41 Restoring Dry Tropical Forests

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Key Points to Retain

Dry tropical forests have been overexploited by humans, and little remains now of this biologically rich and unique ecosystem.

There are a number of valid reasons to restore tropical dry forests, including their rates of endemism, their potential to yield medicines, aromatic herbs, and foods, recreational reasons, their genetic uniqueness and their potential adaptability to climate change.

Case studies show that restoration of tropical dry forests in a landscape context, although a difficult undertaking, is highly possible and necessary.

1. Background and Explanation of the Issue

Vast expanses of the Earth's warm regions—perhaps 40 to 45 percent of all intertropical lands—were once covered with tropical dry forests (TDF).[359] These areas included the leeward coastal plains of tropical America and Madagascar, and many (or even most) islands of the Caribbean, the Pacific and the Indian Oceans, as well as many inland regions of Africa, Asia, and Australia. Today, TDFs are deeply, and perhaps irreversibly, transformed. Only 1 to 2 percent of the original (prehuman) area remains in a relatively intact and ecologically healthy condition. The remainder are so fragmented and subject to species' loss, habitat change, and genetic erosion that they must be considered in imminent danger of extinction.

[359] Bullock et al, 1995.

1.1. Characteristics and Biological Wealth

Reflecting the very wide range of geological substrates on which they occur and the variable, unpredictable climate to which they are subject, TDFs harbour an astonishing variety of plants and animals that are remarkable in their structure, ecophysiology, chemistry, and ecology. They also show exceptionally high rates of endemism in all major groups of organisms. Sadly, however, the ecological importance and conservation value of TDFs only began to be recognised in the last 10 to 15 years, that is, much later than for tropical humid forests.

Tropical dry forests are characterised by continuous tree cover and a multitiered canopy. They also present a unique set of selective forces that have driven the evolution of a remarkable array of life forms. Unpredictable periods of sometimes severe water stress, followed by sudden and often spectacular increases in rainfall, lead to *pulses* in the availability of water, energy, and nutrients to plants and animals alike. This combination of interannual variation and unpredictability in resources, in areas where temperatures never drop below freezing, has catalysed the evolution of impressive arrays of deciduous, semideciduous, and evergreen trees, shrubs, and lianas, with very diverse chemistry, life forms, and reproductive systems. We speak of arrays in the plural because virtually every island, peninsula, or archipelago with TDF has its own unique set of species, many of which are locally endemic. Given the advanced fragmentation they have suffered, each surviving TDF community should be considered as a unique entity of the highest possible conservation value.

1.2. Attractiveness to People and Its Consequences

Due to their seasonality, gentle topographic relief, relatively rich soils, and proximity to tropical coasts where abundant food and water sources were available, TDFs attracted human settlers and hunters from very early times. Their rich and varied mineral deposits drew entrepreneurs and industrialists as well. As a result, the transformation and degradation of these forests often has gone on for long periods of time.

Prior to the onset of major human impact, TDFs were rich in tall canopy and emergent trees of great value for their dense, hard, and often beautiful and fragrant wood, such as Sandalwood (*Santalum album*). These were selectively harvested for local construction and, later, for international timber markets. Only relatively few people, rarely from the local community, benefited as a rule.[360]

Once the tree canopy giants were removed, the TDFs were usually subjected to progressive or wholesale cycles of transformation for cattle grazing or, more rarely, farmland or extractive production of fuel wood and charcoal (e.g., in southwest Madagascar, see below). This process—dating mostly from the late 1800s—often consisted of repeated burning and clearing until there remained little or none of the original assemblages of woody plants and soil-borne seed banks. Faunal and microbial biota also changed as a consequence.

Nowadays, TDF fragments and adjacent areas are mostly used for extensive livestock grazing of limited economic value or biodiversity interest. In some areas, the surviving TDFs near cities are disappearing to make way for coastal hotel complexes and unplanned urban sprawl. In the few places where some TDF remains but is neither protected nor currently sought after for "development," TDF fragments are still subject to selective logging for their slow-growing but often exceedingly valuable timber [e.g., *Cordia*, mahogany, teak, sandalwood, and yellow wood (*Podocarpus* spp.)]. This short-sighted exploitation of the most valuable remaining trees constitutes a flagrant example of "artificial negative selection" which, in TDF and other endangered forests, surely should be controlled and re-legislated, or better yet halted altogether until natural regeneration or active restoration have had some time to permit forest recovery.

[360] Roth, 2001.

1.3. Reasons to Restore

It must be recognised, however, that what remains of TDF today are not especially attractive to most people, and only rarely do they capture the attention of tourists. Their low annual productivity makes TDF of minor interest to foresters or farmers. Therefore, lobbying for their conservation, and, more so still, their restoration, is problematical. However, biodiversity criteria alone more than justify the need for greater efforts, especially at the landscape and ecoregional scales. What's more, the economic perspectives for restored tropical dry forests are by no means negligible, even if the most valuable timber trees and game animals have in most cases long ago been removed.

Many plants in tropical dry forests are known to be of value for nontimber products, including medicines, biopharmaceuticals, food products, potential sources for crop improvement (e.g., an endemic wild rice species in New Caledonia), perfumes, cosmetics, etc. Also, TDFs have significant economic value if managed under multipurpose, multiuser forestry approaches, including the incorporation of innovative eco- and cultural tourism. Restoration should clearly play a major role in both scenarios, with a community role built into these programs.

Additionally, in urban or peri-urban zones, like those of Grande Terre, New Caledonia, restoration of native TDF is the obvious and most cost-effective approach to meeting growing demands for amenity plantings and green areas. The maintenance costs of climatically adapted ecosystems would surely be less than for conventional horticultural plantations of exotic species—and lawn grass!—and the aesthetic result could be well superior. Such garden forests, albeit confined to urban parks, roadside planting areas, and the like, could be a useful complement to educational efforts, and serve as gene banks for extra-urban or peri-urban restoration projects, where hectares of contiguous forest, or corridors among TDF fragments, are in need of seed and germ plasm.

Finally, with global warming and an overall trend toward drying in terrestrial systems, the plants, microorganisms and animals of tropical dry forests represent a wealth of genetic capital that should not be underestimated. These organisms can be anticipated to respond more readily to warming and desertification on a global scale than those adapted to humid tropical forests. Accordingly, they merit special attention from managers and engineers as well as public policy decision makers.

2. Examples

2.1. Área de Conservación Guanacaste, Costa Rica

An extensive and innovative landscape-scale restoration and management project has been underway in Guanacaste, northern Costa Rica, since 1985, under the direction of Dan Janzen.[361] This 110,000 hectare conservation area began as Santa Rosa National Park, and through the efforts of Janzen and successive, far-sighted Costa Rica governments, was gradually increased to a landscape scale that includes not only TDF but also wet forest and montane cloud forest, as well as 45,000 hectares of off-shore marine reserve, and integrates the people who live in the area. This effort may well be unique, and is certainly of considerable relevance and importance to worldwide efforts at TDF conservation. The key points are that ecological management, conservation, and restoration are approached conjointly and at a real landscape scale. Restoration is seen as biocultural and involves the development of highly innovative education activities and ecological economics.

[361] Janzen, 2002.

2.2. New Caledonia (French Pacific Territory)

Following early initiatives of one of the authors (Jaffré), and his colleagues B. Suprin and J.-M. Veillon (as well as the Services Provinciaux de l'Environnement), attention began to grow about 15 years ago to the plight of the dwindling TDFs on the western coast of the largest island of New Caledonia—la Grande Terre. In 1998, WWF, the global conservation organisation, launched an effort to organise a consortium of nongovernmental organisations (NGOs), research institutions, and local government agencies to establish a multifaceted TDF programme in the context of the WWF forest landscape restoration programme. Underway since 2001, this programme has already carried out much of the preliminary reconnaissance and mapping of the many scattered TDF fragments, and has conducted valuable ecological, silvicultural, and horticultural studies for experimental restoration efforts slated to begin in 2004–2005. At the time of this writing, a major effort is underway to secure the possibility of enabling the restoration of a significant pilot landscape in Gouaro Deva, one of the few remaining sites containing a relatively large area (450 hectares) of forest with the potential to conserve a representative piece of the formerly widespread dry tropical forests on la Grande Terre. The prospects for an integrated protect, manage, and restore pilot project remain to be worked out with provincial and national policy and decision makers and, of course, local stakeholders.

Apart from the challenges of restoring a fragmented and degraded forest landscape, TDFs everywhere are facing very high and increasing pressures due to invasive species (ants, plants, deer, etc.), fire, and overgrazing. New Caledonia has perhaps the most endangered TDFs in the world,[362] which face all these threats and more. New Caledonia is one of the highest priority conservation hot spots in the world, with a very rich and highly endemic biota,[363] more than justifying the considerable effort being made to achieve lasting protection.

2.3. Western Madagascar

Together with many others NGOs, WWF has called attention to the alarming state and pressing need to initiate protect, manage, and restore efforts for what is left of TDFs in western Madagascar. Unlike New Caledonia and Costa Rica, relatively larges tracts still remain in Madagascar, from the Baobab-dominated forests north of Tuléar to the spiny forests in the extreme southwest. However, centuries-old Baobabs and all their extraordinary and endemic cohorts are increasingly being cut and cleared to make way for housing and hotels, while the other-worldly and unique Didieraeaceae/tree Euphorb-dominated spiny forest is being cut and transformed into charcoal by poverty-stricken local people entirely dependent on local resources.

In this kind of socioeconomic context, the challenge of protecting and restoring TDF is intimately linked to the lives and livelihoods of the neighbouring human populations, who are the ones primarily impacting the environment. While the Malagasy government has strengthened its commitment to biodiversity conservation, its capacity to implement policy through "normal" administrative measures is very limited in isolated rural areas. Alternatives are required that make use of community-based conservation approaches in which natural resource management is tightly linked to local (traditional) economic and land tenure systems and to youth education aimed an instilling a basic understanding of the short- and long-term importance of natural ecosystems.

[362] Gillespie and Jaffré, 2003.
[363] Lowry et al, 2004.

3. Outline of Tools

3.1. Monitoring Pressures

Controlling the pressures caused by livestock, invasive species, fire or land conversion is itself a restoration tool. For example, in northwestern Argentina, an innovative landowner and rancher named Carlos Saravia Toleda has developed techniques for controlled cattle grazing that actively favour reintroduction of selected native multipurpose trees, such as *Caesalpinia paraguariensis*, which has the special feature of flowering and fruiting over very long periods of the year, providing abundant, nutritious feed for livestock, while also providing habitat for birds, rodents, and other mammals, and a favourable canopy for the autogenic reestablishment of other trees and shrubs.

Passive control methods are usually preferable (see below), but in extreme cases direct action may be necessary, as in the volunteer-based initiative to protect TDF on the island of Hawaii. In other situations, costly tools such as fences or enclosures are required, for example in New Caledonia, where introduced deer were preventing any regeneration of native dry forest species.

3.2. Promoting Natural Dynamics

Relatively inexpensive, passive restoration techniques are best suited to forests where, after controlling or limiting the sources of degradation, ecosystem resilience is high. This is the case in some overgrazed or severely burnt ecosystems, where the exclusion or severe restriction of livestock grazing or fire for several years is sometimes sufficient to promote self-recovery. Because plantations, especially in dry conditions, require considerable technical and financial investment, it is preferable to attempt passive restoration, evaluating its effectiveness and benefiting from innovative techniques developed. Doing so, however, requires knowledge of the functional ecology of tropical dry forests, and especially of the animals that disperse seeds of the main trees (birds, bats, etc.). Passive restoration has, for example, been used effectively in Costa Rica.

3.3. Active Restoration: Improved Planting Methods

In many instances restoration requires the introduction of woody species through planting, especially of the common and framework species of the original ecosystem, but also of rare or endangered species. The "Framework species" approach developed in Queensland, Australia, and applied with success in northern Thailand tropical dry forests[364] seems highly pertinent. Using this approach, 20 to 30 key tree species are selected that together seem to form the structural framework of the forest to be restored. Nursery work on germination and propagation is then required, followed by experimental plantations involving the selection and evaluation of individual species, mixtures of species, or presumed functional groups. This method is a large improvement on the classical approach of old forestry or revegetation efforts where, typically, only two or three fast-growing tree species are used. In long-term projects, the goal will often be to create islands or nuclei of framework trees with animal-dispersed propagules to catalyze the return of mammals, birds, and other mobile dispersers to the area.

Tree planting in seasonally dry areas with unpredictable rainfall obliges foresters, land owners, and restorationists to take into consideration the perennial risk of drought. This underscores the importance of selecting the right species, producing good-quality nursery stock, and carefully timing and effecting outplanting. In some situations direct seeding of dry or pregerminated propagules should be attempted. Inoculation with appropriate strains of rhizobia and/or mycorrhizae may also be advantageous or even necessary.

As mentioned, TDFs are characterised by very high levels of spatial heterogeneity, which has great impact on microscale differences in the availability of water, nutrients, and energy. Planting in straight lines or prepared terraces is thus not necessarily the best way to proceed.

[364] Blakesley et al, 2002.

3.4. Soil Fertility and Amendments

Soils of badly degraded TDFs are frequently poor in organic matter and low in phosphorus availability. Thus, the adjustment and/or addition of organic or inorganic components is frequently essential to achieving plant establishment, even though the original soils may have been very rich.

4. Future Needs

The ecological economic valuation of dry tropical forests has rarely been evoked, let alone attempted. This represents a clear goal for the near future.

A better understanding of TDF biodiversity and ecosystem function is needed to reach meaningful restoration objectives. From early times, humans selectively removed the tallest, straightest, hardest trees for use in boat building, housing, and other activities that require dense, relatively long-lasting timber. A clear indication of the past removal of entire canopies may be found in the presence of remarkable numbers and diversity of lianas and vines representing a broad range of families, which clearly evolved to climb to the tops of trees taller than anything we see today. The remnant tropical dry forests we are now left with are truncated, so to speak, and restorationists must take this into account when setting for structural, functional, and compositional objectives.

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Forest Restoration in Landscapes

Beyond Planting Trees

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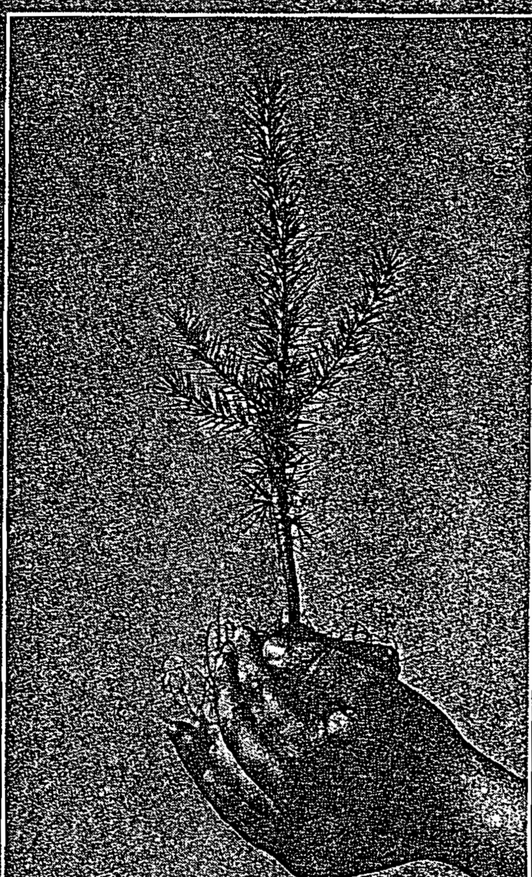

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