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ENHANCING SMART FORESTRY THROUGH AI-DRIVEN KNOWLEDGE MANAGEMENT: A SYNERGISTIC APPROACH TO EFFICIENCY AND SUSTAINABILITY

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Introduction

Forests, long hailed as the lungs of the Earth, span nearly 31% of the planet's land surface, shelter over 80% of its biodiversity, and absorb immense quantities of carbon, making them indispensable in the fight against climate change. Nevertheless, forests all over the world are under increasing pressure from destruction, degradation, poaching, exotic species, and climate-related disruptions such as wildfires and droughts. The traditional methods of forest management, with a great deal of manual inspection, unresponsive policies, and ad hoc decisions, are failing to work in this dynamic environment. The solution lies in embracing the emerging concept of Smart Forestry—a digitally enabled, intelligent, and adaptive model of silviculture that integrates technology with sustainable forest management.

The union of Artificial Intelligence (AI) and Knowledge Management (KM) offers that special ingredient that makes Smart Forestry transformational. Such an integrated approach enables continuous advancements in forestry decision-making, grounded in real-time data, institutional knowledge, scientific principles, and stakeholder insights—thereby promoting both operational efficiency and ecological sustainability

What is Smart Forestry?

Smart Forestry is a paradigm that brings digital technologies, including such areas as satellite and remote image analysis, IoT sensors, drones, big data analytics, and machine learning models, into the lifecycle of planning, monitoring, and management of forests. It facilitates accurate interventions such as proper planting location control or pest control interventions, monitoring of the ecosystem in real time according to the health of the canopy and soil moisture. Predictive modeling—such as assessing wildfire risk or estimating carbon sequestration—highlights the analytical potential of smart forestry systems. Moreover, integrated policy feedback loops allow governments and organizations to dynamically adjust strategies in response to real-time environmental and operational changes.

Nevertheless, the abundance of data presented by Smart Forestry tools without organization and coordination may turn out to be a flood instead of a power. That is why Knowledge Management driven by AI will be necessary.

What Knowledge Management in Forestry?

Knowledge Management relates to catching, structuring, sharing of knowledge and setting its applications among stakeholders. In forestry KM systems can incorporate:

- Forest harvest and inventory historical data
- Best strategies in sustainable management and conservation
- Local, traditional knowledge
- Scientific models and legislations
- Maps, satellites and sensor reports

Organizing and converting this information into machine-readable and accessible form, KM can be used to make AI models which can reason, learn and support decision-making in a context-oriented manner. AI and KM combine to form a smart system of feedback, thus making forest planning and sustainability decisions progressively better.

Role of AI and KM in Smart Forestry

1. **Raw Data to Actionable Knowledge**

Modern forestry generates vast volumes of data, including LiDAR imagery, environmental monitoring outputs, and mobile-based survey information makes the data-cleaning and classification process automatic, and KM platforms will guarantee that the output will be stored in a meaningful form, so the stakeholders can use the historical patterns and domain knowledge. As an example, in case drone video identifies the browning of the leaves in a specific area, the AI could mark it as a pest infestation. KM systems can also correlate this occurrence with the events in the past and can name the likely species and propose effective interventions that have been applied in the past in similar cases.

2. **Sustainability Predictive Analytics**

Machine learning models such as Random Forest, Gradient Boosted Trees, and Deep Neural Networks can predict:

- Growth of the trees through various strategies of planting them
- Climate-based Pest and disease outbreaks
- Use of the humidity, wind, and biomass indices to indicate fire risk data
- Fragmentation of habitats changes biodiversity

When affixed to KM dashboards, these forecasts would enable the managers to plan resilience as opposed to mere reactions to disasters.

3. **Monitoring and compliance**

Remote sensing and audio patterns can be analyzed because AI-enhanced KM systems will also be able to identify illegal activities. These data sources are also instrumental in verifying compliance with sustainable forestry certification standards and carbon credit programs. An AI-integrated knowledge management (AI-KM) forest reserve can autonomously identify areas of unauthorized logging, alert relevant enforcement authorities, and recommend appropriate corrective actions.

Real World Examples

Case study 1: Amazon Rainforest Sensor Networks

Turo et al. (2024) created an innovative system of Wireless Sensor Networks (WSNs) within the Brazilian Amazon. These sensor nodes would apply AI in detecting types of acoustic signals (e.g., chainsaws, wildlife sounds) and identifying the presence of illegal logging.

With the aid of KM integration, the system was trained to follow the previous patterns to increase the correctness in the future and reduce the number of false alarms. Besides, the portal enabled distant native communities to keep watch and report menace independently.

Case study 2: Decision system in Lithuania forestry

Krilavičius (2024) developed a decision support plan of the Lithuanian national forestry agency, in combination of:

- Satellite imagery
- Models of tree growth
- Policy frameworks

Decades of working field knowledge in silviculture knowledge

Artificial intelligence (AI) supports the prediction of yield, disease risk, and optimal harvest periods, while knowledge management (KM) facilitates region-specific adjustments based on forest type and local regulatory frameworks. The system reduced the planning errors by more than 25 percent and could be completely understood by the technicians and the policymakers.

Case study 3: Forestry Processing Industrial Optimization

The work by Ramos-Maldonado et al. (2025) has shown the application of AI-KM to production of plywood. They were able to use their ML model in processing veneer to minimize the waste and maximize efficiency. Linked to the KM repositories of wood type, temperature conditions, and operator feedbacks, it established a learning feedback loop that enhanced the level of production and sustainability of the industries relating to forests.

Advantages of AI Driven KM in Forestry

Accuracy and optimization:

The use of AI guarantees that procedures such as pest identification, biomass assessment, and harvest scheduling are also completed more proficiently and more expeditiously than they are undertaken by humans. KM stores, and re-populates such intelligence so as to guard against duplication, and solidifies best practices.

Accountable Environmental Management:

The managers can predict problems using predictive modelling and solve them even before they blow out of proportion. Knowledge management (KM) enriches this process by incorporating contextual information, thereby ensuring that interventions align with both ecological dynamics and social systems.

Data Democratization:

The digital divide widens the gap in environmental management between highly trained experts in urban centers and local communities. But AI-KM systems enable remote users, community forest groups, and field rangers to receive sophisticated analysis via mobile connections and in-cloud dashboards, closing the gap in environmental governance.

Integration of policies:

Policies on forestry tend to be dynamic, which necessitates evidence in the form of habitat thresholds, carbon sinks, or deforestation indicators. The AI-KM platform facilitates data-driven policymaking, enables effective progress monitoring, and supports the formulation of adaptive regulatory frameworks.

Challenges and Threats

1. **Disjointed Ecosystems of Data**: Information concerning forestry is usually dispersed in various institutions, formats, and languages. In the absence of interoperability, there is either rejection or inaccuracy of AI-KM platforms.
2. **Bad infrastructure in the remote areas**: Poor connectivity and digital literacy possibly create barriers to deployment in the most at-risk forest loss locations.
3. **Ethical Concerns**: The Importation of indigenous knowledge on KM systems should be voluntary, clear, and culture-based. In the same way, AI should not engage in black-box decisions that would disempower the communities.
4. **Lack of Human-AI Trust**: Systems need not only to be efficient but also explainable, transparent, and have value attached to them by the stakeholders to be adopted.

Future Horizons

The future of electronic document management in the coming decade is expected to witness the emergence of increasingly compact and intelligent systems.

- Explainable AI: AI models that explain why a decision or a forecast was reached
- Real-Time simulations, Geo-spatial Digital Twins: Forest ecosystems
- Blockchain-enabled KM: Ownership of community-shared data should be safeguarded
- Artificial Intelligence of climate resilience: The interconnections of forest data with hydrology, agriculture, and the urban world

Conclusion

As various factors lead to an increasing number of environmental challenges, ranging anywhere in between a continuous wildfire season to the loss of biodiversity and deforestation, there is no better time to implement transformative approaches to forestry management. Artificial Intelligence (AI) and Knowledge Management (KM) integration in forestry is a potent combination of two concepts, because it moves the industry in the direction of proactive, data-driven forestry management, as opposed to manual reactivity of interventions. Using AI, there is a provision to handle large amounts of information, identify trends, forecast, and make decisions automatically. Contrary to this, KM makes sure that such data is organized, put in context, and grounded in human talent, historical knowledge, and cultural ethics. Collectively, they allow a sort of smart forestry in which they are not only empirical but also imaginative.

Such integration enables the forest ecosystems to be treated as dynamic/adaptive systems. Forest managers, with the help of monitoring tools powered by AI, can foresee such threats as the outbreaks of pests, illegal logging, or consequences of droughts before they become major ones. When integrated with AI, knowledge management (KM) systems offer an effective means to ensure that knowledge—whether derived from satellite data, scientific research, or indigenous traditions—is continuously updated, disseminated, and applied in practice. In addition to operational efficiency, this harmonized initiative will enable more accommodating governance since various stakeholders, including policymakers and local communities, will be provided with access to the same smartly developed platforms. This transformation redefines forests as dynamic knowledge networks, where information is continuously acquired, decision-making is responsive, and sustainability outcomes are measurable. But technology can simply be as strong as the ecosystem in which it is embedded. To achieve all the potential benefits of AI-based KM in forestry, innovation is not enough. It requires responsible visioning, inclusive design, cross-sectional teamwork, and great infrastructure. Going ahead, we should make our AI systems transparent and explainable, indigenous knowledge platforms must be used to protect and uplift the indigenous knowledge, and we should treat forest data as a common public good. Machines do not and should not replace human judgment, but make it stronger by converting dotted information into clear strategies and scattered databases into collective wisdom.

Forests are not merely timber or carbon stores: they are stores of intelligence, durability, and promise. Guided by well-informed ethical principles, we can harness appropriate technological tools to evolve from basic tree management toward a more sustainable, equitable, and intelligent coexistence with forest ecosystems. To make smart forestry smart, using the AI-powered knowledge management is not primarily about performance optimization but building a new relationship between people, technology, and nature, where the management of forests will be performed not by looking at them as passive assets, but as active participants in the future of the planet.

References

1. Damaševičius, R., & Maskeliūnas, R. (2025). Enhancing smart Forestry through AI-Driven Knowledge Management: a synergistic approach to efficiency and sustainability. *Journal of Sustainable Forestry*, 1–31. https://doi.org/10.1080/10549811.2025.2513220
2. Bernatavičienė, J., & Kurasova, O. (2024). 15th Conference on Data Analysis Methods for Software Systems. November 28–30, 2024. *Vilnius University Proceedings*, *52*, 1–136. https://doi.org/10.15388/damss.15.2024
3. Ramos-Maldonado, M., Gutiérrez, F., Gallardo-Venegas, R., Bustos-Avila, C., Contreras, E., & Lagos, L. (2025). Machine learning and industrial data for veneer quality optimization in plywood manufacturing. *Processes*, *13*(4), 1229. https://doi.org/10.3390/pr13041229