



COVER STORY

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%.

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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!