We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,300

Open access books available

172,000

International authors and editors

190M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

Structure, Diversity, Threats and Conservation of Tropical Forests

Madhugiri Nageswara-Rao^{1,2,*}, Jaya R. Soneji^{2,3} and Padmini Sudarshana⁴

¹*Department of Plant Sciences, University of Tennessee, Knoxville, TN,*

²*Polk State College, Department of Biological Sciences, Winter Haven, FL,*

³*University of Florida, IFAS, Citrus Research & Education Center, Lake Alfred, FL,*

⁴*Monsanto Research Center, Hebbal, Bangalore,*

^{1,2,3}USA

⁴India

1. Introduction

In this elegant book, we have defined 'Tropical Forests' broadly, into five different themes: (1) tropical forest structure, synergy, synthesis, (2) tropical forest fragmentation, (3) impact of anthropogenic pressure, (4) Geographic Information System and remote sensing, and (5) tropical forest protection and process. The cutting-edge synthesis, detailed current reviews, several original data-rich case studies, recent experiments/experiences from leading scientists across the world (Fig.1) are presented as unique chapters. Though, the chapters differ noticeably in the geographic focus, diverse ecosystems, time and approach, they share these five important themes and help in understanding, educating, and creating awareness on the role of 'Tropical Forests' on the diversity of biota, impact of disturbances, climate change and the very survival of mankind.

2. Tropical forests - Structure, synergy, synthesis

Tropical forests are located in the 'tropics' which lie between the Tropic of Cancer and Capricorn, approximately between 23° N and 23° S latitudes (Thomas and Baltzer, 2002). They support vast biodiversity and are a source of wonderment, scientific curiosity, enormous complexity as well as a basic foundation for human welfare (Tilman, 2000). While occupying only one-tenth of the world's land area, tropical forests are economically, ecologically, environmentally (Fig. 2), culturally and aesthetically vital as they play crucial role in ensuring global food security, climate change, poverty eradication and improvement of human health (Rajora and Mosseler, 2001; Thomas and Baltzer, 2002; Nageswara Rao and Soneji, 2010a, 2011). They are important in terms of global biogeochemical cycles and are home to more than half of the world's species (Thomas and Baltzer, 2002).

It is estimated that more than 10 million species of plants, animals and insects live in the tropical rainforests (<http://www.rain-tree.com>). One-fifth of the world's fresh water is in

* Corresponding Author

the Amazon Basin and more tree species are found in 0.5 km² of some tropical forests than in all of North America or Europe (Burslem et al., 2001). These forests sustain the livelihoods of hundreds of millions of people globally (Nageswara Rao et al., 2008a; Uma Shaanker et al., 2001a) and studies estimate that at least 80% of the developed world's diet originated in the tropical rainforests. About 70% plants that are active against cancer cell lines found by the US National Cancer Institute (NCI) are found only in the tropical forests (<http://www.rain-tree.com>).

The dense leafy canopies of tropical forests make them highly productive plant communities storing almost 30% of the global soil carbon (Sayer et al., 2007). This makes tropical forests, with relatively high litterfall, a critical component of the global carbon cycle. To assess the tropical forest productivity, phenology, and turnover of biomass, litterfall collection is a standard non-destructive technique (Newbould, 1967; Lowman, 1988). The amount of leaf material falling reflects a forest's productivity and represents a major flux of carbon from vegetation to soil in the forest. Hence, changes in litter inputs are likely to have far-reaching consequences on the soil carbon dynamics (Proctor et al., 1983; Lowman, 1988; Sayer et al., 2007). In the chapter *"Comparing litterfall and standing vegetation: Assessing the footprint of litterfall traps"*, the authors have analyzed the correspondence between litterfall samples and standing vegetation at three different spatial scales. They examined the factors affecting the relative abundance of species in litterfall samples. To gain an insight for the scaling of litterfall data from the level of sampling plots up to the level of the forest stand, they compared the composition and relative abundance of species collected in litter traps. The authors' findings will prove instrumental for the improvement of methods in terrestrial and forest ecology, especially in the tropics where the high species diversity and structural complexity of forests impose tough challenges to the study of forest structure and their dynamics.

Fig. 1. Author geographic locations of studies in this book.

By regulating the microclimate, the litter layer helps to maintain favorable conditions for decomposition (Vasconcelos and Lawrence, 2005; Sayer et al., 2006) while the soil faunal

activities can indirectly affect decomposition rates and the nutrient cycles (Moore and Walter, 1988). The interactions between the soil fauna and microbes can influence the microbial species composition (Visser, 1985), thus playing an important role in soil ecosystems (Lussenhop, 1992; Sayer et al., 2006) and creating habitats for arthropods (Arpin et al., 1995). Millipedes and other macroarthropods, as detritivores, affect the nutrient cycling by releasing chemical elements such as nitrogen and redistributing the organic material in the soil (Dangerfield and Milner, 1996). In the chapter *“Direct and indirect effects of millipedes on the decay of litter of varying lignin content”*, the authors have used a microcosm approach to answer what are the direct (leaf fragmentation) and indirect effects (microbial biomass) of millipedes on the decomposition of leaf litter and how these outcomes are influenced by the substrate (litter) quality and the density of millipedes. In the chapter *“Quantifying variation of soil arthropods using different sampling protocols: is diversity affected?”*, the authors have assessed how the diversity of extracted arthropods was affected by variations in the collection and extraction methodologies, and by variations in the duration of the extraction. This data will provide researchers with data to simplify the logistics of arthropod sampling and extraction, and to better choose a specific procedure for a given focal organism in a given habitat.

Fig. 2. A typical view of diverse tropical forest (see Chapter 20, by Canuto et al. in this book).

In the chapter *“Patterns of plant species richness within families and genera in lowland Neotropical forests: Are similarities related to ecological factors or to chance?”*, the authors have made a quantitative floristic comparison based on the patterns of species richness in families and genera for more than twenty five tropical areas, and correlated the floristic similarities with the ecological and stochastic factors (i.e. geographical distance). They also attempted to test the significance and relative roles of ecological and stochastic factors. Such studies can provide information on the present-day communities that have resulted from speciation, extinction, and migration (Leigh et al., 2004).

Compared to the wealth of botanical and ecological studies carried out in the tropical ecosystems, little is known about the status of mycorrhizae or the influence of mycorrhizal mutualisms on the tropical forest diversity and tree assemblages (Alexander and Lee, 2005; McGuire et al., 2008). In the chapter “*Dispersion, an important radiation mechanism for ectomycorrhizal fungi in Neotropical low land forest*”, the author has evaluated different hypothesis about the possible origin of ectomycorrhizal (EcM) fungi associated with *Pakaraimaea dipterocarpacea*. The EcM fungi diversity and community structure, and also the phylogenetic analysis have been carried out. This study is the first evidence of host sharing between both sympatric and allopatric tree species belonging to Dipterocarpaceae and EcM Fabaceae in the Neotropics.

3. Tropical forest fragmentation

Fragmentation, due to rapid economic growth and agricultural expansion, of the tropical forests and the natural habitats into smaller and non-contiguous patches is the most serious threat to the long-term survival of the biological diversity on earth (Myers, 1994; Chapin et al., 2000; Pimm and Raven, 2000; Cruse-Sanders and Hamrick, 2004; Nageswara Rao et al., 2008b).

Fig. 3. Shola forest fragments in the Western Ghats (one of the mega diversity ‘hot-spot’ in the world), India (see Rajanikanth et al., 2010).

As a consequence of fragmentation, natural or man-made, plant populations are isolated from their conspecific populations (Fig. 3), have reduced population size (Lamont et al., 1993; Hall et al., 1996; Risser, 1996; Rajanikanth et al., 2010) and have decreased fruit set or poor seed germination relative to large population (Menges, 1991; Byers and Meagher, 1992;

Hendrix, 1994; Heschel and Paige, 1995; Agren, 1996). These fragmented patches of forest are often embedded in a matrix of anthropogenically manipulated landscapes (such as pastures, agricultural fields or habitations; Fig. 4), behave as "islands" in a "sea" of pasture or agricultural ecosystem and may lead to distinct ecological, demographic and genetic consequences which result in the extinction of the native species (Tilman et al., 1994; Gilpin, 1988; Laurance, 2000; Nageswara Rao et al., 2001, 2007; Uma Shaanker et al., 2001b; Honnay et al., 2005). Fragmentation or conversion of forest into grassland or savanna due to forest harvesting, fertilization, atmospheric deposition, and climate change also affects the nitrogen mineralization of the tropical forests (Wang et al., 2004).

Anuran amphibians inhabit regions that have high moisture levels and moderate to warm temperatures owing to their skin permeability and dependence on aquatic and terrestrial habitats during their life cycles (Duellman and Trueb, 1994; Wells, 2007). Fragmentation and/or deforestation makes the environment drier and more seasonal, reduces the population size of anuran species, adversely affects the anuran richness in local assemblages that depend on breeding ponds for reproduction and sometimes eliminating those that depend on humid forest microhabitats (Haddad and Prado, 2005; Becker et al., 2007). In the chapter "*The role of environmental heterogeneity in maintenance of anuran amphibian diversity of the Brazilian mesophytic semideciduous forest*", the authors employed tests of null hypotheses to assess whether patterns of spatial distribution of anuran assemblages differ from a random distribution among aquatic breeding sites monitored at Morro do Diabo State Park. They also verified the existence of indicator anuran species of environmental heterogeneity on a local scale.

The formation of treefall gaps and their influence on forest regeneration and dynamics have ecological consequences (Schnitzer et al., 2008). These canopy gaps, formed by death or injury to one or a few canopy trees, create sufficient resource heterogeneity to allow for resource partitioning and niche differentiation (Grinnell, 1917). They also release sufficient resources (e.g., light and nutrients) to permit the establishment or reproduction of plant species that would otherwise be excluded from the forest in the absence of gaps (Schnitzer et al., 2008). Such transitory events occur frequently in the tropical forests (Brokaw, 1985), where plant species of early successional stages (pioneers and secondary ones) take advantage of the gaps formed as they can tolerate higher micro-climate and ecological variations (Mulkey et al., 1996). In the chapter "*Gap area and tree community regeneration in a tropical semideciduous forest*", the authors have identified ecological patterns related to richness and the potential of natural regeneration of tree species in natural gaps and have investigated whether the tree community responds to different levels of canopy openings represented by gaps of different sizes found in the tropical semideciduous forests.

4. Impact of anthropogenic pressure

In the tropical forests, where both species diversity and anthropogenic pressures on the natural environments are high, biodiversity is threatened by human-driven, land-use changes (Dirzo and Raven, 2003; Gibson et al., 2011). Rapid deforestation of tropical forests for agriculture (Fig. 4), timber production, pasture, firewood, construction of roads and dams, and other uses, have dire consequences on the tropical biodiversity along with the water sources and non-timber forest products (Sudarshana et al., 2001; Uma Shaanker et al., 2003, 2004; Foley et al., 2005; Lamb et al., 2005; Ravikanth et al., 2009; Gibson et al., 2011). The increasing rate of human population in the developing countries, where most of these

forests are located, has triggered a greater demand for timber and other forest products, making sustainable management of these remnant forests a major challenge (Wright and Muller-Landau, 2006). Human disturbances often lead to altered environmental conditions, which influence the process that can both augment and erode species diversity in the tropical forest community (Kennard et al., 2002; Sapkota et al., 2010).

Fig. 4. Conversion of pristine tropical forests into agricultural lands, Western Ghats (one of the mega diversity 'hot-spot' in the world), India.

Changes in vertebrate assemblages in the tropical rain forests caused by anthropogenic disturbances affect the seed dispersal patterns and subsequent tree spatial recruitment patterns in the secondary tropical rain forests. Even though a variety of seed dispersal mechanisms are found within tropical forests, most plants produce fleshy fruits that are dispersed primarily by vertebrate frugivores (Jordano, 1992). Behavioral disparities among vertebrate seed dispersers could influence patterns of seed distribution and thus forest structure (Howe, 1990; Clark et al., 2001). In the chapter "*Seed dispersal and tree spatial recruitment patterns in secondary tropical rain forests*", the author examined the seed dispersal and tree spatial recruitment patterns in three tropical forests whose vertebrate populations have been altered differently over the past few decades. The changes in vertebrate seed disperser community on tree recruitment in the secondary forest landscapes in the wider context of the effectiveness of remnant vertebrate populations in seed dispersal and the possible consequences for tree demography are presented.

Forest fragmentation not only affects the plants but also the large predators that play an important role in regulating herbivore prey populations (Duffy, 2003). The ecological consequences of such fragmentation on the mesoherbivores remain largely undocumented.

In an effort to understand the magnitude of the effects of human-perturbed, mesoherbivore populations on the tropical forest plant communities, in the chapter *“Human altered mesoherbivore densities and cascading effects on plant and animal communities in fragmented tropical forests”*, the authors have reviewed substantial tropical literature on human overhunting of mesoherbivores and the consequences for the tropical forest plant communities. For the first time, the authors have synthesized the sparse and scattered literature involving tropical examples of mesoherbivore release, making a case that the cascading consequences of increased mesoherbivore abundance can be as widespread and ecologically destructive as those resulting from mesoherbivore decline. The authors have also addressed the most pressing conservation and management implications of the research on perturbed mesoherbivore populations and have identified topics in need of further investigation, in terms of both ecology and conservation.

Knowledge of forest structure and floristics are necessary for the study of forest dynamics, plant-animal interactions and nutrient cycling (Reddy and Pattanaik, 2009). In the chapter *“Floristic composition, diversity and status of threatened medicinal plants in tropical forests of Malyagiri hill ranges, Eastern Ghats, India”*, the authors have analyzed the diversity, distribution and population structure of tree species in a tropical deciduous forest stand, with special emphasis on the documentation of threatened medicinal plants. Medicinal plant species belonging to different threat categories were recorded from the forest and suggestive conservation measures for sustainable use of medicinal plant resources are presented.

Aboveground coarse necromass, a major component of the carbon cycle in the tropical forests, accounts for up to 20% of carbon stored above ground and for 14–19% of the annual aboveground carbon flux in the tropical forests (Palace et al., 2008). The dynamics of necromass production and loss through disturbance and decay are poorly understood and quantified in the tropical forests (Eaton and Lawrence, 2006). In the chapter *“A review of above ground necromass in tropical forests”*, the authors have examined literature pertaining to stocks or pools of above ground necromass, the disturbance and the episodic production of coarse necromass, and the slower process of decomposition in the tropical forests. They have described and defined important terms and components in necromass research and have various methodologies designed to measure these components and current literature involved with field based estimates of necromass.

5. Geographic information system and remote sensing

Combating deforestation requires factual information about the tropical forests which is not readily available (Ochego, 2003). Geographic Information System (GIS) and remote sensing provides a unique opportunity to assess (Fig. 5) and monitor deforestation, degradation, and fragmentation (Lyngdoh et al., 2005; Tejaswi, 2007). GIS integrates hardware, software and data for capturing, managing, analyzing and displaying all forms of geographically referenced information (<http://www.gis.com/content/what-gis>) and can be utilized for deciphering location, condition, trends, patterns and modeling of forests. Remote sensing utilizes the acquisition of information about an object, area or phenomenon through the analysis of data acquired by a device that is not in contact with the object, phenomenon or area under investigation (Lillesand and Kiefer, 1987). It has become a very powerful tool associated with the estimation of the interactions between earth's surface materials and electromagnetic energy reflected from them which are recorded by sensors aboard satellites in space (Ochego, 2003).

Remote sensing can work at multiple scales ranging from few meters to several kilometers, even in places where accessibility is an issue, and the data can be acquired periodically (e.g. daily, monthly) with measurements made in near real time basis (Tejaswi, 2007).

Fig. 5. National Forest Inventory map of Mexico (see Chapter 15, by Couturier et al. in this book).

Estimating the rate of change in tropical forest cover has become a crucial component of global change monitoring. In the chapter “*Seasonal pattern of vegetative cover from NDVI time-series*”, the authors have employed seasonal adjustment of time-series statistical method to understand the phenology and detect disturbance on some woody vegetation utilizing the Normalized Difference Vegetation Index (NDVI) time-series of SPOT VEGETATION. In the chapter “*Measuring tropical deforestation with error margins: A method for REDD monitoring in South-eastern Mexico*”, the authors present a methodological framework for the measurement of tropical deforestation in Southeast Mexico, based on the experience of accuracy assessment of regional land cover maps and on-site measurements of tropical forest cover in Mexico. In the chapter “*Natural forest change in Hainan, China, 1991-2008 and conservation suggestions*”, the authors have analyzed the changes in natural forest and plantations on Hainan Island between 1991-2008 by using GIS and remote sensing, have tried to explore the driving factors of changes based on local policies, and have given suggestions for the future conservation plan. In the chapter “*Exchange of carbon between the atmosphere and the tropical Amazon rainforest*”, the authors have examined the subcanopy flow dynamics and local micro-circulation features, how they relate to spatial and temporal distribution of CO₂ on the Manaus LBA Project site and have discussed the contribution of exchange of carbon between the atmosphere and the tropical Amazon Rainforest.

6. Tropical forest protection and process

During the last decade, a need to address conservation questions with a wider social, political and cultural framework was recognized (Hodgkin and Rao, 2002). With rapid vanishing of tropical forests and increasing extinction numbers, it is imperative to evolve holistic strategies to conserve the surviving populations. But launching of any such conservation program is contingent upon the knowledge of what, where and how to conserve (Ganeshaiah and Uma Shaanker, 1998). There is a general consensus among scientists and practitioners that no single conservation method is adequate and different methods should be applied in a complementary manner. In the recent past, approaches such as the *ex situ* conservation, *in situ* conservation, creating biosphere reserves, protected areas, etc. have been extended to address the conservation and restoration of tropical forest resources (Shands, 1991; Uma Shannker et al., 2001b,c; Nageswara Rao et al., 2007, 2011). In the chapter “*Direct sowing: an alternative to the restoration of ecosystems of tropical forests*”, the authors have analyzed ecological, technical, socio-economic and forestry aspects involved in the use of direct sowing to restore degraded ecosystems in the tropical forest regions (Fig. 6). The authors have also highlighted several experiments conducted in the tropical regions, which may contribute to broaden the perspective and enhance methodologies for ecological restoration and bring to light some experiences that may contribute to the decision making over the choice of direct sowing for restoration of degraded ecosystems.

Fig. 6. Seed variability and restoration efforts in tropical forests, Brazil (see Chapter 18, by Ferreira et al. in this book).

In the chapter “*Patterns of tree mortality in monodominant tropical forests*”, the author has used information from a long term study in permanent vegetation plots within 200 ha of monodominant Hakalau Forest National Wildlife Refuge, (Hawaiian, wet forest) to address basic ecological questions such as, how does tree mortality vary with respect to species, size, position in the canopy (crown class), and geographic location? What is the age of trees in this forest? To what extent can patterns of mortality provide evidence for succession in this forest?

Their results provide evidence that gap-phase dynamics may play a role in the succession, stand structure, and community composition in a large structured forest in Hawaii. Dead standing trees also provide important habitat for diverse wildlife, micro flora and fauna.

Protected areas are believed to be the corner stones for biodiversity conservation and the safest strongholds of wilderness around the globe (Pimm and Lawton, 1998; Bruner et al., 2001). With ever increasing threats to the tropical forests, protected areas and their networks offer the best possible approach to conserve the biological diversity (Hogbin et al., 2000; Bruner et al., 2001; Theilade et al., 2001). They harbor a greater level of biodiversity than the adjoining non-protected areas and may serve as *in situ* sites for the conservation of forest resources. In the chapter “*Conservation, management and expansion of protected and non-protected tropical forest remnants through population density estimation, ecology and natural history of top predators; case studies of birds of prey (Spizaetus taxon)*”, the authors have described results of six studies conducted in Brazil by analyzing the incidence of specimens of the genus *Spizaetus* in areas with different fragmentation histories and considering the different population and reproductive ecological aspects of these taxons collected at each locality. The authors promote a reflection on the perspectives of local and punctual conservation of these species, according to their ecological requirements and have used these species as “flags” to point out the problems involving conservation of top predators, which present small density (Fig. 7) but demand a large area, in the fragmented and continuous areas. Protected areas could in fact be the last refugia for several tropical species (Ramesha et al., 2007; Nageswara Rao M et al., 2010). However, most protected areas may be too small to host viable populations. They may not allow for gene pool mixing across the population, due to their insular and isolated habitat. Efforts need to also be complemented by actions outside protected areas such as sustainable management and conservation of forests for multiple uses (FAO, 1993).

Fig. 7. Canopy survey, population estimation, conservation and management of Black Hawk, Black-and-White Hawk eagle in protected and non-protected tropical forests, Brazil (see Chapter 20, by Canuto et al. in this book).

The tropical forests, undoubtedly, are heritage for our future generations. They deal with the totality of gene, species, population and ecosystem on the basis of cellular, molecular, taxonomic and geographic criteria (Sharma, 1996) and face multiple threats. Although, monitoring and conserving the loss of forest biodiversity is crucial, there appears to be no single measure that can assess all the aspects of biodiversity. Consolidated efforts on the information on parameters such as the levels of threats, the spatial patterns of population/species richness, distribution, their interactions, genetic diversity, etc., are utmost needed for planning any effective conservation and sustainable utilization. First and foremost, ecosystems and landscapes with high concentration of endemic and useful species at risk need to be identified. Potential threats that these resources are facing should be highlighted. Species that are rare, endangered, highly threatened and economically important need to be selected and given highest priority (Uma Shaanker et al., 2001c), to study their effective population size, spatial structure, variability, and community interactions. Detailed data on all these parameters affected by native habitat loss, invasiveness, expansion of agriculture, and extraction patterns needs to be generated (Bawa et al., 2001). Mitigation strategies to counter the threats, restoration strategies, and understanding the local adaptive nature information should be an integral component of programs designed to conserve and manage the tropical forest resources (Nageswara Rao and Soneji, 2010b). Well organized national, as well as, international programs should be conducted to bridge the gap between local community, forest managers, policy-makers and the scientific community. They should be brought together through networking, training and public awareness programs. Thus, there is urgent need to consider, consolidate and complement research, policy making and on-field efforts to effectively conserve, efficiently utilize and sustainably manage the tropical forest resources before they are irrevocably lost (Nageswara Rao and Soneji, 2009).

7. References

- Agren, J. (1996) Population size, pollinator limitation, and seed set in self incompatible herb *Lythrum salicaria*. *Ecology* 77: 1779-1790.
- Alexander, I.J. & Lee, S.S. (2005) Mycorrhizas and ecosystem processes in tropical rain forest: implications for diversity. In: Burslem, D.F.R.P., Pinard, M.A. & Hartley, S.E. (eds) *Biotic interactions in the tropics: their role in the maintenance of species diversity*. Cambridge University Press, Cambridge, UK, pp 165-203.
- Arpin, P., Ponge, J.F. & Vannier, G. (1995) Experimental modifications of litter supplies in a forest mull and reaction of the nematode fauna. *Fundamental & Applied Nematology* 18: 371-389.
- Bawa, K.S., Ganeshaiah, K.N. & Uma Shaanker, R. (2001) Conserving tropical forest genetic resources: Threats and mitigation strategies. In: Uma Shaanker, R., Ganeshaiah, K.N. & Bawa, K.S. (eds.), *Forest genetic resources: Status, threats and conservation strategies*. Oxford and IBH Publications, New Delhi, pp. 303-308.
- Becker, C.G., Fonseca, C.R., Haddad, C.F.B., Batista, R.F. & Prado, P.I. (2007) Habitat split and the global decline of amphibians. *Science* 318(5857): 1775-1777.
- Brokaw, N.V.L. (1985) Gap-phase regeneration in a tropical forest. *Ecology* 66: 682-687.
- Bruner, A.G., Gullison, R.E., Rice, E.R. & Fonseca, G.A.B. (2001) Effectiveness of parks in protecting tropical biodiversity. *Science* 291: 125-128.
- Burslem, D.F.R.P., Garwood, N.C. & Thomas, S.C. (2001) Tropical forest diversity – The plot thickens. *Science* 291: 606-607

- Byers, D.L. & Meagher, T.R. (1992) Mate availability in the small populations of plant species with homomorphic sporophytic self-incompatibility. *Heredity* 68: 353-359.
- Chapin, F.S., Zavaleta, E.S., Eviner, V.T., Naylor, R.L., Vitousek, P.M., Reynolds, H.L., Hooper, D.U., Lavore, S., Sala, O.E., Hobbie, S.E., Mack, C.M. & Diaz, S. (2000) Consequences of changing biodiversity. *Nature* 405: 234-242.
- Clark, C.J., Poulsen, J.R. & Parker, V.T. (2001) The role of arboreal seed dispersal groups on the seed rain of lowland tropical forest. *Biotropica* 33(4): 606-620.
- Cruse-Sanders, J.M. & Hamrick, J.L. (2004) Genetic diversity in harvested and protected populations of wild American ginseng *Panax quinquefolia* L. (Araliaceae). *American Journal of Botany* 91: 540-548.
- Dangerfield, J.M. & Milner, A.E. (1996) Millipede faecal pellet production in selected natural and managed habitats of Southern Africa: implications for litter dynamics. *Biotropica* 28: 113-120.
- Dirzo, R. & Raven, P.H. (2003) Global state of biodiversity and loss. *Annual Review of Environment & Resources* 28: 137-167.
- Duellman, W.E. & Trueb, L. (eds) (1994) *Biology of amphibians*. McGraw-Hill, Baltimore, MD, USA, 670 pp.
- Duffy, J.E. (2003) Biodiversity Loss, trophic skew, and ecosystem functioning. *Ecology Letters* 6(8): 680-687.
- Eaton, J.M. & Lawrence, D. (2006) Woody debris stocks and fluxes during succession in a dry tropical forest. *Forest Ecology and Management* 232: 46-55.
- Foley, J.A., DeFries, R., Asner, G.P., Barford, C., Bonan, G., Carpenter, S.R., Chapin, F.S., Coe, M.T., Daily, G.C., Gibbs, H.K., Helkowski, J.H., Holloway, T., Howard, E.A., Kucharik, C.J., Monfreda, C., Patz, J.A., Prentice, I.C., Ramankutty, N. & Snyder, P.K. (2005) Global consequences of land use. *Science* 309: 570-574.
- Food and Agriculture Organization (1993) *Conservation of genetic resources in tropical forest management, Principles and concepts*. FAO, Rome, Italy.
- Ganeshaiah, K.N. & Uma Shaanker, R. (1998) *Biligiri Ranganswamy temple wildlife sanctuary: Natural history, biodiversity and conservation*. Published by Ashoka Trust for Research in Ecology and the Environment and Vivekananda Girijana Kalyana Kendra (ATREE-VGKK), Bangalore, India, pp. 1-28.
- Gibson, L., Lee, T.M., Koh, L.P., Brook, B.W., Gardner, T.A., Barlow, J., Peres, C.A., Bradshaw, C.J.A., Laurance, W.F., Lovejoy, T.E. & Sodhi, N.S. (2011) Primary forests are irreplaceable for sustaining tropical biodiversity. *Nature* 478: 378-383.
- Gilpin, M.E. (1988) A comment on Quinn and Hastings: Extinction in subdivided habitats. *Conservation Biology* 2: 290-292.
- Grinnell, J. (1917) Field tests and theories concerning distributional control. *American Naturalist* 51: 115-128.
- Haddad, C.F.B. & Prado, C.P.A. (2005) Reproductive modes in frogs and their unexpected diversity in the Atlantic forest of Brazil. *Bioscience* 55(3): 207-217.
- Hall, P., Walker, S. & Bawa, K.S. (1996) Effect of forest fragmentation on genetic diversity and mating system in a tropical tree, *Pithecellobium elegans*. *Conservation Biology* 10: 757-768.
- Hendrix, H.D. (1994) Effects of population size on fertilization, seed production and seed predation in two prairie species. *Proceedings of the thirteenth North American Prairie conference: Spirit of land, our prairie legacy*. 13: 115-121.
- Heschel, M. & Paige, K.N. (1995) Inbreeding depression, environmental stress and population size variation in scarlet gilia (*Ipomopsis aggregata*). *Conservation Biology* 9: 126-133.

- Hodgkin, T. & Rao, R.V. (2002) People, plants and DNA: perspectives on the scientific and technological aspects of conserving and using plant genetic resources. In: Engels, J.M.M., Rao, V.R., Brown, A.H.D. & Jackson, M.T. (eds), *Managing plant genetic diversity*. CABI Publications, Wallingford, UK, pp. 469-480.
- Hogbin, P.M., Peakall, R. & Sydes, M.A. (2000) Achieving practical outcomes from genetic studies of rare plants. *Australian Journal of Botany* 48: 375-382.
- Honnay, O., Jacquemyn, H., Bossuyt, B. & Hermy, M. (2005) Forest fragmentation effects on patch occupancy and population viability of herbaceous plant species. *New Phytologist* 166: 723-736.
- Howe, H.F. (1990) Seed dispersal by birds and mammals: implications for seedling demography. In: Bawa, K.S. & Hadley, M. (eds) *Reproductive ecology of tropical forest plants*. Parthenon Publishing Group, Paris, France, pp. 191-218.
- Jordano, P. (1992) Fruits and frugivory. In: Fenner, M. (ed) *Seeds: The ecology of regeneration in plant communities*. CAB International, Wallingford, England, pp. 105-156.
- Kennard, D.K., Gould, K., Putz, F.E., Fredericksen, T.S. & Morales, F. (2002) Effect of disturbance intensity on regeneration mechanisms in a tropical dry forest. *Forest Ecology and Management* 162: 197-208.
- Lamb, D., Erskine, P.D. & Parrotta, J.A. (2005) Restoration of degraded tropical forest landscapes. *Science* 310: 1628-1632.
- Lamont, B.B., Klinkhamer, P.G.L. & Witowaski, E.T.F. (1993) Population fragmentation may reduce fertility to zero in *Banksia goodii* – demonstration of the Allele effect. *Oecologia* 94: 446-450.
- Laurance, W.F. (2000) Do edge effects occur over large spatial scales? *Trends in Ecology and Evolution* 15: 134-135.
- Leigh, E.G., Davidar, P., Dick, C.W., Puyravaud, J.P., Terborgh, J., ter Steege, H. & Wright, S.J. (2004) Why do some tropical forests have so many species of trees? *Biotropica* 36: 447-473.
- Lillesand, T.M. & Kiefer, R.W. (eds) (1987) *Remote sensing and image interpretation*. John Wiley & Sons, 768 pp.
- Lowman MD (1988) Litterfall and leaf decay in three Australian rainforest formations. *Journal of Ecology* 76: 451-465.
- Lussenhop, J. (1992) Mechanisms of microarthropod-microbial interactions in soil. *Advances in Ecological Research* 23: 1-33.
- Lyngdoh, N., Hantode, S.S., Ramesha, B.T., Nageswara Rao, M., Ravikanth, G., Barve, N., Ganeshiah, K.N. & Uma Shaanker, R. (2005) Rattan species richness and population genetic structure of *Calamus flagellum* in North-Eastern Himalayas, India. *Journal of Bamboo and Rattan* 4(3): 293-307.
- McGuire, K.L., Henkel, T.W., Granzow de la Cerda, I., Villa, G., Edmund, F. & Andrew, C. (2008) Dual mycorrhizal colonization of forest-dominating tropical trees and the mycorrhizal status of non-dominant tree and liana species. *Mycorrhiza* 18(4): 217-222.
- Menges, E.S. (1991) Seed germination percentage increases with population size in a fragmented prairie species. *Conservation Biology* 5: 158-164.
- Moore, J.C. & Walter, D.E. (1988) Arthropod regulation of micro and mesobiota in below-ground detrital food webs. *Annual Review of Entomology* 33: 419-439.
- Mulkey, S.S., Chazdon, R.L. & Smith, A.P. (eds) (1996). *Tropical forest plant ecophysiology*. Chapman & Hall, NY, 675 p.
- Myers, N. (1994) Tropical forests and their species: going, going? In: Miller, G.T. (ed) *Living in the Environment*. International Thomson Publishing, Belmont, California, USA, pp 288-289.

- Nageswara Rao, M. & Soneji, J.R. (2009) Threats to forest genetic resources and their conservation strategies. In: Aronoff, J.A. (ed) *Nature conservation: Global, environmental and economic issues*. Nova Science Publishers, Inc. New York, USA, pp 119-147.
- Nageswara Rao, M. & Soneji, J.R. (2010a) Forest biodiversity: Issues and concerns, In: Nageswara Rao, M., Soneji, J.R. (eds) *Tree and forest biodiversity. Bioremediation, Biodiversity and Bioavailability* 4 (Special Issue 1): iv-v.
- Nageswara Rao, M. & Soneji, J.R. (eds) (2010b) *Tree and Forest Genetics. Genes, Genomes and Genomics* 4 (Special Issue 1), 83 p.
- Nageswara Rao, M. & Soneji, J.R. (eds) (2011) *Tree Micropropagation and Tissue Culture. Tree and Forestry Science and Biotechnology* 5 (Special Issue 1), 89p.
- Nageswara Rao, M., Uma Shaanker, R. & Ganeshaiah, K.N. (2001) Mapping genetic diversity of sandal (*Santalum album* L.) in South India: Lessons for *in-situ* conservation of sandal genetic resources. In: Uma Shaanker, R., Ganeshaiah, K.N., Bawa, K.S. (eds) *Forest genetic resources: Status, threats and conservation strategies*. Oxford and IBH Publishing Company Private Limited, New Delhi, India, pp 49-67.
- Nageswara Rao, M., Ganeshaiah, K.N. & Uma Shaanker, R. (2007) Assessing threats and mapping sandal (*Santalum album* L.) resources in peninsular India: Identification of genetic hot-spot for *in-situ* conservation. *Conservation Genetics* 8: 925-935.
- Nageswara Rao, M., Sudarshana, P., Ganeshaiah, K.N. & Uma Shaanker, R. (2008a) Impacts of Human Disturbances on Medicinal NTFP species. *BioSpectrum Asia* (<http://www.biospectrumasia.com/content/150908IND7092.asp>)
- Nageswara Rao, M., Sudarshana, P., Ganeshaiah, K.N., Uma Shaanker, R. & Soneji, J.R. (2008b), Indian Sandalwood Crisis. *Perfumer and Flavorist* 33(10):38-43.
- Nageswara Rao, M., Ravikanth, G., Ganeshaiah, K.N. & Uma Shaanker, R. (2010) Role of protected area in conserving the population and genetic structure of economically important bamboo species, In: Nageswara Rao, M., Soneji, J.R. (eds) *Tree and forest biodiversity. Bioremediation, Biodiversity and Bioavailability* 4: 69-76.
- Nageswara Rao, M., Soneji, J.R. & Sudarshana, P. (2011) *Santalum*. In: Kole C (ed) *Wealth of wild allied plant species, Volume 10: Allies of forest trees*. Springer - Heidelberg, Berlin, New York, Tokyo, pp 131-144.
- Newbould, P.J. (1967) *Methods for estimating the primary production of forests*. IBP Handbook No. 2. Blackwell Scientific Publications, Oxford, 62 pp.
- Ochego, H. (2003) Application of remote sensing in deforestation monitoring: A case study of the Aberdares (Kenya). Paper presented at the 2nd FIG regional conference, TS 11 - Management of water resources, Marrakech, Morocco.
- Palace, M., Keller, M. & Silva, H. (2008) Necromass production: Studies in undisturbed and logged Amazon forests. *Ecological Applications* 18(4): 873-884.
- Pimm, S.L. & Raven, P. (2000) Biodiversity: Extinction by numbers. *Nature* 403: 843-845.
- Pimm, S.L. & Lawton, J.H. (1998) Planning for biodiversity. *Science* 279: 2068-2069.
- Proctor, J., Anderson, J.M., Fogden, S.C.L. & Vallack, H.W. (1983) Ecological studies of four contrasting lowland rain forests in Gunung Mulu National Park, Sarawak: II. Litterfall, litter standing crop and preliminary observations on herbivory. *Journal of Ecology* 71: 261-283.
- Rajanikanth, G., Nageswara Rao, M., Tambat, B., Uma Shaanker, R., Ganeshaiah, K.N. & Kushalappa, C.G. (2010) Are small forest fragments more heterogeneous among themselves than large fragments? In: Nageswara-Rao, M., Soneji, J.R. (eds) *Tree and Forest Biodiversity. Bioremediation, Biodiversity and Bioavailability* 4: 42-46.
- Rajora, O.P. & Mosseler, A. (2001) Challenges and opportunities for conservation of forest genetic resources. *Euphytica* 118: 197-212.

- Ramesha, B.T., Ravikanth, G., Nageswara Rao, M., Ganeshaiah, K.N. & Uma Shaanker, R. (2007) Genetic structure of rattan, *Calamus thwaitesii* in core, buffer and peripheral regions of three protected areas at central Western Ghats, India: Do protected areas serve as refugia for genetic resources of economically important plants? *Journal of Genetics* 86: 9-18.
- Ravikanth, G., Nageswara Rao, M., Ganeshaiah, K.N. & Uma Shaanker, R. (2009) Impacts of harvesting on genetic diversity of NTFP species: Implications for conservation. In: Uma Shaanker, R., Joseph, G.C., Hiremath, A.J. (eds.) *Management, utilization, and conservation of non-timber forest products in the South Asia region*. Universities Press, Bangalore, India, pp 53-63.
- Reddy, C.S. & Pattanaik, C. (2009) An assessment of floristic diversity of Gandhamardan hill range, Orissa, India. *Bangladesh Journal of Plant Taxonomy* 16(1): 29-36.
- Risser, P.G. (1996) A new framework for prairie conservation. In: Samson FB, Knopf FL (eds) *Prairie Conservation: preserving North America's most endangered ecosystem*. Island press, Washington, D.C., USA, pp. 261-274.
- Sapkota, I.P., Tigabu, M. & Oden, P.C. (2010) Changes in tree species diversity and dominance across a disturbance gradient in Nepalese Sal (*Shorea robusta* Gaertn. f.) forests. *Journal of Forestry Research* 21(1): 25-32.
- Sayer, E.J., Powers, J.S. & Tanner, E.V.J. (2007) Increased litterfall in tropical forests boosts the transfer of soil CO₂ to the atmosphere. *PLoS ONE* 2(12): e1299. doi:10.1371/journal.pone.0001299
- Sayer, E.J., Tanner, E.V.J. & Lacey, A.L. (2006) Effects of litter manipulation on early-stage decomposition and meso-arthropod abundance in a tropical moist forest. *Forest Ecology and Management* 229: 285-293.
- Schnitzer, S.A., Mascaro, J. & Carson, W.P. (2008) Treefall gaps and the maintenance of species diversity in tropical forests. In: Carson, W.P., Schnitzer, S.A. (eds) *Tropical forest community ecology*. Blackwell Publishing, Oxford, pp 196-209.
- Shands, H.L. (1991) Complementarity of *in situ* and *ex situ* germplasm conservation from the standpoint of the future user. *Israel Journal of Botany* 40(5-6): 521-528.
- Sharma, A. (1996) Biodiversity, inventory, monitoring and conservation genetical aspects. In: *Conserving bio-diversity for sustainable development*. Published by Indian National Science Academy, New Delhi, India, pp. 27-33.
- Sudarshana, P., Nageswara Rao, M., Ganeshaiah, K.N. & Uma Shaanker, R. (2001) Genetic diversity of *Phyllanthus emblica* in tropical forests of South India: Impact of anthropogenic pressures. *Journal of Tropical Forest Science* 13(2): 297-310.
- Tejaswi, G. (2007) Manual on deforestation, degradation, and fragmentation using remote sensing and GIS: Strengthening monitoring, assessment and reporting on sustainable forest management in Asia (GCP/INT/988/JPN), Forestry Department, Food and Agriculture Organization of the United Nations, 49 pp
- Theilade, I., Sekeli, P.M., Hald, S. & Graudal, L. (2001) Conservation plan for genetic resources of Zambezi teak (*Baikiaea plurijuga*) in Zambia Danida Forest Seed Center. DFSC Case study 2. Humlebaek, Denmark, pp. 1-32.
- Thomas, S.C. & Baltzer, J.L. (2002) Tropical Forests. In: *Encyclopedia of life sciences*. Macmillan Reference Ltd, London, UK, Nature Publishing Group (<http://www.els.net/>), pp 1-8.
- Tilman, D., May, R.M., Lehman, C.L. & Nowak, M.A. (1994) Habitat destruction and the extinction debt. *Nature* 371: 65-66.
- Tilman, D. (2000) Causes, consequences and ethics of biodiversity. *Nature* 405: 208-210.

- Uma Shaanker, R., Ganeshaiah, K.N. & Nageswara Rao, M. (2001a) Conservation of genetic resources of *Triphala* in South India: Identifications of hot-spots for *in-situ* conservation. In: *Medicinal plants, a global heritage*, IDRC and CRDI, pp 115-128.
- Uma Shaanker, R., Ganeshaiah, K.N. & Nageswara Rao, M. (2001b) Genetic diversity of medicinal plant species in deciduous forests of India: Impacts of harvesting and other anthropogenic pressures. *Journal of Plant Biology* 28: 91-97.
- Uma Shaanker, R., Ganeshaiah, K.N., Nageswara Rao, M. & Ravikanth, G. (2001c) Forest gene banks – a new integrated approach for the conservation of forest tree genetic resources. In: Engels, J.M.M., Rao, V.R., Brown, A.H.D. & Jackson, M.T. (eds), *Managing plant genetic resources*. Wallingford, UK, CABI Publications, pp. 229-235.
- Uma Shaanker, R., Ganeshaiah, K.N., Nageswara Rao, M. & Ravikanth, G. (2003) Genetic diversity of NTFP species: Issues and implications. In: Hiremath, A.J., Joseph, G.C. & Uma Shaanker, R. (eds) *Proceedings of International workshop on 'Policies, management, utilization and conservation of non-timber forest products in the South Asia region'*, Ashoka Trust for Research in Ecology and Environment (ATREE) and Forest Research Support Programme for Asia and the Pacific, FAO, Bangkok, pp 40-44.
- Uma Shaanker, R., Ganeshaiah, K.N., Nageswara Rao, M. & Aravind, N.A. (2004) Ecological consequences of forest use - from genes to ecosystem: a case study in the Biligiri Ranganswamy Temple Wildlife Sanctuary, South India, *Conservation and Society* 2: 347-363.
- Vasconcelos, H.L. & Lawrence, W.F. (2005) Influence of habitat, litter type, and soil invertebrates on leaf-litter decomposition in a fragmented Amazonian landscape. *Oecologia* 144: 456-462.
- Visser, S. (1985) Role of the soil invertebrates in determining the composition of soil microbial communities. In: Atkinson D, Fitter AH, Read DJ, Usher MB (eds) *Ecological interactions in soil*. British Ecological Society's Special Publication Service, Blackwell, Oxford, 4: 297-317.
- Wang, C., Xing, X. & Han, X. (2004) Advances in study of factors affecting soil N mineralization in grassland ecosystems. *Ying Yong Sheng Tai Xue Bao (The Journal of Applied Ecology)* 15 (11): 2184-2188 (in Chinese).
- Wells, K.D. (2007) The ecology and behavior of amphibians. The University of Chicago Press, Chicago, USA, 1148 pp.
- Wright, S.J. & Muller-Landau, H.C. (2006) The future of tropical forest species. *Biotropica* 38: 287-301.

IntechOpen

Tropical Forests

Edited by Dr. Padmini Sudarshana

ISBN 978-953-51-0255-7

Hard cover, 388 pages

Publisher InTech

Published online 14, March, 2012

Published in print edition March, 2012

The astounding richness and biodiversity of tropical forests is rapidly dwindling. This has severely altered the vital biogeochemical cycles of carbon, phosphorus, nitrogen etc. and has led to the change in global climate and pristine natural ecosystems. In this elegant book, we have defined "Tropical Forests" broadly, into five different themes: (1) tropical forest structure, synergy, synthesis, (2) tropical forest fragmentation, (3) impact of anthropogenic pressure, (4) Geographic Information System and remote sensing, and (5) tropical forest protection and process. The cutting-edge synthesis, detailed current reviews, several original data-rich case studies, recent experiments/experiences from leading scientists across the world are presented as unique chapters. Though, the chapters differ noticeably in the geographic focus, diverse ecosystems, time and approach, they share these five important themes and help in understanding, educating, and creating awareness on the role of "Tropical Forests" for the very survival of mankind, climate change, and the diversity of biota across the globe. This book will be of great use to the students, scientists, ecologists, population and conservation biologists, and forest managers across the globe.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Madhugiri Nageswara-Rao, Jaya R. Soneji and Padmini Sudarshana (2012). Structure, Diversity, Threats and Conservation of Tropical Forests, Tropical Forests, Dr. Padmini Sudarshana (Ed.), ISBN: 978-953-51-0255-7, InTech, Available from: <http://www.intechopen.com/books/tropical-forests/structure-diversity-threats-and-conservation-of-tropical-forests>

INTECH
open science | open minds

InTech Europe

University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China

Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

© 2012 The Author(s). Licensee IntechOpen. This is an open access article distributed under the terms of the [Creative Commons Attribution 3.0 License](https://creativecommons.org/licenses/by/3.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

IntechOpen

IntechOpen