The importance of adaptive forest management

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Emily Warrender June 20, 2025

Integrated forest management is a fundamental concept for the sustainable provision of demanded ecosystem services and the simultaneous promotion of biodiversity in our forests. Prof, Dr Andreas Rigling from Forest Ecology, Department of Environmental Systems Science, USYS – ETH Zurich, explains

Forests are long-lived and complex systems

‘Growth of trees and forests – from germination to tree death’ is the title of one of my lectures at ETH Zurich. The lecture explores the stages from seed to tree, tree to forest, the long time span, and the many transitions and bottlenecks throughout development. It covers the various components of forest ecosystems and their intricate interactions. This complexity varies across space and time, from one forest type to another, shaped by local site conditions and land-use history. Understanding this complexity is already a challenge, but forest dynamics are now shifting as the boundary conditions change. What applies today may no longer hold true tomorrow, with profound consequences for forests and their sustainable management.

Climate change accelerates forest dynamics

Although climate change has long been acknowledged as a threat to forests, its visible impacts were initially limited, making communication difficult. This has changed dramatically with the occurrence of more frequent extreme heat and drought events in the last decade. The year 2018 marked a turning point in Central Europe: long-anticipated predictions about tree species under stress, altered distribution areas, and changing species composition became a reality and were visible. As a result, trust in forest science grew – foresters could now observe the predicted effects in their own forests. Forest owners and managers realised that what seemed stable and slow-moving systems can become highly dynamic when conditions shift, threatening the provision of vital ecosystem services, such as wood. At the same time, demand for wood as a renewable resource is on the rise. Its use remains economically and ecologically viable if it is produced sustainably and ideally sourced within regional value chains. The importance of wood for a circular bioeconomy and a net-zero society may even increase in the future, as it has the potential to store carbon in high-quality wood products and replace energy-intensive materials, such as steel and concrete, as well as fossil fuels.

Globalization, urbanisation and the biodiversity crisis Beyond climate change, globalization and urbanization are impacting forests. Global trade and mobility introduce harmful organisms – plants, fungi, and insects – that can displace native species and damage ecosystems. Simultaneously, population growth and changing leisure habits are

increasing recreational use of forests, boosting their importance for public health. This additional pressure poses major management challenges. Meanwhile, we are witnessing a global biodiversity crisis, especially in agriculture, but also in forests, driven by deforestation and industrial forestry far from nature, which is still practised in many regions worldwide.

From impacts to integrated forest management

A significant part of my research has focused on the impacts of climate change on forest ecosystems. Increasingly, however, the critical question is how forest management can adapt to safeguard essential ecosystem services and promote biodiversity, the foundation of resilient forests. Beyond timber, forests provide natural hazard protection, erosion control, water purification, recreation, and habitats for fauna and flora.

Some management concepts target these services in separate, adjacent areas (segregative approaches), while others integrate multiple services within a single stand (multifunctional approaches). Many are inspired by natural processes, leading to more ecological forest management.

Integrated forest management combines these ideas. It involves both integrative and segregative strategies – promoting deadwood, natural regeneration, diverse tree species and structures, and the temporary or permanent protection of specific trees or entire areas. It aims to balance timber production with biodiversity conservation and multiple ecosystem services.

The European Integrate Network

The need to promote biodiversity and increase forest resilience amid rapid environmental change led to the establishment of the European Integrate Network. This alliance of representatives from 12 European countries supports the integration of biodiversity conservation into sustainable forest management across policy, practice, and research. With over 240 demonstration sites, the network fosters the exchange of best practices through workshops, webinars, and conferences. One flagship output was the book ‘How to Balance Forestry and Biodiversity Conservation – A View Across Europe,’ to which 159 authors from science, administration, and practice contributed.

The Horizon Europe project TRANSFORMIT

Beyond networking, integrated forest management is also a key focus of ongoing research. The Horizon Europe-funded TRANSFORMIT project aims to evaluate and refine integrated forest management approaches, helping to align biodiversity conservation with social and economic needs in production forests.

The project unites 16 institutions from 12 countries, emphasizing interdisciplinary cooperation between science and practice. Seven regional Living Labs illustrate how integrated management functions in various contexts. These labs act as platforms for

knowledge exchange, capacity building, and collaboration among forest managers, conservationists, researchers, policymakers, and local communities.

Preparing forests for an uncertain future

Despite growing understanding, many questions remain about how our environment and societies will evolve. Forests must be prepared for uncertain futures. Forest management decisions can be made rapidly and implemented in weeks, but their effects emerge over decades. Correcting and learning from past mistakes, restoring damaged ecosystems, and adapting forests to future conditions requires a significant amount of time. Therefore, it is essential to start today to create the scope for informed decision-making for the forests of tomorrow.

The selection of suitable management strategies, therefore, requires careful consideration and solid, broad-based interdisciplinary research, which only Horizon Europe can currently offer. This must be coupled with effective platforms that foster dialogue and mutual learning between experts from science, practice, administration, and policy.

The European Integrate Network and the TRANSFORMIT project are laying the groundwork for shaping the future of sustainable forest management. Their goal is to secure timber and ecosystem services for humanity while promoting and protecting biodiversity. Being part of these efforts is both inspiring and rewarding – a unique opportunity to help shape the future of forests in a rapidly changing world.

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Primary Contributor

Andreas Rigling
ETH Zürich
ORCID: 0000-0003-1944-4042