AFFORESTATION AND REFORESTATION

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Contents

Summary

Forests are rich in structure and correspondingly in ecological niches; hence they can harbour plentiful biological diversity. On a global scale, the rate of forest loss due to human interference is still very high, currently ca. 10 Mha per year. The loss is highest in the tropics; in some tropical regions rates are alarmingly high and in some virtually all forest has been destroyed. In this situation, afforestation appears to be the most significant option to counteract the global loss of forest. Plantation of new forests is progressing over an impressive total area worldwide (sum in 2000: 187 Mha; rate ca. 4.5 $Mha \cdot a^{-1}$), with strong regional differences.

Forest plantations seem to have the potential to provide suitable habitat and thus contribute to biodiversity conservation in many situations, particularly in problem areas of the tropics where strong forest loss has occurred. However, compared to natural tropical forest, plantations are usually less diverse and hence only a helpful alternative where natural forest has been lost, and the land is degraded. In intact cultural landscapes, which prevail in the developed countries of temperate regions, afforestation is commonly considered more critically and should in general not be performed in rare

and valuable biotopes, or in areas where there is already a high proportion of forest cover.

1. Definitions of terms

Afforestation is the human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding or the human-induced promotion of natural seed sources.

Reforestation (or reafforestion) is the establishment of forest in an area where there was forest during the last 50 years. The previous crop is either replaced by different species or by the same species as before.

According to FAO the term **forest plantation** includes all forests established by planting or seeding in the process of afforestation and reforestation. It relates to indigenous and introduced species, but must have a minimum area of 0.5 ha, a minimum crown cover of 10% and a potential minimum height of 5 m at maturity. Young natural stands and all plantations, which have yet to reach a crown density of 10% or tree height of 5 metres, are included under forest.

2. The particular features of forests among terrestrial ecosystems

Forests are characterized by a tree cover of a specific density. A distinct feature of forests among the terrestrial ecosystems is the longevity of their most important structural elements, the trees. The long lifespan of trees allows for accumulation of high stocks of biomass, together with a wealth of structural properties. These assets bear the potential for high permanent carbon storage, and high biodiversity of many natural forest communities. The structural richness does not only extend aboveground—there is usually also high belowground biomass and soil biological activity as well as belowground biodiversity.

Structural complexity of forest ecosystems entails complex processes and self-regulating feedback loops, which eventually provide highly desired ecosystem services such as soil protection, water flow control and water resource generation, as well as filtering and buffering functions of the soil with respect to numerous chemical constituents.

In many of the terrestrial biomes of the Earth, forests of different composition and eco-physiological characteristics form the potential natural vegetation, and they remain as greatly appreciated quasi-natural ecosystems even in the densely populated and industrialized regions of the world, where planted and managed forests have commonly replaced natural forest ecosystems.

3. Ecosystem level effects of afforestation and reforestation

When a forest is newly established, the trees will develop their specific branching and rooting patterns and thus establish new structures above- and belowground. In the course of time from the juvenile to the mature stage, and even more over a sequence of forest generations at the same site, there will be an accumulation of carbon, nitrogen and other nutrients in the system. As the system gets enriched in nutrients and structurally more complex, more niches emerge in the habitat and the potential to augment biodiversity should increase.

There is definitely a potential to achieve net carbon sequestration through making new forests, at least as long as those forests are still in an accretion phase and have not reached equilibrium of biomass accumulation and decay. Plantation forestry with recurring cycles of wood biomass harvest and replanting artificially keeps the systems in an accumulation state and prevents them from attaining equilibrium.

Forestation also provides a potential to create systems of high biological diversity (BD), but there should be critical examination of the conditions and circumstances in which practical improvements of BD can be achieved, and also when new plantations should be rejected because they interfere with sensible systems and communities, which should be conserved. In particular, monoculture forest plantations established and maintained with "quasi-industrial" management methods often carry high specific risk potential with respect to their stability, and may in many cases result in impaired BD. The following section gives an overview based on current literature.

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Biographical Sketches

Michael Bredemeier was born in November 1958 in Dortmund, Germany. He studied forestry at the Universities of Munich and Goettingen from 1978 to 1982 and was an exchange student at Oregon State University's School of Forestry in Corvallis, USA 1980.

He received his diploma in forestry in 1982 from Goettingen University and did his PhD in Soil Science and Forest Nutrition, studying internal and external sources of soil acidification (1987; summa cum laude). After the doctorate, he designed and coordinated several interdisciplinary research projects, *inter alia* the roof manipulation study in the Solling experimental forest of Goettingen University. He passed the Habilitation in Soil Science and Forest Nutrition (1999) with a thesis on time series analysis and modelling in long-term ecological datasets. In his current position he is Professor, Research Scientist and Coordinator at the Forest Ecosystems Research Center of Goettingen University. His research interests encompass terrestrial ecosystems ecology, forest ecology, soil science, soil chemistry, element cycling and budget studies, ecological time series analysis, long-term dynamics in ecosystems, biodiversity assessment and functional biodiversity. Together with Felix Müller of Kiel University, he leads the initiative to form a German national long-term ecosystem research network (LTER) as part of the international ILTER net.

Michael Bredemeier has authored and co-authored a large number of papers, book articles and contributions for Encyclopaedias, *inter alia* EOLSS and the Ullmann's Encyclopaedia of Industrial Chemistry. In 1989, he was awarded the van-der-Grinten Prize for Environmental Research. He holds a German and U.S. patent for his invention of a mobile lysimeter probe for soil water sampling.

Achim Dohrenbusch was born in February 1955 in Leverkusen, Germany. He studied forestry science and medicine at the University of Göttingen. He received his diploma in forestry in 1979 from Goettingen University and did his PhD in silviculture in 1982 on the management of oak coppice stands. He passed his habilitation in silviculture and forest ecology with a thesis on the natural regeneration of Scots pine. In his current position he is professor and research scientist at the Institute of Silviculture of Goettingen University and, since 1983, additionally lecturer for silviculture, forest ecology and forest management at the Institute of Nature Conservation and Landscape Planning, University of Hanover. He directed and coordinated different research projects on natural and artificial regeneration of forests, forest structure and dynamics in different forest communities of the temperate, subtropical and tropical zones, methods of testing the ecological conditions of forest plants, reforestation of difficult sites, tending of young stands, reforestation experiments with foreign tree species, eco-physiological research, especially reactions of damaged trees to air pollution, and forest weed management. He has authored and co-authored more than 80 papers and book articles. He is co-editor of two books published by Springer.

Achim Dohrenbusch has co-operative involvement in several international research and forest education programmes: amongst others in Turkey (1980), China (1984, 2000, 2001), Mexico (1981, 1982, 1997, 2004), Argentina (1992), Iran (1999, 2003, 2004), Chile and Costa Rica (2000, 2003, 2004). In 1992 he worked as visiting professor at the Perdue University in Indiana/USA, 1996 as visiting professor at the Mexican partner University in Monterrey and 2004 at the Mazandaran University in Iran. In 1983 he founded the new IUFRO-project-group 'herbicides in forestry', now known as "Forest weed management" (IUFRO = International Union of Forest Research Organisations) in Strasbourg/France. He was Chairman of this IUFRO-group until 1986 and vice-chairman until 1990.