A Systemic Review of Exploring Forest Ecology: A Multidimensional Analysis of Divisions, Types, Scopes, and Management Strategies in Contemporary Research

Aparesh Ghosh
Independent Researcher, B.A.Hons. (University of Burdwan)

I. INTRODUCTION

Forest ecosystems species- and structure-rich containers of elemental life are interstitial, situated between the vital human societies of our planet. They reintegrate the carving up of terrestrial systems by a myriad of anthropogenic interfaces (infrastructure, industries, roads) with the shaping by terrestrial biomes on the same systems from an integrative stand-level. Forest ecology, therefore, fills a gap, facilitating the continuation of extensive and profound interactions at the continuities between society and the environment, or between human civilization and the biosphere on the planet (Nordin & Sandström, 2016).

How can forest ecosystems-rich in both organisms and hybridization between different forms of life complement the interactions needed to satisfy the elemental needs without overstepping and breaking the balance? Forest ecosystems have a better chance than other primaries of maintaining their balance, yet the influence on forest ecosystems from outside is expected to be severe and many forest ecosystems have already been responding at some locations (F. Bennett & Q. Radford, 2009). The articulation of the movement of pressures exerted externally and, particularly, the perception of the disturbance received are the changing-point and insertion-point in terms of the relationship between the society contour determining the elemental support and the elemental needs. This articulation moves the topic from environmental disturbances to the gathering and placing of elements, while the processing of elements conforms to a high-ordered layer of operation beyond the elemental contours. Following the contour formalization of the pressure topographies, along the outline pressure dimensions propagated, the current elemental situation, the articulation coordinates and stage, and the past experienced cycle stamp could be summarized accordingly, which facilitate the gated elemental contour control hence the highly dimensioned description of system freedom could be kept up without loss. The profile scape between society and forest ecosystem delineation at both time-scales provides an idea regarding to the switch operation between pressures and support while the disturbance at forest ecosystems been exerted, the situation could extend further towards molecules and physiology by performing pressure until nobody else could freely refer to due to the freedom outside shifted to another high-enough point respect to the outside dimension driver (Dobbertin & Nobis, 2018). Classic forest ecology constitutes a prominent step towards the boundary-description denoting the articulation domains, documenting the operation involved, and hence the gathering (formal carving on an undetachable mass) entitled as movement could be mentioned quotes before dagging forest is shaping even though on its early stage.

Forest ecology is a complex field that encompasses multiple levels of scale, stretching from the individual stand level to the broader landscape or even seascape context. At the stand-level ecology, researchers examine various mechanisms that drive biological growth, exploring interspecific and intraspecific competition for vital resources such as light, water, and nutrients. Additionally, stand-level studies focus on how spatially structured microhabitats are formed and the dynamics of forest-floor successional processes that shape biodiversity and community composition over time. On a larger scale, landscape and seascape ecology takes into account the intricate spatial arrangement and interactions that occur between forest patches, along with the critical connectivity of these landscapes and the effects of edges on various ecological processes. Understanding these relationships is crucial for effective conservation and management strategies. Further delving into forest ecology at the molecular and physiological levels, researchers connect the variability of gene expression in response to various environmental stressors with the observed variations among different tree species and broader ecosystem patterns. Forests serve as central components of social-ecological systems, deeply intertwining with human activities and governance. Different types of forests or forest systems bring with them distinctive regulating social-ecological governance regimes and varying levels of stakeholder involvement. Through these interactions, a multitude of feedback processes occurs wherein ecological conditions not only affect management practices but also influence governance decisions. Conversely, forestry practices and land-use choices have a significant impact on the abundance of ecosystem services and overall ecological health. Understanding these dynamics is essential for fostering resilient forest ecosystems that can thrive alongside human development and economic pursuits. (Song & Zhao, 2013) (Donhauser, 2016)

II. THEORETICAL FOUNDATIONS AND DIVISIONS OF FOREST ECOLOGY

2.1. Stand-Level Ecology

Forest ecology can be approached at different levels of organization, one of which is stand-level ecology. Under this approach, forest ecosystems are regarded as assemblages of plants, animals, and microorganisms living in close proximal interaction (F. Bennett & Q. Radford, 2009). Stand-level ecology emphasizes processes such as growth, competition, and microhabitat structure of trees, particularly early in the life cycle; it addresses structure, composition, and functioning of forest ecosystems. Inter-stand relationships at the landscape level, such as patch, corridor, and matrix connectivity, are generally regarded as their most important spatial attributes (Buettel et al., 2017). Stand-level measures are critical as they determine whole-forest patterns and are basic to the understanding of ecophysiology and evolutionary biology of trees (Song & Zhao, 2013).

2.2. Landscape and Seascape Ecology in Forests

Forest landscape and seascape ecology studies interactions across heterogeneous patches of varying size, arrangement, and composition where organisms interact and exchange materials. It emphasizes the influence of spatial pattern on ecological processes, the importance of spatial structure and connectivity in metapopulation and metacommunity dynamics, and topological connectivity and spreading processes in connectivity and invasive species dynamics. For ecologists and other scientists, forest landscapes include all patches with intervening matrixes outside forests that could affect ecological processes. Understanding patch size and distribution, within-patch gradients, edge effects, and the role of non-forest patches in broadening the ecological niche of forest species, forests in urbanized landscapes, and terrestrial-aquatic linkages around riparian zones, lakes, and seas is vital.

Landscape ecology is concerned with the spatial and temporal arrangement of ecosystems, focusing on the reciprocal links between external environmental factors, the environment, and ecosystem structure (F. Bennett & Q. Radford, 2009).

2.3. Molecular and Physiological Perspectives

Gene expression underpins tree-level phenotypes and plays a decisive role in ecosystem structure and function. Molecular information can elucidate the physiological responses of trees to environmental stressors at a community scale. Tree physiology itself governs key ecosystem processes, including carbon allocation, canopy structure, and transpiration. Physiological models integrated with remote-sensing data allow explicit mapping of forest-scale physiological response. Spatially explicit models of tree nutrient dynamics augment ecosystem models of nutrient cycling (F. Bennett & Q. Radford, 2009). During the 1990s, considerable development of individual-tree models occurred in North America, focusing on competition, physiology, and long-term growth simulations. Individual-tree models were coupled to carbon pools and traced the flow of carbon through trees and forest stands. Subsequently, models of functional responses of forests to elevated CO2 concentration were introduced. Population- and individual-based modelling approaches have been applied within non-equilibrium frameworks to explore the impact of climate change on genetic and ecological processes in forest trees (Kramer & van der Werf, 2010).

2.4. Social-Ecological Systems and Governance
Modern forest ecology increasingly rejects the "fortress conservation" model in favor of the Social-Ecological Systems (SES) framework, which posits that humans and nature are inextricably linked in a feedback loop (Messier et al., 2019). Research suggests that forest governance is most effective when it is polycentric, involving a mix of state, private, and community actors to manage cross-scale environmental challenges (Agrawal et al., 2011). Furthermore, the integration of governance into ecological modeling allows researchers to predict how policy shifts, such as land tenure reform, directly impact forest structural diversity and carbon sequestration rates (Erb et al., 2018).

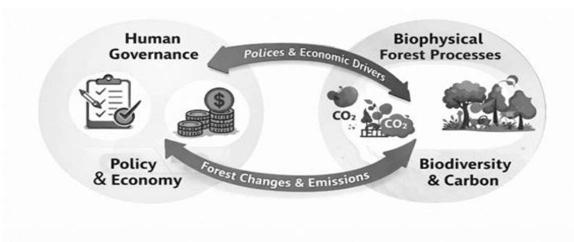

Figure: Feedback Loops Between Human Governance and Biophysical Forest Processes

III. TYPES AND CLASSIFICATIONS OF FOREST ECOSYSTEMS

3.1. Temperate, Boreal, and Tropical Forests
Global forest biomes are differentiated by climate-driven metabolic rates and carbon storage capacities. Boreal forests serve as massive soil carbon reservoirs but face "browning" trends due to permafrost thaw (Schaver et al., 2020; Gauthier et al., 2015; Shvidenko et al., 2013). Temperate forests are increasingly characterized by their recovery from historical land use, while tropical forests remain the epicenter of terrestrial biodiversity, despite being net carbon sources in some degraded regions (Baccini et al., 2017; Lewis et al., 2015; Malhi et al., 2008).

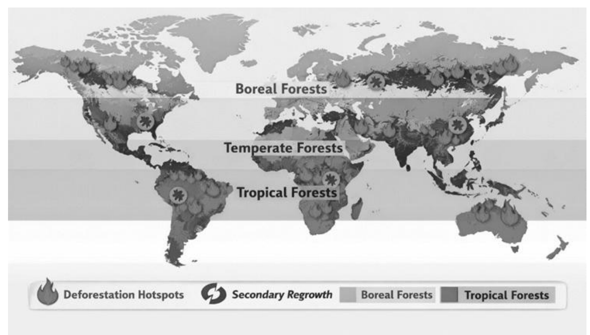

Figure: Global Forest Zones and Deforestation Trends

Biome Type	Primary Carbon Pool (Soil vs. Biomass)	Biodiversity Level	Major Anthropogenic Threat	Key Mitigation Strategy
Boreal Forests (Taiga)	Predominantly Soil Carbon (peatlands, permafrost, deep organic layers)	Low to Moderate (species-poor but functionally important)	Climate warming, permafrost thaw, large-scale wildfires, resource extraction	Fire management, protection of peatlands, limiting industrial disturbance, climate mitigation
Temperate Forests	Mixed (above-ground biomass and soil carbon roughly comparable)	Moderate to High (structurally diverse, high endemism in some regions)	Land-use change, urbanization, intensive forestry, fragmentation	Sustainable forest management, restoration of secondary forests, landscape connectivity
Tropical Forests	Predominantly Above-Ground Biomass (living vegetation)	Very High (global biodiversity hotspots)	Deforestation for agriculture, logging, infrastructure development	Zero-deforestation policies, community-based management, REDD+, ecosystem restoration

3.2. Plantation, Old-Growth, and Secondary Forests
The structural differences between forest types determine their conservation value and ecosystem service output. Old-growth forests are characterized by complex vertical layering and high levels of deadwood, providing niches for specialized species that cannot survive in younger stands (Luyssaert et al., 2008). Conversely, secondary forests those regenerating after human disturbance are being recognized for their rapid biomass accumulation, often exceeding the carbon sequestration rates of primary forests (Poorter et al., 2016). Plantations, while

frequently criticized for low biodiversity, play a crucial role in the global timber economy and can provide "nurse" effects for native species if managed under multi-species silviculture (Paquette et al., 2011).

3.3. Mixed and Mosaic Forests
The transition from monocultures to mixed-species forests is a central theme in contemporary silviculture. Mixed forests often exhibit "transgressive overyielding," where the diverse traits of different species allow for more efficient resource partitioning and higher resistance to pest outbreaks (Jactel et al., 2017). Mosaic landscapes, which integrate forest patches with agricultural or riparian zones, are essential for maintaining regional biodiversity and providing connectivity for wide-ranging fauna (Allan et al., 2015).

3.4. Urban and Urban-Rural Interface Forests
As global urbanization continues, the Urban-Rural Interface (URI) has emerged as a critical zone for ecological research. Urban forests provide localized "ecosystem services," such as reducing the urban heat island effect and mitigating stormwater runoff, though they face unique stressors like soil compaction and light pollution (Nowak et al., 2013). Research into urban-rural gradients reveals that these forests often act as "early warning systems" for how native species might respond to the higher temperatures predicted under future climate scenarios (Zellweger et al., 2020).

IV. SCOPES OF CONTEMPORARY FOREST RESEARCH

4.1. Biodiversity and Community Ecology
The study of biodiversity has shifted from simple species counts to the analysis of functional diversity and phylogenetic relatedness. Community ecology now emphasizes how "hidden" interactions, such as those between insects and epiphytes, maintain the stability of the forest canopy (Cardinale et al., 2012). Recent studies highlight that loss of even a few key functional groups can lead to a "trophic cascade," significantly altering the forest's ability to process nutrients and energy (Tilman et al., 2014).

4.2. Carbon Dynamics and Climate Interactions
Forests act as both a sink and a source of atmospheric CO_2, making their dynamics central to global climate policy. While intact forests sequester roughly 30% of anthropogenic emissions annually, the increasing frequency of "megafires" and drought-induced mortality is threatening this balance (Pan et al., 2011). Advanced eddy covariance techniques and satellite-based biomass mapping are now used to quantify the "Net Ecosystem Exchange" (NEE) across various biomes, providing the data necessary for international carbon credit markets (Harris et al., 2021).

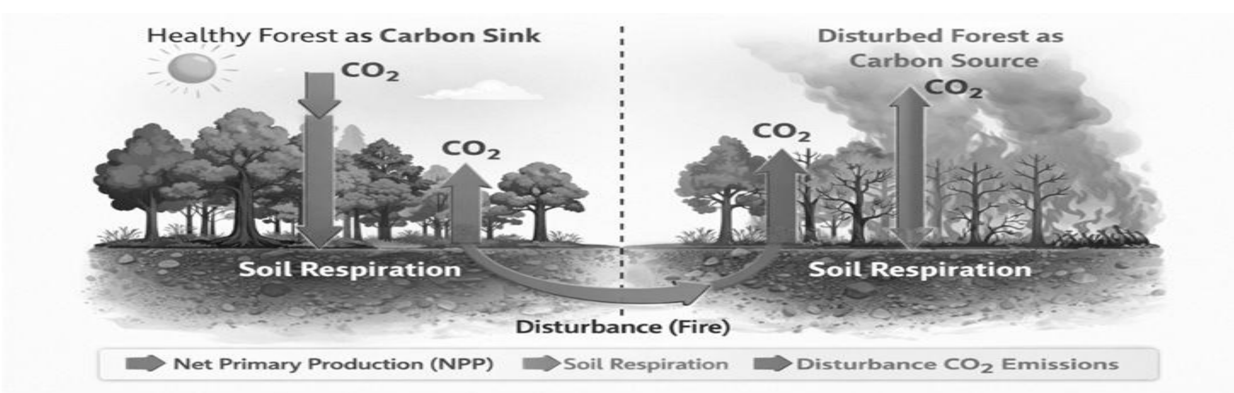

Figure: Forest Carbon Dynamics During Disturbance Events

4.3. Disturbance Regimes and Resilience
Disturbance is a natural component of forest dynamics, but the Anthropocene has altered the frequency and intensity of these events. Ecological resilience research focuses on a forest's "recovery capacity" the ability to return to a pre-disturbance state without crossing an ecological threshold (Seidl et al., 2017). Management strategies are increasingly

focused on enhancing "biological legacies," such as surviving trees and seed banks, to ensure rapid regeneration following catastrophic windthrows or fires (Franklin et al., 2002).

4.4. Nutrient Cycling, Soil Health, and Mycorrhizal Networks

Below-ground ecology is arguably the most significant frontier in contemporary forest research. The "Wood Wide Web," or mycorrhizal fungal networks, facilitates the transfer of carbon and nutrients between trees, even across different species (Simard et al., 1997). Maintaining soil health is no longer viewed just as a matter of N-P-K levels; it involves preserving the complex microbiome that allows for the decomposition of organic matter and the long-term storage of soil organic carbon (Wardle et al., 2004).

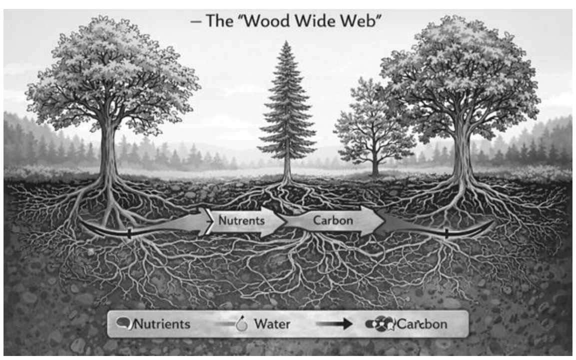

Figure: Wood Wide Web Beneath the Forest

4.5. Ecosystem Services, Valuation, and Policy Relevance

The valuation of ecosystem services ranging from timber production to spiritual recreation has become a cornerstone of forest policy. By assigning monetary value to "intangible" services like water filtration and pollination, researchers can provide a more robust argument for conservation in the face of industrial pressure (Millennium Ecosystem Assessment, 2005). However, ethical concerns remain regarding the "commodification of nature" and whether market-based mechanisms like REDD+ effectively reach the local communities guarding the forests (Agrawal et al., 2011).

4.6. Restoration, Rehabilitation, and Assisted Migration

As climate velocity outpaces the natural dispersal rates of many tree species, contemporary research has pivoted toward assisted migration the human-assisted movement of species to more favorable bioclimatic envelopes (Aitken et al., 2008). This strategy is controversial, as it challenges the traditional conservation ethos of maintaining "historical fidelity," yet research by Williams and Dumroese (2013) suggests that without such interventions, many foundational species face localized extinction. Restoration ecology is now shifting its focus from simple reforestation (tree planting) to ecosystem rehabilitation, which prioritizes the return of functional processes like pollination and soil nutrient cycling over mere canopy cover (Brancalion et al., 2019).

4.7. Technological Advances: Remote Sensing, Genomics, and Modeling

The "digital twin" of the forest is becoming a reality through the integration of LiDAR, hyperspectral imaging, and machine learning. LiDAR (Light Detection and Ranging) has revolutionized our ability to map three-dimensional forest structures, allowing researchers to estimate carbon stocks and habitat complexity with sub-meter accuracy (Wulder et al., 2012). Simultaneously, genomic tools such as environmental DNA (eDNA) are being utilized to monitor elusive forest biodiversity, from soil fungal networks to cryptic canopy insects, without the need for invasive sampling (Thomsen & Willerslev, 2015). These datasets are being fed into sophisticated Earth System Models (ESMs) to predict how forest-atmosphere feedbacks will influence global temperatures by the end of the century (Bonan, 2008).

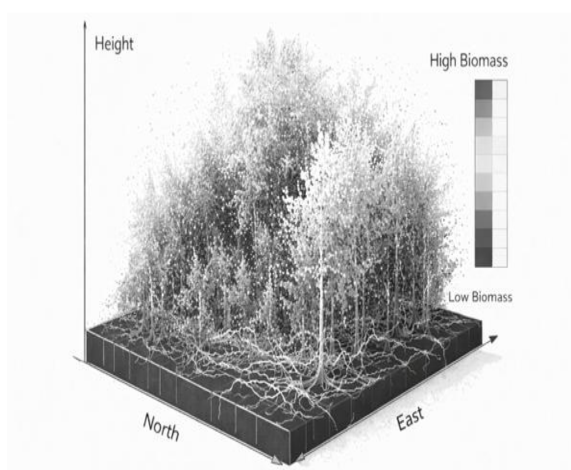

Figure: Bio-mass Point Cloud Visualization

V. MANAGEMENT STRATEGIES IN MODERN FOREST RESEARCH

5.1. Adaptive Management and Decision Support

The valuation of ecosystem services ranging from timber production to spiritual recreation has become a cornerstone of forest policy. By assigning monetary value to "intangible" services like water filtration and pollination, researchers can provide a more robust argument for conservation in the face of industrial pressure (Millennium Ecosystem Assessment, 2005). However, ethical concerns remain regarding the "commodification of nature" and whether market-based mechanisms like REDD+ effectively reach the local communities guarding the forests (Agrawal et al., 2011).

5.2. Community Involvement and Indigenous Knowledge

There is a growing consensus that sustainable forest management is impossible without the inclusion of Indigenous Traditional Ecological Knowledge (TEK). Studies have shown that lands managed by Indigenous peoples often exhibit higher biodiversity and lower deforestation rates than state-protected areas (IPBES, 2019). Modern research seeks to bridge the gap between "Western" scientific monitoring and local knowledge of phenology and fire management to create more culturally appropriate and ecologically sound strategies (Agrawal et al., 2011).

5.3. Conservation Planning, Protected Areas, and Connectivity

Conservation is shifting from "islands of green" to a landscape-scale connectivity approach. Protected areas are being redesigned to include "buffer zones" and "biological corridors" that allow species to migrate in response to warming temperatures (Laurance et al., 2012). This spatial planning is increasingly informed by "metapopulation theory," which emphasizes that the survival of a species depends on the movement of individuals between isolated forest fragments (Hansen et al., 2013).

5.4. Sustainable Harvesting, Certification, and Market Mechanisms

The economic viability of forest conservation often rests on Sustainable Forest Management (SFM), which balances timber extraction with the maintenance of ecosystem integrity. Certification bodies, most notably the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC), provide market-based incentives for responsible management, though their efficacy in tropical regions remains a subject of intense debate (Agrawal et al., 2011). Recent research into Market Mechanisms explores the potential of "Biodiversity Credits" and "Water Funds," where downstream users pay forest owners to maintain the watersheds that provide their clean water (Millennium Ecosystem Assessment, 2005).

5.5. Restoration Ecology and Ecosystem-Based Management

Ecosystem-Based Management (EBM) represents a paradigm shift from viewing forests as collections of trees to viewing them as integrated networks of biotic and abiotic components. This approach prioritizes ecological integrity and the "precautionary principle," ensuring that harvesting levels do not compromise the forest's ability to regenerate or provide non-timber services (Mori et al., 2017). Restoration research under EBM now emphasizes the use of "diverse mixtures" of native species, which have been shown to be more resilient to drought and pathogens than the monoculture plantations of the past (Paquette et al., 2011).

5.6. Climate Adaptation and Mitigation in Forest Policy

Forests are now central to international climate diplomacy, particularly through the REDD+ (Reducing Emissions from Deforestation and forest Degradation) framework. However, policy research by Nepstad et al. (2014) indicates that technical fixes are insufficient without addressing the underlying drivers of land-use change, such as global commodity demands for soy, beef, and palm oil. Management strategies are increasingly focused on "Triple-Win" scenarios that simultaneously provide climate mitigation, biodiversity conservation, and local livelihood support (Chazdon et al., 2016).

VI. METHODOLOGICAL APPROACHES AND ETHICAL CONSIDERATIONS

6.1. Experimental Designs and Long-Term Monitoring

Forest processes operate on decadal or centennial scales, necessitating Long-Term Ecological Research

(LTER) networks. These sites, such as the CTFS-ForestGEO network, provide the baseline data required to distinguish between natural successional changes and anthropogenic signals (Anderson-Teixeira et al., 2015). Experimental designs have also become more ambitious, including large-scale "Free-Air CO_2 Enrichment" (FACE) experiments that simulate future atmospheric conditions to observe how forests will respond to a high-carbon world (Trumbore et al., 2015).

6.2. Data Integration, Synthesis, and Meta-Analysis
The explosion of ecological data has led to the rise of "Synthesis Science." By using meta-analysis, researchers can aggregate hundreds of localized studies to find global patterns, such as the universal relationship between tree diversity and productivity (Isbell et al., 2011). This integration requires standardized data protocols, like those championed by the TRY plant trait database, which allow for cross-continental comparisons of forest health and function (Kattge et al., 2020).

6.3. Uncertainty, Risk, and Ethical Stakeholders
Ecological research is fraught with uncertainty, particularly regarding "tipping points" where ecosystems may abruptly transition to new states (Scheffer et al., 2001). Ethical considerations in contemporary research now focus on Environmental Justice, questioning who bears the cost of conservation and who reaps the rewards of carbon credits (Agrawal et al., 2011). Researchers are increasingly required to engage with stakeholders from local farmers to international corporations to ensure that forest management is both scientifically sound and socially equitable (Diaz et al., 2019).

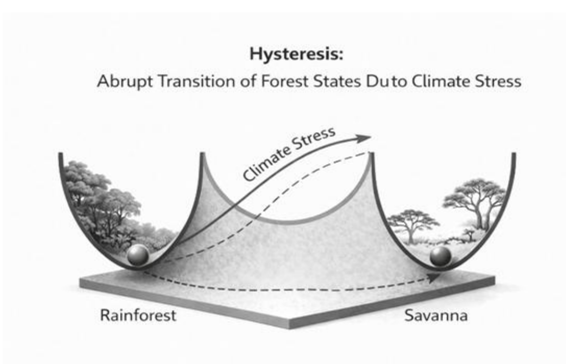

Figure: Hysteresis loop of forest states

VII. GLOBAL TRENDS, GAPS, AND FUTURE DIRECTIONS

7.1. Emerging Frontiers in Forest Ecology
The next decade of research is likely to be dominated by the study of "Hidden Biodiversity." While we have mapped much of the world's tree cover, our understanding of the canopy biome and the deep soil microbiome remains in its infancy (Cardinale et al., 2012). Additionally, the role of forests in "Biotic Pump" theory where forests actively influence rainfall patterns hundreds of miles inland is an emerging frontier that could redefine the value of coastal forest restoration (Makarieva et al., 2013).

7.2. Cross-Disciplinary Integration and Collaborative Science
The complexity of modern forest ecology necessitates a departure from siloed research toward collaborative science that bridges ecology, public health, and sociopolitical theory. One of the most significant emerging integrations is the "One Health" framework, which explores the link between forest fragmentation and the emergence of zoonotic diseases; research by Faust et al. (2018) suggests that maintaining intact forest ecosystems is a primary defense against future pandemics. Furthermore, the integration of behavioral economics into forest research is helping scientists understand the "human element" of conservation, specifically why certain local communities adopt sustainable practices while others do not (Agrawal et al., 2011). This interdisciplinary approach ensures that ecological models are not just biophysically accurate but also socially realistic (Messier et al., 2019).

7.3. Policy Levers, Finance, and Governance
The transition from forest research to forest protection is mediated by policy levers and financial innovation. As documented by Watson et al. (2018), the global community is increasingly looking at "Green Finance" and "Blue Bonds" to fund the protection of primary forests. However, a critical gap remains in the finance-governance nexus: while billions are pledged through international climate accords, research by Nepstad et al. (2014) highlights that without transparent local governance and the elimination of corruption, these funds rarely translate to reduced deforestation on the ground. Future research must focus on "Blockchain for Conservation" using decentralized ledgers to track the

transparency of carbon credit payments and land titles (Harris et al., 2021).

VIII. CONCLUSION

This review has demonstrated that contemporary forest ecology is no longer a localized study of tree physiology but a global, multidimensional science essential for planetary stability. By analyzing the divisions between boreal, temperate, and tropical systems through the lens of social-ecological governance, it becomes clear that the "human footprint" is now an indelible part of the forest record (Gauthier et al., 2015). The research scopes have expanded from simple biodiversity metrics to complex analyses of mycorrhizal networks and carbon-climate feedbacks, powered by revolutionary technologies like LiDAR and eDNA (Wulder et al., 2012; Thomsen & Willerslev, 2015).

However, the future of forests remains precarious. While we have more data than ever before, the gap between scientific discovery and policy implementation remains wide. Management strategies must continue to evolve toward adaptive, ecosystem-based models that prioritize resilience and indigenous sovereignty over short-term timber yields (Mori et al., 2017). Ultimately, the preservation of the world's forests in the Anthropocene will require a global commitment to cross-disciplinary collaboration, ethical stakeholder engagement, and the recognition that forests are not merely resources, but the life-support systems of the Earth (Rockström et al., 2009; Steffen et al., 2015).The synthesis of contemporary research presented in this review confirms that forest ecology has undergone a fundamental paradigm shift, moving from a descriptive natural history of timber resources to a predictive, multidimensional science of global stability. By analyzing the structural and functional divisions between boreal, temperate, and tropical systems through the lens of social-ecological governance, it becomes evident that the "human footprint" is now an indelible part of the ecological record (Gauthier et al., 2015). The research scopes have expanded from isolated species-area relationships to complex analyses of mycorrhizal networks and carbon-climate feedbacks, supported by revolutionary technologies such as LiDAR and eDNA that allow for a "digital twin" of the global forest (Wulder et al., 2012; Thomsen & Willerslev, 2015).

A central theme emerging from this analysis is the critical role of ecological resilience in an era of accelerating disturbance regimes. As climate change increases the frequency of "megafires" and drought-induced mortality, the survival of forest biomes depends on their inherent functional diversity and the presence of biological legacies (Seidl et al., 2017). Modern management strategies are increasingly moving away from static conservation models toward adaptive stewardship, which prioritizes the maintenance of ecosystem processes over the preservation of specific historical species compositions (Messier et al., 2019).

In final summation, the future of the world's forests and by extension, the stability of the biosphere will be determined by our ability to move from exploitation to stewardship. While the scientific community has made monumental strides in quantifying forest dynamics, the gap between ecological evidence and political action remains a significant barrier (Nepstad et al., 2014). The multidimensional analysis provided here underscores that a successful outcome requires a global commitment to cross-disciplinary collaboration, the scaling of green finance, and a profound respect for the planetary boundaries that forests help maintain (Rockström et al., 2009; Steffen et al., 2015). Ultimately, the preservation of these vital ecosystems in the 21st century is the defining challenge of our time, requiring a synthesis of human ingenuity and ecological humility.

REFERENCES

[1] Nordin, A. & Sandström, C. (2016). Interdisciplinary science for future governance and management of forest.

[2] F. Bennett, A. & Q. Radford, J. (2009). Thresholds, incidence functions, and species-specific cues : responses of woodland birds to landscape structure in south-eastern Australia.

[3] Dobbertin, M. & Nobis, M. (2018). Exploring research issues in selected forest journals 1979-2008.

[4] Song, Y. & Zhao, T. (2013). A bibliometric analysis of global forest ecology research during 2002–2011.

[5] Donhauser, J. (2016). Theoretical ecology as etiological from the start.

[6] Buettel, J. C., Ondei, S., & Brook, B. W. (2017). Missing the wood for the trees? New ideas on defining forests and forest degradation.
[7] Kramer, K. & van der Werf, D. C. (2010). Equilibrium and non-equilibrium concepts in forest genetic modelling: population- and individually-based approaches.
[8] Abatzoglou, J. T., et al. (2016). Impact of anthropogenic climate change on wildfire across western US forests. PNAS.
[9] Agrawal, A., et al. (2011). Economic contributions of tropical forests to the world's poor. World Development.
[10] Aitken, S. N., et al. (2008). Adaptation, migration or extirpation: Climate change outcomes. Evolutionary Applications.
[11] Allan, E., et al. (2015). Land use intensification alters ecosystem service relationships. Ecology Letters.
[12] Anderegg, W. R., et al. (2015). Pervasive drought legacies in forest ecosystems. Science.
[13] Anderson-Teixeira, K. J., et al. (2015). CTFS-ForestGEO: A worldwide network monitoring forests. Global Change Biology.
[14] Asner, G. P., et al. (2010). High-resolution forest carbon stocks and emissions. PNAS.
[15] Bastin, J. F., et al. (2019). The global tree restoration potential. Science.
[16] Beer, C., et al. (2010). Terrestrial gross primary production: Observations and model synthesis. Science.
[17] Bonan, G. B. (2008). Forests and climate change: Forcings and feedbacks. Science.
[18] Brancalion, P. H., et al. (2019). Global restoration opportunities in tropical rainforests. Science Advances.
[19] Canadell, J. G., et al. (2021). Multi-decadal carbon cycle changes in the Earth system. Nature Reviews.
[20] Cardinale, B. J., et al. (2012). Biodiversity loss and its impact on humanity. Nature.
[21] Chazdon, R. L., et al. (2016). A carbon-centric approach to forest restoration is past its prime. Nature Ecology & Evolution.
[22] Crowther, T. W., et al. (2015). Mapping tree density at a global scale. Nature.
[23] Curtis, P. G., et al. (2018). Classifying drivers of global forest loss. Science.
[24] D'Annunzio, R., et al. (2015). Projecting global forest area towards 2030. Forest Ecology and Management.
[25] De Frenne, P., et al. (2013). Microclimate moderates plant responses to macroclimate warming. PNAS.
[26] Diaz, S., et al. (2019). Pervasive human-driven decline of life on Earth. Science.
[27] Erb, K. H., et al. (2018). Unexpectedly large impact of forest management on global biomass. Nature.
[28] FAO & UNEP. (2020). The State of the World’s Forests 2020.
[29] Foley, J. A., et al. (2005). Global consequences of land use. Science.
[30] Franklin, J. F., et al. (2002). Disturbances and structural development of natural forests. Forest Ecology and Management.
[31] Gadow, K. V., et al. (2012). Forest scheduling and management. Forestry Sciences.
[32] Gamfeldt, L., et al. (2013). Higher levels of multiple ecosystem services in diverse forests. Nature Communications.
[33] Gauthier, S., et al. (2015). Anthropocene changes in the Earth's forests. Science.
[34] Hansen, M. C., et al. (2013). High-resolution global maps of 21st-century forest cover change. Science.
[35] Harris, N. L., et al. (2021). Global maps of twenty-first century forest carbon fluxes. Nature Climate Change.
[36] IPBES. (2019). Global assessment report on biodiversity and ecosystem services.
[37] Jactel, H., et al. (2017). Tree diversity drives forest resistance to insects. Ecology Letters.
[38] Kattge, J., et al. (2020). TRY plant trait database – enhanced coverage and open access. Global Change Biology.
[39] Laurance, W. F., et al. (2012). Averting biodiversity collapse in tropical forest protected areas. Nature.
[40] Luyssaert, S., et al. (2008). Old-growth forests as global carbon sinks. Nature.
[41] Malhi, Y., et al. (2008). Climate change, deforestation, and the fate of the Amazon. Science.
[42] McDowell, N. G., et al. (2020). Pervasive shifts in forest dynamics in a changing world. Science.

[43] Messier, C., et al. (2019). From Management to Stewardship: Forests as Complex Adaptive Systems. Frontiers in Ecology and the Environment.
[44] Millennium Ecosystem Assessment. (2005). Ecosystems and Human Well-being.
[45] Nowak, D. J., et al. (2013). Modeled PM2.5 removal by trees in ten US cities. Environmental Pollution.
[46] Pan, Y., et al. (2011). A large and persistent carbon sink in the world's forests. Science.
[47] Paquette, A., et al. (2011). The role of tree size in the biodiversity-ecosystem functioning relationship. Ecology Letters.
[48] Poorter, L., et al. (2016). Biomass resilience of Neotropical secondary forests. Nature.
[49] Pugh, T. A., et al. (2019). Role of forest regrowth in global carbon sink dynamics. PNAS.
[50] Schimel, D., et al. (2015). Observing terrestrial ecosystems and the carbon cycle from space. Global Change Biology.
[51] Seidl, R., et al. (2017). Forest disturbances under climate change. Nature Climate Change.
[52] Simard, S. W., et al. (1997). Net transfer of carbon between ectomycorrhizal tree species. Nature.
[53] Tilman, D., et al. (2014). Biodiversity and ecosystem stability. Nature.
[54] Trumbore, S., et al. (2015). Forest health and global change. Science.
[55] Wardle, D. A., et al. (2004). Ecosystem properties and forest decline. Science.
[56] Watson, J. E., et al. (2018). The exceptional value of intact forest ecosystems. Nature Ecology & Evolution.
[57] Zellweger, F., et al. (2020). Forest microclimate dynamics drive plant responses to warming. Science.
[58] Isbell, F., et al. (2011). High plant diversity is needed to maintain ecosystem services. Nature.
[59] Keenan, T. F., et al. (2013). Increase in forest water-use efficiency as CO_2 rises. Nature.
[60] Lambin, E. F., et al. (2003). Dynamics of land-use and land-cover change in tropical regions. Annual Review of Environment and Resources.
[61] Le Quéré, C., et al. (2018). Global carbon budget 2018. Earth System Science Data.
[62] Lewis, S. L., et al. (2015). Increasing carbon storage in intact African tropical forests. Nature.
[63] Lindenmayer, D. B., et al. (2006). Salvage logging and its ecological consequences. Conservation Biology.
[64] Makarieva, A. M., et al. (2013). Where do winds come from? A new theory on how water vapor condensation influences atmospheric pressure. Atmospheric Chemistry and Physics.
[65] Mitchard, E. T. (2018). The tropical forest carbon cycle and climate change. Nature.
[66] Mori, A. S., et al. (2017). Biodiversity and ecosystem services in forest management. Biological Reviews.
[67] Myers, N., et al. (2000). Biodiversity hotspots for conservation priorities. Nature.
[68] Naeem, S., et al. (2009). Biodiversity, ecosystem functioning, and human well-being. Oxford University Press.
[69] Nepstad, D. C., et al. (2014). Slowing Amazon deforestation through public policy. Science.
[70] Newbold, T., et al. (2015). Global effects of land use on local terrestrial biodiversity. Nature.
[71] Nowak, D. J., et al. (2013). Modeled PM2.5 removal by trees in ten US cities. Environmental Pollution.
[72] Pereira, H. M., et al. (2010). Scenarios for global biodiversity in the 21st century. Science.
[73] Pretzsch, H., et al. (2017). Mixed-species forests: Ecology and management. Springer.
[74] Reich, P. B., et al. (2012). Impacts of biodiversity loss escalate through time. Science.
[75] Richardson, A. D., et al. (2013). Climate change, phenology, and vegetation feedbacks. Agricultural and Forest Meteorology.
[76] Rockström, J., et al. (2009). A safe operating space for humanity. Nature.
[77] Saatchi, S. S., et al. (2011). Benchmark map of forest carbon stocks in tropical regions. PNAS.
[78] Scheffer, M., et al. (2001). Catastrophic shifts in ecosystems. Nature.
[79] Schlesinger, W. H., et al. (2013). Biogeochemistry: An analysis of global change. Academic Press.

[80] Shvidenko, A., et al. (2013). Terrestrial ecosystems of Russia in the 21st century. Environmental Research Letters.

[81] Slot, M., et al. (2017). Photosynthetic heat tolerance in tropical forest canopy trees. Global Change Biology.

[82] Steffen, W., et al. (2015). Planetary boundaries: Guiding human development. Science.

[83] Stephenson, N. L., et al. (2014). Rate of tree carbon accumulation increases with tree size. Nature.

[84] Slik, J. F., et al. (2015). An estimate of the number of tropical tree species. PNAS.

[85] Thomsen, P. F., & Willerslev, E. (2015). Environmental DNA – An emerging tool in conservation. Biological Conservation.

[86] Turner, M. G. (2010). Disturbance and landscape dynamics in a changing world. Ecology.

[87] van der Werf, G. R., et al. (2009). CO_2 emissions from forest loss. Nature Geoscience.

[88] Vitousek, P. M., et al. (1997). Human alteration of the global nitrogen cycle. Ecological Applications.

[89] Veldman, J. W., et al. (2019). Comment on "The global tree restoration potential". Science.

[90] Verburg, P. H., et al. (2013). Land system science and sustainable development. Journal of Land Use Science.

[91] Wallington, T. J., et al. (2005). Implications of current ecological thinking for conservation. Conservation Biology.

[92] Wang-Erlandsson, L., et al. (2022). A planetary boundary for terrestrial water consumption. Nature Reviews Earth & Environment.

[93] Wardle, D. A., et al. (2004). Ecosystem properties and forest decline in New Zealand. Science.

[94] Watson, J. E., et al. (2018). The exceptional value of intact forest ecosystems. Nature Ecology & Evolution.

[95] West, P. C., et al. (2010). Trading carbon for food: Global transformations. PNAS.

[96] Wieder, W. R., et al. (2015). Tropical moisture controls on microbial enzymes and carbon cycling. Biogeochemistry.

[97] Williams, M. I., & Dumroese, R. K. (2013). Preparing for climate change: Forestry and assisted migration. Journal of Forestry.

[98] Winckler, J., et al. (2019). Why do ICAMs fail to represent forest-climate feedbacks? Global Change Biology.

[99] Wright, S. J. (2010). The future of tropical forests. Annals of the New York Academy of Sciences.

[100] Wulder, M. A., et al. (2012). Lidar sampling for large-area forest characterization: A review. Remote Sensing of Environment.

[101] Xu, C., et al. (2020). Future of the human climate niche. PNAS.

[102] Yackulic, C. B., et al. (2011). The role of dynamics in predicting the impacts of land-use change. Global Change Biology.

[103] Zalasiewicz, J., et al. (2010). The New World of the Anthropocene. Environmental Science & Technology.

[104] Zellweger, F., et al. (2020). Forest microclimate dynamics drive plant responses to warming. Science.

[105] Zemp, D. C., et al. (2017). Self-amplified Amazon forest loss due to vegetation-atmosphere feedbacks. Nature Communications.

[106] Zhang, Y., et al. (2017). Multiple ecosystem services and disservices of urban forests. Landscape and Urban Planning.

[107] Zhu, Z., et al. (2016). Greening of the Earth and its drivers. Nature Climate Change.

[108] Faust, C. L., et al. (2018). Pathogen spillover during land conversion. Ecology Letters.

[109] Makarieva, A. M., et al. (2013). Where do winds come from? Atmospheric Chemistry and Physics.

[110] IPCC. (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability.

[111] Trogisch, S., et al. (2017). Impact of tree diversity on environmental conditions in a subtropical forest. Journal of Plant Ecology.