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Abstracts



Research Priorities
in Tropical Silviculture:

Towards New Paradigms?



Foreword

Over the past 50 years, deforestation of tropical forests has increased at such an alarming rate that the long term sustainability of these valuable resources is in question. The loss of one of the richest and most ecologically important ecosystems in the world has become a major international concern. Uncontrolled harvesting, including over harvesting and poor practices, are important causes of forest degradation and deforestation. However, sustainable forest management could be a major tool to preserve continuous and large area of forests. Sustainability is indeed central to conservation efforts in “working” landscapes where natural resource management, biodiversity conservation, and maintenance of ecosystem goods and services are shared priorities. In tropical forests from which scattered trees of marketable species are harvested selectively for their timber, achieving sustainable management should include maintenance of the full range of ecosystem goods and services and biodiversity as well as meeting the criterion of non-diminishing timber yields. After more than 100 years of tropical silviculture, research carried out in the major forested regions of the world, and in the framework of the International Year of Forests, Cirad, CIFOR and Ecofor organized an international conference under the auspices of IUFRO (Division 1.02.00 Tropical and Subtropical Silviculture; Division 3.07.00 Forest operations in the tropics ; Division 8.02.00 Forest Biodiversity). The conference had the following objectives:

1. To examine the current state-of-the-art in tropical silviculture.
2. To refine our knowledge on the impact of silvicultural practices on forest dynamics and species diversity.
3. To explore how new, or locally developed, silvicultural approaches can complement those commonly applied for timber production.
4. To question the adequacy of current silvicultural approaches to contribute to long-term sustainability—what modifications might be necessary, and how might these be implemented.
5. To define research priorities in forest ecology and silviculture for a better conservation of tropical forests in the context of global policy instruments such as REDD and other investment funds for mitigating climate change.

The conference included 2 plenary sessions and 7 parallel technical sessions. This book presents the abstracts of the 71 presentations given during the conference.

Plinio Sist



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- Silviculture of Timbers
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- *Silviculture of Timbers* -

Moderator: Plínio Sist

1. Silvicultural practices in the Amazon : State of the art and considerations for improvement

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The paper first examines the current state of silvicultural practice in the Amazon region, considering diverse management scenarios (e.g. production forests, second-growth forests, degraded forests and degraded forest lands) and highlighting a number of important constraints as well as likely impacts (social, economic and ecological). The available experience in several countries of the region is then synthesized and illustrated with selected cases under varied management approaches and scenarios, thus allowing to derive a number of lessons. Aiming to contribute to improve silvicultural practice, the identified major constraints are addressed, followed by an outline of some guiding principles for silviculture. In addition, the opportunities for intensification of silvicultural practice and a framework to cope with climate change are discussed. The paper also identifies major challenges and needs (e.g. information, training, research, communication) for silviculture in the Amazon, and finally offers some recommendations for policy and practice.

Keywords :

Silviculture; Timber species; Tropical forest

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2. Silviculture in African moist forests : *do we have new answers to old questions?*

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The silviculture of African tropical moist forests has a long history punctuated with (few) successes and (many) failures. The European foresters in charge of managing forests in the African colonies realized early – e.g. 1900 in Nigeria – that they were facing a complex ecosystem with a low volume per ha of commercial timber. Somewhat a different situation than the one faced by foresters in South-East Asia where forests were rich in commercial timber of the Dipterocarpaceae family. Confronted to a highly dispersed, highly valuable timber resource and entrenched in their temperate forester culture they worked on ways to produce “the greatest timber volume, as homogenous as possible”. Two main schools of thought confronted one another, promoting respectively natural regeneration vs artificial regeneration techniques. In the 1970’s, realizing the many difficulties and costs linked to enrichment planting, French foresters decided to focus on silvicultural operations targeted at future crop trees, rather than trying to actively favor regeneration. But they came quickly to consider that logging will in most cases be the only economically feasible silvicultural operation in the course of a felling cycle. Attention shifted to establishing simple logging rules supposedly ensuring long-term timber production. Today, we face what foresters in the 30’s and 40’s had anticipated: the “picking” of a small number of valuable light-demanding trees through highly selective logging is slowly but surely exhausting these populations as canopy is not opened enough to allow regeneration. In countries where industrial logging started early, several important commercial species like *Assamela* – *Pericopsis elata* – and most species of *Entandrophragma* are becoming rare and some logging companies are beginning to turn to silviculture, thus demonstrating the modernity of old questions ... and the urgency of finding answers. We went back over 64 years of publications on silvicultural trials in the journal *Bois et Forêts des Tropiques* to highlight the conditions of success, and to propose ways forward.

Keywords :

Silviculture, African moist forests, timber logging, regeneration

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3. Evaluating intensified silviculture systems: challenges to managing tropical forest in Indonesia

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Indonesia has an estimated 114 million hectares of forest designated for different. Over 59 million hectares of forest are intended for timber production. The Dipterocarpaceae family is the most important type of timber for trade. All timber concessions are required to practice silviculture as stipulated by the Ministry of Forestry, which has defined different silviculture regimes since the 1970s. In 2005, a new approach has been introduced, called “SILIN” or intensified silviculture. Through this system, the Ministry of Forestry seeks to intensify forest management activities to achieve higher yields per hectare based on three main assumptions: reduction of the minimum diameter felling limit from 50 cm diameter at breast height (dbh) to 40 cm dbh, systematic line planting requirements, reduction in the rotation cycle from 35 to 25 years. Six target timber species have been selected for SILIN: *Shorea leprosula*, *Shorea parvifolia*, *Shorea platyclados*, *Shorea johoriensis*, *Dryobalanops lanceolata*, *Shorea macrophylla*. This article presents lessons learned from several silviculture systems in Indonesia by evaluating SILIN implementation in several concession models, documenting and analyzing the rationale behind the large-scale adoption policy and comparing SILIN with previous silviculture systems. We found that new regulations have significantly overestimated the growth potential of the planted stocks, left unaddressed the residual forest between the planted lines and do not account for costs that might undermine implementation. Further implications are discussed including logging damage, industrial concerns and policy adjustments over the long term.

Keywords :

intensified silviculture, timber harvesting, Dipterocarpaceae, Indonesia

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4. Five fields of actions to improve tropical silviculture

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The presentation is a result of a cross sectional analysis of recently published papers on the state of the art in tropical silviculture from 44 experts working in all tropical regions. Across a broad range of ecosystems, from dry forests to humid forests, and from silviculture in natural forests over secondary forests to planted forests, we identified five major fields of actions: (1) There is an increasing demand on timber and other forest products. As forestry is in strong competition with other aims of land use, intensification aiming at higher output per area is a promising approach for overcoming this major problem, for example, by short-term rotation forestry, domestication, site improvement, and other measures. (2) Diversification as complementary strategy aims at providing additional products and services, reducing risks and contributing to sustainable management at the landscape level. (3) Therefore, temporal and spatial scales for management have to be adapted to both, needs of individual land owner (usually timber) and to collective needs of societies (protection, water, biodiversity, etc.). Better matching of operational units and ecological spatial scales (e.g., plant–site matching) is an important prerequisite for improving efficiency of silvicultural measures. (4) Sustainable forest management depends strongly on acceptance of all stakeholders involved. It is a common agreement in science and practice that participatory approaches can contribute significantly to sustainability in this context. However, on the global scale participatory approaches are still in the stage of development. (5) Finally, we illustrate how integration of silviculture and forest management including all mentioned aspects can overcome frequently applied timber mining methods, and leads to a modern approach of silviculture in terms of adaptive ecosystem management.

Keywords :

adaptive management, diversification, intensification, participation, natural forest, dry forest, humid forest, plantation, secondary forest

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5. The Long-Term Silvicultural Research Program in Bolivian tropical forests

Peña-Claros Marielos^{1,2}, *Toledo Marisol*², *Licona Juan Carlos*²,
*Alarcon Alfredo*²

Studies have shown that current management practices are not sufficient to guarantee the long-term productivity of tropical forests. The Long-Term Silvicultural Research Program in Bolivia aims to evaluate the sustainability and cost-effectiveness of various silvicultural treatments, and to study their effect on stand dynamics, biodiversity and forest ecosystem function. Plots of 20–30-ha were established in different forest types, and received one of four treatments that range in logging intensity and application of silvicultural treatments. Silvicultural treatments applied included liberation of future crop trees (FCT) through liana cutting and girdling of overtopping trees, marking of FCT, timber stand improvement, and soil scarification. Here we present results on the effect of silvicultural treatments on growth rates. Liana cutting and girdling of overtopping trees resulted in higher diameter growth rates, being the effect of liana cutting stronger than the effect of liberation from overtopping trees. The effect of silvicultural treatments reduces through time suggesting that treatments need to be applied several times during the cutting cycle to assure that trees keep growing under optimal conditions. All the results so far indicate that silvicultural treatments are needed to guarantee the long-term productivity of Bolivian forests.

Keywords :

Bolivia, liana cutting, girdling, LTSRP

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- Silviculture of NTFPs -

Moderator: Manuel Guariguata

6. The Silviculture of Tropical Nonwood Forest Products

Vantomme Paul

Reviewing the silviculture of nonwood forest products (NWFP) first requires a clear understanding of its associated vocabulary. This is necessary in order to prevent confusion in the circumstances when the described “silvicultural techniques” are actually part of “forestry” or “agriculture.” “Silviculture” of NWFP spans both the “forestry” and “agriculture” domains because most NWFP species, of which their products are still in use, are actually in a dynamic process of domestication, moving from traditional gathering/hunting practices in forests toward more intensive cultivation on farms. Silvicultural interventions favoring the growth of NWFP-bearing species in tropical forests are governed by the NWFP user perspectives, which may range from satisfaction of subsistence needs to the production of commodities for industrial processing and international trade. In this paper, the complexities of combining silvicultural interventions for managing tropical dry and humid forests for the production of both timber and nontimber goods and services are described through specific examples, such as Gum Arabic, rattan, palm hearts and edible insects. The planning of silvicultural interventions for NWFP species through basic forest management is rarely done. It requires a multifaceted approach in order to integrate the many and often conflicting user demands for food, fiber, energy, health, and recreational goods. It also requires the active participation of a much wider range of stakeholders than when dealing with timber alone. International organizations such as the FAO can play a key role in raising awareness and building the required technical and institutional capacities in countries to incorporate NWFP silviculture within overall sustainable forest management. For example through technical support in field projects (of which an example is given for Central Africa).

Keywords :

NWFP _ Silviculture _ Sustainable forest management _ Domestication _ Certification

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7. Review of Non Timber Forest Products (NTFPs) in Central Africa

Midoko Iponga Donald

Early man's interaction with the forests was, for many years, almost exclusively centred on non-timber forest products (NTFPs), defined by most Central African countries national legislations and also by FAO as biological forestry products other than wood. This integrates plant product, fauna and aquatic products. Within Central Africa, NTFPs are exploited for subsistence needs and also for sale and are particularly important to rural communities in terms of food, nutritional requirements, medicines, fodder for livestock, related domestic requirements and socio-cultural issues. However the value, quantities and trade circuits are not known precisely. There is also a known trade (again, not yet quantified) out of Central Africa, which has been remarkably little studied. There is also little harmonisation or overview on a regional level on the state of NTFP, to ensure sustainable management of this sector. It is paradoxical that, in spite of their real and potential value, most NTFPs remain grouped as minor products of forests. These products rarely feature in statistics and are hardly studied or researched. This situation is due to lack of knowledge about the potential of NTFPs to support sustainable and remunerative enterprises. The main objective of this presentation is to give an overview of NTFP used in central African countries (Cameroon, Central African Republic, Democratic Republic of Congo, Equatorial Guinea, Gabon, and Republic of Congo) based on the work done by the ACP – FORENET project.

Keywords :

NTFP, Rural communities, socio-cultural issues, statistics

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8. Non-Timber Forest Products in the Philippines: Issues, Constraints, Strategies and Action Programs

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The long-term sustainability and profitability of non-timber forest products (NTFP) industries is influenced by their strengths and opportunities. Strengths include availability of raw materials and manpower, environment-friendly NTFP technologies, the presence of local and export markets, and contributions to the economy by NTFP industries. Opportunities include the biodiversity of raw materials, availability of appropriate tenure instruments for development, and global demand for natural products. Identified weaknesses include threat of substitutes, threat of entry, inappropriate policy instruments, and inadequate knowledge and skills of local communities. Recommendations are as follows: (1) provide information on resource inventory, management alternatives, market facilities, and price information to producers and collectors; (2) provide technologies on propagation, harvest, post-harvest methods and the sustainable management of NTFP resources; (3) encourage the inclusion of NTFP species for ecological restoration in upland areas; (4) review, strengthen and harmonize government policies towards the sustainable management of NTFP resources; (6) empower local groups in managing the NTFP resources; (7) develop value-added products by employing pre-processing treatments, improved and attractive packaging, and longer storage life; and (8) develop a regional or provincial NTFP banner industry for ecotourism and trade promotion.

Keywords :

Non-Timber Forest Products Industries, Strengths , Opportunities, Threats, Sustainable Management

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9. Silvicultural practices as strategy for rattan availability and sustainable management of the resource around Kisangani, D.R. Congo

Kahindo Jean-Marie, Mate Jean-Pierre, Nasi Robert and Rigal Clément

Non Timber Forest Products, and especially rattans, have been neglected by forestry research although their complementary role in rural livelihoods. In D.R. Congo, rattans are among the main non-timber forest products used by the population. They are a significant source of income and the basis of a very active informal sector focused towards supplying the city (1 million inhabitants) with raw canes. As far as the African rattans are concerned the majority of the species naturally grow in closed tropical forest and are early gap colonizers. In fact they are extremely light demanding and respond well to a reduction in forest canopy. We present the effects of harvesting and light availability on the demography of two major rattan species in the Yoko forest reserve, near Kisangani: *Eremospatha haullevilleana* De Wild. and *Laccosperma secundiflorum* (P. Beauv.) Kuntze. We studied clump demography for a year, under 3 light availability levels and after 3 treatments: control, partial harvest and clear-cut of adult stems. Three response variables were measured: recruitment, growth initiation and mortality. Then, analysis of variance with repeated measures was carried out to study the log-transformed response variables, especially to the recruitment. For *Laccosperma secundiflorum* and under partial light availability, the analysis pointed out a significant rise in bud's formation after partial and total harvest (p -value = 0.018) compared with no harvest at all. In the case of *Eremospatha haullevilleana*, it seems that partial harvest speeds up recruitment compared with no harvest at all. The same analysis failed in detecting a difference between the effects of clear-cut and the other treatments. These results are critical to propose silvicultural treatments susceptible to provide better light conditions and so favour regeneration within the rattan clumps and more sustainable harvesting guidelines that could be applied to the resource for the Yoko forest reserve and similar forests. They may promote rattan enrichment planting in disturbed areas in order to increase stock and provide additional incomes in forest areas around Kisangani and in Democratic Republic of Congo.

Keywords :

Silvicultural Practices, Non Timber Forest Products, Rattan, Yoko Forest Reserve, Kisangani, RD Congo

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10. Contribution of non wood forest products on rural livelihoods, a case of Rashad locality in Nuba Mountains, Sudan

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Non-Wood Forest Products (NWFPs) were neglected in past decades by foresters and policy makers leading to lack of attention on their values, and the fact that their uses is less ecologically destructive than timber harvesting. Sustainability and forest conservation needs more association for scientific knowledge with local knowledge than ever in the most appropriate way to planning of forest management schemes, in addition to organization of policies and legislation. This paper shows a vital role of NWFPs to rural livelihood in Rashad locality. Data was collected through a social survey of households with a total number of three hundreds respondents. The majority of households are subsistence poor farmers who suffer scarcity of food supplies and health care and therefore rely on NWFPs to generate products for nutrition, medicine, construction materials as well as animal feeding. The study came out with quantitative result declared the highly dependency of households to NWFPs in there daily lives as an indispensable role toward poverty alleviation. More emphasis of forest management for such products could contribute to both sustainability and conservation objectives.

Keywords :

NWFPs, rural development, local knowledge, utilization and services, forests sustainability.

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11. Participatory construction of best management practices for babaçu palm extractivism in Northeastern Brazil

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Zakia Maria J.B. ⁽⁴⁾, *Santos Michelli F.* ⁽⁵⁾, *Silva Mauricio E.C* ⁽⁶⁾

The babaçu palm (*Attalea speciosa*) is native to the transition zone between the open forests of Southern Amazon and cerrado (savannah vegetation in Brazil). This secondary species presents different densities depending on the silvicultural and agricultural practices adopted; reaching 80% of dominance, especially in frequently burned and degraded rural landscape. From the economical point of view, babaçu almond is the second more important Brazilian non-timber forest product (NTFP), with about 20% of the total production of NTFPs. The extraction of babaçu almond is an essential source of income to about 350,000 rural workers, mainly in the agricultural intercrop. Despite the long term history of babaçu exploitation there is a gap in scientific knowledge on its effect on the species biology. Population structure and genetic diversity on babaçu forests under different extraction regimes were surveyed in Piauí State, Northeastern Brazil. Moreover, silvicultural common practices and divergences, as the use of fire and pesticides, were sampled. This information has been used to subsidize the development and validation of a participatory construction of best management practices, which is essential to the sustainability of babaçu extractivism.

Keywords :

participatory management , babaçu, palm

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12. The ecological study of an unknown non-timber forest product (NTFP): the African walnut (*Coula edulis* Baill.)

*Moupela Christian, Vermeulen Cédric, Lebailly Philippe,
Brostaux Yves*

African walnut, *Coula edulis* Baill., produces fruits of great nutritive value regularly consumed and marketed by various communities. Nevertheless, some fundamental aspects of its ecology such as its production potential and the amount of fruits eaten by animals remain unknown thus hampering its valorization. Our study started in Gabon and is analyzing the fruit production capacity of the species and tends to identify the dispersers and the predators of its fruits. Thirty-nine circular collectors were placed under trees and the obtained data was put in relation with the trees diameter. Seven seeds trees were the subject of indirect observations thanks to camera-traps. The first fruits appear on trees measuring at least 12, 3 cm in diameter. The fruits are produced from January to April and their quantity is related to the tree's diameter ($r^2 = 0,493$; $p = 0,001$). Ten different animal species were spotted at the foot of the seed trees and they play a potentially important role in the regeneration of this tree species.

Keywords :

Coula edulis, NTFP, Gabon

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Plenary session n° 2

- Impacts of silviculture -



- Ecological Impacts -

Moderator: Sylvie Gourlet Fleury

13. Sustainable management of tropical forests : a critical analysis of the concept and of practices of management and environmental assessment

*Leroy Maya¹, Vendé Jérémy², Derroire Géraldine³, Leménager
Tiphaine⁴, Aubert Pierre-Marie⁵, Espinosa Laurie⁶,*

From the 1980s onward, the concept of sustainable forest management has spreaded concomitantly with the wider concept of sustainable development. Although much debated, it has gained general acceptance as a management framework and different doctrines have been developed within this framework. Notwithstanding, forest degradation and deforestation have increased over the same period. The environmental efficiency of the concept and its implementations should therefore be questioned. Since this concept has given birth to different and sometimes contradictory management doctrines, themselves implemented through — or used to justify — different silvicultural practices, assessing environmental efficiency of these doctrines implies a close look at silvicultural practices referring to each doctrine and at the interrelations between doctrines and practices. Our study is based on an academic approach in management sciences and addresses the following questions : what are the links between silvicultural practices and sustainable tropical forests management doctrines? On which scientific understanding of ecosystems do silvicultural practices and environmental assessment of tropical forests management rely? What are the environmental indicators used by practitioners and evaluators and do they differ? The study is carried out using a bibliographic analyse, notably of grey literature, and interviews with stakeholders and stresses on practises promoted by France.

Keywords :

Sustainable forest management, environmental assessment, tropical forests, management doctrines, critical management studies

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14. Thinning after selective logging facilitates floristic composition recovery in a tropical rain forests of Central Africa

*Ouédraogo Dakis¹, Beina Denis², Picard Nicolas¹, Mortier Frédéric¹,
Baya Fidèle³, Gourlet-Fleury Sylvie¹*

In the Congo Basin, where most timber species are light-demanding, low logging intensities commonly implemented (1-2 trees harvested ha⁻¹) do not provide sufficient canopy gaps to ensure species regeneration. The regeneration of light-demanding timber species may therefore benefit from more intensive logging, or from post-harvest treatments such as thinning using poison girdling that increases light penetration. Little is known of the impact of post-harvest treatments on the floristic composition of tropical moist forests. This study therefore aimed to assess the effects of low and high selective logging, followed or not by thinning, on the floristic composition of a tropical moist forest in the Central African Republic, from 7 to 23 years after logging. We analyzed abundance data for 110 tree genera recorded every year for 14 years in 25 1-ha permanent subplots and we compared floristic composition recovery between thinned and unthinned subplots, using unlogged subplots as a reference characterizing the pre-logging floristic composition. We discuss the results and their potential implication for forest management.

Keywords :

Tropical forest management, floristic composition, selective logging, thinning, Central African Republic

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15. Long-term recovery of commercial timber species after logging of Malaysian forest: *impacts of adjacent unlogged Virgin Jungle Reserves*

Nur Hajar, Z.S¹, Abd Rahman, K. & Healey, J.R.²

There is growing concern about the sustainability of timber production from tropical rainforest due to poor forest recovery after logging. Six hill dipterocarp forests distributed throughout Peninsular Malaysia, that had been logged between 46 and 69 years previously were studied to determine long-term recovery. Unlogged virgin jungle reserves (VJR) were present in each forest and the impact of their proximity was tested with sample plots located at five distances from the boundary: from 250 m inside the VJR to 750 m inside the old logged forest (OLF). The density and basal area of seedlings, saplings and trees of the main commercial timber species groups had recovered in the OLF to levels closely to the VJR. While the timber volume of the non-dipterocarp commercial groups had also generally recovered, it had not for the dipterocarps, which varied significantly, but inconsistently, with distance from the boundary. Overall, with the presence of protected VJR, there is a high level of resilience of most timber groups, which showed potential for sustainable timber production on a cycle of up to 70 years. However, more caution is needed for the economically valuable dipterocarps, for which site- or timing-specific factors may limit their recovery rate.

Keywords :

long term recovery, hill dipterocarp forest, sustainability of timber production

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16. Phenology assessment of commercial timber trees of Papua New Guinea

Tavune Maman

Phenology is the study of periodic plant and animal life cycle events and how these events are influenced by seasonal and inter-annual variations in climate. This study mainly looked at the flowering and fruiting pattern and behavior of commercial timber trees, starting from floral bud initiation and development, blooming through to fruit formation and subsequent seed fall. The main objective of this study was to determine the flowering and fruiting pattern and behavior of selected commercial timber trees. Monthly assessments were done on 15 timber tree species, with an average of 10 parent trees per species tagged. This study was initiated in 2005, with parent trees tagged in lowland tropical rainforests of Madang Province in Papua New Guinea (PNG). Progressive results so far indicated that flowering and fruiting of most tree species are complex and irregular in timing, duration and intensity. Results obtain from such study could be a useful forest management tool to further enhance understanding of the ecological traits of valuable trees of PNG. Understanding this ecological trait of forest is fundamental for improved management of natural forests as far as forest ecology is concern.

Keywords :

Phenology, flowering, fruiting, pattern & behavior, weather, forest management tool

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17. Silviculture in logging gaps of a Central African rainforest: *first synthesis from tests with 11 timber tree species*

Dainou Kasso¹, Cerisier Benjamin², Bourland Nils³, Doucet Jean-Louis⁴

The regeneration rates of many timber tree species in Central African rainforests are known to be low partially due to their high light requirements. In order to contribute to the sustainable management of these tree species, we developed a long-term silvicultural program testing the behaviour of 11 tree species established in 126 logging gaps from nursery raised seedlings: *Azelia bipindensis*, *Baillonella toxisperma*, *Diospyros crassiflora*, *Entandrophragma cylindricum*, *E. utile*, *Erythrophleum suaveolens*, *Lovoa trichilioides*, *Milicia excelsa*, *Prioria oxyphylla*, *Pericopsis elata* and *Swartzia fistuloides*. The ages of plantations ranged from 24 to 64 months according to establishment dates. Without any clearance operation, the highest performances (growth rates and survival) were observed in *B. toxisperma*, *M. excelsa* and *P. elata*. Further analyses for these high-performing species revealed that variations in specific growth rates were explained by different pedological variables (especially the soil contents of clay or sand and humus) and characteristics of logging gap (solar radiation and competitive species). Additional silvicultural tests may be conducted in various forest habitats to find out those suitable to the rest of target species.

Keywords :

Timber species, tropical rainforest, silviculture, logging gap

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Impacts on carbon dynamics

Moderator: Robert Nasi

18. Current knowledge of general patterns of biomass dynamics after logging in Amazonian forests

Sist Plinio¹, Blanc Lilian¹, Mazzei Lucas², Baraloto Christopher³

Sustainable management of tropical forests for timber production has been proposed as a potential tool for the conservation of large areas of tropical forest. The key is to identify practices that promote repeated extraction of forest goods (timber and non timber forests products) without compromising important forest services (e.g., biodiversity and carbon). Currently, 350 million hectares of tropical moist forests worldwide are designated as production forests, about a quarter of which is managed by rural communities and indigenous people. Yet general management guidelines remain elusive, in large part because not only harvesting practices but also forest types vary broadly both within and among regions. For example, the Amazon region shows a strong east-west gradient in both floristic composition and forest dynamics. This paper presents a literature review of our present knowledge of the biomass dynamics of tropical forests in the Amazon after logging. The objectives are (i) to disentangle the mechanisms behind different types of responses in different forests; and (ii) to propose research priorities to improve forest management guidelines so that they better reflect the gradient of forest types across the region.

Keywords :

Amazonian tropical forests, forest dynamics, Biomass, logging

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19. Tropical forest carbon stocks estimates. Is tree above-ground biomass variability at the landscape scale really non-significant in a REDD+ context?

Bastin Jean-François¹, Bogaert Jan², De Cannière Charles³

The spatial variability of carbon stocks was studied within two semi-deciduous forests of the Bateke plateau, characterized by a forest-savannah mosaic (Democratic Republic of the Congo). Stem density, basal area and above-ground biomass (AGB) were estimated from a randomized stratified sampling design with total cover of 20 ha. Stratification was applied in order to focus on the variability of biomass using the two most contrasted sites within the forests: the edge zone and the interior habitat. This stratification provided the opportunity to study the role of forest spatial pattern, the edge effect, and to improve estimates of AGB through consideration of spatial pattern as an additive parameter. Moreover, AGB was estimated from tree diameter measured at several heights, total height, bole height and wood specific gravity (WSG), aiming (i) an improvement of non-destructive inventory techniques by testing different height ratios at the species and at the genus level, and by measuring WSG in situ rather than by mean values, and (ii) a reduction of field cost by testing biomass representativeness of dominant trees when compared to the entire tree layer.

Keywords :

Above-ground biomass, landscape ecology, non-destructive sampling, tropical forest

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20. The impacts of logging on carbon storage in SE Asia

Pinard Michelle A and Putz Francis E

Carbon emissions related to logging are an important component of national GHG inventories in SE Asia. Experience with carbon offset projects in the region, combined with knowledge gained from ecological and silvicultural research informs our review of local impacts of logging on carbon storage and sequestration. Socio-economic factors are an important part of the carbon story, particularly at national and regional scales, for example, as they influence shifting baselines, the risk of conversion to non-forest uses, the interaction between legal and illegal logging operations and incidence of wildfire. Variability in logging practice, harvest intensity, post-harvest treatments and the ecological characteristics of the forest explain a large part of the variability in carbon dynamics at relatively small temporal and spatial scales. In this paper we discuss the impacts of logging on carbon emissions and sequestration at local and regional scales with an aim to identify key lessons learned from the region and priorities for future research.

Keywords :

forest recovery, fire, restoration, illegal logging, forest conversion

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- *Socio-economic impacts* -

Moderator: Ariel Lugo

21. Model forests and promotion of women entrepreneurship: case study of the platform of rural women of Campo MA'AN

*Tiani Anne Marie, Gagoe Tchoko Julie, Eboto Hélène,
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The platform of the rural women of the Campo-Ma'an Model Forest (PLAFFERCAM), is created in 2005. It includes the women of all the 7 councils that comprise Campo Ma'an Model Forest. Since its creation, PLAFFERCAM positions as a federative frame of the women associations, a forum of exchange, mutual intensification, capture of opportunities, a dynamic platform susceptible to lead the change in favor of the rural women. Around the Non timber forests Products (NTPF), PLAFFERCAM's women set up frames of dialogue and discussion for a better organization and harmonization of their specific needs. Their investigations allowed them to identify numerous products of which allanblackia was perceived as the best product which can take out the woman of Campo Ma'an of the poverty. From this NTPF, they were able to make a variety of products sold to the local and national level: oil, butter, milk and toilet soap, cream and jam, etc. They participated in this fact in the promotion of the entrepreneurship of the rural woman of Campo Ma'an. They received diverse invitations and organized journeys for exchanges of experiences between the various Model Forests networks. These exchanges experiences contributed to widen the horizons of their strategic vision.

Keywords :

Model Forests, PLAFFERCAM, local dynamism,

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22. The potential of community forestry in the Brazilian Amazon (Pará)

Sablayrolles Philippe, Cruz Hildemberg, Santos Melo Marcelo, Sist Plinio, Garcia Drigo Isabel

In Pará State, 60% of lands destined for forest management are rural communities forests: the concessions intended for companies are not able to supply even half of the current industry needs. Traditional communities and small farmers have no knowledge or economic ability to perform commercial logging. When happens, community forests management is conducted through agreements with companies in different arrangements. Public policies and actions seek to allow the consolidation of forest governance by local communities. The financial framework of the implementation of reduced-impact forest management is analyzed, as well as the key elements that allow control by the local community organization (pre exploratory and public authorizations step financing; diversification of timber and non timber products; marketing; internal control routines of logging). Are proposed guidelines for public policies in order to facilitate the development of community logging in different contexts of land tenure: protected areas, production forests, agrarian reform settlements. The implementation modalities of a public forest technical support are discussed. The potential of forestry in production systems in agrarian reform settlements is analyzed in the context of the current debate concerning the reformulation of Brazilian forest code.

Keywords :

Brazilian amazon, community forestry, public policies, social forestry

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23. Community based forest management plans in the Brazilian Amazon: *current barriers threatening long term economic viability*

Drigo Isabel Garcia¹, Piketty Marie-Gabrielle², Pena Wagner³, Sist Plinio²,

Community-based forest management (CBFM) projects are often seen as an alternative to protect forest and at the same time to provide incomes for small landholders. Since the mid-1990s, the number of CBFM projects has increased in the Brazilian Amazon although most of them face several difficulties despite significant public support. Four CBFM plans were analyzed between 2005 and 2010 to assess the evolution of the socioeconomic arrangements and the main barriers threatening their long term viability. The CBFM plans are located in the State of Acre (West Amazon) and in the State of Para (Eastern Amazon). The community forest producers studied live in settlements. The tenure rights model over land and forests varies from one type of settlement to another. New federal regulation issued in 2010 has added more bureaucratic steps to communities applying for rights to explore their portions of forests. The first important barrier to successful implementation of CBFM is the complex legal framework: it currently takes at least 2 to 3 years to get a plan approved. Moreover management plan elaboration and implementation process is costly. None of the CBFM plan could have been successfully implemented without external national and international financial supports, as well as technical assistance. Community forest certification has decreased and stagnated in the period analyzed. Finally, in the current Amazonian market context, timber harvest only represents a limited complementary income for small farmers, even if forest covers 80 % of their landholding. Market access is very uncertain and small holders communities do not systematically succeed in selling their timber at remunerative prices. Minimum remunerative public prices should be guaranteed for timber from such CBFM plans to make them a truly economic alternative for the Amazon smallholders.

Keywords :

Brazilian Amazon, Community-based Forest Management, tropical timber

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Parallel session 1

- Modeling forest dynamics -

Moderators: Nicolas Picard and Lucas Mazzei



24. Modelling the dynamics of tropical rain forests - *state of the art and perspectives*

Huth Andreas, Wiegand Thorsten, Dislich Claudia, Hartig Florian, Fischer Rico, Kazmierczak Martin

Tropical rain forests cover roughly 12 % of the earth's land surface, but are habitat for more than a half of the species of the world. Logging of timber, land clearing and ongoing fragmentation are threatening tropical rain forests. Understanding the dynamics of disturbed and undisturbed tropical rain forests is an important issue for conservation and adapted management of these forests. In this contribution we will present a review on forest models for tropical rain forests. On one hand we will discuss largely simplified models like the neutral models (Hubbell approach) for describing the dynamics of tree species. On the other hand we will discuss the role of process and individual-based rain forest models to analyse the structure and dynamics of these species rich forests. Process-based models e.g. allow the calculation of detailed carbon balances and carbon fluxes. Typical results of different model types will be shown. Key ecological results, limitations and future perspectives will be discussed.

Keywords :

tropical forests, growth and yield, logging, disturbances, forest modelling, carbon balance, biodiversity

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25.twoe: An R package for modelling tropical forest dynamics from permanent sample plots using a hierarchical Bayesian approach to capture species diversity

Vieilledent Ghislain, Gourlet-Fleury Sylvie, Mortier Frédéric

Permanent sample plots are commonly used in tropical forest ecology for conservation and management purposes. Longitudinal tree data can be used to estimate species demographic functions which can then be implemented in forest dynamics simulators to help decision. For tropical forests, with many species being rare species with few observations, the classical modelling approach assumes a restricted number of functional groups (pioneer, light-demanding and shade-tolerant species groups when light partitioning is supposed to be the main mechanism driving community, which is a frequent assumption). Although this simplified approach is convenient in practice, it relies on strong assumptions: i) that species can be grouped, ii) regarding a limited number of criteria, and it suffers from several pitfalls both on the theoretical and applied side. First, because of the principle of competitive exclusion and of the multidimensionality of the species niche, the functional group approach is likely to be biased and to lead to unrealistic simulations. Second, using functional groups impede conservation planning at the species level which should be the advised approach especially when considering rare species. In this study, we present the "twoe" (2e) software, available as a R package, which allows i) formatting the permanent sample plot data for demographic analysis, ii) estimating the parameters of growth, mortality and recruitment functions including a competition effect, iii) simulating forest dynamics with a forecast of the basal area (possibly carbon) and of the community composition. The modelling approach in the twoe software includes species random effects in a hierarchical Bayesian framework, allowing an independant dynamics for each species. The twoe software includes original MCMC algorithms to handle variable time-interval between census for the mortality and recruitment processes, is easy of use and product usefull objects (table with parameter estimates for each species, graphics) for ecological interpretations.

Keywords :

tropical forest dynamics, simulator, software, demography, inference, hierarchical Bayesian approach, rare species

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26. Incorporating environmental variability in matrix models predictions for highly diverse rainforests

Ouédraogo Dakis-Yaoba¹, Mortier Frédéric², and Picard Nicolas³

In matrix models that describe forest dynamics, the uncertainty on model predictions is directly related to the precision of estimation of the transition parameters of the model (growth, recruitment and mortality rates). The two main sources of variability in parameter estimates are sampling and environmental variability. Sampling variability depends on the amount of available observations. As tropical rainforests have many rare species, most species-specific parameter estimates have huge errors. A solution to this problem is to group species into functional group to increase the number of available observations. Environmental variability is related to the spatio-temporal variations of transition parameters due to environmental fluctuations. This kind of variability is not yet considered in the models used by forest managers. We address rainfall variability in forest dynamic predictions. Species were grouped according to their response to drought. The functional species classification and the relation between transition parameters and climatic covariates for each species group has been simultaneously fitted using cluster-wise regression. Data come from permanent sample plots (25 years monitoring) located in the Central African Republic. We predict stand dynamics and we compare and discuss predictions with and without rainfall variability.

Keywords :

tropical rainforest, matrix model, population dynamics, environmental variability, Central African Republic

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27. The cohort-empirical modelling strategy and its application to forest management for Tapajós Forest, Pará, Brazilian Amazon

Alder Denis ⁽¹⁾, *Macedo Silva José Natalino* ⁽²⁾,
Carvalho, de Lopes J.O.P., Do Carmo José.A., Rushell A. ⁽³⁾

The cohort-empirical modelling strategy is reviewed and applied via an updated version of the CAFOGROM model to sample plot measurements from Tapajós Forest in the Brazilian Amazon. These plots have some 27 years of measurements under various controlled treatments and provide one of the best data sets available for tropical forest growth and yield. Actual growth over the period is compared with projected growth via CAFOGROM as a validation exercise, and the model is then used to evaluate options for silviculture and sustainable harvesting under various scenarios. Cohort modelling as a practical management tool is compared with other approaches, and the minimum data requirements, limitations and advantages discussed in the context of the complexity of tropical forest management and the paucity of available growth and yield data

Keywords :

tropical forest silviculture cohort models Amazon Tapajós growth yield CAFOGROM

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28. Intra-specific variability of allometric relationships between tree outer dimensions in four species of a tropical monsoon forest in the Western Ghats of India

Madelaine-Antin Cécile, Pélissier Raphaël, Vincent Grégoire, Couteron Pierre

Inter-specific differences between mean allometric relationships have long been used to represent specific growth strategies in forest dynamics models. However, recent studies underline the importance of intra-specific variability, and particularly the role it could play in species coexistence. We estimated the variability of individual growth trajectories using quantile regression method for four species that occupy various positions at the adult stage in the canopy of a tropical monsoon forest in the Western Ghats of India. The mean relationships fitted between outer tree dimensions show generally significant differences between species. Relationship between dbh and total height is better fitted with a Weibull model including an asymptote, which reflects the decline of height growth when a tree reaches its adult stage. Slope steepness affects the allocation of biomass to diameter versus height growth of the two upper canopy Dipterocarp species, but not their crown morphology. Besides, the estimation of upper and lower boundaries of allometries by quantile regression underlines the high intra-specific variability and the large overlap between individual growth trajectories of the four species studied. Plasticity level was not directly related with the vertical position in the canopy.

Keywords :

growth trajectories, growth strategies, intra-specific variability, tree allometries

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29. Modeling tree mortality from a 20-year forest survey in the Western Ghats of India

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Tree mortality is a key process in tropical forest dynamics, which plays a major role in the maintenance of species diversity. Since it is a rare event in forest dynamics, modeling tree mortality is a task that requires long-term surveys. We used logistic regression methods to model individual probability of tree mortality from a 20-year demography survey of more than 3800 trees in 5 ha of a tropical evergreen monsoon forest at Uppangala Permanent Sample Plots in the Western Ghats of India. Individual probability of mortality has underlined that species show different mortality patterns driven by different factors or covariates. Models outputs show that some species seem more sensitive to tree fall, senescence or competition as a main cause of mortality. The use of mixed models also revealed the significance of a random individual effect showing that individuals have different responses to similar living conditions. Hence, the importance of considering intraspecific variability to study mortality is evidenced. Nevertheless, models do not explain all the observed variability traducing that unmeasured or unmeasurable covariates cause mortality to be highly stochastic.

Keywords :

tree mortality, forest dynamics, modeling, Western Ghats

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30. The impact of disturbance on simulated vegetation structure in the Congo Basin

Wania Rita. ⁽¹⁾ and The CoForChange Consortium⁽²⁾

Global vegetation models are commonly used to simulate the effect of climate change on tropical forests. Projections are usually made on a large, regional basis and carbon fluxes and carbon pools are normally the variables of interest. However, even if models simulate fluxes and pools correctly, it does not necessarily mean that the simulated vegetation structure resembles reality. In the CoForChange project, we are interested in simulating present and future vegetation biomass and basal area in the Congo Basin in terms of guild composition (pioneer, non-pioneer light demanding and shade-tolerant trees) and phenology (evergreen vs. deciduous). We have adapted the LPJ-GUESS vegetation model - a fusion of a dynamic global vegetation model and a forest gap model - to represent six tropical plant functional types (PFTs). A series of sensitivity tests of PFT and soil parameter values were conducted to detect the most influential parameters for vegetation structure and to find the combination of parameters that give the most realistic results. The model's capability to simulate realistic forest structure under a range of disturbance scenarios is assessed by comparing aboveground biomass and basal area of each PFT to data from 14,000 surveyed plots.

Keywords :

Modelling, basal area, biomass, phenology, guild

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Parallel session 2

- Tools for forest management and inventory -

Moderators: Guillaume Cornu and Valery Gond



31. Yield models for forestry operations in the tropics

Bigshy Hugh

Experience with companies using single-tree selection systems for logging in Sabah and Sarawak shows that they are generally guided only by basic statutory harvesting rules like minimum diameter limits, maximum gap size and permitted species. At best, silvicultural considerations are typically only implied in the harvesting rules, rather than being explicitly considered in harvest planning and operations. Increasingly, companies are moving towards 100 percent enumeration of trees and tree mapping using GPS as part of reduced or low-impact logging systems. Use of GPS results in a spatial database of trees and key descriptors. While this data is currently only used for planning logging operations, it could be used to model growth and yield. Ideally, a company should be able to run a model using this data that forecasts key forest parameters such as DBH and species, and maps the location of trees. Doing this would help to shift the focus of harvest planners and surveyors from operational to silvicultural (spacing, recruitment, future crop trees) considerations when planning harvesting. In addition, this would facilitate forecasting volumes per hectare and logging costs to determine when logging would be economically viable rather than being driven by re-entry rules. The main constraint to doing this is that common approach to modeling tropical forests is to use area-based parameters (whole stand models, size class models) that are only relevant to large scale planning. Typically these models do not make use of the spatial data that is generated in logging planning, require significantly more and different data than what is used in logging planning, and do not produce outputs that are relevant to operational harvest planning. What is more useful is develop single-tree models that make use of spatial data, and that produce output that is operationally relevant, including diameter, species, and location of trees. The paper outlines operational requirements of reduced and low-impact logging systems and recommends yield modelling approaches that would work with these systems.

Keywords :

harvest planning, forest modeling, reduced impact logging

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32.A remote sensing tool for logging-related canopy gap detection : *method and applications*

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Gond Valéry³*

Monitoring the logging impacts is essential to ensuring the sustainability of forest management under a certification process. Control tools need to be put in place in order to achieve these objectives. The use of remote sensing to detect canopy gaps in tropical rainforests is an attractive alternative to ground surveys, which are laborious to carry out and lack precision. In French Guiana, detection of logging-related gaps using very high spatial resolution optical satellite images produced by the SPOT 5 sensor is carried out by ONF (French National Forestry Agency). Gaps are detected using an automatic segmentation method. The principle of the automation is to model the forest's signature and calculate a divergence between that theoretical signature and the image histogram in order to detect gaps that constitute a deterioration of forest cover. This tool has been used to assess the quality of logging operations at different scales: forests, blocks, local (one-hectare-pixels). Results show that canopy opening is quite independent from logging intensity at the blocks scale but well correlated at the local scale. The relief shows also a significant influence on the canopy degradation.

Keywords:

Rainforest, remote sensing, canopy gaps, degradation, logging intensity, relief

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33. Forest degradation estimation using remote sensing: a case study on Central African Republic

Gond Valéry, Bourbier Lucas, Cornu Guillaume (1)

Human activities within tropical rain forests provoke perturbations and degradation. The capacity to measure the extent of these damages is essential for calculating carbon emissions under the REDD+ process. Remote sensing is a powerful tool to provide such information (logging, mining, infrastructure building). Various techniques to identify and quantify forest degradation have been used so far. One step further is to link in-time degradation and past-time degradation to document the recovery of ecosystems after logging. For this, we propose a processing chain adapted to Landsat and Spot imageries. Post-processing is devoted to extract degradation information using specific algorithms. A spatial index, sized to low resolution radiometer, is implemented to render the actual and past degree of degradation. It is then related to continental land cover maps to get insight in the actual state of particular forest categories. This tool is developed in the framework of the CoForChange program (<http://www.coforchange.eu/project>) which general objective is to predict changes in forest and tree species distribution in the Congo Basin due to global change and to elaborate decision-making tools. The presentation is focused on an example in real time and in real size. It covers all the moist forest of Central African Republic at a yearly time-scale during ten years of Landsat images archive.

Keywords :

Remote Sensing, forest degradation, Central African Republic

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34. LIDAR potential for tropical forest canopy dynamics monitoring

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3D gap models of forest dynamics are potentially useful tools to explore the likely change in forest composition and stocking under global change. They are however difficult to calibrate and validate in hyper diverse tropical forest showing high species spatial turnover rate. Airborne light detection and ranging (LiDAR) technology provides horizontal and vertical information at high spatial resolutions and vertical accuracies. LIDAR may prove a decisive breakthrough in the near future to assess key processes in forest dynamics. Tree mortality rates for instance affect species composition as well as the carbon mean residence time. Lidar can provide statistics on canopy disturbance over large areas. Those statistics are directly related to stand level mortality rates. At individual tree level, delineation of individual crowns of the dominant trees in the canopy should allow estimating individual tree height growth rate. In this study we illustrate the potential of Lidar to track canopy dynamics in tropical forest by comparing two multi-temporal Lidar scans taken 5 years apart in two different sites with different forest structure (6 ha in Paracou experimental forest, 9 ha in Montagne Pb). From the initial point clouds, ground points were extracted to build the digital terrain model. For each site, a one meter Canopy Surface Model of the area was derived by taking the local maximum height on a 1 x 1 m grid. Digital Terrain Model interpolated from the ground points was subtracted from the Canopy Surface Model to get the Canopy Height Model (CHM). Canopy height dynamics were obtained by differentiating the canopy surface models between dates. Gap creation and gap closure patterns are compared between sites. We further extract individual tree height growth statistics by segmentation of individual crowns making-up the Canopy Surface Model and by comparing local maximum at two dates. Height distribution increments are compared between sites. Current limitations of the technique and future likely improvement both in Lidar technology and its accessibility and post data processing are discussed.

Keywords :

Lidar, forest dynamics, gaps

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35. The participatory approach: A tool for the sustainable management of forest resources by local communities

Larzillière A¹, Vermeulen C.², Peltier R. ³, Marien J-N ³

The levies for the sustainable supply of wood energy in the cities are now a major cause of deforestation in Central Africa. In Democratic Republic of Congo, wood represents more than 85% of the domestic energy resource and this resource is increasingly over-exploited. This study is part of securing the supply of wood energy in the cities of Kinshasa and Kisangani and in related with the theme of the management of degraded periurban forests in villages, major sites of production. Implementing this management cannot be done without the active participation and of key actors, the village communities themselves. For the phase of design and negotiation of management simple plans, innovative facilitation support has been developed. Under the name of "interactive model", this modular terrain mapping tool consists of elements in wood painted to reproduce the village and local thumbnail. The whole is, along with vignettes illustrating various issues of the negotiation. Its ease of use, both by rural communities by the project officers, allowed both to stimulate thinking and to increase the quality and the intensity of the communication. Beyond a simple tool, therefore the real sharing of knowledge, key element of management consistent, realistic and equitable agreements is questioned.

Keywords :

DRC; participatory approach; forests degradation; charcoal; management plans

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36. Sketching future forest of Bangladesh considering climate change scenarios, silviculture and productivity of species using GIS

Al-Amin M.¹ and Rahman M.S.²

Climate Vegetation and Productivity (CVP) index for selected Agro-ecological zones of Bangladesh was measured and generate maps for the suitable geographic locations (spatial arrangements) of economically important indigenous and exotic forest tree species in temporal settings (for present time and for 2100 AD) using GIS, silviculture of species and climate change scenarios for Bangladesh. The results revealed that the potential productivity of vegetation differ significantly in various Agro-ecological areas, particularly CVP index value is lower in the North Western and South Western part of the country, on the contrary, higher in the Eastern part. This may due to variation and sharp changes in climate variables in last 30 years for both western part and the Eastern part and the silvicultural requirements of forest tree species. The quantitative results revealed that CVP index values for three major types of forests of Bangladesh were measured as follows: Tropical evergreen and semi evergreen type covers the range of 2394 - 2800; Moist and Dry Sal forest covers 1224 - 1896 and Mangrove forest covers 1307 - 1946. Eighteen forest tree species (currently economically and ecologically important) were purposively selected to identify their climatic and edaphic suitability in Bangladesh for future (2100 AD). Maps were generated for all the eighteen species considering its silvicultural requirements and changing climate scenarios for future following a generic version, so that any updated data can be incorporated and may be applied for any other place in the world. The potential suitable lands for indigenous species: *Anisoptera scaphula*, *Hopea odorata*, *Artocarpus chaplasha*, *Swietenia mahagony*, *Albizia lebbeck*, *Albizia procera*, *Lagerstroemia speciosa*, *Cassia fistula*, *Melocanna baccifera*, *Terminalia belerica* and *Heritiera fomes* may decrease significantly in future and on the other hand, some species *Shorea robusta*, *Terminalia arjuna*, *Sonneratia apetala*, some introduced exotics: *Tectona grandis* and *Leucaena leucocephala* may significantly gain suitable land in 2100. In conclusion, study visualizes a methodology and quantifies future potentials to identify the appropriate species, to ensure conservation of biodiversity and the safe investment on plantations, blending climate change scenarios and silviculture of species on a GIS platform with a generic version.

Keywords :

Future forest, silviculture, climate change, biodiversity, GIS

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37. Volume and decay data as a tool for tropical forest inventory and management

Rodney Kenneth P., Trevin Jorge and Pinillos Carlos

A volume and decay study was carried out in the Iwokrama Forest, Central Guyana. The objective was to attain information on volume and decay in commercial trees, their relationship to specific external decay indicators, and their effect on utilization factors and merchantable wood volumes. The study involved the analysis of 155 trees. Classical interrelations between volumes and other parameters were examined, decay losses were measured and registered, their effect on wood utilization was defined and observable decay indicators were registered. The analysis of these attributes has improved the capacity for estimating merchantable tree volumes in inventories in the Iwokrama Forest, and has defined relationships between those volumes and decay losses and between these factors and observable decay indicators. Nine types of decay indicators were analyzed in the study. Significant interrelations were found between utilization factor and number of types of decay indicators in the tree. The application of the results to forest inventories increases the precision of volume estimations, reduces inventory efforts, increases the knowledge base for selecting harvestable trees and helps to identify decayed trees to ensure they are left standing, thus contributing to biodiversity conservation.

Keywords :

Volume and decay study, Iwokrama Forest, tropical forest inventory

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38.Improving the method of harvest inventory through the use of GPS receptors

Forni Eric¹, Teillier Laurent²; Manfoumbi Victor³, Nongo Joseph³, Legault Faustin⁴

Harvesting inventories which involve the counting of all exploitable species are labour intensive operations often neglected by the forestry companies. A full inventory is nevertheless the foundation of a traceability system, which is now required of all companies seeking forest certification as a way of assuring the legal origin of harvested wood. We propose an inventory method that is improved by the use of GPS receptors. The method has the advantage of more precise positioning of each tree, and allows, thanks to the information captured automatically by the GPS, a more effective monitoring of the work of the inventory team. For example, the GPS allows a supervisor to track the exact route walked by each team member and the number of hours worked. Above all, the GPS allows the generation of a digital terrain model based on point measurements of altitude, which resolves the problem, frequently encountered by foresters in the tropics, of inaccurate or inexistent maps.

Keywords :

harvesting inventory, GPS, Gabon

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39. Developing forest parameters estimation model using object-based Texture Measure of ASTER Imagery Data in the Blue Nile forest, Sudan

Mahmoud El-Abbas Mustafa¹, Csaplovics Elmar², Röhle Heinz³

The study aimed to develop a model for forest attributes estimation based on ASTER imagery rather than time consuming and costly at plot-level forest inventory method. The innovative object-based (OB) was tested for improving the accuracy of the forest estimates utilizing image segment feature extraction. Correlation and regression analyses were applied to identify relationship between metrics derived from spectral and spatial properties of the image and forest parameters derived from field samples forest inventory data. In OB the mean layer value and standard deviation of the digital numbers of image segments in addition to various textural attributes were calculated for the objects that correspond to field samples. The Pearson's correlation was applied to determine the highest correlation coefficient, which represented by the forest stem volume with most of the image metrics. Regression analyses were performed using various models. The mean value of layer 3 and a logarithmic model was found to be the best fitting model by the highest determination coefficient ($r^2=0.70$) and the lowest Residual Mean Square Error (RMSE). Subsequently, the best fitted model was validated which achieved $R^2=0.72$.

Keywords :

Forest inventory, Object-based, texture, Blue Nile, Aster

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Parallel session 3

- Silviculture for multiple-use forest management -

Moderators: Manuel Guariguata and Plínio Sist



40. Barriers to multiple-use forest management in the humid tropics

Savilaakso Sini, Guariguata Manuel, Sabogal César, and Sist Plinio

As a concept, multiple-use forest management (MFM) is already old and often seen as a potential way to sustainability in the forest sector. However, it has not achieved broad uptake in tropical countries and remains a marginal activity. Here we present an overview of practical experiences in regard to the barriers hindering the implementation and viability of MFM in the humid tropics. We collected the data via electronic questionnaire from different stakeholders, such as community representatives, decision makers, NGOs, and private sector, who are or have been directly or indirectly involved in MFM initiatives. We discuss the importance of different economic, technical, socio-cultural, and institutional factors for MFM in the context of three regions (Africa, Southeast Asia and Latin America) and scales (experimental, small-scale, and large-scale). We also examine different stakeholders' perceptions of barriers and whether land tenure or different management objectives affect the success of MFM.

Keywords :

Ecosystem services, non-timber forest products, timber production, tropics

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41. Multiple-use forest management in Central Africa: Perceptions, implementation and evolution

Lescuyer Guillaume¹ and Essoungou Nadège Julienne²

Although multiple-use forest management (MUFM) is supported by forestry laws in the Congo Basin countries, this approach remains confused, misunderstood and little implemented. We conducted a survey with 62 people concerned or in charge of forest management in Cameroon, Gabon and DRC. Three conceptions of MUFM are expressed: (1) an intentional and formal management of the main forest goods and services; (2) an informal use of forest resources; (3) timber management with limited integration of other secondary goods, like NTFP or bushmeat. The first perception is supported by NGOs, research institutes and projects, the second by the communities' representatives, and the third by logging companies and forestry administration. Actual implementation of MUFM was reviewed in eight forest management initiatives – six logging concessions and two community forests. Timber production, biodiversity conservation, protection of sensitive areas and exploitation of NTFPs are the main uses integrated in MUFM. However their implementation faces various barriers: an inadequate legislation that prevents locally extracted resources from being traded when they come from logging concessions, precarious rights on forest resources for communities, and lack of economic profitability. In contrast, three approaches favor the adoption of MUFM, respectively forest certification, enforcement of traditional use rights in logging concessions, and the tentative REDD schemes.

Keywords :

tropical forest, logging concession, community forest, certification, NTFP, bushmeat, REDD

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42. Silvicultural options and best management practices for enhanced Brazil nut production

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Brazil nut (*Bertholletia excelsa*) has emerged as a cornerstone of the Amazonian extractive economy and a centerpiece of conservation efforts, particularly in the border region of Brazil, Bolivia and Peru. Drawing on our long-term research, we ask: (1) What patterns of fruit production and resilience to nut (seed) collection have emerged? (2) How is Brazil nut managed? and (3) Could more intensive management augment production? Fruit production variation is high at the individual tree level, but low at the population level. Seedling counts in twelve 9-ha natural forest plots suggest that despite harvesting up to 71% of the annual crop, regeneration is sufficient for population persistence. Even higher seedling/sapling densities were encountered in swidden fallows. Interviews with 300 harvesters in Bolivia, Peru, and Brazil revealed consistency in management through liana cutting, but minimal planting or protecting of seedlings; differing certification schemes promoted environmental practices or product quality enhancement. Our findings suggest that multiple species characteristics confer ecological resilience to seed collection and that more intensive management by harvesters could augment production via liana cutting, regeneration tending, and enrichment planting in shifting cultivation plots, forest gaps and even small pastures.

Keywords :

Amazon, local livelihoods, non timber forest products, sustainable extraction, tropical forest conservation

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43. Need of forestry communities for climate change adaptation and challenge of silviculture in Central Africa.

Sonwa Denis J. ¹, Bele Youssoufa ¹, Gapia Martial ², Mulotwa Emile ³ and Foahom Bernard ⁴

Facing climate change is one of the main challenges of stakeholders interested by forest management in Central Africa. Climate change affects forest resources and can render them vulnerable. On the other hand, some appropriate silviculture practices can help in facing climate change either for mitigation and/or adaptation. Beyond REDD+, adaptation to climate change is gradually becoming important in this part of the world. Within the first project on adaptation to climate change (Cofcca: Congo Basin forest and Adaptation to Climate Change) in this part of the world, some adaptation pilots activities were initiated with forest species in 6 Congo Basin localities in Cameroon, DRC and CAR. Those activities were initiated using the PAR (Participatory Action Research Approach) to identify constraints related to climate change/variability and some potential adaptation solutions. The current communication present (1) The effects of climate change faced by forest communities, (2) vulnerabilities of forest community to climate change, (3) the silviculture needs of these communities in the context of climate change, (4) actions put in place in collaboration with some partners of the region; (5) silvicultural challenges associated with the new needs to adapt to climate change in Central Africa where REDD+ dominated the agenda.

Keywords :

Adaptation to climate change; REDD+; Forest; Congo Basin, Silviculture, NWFP

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44. Wood or resin?

Opportunities and threats in Okoume resin sector development in Gabon

Doumenge C. ¹, Mvou Bihogo T. ², Person S. ³ & Louppe D. ⁴.

Okoume (*Aucoumea klaineana*, Burseraceae) is the most exploited timber tree species in Gabon (Central Africa), because of its great qualities for the production of veneer plywood. This tree is also known from a long time by Gabonese for making torches and as a substitute for incense. With the opening of international trade, the exploitation of okoume resin provides new and sustainable opportunities for the valuation of this species. This resin is sold in the markets of the Gabonese capital, Libreville, but also in Senegal and Europe. However, the European circuit, potentially the most profitable, is diverted to private interests and does not participate in the socio-economic development of the country, especially of that of rural people who often live in poverty. If this constraint can be lifted, the development of the sector will imply new management strategies and silvicultural recommendations according to resin vs timber production. The tappers' current silvicultural practices should be adapted to ensure higher production of better quality resin. Training and organization will be key for the development of this economic sector.

Keywords :

okoume, resin, wood, NTFP market, local development, Gabon

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45. Development and management of emerging NTFP: *the case of Carapa in Congo*

*Mesa Carolina*¹, *Loumeto Jean-Joël*², *Forget Pierre-Michel*³,
*Doumenge Charles*⁴

In Congo, the seeds of Carapa (Carapa spp., Meliaceae) are traditionally used for medicinal purposes and as a stimulant. Until 2009, their use remained very localized and confidential. However, in 2010, Brazzaville markets have seen an explosion in the consumption of seeds, dressed as suddenly the qualities of a panacea. The results are not always conclusive and a local doctor claimed that they could cause side effects if swallowed uncontrolled. Consumption collapsed despite the absence of research proving the toxicity. As a consequence, seed collection has decreased in parallel with an increase in the harvest of bark, supposedly less harmful. Changes in collection practices sometimes caused a total debarking and death of trees. Currently, the issue of sustainability of the resource is mitigated by the prohibition of logging, but it is insufficient. The silvicultural practices will depend on market orientation and the sharing of profits in the sector, encouraging or not the producers to sustainably manage this resource. The management of Carapa resources, which could participate in future development programs in the Lac Télé Community Reserve, should be designed with producers, taking into account the local cultural context.

Keywords :

NTFP management, medicinal uses, seeds, bark, Carapa, Africa

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Parallel session 4

- Rehabilitation of degraded forests -

Moderators: Robert Nasi



46. Assisted *natural* regeneration: a tool for degraded tropical forests rehabilitation in central Africa

Marien Jean-Noël, Proce Pierre, Peltier Régis, Marquant Baptiste, Dubiez Emilien

A major part of anthropic impacts on natural tropical forests in central Africa is related to unmanaged shifting agriculture and fuelwood extraction by local communities, mainly along access tracks (roads, rivers,...) and at the edge of forests. Assisted Natural Regeneration has been largely designed and used in dry countries. In a EU projet in DRC and Congo (Makala), we have adapted these techniques to shifting agriculture. We used the capacity of sprouts and seeds of remaining local forest species and induced specific management techniques amongst farmers. The results show a very good reactivity and regrowth of natural forest species with a low cost and low technicity involvement of farmers. Social acceptance is the most critical factor for successfull large scale development of such techniques. Such techniques can also be adaptated to industrial concessions in their efforts to rehabilitate deforested and/or unproductive areas and in their efforts towards sustainable management and certification.

Keywords :

assisted natural regeneration - shifting agriculture - degraded forests - projet Makala

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47. Developing management plans for periurban degraded forests around Kinshasa (DRC)

Dubiez Emilien, Vermeulen Cédric, Yamba Yamba Timothée, Peltier Régis

The forests of the Democratic Republic of Congo are part of the second largest tropical forest in the world. Many of the rural population of this country are located nearby and live from them. The need for wood energy in the capital Kinshasa, estimated at 490,000 tons / year (Makala Project, 2011), leading to a dynamic of deforestation and degradation of forest ecosystems in suburban areas and inducing significative deterioration living conditions of populations. This study is part of the EU project Makala. It focuses on the management of degraded natural forests through participatory management of village in the periurban area of Kinshasa. The main objective of this work is to provide an opportunity for an endogenous group, traditionally managing the village territory, to develop a vision for the sustainable development of their living space. Three stages were carried out: the sustainable management of relict forests, the development of agroforestry systems, and last planification of logging and forest recovery operations. The challenge for management planning is to combine these three types of actions, depending on the local landscape units, representative of the diversity inherent in soils: diversity of objectives (conservation, production, agroforestry, ...); diversity of soil conditions; diversity of users' rights; diversity of actors involved... This development is based on the local names, the perception and the appropriation of village territory experienced by the local population.

Keywords :

Management plans, rural communities, periurban area, degraded forests, fuel-wood, Kinshasa, DRC

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48. Effect of silvicultural practices on the initial rates of carbon sequestration in Atlantic forest restorations

Ferez Ana Paula

We used an Atlantic forest restoration project (6 yr) submitted to contrasting management conditions (usual and intensive) to estimate rates of above- and belowground C sequestration and compare C stocks with data from 10 permanent-plots installed in mature forest. In the test C stocks were calculated applying biomass allometric equations developed through destructive sampling of 80 trees, and determined coefficients for dry weight and C content. Wood density varied between species by up to 3 times (0.22 to 0.70g/cm³) while C content was constant (46.5%). Appropriately adjusted equations were established using cross-sectional area, height and wood density. Intensive forestry increased wood growth by 250% (1.85 to 6.45Mg/ha/yr), given greater canopy efficiency and C allocation to trunk. Although representative in stock, soil didn't sequester C in this period, given its high spatial variability. Largest C sequestration was observed in intensive treatment, reaching 4.22MgC/ha/yr, 64% on woody compartment and 20% in roots. C stock in soil and litter were similar between intensive system and mature forest. Based on C sequestration average (5.2 and 18.2MgC/ha respectively in usual and intensive treatment), 50 yr was estimated for intensive system to reach forest maturity but biodiversity and sustainability studies are needed in the long run.

Keywords :

Forest restoration; Carbon sequestration; Silvicultural practices.

Orator : Ana Paula Cervi Ferez

49. Ingenuity, diversity, vision and adaptability of farmers producing timber and NTFP in western Cameroon

Temgoua Lucie¹, Njoukam Raphael² and Peltier Régis³

Most development workers, involved in farm forestry in southern countries, act on the basis of paradigms such as: “poor farmers only consider the short-term production, their traditional agroforestry systems are immutable or being abandoned, we can offer them only well-established techniques, including simple and standardized fast-growing exotic species plantation methods for live-fences, fodder-banks or production of poles”. The study of the practices of farmers in western Cameroon, on the contrary, shows that there is a wide range of behaviour concerning the silviculture. Farmers show ingenuity to adapt traditional systems or integrate external technologies and adapt them to their current needs and their ability, while looking at different uses, sometimes over several generations. Thus, for private Eucalyptus plantations, they integrated the system used by state departments and projects, innovating in the following areas: plant production and direct seeding, spacing, association with crops, coppice selection, and diversity of products. By cons, for Pinus, also encouraged by the state and projects, very few farmers' plantations were carried out, mainly because of lack of markets for products at different ages of stands. Regarding the traditional live-fences, we find that species that have no current use are eliminated in favour of new species. These are selected, on the base of family needs and local market opportunities. For example, near the art centre of Foumban, Polyscias are planted because wood can be sold to the sculptors of masks. The Canarium multipurpose species (fruit and timber), with an average growth, is largely retained and planted. It is surprising to see a small number of farmers planting hedges with local species producing timber after more than 50 years, as Podocarpus or Entandrophragma, while the state itself does not. Rather, the state or municipal plantations burn in a general indifference, despite the best efforts of their managers. The question is whether the aid credits for public reforestation would not be used more effectively as an aid for private reforestation.

Keywords :

Western-Cameroon, Reforestation, Local Uses, Adaptation, Farm-forestry, Agroforestry

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50. Effect of some indigenous woody plantations on soil carbon sequestration in rehabilitated Coal Mine habitats in a dry Tropical Environment, India

Singh A.N.

Accumulation of significant C stock in redeveloping soils of mine spoil depends upon the quality and rapidity of biodiversity reconstruction and establishing young native woody plant species that could be able to develop a reliable forest. Evidences from a number of researches conducted on the same or similar habitats in the tropics reported that developing forest on any particular degraded ecosystems play a significant role in mitigating the effect of global climate change by carbon sequestration. However, restructuring of vegetation on such degraded ecosystems is not an easy task. It needs careful scientific consideration prior applying restoration principles. Present study was conducted on a degraded ecosystem in a dry tropical region of India where mining is one of the serious problem, degrading precious forests with unprecedented rates. Mining operation not only degrade the forest cover even degrade the soil composition. Thus, degraded soils have no ability to sequester essential nutrients (C, N and P) for vegetation development because soil-plant relationships and nutrient circuit in the soil medium has been damaged. Hence, soil restoration is a really challenging ecological problem; moreover, their recovery into previous version by natural succession is very slow. Therefore, biological soil restoration by establishing desirable plant species is cost-effective and more stable technique than physical and chemical rehabilitation procedure. We selected eight woody species which were indigenous and hard in nature; of which four of them (*Albizia lebbeck*, *Pongamia pinnata*, *Dalbergia sissoo*, *Albizia procera*) were leguminous tree and short stature in size, while remaining (*Azadirachta indica*, *Tectona grandis*, *Dendrocalamus strictus* and *Shorea robusta*) species were non-leguminous in nature. The objective of the present study was to quantify biodiversity recruitment under plantation plots, and to estimate biomass, net primary production (NPP) and carbon cycling stock in planted species and their role in soil carbon accretion with respective time. Results indicated that influence of these plantations in terms of accumulation of soil organic C and their sequestration was more pronounced with planted age but there is no synchronize trend observed among plants. Therefore, entry and re-establishing of plant biodiversity and soil carbon sequestration rates among planted species were significantly varied and showed a strong effect of species and plantation age confirming accretion of carbon which may in turn more strong enhancement of biological fertility that will make a fertile ecosystem in a short range of time.

Keywords :

Key words: Ecological restoration; coal mine spoil; biomass; NPP; Indigenous plantations; Carbon sequestration; soil redevelopment.

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51. Spatial structure of forest trees in tropical agroforests

Ngo Bieng Marie Ange¹, Gidoïn Cynthia^{1,2}

In the context of the ongoing destruction of tropical rain forests, the potential value of tropical agroforests as a model of agricultural sustainability has increased. Tropical agroforests consist in complex associations of trees and crops. However few studies dealt with spatial structure of forest trees in tropical agroforest systems and their similarity to spatial organisation of trees in forest ecosystems. Our aim is to analyse the spatial structure of forest trees in tropical agroforests. We used a classical method of spatial statistics: Ripley's K-function. We linked the different spatial organisation of trees with diversity of associated plants (ecological performance) and to pest and diseases pressure (agronomical performance).

This paper focuses on 36 plots in a tropical cocoa based agroforest in the region of Talamanca (Costa Rica). Forest trees were not significantly present in 7 plots; randomly distributed in 15 plots; regularly distributed in 8 plots; clustered in 6 plots. The clustered structure of forest trees was correlated with a higher diversity in associated plants in the studied stand, and with a the highest pest and diseases pressure. We discuss advantage and drawback to introduce structural characteristics of forest in cropping systems.

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Parallel session 5

- Silviculture of logged over and secondary forests -

Moderator: Sylvie Gourley Fleury



52. Intensive silviculture of natural semi-deciduous forest and reforestation strategy of Aplicam a forest management and logging company in Cameroon

Bastin Didier ¹, Plancheron Françoise ²

Silviculture industrial in natural semi-deciduous forest and reforestation of the forestry company ALPICAM in Cameroon Didier BASTIN - ALPICAM Françoise PLANCHERON - ALPICAM-ONFi The forest harvesting Company ALPICAM has been engaged in the forest certification process for several years, receiving in April 2009 the OLB certificate of legality for its concessions and processing units in Cameroon. The Company confirmed its willingness to go further in the process by creating a Forestry Research and Development Department in November 2009 with the technical assistance of ONFI. The R & D programme consists of several components related to natural stand dynamics and is to result in the creation of an Ayous plantation (*Triplochiton scleroxylon*) in the savannah zone. Ayous is an indigenous hardwood used for peeling in Cameroon and the most harvested species by Alpicam. In programme also involves the establishment and monitoring of a number of experimental permanent sample plots will allow phenological monitoring, the improvement of planning parameters, evaluation of the impact of logging and the implementation of silvicultural techniques to promote the natural regeneration of Ayous. The reforestation activities in the forest-savannah transition zone are conducted by ALPICAM in partnership with STBK in Batouri. The project consists in the afforestation of 1000 ha of savannah with Ayous and is to be put forward as a potential CDM project. A vegetative propagation garden and a unit for the production of plants from Ayous cuttings were set up on the site of STBK.

Keywords :

Cameroun, forêt semi-décidue, ayous, reboisement, sylviculture

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53. The efficiency of enrichment planting method (TPTJ) in a logged over forest in Indonesia

Inada Tomoya, Kanzaki Mamoru and Sedono Ronggo

Line planting of the commercial species *Shorea johorensis* and other *Shorea* species is conducted in logged-over forests. However the sustainability has not been evaluated based on long-term monitoring data. The aim of this study was to evaluate the direct and indirect effects of line planting. Monitoring plots were established in a logged-over stand using the reduced impact logging (RIL) method, and treated with line planting. In the treatment plots, 80 seedlings/ha of *Shorea johorensis* were planted along a 3-m wide planting strip opened in the stand. The control plots without planting were also established. Invasion by pioneer species was poor, indicating that the RIL method functioned well. In the treatment plots, planted *S. johorensis* grew to an average dbh of 15 cm and the survival rate was 78.2% after 10 years. Strip cutting for the line planting also enhanced the natural recruitment of dipterocarp seedlings. The density of naturally recruited dipterocarps (dbh > 10 cm) after 10 years was about 82 trees/ha in the treatment plots, as compared to 27 trees/ha in the control plots. We conclude that line planting is a robust way to sustain and enhance the regeneration of dipterocarps in logged-over Indonesian forests.

Keywords :

Enrichment planting, Dipterocarpaceae, *Shorea* , TPTJ

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54. Spatial dynamics of an aggregated logged tree, *Dicorynia guianensis*, a semi-heliophilous species of French Guiana forest

Traissac S. (1), Guitet S. (2), Brunaux O. (2)

In French Guiana, most logged species exhibit an aggregated distribution. This study is part of DYGEPOP research program that aims to understand origin and maintenance of these aggregated patterns. *Dicorynia guianensis* is the most logged species in French Guiana. Previous study suggests that spatial dynamic of *Dicorynia* is cyclical and based on small aggregate around 50m radius. But, inventories on new managed forests show that *Dicorynia* may show a 'plaque' distribution: much bigger tree groups, up to 350m radius. We studied three undisturbed forest sites along an adults' density gradient. We made exhaustive mapping of adults, young trees and saplings, and description of a local disturbance index at each studied site. Spatial relations between individuals were describe using Ripley's K function and derived ones. We show that adult's density gradient between studied site can be related to gradient of spatial structure and dynamic index of studied populations. Namely, we show that saplings and adults exclude each other where adults' density is high. Inside plaques, saplings are structured in small aggregate which positions are linked to local disturbance index. These results allow us to improve existing dynamic spatial model of *Dicorynia*: plaques are demographically unbalanced and result from juxtaposition of small aggregate that follow pseudo-cohorte cycles.

Keywords :

Spatial pattern dynamics, tree population dynamics, tropical rain forest, *Dicorynia Guianensis*, spatial analysis, Ripley's K function, colonization model

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55. First results of an enrichment method tested on recent skidding trails in Marantaceae forests (Republic of Congo)

Gillet JF and Doucet JL

Open canopy Marantaceae forests cover large areas in the Northern Republic of Congo. The contiguous largest unit is estimated at ca. 600 000 ha. Regeneration studies suggest that without silvicultural treatments, the natural regeneration of trees is inhibited by giant Marantaceae and Zingiberaceae. A survey conducted in open canopy Marantaceae forests provided an estimate of 20 seedlings 100 m⁻² (> 50 cm height) in unlogged areas while the density observed on skidding trails reached 110 seedlings 100 m⁻². This higher density could be due to the destruction of herbaceous rhizomes. The future of these seedlings being uncertain, a method was proposed in order to maintain natural timber species regeneration and to complete it with nursery raised plants. Concerning the maintained natural regeneration, the best results were obtained for *Terminalia superba* and *Nauclea diderrichii* with annual growth rates in height reaching 124 and 121 cm. As for the introduced plants, the highest values were observed for *Triplochiton scleroxylon* and *Millettia laurentii* with 91 cm and 61 cm. A single clearing is recommended one year after installation and the total cost of the technique is estimated at 64 EUR per km of skidding trails. This method could restore a positive evolutionary dynamic and increase the long term caption of atmospheric carbon.

Keywords :

Congo, Marantaceae, regeneration, enrichment, skidding trail

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56. Mid-term effects of Reduced-Impact Logging (RIL) on the regeneration of seven commercial tree species in the Eastern Amazon

*Schwartz Gustavo¹; Peña-Claros Marielos², Lopes José C.A. ³,
Mohren Godefridus M.J. ⁴, Kanashiro Milton⁵*

Reduced-impact logging (RIL) techniques have been accepted as environmentally and socially friendly forestry practices in the Brazilian Amazon. We present responses of seedlings and saplings of seven commercial tree species to RIL in the Eastern Amazon: *Bagassa guianensis*, *Jacaranda copaia* (long-lived pioneers), *Hymenaea courbaril*, *Dipteryx odorata*, *Carapa guianensis* (partial shade-tolerant), *Symphonia globulifera* and *Manilkara huberi* (total shade tolerant). The experiment was carried out in the National Forest of Tapajós in mid-2003, having two sets of 237 10×10m plots, where regeneration was inventoried and measured before logging and one, three, and six years after it. Of each individual, height and diameter at 1.3 m aboveground (for those ≥ 3m) and crown position were measured. During the monitoring period, we assessed the fate of each plant and tagged new recruits. Results indicate that long-lived pioneers had higher density and growth rates during the first years after logging, which decreased through time. Partial and total shade tolerant species presented the same pattern, except *M. huberi* with no tendency and *C. guianensis*, which decreased in density. Although RIL, following the Brazilian regulations, has positive short-term effects on long-lived pioneers, they tend to return to pre-logging parameters, corroborating to RIL as an environmentally friendly practice. Thus, RIL may be considered an efficient silvicultural technique for increasing density and growth rates of such species. However additional silvicultural interventions might be required for maintaining those positive effects in the long run.

Keywords :

Silviculture; Forest Ecology; Brazilian Amazon; Long-Lived Pioneer; Forest Management

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57. Sustainable Forest Management and post-harvest Silvicultural practices: The case of CIKEL Group¹

Baitz Wandreia PhD²

The time is gone when working in Forest industry was facilitated by public policies which needed it, for instance, in order to open new borders. In order to stay in the market, businessmen must take enterprising, visionary, sustainable actions. Forestry industry is one of the most important productive activities in the Amazon. With broad forest coverage, around 325 million hectares of native forest, and great part of which is fit for sustainable exploitation, the industry can generate a considerable income per year. In the line with the context of the industry, Cikel Group constantly renews its commitment to sustainability and to modern managing process. Cikel is a Brazilian private-owned company that manages native forest with in the North part of Brazil. Cikel owns one of the largest forest management plan of the State of Pará. It is totally integrated, and over forest operations and harvesting, manufacturing (primary and secondary processing facilities), and trading. Silvicultural treatments can increase the growth rates of trees in tropical rain forests. Post-harvest silvicultural practices in managed forests are seldom applied in the Amazon region. In view of this deficit an experiment was established in 700ha of dense forest at Cikel aiming at testing the most applied silvicultural treatments in order to select the most promising ones to recommend their application as part of management practices in the region. The experiment promoted formerly selected potential crop trees by increasing solar radiation through girdling undesirable trees and has favoured seedlings in gaps either planted or from natural regeneration of selected species. Three assessments took place from 2005 to 2008. It is important to emphasize that the aim is not only to enhance growth and the commercial value but also to keep the equilibrium of the forest ecosystem, with the minimum impact on the floristic composition and ecological structure of the managed forest. So far, more studies on post-harvesting silviculture are necessary to identify families or group of species more susceptible or more resistant according the treatment, even if it is economic viable

1. Study developed by Embrapa/UFRA and supported by CNPq/CIKEL
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Parallel session 6

- Managing tropical production and secondary forests for biodiversity values -

Moderator: Ariel Lugo



58. Structural and ecological characteristics of successional vegetation stages: silvicultural systems for forest rehabilitation and sustainable management in Lama Forest Reserve (Benin, West Africa)

Ganglo Jean C.¹, Hounkpevi Achille¹, Ganse Judy R.², Devineau Jean-Louis³, Gourlet-Fleury Sylvie⁴

The study was carried out in the Lama Forest Reserve located 100 km North of Cotonou, Benin (6°55' - 7°00' N, 2°04' - 2°12' E). Its main objective was to study the structural and ecological characteristics of the forest so as to design adequate silvicultural systems for the forests' rehabilitation and sustainable management. The species diversity of the forest was appreciated by computing Shannon index, Evenness coefficient of Pielou, alpha, beta and gamma diversity of the plant-communities. To assess dendrometric parameters, eight 0.25 ha (50 m * 50 m) permanent sampling plots were set up at representative points of each plant-community. In the sampling plots, diameter at breast height (dbh) (1.30 m above ground) and height of valuable species were measured on individuals with dbh \geq 10 cm. In each permanent plot, 02 square subplots of 100 m² each were set up to assess regeneration (individuals with dbh < 10 cm). The diameter structures of the plant-communities and valuable species were adjusted to the theoretical distribution of Weibull, and served as a reliable indicator to choose adequate silvicultural systems. From the main results, four stages are observed in the successional vegetation of Lama Forest. They are composed of pioneer herbaceous, annual and perennial plant-communities, young and old secondary forest-communities. The secondary forests are in general the most diversified plant communities in terms of α and γ diversity. The tree-density of the forests ranged from 228 to 326 stems/ha with no significant difference at 5% of probability level. However, the basal area, the mean quadratic diameter, and the Lorey's mean height respectively varied from 9.27 to 21.20 m²/ha; 21.57 to 32.41 cm and, 15.21 to 22.28 m with significant difference at 5% of probability level. The highest values of these parameters are obtained in old secondary forests. On the basis of ecological traits, ability of regeneration, and diameter structure of the valuable / dominant forest species, silvicultural systems are proposed to enhance the forests' rehabilitation and sustainable management. They comprised valuable forest species planting in pioneer herbaceous plant-communities; enrichment planting, single-tree selection system, group-felling system, and follow up through tending operations (liana cutting, understory clearing, and canopy opening...) in secondary forests

Keywords :

Lama Forest Reserve, plant-communities, structural and ecological characteristics, silvicultural systems, Benin, West Africa

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59. Mampu Agroforestry system in DRC: Is it sustainable and can it be a model for large scale plantations?

Proces Pierre¹, Bisiaux Franck², Marien Jean-Noël³

The hundreds of thousands of hectares of savannah of the Plateau des Bateke, situated around the megacity of Kinshasa (capital of the Democratic Republic of Congo) offers a promising perspective on the development of agriculture and forestry. Several projects have been initiated in the area, among them the Mampu Project in which 308 farmers are developing an agroforestry system of fallow land based on the traditional cultivation method of slash-and-burn to manage 8000 hectares of planted *Acacia auriculiformis*. The impact of the agroforestry system on the living conditions of the farmers and their surroundings is remarkable. However, the durability of the system is jeopardized by some poor agroforestry practices and a lack of social cohesion necessary for the management of brush fires (or maybe “controlled burning”). In addition, despite the beneficial effects of *Acacia* on the level of nitrogen the nutrient assessment of the soil threatens the viability of the system due to a lack of measurement of the fertility management of the soil. A decrease in the yield of the cultivated land as well as the acacias is observed in the second crop rotation. Although the Mampu Project is promising, technical and social modifications would be desirable for sustainable replication on a large scale.

Keywords :

agroforestry - DRC - acacia - social

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60.PROTA: a useful tool for forest and tree plantations management in Tropical Africa

Louppe Dominique

A good management of a natural forest depends on a good knowledge of the uses of all the trees species growing in that forest. These uses are generally not well known and may be cause of conflicts between stakeholders. Only a few number of tree species are planted at a large scale because of a lack of knowledge on other promising species: biological properties, nursery and planting techniques. However, the information exists somewhere: research has been done for over a century; but this knowledge is scattered, often through grey literature, and difficult to find and consult. The main objective of Prota (Plant Resources of Tropical Africa) encyclopaedia is to collect and synthesize scattered information on 8,000 useful plants of Tropical Africa and among them 1,100 are timber trees. Prota aims to provide a wide access to that information through Webdatabases, Books, CD-Roms and Special Products. "Timbers" is founded by ITTO and translated by CTA. So, PROTA is a fully bilingual (English/French) information system. Actually 700 timber species are freely accessible on the Prota Webdatabase. A short presentation on how to use that database is given.

Keywords :

database, encyclopaedia, trees, uses, silviculture, management

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61. Enrichment planting of restored areas with *Euterpe edulis* Martius, Arecaceae, a Keystone atlantic forest species : overcoming barriers to its initial establishment

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The heart-of-palm tree (*Euterpe edulis* Martius), an endangered species, is one of the main non-timber forest products of the Brazilian Atlantic Forest. It has a great potential for enrichment of secondary forests, conciliating biodiversity conservation and economic incomes for landowners. Besides proving the heart-of-palm, their fruits are source of a nutrition-rich pulp consumed in natura, as juices, ice-creams or comfitures. It is suggested that this species has a key role in accelerating forest succession by attracting the frugivorous fauna. However, it has been observed a low sapling survival where there's a definite dry season. This study aimed at testing the hypothesis that the soil water deficit is a main barrier for species' successful establishment in agroforestry systems and restored areas. We used a 3 x 2 factorial randomized block design (no irrigation, irrigation every seven or 21 days, combined with the usage or not of a hydrophylic gel). Plant survival was observed weekly (for logistic regression) and growth in height and diameter at soil level quarterly (for mixed linear models), during 30 weeks throughout the whole dry season. The survival analysis indicated that irrigation every seven days provided the best conditions for the establishment of heart-of-palm plants, independently of the usage of hydrogel. The use of hydrogel provoked a reduction of 57% in seedling survival, regardless irrigation frequency. For height growth the effect of time and hydrogel were significant ($p < 0.0001$ and 0.002 respectively) although there was no effect of irrigation ($p < 0.7222$). For diameter growth there was only the effect of time. We have concluded that, attention to water availability is necessary for the successful reintroduction of this species, because the soil water deficit appears to be the main limiting factor to its initial establishment in restored areas or secondary forests.

Keywords :

heart-of-palm tree; enrichment planting; Atlantic Forest

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62. Human Impact in the Forest Cover of East-Timor

Fonseca Teresa F.¹, Pacheco Marques Carlos¹

East-Timor was formerly well endowed with forests. Those forests contained many non-timber forest products of importance to rural communities: fuelwood, medicinal plants, honey, rattan, bamboo and animals for meat. In former times, when the population was lower, shifting cultivation in the forests was the traditional and generally sustainable land management system. With increasing population and exploitation during the last 35 years, the forests have been reduced in extent and in condition. The continuing degradation of forest conditions is driven mainly by illegal logging, demand for fuelwood (especially around urban areas) and shifting cultivation. This continuing degradation is having an adverse effect on watershed conditions (linked directly to water supplies for irrigation, and therefore to food security), water supply and quality, and biodiversity. The results obtained in the first National Forest Inventory made in the country, at the Bobonaro and Covalima districts, under the RDP-II Project (Marques et al. 2010) show how the environmental conditions have been affected by man. The aspects that seemed most important will be highlighted in the conference. For the moment, the forests still make a useful contribution to local timber supplies, especially fuelwood, and to watershed protection. However, it should be stressed that the relatively low density of forested areas in both districts is a concerning feature. Implementation of policies to increase rural incomes, generate employment in rural areas and, consequently, reduce poverty and improve the welfare of rural communities, replant former forests, and protect and manage the existing ones are need to ensure an effective sustainability of the forest resources, soil conservation and of biodiversity promotion in the country.

Keywords :

Rural communities, Shifting cultivation, Biodiversity

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63. Dynamics Palm in forest land in the Colombian Amazon

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Palms are common and major components in Amazonian landscapes. In tropical forests, palms and livelihoods are closely linked because palm species provide multiple goods and services. Dynamic, understood as mortality, recruitment and rotation, is a key aspect to establish appropriate management criteria. However, palm dynamic is poorly understood in Amazonian forests. Hence, we analyzed palm community dynamic in a terra firme forest located in the Colombian Amazonia, based on five years (2006-2011) data of a 20-ha permanent plot. Using three censuses data (2006-2007, 2007-2009, 2009-2011) we estimated mortality, recruitment and rotation rates as well as types of mortality (e.g. died standing, uprooted, snapped) for two diametric classes: (1) young palms: 5-10 cm and (2) adult palms: ≥ 10 cm. We include 9 palm species of which 6 were adult palms, 8 small palms and 5 common species, each category with 402 and 480 individuals, respectively. In adult palms we found an increase in mean annual mortality rate with intervals from 4.1 to 5.3%, while mean annual recruitment rate decreases over from 5.3 to 1.4% with significant differences between time intervals ($P 0.017$). We observed mean annual rotation rate tends to decrease over time from 4.7 to 3.4% due to an increase in mortality. Young palms had an opposite behavior: mortality rate decreased with time from 5.9 to 2.4% without significant differences between intervals ($P 0.579$) and recruitment rate showed a significant increase from 6.7 to 10.10% in the last interval, which influenced mean annual rotation rate from 5.3 to 6.7% with time. In all censuses, the more common mortality type for both categories was uprooted (48%) related to *Euterpe precatória*, followed by died standing (25,5%) related to *Socratea exorrhiza*. Mortality and recruitment data are high compared to others Amazonian forests but are within the ranges reported for another palms. Due to especial allometric characteristics of palms, there are several factors that can determine the type of mortality. Therefore, it will be necessary to investigate climatic variations and environmental factors such as topography to get a better knowledge of palms dynamics in terra firme forests. These results can be key to future silvicultural management practices based on the rate of rotation.

Keywords :

Mortality, recruitment, rotation, palms, Amazons,

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64. Fallows, agroforests and forests: should tropical silviculture go beyond the forest margin?

Valentina Robiglio¹, P. O. Cerutti¹, J. Gockowski¹, G. Lescuyer²

Over the recent years, studies on small scale, chainsaw logging in a number of countries of West and Central Africa have documented the gap between timber production as recorded in official statistics vs. actual national production. The latter includes both the large-scale, industrial, export-oriented, forestry sector and the small-scale, artisanal one, largely feeding domestic and regional timber markets. In countries such as Ghana and Cameroon preliminary findings indicate that timber informally harvested in a range of agricultural land use units, such as fallows and cocoa-agroforests, contributes to about half of national production. We present the preliminary results of a series of studies conducted in two regions of Cameroon to assess timber stock and production in the rural mosaic and assess the sustainability of present exploitation practices. Results indicate that timber harvesting intensely focuses on, and is rapidly depleting, a handful of useful trees that farmers traditionally maintained on the rural land. Density, diameter distribution and basal area vary significantly by species and across the various agricultural units. Some species regenerate, in particular in the fallow units, but fuel wood extraction and pole production combined to field preparation practices seriously mine the reconstitution of the timber stock and its preservation across the fallow cycles. We conclude that models to join production of forestry and agricultural crops should be developed at the landscape level with a particular focus on the integration of the land uses that represent the largest portion of the rural mosaic, i.e. those with fallows, agroforests and secondary forests. Production and management tradeoffs (e.g. fallow length versus trees growth rates, damages to main crops, competition), and the factors that could enable the adoption of those models (e.g. land and trees tenure, options for alternative land uses) have to be carefully assessed.

Keywords :

on-farm timber, agroforestry, fallow management, secondary forests, small-scale logging

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Parallel session 7

- Forest certification -

Moderator Claudia Romero and Plínio Sist



65. Evaluating the impacts of forest certification: *opportunities and constraints*.

*Romero Claudia and s PutzFranci*¹

In the early 90s, after a long and comprehensive process of consultation and debate, the possibility of reaching international consensus on what could constitute responsible forest management, from the social, economic, and ecological perspectives, became a reality with the creation of the Forest Stewardship Council (FSC). The dynamism of the process, which dealt with reaching the broad range of stakeholders involved in the timber sector in several countries across the globe, identified the key social, economic, and ecological issues related with tropical forest management that should be complied with in order to guarantee sustained forest values. This presentation summarizes current understanding of the impacts of certification. It critically examines the practical difficulties in attempting to determine the achievements of timber certification with emphasis on tropical forests. The discussion is based on reflections on publications that attempt to evaluate its impacts in a range of countries. It introduces a research approach to advance actions towards the evaluation of the effectiveness of certification of forest management.

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66. Classification of natural forests sites by partial abundance of indicator tree species

Oavika Forova

Analysis of common natural forest tree species abundance and distribution in Papua New Guinea, showed contrasting patterns between groups of tree species. Most noticeable was between *Syzygium* spp and *Pometia* spp. It was observed that where one was partially abundant, the other was rare and vice versa. Partial abundance of the two tree species was further explored to determine the nature of the contrast using Correspondence Analysis and field observations. Data was obtained from 68, one hectare permanent sample plots randomly established throughout the country in logged over forest sites. Results revealed that the contrasting nature of partial abundance between the two tree species was directly related to soil types and some of the soil properties were thus determined from the result. Both tree species were therefore concluded as indicator species and hence their distribution and abundance pattern could be used to classify site types in natural forests for management purposes.

Keywords :

partial abundance, *Pometia* spp, *Syzygium* spp, natural forest management

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67.FSC or Business as usual?

Social impacts of forest certification in Cameroon

Tsanga Raphael¹, Lescuyer Guillaume^{1&2}, Cerutti Paolo Omar^{1&3}

FSC or Business as usual? Social impacts of forest certification in Cameroon The paradigm of Sustainable Forest Management is central in the forestry laws enacted over the latest decades in the Congo Basin countries. However its implementation, and hence effectiveness are questioned because of weak control and law enforcement by the forestry services. Under pressure from western markets, international NGOs and cooperation agencies, several logging companies have opted for privately certified forest management with the Forest Stewardship Council (FSC) standard. The FSC scheme has a strong social component aiming at the optimal integration of local populations in the forest management process. The article examines the effectiveness of local organizations put in place around 9 FSC certified concessions from 3 logging companies in Cameroon and assesses the “renewed” relationships with local communities. Overall, results show that social issues are better integrated in the management practices of certified companies as compared to non-certified one. The main success of forest certification is to transform violent conflict to latent tensions and move towards negotiated solutions instead of repression. However, remain very much the FSC promoted local organizations are financially and technically dependent on logging companies and face a lack of grassroots legitimacy. Even when FSC certified, logging companies tend to assess their initiatives towards communities more in terms of their existence than in terms of their actual effectiveness, which is still a step further from the actual adoption of concerned social forestry.

Keywords :

Effectiveness - Forest Certification – Legitimacy – social conflict

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68. New FSC criteria and indicators – Update on the FSC Review processes

Synnott Timothy¹, Karmann Marion²

The FSC Principle and Criteria (P&C) are core document for FSC forest management certification, and can only be changed by a vote from the FSC membership. Since their adoption in 1993 the P&C have not been consistently reviewed, and only few changes have been approved. In 2007 FSC initiated a limited review and revision process of the P&C, focusing on requirements from membership motions and the Plantations Review process. The initial review evolved to a full review process. To reach out to all relevant stakeholders and to consider all input, a sub-chamber balanced Working Group was established to lead the process, which follows international “Procedures for the Development and Approval of Social and Environmental Standards”. The process is likely to end in late 2011. Additionally the paper describes how the process for development and endorsement of FSC Indicators works. Indicators are the regionally adapted “translation” of requirements expressed in the P&C. FSC aims to generate generic indicators to be used for certification in the absences of indicators developed by National Working Groups. Some generic indicators would be internationally applicable, others would apply only for subsets of forest types.

Keywords :

forest management certification, FSC Principles, Criteria, Indicators

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69.FSC certification as a tool to recognize and safeguard cultural values

Karmann Marion ¹, Droste Hans-Joachim ²

Since 1993 FSC forest management certification demands that local, in particular indigenous populations, can give or withhold their consent to forest management activities affecting the areas traditionally used and inhabited by them. This addresses the concept of Free, Prior and Informed Consent (FPIC), one of the principles of human rights law to protect indigenous peoples, established in many conventions and laws. Additionally to consent FSC demands that from development to implementation of FSC's standards consultation and monitoring processes guarantee that in certified forest operations the range of environmental and economic values, and the quality of life of those people living in and from the forest are fully respected. FSC's High Conservation Value Forest (HCVF) was developed to describe those forests which must be managed and evaluated under the precautionary principle; HCVF include those areas fundamental to meeting basic needs of local communities and/or critical to their traditional cultural identity. The paper explains which tools and criteria FSC provides to identify the different values of forest landscapes, the challenges to implement these requirements, and how FSC can be used as a tool for preventing and resolving conflicts and regulating fair contractual relationships between forest companies and local populations.

Keywords :

FSC forest management certification, FPIC, HCVF, social impacts

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70.Environmental Risk Assessments (ERA) for FSC-certification

Synnott Timothy¹, Wenban-SmithMatthew², Karmann Marion³

Activities in managed tropical forests should never have unacceptably heavy environmental impacts. FSC's monitoring system ensures that this minimum requirement is met in certified forests, and requires Environmental Impact Assessments. But these are often costly and unreliable. ERA can help identify which actions or activities are likely to be most important in relation to specified environmental outcomes. Management or monitoring effort can then be focussed on those actions or activities that are most significant. The paper shows how the ERA tool can be by forest managers to determine when detailed environmental monitoring is (or is not) justified, taking account of the scale and intensity of forest management, and the vulnerability of the forest resource. The tool was developed in a project for the Selva Maya in Central America, to reduce costs and to increase accessibility of FSC certification of community-managed forests. However, the generic ERA system should be applicable in any region of the world, with relatively minor adaptations based on local expertise and testing. A second phase of the project proposes to adapt and test the ERA technique for use for FSC certification in the Amazon basin, Congo basin and SE Asia.

Keywords :

Environmental Risk Assessments, forest management certification

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71. Typology of logging companies in the Brazilian Amazon

Martinez Santiago ¹, Sist Plinio ¹, Pereira Denys ²

After 20 years of labeling with a strong increase of certified surfaces all around the world, real advantages and inconveniences of a company certified with regard to a normal company are not well known. To make a correct assessment of the ecological, social and economic impacts of tropical forest certification, it is first essential to compare companies with similar profiles. This study focused in the Brazilian Amazonia, aimed to identify the different profiles of harvesting companies by the construction of a typology. We used the data collected by Imazon during a extensive assessment of the Brazilian amazon forest sector which main results were published in 2010. From the analysis of this data base, we compared the main characteristics of the uncertified forest companies with the 13 certified companies.

Keywords: Amazonian tropical forests, forest certification, evaluation, typology

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72. Monitoring selective logging in certified forest: a case study in North Congo (Brazzaville)

Desclée Baudouin and Mayaux Philippe

In the framework of the Sustainable Forest Management and the UN-REDD program, efficient tools are required for providing reliable and continuous information on changes in forest. The focus of forest monitoring is not only on deforestation process (conversion of forest into other land cover) but also on forest degradation, the area changes within forest land which leads to reduction in carbon stocks. Using remote sensing, many activities causing reduction of carbon stocks can be monitored, from selective logging to fuel wood collection. While many studies conducted on deforestation lead to satisfactory estimates of forest cover changes, a reliable assessment of forest degradation is still challenging to monitor and requires more sophisticated analytical techniques. Based on a satellite time series, this study aims at evaluating the forest changes over a certified forest concession in the North of the Republic of Congo. Different forest disturbances are identified thanks to satellite image analysis based on multivariate object-based approach. The information provided by the concession can be linked to the forest cover loss maps. This forest cover change monitoring approach is promising for improving global forest monitoring tools.

Keywords :

Forest changes, remote sensing, deforestation, forest degradation

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