TROPICAL ARTIFICIAL FORESTS

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Summary

Artificial forests comprise non-native and/or native tree species and differ from natural forests in structure, composition, intensity of management, orderliness and uniformity. Natural habitat loss represents the main threat to the maintenance of biodiversity in the tropical region. Artificial forests may help alleviate the damaging consequences of the loss of natural forests on ecological, social and economic basis providing effective ways to reduce the pressure over remaining natural forests. Here, we provide a brief overview about artificial forests implementation efforts in the tropics. We address some important concepts on the topic as well as historical and quantitative aspects. Illustrative case studies are presented and commented. We conclude that, if properly projected and managed, artificial forests in the tropics can contribute to ecological restoration efforts. For this, special attention to key aspects is needed such as the spatial scales over which plantations are implemented and the integration of protective and production efforts. The higher productivity and biodiversity of tropical forests provide a challenging and mostly unexplored potential to tackle these objectives.

1. Introduction

Natural habitat loss represents the main threat to the maintenance of biodiversity in the tropical region. It is caused by deforestation, land conversion and degradation which are motivated by the increasing demand for agricultural, urban and industrial areas. Every year ca. thirteen million hectare of native forests are lost in the world, which is a problem mostly concentrated in Latin America, Caribbean and Africa (FAO 2007). Only tropical humid forests decreased about 2.36 % in its area between 2000 and 2005 (Hansen et al 2008). Those anthropogenic impacts create novel ecosystems which have different structural and functional characteristics and alter the **ecosystem services** provided by tropical forests, such as climate control, water cycling, erosion and sediment retention, nutrient cycling and soil formation.

Current deforestation rates and the increasing accumulation of degraded areas in tropical regions reveal the urgency of human interventions to restore biodiversity, functions and provisions of ecological goods and services, mainly in poor agricultural zones. In addition, there is an increasing demand for wood and non-wood products that may not be fulfilled by the remaining natural forests. Within this context, distinct types of artificial forests may help filling the gap led by the loss of natural forests on ecological, social and economic basis (Lamb et al 2005), and may provide effective ways to reduce the pressure over remaining natural forests.

Artificial forests cover globally about 2 % of land area, which represents 7 % of global forest area (about 300 million hectares). In spite of its low quantitative representation in relation to global forested area, they provide more than half of the industrial wood produced in the world. Those forests are found from boreal to tropical zones, and can use native or introduced tree species, although **exotic species** are more common in tropical plantations designed for timber production or rural development. In the tropics, artificial forests cover about 88 million hectare (Evans & Turnbull 2004).

Here, we aimed to give an overview about artificial forests implementation efforts in the tropics and their role to improve the production of goods and services, and to restore and recover degraded land. In order to tackle these objectives, we first briefly review the main concepts and terms related to planted forests theoretical framework. Brief historical and quantitative aspects are addressed along with the potential of artificial forests to contribute to restoration efforts and the criticism associated with their implementation in tropical areas. Finally, some case studies are presented.

2. Concepts, Definitions and Purposes

Artificial forests differ from native forests in that they comprise both non-native and native tree species and differ in structure, composition and intensity of management and because of the orderliness and uniformity that they show. Agricultural areas, gardens, agroforestry systems, enrichment planting and linear planting are not included in this definition. The terms ‘artificial’, ‘planted’ and ‘human-made forests’ are all synonyms of forest plantations and will be used interchangeably hereafter.

Planted forests have multiple purposes, though their targets may be polarized in production or protection forests. The types of interfaces of these planted forests with natural forests perform a continuum and, in some cases, they may be very similar to natural adjacent forests. On one hand, there are productive plantations which are defined by the rotation period. **Fast-wood plantations** may be smaller in extent than longer-rotation plantations and demand huge financial and technological investments. They are usually composed by a single species and are intensively managed reaching maturity faster and producing 1 ½ - 2 times more wood/hectare/year than longer-rotation plantations. Longer-rotation **softwood plantations** are less productive and take 20 to 35 years to reach maturity. They occupy 2 to 3 times more lands than the fast-wood plantations and require longer investment periods. Logs yielded have higher timber quality and income value, so those kinds of plantations have a much higher financial return. Furthermore, as their biodiversity values depend on local management practices and the landscape context, they may contribute effectively to improve local economies and also to provide biodiversity benefits. Production forests, both from long and fast-wood plantations, may use native and/or exotic tree species.

On the other hand, there are protective forests established for provision of environmental services (soil and water protection) and sustain habitats for biodiversity maintenance. They may be composed by native or non native tree species. This category includes efforts for recovering degraded areas, aiming biodiversity restoration and/or conservation. Thus, in the tropics, they constitute a major challenge to the scientific community, environmental agencies and private initiative due to the high diversity of these forests.

These approaches, protection and production, should ideally provide both, goods and ecosystem services, but in different proportions (Figure 1). However, the optimization of productive, environmental and social benefits is a challenging enterprise. There is a handful of reasons to implement artificial forests: (i) to compensate ecological and economic losses as well as social impoverishment caused by deforestation; (ii) to supply raw materials for industry such as pulp, paper and high-quality products for both, domestic uses and exportation; (iii) to restore, recover and rehabilitate degraded sites in order to increase biological diversity and/or ecosystem services as well as genetic diversity; (iv) the higher wood productivity of planted forest when compared to native forests; and (v) other purposes such as rural development, to provide firewood, windbreaks, protection of water sources for irrigation, and may also be used to carbon sequestration and storage.

Tree cover has significant positive impacts in environmental protection. It can reduce soil erosion, slow wind speed, trap airborne sand and dust particles, moderate the forces of rain and slows water runoff after heavy rain. Farther, in a context of degraded tropical areas, the establishment of tree cover means the first step in soil **rehabilitation** and land **restoration**. Tree cover, whether artificial or natural, protects soil and reduces erosion through (i) high filtration rates reducing surface runoff and soil transport, (ii) binding action of roots increasing soil stability in slopes and reducing erosion, (iii) forest canopy, understory and ground layers acting in rainfall interception dissipating rain force, (iv) reducing wind speed force and consequent wind erosion, (v) presence of litter and humus layer reducing erosion and increasing moisture retention. Vegetation cover has also effects on the hydrology of a watershed as it reduces soil erosion preventing loss of fertile topsoil and increase retention of sediments. Tree cover also act in shelter provision through shelterbelts, thus reducing wind velocity, filtering airborne particles of sand and dust, protecting animals, agricultural crops and habitations (Evans & Turnbull 2004).

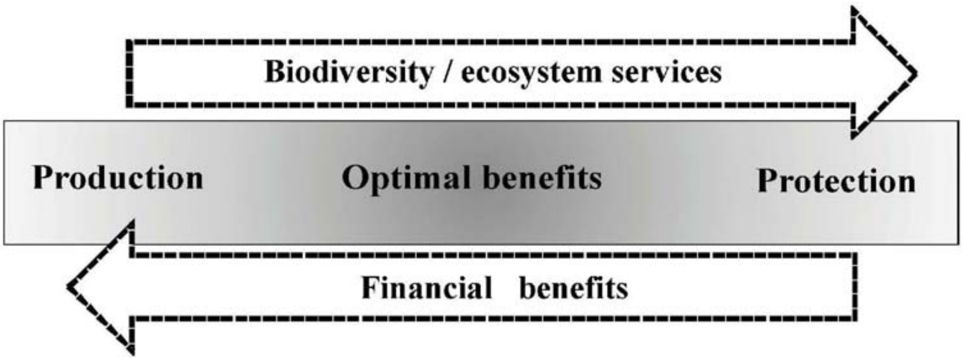

Figure 1. Planted forest for production or protection and their relationship with economical and biodiversity benefits. Traditional monoculture plantations mostly generate just financial benefits (production planted forests). Plantations aiming protection maximize diversity and/or ecosystem services having few direct financial benefits at least in the short term. Optimal benefits are attained by: (i) initially aiming financial benefits by using few plant species, generally monocultures, and, after some **cutting cycles**, diversity in the site is enhanced with native tree species increasing biodiversity and/or ecosystem services; and (ii) high diversity plantations may be managed by harvesting only tree species that maximize economic profit. Modified from Lamb et al (2005).

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Biographical Sketches

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