban tree management enhances the benefits offered by trees through precise monitoring, management, and optimization of green spaces to maximize their environmental impact. This technology can also be used to facilitate nature-based solutions to mitigate excessive urban heat.

Combating the Urban Heat Island Phenomenon

Urban Heat Islands (UHIs) are urban areas that experience significantly higher temperatures due to human activities, concentrated infrastructure, and heat-absorbing surfaces. Cities are accumulating more heat every year, with Delhi recently measuring a record high temperature of 52.9°C. Nature-based solutions offer some of the best means to combat this phenomenon; trees are known to have a cooling effect in cities by releasing moisture through transpiration, providing shade, and reducing heat absorption by roads. The need for increasing green cover is also emphasized by guidelines put forth in the AMRUT 2.0 scheme. Efforts towards urban greening in this regard can be optimized with the use of Digital Twins and 3D mapping technologies.

To begin with, Digital Twins enable the precise identification of heat hotspots by integrating high-resolution spatial data with thermal imaging, and IoT sensors placed around an urban area. This allows planners to pinpoint areas with elevated temperatures to target tree-planting efforts more effectively. These interventions can be monitored by analysing tree canopies' effects on local temperatures. With simulations and scenario modelling, planners can also test strategies like tree-planting, rooftop greening, and using reflective surfaces. Once strategies are implemented, Digital Twins can provide real-time monitoring of microclimates within the city. This continuous data collection allows for the evaluation of different interventions' effectiveness, ensuring that mitigation efforts are adaptive and responsive to changing conditions. Moreover, cities can also leverage rooftops and excessive sunshine by using Digital Twins to maximise capture of solar energy.

Optimizing Rooftop Solar Installation

As cities strive to meet their energy requirements in a warming and increasingly polluted world, solar energy has emerged as a promising, emission-free solution. While large solar farms in and around cities are impractical, the untapped solar potential of building rooftops can be capitalized on, and Digital Twins can prove to be a vital tool for enhancing the decentralized adoption of solar technologies.

Firstly, Digital Twins can be used to conduct suitability analyses based on roof area measurements, annual sunlight exposure simulations and shadow analyses. Figure 2 shows how shadows can be simulated with Genesys' Digital Twin technology, for any given date and time. Figure 3 shows the roof area measurement functionality. These insights can identify with a high degree of accuracy, optimum sites and rooftops for solar installations. Moreover, angles and orientations of panel placement can be further optimized to maximize energy yield. Based on these parameters, another insight that can be drawn by employing Digital Twins is energy yield estimation, including annual seasonal trends, allowing us to accurately quantify solar potential of each building and understand how energy yields change over the year. From a private sector perspective, electricity distributors could integrate advanced solar calculators into their platforms,

As leaders in geospatial solutions, we are committed to supporting India's vision for greener, cooler, and smarter urban environments.

reducing site visits and providing accurate estimates to customers. From a policy perspective, these insights could support the creation of regional 'solar maps' to evaluate solar potential across larger areas. Digital Twins can form the basis of interactive platforms for utility companies, property owners, and consumers to estimate solar potential across cities. Beyond those mentioned above, some other personalized insights that can be drawn are cost estimates on electricity savings, carbon emission reduction, subsidy calculations, solar installation costs and payback periods. Increasing accessibility of widespread self-assessment of solar potential can improve adoption of solar energy solutions by allowing for more decentralized adoption and informed decision-making.

Conclusion

Genesys is at the forefront of developing Digital Twins in India, providing cutting-edge solutions for urban carbon sequestration, combating urban heat islands, and optimizing rooftop solar. Through its 3D Content Program, Genesys offers datasets and its Platform that align with the objectives and priorities set by the Prime Minister and Government of India to enhance green cover in cities. Genesys' Digital Twin solutions offer significant benefits to government agencies, such as forest departments, pollution control boards and urban local bodies. By harnessing our data and expertise, these organisations can effectively manage natural resources, improve urban sustainability and create resilient cities for the future. As leaders in geospatial solutions, we are committed to supporting India's vision for greener, cooler, and smarter urban environments.

image Source: Hexagon

ARTICLE

Forest Management Using Airborne LiDAR Systems and Geospatial technologies

Hexagon

Forests are not just green patches on the map; they are ecological wonders, cultural symbols, and economic resources. These forests have been intertwined with India's history, providing habitat to a myriad of species and livelihoods to countless communities. The biodiversity within India's forests is awe-inspiring.

An increase in forest cover in India has significant positive implications for the country's environment, economy, and society. Forest cover is crucial for maintaining ecological balance, supporting livelihoods, and contributing to overall well-being. Here's an analysis of what an increase in forest cover means for India:

Environmental Benefits

Biodiversity Conservation

- Habitat Restoration: Increased forest cover provides more habitats for wildlife, contributing to the conservation of endangered and endemic species.

Ecosystem Services: Forests offer essential services like pollination, seed dispersal, and nutrient cycling, which are vital for biodiversity.

Climate Change Mitigation

- Carbon Sequestration: More forests mean higher capacity for carbon sequestration, helping to reduce greenhouse gas concentrations in the atmosphere.
- Temperature Regulation: Forests help regulate local and regional climates by influencing temperature and humidity, which can mitigate the effects of climate change.

Water Resource Management

- Watershed Protection: Increased forest cover improves watershed health, leading to better groundwater recharge and reduced surface runoff.
- Flood and Erosion Control: Forests act as natural barriers against floods and soil erosion, protecting agricultural lands and human settlements.

An increase in forest cover in India brings multifaceted benefits, ranging from environmental protection and climate change mitigation to economic development and social well-being. Effective forest management policies, community involvement, and the integration of modern technologies are essential to sustain and enhance forest cover. By focusing on these areas, India can achieve its conservation goals, support sustainable development, and improve the quality of life for its citizens.

Maintaining and enhancing forest cover in India, How?

Maintaining and enhancing forest cover in India requires a comprehensive approach that involves sustainable management practices, community participation, policy support, and the integration of advanced technologies. Here are the key strategies to maintain forest cover in India:

Sustainable Forest Management

Implement LiDAR for detailed 3D mapping of forest structure, aiding in precise planning and management. Remote Sensing and GIS: Utilize remote sensing and geographic information systems (GIS) to monitor forest cover changes, detect deforestation, and assess forest health.

Forest management is essential for balancing the ecological, economic, and social functions of forests.

Forest Management Using Airborne LiDAR Systems

- Implement LiDAR for detailed 3D mapping of forest structure, aiding in precise planning and management.
- Utilize remote sensing and geographic information systems (GIS) to monitor forest cover changes, detect deforestation, and assess forest health.

Forest management is critical for maintaining biodiversity, regulating climate, and supporting local economies. Traditional methods of forest inventory and monitoring are labor-intensive and time-consuming. However, advancements in technology, particularly airborne LiDAR (Light Detection and Ranging) systems, have revolutionized the field. Leica Geosystems, a leader in geospatial technology, offers sophisticated airborne LiDAR solutions that provide high-resolution, accurate, and efficient data for forest management.

Airborne LiDAR is a remote sensing technology that uses laser pulses to measure distances from an aircraft to the ground. By emitting thousands of laser pulses per second and measuring the time it takes for the pulses to return, LiDAR systems create detailed 3D maps of the terrain and vegetation below. These maps can reveal intricate details about forest structure, topography, and biomass.

Key Components of Airborne LiDAR Systems

- LiDAR Sensor: Emits and detects laser pulses.
- GPS System: Provides precise location data for each laser pulse.
- Inertial Measurement Unit (IMU): Measures the orientation of the LiDAR sensor.
- Data Processing Software: Converts raw data into usable 3D maps and models.

Application in Forest Management using Airborne LiDAR System

Forest Inventory

LiDAR systems provide detailed 3D data on tree height, canopy structure, and stand density, which are essential for forest inventory. Traditional ground-based surveys can be augmented or even replaced by airborne LiDAR, reducing the time and effort required.

Biodiversity Monitoring

By analyzing the vertical structure of forests, LiDAR can help identify habitats and assess biodiversity. Different species occupy different strata within a forest, and LiDAR's detailed vertical profiles can reveal these patterns.

Detecting Deforestation

LiDAR's ability to detect changes in forest structure makes it an invaluable tool for monitoring deforestation and forest degradation. It can identify areas where trees have been removed or damaged, providing data for enforcement and conservation efforts.

Carbon Stock Assessment

Accurate measurement of forest biomass is crucial for estimating carbon stocks. LiDAR provides precise data on tree volume and biomass, which can be used to calculate the amount of carbon stored inforests.

Benefits of Airborne LiDAR in Forest Management

Accuracy and Precision: LiDAR systems provide highly accurate and detailed spatial data, essential for effective forest management.

Efficiency: LiDAR surveys cover large and inaccessible areas quickly, providing comprehensive data that traditional ground surveys cannot match.

Cost-Effectiveness: Over time, the use of LiDAR reduces the need for extensive ground surveys, saving time and resources.

Data Integration: LiDAR data can be integrated with other geospatial information systems (GIS) and remote sensing data, enhancing analysis and decision-making.

Conclusion

Forest management is essential for balancing the ecological, economic, and social functions of forests. Sustainable practices ensure that forests continue to provide critical ecosystem services, support livelihoods, and mitigate environmental challenges such as climate change and natural disasters. By integrating modern technologies like airborne LiDAR systems and involving local communities, forest management can become more effective and resilient, ensuring the preservation and sustainable use of forest resources for future generations.

Leica's airborne LiDAR systems have proven to be transformative in forest management, offering unparalleled accuracy, efficiency, and detailed data. These systems support a wide range of applications, from forest inventory and biodiversity monitoring to deforestation detection and carbon stock assessment. The case study of the Western Ghats in India exemplifies the profound impact of LiDAR technology on forest conservation and sustainable management. As the technology continues to advance, its integration into forest management practices will become increasingly essential, ensuring the protection and sustainable use of forest resources worldwide.

3D View; Image Source: Asteria Aerospace

ARTICLE

Optimize Mine Mapping & Surveillance with DGCA Type Certified Drones & Cloud Tech

Asteria Aerospace

The mining industry has seen a significant surge in the adoption of drone technology in recent years. Drones have proven their versatility with a wide array of applications, including exploration, surveying, mapping, safety maintenance, and security enhancement. The gradual shift from traditional surveys to drone-based surveys can be attributed to the advantages of using drones:

- Higher Spatial Resolution and Cloud-Free Images: Drones fly at lower altitudes, capturing high-resolution, cloud-free images.
- Choice of Captures and Outputs: Drones can capture data in various formats, including RGB, multispectral, LIDAR, and video.
- On-Demand Capture for Situational Awareness: Drones provide real-time surveillance and monitoring through live video streaming.
- Site-Specific Data Collection: Focused data collection enhances cdata utility and reduces redundant coverage.
- High Accuracy Data: Fine-scale Ground Sampling Distance (GSD) ensures high-accuracy data.
- Enhanced Outputs: Drones can generate orthophotos, Digital Elevation Models (DEM), Digital Terrain Models (DTM), bare earth models, volume estimations, and change detection maps.

These advantages also lead to a higher demand for computing and storage capabilities because of the large data volumes involved. Furthermore, the remote and scattered locations of mining areas necessitate careful planning to ensure effective data capture.

Asteria Aerospace Leading the Way

Asteria Aerospace Limited, India's leading full-stack drone technology company, offers a unique combined solution. This includes DCGA type certified drones for mapping and surveillance, an end-to-end drone data management platform, SkyDeck built on India-hosted, MEITY-certified cloud infrastructure, and support from a team of DGCA-certified pilots.

DCGA Type Certified Drone: A200-XT for Advanced Mapping & Surveillance

The A200-XT is designed to meet the rigorous demands of the mining sector. It features:

Versatile and Multi-functional: The A200-XT drone is designed for various applications with its quick-connect swappable payloads, allowing seamless configuration for day or night surveillance, inspections, or mapping missions.

Compact and Portable: Weighing just 2.6 kg, the A200-XT is packed with features while maintaining a lightweight profile. It comes with an ergonomic backpack that includes

accessories needed for a full day of flight operations, making it exceptionally portable.

Rapid Deployment: With tool-less assembly, the A200-XT can be ready for flight in under five minutes, enabling rapid response for urgent situations.

User-Friendly Operation: Asteria Mission Control simplifies piloting the A200-XT. The system offers point-and-click mission planning, full payload control, and video management features like snapshot and record/playback, unlocking the drone's full potential.

Comprehensive Safety Features: The A200-XT ensures safe operations with omni-directional obstacle detection and avoidance. It includes dual GPS sensors for redundancy and built-in features such as geofencing, quick return to launch, and failsafe modes for communication loss, low battery, and high winds.

Advanced Surveillance and Inspection: The A200-XT features a 10x optical zoom daytime camera, capable of 1080p high-resolution video with 360-degree pan. A three-axis gimbal stabilization and passive vibration damping ensure smooth and stable video at all zoom levels. The camera includes target tracking, maintaining focus on stationary or moving objects.

Enhanced Night Vision: The A200-XT is equipped with a 320 x 240 resolution long-wave infrared thermal camera for nighttime operations, featuring 360-degree pan and 4x digital zoom. The three-axis gimbal stabilization and passive vibration damping ensure clear and stable video. The thermal camera also has target tracking to stay locked onto targets without constant control.

Applications of Asteria Drones in Mining

Mine Mapping: Effectively map mine areas using RGB or multispectral cameras. Generate orthophotos, DEMs, and DTMs to derive contours and visualizations.

Mine Monitoring: Monitor afforestation and slope stabilization activities with temporal captures. Compare time-lapsed data to detect ground changes.

Surveillance: Enhance security with day and night surveillance of mining areas, core and buffer zones, and dumping areas. Live stream data to a central control room or store and playback videos for situational awareness. Utilize AI/ML capabilities to identify people, vehicles, etc.

Incident Response: Deploy Asteria drones in less than 10 minutes for rapid incident response, providing a 'first responder' view of events.

PAP Project Monitoring: Use drone captures to plan and monitor local development activities for project-affected people. Create temporal repositories of project progress and implementation milestones.

SkyDeck: The Ultimate Cloud Platform for Drone Data Management

SkyDeck is a unified cloud-based Software-as-a-Service platform for end-to-end drone fleet management, scheduling and executing drone flights, data processing, and visualization, AI-based analysis and reporting of aerial data captured using drones. SkyDeck ensures operational transparency, improves collaboration between stakeholders, and provides secure and centralized management for scaling drone programs across multiple applications.

Planning and Capture: Users can

- Define flight paths and parameters to ensure comprehensive coverage of the area of interest.
- Schedule and execute drone flights automatically, reducing the need for manual intervention.
- Monitor flight progress and data capture in real-time, ensuring mission objectives are met.

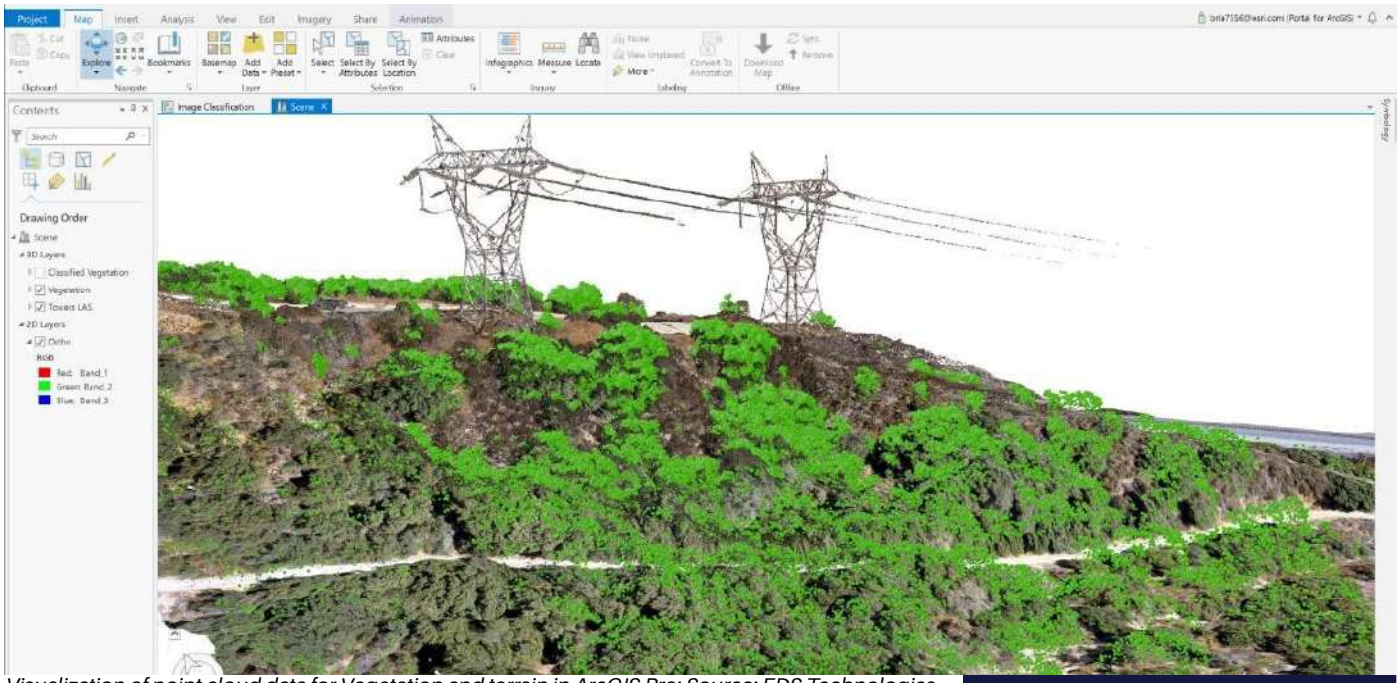
Data Visualisation: Experience seamless data exploration with SkyDeck's powerful 2D and 3D visualization tools, enabling comprehensive analysis from every angle. Engage with your data like never before by interacting directly with visual elements, enhancing your ability to analyze and draw insights.

Data Processing and Analysis: Automatically process captured data to generate high-quality outputs such as orthomosaics, DEMs, and DTMs. Utilize built-in analytics tools to derive actionable insights from the data. This includes vegetation indices, volume calculations, and change detection. Leverage AI/ML models to interpret data and extract valuable information, enhancing decision-making processes.

Data Reporting: From the initial flight to data capture and processing, the platform provides in-depth insights and actionable findings. This end-to-end analysis helps in understanding trends and identifying issues. SkyDeck empowers your team by providing instant access to comprehensive reports, allowing your team to respond promptly to any issues or opportunities.

Enhancing Operational Efficiency: The combined solution offers. Automated workflows and efficient data processing reduce the need for manual labor and associated costs. High-quality data and advanced analytics provide valuable insights, enabling informed decision-making. Real-time surveillance and monitoring improve situational awareness, enhancing safety for personnel and assets.

Drone technology is transforming the mining sector, providing unparalleled advantages over traditional survey methods. Asteria Aerospace Limited, with its DCGA-certified drones and the SkyDeck cloud platform, offers a comprehensive solution that addresses the unique challenges of mining operations. By adopting these cutting-edge technologies, mining companies can optimize their workflows, improve data accuracy, and achieve greater operational efficiency.



Visualization of point cloud data for Vegetation and terrain in ArcGIS Pro; Source: EDS Technologies

ARTICLE

Mapping a Greener Future: The Role of GIS Technology

EDS Technologies

In the modern era, the sustainable management of natural resources is crucial for maintaining ecological balance and ensuring the well-being of future generations. Geographic Information System (GIS) technology has revolutionized the field of natural resource management by providing sophisticated tools for mapping, analyzing, and visualizing data. Among the leaders in this domain, ESRI GIS solutions stand out for their comprehensive and innovative offerings, enabling organizations to harness the power of spatial data effectively.

The Role of Spatial Technology in Natural Resource Management

Managing natural resources such as water, soil, minerals, forests, and wildlife requires advanced tools. Spatial technology plays a pivotal role in this field by offering the following capabilities:

Data Integration and Analysis: Integrating diverse data sources, including satellite imagery, remote sensing data, LiDAR data, and field surveys, allows for comprehensive analysis and better decision-making.

Mapping and Visualization: Creating detailed maps that visualize resource distribution, usage patterns, and environmental changes is essential for communicating complex information to stakeholders. Advanced technologies, like LiDAR, provide high-resolution data that enhance terrain and vegetation mapping.

Monitoring and Management: Continuous monitoring helps track changes in natural resources over time. This is crucial for identifying trends, assessing the impact of human activities, and implementing effective management strategies.

Scenario Modeling and Prediction: Modeling different scenarios to predict the outcomes of various management practices helps in planning sustainable practices and mitigating potential risks.

Resource Allocation and Optimization: Optimizing the allocation of resources by providing insights into the most efficient use of available resources is particularly important in managing limited resources like water and arable land.

Applications in Natural Resource Management

Spatial technology is applied across various domains, enhancing efficiency and effectiveness in each area.

Forest Management
Forests are vital for biodiversity, climate regulation, and providing raw materials. Spatial tools aid in:

- Forest Inventory and Mapping: Creating detailed maps of forest cover, species distribution, and biomass. High-resolution elevation data enhances these efforts by providing precise measurements of tree height, canopy structure, and biomass.
- Fire Management: Identifying fire-prone areas, planning firebreaks, and managing

firefighting resources efficiently.
Wildlife Habitat Management: Mapping habitats and tracking wildlife movements to support conservation and manage human-wildlife conflicts.

Water Resource Management
Water is one of the most critical natural resources, and spatial tools play a key role in its management:

- Watershed Management: Analyzing watershed characteristics, monitoring water quality, and managing water resources sustainably. Detailed terrain information helps in creating accurate watershed models.
- Flood Modeling and Management: Enabling the modelling of flood scenarios aids in the design of effective flood mitigation strategies.
- Irrigation Management: Optimizing irrigation practices by mapping soil moisture levels, crop water requirements, and irrigation infrastructure.

Soil and Land Use Management
Soil health and land use planning are crucial for agriculture and urban development:

- Soil Mapping and Analysis: Creating detailed soil maps that inform agricultural practices, land use planning, and erosion control measures.
- Land Use Planning: Supporting the development of land use plans that balance agricultural, industrial, and residential needs while protecting natural ecosystems.
- Erosion and Degradation Monitoring: Monitoring soil erosion and land degradation, enabling timely interventions to prevent further damage. High-resolution topographical data is invaluable in identifying areas at risk of erosion.

Mineral and Mining Resource Management
The extraction and management of mineral and energy resources benefit significantly from spatial technology:

Resource Exploration: Aiding in the exploration of mineral deposits and energy resources by integrating geological, geophysical, and geochemical data. High-resolution elevation data contributes to more precise site analysis.
- Operational Efficiency: Monitoring mining activities in real-time ensures optimal resource extraction, reduces operational costs, and improves safety by identifying hazardous areas.
- Environmental Impact Assessment: Assessing the environmental impacts of mining and energy projects to ensure compliance with regulations and minimize ecological damage4.
- Rehabilitation and Reclamation: Planning and monitoring land rehabilitation and reclamation efforts post-extraction. Detailed landscape mapping assists in accurately guiding reclamation efforts.
- Post-Mining Land Use: Planning the reclamation and rehabilitation of mined land ensures that it can be restored for other uses, such as agriculture or wildlife habitats, once mining activities cease.

Carbon Credit Management
With the growing emphasis on reducing carbon footprints and combating climate change, carbon credits have become a crucial tool for environmental management. Spatial technology provides significant advantages in managing carbon credits:

- Carbon Stock Assessment: Accurately mapping and quantifying carbon stocks in forests, wetlands, and other ecosystems is essential for determining the amount of carbon sequestered and available for credits. High-resolution data aids in precise biomass and canopy height measurements, critical for accurate carbon stock assessments.
- Monitoring and Verification: Continuous monitoring using remote sensing and satellite data ensures that carbon sequestration projects are performing as expected and verifies the amount of carbon sequestered over time.
- Project Planning and Optimization: Spatial tools help identify optimal locations for carbon sequestration projects, such as reforestation and afforestation efforts, by analyzing soil type, climate, and existing vegetation.
- Compliance and Reporting: Ensuring projects meet regulatory standards and accurately reporting carbon sequestration to stakeholders and regulatory bodies is facilitated by precise spatial data.

With the growing emphasis on reducing carbon footprints and combating climate change, carbon credits have become a crucial tool for environmental management. Spatial technology provides significant advantages in managing carbon credits.

EDS Technologies Pvt Ltd: Pioneers in GIS Solutions

With about 30 years of experience, EDS Technologies Pvt Ltd has been at the forefront in providing digital transformation solutions and services. As a trusted partner of ESRI India, we specialize in delivering state-of-the-art software and services that cater to the unique needs of our customers. Our expertise spans various industries, including natural resource management, urban planning, and environmental conservation.

At EDS Technologies, we understand the critical role that accurate and timely information plays in managing natural resources. Our solutions, powered by ESRI's cutting-edge technology, help organizations streamline their operations, enhance their decision-making processes, and achieve their sustainability goals. Whether it's through customized applications, training, or support services, we are committed to empowering our customers with the tools they need to succeed.

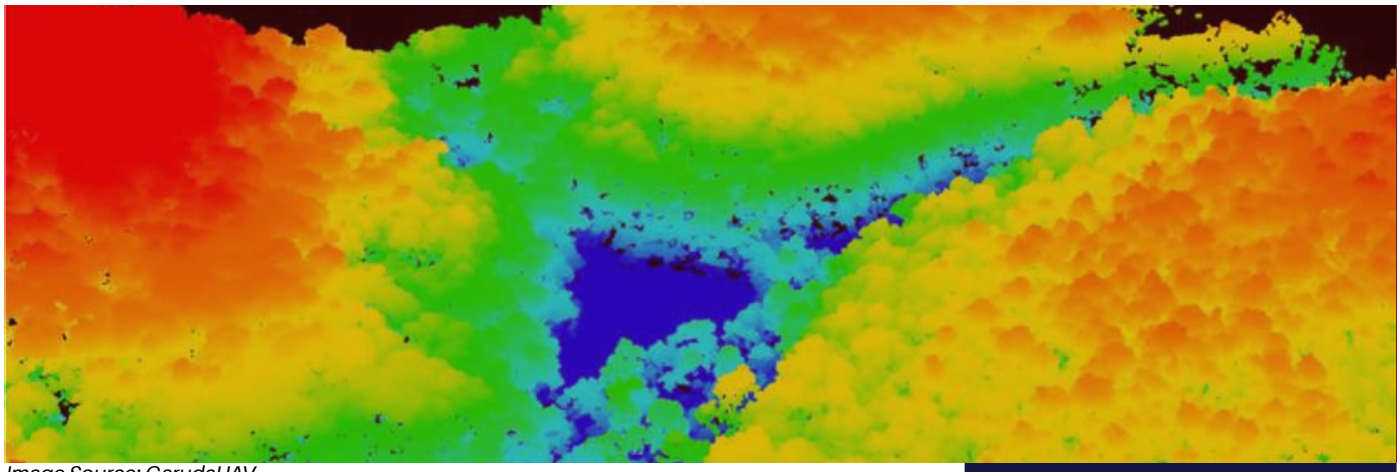


Image Source: GarudaUAV

ARTICLE

Exploring the Canopy: Journeying into Aerial Survey

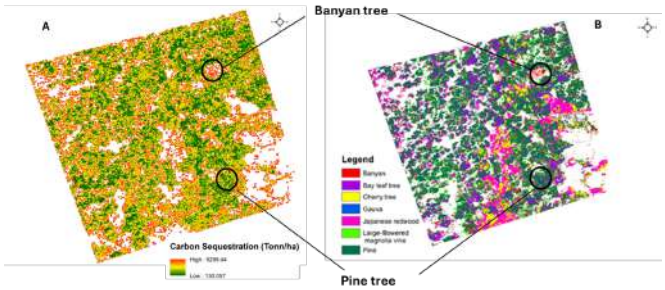
GarudaUAV

Forestry enterprises face a multitude of challenges in managing vast and diverse forest landscapes. Traditional methods of data collection, such as manual ground surveys, often prove insufficient in providing comprehensive insights into forest structure, biodiversity, and carbon dynamics. This data gap hampers decision-making processes, impedes operational efficiency, and limits the ability to capitalize on emerging market opportunities.

The Solution: Aerial LiDAR and Hyperspectral-based Survey

GarudaUAV's state-of-the-art aerial LiDAR and Hyperspectral imaging capabilities are reshaping forestry management. Our powerful aerial LiDAR provides highly efficient data acquisition at low, mid, and high altitudes, with a very high-point density of up to 1.33 million measurements/sec on the ground and wide-area mapping. LiDAR pulses can slice through the dense forest canopy cover, unveiling detailed metrics on tree height and structure and biomass distribution with exceptional precision.

This data isn't just numerical; it's crucial for optimizing resource allocation and quantifying carbon sequestration potential. In particular, the carbon sequestration potential of various tree species is of great value since they help mitigate climate change by sequestering carbon dioxide from the atmosphere. GarudaUAV's LiDAR provides areas inside the forest with the highest and lowest carbon sequestration at unprecedented accuracy and resolution which cannot be matched by any satellite-derived products. In addition to the forestry products, topographical products like



A) Carbon Sequestration potential and (B) Phyto diversity/ tree species map; Source: GarudaUAV

DEM/DTM, Contour (30 cm resolution), and Ortho photo (up to 5 cm resolution) with a 10 cm Horizontal and 10-15 cm vertical accuracy are also generated.

Combine this with GarudaUAV's advanced aerial Hyperspectral sensor that captures spectral signatures in 400+ bands across RGB, VNIR, NIR, and SWIR wavelengths, providing comprehensive insights into vegetation composition, health, and Phyto diversity (Figures A and B). Unlike traditional multispectral imagery (which typically has a few broad bands), hyperspectral sensors collect hundreds of narrow contiguous bands, allowing for precise spectral discrimination. It enables tree species mapping by accurately classifying species based on their unique spectral signatures.

The classification is based on ground truthing that involves the collection of spectral signatures for major tree species using a spectroradiometer. The ground data is utilized as a reference to classify the hyperspectral data cube to generate a Phyto diversity (species) map for the study area. The species map for a patch in Meghalaya has been prepared by Artificial Neural Network (ANN) algorithms based on ground truth data with a post-classification accuracy of 82.12% to ground truthing &kappa coefficient 0.60.

Fusion of LiDAR and Hyperspectral-based Outputs

Results of Carbon Sequestration areas derived from Aerial LiDAR, overlayed on the species map from Aerial Hyperspectral help identify tree species with the highest CS potential. Results show that the Banyan tree species has the highest carbon sequestration potential, while the pine tree species have the lowest. This integrated approach optimizes site selection, tree species choice, and growth conditions for afforestation planning, ensuring successful establishment and long-term forest health while maximizing carbon sequestration benefits. Additionally, it enables ongoing monitoring and adaptive management.

GarudaUAV's innovative integration of aerial LiDAR and hyperspectral sensors for carbon sequestration and species analysis represents a paradigm shift in afforestation planning and carbon financing. This pioneering approach empowers stakeholders with unparalleled precision. With GarudaUAV's cutting-edge technology, a greener and more sustainable future is within reach.

Image Source: NeoGeoInfo Technologies

CASE STUDY

Revolutionizing Land Management in Assam

NeoGeoInfo Technologies

In the heart of Assam, a quiet revolution is brewing. It's not a revolution on the streets, but a transformation happening behind the scenes, poised to change the way land is managed in the state.Through a collaborative effort, the **Directorate of Land Records and Surveys (DLRS) Assam, and NeoGeoInfo Technologies** are reshaping the narrative of land management with state-of-the-art geospatial solutions. This project aligns with the Government of Assam's Mission Basundhara, PM GatiShakti, and the Digital India Land Records Modernization Programme (DILRMP), aiming to enhance land mapping, governance, and transparency in the state.

Building the Foundation

The first phase focuses on meticulous planning and infrastructure development for the GIS Lab for Assam DLRS. NeoGeoInfo meticulously designs the physical space to optimize workflow and technology integration. Construction adheres to rigorous standards, ensuring a stable foundation for advanced geospatial activities. Next, the technological backbone is established.
High-performance hardware from Dell Technologies, Hewlett Packard Enterprise, LG Electronics, Delta Technologies, PeopleLink, and Spacewood is installed, alongside plotting and scanning equipment from Canon. ESRI's ArcGIS software is deployed, followed by comprehensive training for lab personnel to ensure proficiency in geospatial data analysis. To guarantee smooth operations, a team of skilled professionals from NeoGeoInfo is assigned to manage the lab. Extended support services are established for both hardware and software, ensuring long-term functionality and reliability.

Enhancing Capabilities

The second phase, under PM GatiShakti, elevates the lab's capabilities by incorporating high-resolution satellite imagery (HRSI) for the entire state, Digital Terrain Models (DTMs), and Trimble DA2 GNSS Rovers. NeoGeoInfo partners with Maxar Technologies to provide 30cm and 50cm resolution OR2A satellite imagery, offering exceptional detail and accuracy for informed decision-making. The integration of DTMs provides a comprehensive understanding of the land's physical characteristics, crucial for areas with connectivity challenges.

A critical addition to the lab's toolkit in this phase is the inclusion of Trimble DA2 GNSS Rovers. The rovers use GNSS to pinpoint locations with centimetre-level precision. The combined use of HRSI, DTMs, and Trimble GNSS Rovers provides highly precise geospatial data collection solutions for the state.

Empowering the Workforce

The final phase emphasizes human resource development.
Recognizing the importance of skilled personnel, NeoGeoInfo commits to training and deploying 500 surveyors under the DILRMP Project. Intensive training programs equip them with the necessary expertise in data collection, analysis, and interpretation of geospatial data. Further workshops delve into advanced surveying techniques, data management practices, and specialized software tools. This large-scale training initiative ensures a skilled workforce to maintain and expand the lab's operations. The influx of trained surveyors facilitates extensive data collection and analysis, maximizing the lab's potential.

Recognition and Future Prospects

NeoGeoInfo's contribution to Mission Basundhara has garnered recognition from the Honourable Chief Minister of Assam, Himanta Biswa Sarma, highlighting the outstanding contribution to transforming land management services in the state. NeoGeo also received ESRI's Partner of the Year 2023 award for Best GIS Project for the GIS lab establishment for Assam DLRS. Beyond the initial setup, NeoGeoInfo has provided comprehensive maintenance and support services for five years, ensuring continued access to critical geospatial tools and hardware functionality.

A Sustainable Future for Land Management

By leveraging advanced technologies, robust infrastructure, and a skilled workforce, the project sets a new standard for land management in Assam. This holistic strategy positions the GIS Lab as a cornerstone for geospatial excellence in Assam, paving the way for more efficient and transparent land management practices. The project's long-term vision is to streamline land dispute resolution, enhance land planning and facilitate precise land monitoring.

Image Source: Planet

CASE STUDY

Unveiling Aquatic Mysteries: Blue Carbon Exploration

Planet

Identifying and mapping blue carbon, despite its vast potential, has posed significant challenges. Traditional approaches, which depended on labor-intensive field surveys, were not only time-consuming and expensive but also difficult to extend to broader coastal areas. This restricted access to essential data is crucial for effective coastal planning. A lack of high-quality functional data and aquaculture literacy along the value chain has drastically limited the expansion of the industry. On the production side, many farms collect vast amounts of data but need help using them in a meaningful way to understand and improve their farm operations. This is further complicated by the fact that, unlike agriculture, aquaculture spans multiple species and production environments, making data collection all the more challenging.

At a global level, this gap in quality data availability is further highlighted by society's push for a blue economy and carbon neutrality in recent years. Despite the immense potential of blue carbon, accurately identifying and mapping these valuable ecosystems has been a challenge. Previous methods relying on labor-intensive field surveys proved time-consuming, costly, and challenging to scale up to larger coastal zones. This limited the availability of crucial information necessary for effective coastal planning. Recognizing this constraint, UMITRON worked to revolutionize the process through their advanced technology and the satellite remote sensing capabilities of Planet.

The Journey Towards Sustainable Aquaculture

UMITRON's team of expert engineers, researchers, and biologists has been united in a shared mission - to install sustainable aquaculture on Earth and, in doing so, create a food-secure and environmentally safe future for our blue planet. Through their cutting-edge technology and deep commitment, they've been using their combined expertise in machine learning, IoT, and satellite remote sensing to change how we farm our oceans and address the pressures faced by the aquaculture industry. From the beginning, it was understood that achieving their sustainability goals would require them to focus on every aspect of the value chain.

As a result, they created **production focused solutions such as REMORA and CELL that use their bespoke machine learning algorithms** to tackle crucial farming activities like feeding while also taking into account the adverse effects these activities can have on the environment. Other tools, such as PULSE, utilize the Planet satellite remote sensing capability and their powerful algorithms to provide farmers with near real-time data and long-term water quality conditions at their production sites. This data is invaluable in helping farmers monitor the surrounding waters and better understand the environmental variability around their farms.

UMITRON has created a project to estimate the amount of blue carbon. In estimating it, they need to know where and how much seagrasses are growing. Since the area they were targeting was over 100 km2, it was difficult to observe everything with a drone. Therefore, they attempted to create a map from Planet satellite data. In creating the seagrass map, the frequency of photography is important. This is because many factors are involved, not only the presence or absence of clouds but also the state of the ocean and the timing of the tides.

UMITRON has created a project to estimate the amount of blue carbon.

Also, the spatial resolution must be high so as not to miss the eelgrass area. They compared several other platforms besides Planet and finally chose to use the PlanetScope product because of the high-frequency imagery updates and the quality of satellite images.

Unlocking a Sustainable Future for Global Impact

The UMITRON team of experts in remote sensing and artificial intelligence has also been able to apply their expertise beyond the production environment to develop a new method to efficiently locate and map blue carbon sinks in large coastal areas, a feat that previously proved to be laborious and time-consuming when applied at that scale. **UMITRON's solution unlocks greater opportunities and empowers global coastal communities to leverage the potential of blue carbon and contribute to the fight against climate change.** Their successful demonstration in Japan has paved the way for other countries to adopt the same approach and efficiently manage their national carbon accounting and planning.

Using the maps they created, UMITRON was able to successfully estimate the amount of blue carbon. The estimated content and maps have already been used to discover previously undiscovered seagrass. They have found that PlanetScope speeds up the cycle for the creation of eelgrass maps, and hope it will accelerate efforts to increase blue carbon on Earth.

Image Source: Marvel Geospatial Solutions

CASE STUDY

LiDAR Technology Uses Forest Data for Climate Impact Studies

Marvel Geospatial Solutions

Forest canopy and biomass data are crucial in advancing studies on climate impacts and global climate change. This data helps scientists understand carbon sequestration, as forests store significant amounts of carbon in their biomass. By analyzing changes in canopy density and biomass over time, researchers can track how much carbon is being absorbed or released.

NASA-ISRO Project to Monitor Forest Extent and Other Parameters

NISAR (NASA-ISRO Synthetic Aperture Radar) mission is a collaboration between NASA and ISRO. It is designed to monitor global forest extent and quality and to provide accurate and timely forest information. A joint work plan has been designed for the establishment of long-term 1-hectare plots and their inventory in the Shimoga Division of North Karnataka for the Validation of NISAR forest biomass products.

The participants of this Joint Work Plan are Space Application Center, ISRO, Ahmedabad, College of Forestry, Dharwad, and Kerala University of Fisheries & Ocean Studies (KUFOS). NISAR will also provide forest volume and biomass over time and with enough detail to reveal changes on human scales. Products are expected to be available 1-2 days after observation, and within hours in response to disasters, providing actionable, timely data for many applications.

Determining Appropriate Forest Parameters

Appropriate forest parameters are crucially related to forest inventory. Traditionally, parameters such as diameter and total height are measured in the arena by level gauges and hypsometer. However, full field inventory is usually established on sample plots, which, irrespective of providing valuable and necessary data, are laborious, expensive, and spatially limited. Most of the traditional work developed for remote measurement features make use of terrestrial laser scanning, which continues to have a spatial limit to its application because it needs to be manually carried to succeed in market, which necessitates difficult field access and frequent requirement of field crew.

Airborne LiDAR Survey for Inventory Mapping

When compared to aircraft-borne programs, drone-based LiDAR provides much higher likelihood of measuring the parameters and occurrence in point cloud data. India-headquartered global geospatial technology company **Marvel Geospatial Solutions has been commissioned by Kerala University of Fisheries & Ocean Studies (KUFOS)** for drone-based LiDAR survey to support the project.

This project uses drone LiDAR system to measure an individual's considerable tree height and girth while working with an automated and integrated approach. It maps forest canopies, tree heights, tree girth, and biomass using innovative technologies like drone-based LiDAR survey. It used an industry-standard drone to acquire LiDAR and RGB imagery. To improve the accuracy and quality of the data, the ground control points (GCPs) were collected from the ground using DGPS. The associated products are DSM (digital surface model), DTM (digital terrain model), and ortho-rectified imagery (ORI).

The LiDAR Advantage for Forest Mapping

According to KUFOS, LiDAR survey, such as that conducted by Marvel Geospatial for this project, offers several advantages:

Higher Density and Resolution: Dense point cloud, captures detailed information about the forest canopy, allowing precise mapping of tree structures and terrain features.
Centimeter-Level Accuracy: LiDAR measurements are incredibly accurate, enabling precise elevation modeling and vegetation characterization, valuable for forest inventory and carbon estimation.
Minimal Ground Control Required: Unlike traditional methods that rely heavily on ground control points, LiDAR is largely self-referencing, reducing the need for extensive ground surveys, saving time and resources.
Weather and Light Independence: LiDAR sensors operate effectively in various weather conditions (including cloud cover) and at any time of day, ensuring consistent data collection.
Digital Data from the Start: LiDAR data is available in digital format immediately after collection, streamlining processing and analysis, making it accessible for research and decision-making.

The Way Forward

Forest canopy & biomass data have practical applications across domains. Policymakers & conservationists can use this data to design effective strategies for **climate change mitigation**. By understanding biomass distribution, they can prioritize reforestation efforts in areas with high carbon storage potential. Assessing canopy cover helps identify critical habitats; conservationists can target them for protection, ensuring the **survival of diverse ecosystems**. Foresters and land managers use canopy data to **monitor forest health**, assess tree growth, and plan logging practices.

Image Source: Satpalda (sourced from The Indian Express)

CASE STUDY

Impact of Climate Change on Forest Fires in Uttarakhand

Satpalda

The Pauri Garhwal region in Uttarakhand, India, is a picturesque landscape known for its dense forests, diverse wildlife, and serene environment. However, in recent years, this region and other Himalayan areas have become increasingly susceptible to forest fires, a phenomenon that has escalated significantly from 2019. The increasing frequency and intensity of these fires can be attributed to the overarching influence of climate change, which has led to higher temperatures and drier conditions, exacerbating the vulnerability of these mountainous regions.

Rising Temperatures and Their Consequences

One of the most apparent effects of climate change in the Pauri Garhwal region is the significant increase in temperatures. The data collected from remote sensing satellites reveal a steady rise in average temperatures over the past few decades. Higher temperatures lead to drier conditions, reducing the moisture content in vegetation and soil, thereby creating an environment more conducive to forest fires. The years 2019 to 2023 have seen some of the highest recorded temperatures, correlating with a marked increase in forest fire occurrences.

The Role of Remote Sensing in Forest Fire Analysis

Remote sensing and Geographic Information System (GIS) technologies have played a crucial role in analyzing and understanding the patterns and impacts of forest fires in Pauri Garhwal. By leveraging satellite imagery and spatial data analysis, helps to monitor changes in vegetation, assess the extent of burnt areas, and identify the underlying factors contributing to the rise in forest fire incidents.

Remote sensing technology has revolutionized the way we understand and manage forest fires. Through the use of satellites has helped to obtain high-resolution images of the earth's surface. These images are analyzed to detect thermal anomalies, monitor vegetation health, and map the extent of fire-affected area. For instance, the data indicates that most fires occur during the pre-monsoon season, when the vegetation is driest.

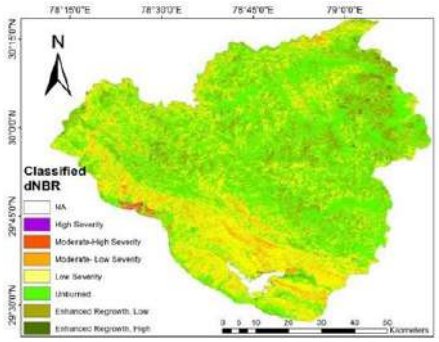
Impacts on Ecosystem and Human Communities

The forest fires in Pauri Garhwal have far-reaching impacts on both the ecosystem and the local human communities. Ecologically, these fires result in the loss of biodiversity, as many plant and animal species are unable to survive the intense heat and destruction. The destruction of vegetation also leads to soil erosion, which can result in landslides, particularly in the hilly terrains of Uttarakhand. For the local communities, forest fires pose a direct threat to their livelihoods and safety. The fires not only destroy these resources but also create hazardous living conditions due to the smoke and reduced air quality.

> **Addressing the issue of forest fires requires a multi-faceted approach.**

Mitigation and Management Strategies

Addressing the issue of forest fires in the context of climate change requires a multi-faceted approach. Remote sensing and GIS technologies provide the necessary tools for effective monitoring and early warning systems. By predicting fire-prone conditions and identifying

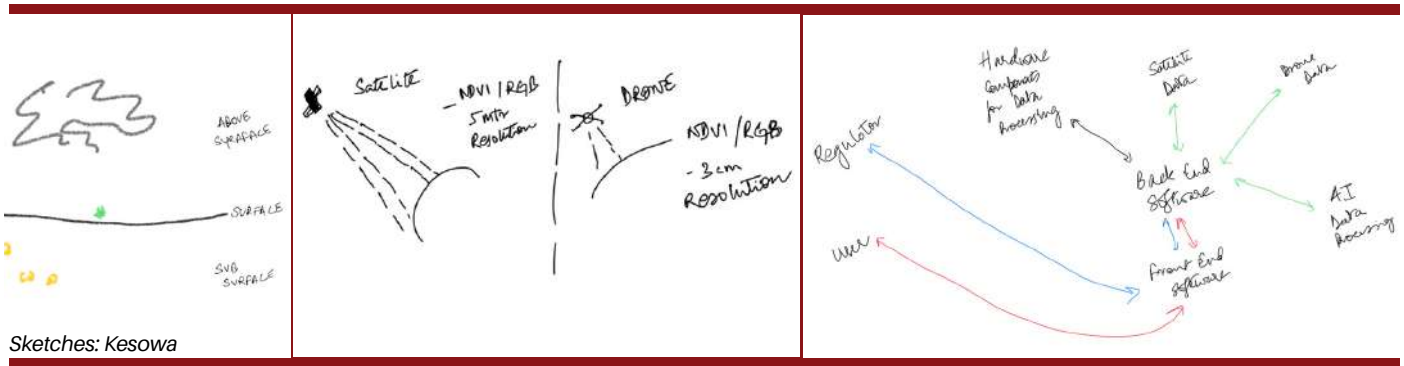


Differenced Normalized Burn Ratio (dNBR); Source: Satpalda

high-risk areas, authorities can take pre-emptive measures, such as controlled burns and creating firebreaks, to prevent the spread of wildfires. Furthermore, there is also a need for community engagement and awareness programs to educate the local population about fire prevention techniques and the importance of preserving the forest ecosystem. Sustainable land management practices, reforestation, and the use of fire-resistant plant species are some of the strategies that can help mitigate the impact of forest fires.

Conclusion

The rising incidence of forest fires in the Pauri Garhwal and nearby Himalayan regions is a stark reminder of the broader implications of climate change. As temperatures continue to rise and weather patterns become more unpredictable, the risk of forest fires will likely increase. However, with the advancements in remote sensing and GIS technologies, there is hope for better management and mitigation of these fires. By combining technological tools with community-based approaches, it is possible to protect both the natural environment and the human communities that depend on it.



Sketches: Kesowa

SHOWCASE

Hyper-local Map Data for Natural Resources Ecosystems in the Information Age

Kesowa

What are Natural Resources?

A search on the internet says: Natural resources are materials from the Earth that are used to support life and meet people's needs. Any natural substance that humans use can be considered a natural resource. Fossil Fuels such as Oil, coal, natural gas, metals, stone and sand are natural resources. Other natural resources are air, sunlight, soil and water.

A GIS-first approach which combines Satellite Imagery and Drone Imagery can enable positive difference to help stakeholders achieve their goals.

This article identifies four Use Case Concepts where Hyper-Local Map data can provide positive change:

GIS Based Education at Grass Root for Natural Resources - Flora and Fauna Preservation

This can provide and build educational infrastructure to help locals schools and colleges organise field trips around basic science courses in K12, around biology, plant and animal life, geology and more; learning can also help to build capability and learning amongst local stakeholders paving the way for Flora and Fauna Preservation.

Natural Resources Study from GIS for Mining and Resource Extraction to increase GDP

This can provide a structured process to enable entrepreneurial sustainable mining solutions, ensuring proper reporting from mine-site identification, greenery relocation, mine-site planning, mining, to end of mining activity and closure of mine.

GIS Mapping of Underwater Ponds/ Dams/ Coral Reefs

This can help enable increased livelihood opportunities, boost local markets, provide entrepreneurial opportunities for the Fishing Community like Ornamental Fish, Aquarium Fish.

GIS Mapping of Shade Free Areas for Solar Installations

This can enable and provide energy security to a region, create entrepreneurial opportunities and help boost demand of products to meet the domestic manufacturing goals.

Proposed Implementation Framework with Components

A GIS first approach requires understanding of measurable components of an ecosystem in terms of natural resources. Above Surface and Surface Measurement are possible by Satellite and Drone Data to a certain level of resolution which can be studied to create an index of natural resources available and developable.

A framework has been identified with components to make this possible.

- Identifying Actors - It becomes imperative to identify stakeholders accurately to ensure a complete implementable framework.
- Incentivising Actors - Without proper short term, medium term or long term incentives there may not be stakeholder buying, leading to failure of implementation.
- Approach - It becomes important to decided on a approach philosophy and methodology along with pathway drivers to ensure success of long term and short term objectives.

Challenges

- Awareness of GIS amongst non-technical personnel and help increase stakeholder buy-in
- Understanding of Positive Impact

Hyper-Local Map Data for Natural Resources Ecosystem can enable quality data availability of a local stakeholder level to enable positive change.

Potential GIS Use Cases w.r.t. Satellite and Drone Data (AOI = Area of Interest)

Use Case	What do we need our Satellite Data to tell us?	What do we need our Drone Data to tell us?	Final Outcome supported by Human Intelligence/ AI
1. GIS Based Education at Grass Root for Natural Resources - Flora and Fauna Preservation	What is the natural resources nearby an AOI? What type of natural resource is it - e.g. Tropical Deciduous Forest aged 1000+ Years?	What is the colour of the leaves during the data capture season? What are the granular NDVI Values of a specific season?	This forest patch is 1500 years old, very unique deciduous forest having 400 species of plants and animal ecosystem. This can be accessed by these schools nearby.
2. Natural Resources Study from GIS for Mining and Resource Extraction to increase GDP	Is there a Mineable Natural Resource at or nearby an AOI on a Surface? Is there a Mineable Natural Resource at an AOI based on tectonic plate movement below the ocean?	What is the possibility of existence of a specific resource sub surface? Can this be predicted on a 0-100 scale?	This AOI has potential iron ore reserves below it. It is predicted that this is 86% Accurate. It is observed there are 300 Household Dwellings and 30% Greenery on the surface.
3. GIS Mapping of Underwater Ponds/ Dams/ Coral Reefs	Are there multiple ponds in an AOI like a town? What is the FTL (Full Tank Load) of a Large Pond?	Are the water bodies being maintained today? Are they dirty? Do they have the potential for fish farming?	This AOI has 300 ponds, with 95% being dirty/ not maintained. 30% can be developed into parks, balance can be cultivated for fish farming.
4. GIS Mapping of Shade Free Areas for Solar Installations	Which area can we propose for setting up a Solar Park? Does have a industrial/ urban center near it?	Is the proposed space having any other livelihood? Does it have adequate shade free area?	This area is suitable for solar with a 92% shade free area all year round.

Updates from AGI

Governing Council and Office Bearers Elections 2024-26

As a regular practice, AGI elected its team of new Governing Council and Office Bearers in April 2024, for the ensuing two years. This esteemed group brings together a wealth of diverse experiences and proven leadership qualities within the geospatial sector.

Office Bearers (2024-26)

- **President**: Nikhil Kumar, President - Geospatial, MapmyIndia
- **Senior Vice President**: Sreeramam GV, CEO, NeoGeoInfo Technologies
- **Vice President**: Deepak Awari, Director - Strategy & Development, Secon
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Governing Council (2024-26)

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Ms. Mitika Garg Sr Solutions Engineer **Oracle**	**Mr. Deepak Awari** Director Strategy & Dev **Secon**	**Mr. Abhay Kimmatkar** Managing Director **Ceinsys Tech**	**Mr. Rajesh Alla** CEO **IIC Technologies**	**Dr. Pradeep N** General Manager - BD **Asteria Aerospace**
Mr. Surendra Das CEO – Global Geospatial Dev Business **Azure Cloud**	**Mr. Abhishek Kotangale** Director (India Subcontinent) **Geospatial World**	**Dr. Atul Kapoor** General Manager **ML Infomaps**	**Mr. Amit Seymour** Director **Satpalda**	

Industry News and Updates

DST Issues Call for Proposals for Geospatial Technologies and Solutions in Consortium Model

DST has issued the Call for Proposals for Consortium on Geospatial Technology & Solutions. The goal is to create impactful solutions that address grassroots-level issues and realize the vision of establishing a robust geospatial ecosystem. The department invites proposals in consortium mode, comprising academia, startups/MSMEs/industry, and user agencies/practitioners. **Last date for submission of proposals is 15th July 2024.**

AGI Partners for India Space Congress 2024 organized by SIA-India

AGI partnered with the Satcom Industry Association (SIA-India) for the India Space Congress 2024 as a Supporting Organization. The event's theme focused on "Space Innovation: Bridging Boundaries, Transforming Tomorrow", a topic critical to the future trajectory of the space and Geospatial industries.