

Need for Integrated Research for a Sustainable Future in Tropical Dry Forests

In the context of ecosystem conservation, tropical dry forests have received little or no attention compared with their next-door neighbors, the tropical rainforests. This lack of conservation effort in tropical dry forests is reflected in the fact that few national parks and biological reserves protect and preserve their natural richness, and there are only a handful of real biological research stations with a mandate to bridge the gap between ecology and conservation biology in these ecosystems. The funding and legal framework developed by international institutions and local governments has been implemented mainly to protect mature forest or pristine national parks located in regions other than dry forests.

Several complex reasons may explain the lack of protection afforded to tropical dry forests. One of them is rooted in the romanticized vision that the tropics do not exist beyond the Amazon basin, a vision one finds every day in the scientific and nonscientific literature and in the electronic media. Another reason is the high economic value associated with goods and services that can be extracted from tropical dry forests, which contrasts with the relatively small economic value of tropical rainforests. This exploitation is furthered by local and national governments when they use dry forests not as the last frontier but as the first frontier of economic development. In the Caribbean, Mesoamérica, and northern South America, tropical dry forests are located in the most fertile zones for agroindustry and ecotourism development, and they contain a large proportion of the human population. Thus, only a small proportion of their total area is under some level of conservation. In Mesoamérica and in Venezuela, <1% of this ecologically, socially, and economically essential ecosystem is protected.

Tropical dry forests are in dire need of integrated and multidisciplinary conservation research projects aimed at expanding traditional species- and niche-based research; increasing the biological and ecological knowledge base; and including human dimensions, which inevitably underlie how ecosystems change over time. Ecological studies on tropical dry forest succession, degradation, and restoration are few and most of them have been generated from a few sites. Tied to these ecological studies, conservation schemes are necessary that emphasize the tropical dry forest's contribution to environmental services and its value as a forest ecosystem, rather than as range or agricultural land.

Rather than solely promoting the conservation of forest patches that will form isolated national parks or reserves, conservation approaches that pay landowners for environmental services must be implemented. Integrated land-management plans that complement the efforts of governments and the private sector must be enforced. The payment for ecosystem services carried out by the Costa Rican National Forest Financing Fund (FONAFIFO) is a good example of the feasibility of such initiatives. Furthermore, efforts toward conservation of tropical dry forests must also address the need to consider ecosystem services provided by mature ecosystems and areas at various successional stages within and outside public lands. In fact, secondary dry forests may be the dominant landscape in the forthcoming years, as land abandoned by local farmers recovers. In Costa Rica alone, almost 50% of the Guanacaste Peninsula is covered by deciduous secondary forests. Payment for ecosystem services in the tropics, however, requires funds that are largely unavailable.

For a payment strategy to succeed, it is critical that national environmental authorities display the necessary political will to invest resources and develop the required regulatory framework. But it is also fundamental that the governments of developed countries, as well as multinational agencies, international conservation organizations, and private donors, look beyond humid tropical ecosystems and expand their portfolio of conservation investments toward tropical dry forests.

We could uncover a wealth of valuable information by consciously promoting land-use practices that minimize the amount of stress and land-cover conversion carried out around dry forested areas. Such an approach, combined with educational programs that promote bioliteracy in local schools and community decision-making organizations, would highlight the economic and ecological value of the tropical dry forest as an ecosystem. This approach would further uncover the contributions of tropical dry forests to society, a role that far surpasses their value for anything else.

Such an approach, however, can only be explored and demonstrated by further investigating how to successfully integrate alternative land uses into the management of dry forest ecosystems. With an increasing population, a long history of land-use change, and free-trade agreements that encourage large agroindustry developments

(e.g., extensive cattle ranching, and watermelon and sugarcane plantations in Mexico and Costa Rica) and a significant increase of their exploitation for ecotourism, the future of tropical dry forests, at least in the Caribbean, Mesoamérica, and northern South America, is of great concern. Land-use choices that are made around these forests will continue to influence their rapid degradation regardless of how many studies we conduct to find out what it is needed to promote their conservation.

The remaining dry forests, which include numerous rare and endemic species, offer a unique opportunity to learn more about types of interactions between species and the resulting ecological processes. This information, in turn, would be of tremendous help to policy makers responsible for defining sustainable development policies aimed at benefiting threatened species (e.g., Scarlet Macaw [*Ara macao*], Yellow-shouldered Parrot [*Amazilia barbadensis*], jaguar [*Panthera onca*], Baird's tapir [*Tapirus bairdii*], great false vampire bat [*Vampyrus spectrum*]), guayacán [*Guaiacum sanctum*]). More studies are also needed to understand the ecological succession of disturbed tropical dry forest left in fragments and its contribution as a stepping stone between fragments and the forest. Because small populations or communities may be recovering in regenerating fragments, these areas should not be considered waste land but rather important elements that connect protected areas. Furthermore, the immediate sharing of this ecological knowledge with local communities would help convince them to invest in the longevity of this ecosystem and to promote the recovery of degraded areas.

An additional and highly contentious topic is the conflict between increasing human demands on water resources and the varying water needs of the differing components of the tropical forest matrix. The matrix is composed of deciduous tropical forest, mangroves, wetlands, savannas, and riparian forests. Such biological wealth is currently endangered by human water demands that depend on this limited resource. Increasing and uncontrolled use of limited water resources for irrigation,

human consumption, and tourism—a phenomenon that translates into new dams, deviation of rivers, and the use of river discharge during low-flow seasons—jeopardizes the future of tropical dry forest biodiversity.

We believe that research and conservation in tropical dry forests must generate conservation models that are promoted with the same fervor as those designed for humid forests. For example, phenological aspects (e.g., leaf shed, flowering, fruiting) have been especially neglected in large-scale studies, downplaying the fact that part of the uniqueness of this ecosystem is its phenological responses to changing environmental conditions. These “preadaptations” may be essential as global-change-coping mechanisms by tropical biotas. Many questions have yet to be answered. But if we are to understand the phenological responses of individual species and the drivers and effects of degradation and land exploitation on the phenological cycles of the ecosystem at a larger scale—including the organisms that depend on them—more comprehensive conservation efforts are necessary. These efforts must be linked to adequate funding levels that promote comprehensive in situ and comparative studies among dry forest ecosystems across the Americas.

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